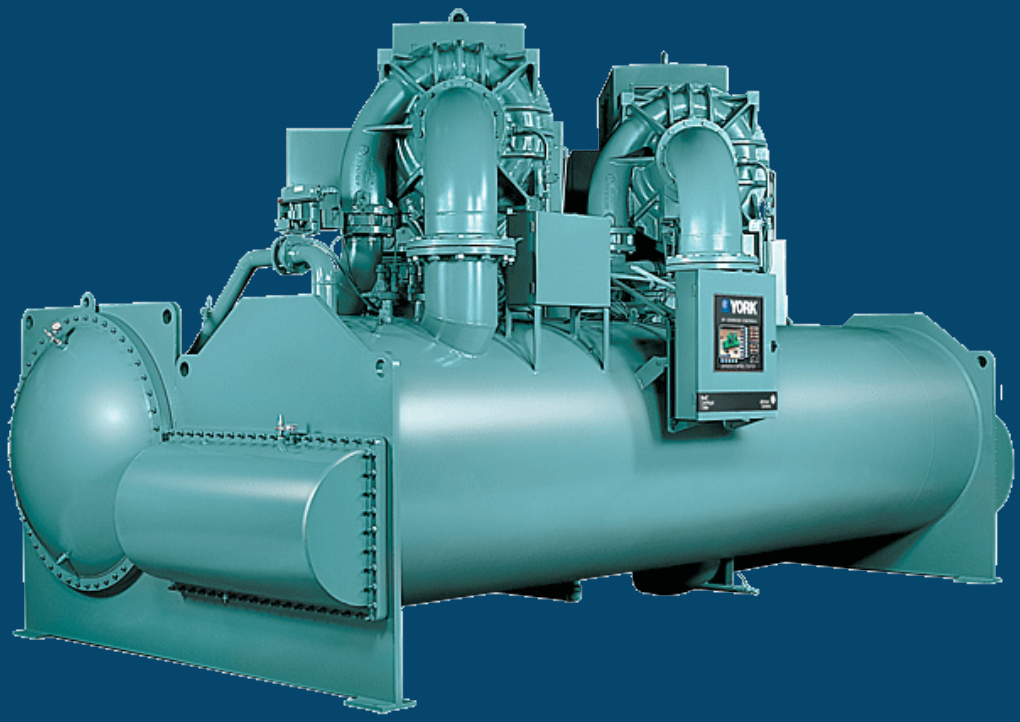
FORM 160.69-EG3 (815)

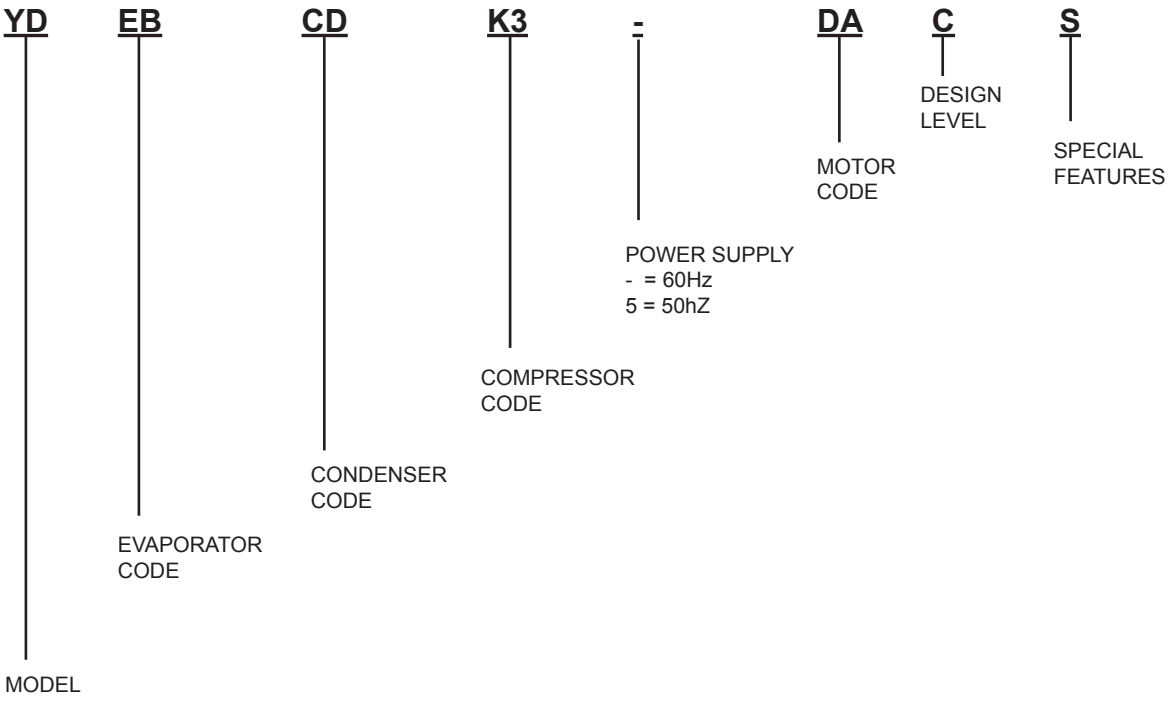
MODEL YD
DUAL CENTRIFUGAL COMPRESSOR CHILLERS
STYLE C

1500 - 6000 Tons
5265 - 21096 kW
Utilizing R-134a



YORK®
BY JOHNSON CONTROLS

Nomenclature



Approvals

- ASME Boiler and Pressure Vessel Code – Section VIII Division 1.
- AHRI Standard 550/590 (up to 3000 tons or 10,500 kW).
- UL 1995 – Heating and Cooling Equipment.
- ASHRAE 15 – Safety Code for Mechanical Refrigeration.
- ASHRAE Guideline 3 – Reducing Emission of Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.
- N.E.C. – National Electrical Code.
- OSHA – Occupational Safety and Health Act.

Table Of Contents

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Introduction

The YORK® YD™ chillers offer a complete combination of features for total owner satisfaction. The YD line of chillers utilize two YORK centrifugal compressors operating in parallel on a common set of heat exchanger shells to obtain large chiller capacities, and efficient part load operation.

MATCHED COMPONENTS MAXIMIZE EFFICIENCY

Actual chiller efficiency cannot be determined by analyzing the theoretical efficiency of any one chiller component. It requires a specific combination of heat exchanger, compressor, and motor performance to achieve the lowest system kW/ton. YORK YD chiller technology matches chiller system components to provide maximum chiller efficiency under actual – not just theoretical – operating conditions.

Off-design is not only part load, but full load operation as well, with reduced entering condenser water temperatures (ECWTs)

REAL WORLD ENERGY PERFORMANCE

Johnson Controls pioneered the term “Real World Energy” to illustrate the energy saving potential of focusing on chiller performance during off design conditions. Off design is not only part load, but full load operation as well, with reduced entering condenser water temperatures (ECWTs). This is where chillers operate 99% of the time, and where operating costs add up.

YORK YD chillers are the only chillers designed to operate on a continuous basis with cold ECWT and full condenser flow at all load points, taking full advantage of Real World conditions. This type of operation benefits the cooling tower as well; reducing cycling of the fan motor and ensuring good coverage of the cooling fill.

The YD dual compressor chiller provides further energy savings by running in single compressor mode at part loads of 50% and lower. The chiller operates more efficiently by running with a single more fully loaded compressor. The two compressors share a common refrigerant circuit, thereby utilizing the full heat transfer surface available for part load single compressor operation.

YORK YD chillers offer the most efficient Real World operation of any chiller, meaning lower operating costs and an excellent return on your chiller investment.

OPEN DRIVE DESIGN

Hermetic-motor burnout can cause catastrophic damage to a chiller. The entire chiller must be cleaned, and the refrigerant replaced. YORK YD centrifugal chillers eliminate this risk by utilizing air-cooled motors. Refrigerant never comes in contact with the motor, preventing contamination of the rest of the chiller.

Insurance companies that offer policies on large air conditioning equipment often consider air-cooled motors a significant advantage over hermetic refrigerant cooled units.

The YD chiller uses two motors, each roughly half the size of a motor used on an equivalent size single compressor chiller. By staggering the start of these motors, the starting in-rush current of each smaller motor is less (Electromechanical and Solid State Starter only). This

Introduction (Cont'd)

provides a lower burden on the building electrical system. Also, use of two smaller motors allows low voltage compressor drive motors to be applied on larger chillers. This can be an advantage for applications where medium voltage power sources are not available.

HIGH-EFFICIENCY HEAT EXCHANGERS

YD chiller heat exchangers offer the latest technology in heat transfer surface design to give you maximum efficiency and compact design. Waterside and refrigerant-side design enhancements minimize both energy consumption and tube fouling.

SINGLE-STAGE COMPRESSOR DESIGN AND EFFICIENCY PROVEN IN THE MOST DEMANDING APPLICATIONS

The YD chillers feature two variable speed drive oil pumps, monitoring and providing the right amount of oil flow to each compressor on a continuous basis.

Designed to be the most reliable chillers we've ever made, YORK YD centrifugal chillers incorporate single stage compressor design. With fewer moving parts and straightforward, efficient engineering, YORK single stage compressors have proven durability records in the U.S. Navy, hospitals, chemical plants, gas processing plants, and in other applications where minimal downtime is a crucial concern.

In thousands of installations worldwide, YORK single stage compressors are working to reduce energy costs. High strength aluminum alloy compressor impellers feature backward-curved vanes for high efficiency. Airfoil shaped pre-rotation vanes minimize flow disruption for the most efficient part load performance. Precisely positioned and tightly fitted, they allow the compressor to unload smoothly from 100% to minimum load for excellent operation in air conditioning applications.

PRECISION CONTROL OF COMPRESSOR OIL PRESSURE

Utilizing our expertise in variable speed drive technology and applications, Johnson Controls has moved beyond the fixed head and bypass approach of oil pressure control. The old approach only assures oil pressure at the outlet of the pump rather than at the compressor, and allows no adjustment during chiller operation. The YD chillers feature two variable speed drive oil pumps, monitoring and providing the right amount of oil flow to each compressor on a continuous basis. This design also provides sophisticated electronic monitoring and protection of the oil pump electrical supply, ensuring long life and reliable operation of the oil pump motor. Variable speed drive technology reduces oil pump power consumption, running only at the speed required, rather than at full head with a pressure regulating bypass valve.

FACTORY PACKAGING REDUCES FIELD LABOR COSTS

YORK YD centrifugal chillers are designed to keep installation costs low. Where installation access is not a problem, the K1 and K2 compressor size YD dual compressor chillers may be shipped completely packaged. In order to save on shipping and rigging costs, larger K3 to K7 compressor size units are disassembled into four major components: two drivelines, the evaporator, and the condenser. Piping break points are flanged, and wiring connections are simple plug connections to ensure a simple chiller commissioning utilizing a Variable Speed Drive or a factory-installed Solid-State Starter.

Introduction (Cont'd)

AHRI CERTIFICATION PROGRAM

YORK YD chillers have been tested and certified by Air- Conditioning, Heating and Refrigeration Institute (AHRI) in accordance with the latest edition of AHRI Standard 550/590 (I-P) & 551/591 (up to 3,000 tons or 10.550 kW) . Under this Certification Program, chillers are regularly tested in strict compliance with this Standard. This provides an independent, third-party verification of chiller performance. Refer to the AHRI site at: www.ahrinet.org/water_chilling+packages+using+vapor+compression+cycle+_water_cooled_.aspx for complete Program Scope, Inclusions, and Exclusions as some options listed herein fall outside the scope of the AHRI certification program. For verification of certification, go to the AHRI Directory at www.ahridirectory.org.

TAKE ADVANTAGE OF COLDER COOLING TOWER WATER TEMPERATURES

YORK YD centrifugal chillers have been designed to take full advantage of colder cooling tower water temperatures, which are naturally available during most operating hours. Considerable energy savings are available by letting tower water temperature drop, rather than artificially holding it above 75°F (23.9°C), especially at full load and full condenser flow, as some chillers require.

UL COMPLIANCE – YOUR ASSURANCE OF RELIABILITY

YORK YD centrifugal chillers are approved to UL Standard 1995 for listing by a qualified nationally recognized testing laboratory for the United States and Canada. Recognition of safety and reliability is your assurance of trouble free performance in day today building operation. Some chiller options or modifications may affect the UL compliance of the chiller. Some examples include: special motor enclosures (like TEFC, TEWAC, or TEAAC) or special panels (NEMA 4X) or special unit wiring options (anything other than NEMA 1). For further clarification, contact your local Johnson Controls Sales Office.

COMPUTERIZED PERFORMANCE RATINGS

Each chiller is custom-matched to meet the individual building load and energy requirements. Several standard heat exchanger tube bundle sizes and pass arrangements are available to provide the best possible match.

It is not practical to provide tabulated performance for each combination, as the energy requirements at both full and part load vary significantly with each heat exchanger and pass arrangement. Computerized ratings are available through each Johnson Controls Sales Office. These ratings can be tailored to specific job requirements.

Introduction (Cont'd)

OFF DESIGN PERFORMANCE

Since the vast majority of its operating hours are spent at off-design conditions, a chiller should be chosen not only to meet the full load design, but also for its ability to perform efficiently at lower loads and lower tower water temperatures. It is not uncommon for chillers with the same full load kW/ton to have an operating cost difference of over 10% due to part-load operation.

Part load information can be easily and accurately generated by use of the computer. And because it is so important to an owner's operating budget, this information has now been standardized within the AHRI Certification Program in the form of an Integrated Part Load Value (IPLV), and Non Standard Part Load Value (NPLV).

The IPLV/NPLV formulas from AHRI Standard 550/590 much more closely track actual chiller operations. A more detailed analysis must take into account actual building load profiles, and local weather data. Part load performance data should be obtained for each job using its own design criteria.

Sustainability Focus

OZONE-DEPLETION POTENTIAL (ODP)

The YORK YD chiller employs one of the most environmentally friendly refrigerants available today, HFC-134a, with no Ozone Depletion Potential (ODP) and no phase out date per the Montreal Protocol.

Ozone is a very small part of the atmosphere, but its presence is nevertheless vital to human well-being. Most ozone resides in the upper part of the atmosphere. This region, called the stratosphere, is more than 10 kilometers (6 miles) above the Earth's surface. There, about 90% of atmospheric ozone is contained in the "ozone layer," which shields us from harmful ultraviolet radiation from the sun. However, it was discovered in the mid-1970s that some human-produced chemicals could destroy ozone and deplete the ozone layer. The resulting increase in ultraviolet radiation at the Earth's surface may increase the incidences of skin cancer and eye cataracts. Following the discovery of this environmental issue, researchers focused on gaining a better understanding of this threat to the ozone layer.

Monitoring stations showed that ozone-depleting chemicals were steadily increasing in the atmosphere. These trends were linked to growing production and use of chemicals like chlorofluorocarbons (CFCs) for refrigeration and air conditioning, foam blowing, and industrial cleaning. Measurements in the laboratory and the atmosphere characterized the chemical reactions that were involved in ozone destruction. Computer models employing this information could predict how much ozone depletion was occurring and how much more could occur in the future.

The typical usage of the refrigerant, the phase-out status by the Montreal Protocol and the global usage of refrigerant in tons is shown in the table below.

REFRIGERANT		COMMON USE	ODP	GWP	STATUS	2007 GLOBAL USAGE (TONS)
CFC	CFC-11	Centrifugals	1.00	5000	Phased Out	Trace
	CFC-12	Centrifugals	0.80	8500	Phased Out	Trace
HCFC	HCFC-22	Scrolls, Screws, Unitary products	0.05	1700	Phasing Out	700,000
	HCFC-123	Centrifugals	0.02	120	Phasing Out	4,000
HFC	HFC-134a	Centrifugals, Screws	-	1300	No Phase Out	250,000
	HFC-407c	Screws, Scrolls	-	1600	No Phase Out	100,000
	HFC-410A	Scrolls, Unitary products	-	1890	No Phase Out	
	HFC-404A		-	3750	No Phase Out	
	HFC-245fa	Centrifugals	-	1020	No Phase Out	Trace
HFO	HFO-1234yf	Centrifugals	-	4	No Phase Out	New
HC (NATURAL REFR.)	HC-717 (NH3)	Screws, Centrifugals	-	1	No Phase Out	
	HC-718 (water)	Absorption, Vapor Compression	-	0	No Phase Out	
	HC-290 (propane)		-	3	No Phase Out	
	HC-600a (butane)		-	3	No Phase Out	
	HC-744 (CO2)		-	1	No Phase Out	

Sustainability Focus (Cont'd)

Observations of the ozone layer showed that depletion was indeed occurring. The most severe and most surprising ozone loss was discovered to be recurring in springtime over Antarctica. The loss in this region is commonly called the “ozone hole” because the ozone depletion is so large and localized. A thinning of the ozone layer also has been observed over other regions of the globe, such as the Arctic and northern middle latitudes. The work of many scientists throughout the world has provided a basis for building a broad and solid scientific understanding of the ozone depletion process. With this understanding, we know that ozone depletion is occurring and why. And, most important, we know that if ozone-depleting gases were to continue to accumulate in the atmosphere, the result would be more depletion of the ozone layer. In response to the prospect of increasing ozone depletion, the governments of the world crafted the 1987 United Nations Montreal Protocol as a global means to address this global issue. As a result of the broad compliance with the Protocol and its Amendments and Adjustments and, of great significance, industry’s development of “ozone friendly” substitutes for the now-controlled chemicals, the total global accumulation of ozone-depleting gases has slowed and begun to decrease. This has reduced the risk of further ozone depletion.

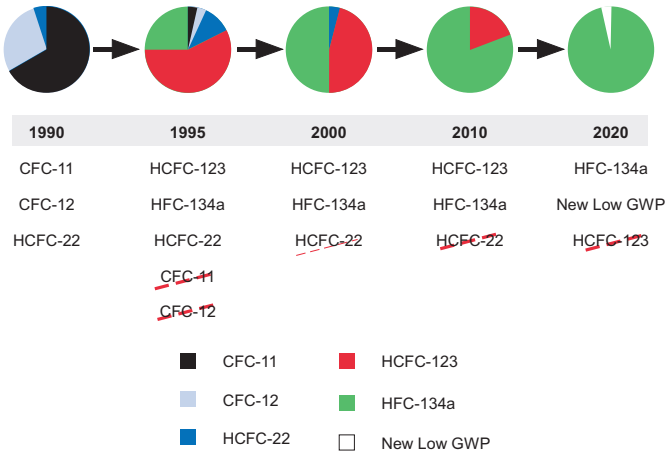
THE MONTREAL PROTOCOL ADDRESSED CFC’S AND HCFC’S

The Montreal Protocol (MP) addressed CFCs and HCFCs with phase out schedules for all member parties of the MP based on the ODP characteristics. So this affects the first two categories of refrigerants listed in the table. Manufacturers in developed nations are in the final processes of converting from HCFCs to HFCs in accordance with the Montreal Protocol treaty. Markets in developing countries are already seeing a transition away from HCFCs ahead of legislative requirements.

HCFCs were used as a transitional refrigerant as they were a “Lesser Evil” and allowed the HVAC industry to quickly transition away from CFCs while maintaining energy efficiency. The fact remains that they destroy the ozone layer and are legislated to be completely phased out.

The Montreal Protocol does not extend to HFCs as they have no ODP nor does it extend to natural refrigerants for the same reason.

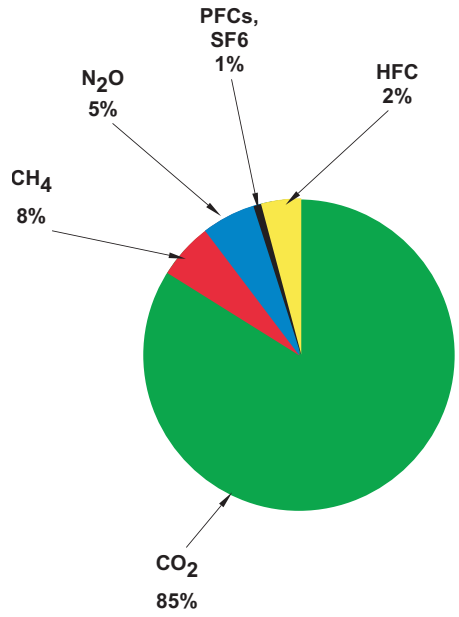
The chart below shows the growing use of HFC-134a in centrifugal chillers from 1995 up to 2010 and the forecast until the phase-out of HCFCs.



Sustainability Focus (Cont'd)

GLOBAL WARMING POTENTIAL (GWP)

Another main environmental topic is Global Warming potential (GWP), and when we talk about global warming we're primarily talking about smoke stacks and tail pipes. 85% of GWP is attributed to CO_2 emissions, while only about 2% is related to HFCs.

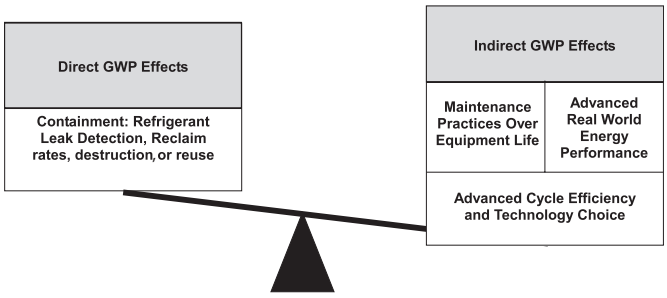


DIRECT & INDIRECT GLOBAL WARMING POTENTIAL

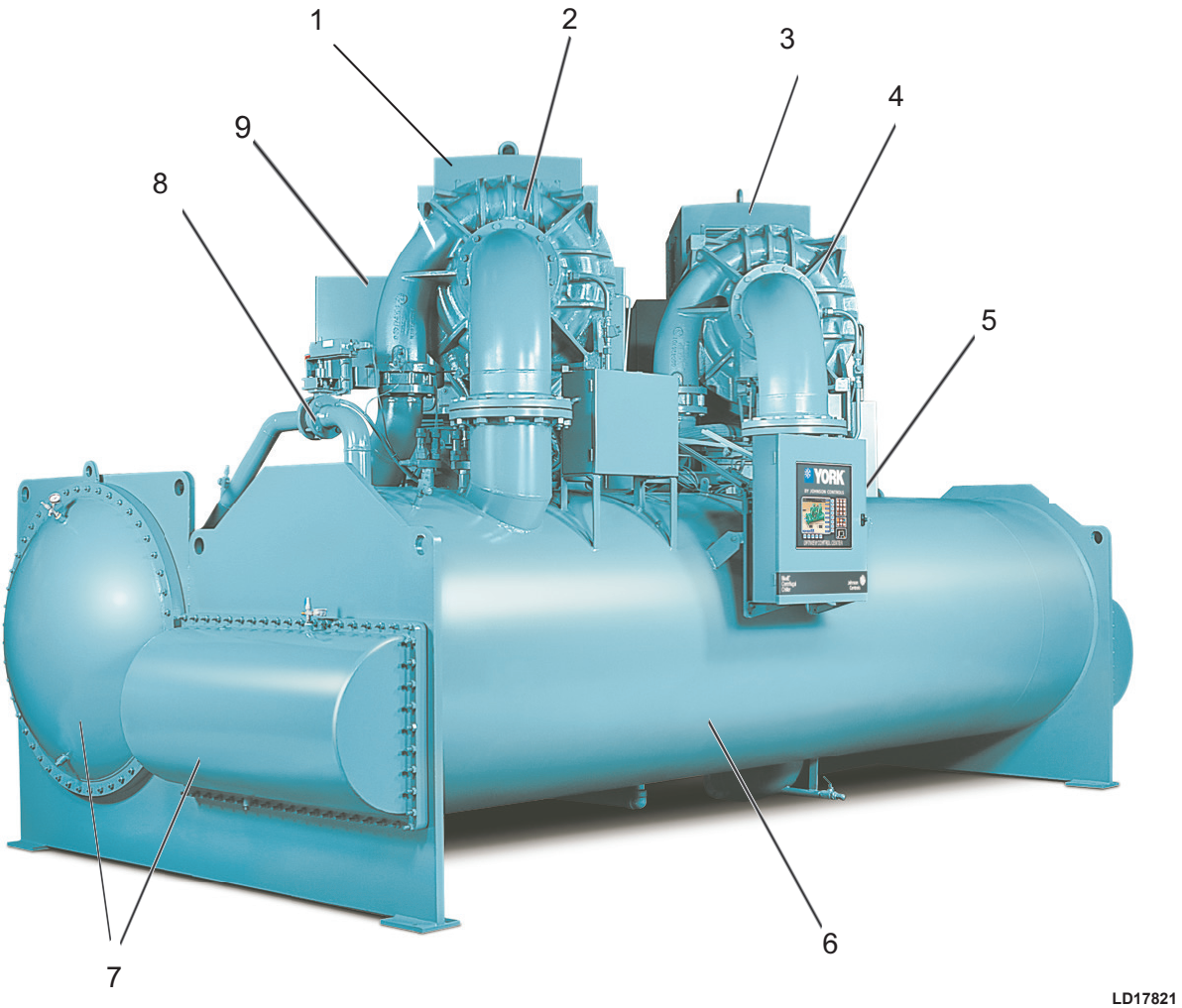
98% of the global warming potential of a centrifugal chiller is from the indirect effect or the greenhouse gases produced to generate the electricity to run the chiller. The YORK YD centrifugal chiller and its superior efficiency levels dramatically reduces the indirect GWP. Two percent of the GWP is from the direct effect or release of the refrigerant gases into the atmosphere.

Minimizing the total climatic impact (direct and indirect GWP) requires a comprehensive approach to refrigerant choice.

However, when we talk about the direct impact the YORK YD Centrifugal Chiller has on the environment we can make strides forward, like ensuring leak tight designs are created, and manufacturers are working to reduce refrigerant charges as much as possible.



Unit Components



LD17821

NUMBER	ITEM
1	SYSTEM 1 MOTOR
2	SYSTEM 1 COMPRESSOR
3	SYSTEM 2 MOTOR
4	SYSTEM 2 COMPRESSOR
5	OPTIVIEW CONTROL PANEL
6	EVAPORATOR
7	COMPACT WATERBOXES
8	HOT GAS BYPASS (OPTIONAL)
9	LOW VOLTAGE UNIT MOUNTED VSD (OPTIONAL)

Equipment Overview

The YORK YD Centrifugal Liquid Chillers are completely factory packaged including the evaporator, condenser, compressor, motor, lubrication system, and all interconnecting unit piping and wiring. Larger (K3 to K7 compressor) YD chillers are disassembled for shipment.

The initial charge of refrigerant and oil is supplied for each chiller. Actual shipping procedures will depend on a number of project specific details.

The services of a Johnson Controls factory-trained or field service representative are incurred to supervise or perform the final leak testing, charging, the initial start up, and concurrent operator instructions.

Lubrication oil is force-fed to all bearings, gears and rotating surfaces by a variable speed drive pump which operates prior to startup...

COMPRESSOR

Each compressor is a single-stage centrifugal type powered by an open-drive electric motor. The casing is fully accessible with vertical circular joints and fabricated of close-grain cast iron. The complete operating assembly is removable from the compressor and scroll housing.

The rotor assembly consists of a heat-treated alloy steel drive shaft and impeller shaft with a high strength, cast aluminum alloy, fully shrouded impeller. The impeller is designed for balanced thrust and is dynamically balanced and overspeed tested for smooth, vibration free operation.

The insert type journal and thrust bearings are fabricated of aluminum alloy and are precision bored and axially grooved. The specially engineered, single helical gears with crowned teeth are designed so that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears are integrally assembled in the compressor rotor support and are film lubricated. Each gear is individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces.

OPTISOUND™ CONTROL

The YORK OptiSound Control is a patented combination of centrifugal chiller hardware and software that reduces operational sound levels, expands the chiller operating range, and improves chiller performance. The OptiSound Control feature continuously monitors the characteristics of the compressor discharge gas and optimizes the diffuser spacing to minimize gas flow disruptions from the impeller. This innovative technology improves operating sound levels of the chiller an average of 7 dBA, and up to 13 dBA on the largest models. It can also reduce part load sound levels below the full load level.

In addition, the OptiSound Control provides the benefit of an expanded operating range. It improves performance and reliability by minimizing diffuser gas stall at off design operation, particularly conditions of very low load combined with little or no condenser water relief. The elimination of the gas stall condition can also result in improved chiller efficiency at off design conditions.

Equipment Overview (Cont'd)

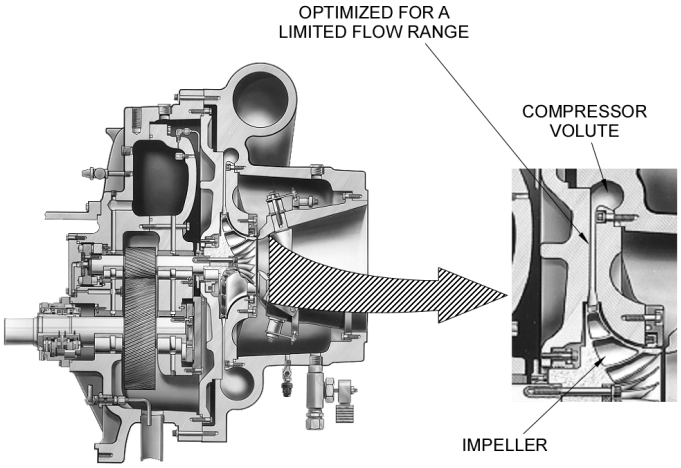


FIGURE 1 - TYPICAL OPTIMIZED CENTRIFUGAL COMPRESSOR

CAPACITY CONTROL

Pre rotation vanes (PRV) in each compressor modulate chiller capacity from 100% to 10% of design for normal air conditioning applications. Operation is by an external, electric PRV actuator which automatically controls the vane position to maintain a constant leaving chilled liquid temperature. Rugged airfoil shaped cast manganese bronze vanes are precisely positioned by solid vane linkages connected to the electric actuator.

Both compressors are operated when needed to satisfy the building load. At loads below 50%, a single compressor is able to handle the load more efficiently.

For units equipped with Variable Speed Drives (VSD), the capacity control will be achieved by the combined use of variable speed control and pre-rotation vanes (PRV) to provide fully modulating control from maximum to minimum load. For each condition the speed and the PRV position will be automatically optimized to maintain a constant leaving chilled liquid temperature.

LUBRICATION SYSTEM

Lubrication oil is force-fed to all bearings, gears and rotating surfaces by a variable speed drive pump which operates prior to startup, continuously during operation and during coast down. A gravity-fed oil reservoir is built into the top of each compressor to provide lubrication during coast down in the event of a power failure.

A common oil reservoir is mounted below the dual compressors. The reservoir contains a 2 HP submersible oil pump for each compressor. Each pump is built into a removable cover, one at each end of the reservoir.

Two 2 kW immersion oil heaters are provided, one mounted in each pump cover. The heaters are thermostatically controlled from the sump oil temperature sensor.

Equipment Overview (Cont'd)

A refrigerant cooled oil cooler is provided after each oil pump, eliminating the need for field water piping. A thermostatically controlled expansion valve maintains the required oil temperature supply from each oil cooler to its compressor. Oil is filtered by externally mounted ½ micron replaceable cartridge oil filters, equipped with service valves. An automatic oil return system recovers any oil that may have migrated to the evaporator. Oil piping is completely factory installed.

MOTOR DRIVELINE

The compressor motors are open drip-proof, squirrel cage, induction type constructed to YORK design specifications. 60 hertz motors operate at 3570 rpm. 50 hertz motors operate at 2975 rpm.

The open motor is provided with a D-flange, and is factory mounted to a cast iron adaptor mounted on the compressor. This unique design allows the motor to be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.

Motor drive shaft is directly connected to the compressor shaft with a flexible disc coupling. Coupling has all metal construction with no wearing parts to assure long life, and no lubrication requirements to provide low maintenance.

A large, steel terminal box with gasketed front access cover is provided on each motor for field connected conduit. There are six terminals (three for medium voltage) brought through the motor casing into the terminal box. Jumpers are furnished for three lead types of starting. Motor terminal lugs are not furnished. Overload/over current transformers are furnished with all units.

HEAT EXCHANGERS

Shells

Evaporator and condenser shells are fabricated from rolled carbon steel plates with fusion welded seams. Carbon steel tube sheets, drilled and reamed to accommodate the tubes, are welded to the end of each shell. Intermediate tube supports are fabricated from carbon steel plates, drilled and reamed to eliminate sharp edges, and spaced no more than four feet apart. The refrigerant side of each shell is designed, tested, and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Division I, or other pressure vessel code as appropriate.

Tubes

Heat exchanger tubes are state of the art, high efficiency, externally and internally enhanced type to provide optimum performance. Tubes in both the evaporator and condenser are 3/4" or 1” O.D. copper alloy and utilize the “skip fin” design, providing a smooth internal and external surface at each intermediate tube support. This provides extra wall thickness (up to twice as thick) and non work hardened copper at the support location, extending the life of the heat exchangers. Each tube is roller expanded into the tube sheets providing a leak proof seal, and is individually replaceable.

Equipment Overview (Cont'd)

Evaporator

The evaporator is a shell and tube, flooded type heat exchanger. A distributor trough provides uniform distribution of refrigerant over the entire shell length to yield optimum heat transfer. Mesh eliminators are located above the tube bundle to prevent liquid refrigerant carryover into the compressor. A 1.5" (38mm) liquid level sight glass is conveniently located on the side of the shell to aid in determining proper refrigerant charge. The evaporator shell contains a single relief valve arrangement set at 180 psig (12.4 barg). A 1" refrigerant charging valve is provided.

Condenser

The condenser is a shell and tube type, with discharge gas diffuser to prevent direct high velocity impingement on the tubes. The diffusers provide dynamic pressure recovery and enhanced chiller efficiency. An integral sub-cooler is located at the bottom of the condenser shell providing highly effective liquid refrigerant subcooling to provide the highest cycle efficiency. The condenser contains dual refrigerant relief valves set at 235 psig (16.2 barg).

Water Boxes

The removable water boxes are fabricated of steel. The design working pressure is 150 psig (10.3 barg) and the boxes are tested at 225 psig (15.5 barg). Integral steel water baffles are located and welded within the water box to provide the required pass arrangements. Stub-out water nozzle connections with ANSI/AWWA C-606 couplings grooves are welded to the water boxes. These nozzle connections are suitable for ANSI/AWWA C-606 couplings, welding or flanges, and are capped for shipment. Plugged drain and vent connections are provided in each water box.

WATER FLOW SWITCHES

Thermal-type water flow switches are factory mounted in the chilled and condenser water nozzles, and are factory wired to the OptiView control panel. These solid state flow sensors have a small internal heating element. They use the cooling effect of the flowing fluid to sense when an adequate flow rate has been established. The sealed sensor probe is 316 stainless steel, which is suited to very high working pressures.

REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator is controlled by the YORK variable orifice control system. Liquid refrigerant level is continuously monitored to provide optimum subcooler, condenser and evaporator performance. The variable orifice electronically adjusts to all real world operating conditions, providing the most efficient and reliable operation of refrigerant flow control.

COMPRESSOR DISCHARGE VALVES

Automated valves are provided in the discharge of each compressor. The discharge valve ensures that there is no backspin of the non running compressor when the chiller is in single compressor operating mode. These valves are cycled by the control panel during the start and stop sequence of the lag (2nd) compressor.

ISOLATION MOUNTING

The unit is provided with vibration isolation mounts of nominal 1" operating height. The pads have a neoprene pad to contact the foundation, bonded to a steel plate. The vibration isolation pads assemblies mount under steel plates affixed to the chiller tube sheets.

Equipment Overview (Cont'd)

REFRIGERANT CONTAINMENT

The standard unit has been designed as a complete and compact factory packaged chiller. As such, it has minimum joints from which refrigerant can leak. The entire assembly has been thoroughly leak tested at the factory prior to shipment. The YORK chiller includes service valves conveniently located to facilitate transfer of refrigerant to a remote refrigerant storage/recycling system.

PAINT

Exterior surfaces are protected with one coat of Caribbean blue, durable alkyd-modified, vinyl enamel, machinery paint.

SHIPMENT

K1 and K2 compressor size units may ship as a complete assembly. K3 to K7 compressor size units are disassembled for shipment. The two drivelines are removed and skidded. The evaporator and condenser shells are split. The control center, oil pump panel and wire remain mounted on the evaporator shell. The oil sump housing remains attached to the condenser. Connections are closed and the heat exchanger refrigerant sides are charged with nitrogen. Electrical boxes and the motor openings are covered with shrink wrap plastic.

OptiView Control Center

NOTE: Please refer to the OptiVew Control Center Operator's Manual for a complete description of features and functionality.

The YORK OptiView Control Center is a factory mounted, wired and tested microprocessor based control system for HFC-134a centrifugal chillers. For the YD, it controls the leaving chilled liquid temperature and limits the motor current via control of the Variable Speed Drive (VSD) (if used).

LD19212

The panel comes configured with a full screen LCD Graphic Display mounted in the middle of a keypad interface with soft keys, which are redefined with one keystroke based on the screen displayed at the time. The graphic display allows the presentation of several operating parameters at once. In addition, the operator may view a graphical representation of the historical operation of the chiller as well as the present operation. For the novice user, the locations of various chiller parameters are clearly and intuitively marked. Instructions for specific operations are provided on many of the screens. To prevent unauthorized changes of set points and operating conditions, security access is provided with three different levels of access and passwords.

The graphic display also allows information to be represented in both English (temperatures in °F and pressures in PSIG) and Metric (temperatures in °C and pressures in kPa) mode. The advantages are most apparent, however, in the ability to display many languages.

The Control Center continually monitors the system operation and records the cause of any shutdowns (Safety, Cycling or Normal). This information is recorded in memory and is preserved even through a power failure condition. The user may recall it for viewing at any time. During operation, the user is continually advised of the operating conditions by various status and warning messages. In addition, it may be configured to notify the user of certain conditions via alarms. The Control Center expands the capabilities of remote control and communications. By providing a common networking protocol through the

OptiView Control Center (Cont'd)

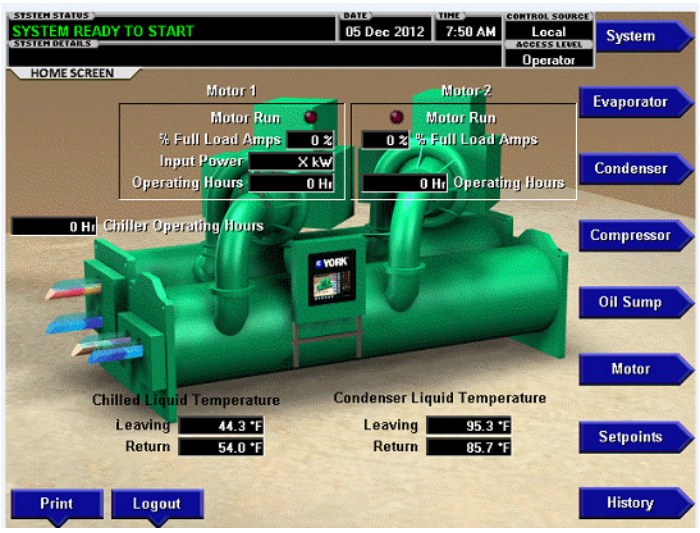
Building Automation System (BAS), YORK Chillers not only work well individually, but also as a team. This new protocol allows increased remote control of the chiller, as well as 24 hour performance monitoring via a remote site. In addition, compatibility is maintained with the present network of BAS communications. The chiller also maintains the standard digital remote capabilities as well. Both of these remote control capabilities allow for the standard Energy Management System (EMS) interface:

- Remote Start
- Remote Stop
- Remote Leaving Chilled Liquid Temperature Setpoint adjustment (0 to 10VDC, 2 to 10VDC, 0 to 20mA or 4 to 20mA or Pulse Width Modulation)
- Remote Current Limit Setpoint adjustment (0 to 10VDC, 2 to 10VDC, 0 to 20mA or 4 to 20mA or Pulse Width Modulation)
- Remote READY TO START Contacts
- Safety Shutdown Contacts
- Cycling Shutdown Contacts

The following are examples of the information displayed on some of the more important screens:

SYSTEM SCREEN

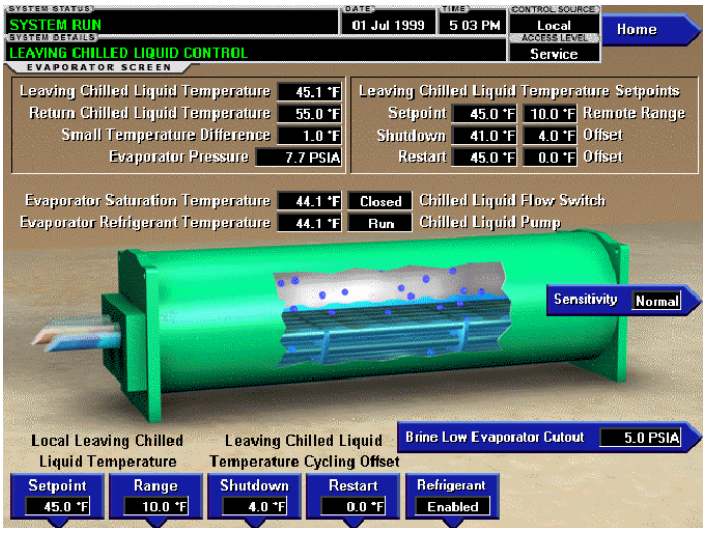
This screen gives a general overview of common chiller parameters.



OptiView Control Center (Cont'd)

EVAPORATOR SCREEN

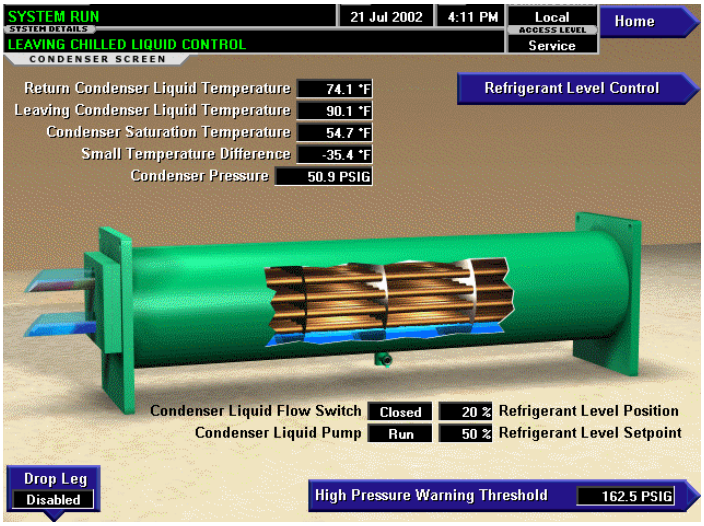
This screen displays a cutaway view of the chiller evaporator. All setpoints relating to the evaporator side of the chiller are maintained on this screen. Animation of the evaporation process indicates whether the chiller is presently in a RUN condition (bubbling) and liquid flow in the pipes is indicated by alternating shades of color moving in and out of the pipes.



00301vipc

CONDENSER SCREEN

This screen displays a cutaway view of the chiller condenser. All setpoints relating to the condenser side of the chiller are maintained on this screen. Animation indicates condenser liquid flow.

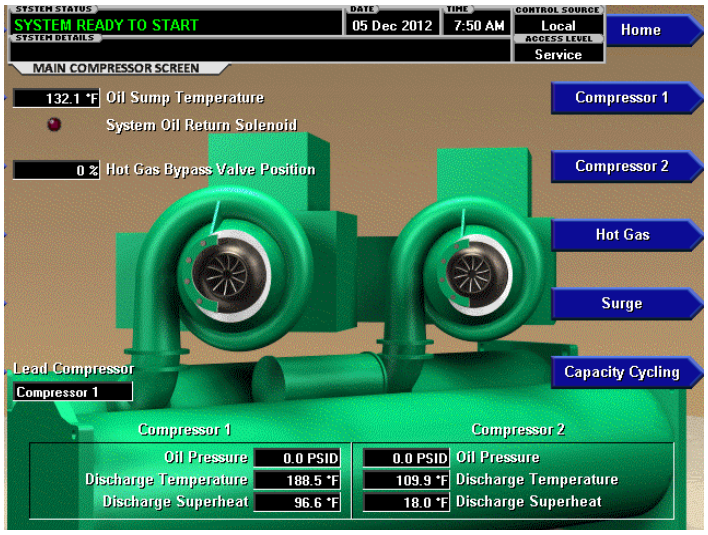


LD08603

OptiView Control Center (Cont'd)

COMPRESSOR SCREEN

This screen displays a cutaway view of the chiller compressors, revealing the impellers, and shows all conditions associated with the compressor. Animation of the compressor impeller indicates whether the chiller is presently in a RUN condition. This screen also serves as a gateway to subscreens Hot Gas Bypass, Surge Protection, Compressor Capacity Cycling Setup and viewing and calibration of individual compressor functions.



LD18362

VARIABLE GEOMETRY DIFFUSER SCREEN

This screen can be accessed from the compressor screen and gives the basic stall, position, and pressure details.

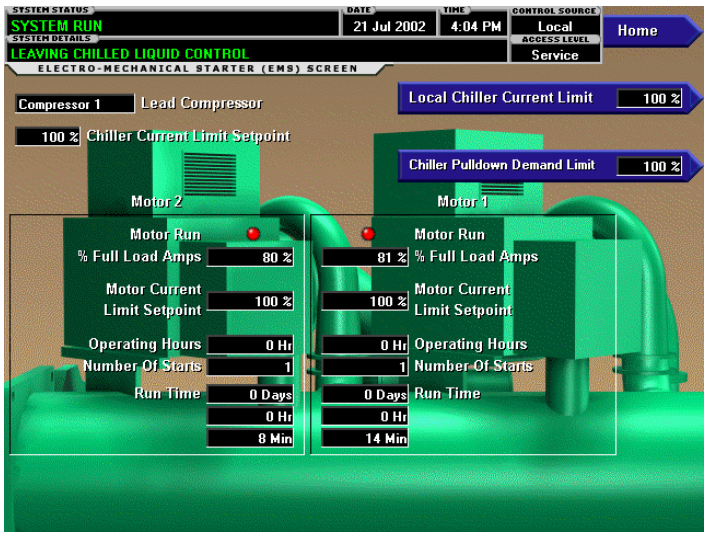
LD18363

OptiView Control Center (Cont'd)

STARTER SCREEN

This screen displays all information pertaining to the YORK Electro-Mechanical Starter, Solid-State Starter or a Variable Speed Drive Screen depending on chiller configuration .

Electro-Mechanical Starter (EMS)



LD08624

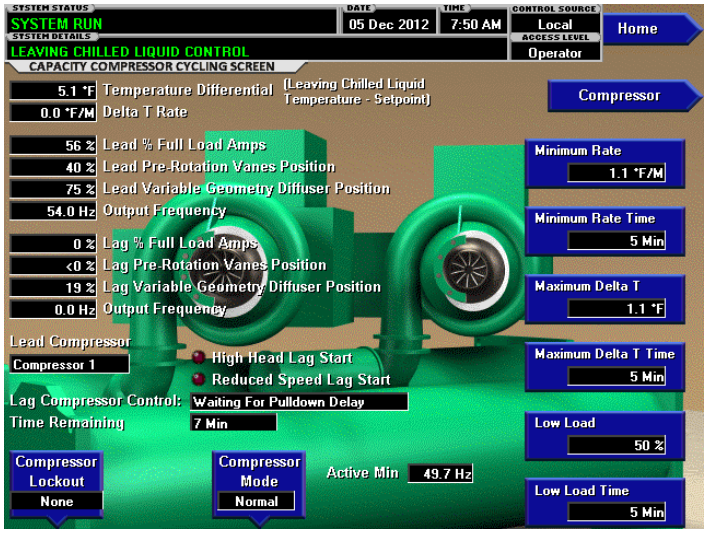
Low Voltage Variable Speed Drive (VSD)

LD18364

OptiView Control Center (Cont'd)

CAPACITY CONTROL SCREEN

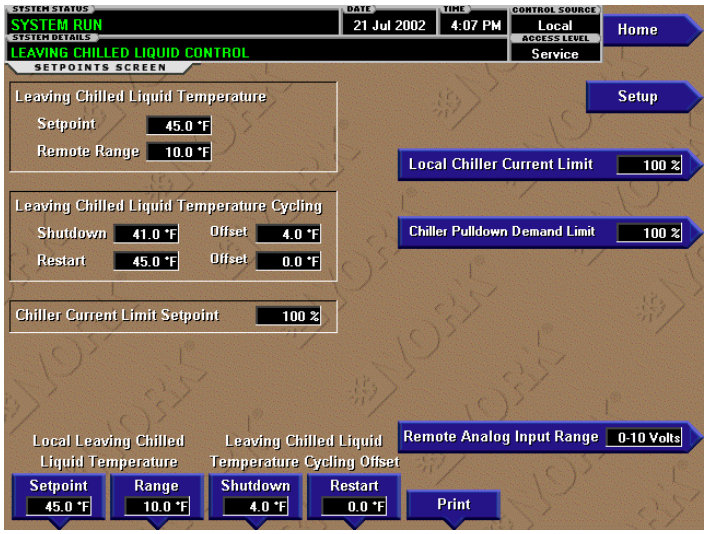
This screen allows the user to specify the chiller load conditions under which the lag compressor is cycled on and off. Both compressors are not started at the same time. The lead compressor is started first. If it does not meet the load requirements as established with the following setpoints, the lag compressor is started. After the lag compressor is running, it will be shutdown if the load decreases to the point established by the following setpoints.



LD18365

SETPOINTS SCREEN

This screen provides a convenient location for programming the most common chiller control setpoints. Changing setpoints and setup requires proper password access. This screen also serves as a gateway to a subscreen for defining the setup of general system parameters.

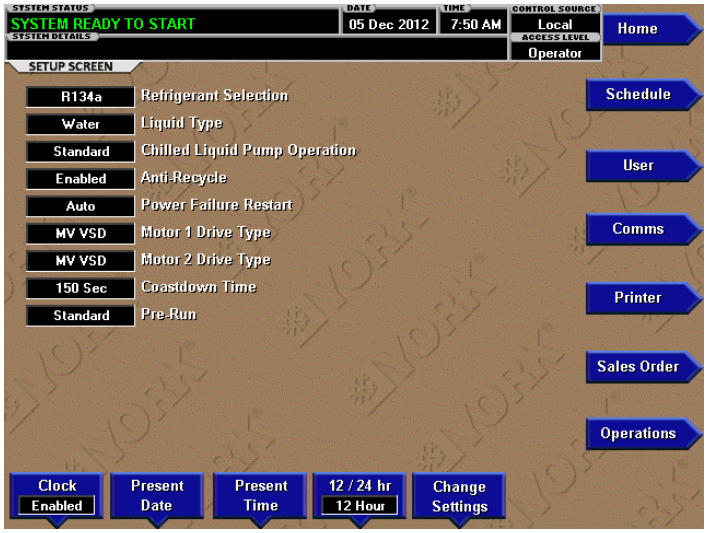


LD08625

OptiView Control Center (Cont'd)

SETUP SCREEN

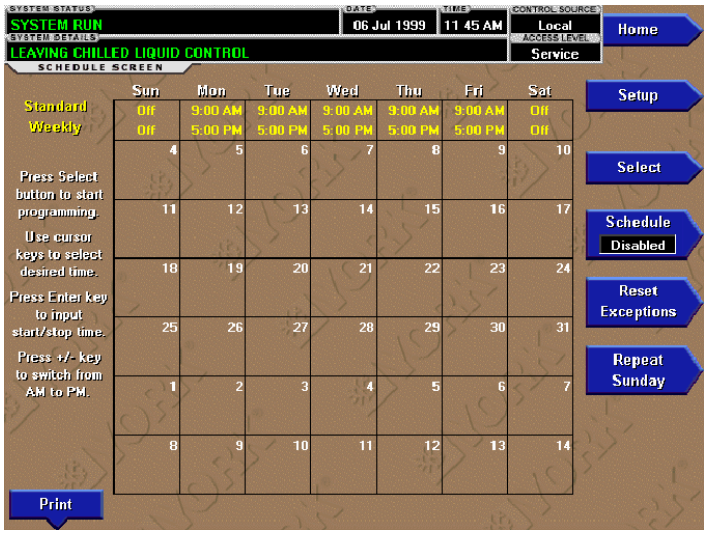
This screen is the top level of the general configuration parameters. It allows programming of the time and date, along with specifications as to how the time will be displayed. In addition, the chiller configuration as determined by the microprocessor and program switches is displayed.



LD18366

SCHEDULE SCREEN

This screen allows the user to program the Start/Stop times for any day of the week up to 6 weeks in advance. The user also has the ability to define a standard set of Start/Stop times that are utilized every week or specify exceptions to create a special week.

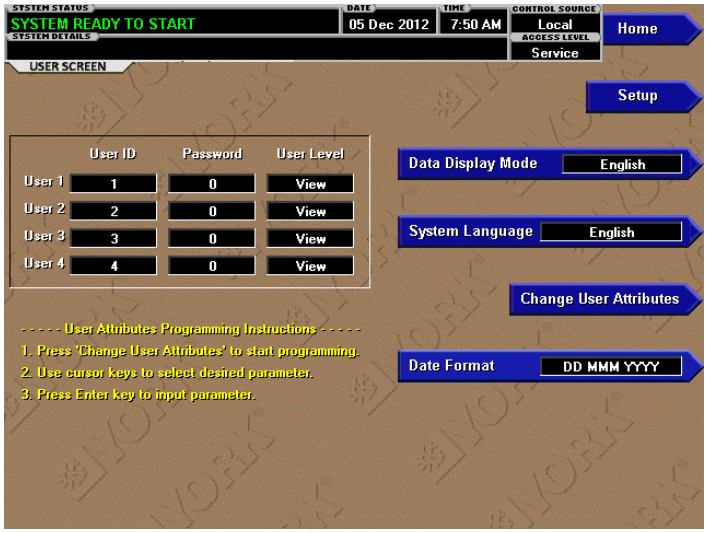


00331vipc

OptiView Control Center (Cont'd)

USER SCREEN

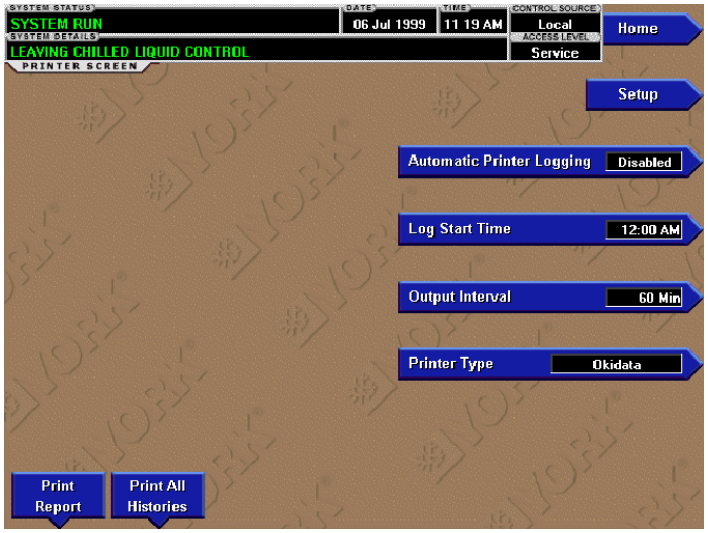
This screen allows definition of the language for the chiller to display and defines the unit of measure.



LD18367

PRINTER SCREEN

This screen allows definition of the necessary communications parameters for the printer. A printer or a PC can be connected to gather status reports, event logs, and history reports.

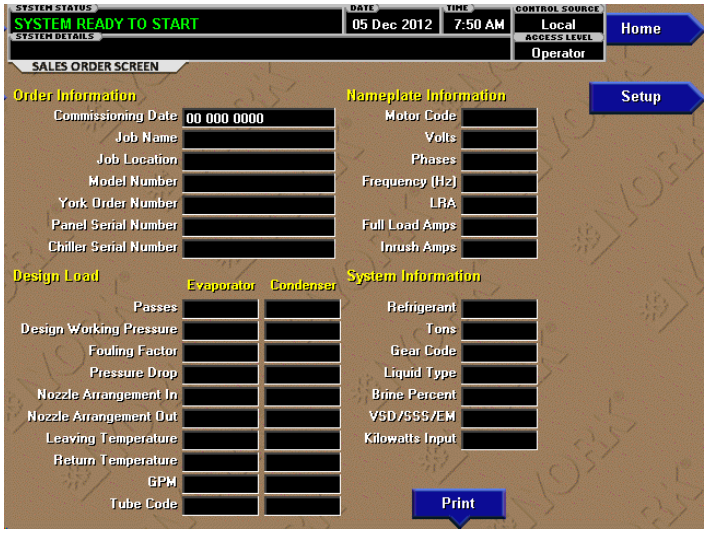


00319vipc

OptiView Control Center (Cont'd)

SALES ORDER SCREEN

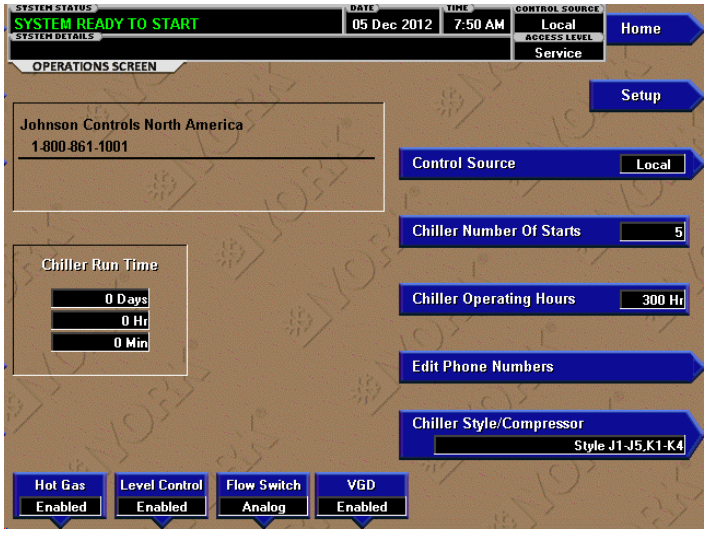
This screen displays the order parameters. This information is loaded at the factory or by the installation/service technician.



LD18368

OPERATIONS SCREEN

This screen allows definition of parameters related to the operation of the chiller. This includes the control source (Local, Digital Remote, Analog Remote, Modem Remote or BAS Remote). Also displayed is Run Time, Operating Hours, and number of starts for the chiller.



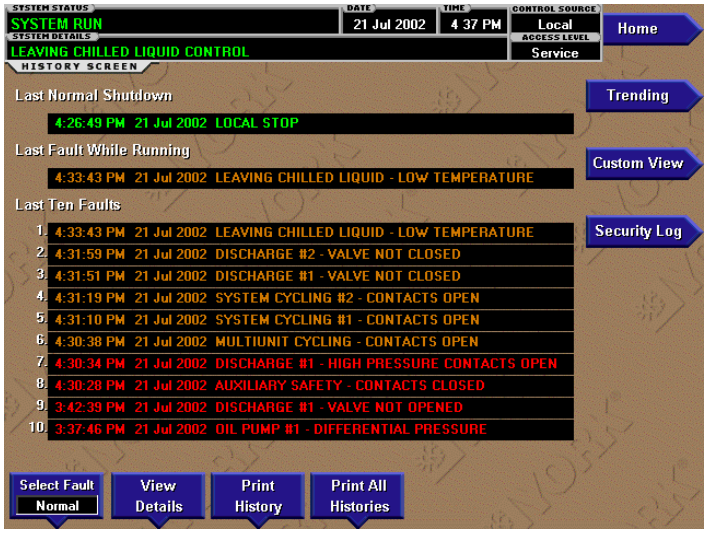
LD18368

OptiView Control Center (Cont'd)

HISTORY SCREEN

This screen allows the user to browse through the last ten faults; either safety or cycling shutdowns with the conditions while the chiller is running or stopped. The faults are color coded for ease in determining the severity at a glance, recording the date, time and description.

The OptiView Control Center continually monitors the operating system displaying and recording the cause of any shutdowns (Safety, Cycling or Normal). The condition of the chiller is displayed at the System Status line that contains a message describing the operating state of the chiller; whether it is stopped, running, starting or shutting down. A System Details line displays Warning, Cycling, Safety, Start Inhibit and other messages that provide further details of Status Bar messages. Messages are color-coded: Green – Normal Operations, Yellow - Warnings, Orange – Cycling Shutdowns, and Red – Safety Shutdowns. These aid in identifying problems quickly.



LD18369

OptiView Control Center (Cont'd)

TRENDING SCREEN

On this screen, up to 6 user-selected parameters selected from a list of over 140, can be plotted in a time-line graph format. The graph can be customized to record points once every second up to once every hour. There are two types of charts that can be created: a single or continuous screen. The single screen collects data for one screen width (450 data points across the X-axis) then stops. The continuous screen keeps collecting the data but the oldest data drops off the graph from left to right at the next data collection interval. For ease of identification, each plotted parameter, title and associated Y-axis labeling is color coordinated.

LD00472VIPC

Starters and Drives

JOHNSON CONTROLS OPTISPEED™ DRIVE STARTER

When a YORK YD chiller is equipped with a variable speed drive, It is designed to vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic automatically adjusts motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller.

The variable speed drive was specifically developed for commercial air-conditioning applications. No one matches Johnson Controls experience in the application of variable speed drive technology to chillers. Since pioneering the concept in 1978, Johnson Controls has installed more variable speed drive chillers than all other chiller manufacturers combined.

Variable speed drives will save in both single-chiller installations and multiple-chiller installations. In multiple-chiller installations, cycling chillers off as the building load falls will result in higher loads on the remaining chillers. This would seem to reduce the opportunity for drives to save energy. However, even though chiller loads remain high, entering condenser-water temperature has most likely fallen. And, reductions in entering condenser water temperature offer a far greater potential to enhance chiller efficiency than load reductions do. Therefore, variable speed drive will deliver major energy savings in multiple-chiller plants, too.

The OptiSpeed Drive is available for low and medium voltage options for the compressor motor (See Table 1, below).

TABLE 1 - OPTISPEED DRIVE STARTER OPTION

LOW VOLTAGE STARTERS								
UNIT MOUNTED	60 Hz				50 Hz			
	380V		460V		380V	400V	415V	
	X		X		X	X	X	
60 HZ MEDIUM VOLTAGE STARTERS								
FLOOR MOUNTED	2300V	3300V	4000V	4160V	6000V	6600V	12470V	13200V
	X	X	X	X	O	O	O	O
50 HZ MEDIUM VOLTAGE STARTERS								
FLOOR MOUNTED	2300V	3000V	3300V	6000V	6600V	10000V	11000V	
	X	X	X	O	O	O	O	

O=Available by Special Quotes (SQ)

LOW VOLTAGE OPTISPEED DRIVE

The Low Voltage OptiSpeed variable speed drive is factory-packaged and mounted on the YORK YD chiller. It is designed to vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic automatically adjusts motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller.

The variable speed drive is mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory-installed. Electrical lugs for incoming power wiring are provided.

Starters and Drives (Cont'd)

The variable speed drive provides automatic displacement power factor correction to 0.95 or better at all load conditions. Separate displacement power factor correction capacitors are not required. The displacement power factor is 0.98 or better when the optional harmonic filter is provided. See Table 2 for additional advantages of variable speed drives.

TABLE 2 - LOW VOLTAGE OPTISPEED VARIABLE SPEED DRIVE

STARTER TYPE	ADVANTAGES
OPTISPEED VARIABLE SPEED DRIVE (LOW VOLTAGE)	Lowest chiller life cycle through part load energy savings. Application-specific designs enable efficient, precise load control and seamless integration with equipment control panel and BAS. Soft start with input current less than full load current. Smooth acceleration reduces stresses on motor and driveline. Reduces compressor sound levels at most operating conditions. Rugged and reliable with no moving parts. IEEE-519 2014 compliant if used with an optional harmonic filter.

Standard features include: a door interlocked lockable circuit breaker; UL/cUL listed ground fault protection; over-voltage and under-voltage protection; 3-phase sensing motor over-current protection; single-phase protection; insensitive to phase rotation; over-temperature protection; digital readout at the OptiView Control Center of:

- Output Frequency
- Output Voltage
- 3-phase output current
- Input Power (kW)
- Self diagnostic service parameters
- Kilowatt-Hours (kWh)

An optional harmonic filter limits electrical power supply distortion from the variable speed drive to help the building comply with the guidelines of IEEE- 519 2014. The filter is unit mounted within the same NEMA-1 enclosure and is UL listed. The following digital readout is standard with the optional filter:

- Input kVA
- Total power-factor
- 3-phase input voltage
- 3-phase input current
- 3-phase input voltage total harmonic distortion (THD)
- 3-phase input current total demand distortion (TDD)
- Self-diagnostic service parameters

Starters and Drives (Cont'd)

MEDIUM VOLTAGE OPTISPEED DRIVE

A variable speed drive is factory-packaged and configured for easy remote mounting. It is designed to vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic automatically adjusts motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller.

The variable speed drive is mounted in a NEMA-1 enclosure and comes with a certification label from a nationally recognized testing laboratory. The connection points between the drive and chiller are factory labeled. Electrical lugs for incoming power wiring are **NOT** provided.

The variable speed drive provides automatic displacement power factor correction to 0.98 or better at all load conditions. Separate displacement power factor correction capacitors are not required.

Standard features include: a lockable door interlocked disconnect switch; UL listed ground fault protection; over-voltage and under-voltage protection; 3-phase sensing motor over-current protection; single-phase protection; insensitive to phase rotation; over-temperature protection; digital readout at the Control Center of:

- Output frequency
- 3-phase output voltage
- 3-phase output current
- Input power (kW)
- Self diagnostic service parameters
- Kilowatt-hours (kWh)
- Input KVA
- Total power-factor
- 3-phase input voltage
- 3-phase input current
- Self diagnostic service parameters

The 24 pulse design limits the electrical power supply distortion from the variable speed drive to comply with the guidelines of IEEE- 519 2014.

TABLE 3 - MEDIUM VOLTAGE OPTISPEED VARIABLE SPEED DRIVE

STARTER TYPE	ADVANTAGES
OPTISPEED VARIABLE SPEED DRIVE (MEDIUM VOLTAGE)	Lowest chiller life cycle through part load energy savings. Application-specific designs enable efficient, precise load control and seamless integration with equipment control panel and BAS. Soft start with input current less than full load current. Smooth acceleration reduces stresses on motor and driveline. Reduces compressor sound levels at most operating conditions. Rugged and reliable with no moving parts. IEEE-519 2014 compliant. No optional filter needed. Multi-level PWM output closely simulates a true sine wave, allowing the use of standard motors and bearings.

Starters and Drives (Cont'd)

MEDIUM VOLTAGE SOLID-STATE STARTER

The Medium Voltage Solid-State Starter is a reduced voltage in-line bypass starter that controls and maintains a constant current flow to the motor during startup. Available for 2300 - 4160 volts (see Table 4), the starter enclosure is NEMA-1, with a hinged access door with lock and key. Electrical lugs for incoming power wiring are not provided.

TABLE 4 - SOLID-STATE STARTER (MEDIUM VOLTAGE)

STARTER TYPE	ADVANTAGES
UNIT MOUNTED	Smooth, controlled start profile. Unit mounted, factory wired and tested. Rugged and reliable with no moving parts. Application-specific designs enable seamless integration with equipment control panel and BAS.

Standard Features include digital readout at the Control Center of the following:

Display Only

- 3-phase input voltage
- 3-phase current
- Input Power (kW)
- Kilowatt-Hours (KWH)
- Starter Model
- Motor Run (LED)
- Motor Current % Full Load Amps
- Current Limit Setpoints
- Pulldown Demand Time Left

Programmable

- Local Motor Current Limit
- Pulldown Demand Limit
- Pulldown Demand Time

Other features include: low line voltage; 115V control transformer; three-leg motor current sensing overloads; phase rotation and single-phase failure protection; high temperature safety protection; motor current imbalance and under-voltage safeties; open and shorted SCR protection; momentary power interruption protection. The Solid-State Starter is air cooled generating about the same heat as an auto-transformer E-M starter. Ground fault protection and surge protection are also standard features. The 50,000 amp short circuit withstand rating is in accordance with UL Standard 508. See Table 5 for availability of Solid-State Starters.

Starters and Drives (Cont'd)

TABLE 5 - MEDIUM VOLTAGE SOLID-STATE STARTER

MEDIUM VOLTAGE SOLID-STATE STARTER	60 HZ				50 HZ
	2300V	3300V	4000V	4160V	3300V
FLOOR MOUNTED	X	X	X	X	X

ELECTRO-MECHANICAL STARTER - (FIELD-INSTALLED)

A field installed, electro-mechanical compressor motor starter assembly is available, selected for proper size and type for job requirements and in accordance with YORK Engineering Standard (R-1137) for Starters. The starter assembly has contactors and accessories for controlling the two compressor motors per chiller.

Characteristics

For comparison purposes, here is a description of some of the general characteristics of electromechanical starters. Until the development of the Solid State Starter, all centrifugal chillers required the use of starters using electro-mechanical contactors, which are limited to operating totally ON, or totally OFF. There was no alternative to this mechanical equipment with its inability to control applied voltage or power. This contrasts markedly with the YORK Medium Voltage Solid State Starter which automatically maintains a predetermined current during starting, regardless of variations in line voltage or motor load, to give optimum acceleration without surges. Even with the addition of transformers, reactors, resistors and additional contactors, timers and relays, the mechanical controllers offer limited adjustment, no positive control during starting and impose an objectionable transition spike. Some also require modified motors. A field-installed, electro-mechanical compressor motor starter is available, selected for proper size and type for job requirements and in accordance with Johnson Controls Engineering Standard (R-1137) for Starters. See Table 6.

TABLE 6 - ELECTRO-MECHANICAL STARTER

STARTER OPTIONS	LOW VOLTAGE / FREQUENCY							
LV ACROSS THE LINE (FLOOR MOUNTED)	60Hz					50Hz		
	380V	440V	460V	480V	575V	380V	400V	415V
	X	X	X	X	X	X	X	X
LV STAR-DELTA CLOSED (FLOOR MOUNTED)	60Hz					50Hz		
	380V	440V	460V	480V	575V	380V	400V	415V
	X	X	X	X	X	X	X	X

STARTER OPTIONS	MEDIUM VOLTAGE / FREQUENCY												
MV ACROSS THE LINE (FLOOR MOUNTED)	60Hz							50Hz					
	2300	3300	4000	4160	6600	12470	13200	2300	3000	3300	6600	10000	11000
	X	X	X	X	O	O	O	X	X	X	O	O	O
MV AUTO-TRANSFORMER 65% (FLOOR MOUNTED)	60Hz							50Hz					
	2300	3300	4000	4160	6600	12470	13200	2300	3000	3300	6600	10000	11000
	X	X	X	X	O	O	O	X	X*	X*	O	O	O
MV AUTO-TRANSFORMER 80% (FLOOR MOUNTED)	60Hz							50Hz					
	2300	3300	4000	4160	6600	12470	13200	2300	3000	3300	6600	10000	11000
	X	X	X	X	O	O	O	X	X	X	O	O	O

* Not available with 5DJ motor / O= available by Special Quote (SQ)

Starters and Drives (Cont'd)

The most common failure mode of mechanical contactors is OFF. This occurs due to the coil open-circuiting or failure of a pole to make an electrical contact when it closes. However, failure in the ON mode is not completely uncommon and can be a more dramatic type of failure, particularly if this failure mode exists at the same time that equipment safety controls are demanding a shutdown.

When contacts are “made,” the current builds up to its maximum value from zero, but when contacts are separated the current tends to flow through the gap thus formed and causes an arc. This arcing depends upon the voltage between the separating contacts. For medium voltage starters, the use of vacuum contactors mitigates this problem somewhat by providing an environment to extinguish the arc. In the alternating current circuit, the separation of contacts may take place when the current is zero or maximum or at any value in between. An alternating current passes through zero and reverses its polarity twice during each cycle. If two or more contacts, one in each leg of a polyphase system, are separated simultaneously, the current values in each will vary. In a three-phase system, if one contact has zero current when opened, the other two contacts will have 86.6% of their maximum values, as an example. Additionally, when inductive circuits are broken, the voltage is increased at the contacts due to the counter (induced) EMF of the circuit. The instant the contacts separate, the voltage between them momentarily rises from zero to the maximum of the circuit, or higher if inductance is present in the circuit. In practice, every time the contacts close, they bounce. When they bounce, they arc. The arcing occurs as the contacts make or break may result in rapid and excessive erosion of the contacts, causing prematurely short contact life.

Types

YORK chillers are designed for use with the following types of electro-mechanical starters, here briefly described.

Across-the-Line (ACL)

These are the simplest and lowest-cost starters available. They apply full voltage to the three motor leads at the instant of starting. Since inrush is 100% of LRA and starting torque is 100%, this is the roughest type of starting on the motor and drive- line. In physical size, the ACL is the smallest of electro-mechanical starters and there is no transition surge. In most areas, utilities will not permit the use of this type of starter for chiller-size motors because of their large current draw on startup.

Auto Transformer (AT)

These starters are reduced-voltage starters. Transformers are used to step down the voltage to the motor during startup. The result is reduced inrush current and starting torque at the level of 42% or 64% depending upon whether 65% or 80% voltage taps are used. They provide closed transition (with three-lead motors) with reduced line disturbance.

Star-Delta Starters

During starting, the motor is connected in a Star or Wye configuration. This reduces the voltage to the motor stator by a factor of three. This 1/3 voltage results in 1/3 current into the motor at start and 1/3 torque to the shaft. Centrifugal compressor starting torque requirements are low enough to allow the motor to start at 1/3 of full load torque.

Accessories and Modifications

BAS REMOTE CONTROL

A communication interface permitting an exchange of chiller data with a BACnet MS/TP, Modbus RTU, LONworks or N2 Metasys network is available by means of an optional E-Link®Gateway. The Johnson Controls E-Link® Gateway mounts conveniently inside the Optiview panel and allows remote BAS networks to monitor values and issue commands to the chiller to control operation.

FACTORY INSULATION OF EVAPORATOR

Factory-applied thermal insulation of the flexible, closed-cell plastic type, 3/4" (19 mm) thick is attached with vapor-proof cement to the evaporator shell, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. Not included is the insulation of waterboxes and nozzles. This insulation will normally prevent condensation in environments with relative humidities up to 75% and dry bulb temperatures ranging from 50° to 90°F (10° to 32.2°C). 1-1/2" (38 mm) thick insulation is also available for relative humidities up to 90% and dry bulb temperatures ranging from 50° to 90°F (10° to 32.2°C).

KNOCK-DOWN SHIPMENT

The YD Chiller with K1-K2 compressor can be shipped knocked down into major subassemblies (evaporator, condenser, driveline, etc.) as required to rig into tight spaces. This is particularly convenient for existing buildings where equipment room access does not allow rigging a factory packaged chiller.

HINGES AND DAVITS ARMS

Hinges and/or davit arms are available to ease serviceability. Hinges on the nozzle end of a compact water box still require that facility water piping be disconnected.

MARINE WATER BOXES

Marine water boxes allow service access for cleaning of the heat exchanger tubes without the need to break the water piping. Bolted-on covers are arranged for convenient access. ANSI/AWWA C-606 couplings nozzle connections are standard; flanges are optional. Marine water boxes are available for condenser and/or evaporator.

REFRIGERANT STORAGE/RECYCLING SYSTEM

A refrigerant storage/recycling system is a self-contained package consisting of a refrigerant compressor with oil separator, storage receiver, water-cooled condenser, filter drier and necessary valves and hoses to remove, replace and distill refrigerant. All necessary controls and safety devices are a permanent part of the system.

Accessories and Modifications (Cont'd)

SPECIAL MOTORS ENCLOSURES

There are job applications, primarily in manufacturing plants, and process applications, where more motor protection is required. Listed below are several alternatives. NOTE: Chiller certification to UL by a third party could be affected. Contact a Johnson Controls sales office for a specific selection.

Weather-Protected Type I Motors (WP-I) - A Weather-Protected Type I motor is an open machine with its ventilating passages constructed to prevent the passage of a cylindrical rod ¾" in diameter. This affords protection against intrusion of rodents and some types of debris. These are regularly used in the pulp industry and where grime is present.

Weather-Protected Type II Motors (WP-II) - A Weather-Protected Type II motor has, in addition to the enclosure defined for Weather-Protected Type I motor, ventilating passages at both intake and exhaust so arranged that high-velocity air and air-borne particles, blown into the motor, can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. Space heaters are required with WP-II.

Totally Enclosed Fan-Cooled Motors (TEFC) - TEFC motors are used where the location is extremely dirty, dusty, or wet, both indoors and outdoors. A totally enclosed fan-cooled unit is enclosed to prevent the free exchange of air between the inside and outside of the case but not sufficiently enclosed as to be termed air-tight. It is air-cooled by means of a fully guarded fan blowing cooling air over the outside of the motor. The fan is externally mounted on the motor shaft.

Totally Enclosed Air-to-Air Cooled (TEAAC) - TEAAC motors are used when the environment is dirty or corrosive. A TEAAC motor is a totally enclosed motor, cooled by circulating the internal air through an air-to-air heat exchanger.

Totally Enclosed Water-to-Air Cooled (TEWAC) - TEWAC motors are used when the environment is dirty or corrosive, in hazardous areas, or where minimum noise levels are required. A TEWAC motor is a totally enclosed machine which is cooled by circulating internal air which, in turn, is cooled by circulating water. It is provided with an internal water-cooled heat exchanger for cooling the internal air and fans, integral with the rotor shaft for circulating the internal air.

SPRING ISOLATION MOUNTING

Spring isolation mounting is available instead of standard isolation mounting pads when desired. Four level-adjusting, spring-type vibration isolator assemblies with non-skid pads are provided for field installation. Isolators are designed for one-inch (25 mm) deflection.

WATER FLANGES

Four 150 lb. ANSI raised-face flanges for condenser and evaporator water connections, are factory welded to water nozzles. Companion flanges, bolts, nuts and gaskets are not included.

Application Data

The following discussion is a user's guide in the application and installation of YD chillers to ensure the reliable, trouble-free life for which this equipment was designed. While this guide is directed towards normal, water-chilling applications, the Johnson Controls sales representative can provide complete recommendations on other types of applications.

LOCATION

YD chillers are virtually vibration free and may generally be located at any level in a building where the construction will support the total system operating weight.

The unit site must be a floor, mounting pad or foundation which is level within 1/4" (6.4 mm) and capable of supporting the operating weight of the unit.

Sufficient clearance to permit normal service and maintenance work should be provided all around and above the unit. Additional space should be provided at one end of the unit to permit cleaning of evaporator and condenser tubes as required. A doorway or other properly located opening may be used.

The chiller should be installed in an indoor location where temperatures range from 40°F to 104°F (4.4°C to 40°C). The dew point temperature in the equipment room must be below the entering condenser water temperature to prevent condensing water vapor inside of the solid state starter or low voltage variable speed drive cabinet (if applicable). Applications using cooling sources other than evaporative or closed loop air exchange methods need to request a factory-supplied temperature control valve to prevent condensation inside the solid state starter or low voltage variable speed drive cabinet (if applicable). Other areas susceptible to water vapor condensate are outside of the condenser shell and condenser water boxes. Example applications include when the condenser water comes from chilled water, wells, river, or other low temperature fluids.

WATER CIRCUITS

Flow Rate – For normal water chilling duty, evaporator and condenser flow rates are permitted at water velocity levels in the heat exchangers tubes of between 3 ft/sec and 12 ft/sec (0.91 m/s and 3.66 m/s) for constant flow applications. Variable flow applications are possible, and initial chiller selections should be made accordingly to allow proper range of flow while maintaining the minimum velocity indicated at the certified rating for the unit. Variable flow in the condenser is not recommended, as it generally raises the energy consumption of the system by keeping the condenser pressure high in the chiller. Additionally, the rate of fouling in the condenser will increase at lower water velocities associated with variable flow, raising system maintenance costs. Cooling towers typically have narrow ranges of operation with respect to flow rates, and will be more effective with full design flow. Ref. Table 8 for flow limits.

Temperature Ranges – For normal water chilling duty, leaving chilled water temperatures may be selected between 38°F (3.3°C) [36°F (2.2°C) with Smart Freeze enabled] and 70°F (21.1°C) to obtain temperature deltas between entering chilled and leaving chilled water temperature of 3°F up to 30°F (1.7°C and 16.7°C).

Application Data (Cont'd)

Water Quality – The practical and economical application of liquid chillers requires that the quality of the water supply for the condenser and evaporator be analyzed by a water treatment specialist. Water quality may affect the performance of any chiller through corrosion, deposition of heat-resistant scale, sedimentation or organic growth. These will degrade chiller performance and increase operating and maintenance costs. Normally, performance may be maintained by corrective water treatment and periodic cleaning of tubes. If water conditions exist which cannot be corrected by proper water treatment, it may be necessary to provide a larger allowance for fouling, and/or to specify special materials of construction. See the Application Guide 160.00-AD5 for more details.

General Piping – All chilled water and condenser water piping should be designed and installed in accordance with accepted piping practice. Chilled water and condenser water pumps should be located to discharge through the chiller to assure positive pressure and flow through the unit. Piping should include offsets to provide flexibility and should be arranged to prevent drainage of water from the evaporator and condenser when the pumps are shut off. Piping should be adequately supported and braced independently of the chiller to avoid the imposition of strain on chiller components. Hangers must allow for alignment of the pipe. Isolators in the piping and in the hangers are highly desirable in achieving sound and vibration control.

Convenience Considerations – To facilitate the performance of routine maintenance work, some or all of the following steps may be taken by the purchaser. Evaporator and condenser water boxes are equipped with plugged vent and drain connections. If desired, vent and drain valves may be installed with or without piping to an open drain. Pressure gauges with stop-cocks and stop valves may be installed in the inlets and outlets of the condenser and chilled water line as close as possible to the chiller. An overhead monorail or beam may be used to facilitate servicing.

Connections – The standard chiller is designed for 150 PSIG (10.3 bar) design working pressure in both the chilled water and condenser water circuits. The connections (water nozzles) to these circuits are furnished with grooves to ANSI/AWWA C 606 Standard for grooved and shouldered joints. Piping should be arranged for ease of disassembly at the unit for tube cleaning. All water piping should be thoroughly cleaned of all dirt and debris before final connections are made to the chiller.

Fluid Strainer – A fluid strainer with perforated holes no larger than 1/8” (3.2 mm) must be field-installed in the chilled fluid inlet line as close as possible to the chiller. If located close enough to the chiller, the chilled fluid pump may be protected by the same strainer. The strainer is to protect the chiller from debris or objects which could block flow through individual heat exchanger tubes. A reduction in flow through tubes could seriously impair the chiller performance or even result in tube freeze up. A thermal-type flow switch is factory installed in the evaporator nozzle and connected to the OptiView panel, which assures adequate chilled fluid flow during operation.

Condenser Fluid – The chiller is engineered for maximum efficiency at both design and part-load operation by taking advantage of the colder cooling tower fluid temperatures which naturally occur during the winter months and off-design conditions. Appreciable power savings are realized from these reduced heads.

The unique design of YORK YD centrifugal chillers in the HVAC industry allows cold condenser fluid starts, without the nuisance trips experienced by most other manufacturers, as detailed below:

1. The condenser shell is higher than the evaporator, thus when the chiller is not in operation, gravity moves refrigerant from the condenser into the evaporator. On start-up, the compressor begins pumping refrigerant gas from the evaporator into the condenser and thus builds head pressure.

Application Data (Cont'd)

2. The butterfly type liquid expansion valve (variable orifice valve) is controlled by the condenser liquid level at the sub-cooler inlet. As that level increases, the valve would be driven open to allow maximum refrigerant flow.

3. YORK YD centrifugal chillers start-up with vanes closed, which reduces the amount of refrigerant gas pumped out of the evaporator over time.

4. The control system is set to stop the vanes from further opening if the evaporator fluid temperature achieves 1°F (0.6°C) above the trip set-point for low water temperature cut-out, typically 4°F (2.2°C) below set point.

At initial start-up, entering condenser water temperature may be 25° F (13.9° C) colder than standby chilled water temperature, but the minimum temperature should be above the freezing point of the chilled liquid.

Handling cold condenser fluid at the onset of changeover from free cooling with tower/heat exchangers is often a realistic requirement. The chiller will start and continue to operate because pressure differential increases quickly, thus preventing nuisance trips on low evaporator pressure usually caused by: system depression, refrigerant stack-up in the condenser, and starvation of the evaporator.

For continuous operation, the minimum entering condenser fluid temperature for both full and part load conditions is provided by the following equation:

English

$$\text{Min. ECWT} = \text{LCHWT} - \text{C RANGE} + 5^{\circ}\text{F} + 12 \left(\frac{\%\text{Load}}{100}\right)$$

SI

$$\text{Min. ECWT} = \text{LCHWT} - \text{C RANGE} + 2.8^{\circ}\text{C} + 6.6 \left(\frac{\%\text{Load}}{100}\right)$$

where:

ECFT = entering condensing fluid temperature

LCHFT = leaving chilled fluid temperature

COND.RANGE = leaving condenser fluid temperature - entering condenser

Fluid temperature at given load condition.

Examples:

a. 2000 TR (7032 kW) chiller

b. 44°F (6.7°C) leaving chilled fluid temperature

c. 85/94.3°F (29.4/34.6°C) condenser fluid temperature range @ full load

Application Data (Cont'd)

English Example

At full load:

$$\text{Min. ECFT} = 44 - (94.3 - 85) + 5 + 12\,\frac{100}{100} = 44 - 9.3 + 5 + 12 =$$

$$\text{Min. ECFT} = 51.7\ ^{\circ}\text{F}$$

At 20% load:

$$\text{Min. ECFT} = 44 - (87 - 85) + 5 + 12\,\frac{20}{100} = 44 - 2 + 5 + 2.4 =$$

$$\text{Min. ECFT} = 49.4\ ^{\circ}\text{F}$$

SI Example

At full load:

$$\text{Min. ECFT} = 6.7 - (34.6 - 29.4) + 2.8 + 6.6\,\frac{100}{100} = 6.7 - 5.2 + 2.8 + 6.6 =$$

$$\text{Min. ECFT} = 10.9^{\circ}\text{C}$$

At 20% load:

$$\text{Min. ECFT} = 6.7 - (30.6 - 29.4) + 2.8 + 6.6\,\frac{20}{100} = 6.7 - 1.2 + 2.8 + 1.3 =$$

$$\text{Min. ECFT} = 9.6\ ^{\circ}\text{C}$$

BRINE APPLICATIONS

Various types of brine can be used in both the evaporator and condenser in lieu of water. The OptiView panel is programmed in the factory to allow extending the evaporator leaving brine temperature setpoint below 36°F (2.2°C). The low evaporator pressure cutout is factory programmed to the appropriate value depending on the percentage concentration and type of brine solution.

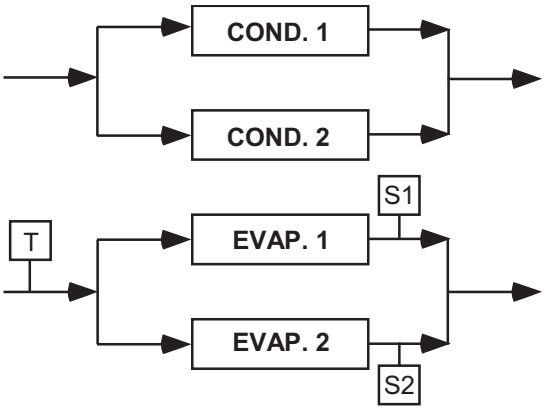
When the chiller is not running, brine should not be flowing through the evaporator. However, if there is brine flowing through the evaporator, there must be flow through the condenser to prevent tubes from freezing. In brine applications, the condenser pump control will close when the condenser saturation temperature reaches 35°F (1.7°C) and the pump will shut off when the temperature increases to 40°F (4.4°C). This is applicable if tied to the condenser pump control.

MULTIPLE UNITS

Selection – Many applications require multiple units to meet the total capacity requirements as well as to provide flexibility and some degree of protection against equipment shutdown. There are several common unit arrangements for this type of application. The YD chiller has been designed to be readily adapted to the requirements of these various arrangements.

Application Data (Cont'd)

Parallel Arrangement (Refer to Fig. 2) – Chillers may be applied in multiples with chilled and condenser water circuits connected in parallel between the units. Fig. 2 represents a parallel arrangement with two chillers. Parallel chiller arrangements may consist of equally or unequally sized units. When multiple units are in operation, they will load and unload at equal percentages of design full load for the chiller.



S – Temperature Sensor for Chiller Capacity Control

T – Thermostat for Chiller Capacity Control

FIGURE 2 - PARALLEL EVAPORATORS PARALLEL CONDENSERS

Depending on the number of units and operating characteristics of the units, loading and unloading schemes should be designed to optimize the overall efficiency of the chiller plant. It is recommended to use an evaporator bypass piping arrangement to bypass fluid around evaporator of any unit which has cycled off at reduced load conditions. It is also recommended to alternate the chiller cycling order to equalize chiller starts and run hours.

Series Arrangement (Refer to Fig. 3) **–** Chillers may be applied in pairs with chilled water circuits connected in series and condenser water circuits connected in parallel. All of the chilled water flows through both evaporators with each unit handling approximately one-half of the total load. When the load decreases to a customer selected load value, one of the units will be shut down by a sequence control. Since all water is flowing through the operating unit, that unit will cool the water to the desired temperature.

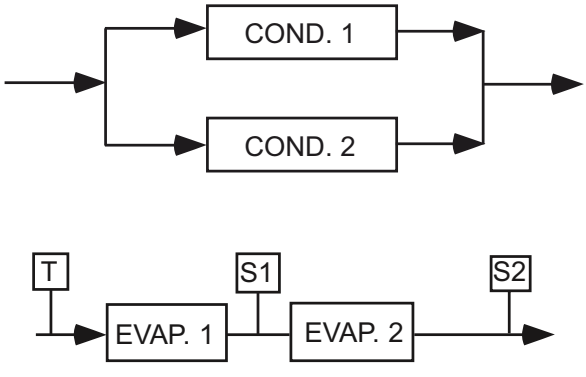


FIGURE 3 - SERIES EVAPORATORS PARALLEL CONDENSERS

Application Data (Cont'd)

Series Counterflow Arrangement (Refer to Fig. 4) – Chillers may be applied in pairs with chilled water circuits connected in series and with the condenser water in series counterflow. All of the chilled water flows through both evaporators. All of the condenser water flows through both condensers. The water ranges are split, which allows a lower temperature difference or "head" on each chiller, than multiple units in parallel. For equal chillers, the machine at higher temperature level will typically provide slightly more than half the capacity. The compressor motors and gear codes on the two chillers are often matched, such that the high temperature machine can operate at the low temperature conditions when one unit is cycled off at part loads (as compared to series parallel chillers which are typically not identical).

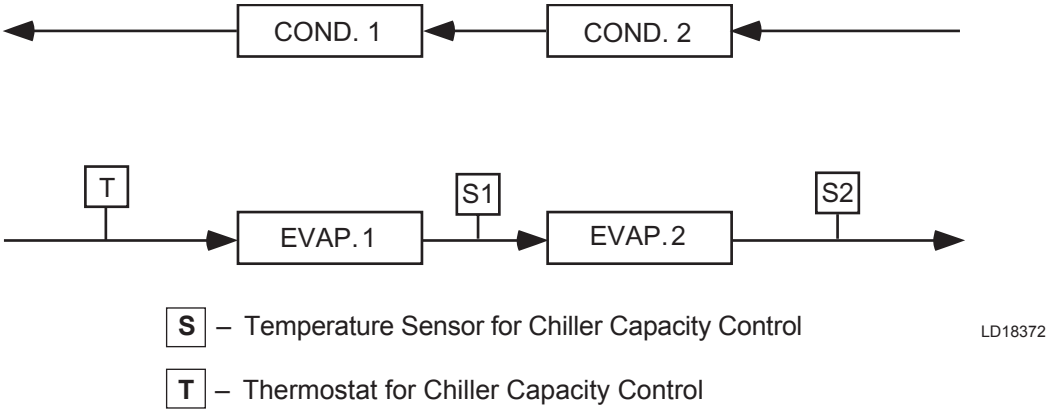


FIGURE 4 - SERIES EVAPORATORS SERIES-COUNTER FLOW CONDENSERS

Series counter flow application can provide a significant building energy savings for large capacity plants which have chilled and condenser water temperature ranges greater than typical AHRI.

REFRIGERANT RELIEF PIPING

Each chiller is equipped with dual relief valves on the condenser and a single relief valve on the evaporator. The dual relief valves on the condenser are redundant and allow changing of either valve while the unit is fully charged. The purpose of the relief valves is to quickly relieve excess pressure of the refrigerant charge to the atmosphere, as a safety precaution in the event of an emergency such as fire. They are set to relieve at an internal pressure as noted on the pressure vessel data plate, and are provided in accordance with ASHRAE 15 safety code and ASME or applicable pressure vessel code.

Sized to the requirements of applicable codes, a vent line must run from the relief device to the outside of the building. This refrigerant relief piping must include a cleanable, vertical-leg dirt trap to catch vent-stack condensation. Vent piping must be arranged to avoid imposing a strain on the relief connection and should include at least one flexible connection.

SOUND AND VIBRATION CONSIDERATIONS

A YD chiller is not a source of objectionable sound and vibration in normal air conditioning applications. Neoprene isolation mounts are furnished as standard with each unit. Optional level-adjusting spring isolator assemblies designed for 1" (25 mm) static deflection are available from Johnson Controls.

YD chiller sound pressure level ratings will be furnished on request.

Application Data (Cont'd)

Control of sound and vibration transmission must be taken into account in the equipment room construction as well as in the selection and installation of the equipment.

THERMAL INSULATION

No appreciable operating economy can be achieved by thermally insulating the chiller. However, the chiller's cold surfaces should be insulated with a vapor barrier insulation sufficient to prevent condensation. A chiller can be factory insulated with 3/4" (19 mm) or 1-1/2" (38 mm) thick insulation, as an option. This insulation will normally prevent condensation in environments with dry bulb temperatures of 50°F to 90°F (10°C to 32°C) and relative humidities up to 75% [3/4" (19 mm) thickness] or 90% [1-1/2" (38 mm) thickness]. The insulation is painted and the surface is flexible and reasonably resistant to wear. It is intended for a chiller installed indoors and, therefore, no protective covering of the insulation is usually required. If insulation is applied to the water boxes at the job site, it must be removable to permit access to the tubes for routine maintenance.

VENTILATION

The ASHRAE Standard 15 Safety Code for Mechanical Refrigeration requires that all machinery rooms be vented to the outdoors utilizing mechanical ventilation by one or more power-driven fans. This standard, plus National Fire Protection Association Standard 90A, state, local and any other related codes should be reviewed for specific requirements. Since the YD chiller motors are air-cooled, ventilation should allow for the removal of heat from the motors.

In addition, the ASHRAE Standard 15 requires a refrigerant vapor detector to be employed for all refrigerants. It is to be located in an area where refrigerant from a leak would be likely to concentrate. An alarm is to be activated and the mechanical ventilation started at a value no greater than the TLV (Threshold Limit Value) of the refrigerant.

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K1	18	GPM (L/S)	BB	3851 (243)	15405 (972)	1923 (121)	5094 (321)	1282 (81)	3357 (212)	LB	4983 (314)	17956 (1133)	2492 (157)	6790 (428)	1660 (105)	4556 (287)
		Ft (kPa)		4 (13)	52 (157)	8 (24)	45 (134)	12 (36)	67 (201)		4 (13)	38 (114)	8 (23)	45 (134)	11 (33)	67 (201)
		GPM (L/S)	BC	4704 (297)	18816 (1187)	2352 (148)	6162 (389)	1568 (99)	4069 (257)	LC	5466 (345)	19695 (1243)	2730 (172)	7398 (467)	1820 (115)	4981 (314)
		Ft (kPa)		5 (14)	57 (170)	8 (24)	45 (134)	12 (36)	67 (201)		4 (13)	39 (118)	8 (23)	45 (134)	11 (33)	68 (202)
		GPM (L/S)	BD	5522 (348)	22088 (1394)	2761 (174)	7151 (451)	1841 (116)	4731 (298)	LD	5828 (368)	21002 (1325)	2914 (184)	7836 (494)		
		Ft (kPa)		5 (15)	63 (187)	8 (24)	45 (134)	12 (36)	67 (201)		4 (13)	41 (121)	8 (23)	45 (134)		
		GPM (L/S)	B2	3957 (250)	15828 (999)	1979 (125)	6786 (428)	1319 (83)	4478 (283)	L2	4303 (271)	17087 (1078)	2152 (136)	8201 (517)	1434 (90)	5561 (351)
		Ft (kPa)		3 (9)	37 (109)	5 (14)	45 (134)	7 (22)	67 (201)		3 (8)	26 (78)	5 (14)	45 (134)	7 (19)	64 (192)
		GPM (L/S)	B3	4706 (297)	18825 (1188)	2353 (148)	7953 (502)	1569 (99)	5255 (332)	L3	5072 (320)	19857 (1253)	2536 (160)	9370 (591)	1691 (107)	6396 (403)
		Ft (kPa)		3 (9)	41 (122)	5 (15)	45 (134)	7 (22)	68 (202)		3 (9)	28 (84)	5 (14)	45 (134)	7 (20)	66 (196)
		GPM (L/S)	B4	5359 (338)	21435 (1352)	2679 (169)	8922 (563)	1786 (113)	5912 (373)	L4	5989 (378)	23163 (1461)	2995 (189)	10684 (674)		
		Ft (kPa)		3 (10)	45 (134)	5 (15)	45 (134)	8 (22)	68 (202)		3 (9)	31 (92)	5 (15)	45 (134)		

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES (CONT'D)

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K2	22	GPM (L/S)	MB	3851 (243)	15406 (972)	1926 (121)	4574 (289)	1284 (81)	3011 (190)	MB	4980 (314)	17956 (1133)	2490 (157)	6116 (386)	1660 (105)	4093 (258)
		Ft (kPa)		5 (16)	62 (185)	10 (29)	45 (134)	15 (43)	67 (201)		5 (16)	52 (156)	9 (26)	45 (134)	13 (40)	67 (201)
		GPM (L/S)	MC	4704 (297)	18817 (1187)	2352 (148)	5551 (350)	1568 (99)	3654 (230)	MC	5460 (344)	19695 (1243)	2730 (172)	6672 (421)	1820 (115)	4472 (282)
		Ft (kPa)		6 (16)	67 (199)	10 (29)	45 (134)	15 (44)	67 (201)		5 (16)	55 (164)	9 (26)	45 (134)	13 (40)	67 (201)
		GPM (L/S)	MD	5522 (348)	22088 (1394)	2761 (174)	6447 (407)	1841 (116)	4261 (269)	MD	5820 (367)	21002 (1325)	2914 (184)	7075 (446)		
		Ft (kPa)		6 (17)	72 (215)	10 (29)	45 (134)	15 (44)	67 (201)		6 (18)	57 (170)	9 (27)	45 (134)		
		GPM (L/S)	M2	3957 (250)	15828 (999)	1979 (125)	6133 (387)	1319 (83)	4043 (255)	M2	4303 (271)	17087 (1078)	2152 (136)	7433 (469)	1434 (90)	5005 (316)
		Ft (kPa)		3 (10)	42 (126)	6 (17)	45 (134)	9 (26)	68 (202)		4 (11)	37 (109)	6 (16)	45 (134)	8 (24)	68 (202)
		GPM (L/S)	M3	4706 (297)	18825 (1188)	2353 (148)	7200 (454)	1569 (99)	4753 (300)	M3	5072 (320)	19557 (1234)	2536 (160)	8514 (537)	1691 (107)	5775 (364)
		Ft (kPa)		4 (11)	46 (139)	6 (18)	45 (134)	9 (27)	67 (201)		4 (12)	41 (123)	6 (16)	45 (134)	8 (24)	67 (201)
		GPM (L/S)	M4	5359 (338)	21435 (1352)	2679 (169)	8105 (511)	1786 (113)	5359 (338)	M4	5989 (378)	23163 (1461)	3995 (252)	9728 (614)		
		Ft (kPa)		4 (12)	51 (151)	6 (18)	45 (134)	9 (27)	68 (202)		4 (13)	47 (140)	10 (30)	45 (134)		
	18	GPM (L/S)	NB	4872 (307)	19489 (1230)	2436 (154)	6370 (402)	1624 (102)	4206 (265)	BB	6213 (392)	22389 (1412)	3107 (196)	8312 (524)	2070 (131)	5634 (355)
		Ft (kPa)		5 (14)	58 (174)	8 (24)	45 (134)	12 (36)	67 (201)		4 (13)	42 (124)	8 (23)	45 (134)	11 (34)	68 (202)
		GPM (L/S)	NC	5386 (340)	21543 (1359)	2693 (170)	6988 (441)	1795 (113)	4623 (292)	BC	6740 (425)	24286 (1532)	3370 (213)	8925 (563)	2245 (142)	6082 (384)
		Ft (kPa)		5 (15)	62 (184)	8 (24)	45 (134)	12 (36)	67 (201)		5 (14)	43 (129)	8 (24)	45 (134)	11 (34)	67 (201)
		GPM (L/S)	ND	5864 (370)	23457 (1480)	2932 (185)	7565 (477)	1955 (123)	4994 (315)	BD	7115 (449)	25639 (1618)	3557 (224)	9358 (590)	2370 (150)	6399 (404)
		Ft (kPa)		5 (15)	65 (194)	8 (24)	45 (134)	12 (37)	68 (202)		5 (14)	45 (133)	8 (24)	45 (134)	12 (34)	68 (202)

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES (CONT'D)

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K2	18									BE	7449 (470)	26544 (1675)	3725 (235)	9731 (614)		
											5 (14)	46 (137)	8 (24)	45 (134)		
		GPM (L/S)	N2	4875 (308)	19501 (1230)	2438 (154)	8215 (518)	1625 (103)	5428 (342)	B2	5772 (364)	22381 (1412)	2886 (182)	10379 (655)	1924 (121)	7143 (451)
		Ft (kPa)		3 (10)	42 (125)	5 (15)	45 (134)	7 (22)	67 (201)		3 (9)	30 (90)	5 (15)	45 (134)	7 (20)	67 (199)
		GPM (L/S)	N3	5763 (364)	23054 (1454)	2882 (182)	9810 (619)	1921 (121)	6311 (398)	B3	6380 (403)	24570 (1550)	3190 (201)	11210 (707)	2127 (134)	7770 (490)
		Ft (kPa)		4 (11)	48 (142)	5 (15)	45 (134)	8 (23)	67 (201)		3 (10)	32 (96)	5 (15)	45 (134)	7 (21)	67 (201)
		GPM (L/S)	N4	6422 (405)	25688 (1621)	3211 (203)	10420 (657)	2141 (135)	6925 (437)	B4	6981 (440)	26737 (1687)	3491 (220)	11981 (756)	2327 (147)	8377 (529)
		Ft (kPa)		4 (12)	53 (157)	5 (16)	45 (134)	8 (23)	68 (202)		3 (10)	34 (102)	5 (16)	45 (134)	7 (21)	67 (201)
										B5	7713 (487)	29372 (1853)	3856 (243)	12869 (812)		
											4 (10)	37 (111)	5 (16)	45 (134)		

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES (CONT'D)

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K3	22	GPM (L/S)	EB	6353 (401)	25410 (1603)	3176 (200)	7464 (471)	2118 (134)	4934 (311)	CB	6241 (394)	22491 (1419)	3121 (197)	7661 (483)	2080 (131)	5079 (320)
		Ft (kPa)		5 (16)	65 (193)	10 (29)	45 (134)	15 (44)	68 (202)		5 (16)	49 (145)	9 (27)	45 (134)	14 (40)	67 (201)
		GPM (L/S)	EC	7159 (452)	28631 (1806)	3579 (226)	8339 (526)	2386 (151)	5523 (348)	CC	6967 (440)	25105 (1584)	3483 (220)	8488 (536)	2322 (146)	5638 (356)
		Ft (kPa)		6 (17)	68 (203)	10 (30)	45 (134)	15 (44)	68 (202)		5 (16)	51 (152)	9 (27)	45 (134)	14 (41)	67 (201)
		GPM (L/S)	ED	7938 (501)	31750 (2003)	3969 (250)	9168 (578)	2646 (167)	6085 (384)	CD	7900 (498)	28469 (1796)	3950 (249)	9519 (601)		
		Ft (kPa)		6 (17)	71 (213)	10 (30)	45 (134)	15 (45)	68 (202)		6 (17)	55 (163)	9 (28)	45 (134)		
		GPM (L/S)	E2	6428 (406)	25712 (1622)	3214 (203)	9754 (615)	2143 (135)	6483 (409)	C2	4969 (313)	19879 (1254)	2484 (157)	8697 (549)	2030 (128)	5782 (365)
		Ft (kPa)		4 (10)	45 (134)	6 (18)	45 (134)	9 (27)	68 (202)		3 (10)	33 (97)	5 (16)	45 (134)	12 (35)	68 (202)
		GPM (L/S)	E3	7117 (449)	28467 (1796)	3558 (224)	10693 (675)	2372 (150)	7117 (449)	C3	6487 (409)	25352 (1599)	3244 (205)	10838 (684)	2162 (136)	7246 (457)
		Ft (kPa)		4 (11)	48 (142)	6 (18)	45 (134)	9 (27)	67 (201)		4 (11)	37 (111)	6 (16)	45 (134)	8 (25)	68 (202)
		GPM (L/S)	E4	7842 (495)	31367 (1979)	3921 (247)	11645 (735)	2614 (165)	7776 (491)	C4	8099 (511)	31159 (1966)	4049 (255)	12951 (817)		
		Ft (kPa)		4 (12)	51 (151)	6 (19)	45 (134)	9 (27)	68 (202)		4 (12)	44 (130)	6 (17)	45 (134)		
	18	GPM (L/S)	FB	7995 (504)	31978 (2018)	3997 (252)	10213 (644)	2665 (168)	6915 (436)	DB	7569 (478)	27275 (1721)	3780 (238)	10143 (640)	2520 (159)	6876 (434)
		Ft (kPa)		5 (15)	62 (186)	8 (25)	45 (134)	12 (36)	67 (201)		5 (14)	46 (138)	8 (22)	45 (134)	11 (32)	68 (202)
		GPM (L/S)	FC	8946 (564)	35782 (2257)	4473 (282)	11294 (713)	2982 (188)	7678 (484)	DC	8440 (532)	30412 (1919)	4215 (266)	11176 (705)	2810 (177)	7628 (481)
		Ft (kPa)		5 (16)	67 (200)	9 (25)	45 (134)	12 (36)	68 (202)		5 (15)	50 (148)	8 (23)	45 (134)	11 (33)	67 (201)
		GPM (L/S)	FD	9009 (568)	39637 (2501)	4955 (313)	12337 (778)	3303 (208)	8456 (533)	DD	9326 (588)	33606 (2120)	4663 (294)	12182 (769)	3105 (196)	8359 (527)
		Ft (kPa)		6 (17)	72 (216)	9 (26)	45 (134)	12 (37)	68 (202)		5 (16)	54 (160)	8 (23)	45 (134)	11 (33)	68 (202)
										DE	9714 (613)	35003 (2208)	4857 (306)	12601 (795)		
											5 (16)	56 (166)	8 (24)	45 (134)		
		GPM (L/S)	F2	8047 (508)	32188 (2031)	4024 (254)	13056 (824)	2682 (169)	8986 (567)	D2	7206 (455)	27943 (1763)	3603 (227)	12958 (818)	2402 (152)	8930 (563)
		Ft (kPa)		3 (10)	46 (137)	5 (16)	45 (134)	7 (22)	68 (202)		3 (10)	36 (106)	5 (14)	45 (134)	7 (20)	67 (201)
	18	GPM (L/S)	F3	8941 (564)	35765 (2256)	4471 (282)	14216 (897)	2980 (188)	9880 (623)	D3	7944 (501)	30601 (1931)	3972 (251)	13962 (881)	2648 (167)	9703 (612)
		Ft (kPa)		4 (11)	50 (151)	5 (16)	45 (134)	8 (22)	67 (201)		4 (11)	39 (115)	5 (15)	45 (134)	7 (21)	67 (201)
		GPM (L/S)	F4	9920 (626)	39800 (2510)	4960 (313)	15425 (973)	3307 (209)	10829 (683)	D4	8756 (552)	33527 (2115)	4378 (276)	15003 (947)	2919 (184)	10533 (665)
		Ft (kPa)		4 (12)	56 (167)	6 (17)	45 (134)	8 (23)	68 (202)		4 (12)	42 (126)	5 (16)	45 (134)	7 (21)	67 (201)
										D5	9909 (625)	37681 (2377)	4954 (313)	16391 (1034)		
											4 (13)	48 (142)	5 (16)	45 (134)		

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES (CONT'D)

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K4	22	GPM (L/S)	GB	7995 (504)	31978 (2018)	3997 (252)	9234 (583)	2665 (168)	6209 (392)	EB	7708 (486)	27775 (1752)	3850 (243)	9322 (588)	2565 (162)	6307 (398)
		Ft (kPa)		6 (17)	72 (214)	10 (30)	45 (134)	15 (44)	67 (201)		6 (17)	54 (162)	9 (28)	45 (134)	14 (42)	67 (201)
		GPM (L/S)	GC	8946 (564)	35872 (2263)	4473 (282)	10220 (645)	2982 (188)	6918 (436)	EC	8578 (541)	30912 (1950)	4285 (270)	10259 (647)	2855 (180)	6981 (440)
		Ft (kPa)		6 (18)	76 (228)	11 (32)	45 (134)	15 (44)	67 (201)		6 (17)	58 (173)	9 (27)	45 (134)	14 (41)	68 (202)
		GPM (L/S)	GD	9909 (625)	39637 (2501)	4955 (313)	11197 (706)	3303 (208)	7614 (480)	ED	9465 (597)	34106 (2152)	4732 (299)	11191 (706)	3150 (199)	7660 (483)
		Ft (kPa)		6 (19)	82 (244)	10 (31)	45 (134)	15 (45)	68 (202)		6 (19)	62 (185)	10 (29)	45 (134)	14 (41)	67 (201)
										EE	9853 (622)	35503 (2240)	4926 (311)	11583 (731)		
											6 (19)	64 (190)	10 (29)	45 (134)		
		GPM (L/S)	G2	8047 (508)	32188 (2031)	4024 (254)	11910 (751)	2682 (169)	8128 (513)	E2	7345 (463)	28926 (1825)	3673 (232)	12149 (766)	2448 (154)	8352 (527)
		Ft (kPa)		4 (12)	52 (154)	6 (19)	45 (134)	9 (27)	68 (202)		4 (11)	41 (123)	6 (17)	45 (134)	8 (25)	68 (202)
		GPM (L/S)	G3	8941 (564)	35765 (2256)	4471 (282)	13009 (821)	2980 (188)	8956 (565)	E3	8083 (510)	31584 (1993)	4041 (255)	13087 (826)	2694 (170)	9054 (571)
		Ft (kPa)		4 (13)	56 (168)	6 (19)	45 (134)	9 (27)	67 (201)		4 (13)	44 (133)	6 (18)	45 (134)	8 (25)	67 (201)
		GPM (L/S)	G4	9920 (626)	39680 (2503)	4960 (313)	14161 (893)	3307 (209)	9837 (621)	E4	8895 (561)	34510 (2177)	4447 (281)	14063 (887)	2965 (187)	9806 (619)
		Ft (kPa)		5 (14)	62 (184)	7 (20)	45 (134)	9 (27)	67 (201)		5 (14)	48 (144)	6 (19)	45 (134)	9 (26)	67 (201)
										E5	10048 (634)	38664 (2439)	5024 (317)	15393 (971)		
											5 (15)	54 (161)	7 (20)	45 (134)		
	18	GPM (L/S)	HB	9155 (578)	36619 (2310)	4577 (289)	11512 (726)	3052 (193)	7858 (496)	FB	9121 (575)	32867 (2074)	4560 (288)	12428 (784)	3040 (192)	8326 (525)
		Ft (kPa)		5 (16)	68 (203)	9 (25)	45 (134)	12 (36)	67 (201)		5 (16)	54 (161)	8 (23)	45 (134)	12 (35)	68 (202)
		GPM (L/S)	HC	10068 (635)	40271 (2541)	5034 (318)	12484 (788)	3356 (212)	8574 (541)	FC	10098 (637)	36390 (2296)	5049 (319)	13646 (861)	3366 (212)	9158 (578)
		Ft (kPa)		6 (17)	73 (219)	9 (26)	45 (134)	12 (37)	67 (201)		6 (17)	58 (174)	8 (24)	45 (134)	12 (35)	67 (201)
		GPM (L/S)	HD	11247 (710)	44988 (2838)	5623 (355)	13693 (864)	3749 (237)	9485 (598)	FD	10865 (685)	39152 (2470)	5432 (343)	14584 (920)	3622 (229)	9820 (620)
		Ft (kPa)		6 (18)	81 (241)	9 (27)	45 (134)	13 (37)	67 (201)		6 (18)	62 (186)	8 (24)	45 (134)	12 (35)	67 (201)
										FE	11281 (712)	40652 (2565)	5641 (356)	15092 (952)		
											6 (19)	65 (193)	8 (24)	45 (134)		
		GPM (L/S)	H2	9002 (568)	36006 (2272)	4501 (284)	14290 (902)	3001 (189)	9947 (628)	F2	8721 (550)	33884 (2138)	4361 (275)	16116 (1017)	2907 (183)	10899 (688)
		Ft (kPa)		4 (11)	51 (151)	5 (16)	45 (134)	8 (22)	68 (202)		4 (12)	43 (129)	5 (15)	45 (134)	7 (21)	67 (201)

Application Data (Cont'd)

TABLE 7 - WATER FLOW RATE LIMITS GPM (L/S) BASED ON CONSTANT FLOW APPLICATION AND STANDARD TUBES (CONT'D)

COMP	LENGTH (FT)	FLOW/ PD	SHELL CODE	EVAPORATOR						SHELL CODE	CONDENSER FLOW RATE (GPM)					
				1 PASS		2 PASS		3 PASS			1 PASS		2 PASS		3 PASS	
				MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
K4	18	GPM (L/S)	H3	10004 (631)	40018 (2525)	5002 (316)	15532 (980)	3335 (210)	10922 (689)	F3	9620 (607)	37123 (2342)	4810 (303)	16116 (1017)	3207 (202)	11848 (748)
		Ft (kPa)		4 (12)	56 (168)	6 (17)	45 (134)	8 (23)	67 (201)		4 (13)	48 (142)	5 (15)	45 (134)	7 (21)	68 (202)
		GPM (L/S)	H4	11116 (701)	44464 (2805)	5558 (351)	16813 (1061)	3705 (234)	11950 (754)	F4	10590 (668)	40674 (2566)	5303 (335)	18863 (1190)	3535 (223)	12863 (812)
		Ft (kPa)		5 (13)	63 (189)	6 (17)	45 (134)	8 (23)	67 (201)		4 (13)	53 (158)	5 (15)	45 (134)	7 (22)	675 (2016)
										F5	11703 (738)	44628 (2816)	5851 (369)	20361 (1285)		
											5 (15)	59 (177)	5 (16)	45 (134)		
K7	22	GPM (L/S)	KB	9155 (578)	36619 (2310)	4577 (289)	10459 (660)	3052 (193)	7064 (446)	KB	10767 (679)	38799 (2448)	5384 (340)	13070 (825)	3589 (226)	8762 (553)
		Ft (kPa)		6 (19)	78 (231)	10 (30)	45 (134)	15 (44)	67 (201)		7 (20)	69 (206)	9 (28)	45 (134)	14 (42)	67 (201)
		GPM (L/S)	KC	10068 (635)	40271 (2541)	5034 (318)	11376 (718)	3356 (212)	7735 (488)	KC	11969 (755)	43129 (2721)	5984 (378)	14367 (906)	3990 (252)	9668 (610)
		Ft (kPa)		7 (19)	83 (247)	10 (30)	45 (134)	15 (45)	67 (201)		7 (22)	76 (227)	10 (29)	45 (134)	14 (43)	68 (202)
		GPM (L/S)	KD	11247 (710)	44988 (2838)	5623 (355)	12512 (789)	3749 (237)	8566 (540)	KD	12647 (798)	45573 (2875)	6323 (399)	15096 (952)	4216 (266)	10178 (642)
		Ft (kPa)		7 (21)	90 (269)	10 (31)	45 (134)	15 (45)	67 (201)		8 (23)	80 (239)	10 (29)	45 (134)	14 (43)	68 (202)
										KE	13303 (839)	47936 (3024)	6651 (420)	15789 (996)		
											8 (24)	84 (251)	10 (30)	45 (134)		
		GPM (L/S)	K2	9002 (568)	26006 (1641)	4501 (284)	13097 (826)	3001 (189)	9017 (569)	K2	9944 (627)	38642 (2438)	4972 (314)	16423 (1036)	3315 (209)	11126 (702)
		Ft (kPa)		4 (13)	57 (169)	6 (19)	45 (134)	9 (27)	67 (201)		5 (15)	54 (162)	6 (18)	45 (134)	9 (25)	67 (201)
		GPM (L/S)	K3	10004 (631)	40018 (2525)	5002 (316)	14256 (899)	3335 (210)	9921 (626)	K3	10961 (692)	42305 (2669)	5480 (346)	17768 (1121)	3654 (231)	12075 (762)
		Ft (kPa)		5 (14)	62 (185)	7 (20)	45 (134)	9 (27)	68 (202)		5 (16)	60 (179)	6 (18)	45 (134)	9 (26)	68 (202)
		GPM (L/S)	K4	16500 (1041)	44464 (2805)	5558 (351)	15479 (977)	3705 (234)	10894 (687)	K4	12082 (762)	46348 (2924)	6041 (381)	19176 (1210)	4027 (254)	13113 (827)
		Ft (kPa)		11 (32)	69 (206)	7 (20)	45 (134)	9 (28)	67 (201)		6 (17)	67 (200)	6 (18)	45 (134)	9 (25)	68 (202)
										K5	13682 (863)	52111 (3288)	6841 (432)	21105 (1331)		
											7 (19)	78 (232)	6 (19)	45 (134)		

Electrical Considerations

ELECTRICAL CONSIDERATIONS

Motor Voltage – Low voltage motors (380 to 575 volts) are furnished with six leads (or multiples of six leads). Medium voltage (2300 volts and above) motors have three leads. Motor circuit conductor size must be in accordance with the National Electrical Code (N.E.C.), or other applicable codes, for the motor full load amperes (FLA). Flexible conduit should be used for the last several feet to the chiller in order to provide vibration isolation. Table 9 lists the allowable variation in voltage supplied to the chiller motor. The unit name plate is stamped with the specific motor voltage, and frequency for the appropriate motor.

Starters – The YD chiller requires two starters, one connected to each of the chiller motors. The two starters may be individually connected to a power source, or the starters may be furnished as a package with the two incoming feeds bussed or cabled together. When used, electro-mechanical starters must be furnished in accordance with YORK Standard Specifications (R-1137). This will ensure that starter components, controls, circuits, and terminal markings will be suitable for required overall system performance.

Oil Pump Power Supply – The YD chiller is provided with an auxiliary variable speed oil pump drive panel. This panel operates the two oil pump motors, powers the 3 phase oil reservoir heater, and includes the control power transformer for the chiller control panel. A common incoming disconnect is provided at the panel. For remote electromechanical starters and medium voltage variable speed drive the components feeds are individually fused and a separate 3 phase power supply (380 to 575 voltages as listed on Table 9) is required. This power can be from a separate source available in the building, or optionally fed from an auxiliary source in one of the drive motor starters. For chillers with unit mounted low voltage speed drives and unit mounted solid state starter, the control panel is supplied from the drive or starter panels, in case a special connection is requested (SQ).

Controls – For remote electromechanical starters and medium voltage variable speed drive a 115 volt, single phase, 60 or 50 Hertz 2 KVA power supply is furnished at the chiller from a separate control transformer, included in the 3 phase variable speed oil pump auxiliary power panel.

Copper Conductors – ***Only copper conductors should be connected to compressor motors and starters.*** Aluminum conductors have proven to be unsatisfactory when connected to copper lugs. Aluminum oxide and the difference in thermal conductivity between copper and aluminum cannot guarantee the required tight connection over a long period of time.

Electrical Considerations (Cont'd)

TABLE 8 - MOTOR VOLTAGE VARIATIONS

FREQ.	RATED VOLTAGE	NAME PLATE VOLTAGE*	OPERATING VOLTAGE	
			MIN.	MAX.
60Hz	380	380	342	415
	460	440/460/480	414	508
	575	575	520	635
	2300	2300	2070	2530
	3300	3300	2970	3630
	4000	4000/4160	3600	4576
50Hz	380	380/400	342	423
	415	415	374	440
	2300	2300	2070	2530
	3300	3300	2970	3630

*For motor voltage above 4160V/60Hz and 3300V/50Hz contact the Johnson Controls Sales Office for a specific selection.

Power Factor Correction Capacitors – Capacitors can be applied to a constant speed chiller for the purpose of power factor correction. For remote mounted electro mechanical starters, the capacitors should be located on the load-side of the starter. The capacitors must be sized and installed to meet the National Electrical Code and be verified by Johnson Controls.

Ampacity on Load Side of Starter – Electrical power wire size to each chiller motor is based on the minimum ampacity. For remote starters, the National Electrical Code defines the calculation of ampacity, as summarized below. More specific information on actual amperage ratings will be supplied with the submittal drawings.

- Six-lead type of starting (Star-Delta)
- Minimum circuit ampacity per conductor (1 of 6):
- Ampacity = 0.721 x compressor motor amps.
- Three-lead type of starting
- (Across-the-Line, Autotransformer and Primary Reactor)
- Minimum circuit ampacity per conductor (1 of 3):
- Ampacity = 1.25 x compressor motor amps.

Ampacity on Line-Side of Starter – The YD chiller utilizes two compressor motors and starters. If the starters are connected together to the line side, the individual ampacity requirements should be multiplied by two to obtain the total. The only additional load on the circuit for the chiller would be the control transformer and oil pump motors unless they are supplied by a separate source.

Minimum Circuit Ampacity = 125% of compressor motor amps + FLA of all other loads on the circuit.

Branch Circuit Overcurrent Protection – The branch circuit overcurrent protection device(s) should be a time-delay type, with a minimum rating equal to the next standard fuse/breaker rating above the calculated value. It is calculated taking into account the compressor motor amps and may also include control transformer and oil pump motor. Refer to submittal drawings for the specific calculations for each application.

Electrical Considerations (Cont'd)

MOTOR ELECTRICAL DATA

The smallest motor available which equals or exceeds the Input power (kW) from the chiller rating program is selected from Tables 12 through 15. The full load amperes (FLA) listed in the tables are maximum values and correspond to the maximum motor kW listed. When the input power (kW) is less than maximum motor kW, the FLA should be reduced per the following equation:

$$FLA = \frac{\text{Motor kW}}{\text{Max Motor kw}} \text{ Max. Motor FLA}$$

TABLE 9 - AVAILABLE 60 HZ COMPRESSOR/SHELL/MOTOR COMBINATIONS

COMPRESSOR CODE	EVAPORATOR CODE	CONDENSER CODE	MOTOR CODES 60HZ			
			LOW VOLTAGE (NONE/EM)	LOW VOLTAGE (VSD)	MEDIUM VOLTAGE (NONE/EM/ PR/AT)	MEDIUM VOLTAGE (VSD)
K1	BB, BC, BD, B2, B3, B4	LB, LC, LD, L2, L3, L4	EW-FC	EW-FB	CW-DC	CW-DC
K2	MB, MC, MD, M2, M3, M4	MB, MC, MD, M2, M3, M4	EW-FC	EW-FB	CW-DC	CW-DC
	NB, NC, ND, N2, N3, N4	BB, BC, BD, BE,B2, B3, B4, B5				
K3	EB, EC, ED, E2, E3, E4	CB, CC, CD, C2, C3, C4	FA-FC	FA-FB	DA-DJ	DA-DJ
	FB, FC, FD, F2, F3, F4	DB, DC, DD, DE,D2, D3, D4, D5				
K4	GB, GC, GD, G2, G3, G4	EB, EC, ED, EE,E2, E3, E4, E5	FA-FC	FA-FB	DA-DJ	DA-DJ
	HB, HC, HD, H2, H3, H4	FB, FC, FD, FE,F2, F3, F4, F5				
K7	KB, KC, KD, K2, K3, K4	KB, KC, KD, KE,K2, K3, K4, K5	N/A	N/A	DD-DL	DD-DL
VOLTAGE (V)			380 up to 575	380 - 460	2300 up to 13200	2300 up to 13200

Electrical Considerations (Cont'd)

The benefit from the FLA correction is the possible use of smaller power wiring and/or starter size.

The locked rotor amperes (LRA) are read directly from Tables 12 through 15 for specific Motor Code and voltage. This is because the LRA is dependent only on motor size and voltage and is independent of input power (kW).

In-rush amperes (IRA) depend on LRA and the type of starter applied. The in-rush can be calculated using a percentage of LRA shown in Table 16

TABLE 10 - AVAILABLE 50HZ COMPRESSOR/SHELL/MOTOR COMBINATIONS

COMPRESSOR CODE	EVAPORATOR CODE	CONDENSER CODE	MOTOR CODES			
			50HZ			
			LOW VOLTAGE (NONE/EM)	LOW VOLTAGE (VSD)	MEDIUM VOLTAGE (NONE/EM/ PR/AT)	MEDIUM VOLTAGE (VSD)
K1	BB, BC, BD, B2, B3, B4	LB, LC, LD, L2, L3, L4	5ES-5FB	5ES-5FB	5CS-5DC	5CS-5DC
K2	MB, MC, MD, M2, M3, M4	MB, MC, MD, M2, M3, M4	5ES-5FB	5ES-5FB	5CS-5DC	5CS-5DC
	NB, NC, ND, N2, N3, N4	BB, BC, BD, BE,B2, B3, B4, B5				
K3	EB, EC, ED, E2, E3, E4	CB, CC, CD, C2, C3, C4	5FA-5FB	5FA-5FB	5DA-5DH	5DA-5DH
	FB, FC, FD, F2, F3, F4	DB, DC, DD, DE,D2, D3, D4, D5				
K4	GB, GC, GD, G2, G3, G4	EB, EC, ED, EE,E2, E3, E4, E5	5FA-5FB	5FA-5FB	5DA-5DJ	5DA-5DJ
	HB, HC, HD, H2, H3, H4	FB, FC, FD, FE,F2, F3, F4, F5				
K7	KB, KC, KD, K2, K3, K4	KB, KC, KD, KE,K2, K3, K4, K5	N/A	N/A	5DD-5DL	5DD-5DL
VOLTAGE (V)			380 up to 415	380 up to 415	2300 up to 11000	3300 up to 11000

Electrical Considerations (Cont'd)

TABLE 11 - 60 HZ ELECTRICAL DATA*

MOTOR CODE	CW	CX	CY	CZ	CA	CB	DA	DB	DC	DD	DE	DF	DH	DJ**	DK	DL
kW (MAX.)	514	542	578	617	660	703	781	859	937	1015	1093	1171	1359	1554	1748	1942
SHAFT HP	655	690	740	790	845	900	1000	1100	1200	1300	1400	1500	1750	2000	2250	2500
FL EFF.-%	95	95	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	96	96	96	96
F.L. Power Factor	0.87	0.87	0.88	0.88	0.89	0.89	0.87	0.87	0.87	0.88	0.88	0.88	0.87	0.89	0.89	0.89

VOLTS		AMPERES (MAX.)															
380	FLA	879	942	997	1065	1126	1200	1364	1500	1636	—	—	—	—	—	—	—
	LRA	5780	6782	5780	6644	7106	7513	7794	8491	9431	—	—	—	—	—	—	—
440	FLA	579	813	861	920	973	1036	1178	1295	1413	—	—	—	—	—	—	—
	LRA	4783	5357	4783	5249	5529	5529	6160	6709	7455	—	—	—	—	—	—	—
460	FLA	726	778	824	880	931	991	1127	1239	1352	—	—	—	—	—	—	—
	LRA	5000	5600	5000	5488	5780	5780	6440	7014	7794	—	—	—	—	—	—	—
480	FLA	696	746	790	843	892	950	1080	1187	1296	—	—	—	—	—	—	—
	LRA	5217	5843	5217	5727	6031	6031	6720	7319	8133	—	—	—	—	—	—	—
575	FLA	581	622	659	704	744	793	901	991	1081	—	—	—	—	—	—	—
	LRA	4039	4440	4300	4200	4694	4963	5148	5610	6232	—	—	—	—	—	—	—
2300	FLA	146	154	165	176	186	198	225	248	267	290	312	334	389	438	493	548
	LRA	935	960	1008	1100	1172	1230	1350	1592	1592	1882	2031	2171	2390	2879	3199	3356
3300	FLA	102	108	115	123	130	138	157	173	186	202	217	233	271	306	344	382
	LRA	652	682	719	744	819	858	942	1110	1110	1311	1514	1416	1661	2011	2388	2479
4000	FLA	84	89	95	101	107	114	130	143	154	166	179	192	224	252	283	315
	LRA	538	540	554	631	674	713	780	923	923	1077	1177	1246	1428	1669	1842	2047
4160	FLA	81	85	91	97	103	110	125	137	149	160	172	185	215	242	273	303
	LRA	560	562	576	656	701	742	811	960	960	1120	1296	1224	1485	1736	1772	1968

* High voltage and special motor designs may not meet efficiency, power factor or amperes values shown for standard motors.

**Min. reduced voltage tap 80%

TABLE 12 - 60 HZ ELECTRICAL DATA - PREMIUM EFFICIENCY

MOTOR CODE		EW	EX	EY	EZ	EA	EB	FA	FB	FC
SHAFT HP (MAX)		655	690	740	790	845	900	1000	1100	1200
INPUT KW (MAX)		508	535	574	612	655	698	775	853	930
F.L. EFF. - %		96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2
F.L. POWER FACTOR		0.87	0.87	0.88	0.87	0.88	0.88	0.87	0.87	0.87
VOLTS		AMPERES (MAX.)								
380	FLA	887	934	990	1069	1131	1204	1354	1489	1624
	LRA	5780	5859	6244	6644	7106	7513	7794	8491	9431
440	FLA	766	807	855	924	977	1040	1169	1286	1403
	LRA	4668	4744	5050	5098	5529	5782	6160	6709	7455
460	FLA	732	772	818	883	934	995	1118	1230	1342
	LRA	4880	4960	5280	5330	5780	6045	6440	7014	7794
480	FLA	702	739	784	847	895	954	1072	1179	1286
	LRA	5092	5175	5510	5562	6031	6308	6720	7319	8133
575	FLA	586	617	654	707	747	796	895	984	1074
	LRA	4039	4100	4200	4200	4694	4963	5148	5610	6232

Note: These motors are designed to meet or exceed NEMA Premium and European IE2 efficiency requirements.

Electrical Considerations (Cont'd)

TABLE 13 - 50 HZ ELECTRICAL DATA*

MOTOR CODE	5CS	5CT	5CU	5CV	5CW	5CX	5DA	5DB	5DC	5DD	5DE	5DF	5DG	5DH	5DJ**	5DK	5DL
kW (MAX)	518	554	591	630	669	709	785	863	942	1015	1093	1171	1288	1360	1554	1748	1942
SHAFT HP	658	704	750	800	850	900	1000	1100	1200	1300	1400	1500	1650	1750	2000	2250	2500
FL EFF. % FL	94.7	94.7	94.7	94.7	94.7	94.7	95	95	95	95.5	95.5	95.5	95.5	96	96	96	96
PF	0.88	0.88	0.89	0.89	0.89	0.89	0.88	0.87	0.88	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89

VOLTS		AMPERES (MAX.)																
380	FLA	895	957	1008	1075	1143	1210	1355	1508	—	—	—	—	—	—	—	—	—
	LRA	5491	5491	6313	6694	7113	7404	7794	8511	—	—	—	—	—	—	—	—	—
400	FLA	850	909	958	1021	1086	1150	1287	1433	—	—	—	—	—	—	—	—	—
	LRA	5780	5780	6645	7046	7487	7794	8204	8959	—	—	—	—	—	—	—	—	—
415	FLA	819	876	923	985	1046	1108	1241	1381	—	—	—	—	—	—	—	—	—
	LRA	5108	5512	5780	6131	6513	6938	7138	7794	—	—	—	—	—	—	—	—	—
3300	FLA	103	110	116	124	132	139	156	174	187	202	217	233	256	267	306	344	382
	LRA	644	693	725	744	819	875	871	1135	1135	1135	1415	1415	1415	1667	1836	2233	2481

* High voltage and special motor designs may not meet efficiency, power factor or amperes values shown for standard motors.

**Min. reduced voltage tap 80%

TABLE 14 - 50 HZ ELECTRICAL DATA - PREMIUM EFFICIENCY

MOTOR CODE		5ES	5ET	5EU	5EV	5EW	5EX	5FA	5FB
SHAFT HP (MAX)		658	704	750	800	850	900	1000	1100
INPUT KW (MAX)		512	548	584	623	662	701	778	856
F.L. EFF. - %		95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8
F.L. POWER FACTOR		0.87	0.88	0.88	0.87	0.87	0.87	0.87	0.87
VOLTS		AMPERES (MAX.)							
380	FLA	894	946	1008	1087	1155	1223	1359	1495
	LRA	5491	5491	6313	6694	7113	7404	7794	7975
400	FLA	850	899	958	1033	1098	1162	1291	1421
	LRA	5780	5780	6645	7046	7487	7794	8204	8395
415	FLA	819	866	923	996	1058	1120	1245	1369
	LRA	5108	5512	5780	6131	6513	6938	7138	7302

Note: These motors are designed to meet or exceed NEMA Premium and European IE2 efficiency requirements.

Electrical Considerations (Cont'd)

TABLE 15 - MOTOR STARTERS

TYPE STARTER	SOLID STATE	STAR-DELTA	AUTO TRANSFORMER		ACROSS-THE-LINE	PRIMARY REACTOR		VARIABLE SPEED DRIVE	
VOLTAGE	MEDIUM	LOW	MEDIUM		HIGH	MEDIUM		LOW	MEDIUM
60HZ	2300-4160	380-575	2300-4160		2300-4160	2300-4160		380-460	2300-4160
50HZ	2300-3300	380-415	2300-3300		2300-3300	2300-3300		380-415	2300-3300
TRANSITION	-	CLOSED	CLOSED		-	CLOSED		-	
% TAP	-	-	65	80	-	65	80	-	
INRUSH AS % OF LRA	45	33	42.3	64	100	65	80	-	

NOTES:
1. For motor starters above 4160V/60Hz and 3300V/50Hz contact your nearest Johnson Controls Sales office for a specific selection.
2. Minimum tap for 5DJ motor is 80%.

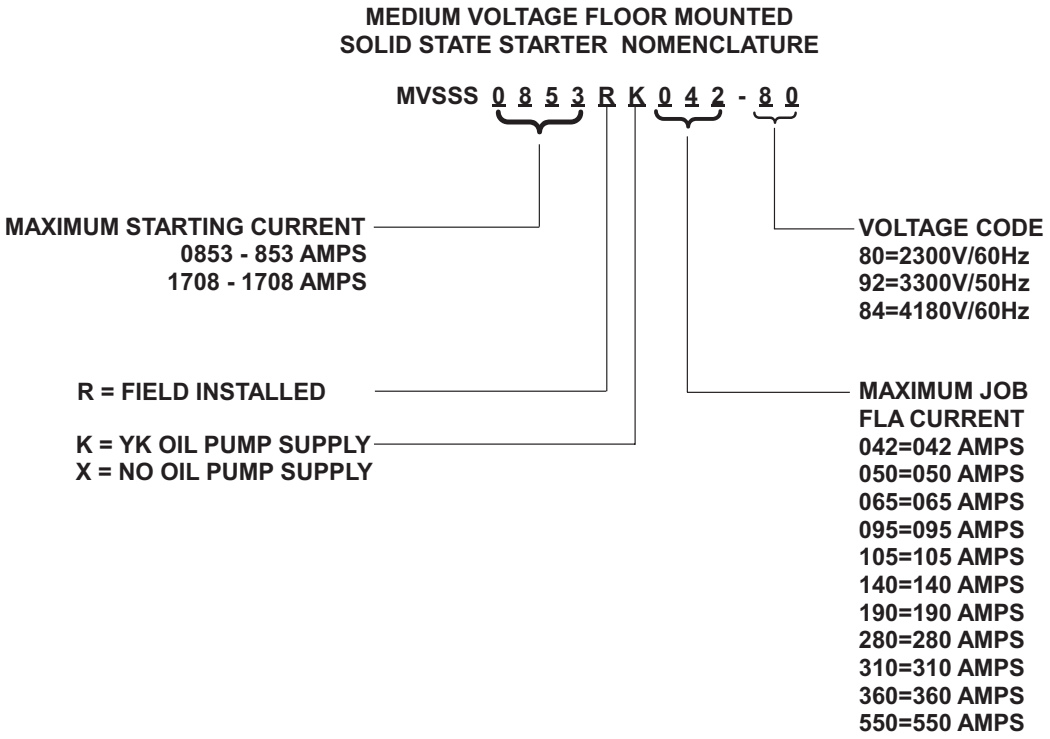
TABLE 16 - LOW VOLTAGE VARIABLE SPEED MODELS

Rated Voltage	Actual Voltage	Phase	Hz	Max. LRA	Max. Motor Hp	Min. FLA	Max. FLA
380	380	3	60	7610	845	300	1126
460	440/460/480			5777	790	200	880
				7014	1048	300	1180
380	380/400	3	50	5780	658	200	880
				8205	917	300	1180
415	415			5512	704	200	876
				6938	900	300	1108

Electrical Considerations (Cont'd)

TABLE 17 - MEDIUM VOLTAGE FLOOR MOUNTED SOLID-STATE STARTER MODELS

MODEL FLOOR MOUNTED MV-SSS	MAXIMUM FLA	MAXIMUM LRA
36" CABINET UNIT MODEL REFERENCE CHART		
MVSSS0853R_095-V	95	1896
MVSSS0853R_105-V	105	1896
MVSSS0853R_140-V	140	1896
MVSSS0853R_190-V	190	1896
MVSSS0853R_280-V	280	1896
MVSSS0853R_310-V	310	1896
MVSSS0853R_360-V	360	1896
MVSSS1708R_360-V	360	3796
72" CABINET UNIT MODEL REFERENCE CHART		
MVSSS1708R_550-V	550	3796

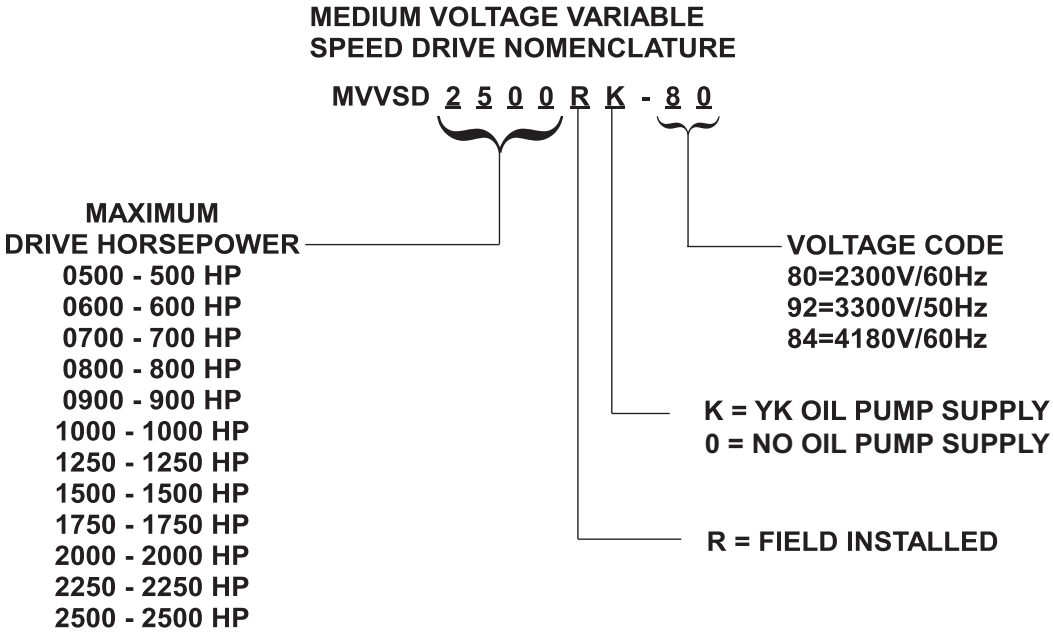


Electrical Considerations (Cont'd)

TABLE 18 - MEDIUM VOLTAGE VARIABLE SPEED DRIVE MODELS

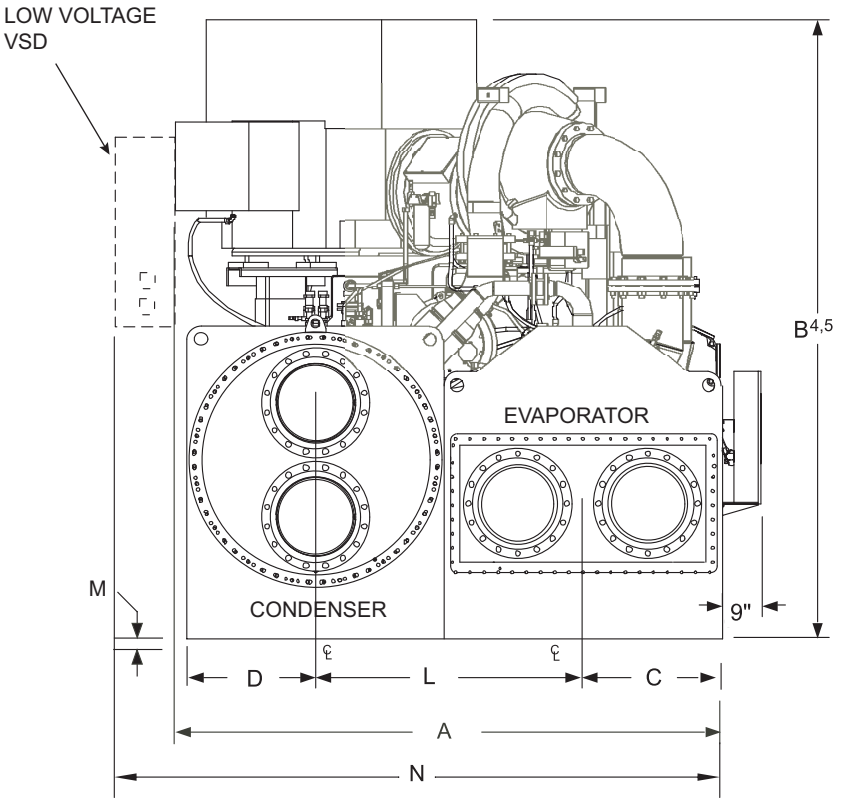
MV-VSD	MAX. MOTOR HP	MAX. FLA	VOLTAGE	PHASE	HZ
MVVSD0500RK-80	500	107	2300	3	60
MVVSD0600RK-80	600	129			
MVVSD0700RK-80	700	157			
MVVSD0800RK-80	800	172			
MVVSD0900RK-80	900	202			
MVVSD1000RK-80	1000	224			
MVVSD1250RK-80	1250	280			
MVVSD1500RK-80	1500	336			
MVVSD1750RK-80	1750	392			
MVVSD2000RK-80	2000	438			
MVVSD2250RK-80	2250	494			
MVVSD2500RK-80	2500	561			
MVVSD0500RK-94	500	78	3300	3	60
MVVSD0600RK-94	600	93			
MVVSD0700RK-94	700	110			
MVVSD0800RK-94	800	124			
MVVSD0900RK-94	900	141			
MVVSD1000RK-94	1000	156			
MVVSD1250RK-94	1250	195			
MVVSD1500RK-94	1500	235			
MVVSD1750RK-94	1750	274			
MVVSD2000RK-94	2000	312			
MVVSD2250RK-94	2250	345			
MVVSD2500RK-94	2500	391			
MVVSD0500RK-92S	500	62	4160	3	60
MVVSD0600RK-92S	600	74			
MVVSD0700RK-92S	700	87			
MVVSD0800RK-92S	800	99			
MVVSD0900RK-92S	900	112			
MVVSD1000RK-92S	1000	125			
MVVSD1250RK-92S	1250	155			
MVVSD1500RK-92S	1500	186			
MVVSD1750RK-92S	1750	217			
MVVSD2000RK-92S	2000	248			
MVVSD2250RK-92S	2250	274			
MVVSD2500RK-92S	2500	310			
MVVSD0500RK-92	500	78	3300	3	50
MVVSD0600RK-92	600	93			
MVVSD0700RK-92	700	110			
MVVSD0800RK-92	800	124			
MVVSD0900RK-92	900	141			
MVVSD1000RK-92	1000	156			
MVVSD1250RK-92	1250	195			
MVVSD1500RK-92	1500	235			
MVVSD1750RK-92	1750	274			
MVVSD2000RK-92	2000	312			
MVVSD2250RK-92	2250	345			
MVVSD2500RK-92	2500	391			

Electrical Considerations (Cont'd)

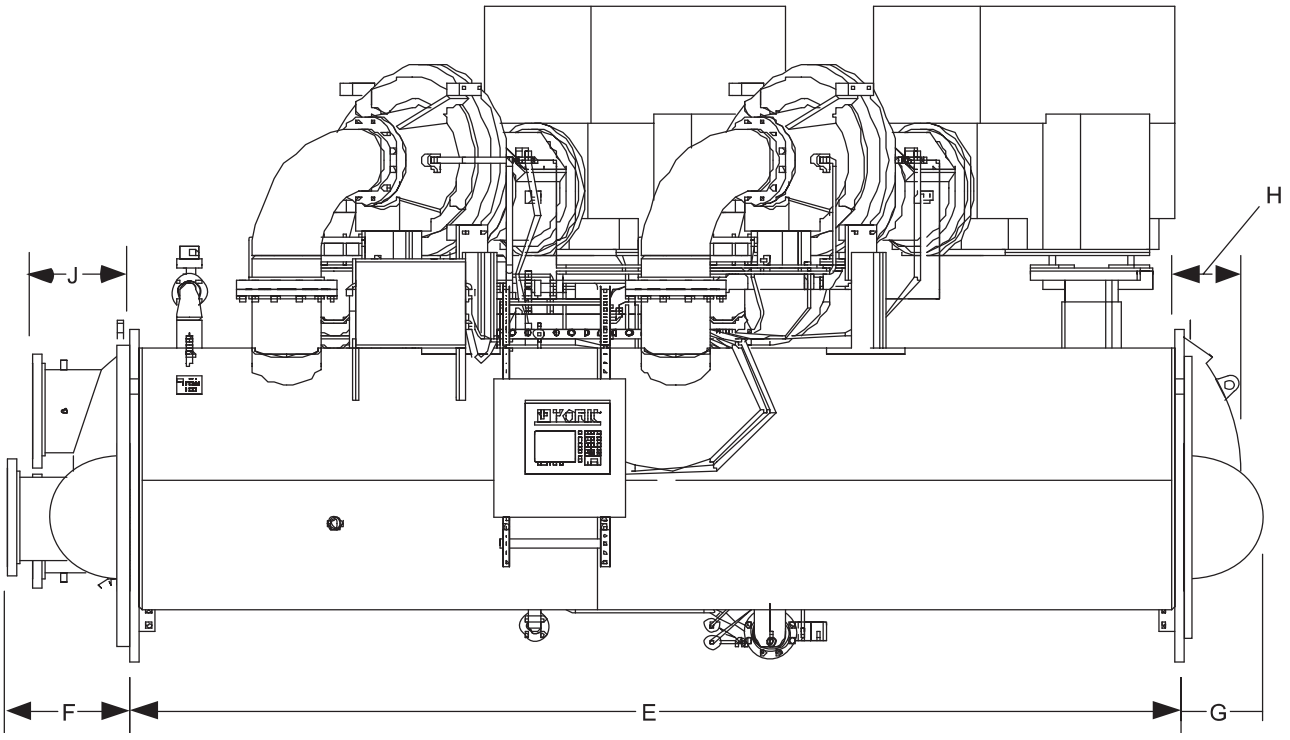


Dimensions

K COMPRESSOR UNITS



LD18373



LD18374

Dimensions (Cont'd)

EVAPORATOR - CONDENSER SHELL CODES FT-IN (MM)								
DIM.	B-L	M-M	N-B	E-C	F-D	G-E	H-F	K-K
A	11’-6” (3505)	11’-6” (3505)	11’-11” (3632)	13’-4” (4064)	14’-6” (4420)	14’-6” (4420)	15’-0” (4572)	16’-0” (4877)
B	12’-8” (3861)	12’-8” (3861)	13’-0” (3962)	13’-10” (4216)	14’-4” (4369)	14’-4” (4369)	14’-10” (4521)	15’-3” (4648)
C	2’-8” (813)	2’-8” (813)	2’-11 1/2” (902)	3’-5” (1041)	3’-9” (1143)	3’-9” (1143)	4’-0” (1219)	4’-0” (1219)
D	2’-5 1/2” (749)	2’-5 1/2” (749)	2’-5 1/2” (749)	2’-8” (813)	3’-1 1/2” (953)	3’-1 1/2” (953)	3’-1 1/2” (953)	3’-4” (1016)
E	18’-0” (5486)	22’-0” (6706)	18’-0” (5486)	22’-0” (6706)	18’-0” (5486)	22’-0” (6706)	18’-0” (5486)	22’-0” (6706)
F	5’-1 1/2” (1562)	5’-1 1/2” (1562)	5’-5” (1651)	6’-1” (1854)	6’-10 1/2” (2096)	6’-10 1/2” (2096)	7’-1 1/2” (2172)	7’-4” (2235)
N	13'-3" (4039)	13'-3" (4039)	14’-5” (4395)	15’-10” (4826)	17’ (5182)	N/A	N/A	N/A

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

NOTES:

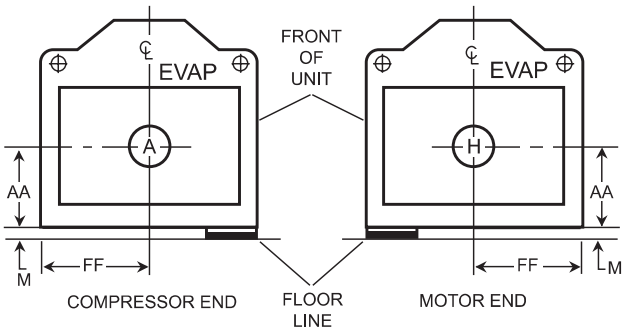
1. All dimensions are approximate. Certified dimensions are available on request.
2. For compact water boxes (shown above), determine overall unit length by adding water box depth to tube sheet length. For Marine Water Boxes, see pages 62-67.
3. Water nozzles can be located on either end of unit. Add 1/2" to nozzle length for flanges connections.
4. To determine overall height, add dimension "M" for the appropriate isolator type. See table above.
5. Use of motors with motor hoods may increase overall unit dimensions. Add 6" for 5DJ size motor.

Dimensions (Cont'd)

EVAPORATORS – COMPACT WATER BOXES

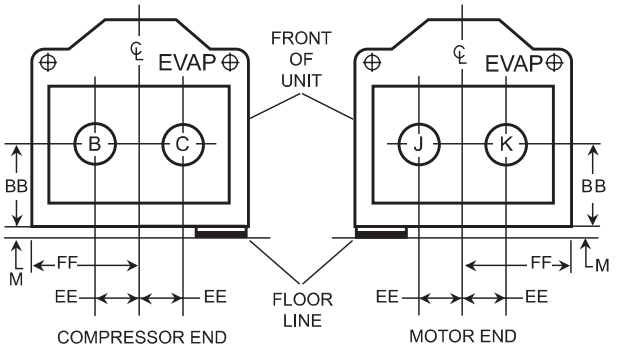
B, M, N SHELLS

1-PASS



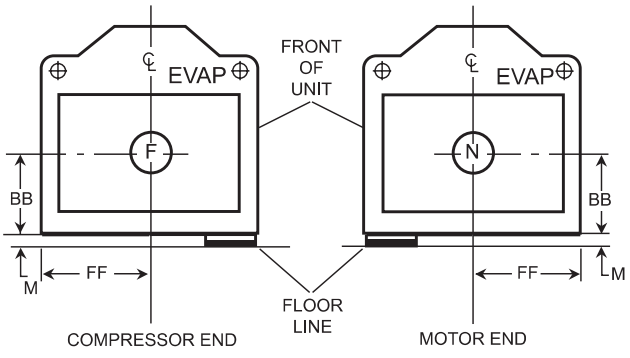
NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	IN	OUT
1	A	H
	H	A

2-PASS



NOZZLE ARANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	B, M, N	
	IN	OUT
2	B	C
	C	B
	J	K
	K	J

3-PASS



LD08641

NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	IN	OUT
3	F	N
	N	F

Dimensions (Cont'd)

EVAPORATORS – COMPACT WATER BOXES

B, M, N SHELLS

EVAPORATOR SHELL CODE	NOZZLE PIPE SIZE NUMBER OF PASSES (IN)			NOZZLE DIMENSIONS FT-IN (MM)								
	1 PASS	2 PASS	3 PASS	1-PASS		2-PASS				3-PASS		
	1	2	3	AA[2]	FF	AA	BB[2]	EE	FF	BB[2]	EE	FF
B,M	20”	18”	14”	2’-8 1/4” (819)	2’-8” (813)	—	2’-8 1/4” (819)	1’-3” (381)	2’-8” (813)	2’-8 1/4” (813)	—	2’-8” (813)
N	20”	18”	14”	2’-10 1/2” (876)	2’-11” (889)	—	2’-10 1/2” (889)	1’-3” (381)	2’-11” (889)	2’-10 1/2” (889)	—	2’-11” (889)
E	24”	20”	16”	4’-1” (1245)	3’-5” (1041)	3’-0” (914)	5’-2” (1575)	1’-1” (330)	3’-5” (1041)	4’-1” (1245)	1’-4” (406)	3’-5” (1041)
F,G	24”	20”	18”	4’-9 1/2” (1461)	3’-9” (1143)	3’-8 1/2” (1130)	5’-10 1/2” (1791)	1’-1” (330)	3’-9” (1143)	4’-9 1/2” (1461)	1’-4” (406)	3’-9” (1143)
H,K	24”	20”	18”	5’-0 1/2” (1537)	4’-0” (1219)	3’-11 1/2” (1207)	6’-1 1/2” (1867)	1’-1” (330)	4’-0” (1219)	5’-0 1/2” (1537)	1’-4” (406)	4’-0” (1219)

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

NOTES:

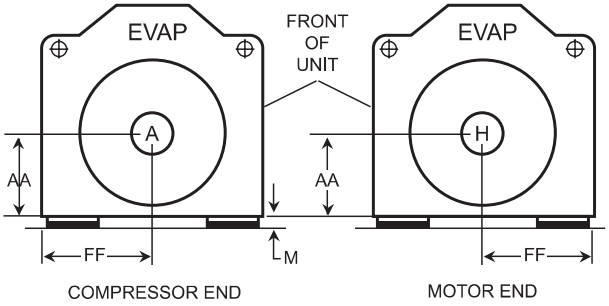
1. Standard water nozzles are furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. Add dimension "M" for the appropriate isolator type.
3. One , two and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles.
4. Connected piping should allow for removal of compact water boxes for tube access and cleaning.

Dimensions (Cont'd)

EVAPORATORS – COMPACT WATER BOXES

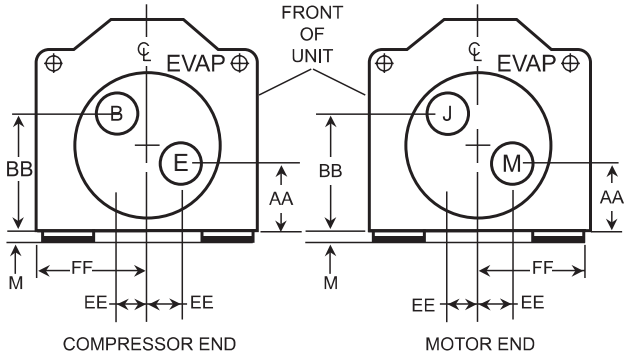
E, F, G, H, K SHELLS

1-PASS



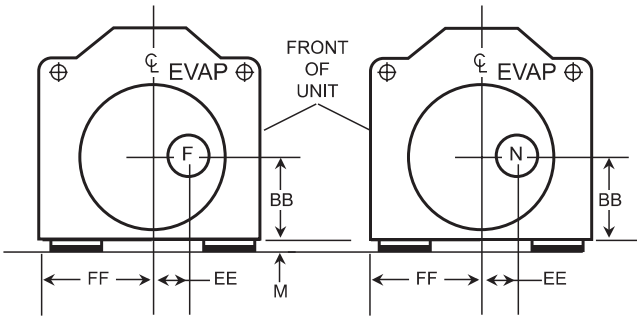
NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	IN	OUT
1	A	H
	H	A

2-PASS



NOZZLE ARANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	E, F,G, H, K	
	IN	OUT
2	–	–
	E	B
	–	–
	M	J

3-PASS



NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	EVAPORATOR CODES	
	IN	OUT
3	F	N
	N	F

LD08640 COMPRESSOR END MOTOR END

Dimensions (Cont'd)

EVAPORATORS – COMPACT WATER BOXES

E, F, G, H, K SHELLS

EVAPORATOR SHELL CODE	NOZZLE PIPE SIZE NUMBER OF PASSES (IN)			NOZZLE DIMENSIONS FT-IN (MM)								
	1 PASS	2 PASS	3 PASS	1-PASS		2-PASS				3-PASS		
	1	2	3	AA[2]	FF	AA	BB[2]	EE	FF	BB[2]	EE	FF
B,M	20”	18”	14”	2’-8 1/4” (819)	2’-8” (813)	—	2’-8 1/4” (819)	1’-3” (381)	2’-8” (813)	2’-8 1/4” (813)	—	2’-8” (813)
N	20”	18”	14”	2’-10 1/2” (876)	2’-11” (889)	—	2’-10 1/2” (889)	1’-3” (381)	2’-11” (889)	2’-10 1/2” (889)	—	2’-11” (889)
E	24”	20”	16”	4’-1” (1245)	3’-5” (1041)	3’-0” (914)	5’-2” (1575)	1’-1” (330)	3’-5” (1041)	4’-1” (1245)	1’-4” (406)	3’-5” (1041)
F,G	24”	20”	18”	4’-9 1/2” (1461)	3’-9” (1143)	3’-8 1/2” (1130)	5’-10 1/2” (1791)	1’-1” (330)	3’-9” (1143)	4’-9 1/2” (1461)	1’-4” (406)	3’-9” (1143)
H,K	24”	20”	18”	5’-0 1/2” (1537)	4’-0” (1219)	3’-11 1/2” (1207)	6’-1 1/2” (1867)	1’-1” (330)	4’-0” (1219)	5’-0 1/2” (1537)	1’-4” (406)	4’-0” (1219)

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

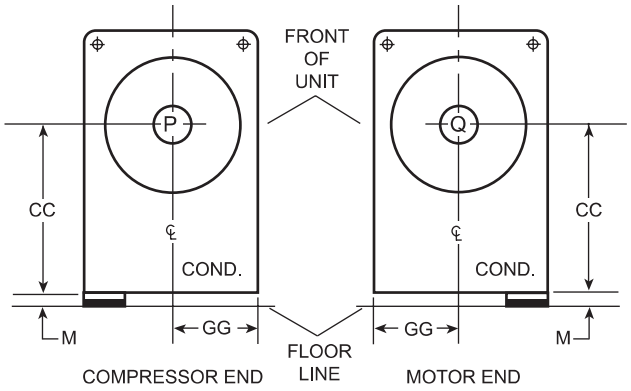
NOTES:

1. Standard water nozzles are furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. Add dimension "M" for the appropriate isolator type.
3. One , two and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles.
4. Connected piping should allow for removal of compact water boxes for tube access and cleaning.

Dimensions (Cont'd)

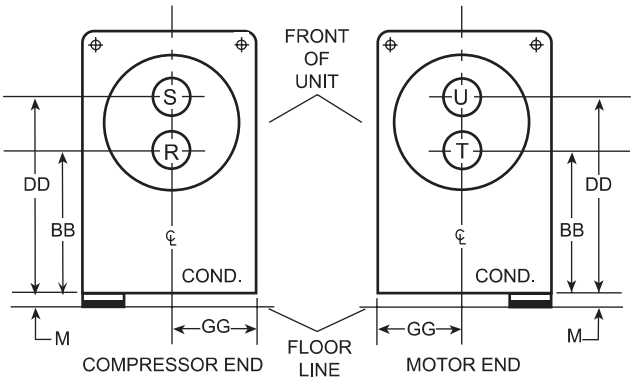
CONDENSERS – COMPACT WATER BOXES

1-PASS



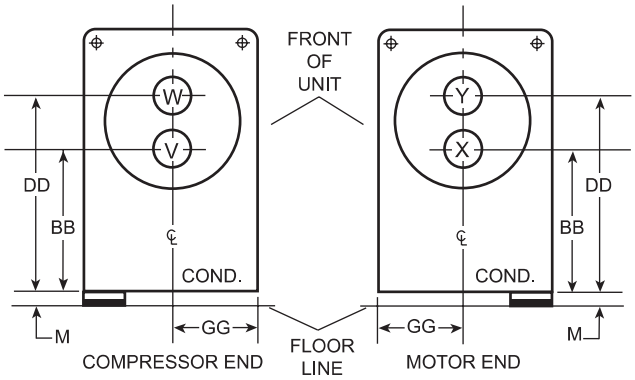
CONDENSER NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	CONDENSER	
	IN	OUT
1	P	Q
	Q	P

2-PASS



CONDENSER NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	CONDENSER	
	IN	OUT
2	R	S
	T	U

3-PASS



CONDENSER NOZZLE ARRANGEMENTS		
NUMBER OF PASSES	CONDENSER	
	IN	OUT
3	V	Y
	X	W

LD06843

Dimensions (Cont'd)

CONDENSERS – COMPACT WATER BOXES

CONDENSER SHELL CODE	NOZZLE PIPE SIZE NO. OF PASSES (IN)			NOZZLE DIMENSIONS FT-IN (MM)							
	1 PASS	2 PASS	3 PASS	1 PASS		2 PASS			3 PASS		
	1	2	3	CC[2]	GG	BB[2]	DD[2]	GG	BB[2]	DD	GG
L, M	20”	18”	14”	3’-6” (1067)	2’-5 1/2” (749)	2’-5” (737)	4’-7” (1397)	2’-5 1/2” (749)	2’-5” (737)	4’-7” (1397)	2’-5 1/2” (749)
B	24”	18”	16”	3’-6 3/4” (1086)	2’-5 1/2” (749)	2’-4 1/2” (724)	4’-9 1/4” (1461)	2’-5 1/2” (749)	2’-4 1/4” (718)	4’-9 1/4” (1461)	2’-5 1/2” (749)
C	24”	20”	16”	3’-11 1/2” (1207)	2’-8” (813)	2’-7 1/2” (800)	5’-3 1/2” (1613)	2’-8” (813)	2’-7 1/2” (800)	5’-3 1/2” (1613)	2’-8” (813)
D, E	24”	20”	18”	4’-0” (1219)	3’-1 1/2” (953)	2’-8 1/2” (826)	5’-3 1/2” (1613)	3’-1 1/2” (953)	2’-6” (762)	5-6” (1676)	3’-1 1/2” (953)
F	24”	24”	20”	4’-4” (1321)	3’-1 1/2” (953)	2’-9 1/2” (851)	5’-10 1/2” (1791)	3’-1 1/2” (953)	2’-8” (813)	6’-0” (1829)	3’-1 1/2” (953)
K	24”	24”	20”	4’-6” (1372)	3’-4” (1016)	3’-0” (914)	6’-0” (1829)	3-4” (1016)	2’-9 3/4” (857)	6’-2 1/4” (1886)	3’-4” (1016)

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

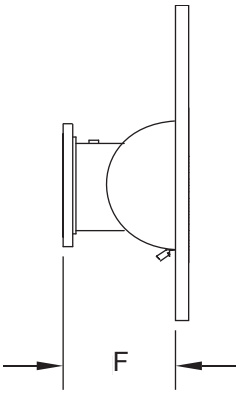
NOTES:

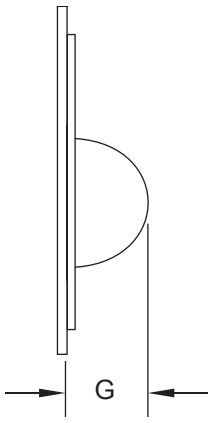
1. Standard water nozzles are furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. Add dimension "M" for the appropriate isolator type.
3. One , two and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles.
4. Connected piping should allow for removal of compact water boxes for tube access and cleaning.

Dimensions (Cont'd)

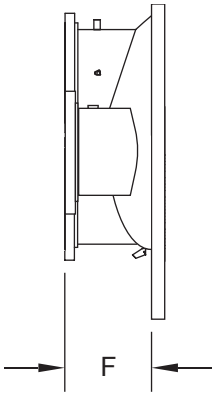
EVAPORATORS – COMPACT WATER BOXES

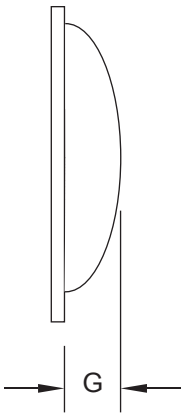
B, M, N SHELLS





E, F, G, H, K SHELLS



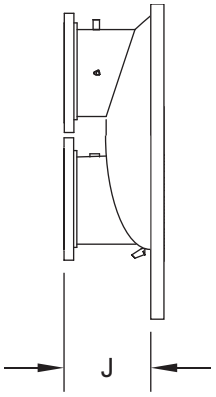


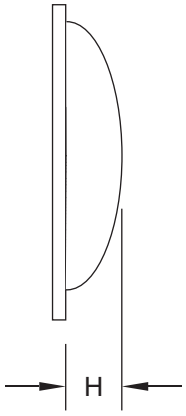
LD18375

EVAPORATOR - CONDENSER SHELL CODES FT-IN (MM)								
DIM.	**B-L**	**M-M**	**N-B**	**E-C**	**F-D**	**G-E**	**H-F**	**K-K**
F	2’-3/4” (629)	2’-3/4” (629)	2’-1 11/16” (660)	2’-13/16” (635)	2’-3” (686)	2’-3” (686)	2’-3 9/16” (699)	2’-3 9/16” (699)
G	1’-4 1/2” (419)	1’-4 1/2” (419)	1’-5 11/16” (445)	1’-4 3/16” (413)	1’-6 1/4” (464)	1’-6 1/4” (464)	1’-6 7/8” (483)	1’-6 7/8” (483)

Dimensions (Cont'd)

CONDENSERS – COMPACT WATER BOXES





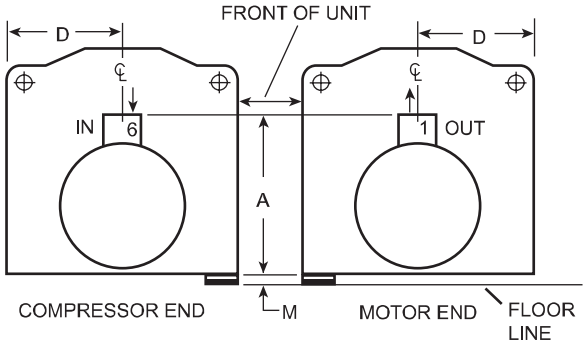
LD18376

EVAPORATOR - CONDENSER SHELL CODES FT-IN (MM)								
DIM.	**B-L**	**M-M**	**N-B**	**E-C**	**F-D**	**G-E**	**H-F**	**K-K**
H	0’-11 11/16” (305)	0’-11 11/16” (305)	0’-11” (279)	0’-11” (279)	1’-2 9/16” (368)	1’-2 9/16” (368)	1’-3 9/16” (394)	1’-4 3/16” (413)
J	1’-7 3/8” (492)	1’-7 3/8” (492)	1’-7 1/2” (495)	1’-7 3/8” (492)	2’-1 1/2” (648)	2’-1 1/2” (648)	2’-2” (660)	2’-13/16” (635)

Dimensions (Cont'd)

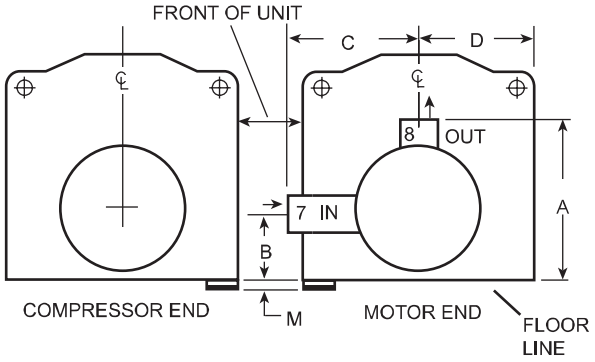
EVAPORATORS – MARINE WATER BOXES

1-PASS



EVAPORATOR	
1 PASS	
IN	OUT
6	1

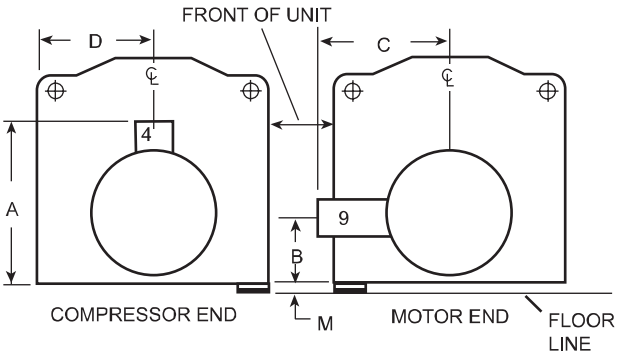
2-PASS



EVAPORATOR	
2 PASS	
IN	OUT
7	8

3-PASS

IN-4, OUT-9: D-K Evaporators Only
IN-9, OUT-4: All YD Evaporators



EVAPORATOR	
3 PASS	
IN	OUT
9	4

LD08644A

Dimensions (Cont'd)

EVAPORATORS – MARINE WATER BOXES

EVAPORATOR SHELL CODE	EVAPORATOR NOZZLE DIMENSIONS - FT-IN (mm)									
	1 PASS		2 PASS				3 PASS			
	A[5]	D	A[5]	B[5]	C	D	A[5]	B[5]	C	D
B, M	6'-5 3/4" (1975)	2'-8" (813)	6'-5 3/4" (1975)	1'-3 3/4" (400)	3'-0 1/4" (921)	2'-8" (813)	6'-5 3/4" (1975)	1'-3 3/4" (400)	3'-0 1/4" (921)	2'-8" (813)
N	7'-1 1/4" (2165)	2' 11 1/2" (902)	7'-1 1/4" (2165)	1'-9 3/4" (540)	3'-0 3/4" (933)	2' 11 1/2" (902)	7'-1 1/4" (2165)	1'-9 3/4" (540)	3'-0 3/4" (933)	2'-11 1/2" (902)
E	7'-8 1/2" (2350)	3'-5" (1041)	7'-8 1/2" (2350)	4'-1" (1245)	3'-7 1/2" (1105)	3'-5" (1041)	7'-8 1/2" (2350)	4'-1" (1245)	3'-7 1/2" (1105)	3'-5" (1041)
F, G	8'-9 3/4" (2686)	3'-9" (1143)	8'-9 3/4" (2686)	4'-9 1/2" (1461)	4'-0 1/4" (1226)	3'-9" (1143)	8'-9 3/4" (2686)	4'-9 1/2" (1461)	4'-0 1/4" (1226)	3'-9" (1143)
H, K	9'-4" (2845)	4'-0" (1219)	9'-4" (2845)	5'-0 1/2" (1537)	4'-3 1/2" (1308)	4'-0" (1219)	9'-4" (2845)	5'-0 1/2" (1537)	4'-3 1/2" (1308)	4'-0" (1219)

EVAPORATOR SHELL CODE	NOZZLE PIPE SIZE (IN) Number OF PASSES		
	1	2	3
B,M	20"	18"	14"
N	20"	18"	14"
E	24"	20"	16"
F.G	24"	20"	18"
H, K	24"	20"	18"

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

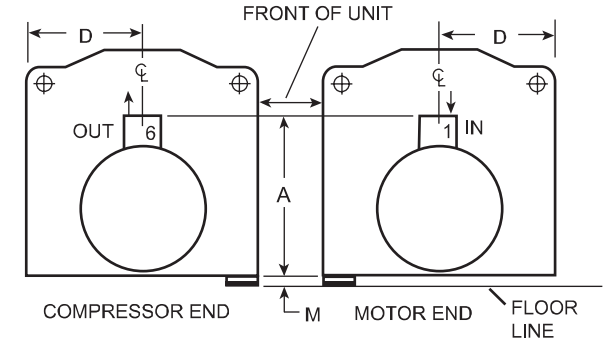
NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Standard wall (0.375") pipe size, furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One , two , and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact water boxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.
4. Water must enter the water box through the bottom connection to achieve rated performance.
5. Add dimension "M" for the appropriate isolator type.

Dimensions (Cont'd)

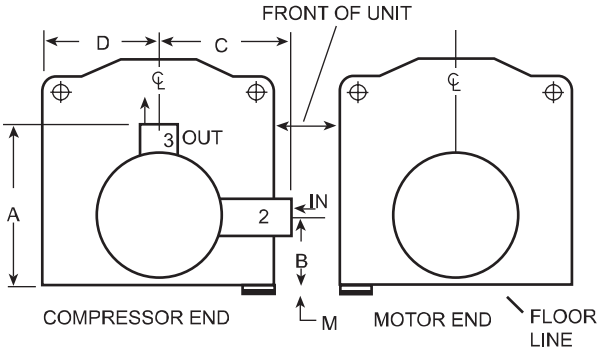
EVAPORATORS – MARINE WATER BOXES

1-PASS



EVAPORATOR	
1 PASS	
IN	OUT
1	6

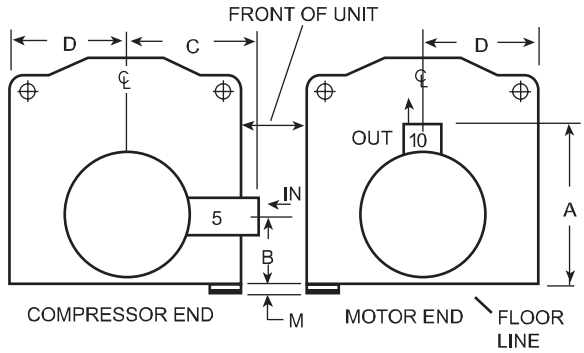
2-PASS



EVAPORATOR	
2 PASS	
IN	OUT
2	3

3-PASS

B, C Shells Only



EVAPORATOR	
3 PASS	
IN	OUT
5	10

LD08644B

Dimensions (Cont'd)

EVAPORATORS – MARINE WATER BOXES

EVAPORATOR SHELL CODE	EVAPORATOR NOZZLE DIMENSIONS - FT-IN (mm)									
	1 PASS		2 PASS				3 PASS			
	A[5]	D	A[5]	B[5]	C	D	A[5]	B[5]	C	D
B, M	6'-5 3/4" (1975)	2'-8" (813)	6'-5 3/4" (1975)	1'-3 3/4" (400)	3'-0 1/4" (921)	2'-8" (813)	6'-5 3/4" (1975)	1'-3 3/4" (400)	3'-0 1/4" (921)	2'-8" (813)
N	7'-1 1/4" (2165)	2' 11 1/2" (902)	7'-1 1/4" (2165)	1'-9 3/4" (540)	3'-0 3/4" (933)	2' 11 1/2" (902)	7'-1 1/4" (2165)	1'-9 3/4" (540)	3'-0 3/4" (933)	2'-11 1/2" (902)
E	7'-8 1/2" (2350)	3'-5" (1041)	7'-8 1/2" (2350)	4'-1" (1245)	3'-7 1/2" (1105)	3'-5" (1041)	7'-8 1/2" (2350)	4'-1" (1245)	3'-7 1/2" (1105)	3'-5" (1041)
F, G	8'-9 3/4" (2686)	3'-9" (1143)	8'-9 3/4" (2686)	4'-9 1/2" (1461)	4'-0 1/4" (1226)	3'-9" (1143)	8'-9 3/4" (2686)	4'-9 1/2" (1461)	4'-0 1/4" (1226)	3'-9" (1143)
H, K	9'-4" (2845)	4'-0" (1219)	9'-4" (2845)	5'-0 1/2" (1537)	4'-3 1/2" (1308)	4'-0" (1219)	9'-4" (2845)	5'-0 1/2" (1537)	4'-3 1/2" (1308)	4'-0" (1219)

EVAPORATOR SHELL CODE	NOZZLE PIPE SIZE (IN)		
	Number OF PASSES		
	1	2	3
B,M	20"	18"	14"
N	20"	18"	14"
E	24"	20"	16"
F.G	24"	20"	18"
H, K	24"	20"	18"

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

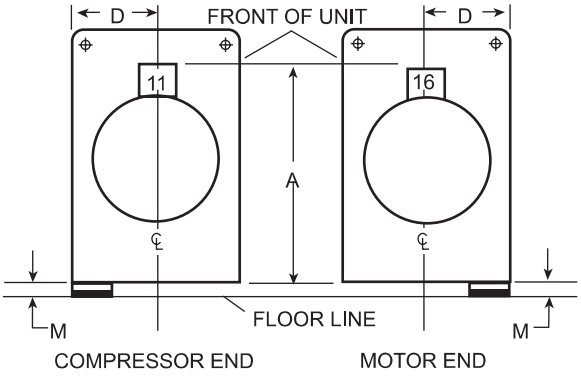
NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Standard wall (0.375") pipe size, furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One , two , and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact water boxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.
4. Water must enter the water box through the bottom connection to achieve rated performance.
5. Add dimension "M" for the appropriate isolator type.

Dimensions (Cont'd)

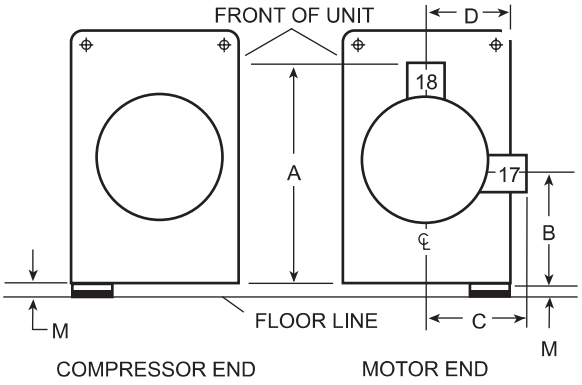
CONDENSERS – MARINE WATER BOXES

1-PASS



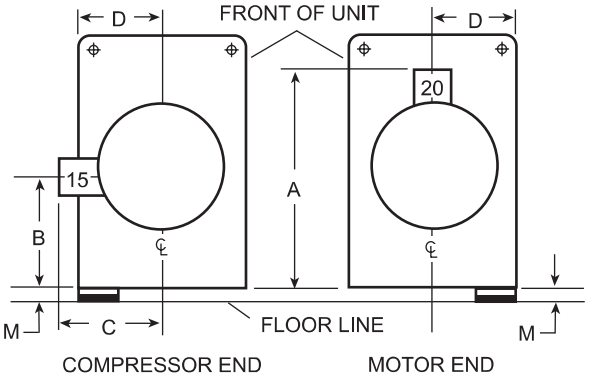
CONDENSER	
1 PASS	
IN	OUT
11	16
16	11

2-PASS



CONDENSER	
2 PASS	
IN	OUT
17	18

3-PASS



CONDENSER	
3 PASS	
IN	OUT
15	20

LD08645A

Dimensions (Cont'd)

CONDENSERS – MARINE WATER BOXES

CONDENSER SHELL CODE	CONDENSER NOZZLE DIMENSIONS IN (MM)									
	1 PASS		2 PASS				3 PASS			
	A[5]	D	A[5]	B[5]	C	D	A[5]	B[5]	C	D
L, M	6'-2 1/2" (1892)	2'-5 1/2" (749)	6'-2 1/2" (1892)	2'-2" (660)	2'-7 1/2" (800)	2'-5 1/2" (749)	6'-2 1/2" (1892)	2'-2" (660)	2'-7 1/2" (800)	2'-5 1/2" (749)
B	6' 5 1/2" (1969)	2'-5 1/2" (749)	6' 5 1/2" (1969)	2' 1 1/4" (641)	2'-10" (864)	2'-5 1/2" (749)	6' 5 1/2" (1969)	2' 1 1/4" (641)	2'-10" (864)	2'-5 1/2" (749)
C	7'-0" (2134)	2'-8" (813)	7'-0" (2134)	2'-6" (762)	2'-11 1/2 (902)	2'-8" (813)	7'-0" (2134)	2'-6" (762)	2'-11 1/2 (902)	2'-8" (813)
D,E	7'-4" (2235)	3-1 1/2" (953)	7'-4" (2235)	2'-9" (838)	3'-4" (1016)	3-1 1/2" (953)	7'-4" (2235)	2'-5" (737)	3'-4" (1016)	3-1 1/2" (953)
F	7'-10" (2388)	3-1 1/2" (953)	7'-10" (2388)	3'-1" (940)	3'-6" (1067)	3-1 1/2" (953)	7'-10" (2388)	2'-8" (813)	3'-6" (1067)	3-1 1/2" (953)
K	8'-1 1/2" (2477)	3'-4" (1016)	8'-1 1/2" (2477)	3'-2" (965)	3'-7 1/2" (1105)	3'-4" (1016)	8'-1 1/2" (2477)	2'-10" (864)	3'-7 1/2" (1105)	3'-4" (1016)

CONDENSER SHELL CODE	NOZZLE PIPE SIZE (IN) NO. OF PASSES		
	1	2	3
L, M	20"	18"	14"
B	24"	18"	16"
C	24"	20"	16"
D, E	24"	20"	18"
F, K	24"	24"	20"

ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

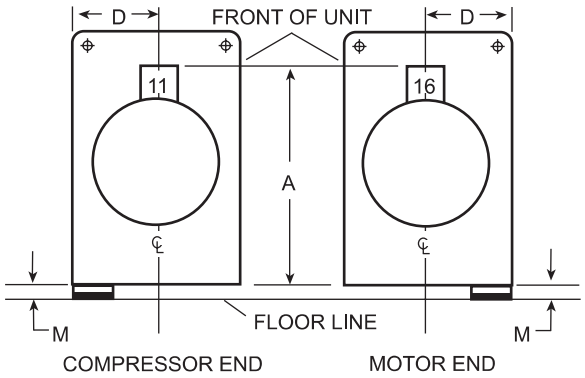
NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Standard wall (0.375") pipe size, furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One , two , and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact water boxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.
4. Water must enter the water box through the bottom connection to achieve rated performance.
5. Add dimension "M" for the appropriate isolator type.

Dimensions (Cont'd)

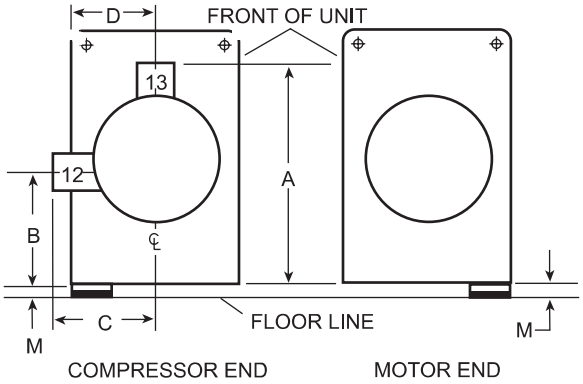
CONDENSERS – MARINE WATER BOXES

1-PASS



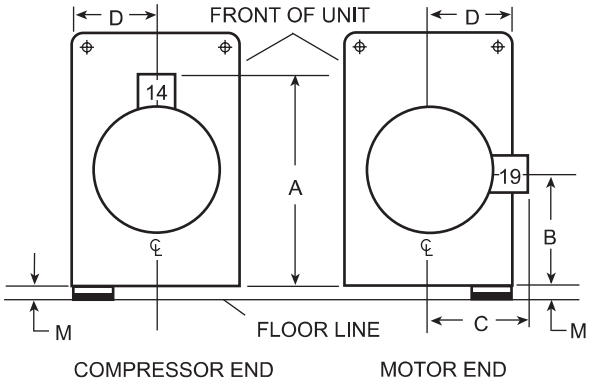
CONDENSER	
1 PASS	
IN	OUT
11	16
16	11

2-PASS



CONDENSER	
2 PASS	
IN	OUT
12	13
-	-

3-PASS



CONDENSER	
3 PASS	
IN	OUT
-	-
19	14

LD08645B

Dimensions (Cont'd)

CONDENSERS – MARINE WATER BOXES

CONDENSER SHELL CODE	CONDENSER NOZZLE DIMENSIONS IN (MM)									
	1 PASS		2 PASS				3 PASS			
	A[5]	D	A[5]	B[5]	C	D	A[5]	B[5]	C	D
L, M	6'-2 1/2" (1892)	2'-5 1/2" (749)	6'-2 1/2" (1892)	2'-2" (660)	2'-7 1/2" (800)	2'-5 1/2" (749)	6'-2 1/2" (1892)	2'-2" (660)	2'-7 1/2" (800)	2'-5 1/2" (749)
B	6' 5 1/2" (1969)	2'-5 1/2" (749)	6' 5 1/2" (1969)	2' 1 1/4" (641)	2'-10" (864)	2'-5 1/2" (749)	6' 5 1/2" (1969)	2' 1 1/4" (641)	2'-10" (864)	2'-5 1/2" (749)
C	7'-0" (2134)	2'-8" (813)	7'-0" (2134)	2'-6" (762)	2'-11 1/2 (902)	2'-8" (813)	7'-0" (2134)	2'-6" (762)	2'-11 1/2 (902)	2'-8" (813)
D,E	7'-4" (2235)	3-1 1/2" (953)	7'-4" (2235)	2'-9" (838)	3'-4" (1016)	3-1 1/2" (953)	7'-4" (2235)	2'-5" (737)	3'-4" (1016)	3-1 1/2" (953)
F	7'-10" (2388)	3-1 1/2" (953)	7'-10" (2388)	3'-1" (940)	3'-6" (1067)	3-1 1/2" (953)	7'-10" (2388)	2'-8" (813)	3'-6" (1067)	3-1 1/2" (953)
K	8'-1 1/2" (2477)	3'-4" (1016)	8'-1 1/2" (2477)	3'-2" (965)	3'-7 1/2" (1105)	3'-4" (1016)	8'-1 1/2" (2477)	2'-10" (864)	3'-7 1/2" (1105)	3'-4" (1016)

CONDENSER SHELL CODE	NOZZLE PIPE SIZE (IN) NO. OF PASSES		
	1	2	3
L, M	20"	18"	14"
B	24"	18"	16"
C	24"	20"	16"
D, E	24"	20"	18"
F, K	24"	24"	20"

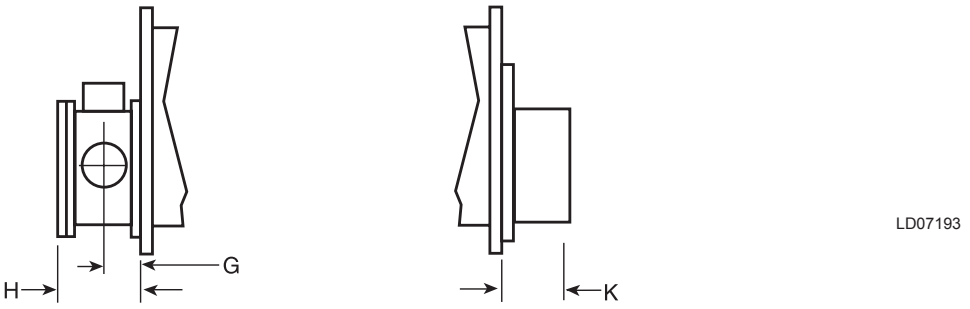
ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4" (44)
SPRING ISOLATORS 1" DEFLECTION	1" (25)
DIRECT MOUNT	3/4" (19)

NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Standard wall (0.375") pipe size, furnished as welding stub outs with ANSI/AWWA C-606 couplings grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory installed, class 150 (ANSI B16.5, round slip on, forged carbon steel with 1/16" raised face), water flanged nozzles are optional (add 1/2" to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One , two , and three pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact water boxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.
4. Water must enter the water box through the bottom connection to achieve rated performance.
5. Add dimension "M" for the appropriate isolator type.

Dimensions (Cont'd)

EVAPORATORS – MARINE WATER BOXES



(2-PASS BACK HEAD)

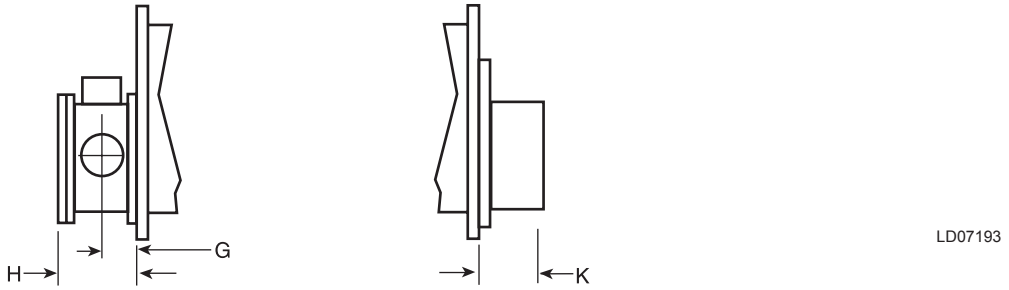
1-PASS EVAPORATOR SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	EVAPORATOR NOZZLE DIMENSIONS - FT-IN (MM)	
		G	H
B,M	150 (1034)	1’-2 1/2” (368)	2’-8” (813)
	300 (2068)	1’-3 3/4” (400)	2’-11 1/4” (895)
N	150 (1034)	1’-2 1/2” (368)	2’-8” (813)
	300 (2068)	1’-3 1/4” (387)	2’-9 1/2” (851)
E	150 (1034)	1’-6 1/2” (470)	3’-4 1/2” (1029)
	300 (2068)	1’-9 3/4” (552)	3’-11” (1194)
F,G	150 (1034)	1’-7” (483)	3’-5 3/4” (1060)
	300 (2068)	1’-10” (559)	4’-0” (1219)
H,K	150 (1034)	1’-6 1/2” (470)	3’-5” (1041)
	300 (2068)	1’-9 1/2” (546)	3’-11” (1194)

2-PASS EVAPORATOR SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	EVAPORATOR NOZZLE DIMENSIONS - FT-IN (MM)		
		G	H	K
B,M	150 (1034)	1’-1 1/2” (343)	2’-6” (762)	0’-11” (279)
	300 (2068)	1’-2 3/4” (375)	2’-9 1/4” (845)	1’-2 1/2” (368)
N	150 (1034)	1’-1 1/2” (343)	2’-6” (762)	0’-11” (279)
	300 (2068)	1’-2 1/2” (368)	2’-8” (813)	1’-3” (381)
E	150 (1034)	1’-4 1/4” (413)	3’-0” (914)	1’-4” (406)
	300 (2068)	1’-7” (483)	3’-5 1/2” (1054)	1’-5 1/2” (445)
F,G	150 (1034)	1’-4 1/2” (419)	3’-1 1/4” (946)	1’-6 1/4” (464)
	300 (2068)	1’-7 1/4” (489)	3’-6 1/2” (1080)	1’-7 1/2” (495)
H,K	150 (1034)	1’-4 1/4” (413)	3’- 1/2” (927)	1’-7” (483)
	300 (2068)	1’-6 3/4” (476)	3’-5 1/2” (1054)	1’-8” (508)

3-PASS EVAPORATOR SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	EVAPORATOR NOZZLE DIMENSIONS - FT-IN (MM)	
		G	H
B,M	150 (1034)	1’-1 1/2” (343)	2’-6” (762)
	300 (2068)	1’-2 3/4” (375)	2’-9 1/4” (845)
N	150 (1034)	1’-1 1/2” (343)	2’-6” (762)
	300 (2068)	1’-2 1/2” (368)	2’-8” (813)
E	150 (1034)	1’-2 1/4” (362)	2’-8” (813)
	300 (2068)	1’-4 1/2” (419)	3’- 1/2” (927)
F,G	150 (1034)	1’-3 1/2” (394)	3’- 10 3/4” (1187)
	300 (2068)	1’-6” (457)	3’-4” (1016)
H,K	150 (1034)	1’-3” (381)	2’-10” (864)
	300 (2068)	1’-5 1/2” (445)	3’-3” (991)

Dimensions (Cont'd)

CONDENSERS – MARINE WATER BOXES



(2-PASS BACK HEAD)

1-PASS CONDENSER SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	CONDENSER NOZZLE DIMENSIONS - FT-IN (MM)	
		G	H
L,M	150 (1034)	1'-2 1/2" (368)	2'-7 1/4" (794)
	300 (2068)	1'-3 1/2" (394)	2'-10 1/4" (870)
B	150 (1034)	1'-4 1/2" (419)	2'-11 1/2" (902)
	300 (2068)	1'-5 1/4" (438)	3'-2" (965)
C	150 (1034)	1'-4 1/2" (419)	3'-0" (914)
	300 (2068)	1'-5 1/2" (445)	3'-3 3/4" (1010)
D,E	150 (1034)	1'-6 3/4" (476)	3'-4 3/4" (1035)
	300 (2068)	1'-9 3/4' (552)	3'-10 3/4" (1187)
F	150 (1034)	1'-7" (483)	3'-5 1/4" (1048)
	300 (2068)	1'-11" (584)	4'-1 1/4" (1251)
K	150 (1034)	1'-6 1/2" (470)	3'-4 1/2" (1029)
	300 (2068)	1'-9 3/4" (552)	3'11" (1194)

2-PASS CONDENSER SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	CONDENSER NOZZLE DIMENSIONS - FT-IN (MM)		
		G	H	K
L,M	150 (1034)	1'-1 1/2" (343)	2'-5 1/4" (743)	0'-11 3/4" (298)
	300 (2068)	1'-2 1/2" (368)	2'-8 1/4" (819)	1'-0" (305)
B	150 (1034)	1'-1 1/2" (343)	2'-5 1/2" (749)	0'-11" (279)
	300 (2068)	1'-2 1/4" (362)	2'-8" (813)	1'-1 1/2" (343)
C	150 (1034)	1'-2 1/2" (368)	2'-8' (813)	0'-11" (279)
	300 (2068)	1'-3 3/4" (400)	1'-11 1/4" (591)	1'-2 1/2" (368)
D,E	150 (1034)	1'-4 1/2" (419)	3'- 1/4" (921)	1'-2 1/2" (368)
	300 (2068)	1'-5 1/2" (445)	3'-2 1/4" (972)	1'-3 1/2" (394)
F	150 (1034)	1-7" (483)	3'-5 1/2" (1048)	1'-3 1/2" (394)
	300 (2068)	1'-11" (584)	4'-1 1/4" (1251)	1'-4 1/2" (419)
K	150 (1034)	1'-6 1/2" (470)	3'-4 1/2" (1029)	1'-4 1/4" (413)
	300 (2068)	1'-9 3/4" (552)	3'-11" (1194)	1'-5 1/2" (445)

3-PASS CONDENSER SHELL CODE	DESIGN WORKING PRESSURE PSIG (KPA)	CONDENSER NOZZLE DIMENSIONS (3-PASS) (MM)	
		G	H
L,M	150 (1034)	1'-1 1/2" (343)	2'-5 1/4" (743)
	300 (2068)	1'-2 1/2" (368)	2'-8 1/4" (819)
B	150 (1034)	1'- 1/2" (343)	2'-5 1/2' (749)
	300 (2068)	1'-2 1/4" (362)	2'-8" (813)
C	150 (1034)	1'-2 1/2" (368)	2'-8" (813)
	300 (2068)	1'-3 3/4" (400)	2'-11 1/4" (591)
D,E	150 (1034)	1'-3 1/4' (387)	2'-9 3/4" (857)
	300 (2068)	1'-5 1/2" (495)	3'-2 1/4' (972)
F	150 (1034)	1'-4 3/4" (425)	3'-3 3/4" (1010)
	300 (2068)	1'-7 3/4" (502)	3'-6 3/4" (1086)
K	150 (1034)	1'-4 1/4" (413)	3'-0" (914)
	300 (2068)	1'-7" (483)	3'-5 1/2" (1054)

Isolators

NEOPRENE ISOLATORS

Shells: B/L, M/M, N/B

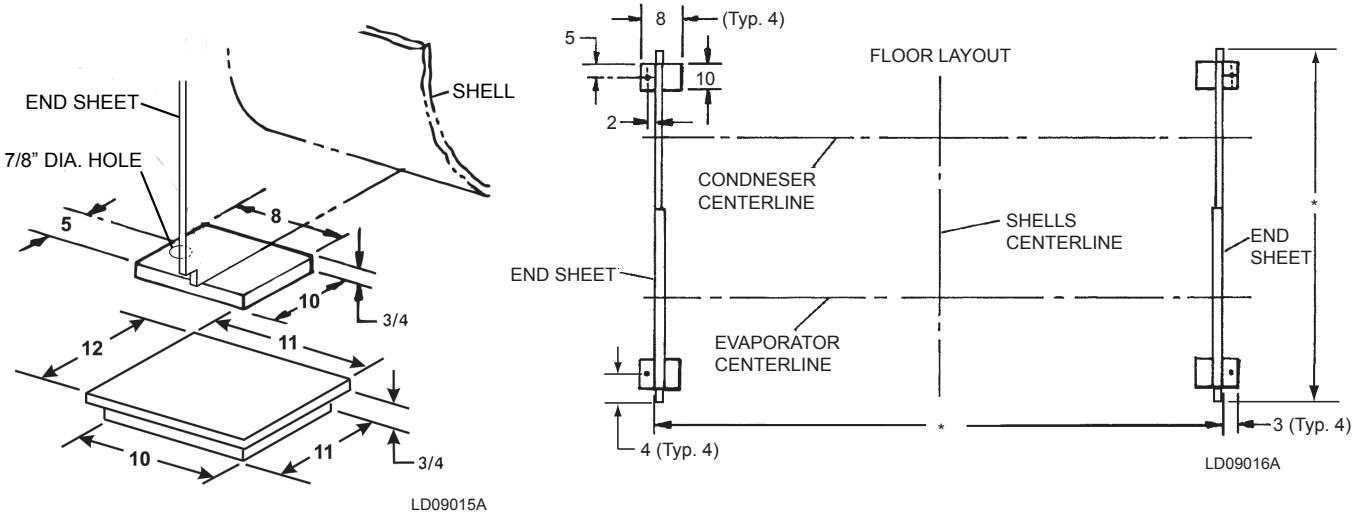


FIGURE 5 - NEOPRENE ISOLATORS DIMENSIONS (INCHES)

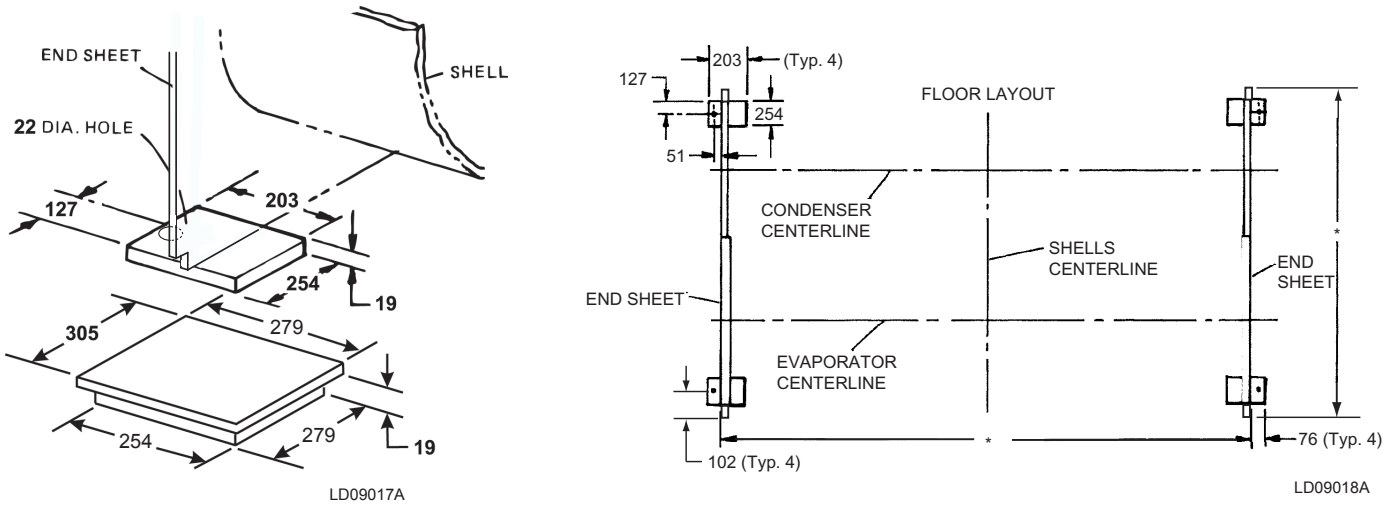


FIGURE 6 - NEOPRENE ISOLATORS DIMENSIONS (MM)

Isolators (Cont'd)

NEOPRENE ISOLATORS

Shells: E/C, F/D

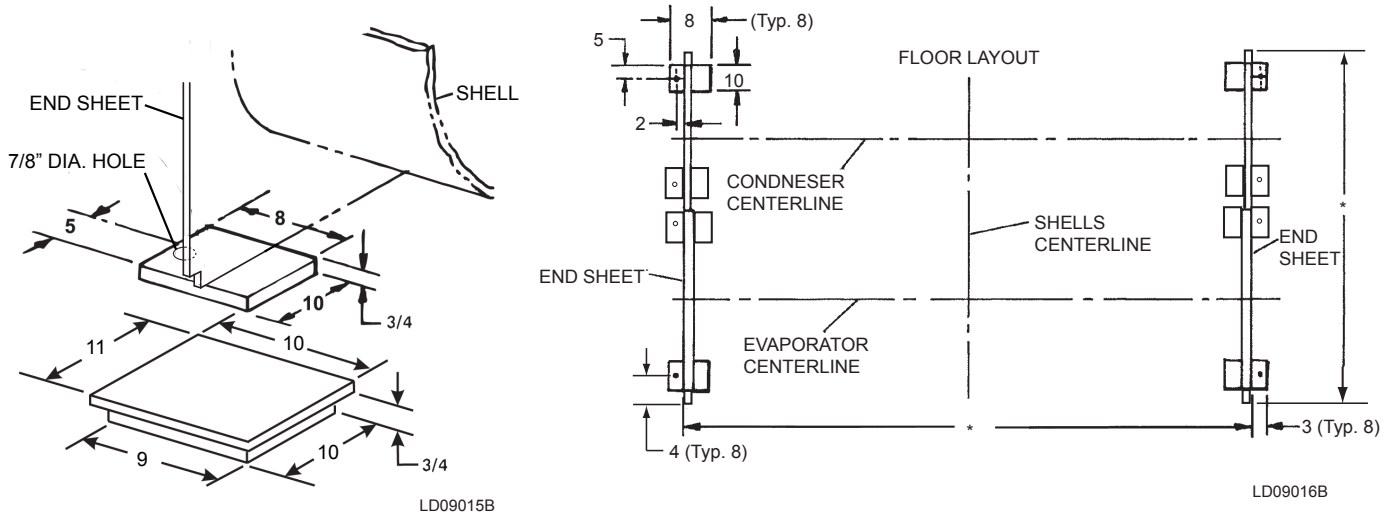


FIGURE 7 - NEOPRENE ISOLATORS DIMENSIONS (INCHES)

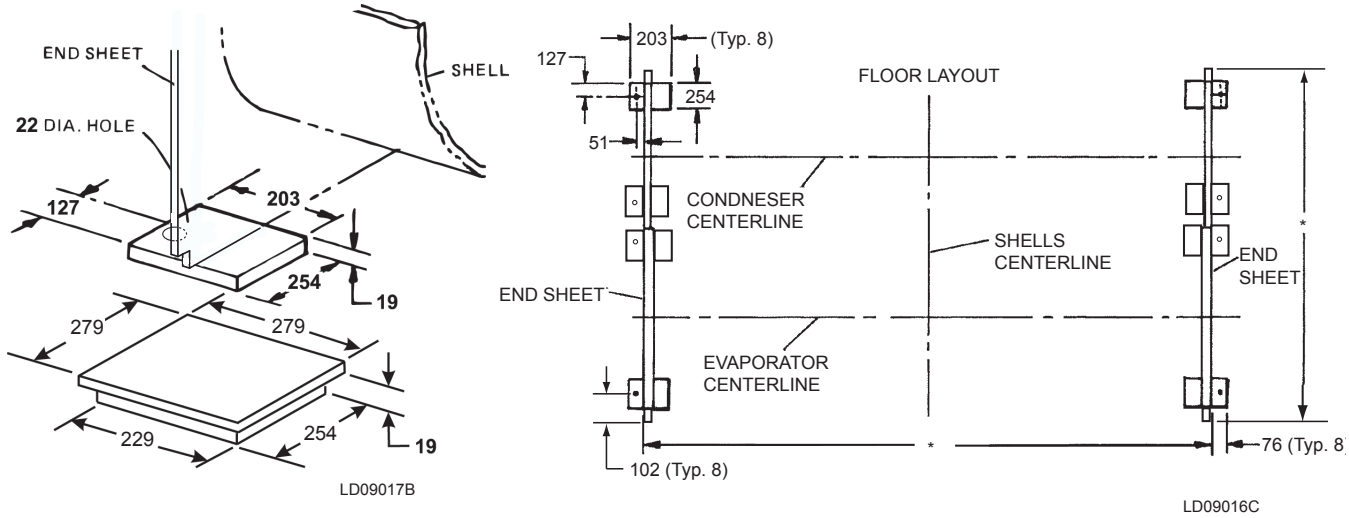


FIGURE 8 - NEOPRENE ISOLATORS DIMENSIONS (MM)

Isolators (Cont'd)

NEOPRENE ISOLATORS

Shells: G/E, H/F, K/K

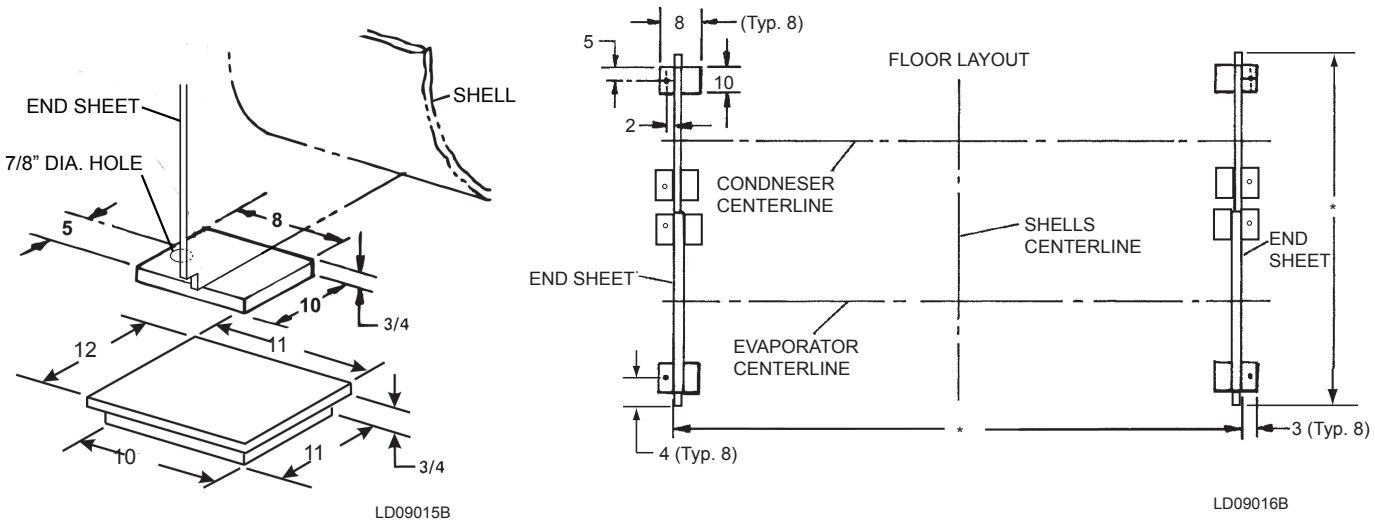


FIGURE 9 - NEOPRENE ISOLATORS DIMENSIONS (INCHES)

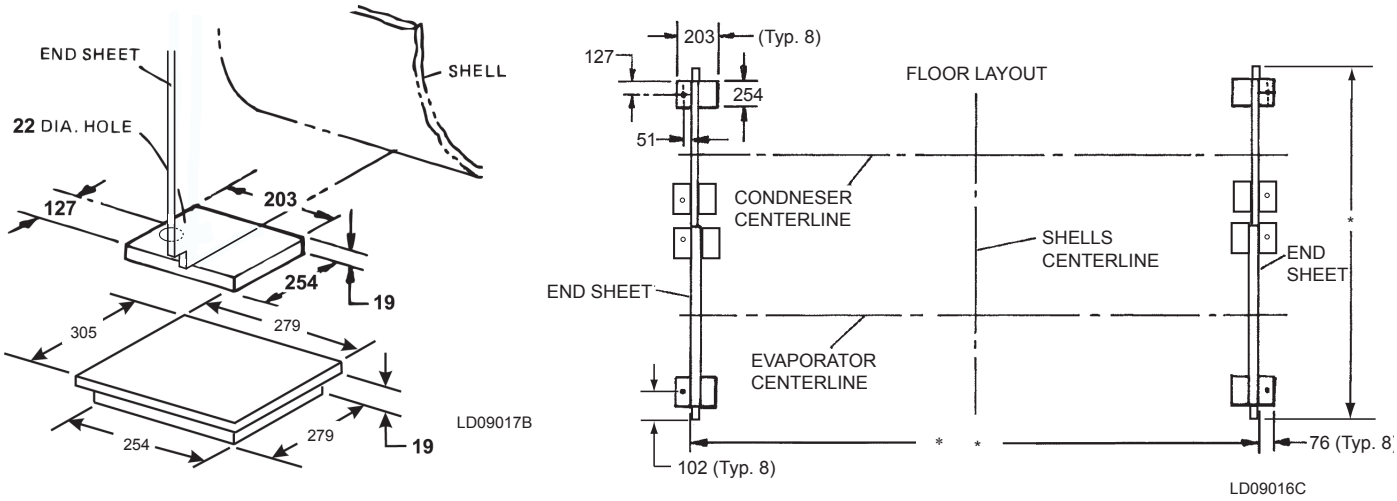
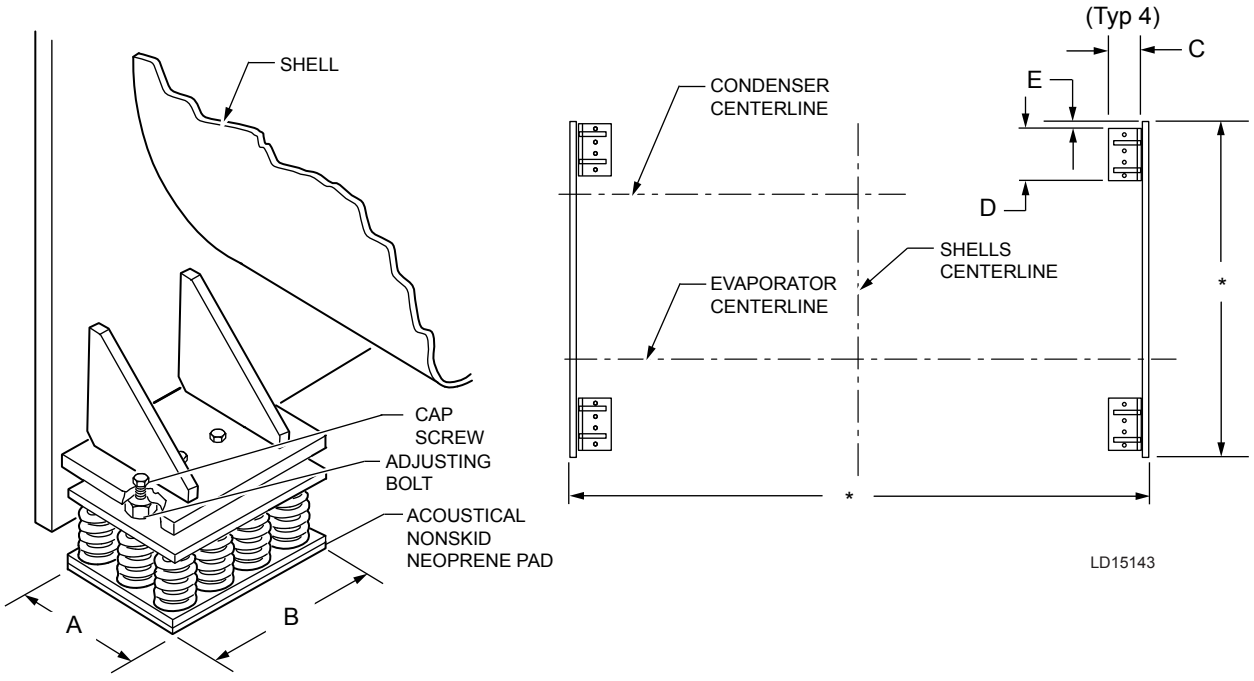


FIGURE 10 - NEOPRENE ISOLATORS DIMENSIONS (MM)

Isolators (Cont'd)

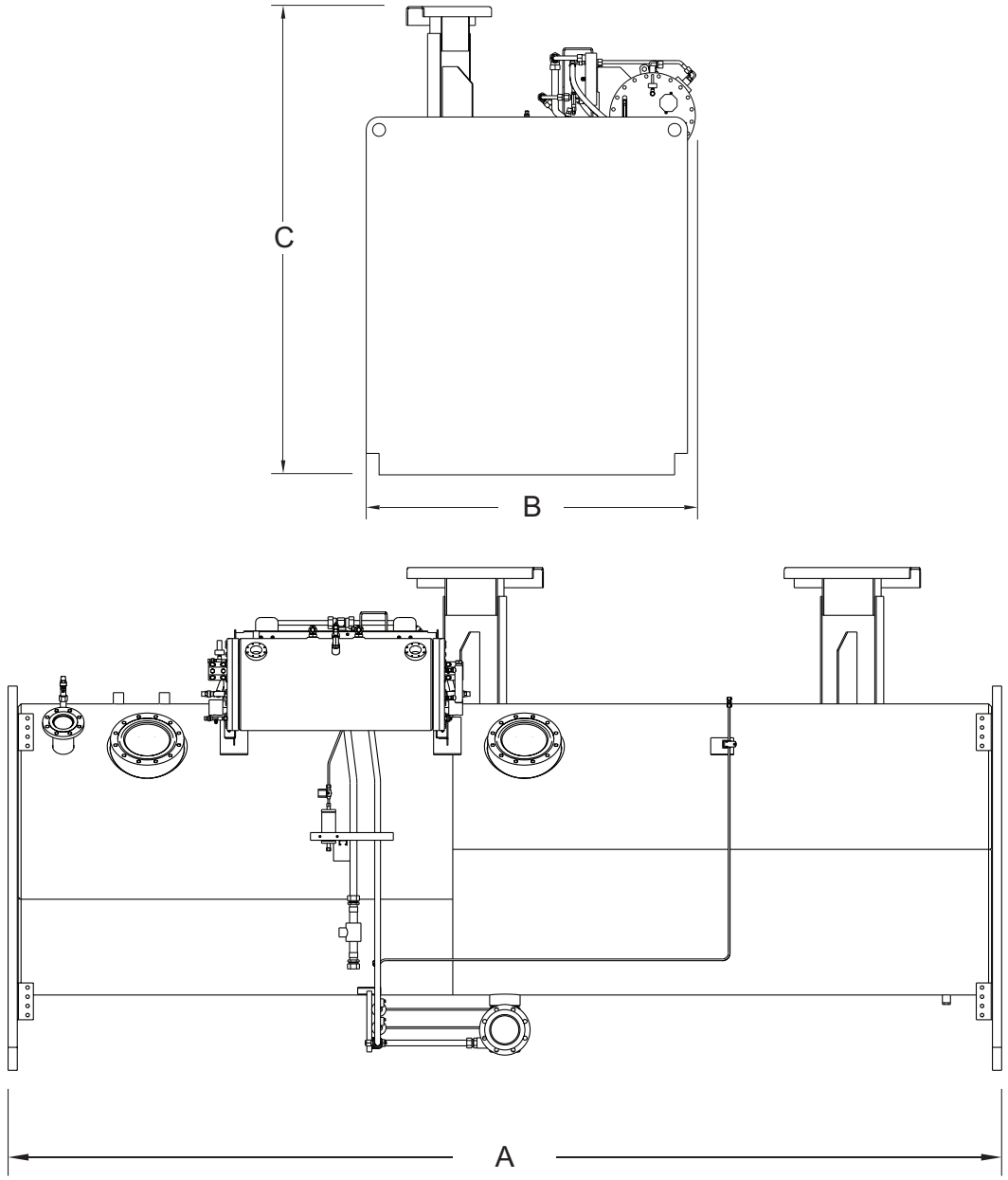
SPRING ISOLATORS



EVAPORATOR - CONDENSER SHELL CODES								
	B-L	**M-M**	**N-B**	**E-C**	**F-D**	**G-E**	**H-F**	**K-K**
A	11 (280)	11 (280)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)
B	14 (356)	14 (356)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)
C	8 (203)	8 (203)	17 (432)	17 (432)	17 (432)	17 (432)	17 (432)	17 (432)
D	13-1/2 (343)	13-1/2 (343)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)	16 (406)
E	1/2 (13)	1/2 (13)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)

FIGURE 11 - SPRING ISOLATORS DIMENSIONS INCHES (MM)

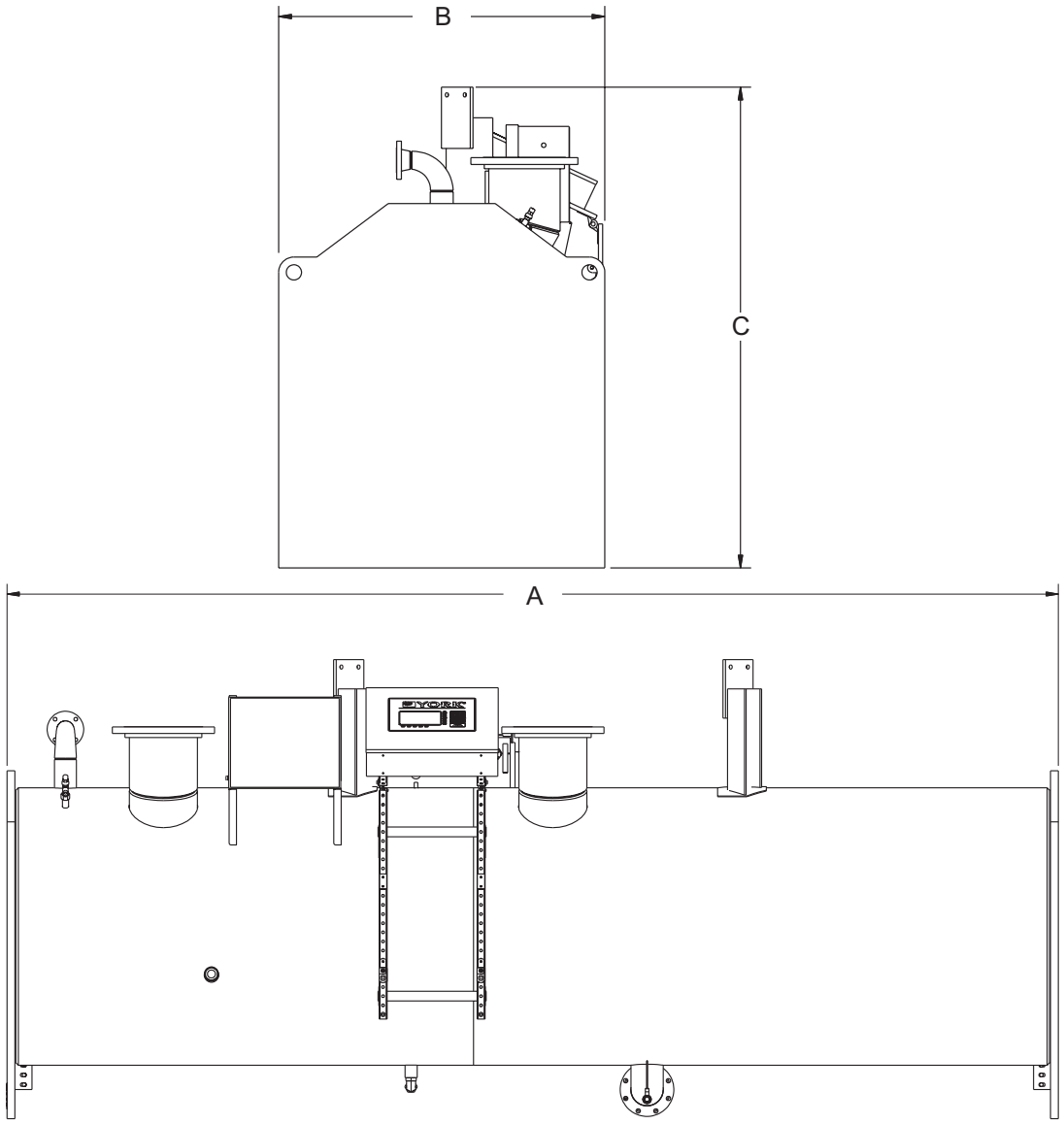
Component Dimensions



LD18377

CONDENSER SECTION DIMENSIONS						
UNIT MODEL COMPR/SHELLS	DIMENSIONS (FT. IN.)			DIMENSIONS (MM)		
	A	B	C	A	B	C
K1/L SHELLS	18-0”	5’-8”	7’-8 3/4”	5486	1727	2356
K2/M SHELLS	22’-0”	5’-8”	7’-8 3/4”	6708	1727	2356
K2/B SHELLS	18’-0”	5’-9”	8’-0 3/4”	5486	1753	2,457
K3/C SHELLS	22’-0”	6’-2”	8’-7 1/4”	6708	1880	2,623
K3/D SHELLS	18’-0”	6’-6”	9’-1 1/4”	5486	1,981	2,775
K4/E SHELLS	22’-0”	6’-6”	9’-1 1/4”	6708	1981	2775
K4/F SHELLS	18’-0”	6’-8”	9’-7 1/4”	5486	2032	2927
K7/K SHELLS	22’-0”	7’-3”	9’-8”	6708	2210	2946

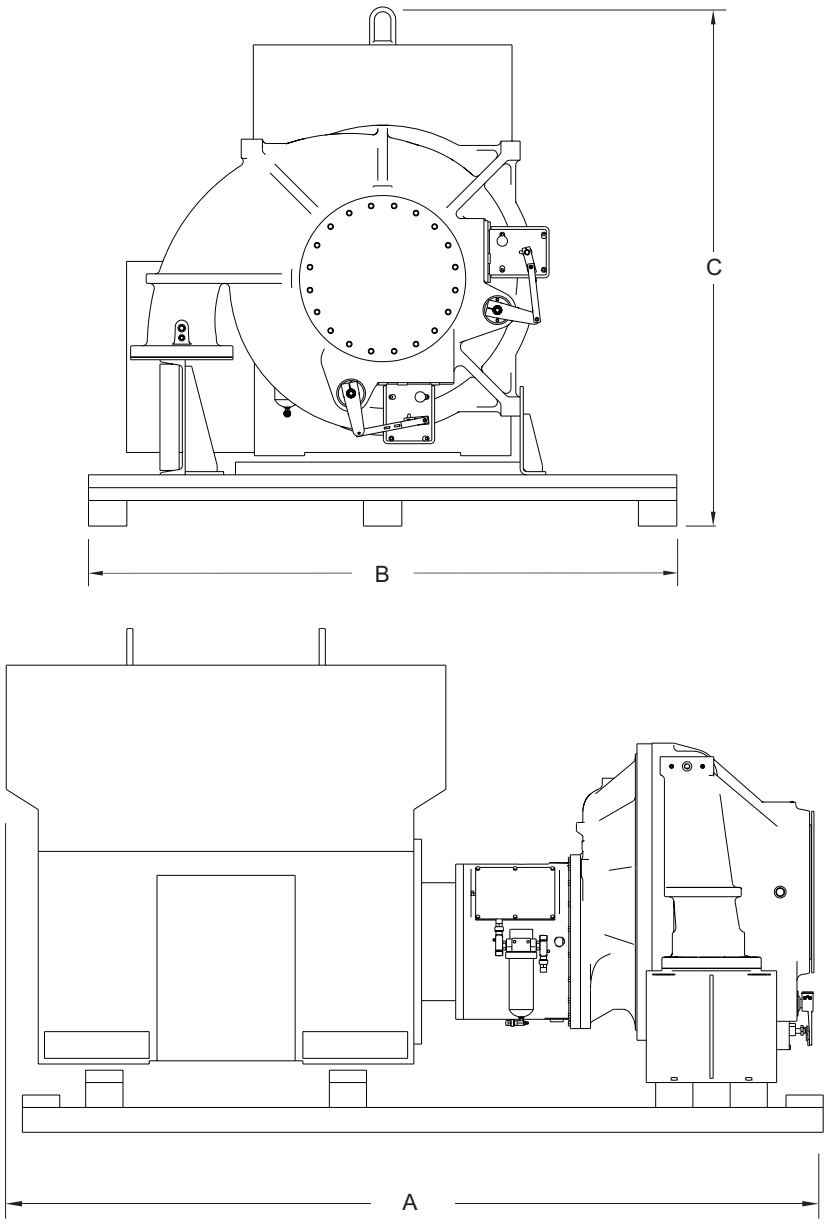
Component Dimensions (Cont'd)



LD18378

EVAPORATOR SECTION DIMENSIONS						
UNIT MODEL	DIMENSIONS (FT. IN.)			DIMENSIONS (MM)		
COMPR/SHELLS	A	B	C	A	B	C
K1/B SHELLS	18-0”	5’-4”	8’-2”	5486	1626	2489
K2/M SHELLS	22’-0”	5’-4”	8’-0”	6706	1626	2438
K2/N SHELLS	18’-0”	5’-11”	8’-4”	5486	1803	2540
K3/E SHELLS	22’-0”	6’-10”	9’-0”	6706	2083	2743
K3/F SHELLS	18’-0”	7’-6”	9’-6”	5486	2286	2896
K4/G SHELLS	22’-0”	7’-6”	9’-6”	6706	2286	2896
K4/H SHELLS	18’-0”	8’-0”	10’-0”	5486	2438	3048
K7/K SHELLS	22’-0”	8’-0”	10’-1”	6706	2438	3073

Component Dimensions (Cont'd)



LD18379

DRIVELINE SECTION (TWO)						
UNIT MODEL COMPR./ SHELLS	DIMENSIONS (FT./IN.)			DIMENSIONS (MM)		
	A	B	C	A	B	C
K1	10’-9”	6’-6”	7’-8”	3277	1981	2337
K2	10’-9”	6’-6”	7’-8”	3277	1981	2337
K3	11’-3”	6’-10”	7’-8”	3429	2083	2337
K4	11’-3”	6’-10”	7’-8”	3429	2083	2337
K7	13’-0”	7’-0”	7’-0”	3962	2134	2134

Weights

TABLE 19 - APPROXIMATE UNIT WEIGHT INCLUDING MOTOR & 150 # COMPACT WATER BOXES [1]

SHELLS	COMPRESSOR	SHIPPING WEIGHT LBS (kg)[2]	OPERATION WEIGHT- LBS (kg)	EST. REFRIGERANT CHARGE - LBS (kg) [3]
B-L	K1	74800 (33926)	92500 (41953)	6000 (2721)
M-M	K2	83200 (37735)	104100 (47215)	7300 (3311)
N-B	K2	84200 (38189)	105100 (47668)	7200 (3266)
E-C	K3	116600 (52884)	147100 (66717)	10600 (4808)
F-D	K3	125500 [4] (56921)	157500 (71434)	9800 (4445)
G-E	K4	141100 [4] (63996)	179100 (81231)	12200 (5533)
H-F	K4	139000 [4] (63043)	176300 (79961)	11500 (5216)
K-K	K7	174100 [4] (78963)	222200 (100779)	15800 (7166)

1. Refer to product drawings for detailed weight information.
2. Does not include refrigerant charge.
3. Add 5% for 1" tube option.
4. Unit shipped disassembled. Consult the performance page for individual weight.

TABLE 20 - MARINE WATER BOX WEIGHTS - LBS(KG) (TO BE ADDED TO STANDARD UNIT WEIGHTS SHOWN ABOVE).

EVAP CODE	SHIPPING WEIGHT INCREASE (KG)			OPERATING WEIGHT INCREASE (KG)			COND. CODE	SHIPPING WEIGHT INCREASE (KG)			OPERATING WEIGHT INCREASE (KG)		
	1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS		1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS
B	7124 (3231)	3851 (1747)	7086 (3214)	8966 (4067)	5520 (2504)	8755 (3971)	L	3808 (1727)	1947 (883)	3960 (1796)	5901 (2676)	3195 (1449)	5256 (2384)
M	7124 (3231)	3851 (1747)	7086 (3214)	8966 (4067)	5520 (2504)	8755 (3971)	M	3808 (1727)	1947 (883)	3960 (1796)	5901 (2676)	3195 (1449)	5256 (2384)
N	7088 (3215)	3604 (1635)	7244 (3286)	9319 (4227)	5758 (2612)	9320 (4227)	B	5092 (2309)	2498 (1133)	5060 (2295)	7103 (3222)	3945 (1789)	6631 (3007)
E	10692 (4849)	6554 (2973)	13316 (6039)	14334 (6501)	9502 (4310)	15708 (7124)	C	5768 (2616)	2882 (1307)	5826 (2642)	8127 (3686)	4864 (2206)	7872 (3570)
F	15696 (7119)	8370 (3796)	16778 (7610)	19517 (8852)	12191 (5529)	20599 (9343)	D	7394 (3354)	3889 (1764)	7592 (3443)	10256 (4652)	6333 (2872)	9722 (4409)
G	15696 (7119)	8370 (3796)	16778 (7610)	19517 (8852)	12191 (5529)	20599 (9343)	E	7394 (3354)	3889 (1764)	7592 (3443)	10256 (4652)	6333 (2872)	9722 (4409)
H	17374 (7880)	8478 (3845)	16744 (7594)	22366 (10144)	12630 (5728)	20267 (9192)	F	8422 (3820)	4643 (2106)	8910 (4041)	11745 (5327)	7965 (3613)	11637 (5278)
K	17374 (7880)	8478 (3845)	16744 (7594)	22366 (10144)	12630 (5728)	20267 (9192)	K	10332 (4686)	5520 (2504)	10798 (4897)	14048 (6371)	9236 (4189)	13809 (6263)

Guide Specifications

GENERAL

Furnish and install where indicated on the drawings ____ a dual centrifugal compressor liquid chilling Unit(s). Each unit shall produce a capacity of ____tons, cooling_____GPM of ____ from _____°F to _____ °F when supplied with _____ GPM of condenser water at _____°F. Total power input (two motors) shall not exceed _____ kW with an IPLV (NPLV) of _____. The evaporator shall be selected for _____fouling factor and a maximum liquid pressure drop of _____ft. Water side shall be designed for 150 PSIG working pressure. The condenser shall be selected for_____fouling factor and maximum liquid pressure drop of _____ft. Waterside shall be designed for 150 PSIG working pressure.

Low voltage units:

Power shall be supplied to the compressor drive motors at _____volts – 3 phase – (60) (50) Hertz.

Medium voltage units:

Power shall be supplied to the compressor drive motors at _____volts – 3 phase – (60) (50) Hertz. Auxiliary power to the oil pump motors shall be supplied at _____ volts – 3 phase – (60) (50) Hertz and controls shall be supplied at 115 volts – 1 phase – (60) (50) Hertz.

Performance shall be rated in accordance with the latest edition of AHRI Standard 550/590 as applicable.

Each unit shall be completely factory packaged including evaporator, condenser, sub cooler, compressors, open motors, lubrication system, Control Center, and all interconnecting unit piping and wiring. The chiller shall be painted prior to shipment. Larger (K3 to K7 compressor) size chillers shall be shipped disassembled, with the drivelines removed and skidded and the evaporator and condenser split. The initial charge of oil and refrigerant shall be supplied, shipped in containers and cylinders for field installation in the chiller.

COMPRESSORS

Two centrifugal compressors shall be provided, operating in parallel and utilizing a common refrigerant circuit on the chiller. An electrically operated tight closing butterfly valve shall be furnished in the discharge of each compressor, to allow either compressor to be turned off at low chiller loads.

Each compressor shall be a single stage centrifugal type, powered by an open-drive electric motor. The housing shall be fully accessible with vertical circular joints, with the complete operating assembly removable from the compressor and scroll housing. Compressor castings shall be designed for a minimum 235 PSIG working pressure and hydrostatically pressure tested at a minimum of 352 PSIG. The rotor assembly shall consist of a heat treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller. The impeller shall be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration free operation. Insert type journal and thrust bearings shall be fabricated of aluminum alloy, precision bored and axially grooved.

Guide Specifications (Cont'd)

Internal single helical gears with crowned teeth shall be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear shall be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal shall be provided in double bellows, double seal and cartridge type. A gravity fed oil reservoir shall be built into the top of the compressor to provide lubrication during coast down in the event of a power failure.

Capacity control shall be achieved by use of pre-rotation vanes to provide fully modulating control from full load to minimum load. Control shall automatically compensate for adverse operating conditions, such as fouled tubes, and adjust to prior operation after correction of these conditions.

The unit shall be capable of continuous, reliable operation with low entering condenser fluid temperature at all load conditions as outlined on the equipment schedule. An external electric actuator shall automatically control pre rotation vane position for each compressor.

LUBRICATION SYSTEM

Lubrication oil shall be force fed to all compressor bearings, gears, and rotating surfaces by variable speed oil pumps mounted in a common pump housing or oil reservoir. Each oil pump shall vary oil flow to its compressor based on operating and stand by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start up, during compressor operation and during coast down. Each compressor shall have an internal auxiliary reservoir to provide lubrication during coast down in the event of a power failure.

A common oil reservoir mounted below the dual centrifugal compressors shall contain a 2 HP submersible oil pump for each compressor. Each oil pump shall be built into a removable cover, one at each end of the reservoir. The oil reservoir shall be UL listed and shall be factory air strength tested at 1.1 times design working pressure.

Two 2kW immersion oil heaters shall be provided, one in each pump cover. The heaters shall be thermostatically controlled to remove refrigerant from the oil.

Oil cooling shall be done via a refrigerant cooled oil cooler at the discharge of each oil pump. A thermostatically controlled expansion valve shall maintain the required oil temperature supply from each oil cooler to its compressor. Oil shall be filtered by externally mounted ½ micron replaceable cartridge oil filters, equipped with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

MOTOR DRIVELINE

Each compressor motor shall be an open drip proof, squirrel cage, induction type operating at 3570 rpm (2975 rpm for 50 Hz operation).

Each open motor shall be provided with a D flange, bolted to a cast iron adaptor mounted on the compressor to allow the motor to be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts. Each Motor drive shaft shall be directly connected to its compressor shaft with a flexible disc coupling. The coupling shall have all metal construction with no wearing parts to assure long life, and no lubrication requirements to provide low maintenance. For units utilizing remote starters or drives, a large steel terminal box with gasketed front access cover shall be provided for field connected conduit. Overload/overcurrent transformers shall be furnished with all units.

Guide Specifications (Cont'd)

EVAPORATOR

Evaporator shall be of the shell and tube, flooded type designed for a minimum of 180 PSIG (12.4 barg) working pressure on the refrigerant side. Shell shall be fabricated from rolled carbon steel plates with fusion welded seams, carbon steel tube sheets, drilled and reamed to accommodate the tubes, and intermediate tube supports spaced no more than four feet apart. The refrigerant side of each shell is designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Division I, or other pressure vessel code as appropriate. Heat exchanger tubes shall be high efficiency, externally and internally enhanced type. Tubes shall utilize the “skip fin” design, providing a smooth internal and external surface at each intermediate tube support. This provides extra wall thickness and non work-hardened copper at the support location, extending the life of the heat exchangers. If skip fin tubes are not used, minimum tube wall thickness shall be 0.035” (0.9 mm). Each tube shall be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 ft./sec. (3.65 m/sec). A liquid level sight glass shall be provided on the side of the shell to aid in determining proper refrigerant charge and to check condition of the refrigerant charge. Aluminum mesh eliminators shall be located above the tube bundle to prevent liquid refrigerant carryover to the compressor. The evaporator shall have a refrigerant relief device sized to meet the requirements of the ASHRAE 15 Safety Code for Mechanical Refrigeration.

Water boxes shall be removable to permit tube cleaning and replacement. Stub out water connections having ANSI/AWWA C 606 couplings grooves shall be provided. Water boxes shall be designed for 150 PSIG (1034 kPa) design working pressure and be tested at 225 PSIG (1550 kPa). Vent and drain connections with plugs shall be provided on each water box. Low flow protection shall be provided by a thermal type flow sensor, factory mounted in the water nozzle connection and wired to the chiller panel.

CONDENSER

Condenser shall be of the shell and tube type, designed for a minimum of 235 PSIG (1620 kPa) working pressure on the refrigerant side. Shell shall be fabricated from rolled carbon steel plates with fusion welded seams. Carbon steel tube sheets, drilled and reamed to accommodate the tubes, are welded to the end of each shell. Intermediate tube supports are drilled and reamed to eliminate sharp edges, fabricated from carbon steel plates. The refrigerant side of each shell is designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Division I, or other pressure vessel code as appropriate.

Heat exchanger tubes shall be high efficiency, externally and internally enhanced type. Tubes shall utilize the “skip fin” design, providing a smooth internal and external surface at each intermediate tube support. This provides extra wall thickness and non work hardened copper at the support location, extending the life of the heat exchangers. If skip fin tubes are not used, minimum tube wall thickness shall be 0.035” (0.9 mm). Each tube shall be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 ft./sec. (3.65 m/sec.). A liquid level sight glass shall be provided on the side of the shell to aid in determining proper refrigerant charge and to check condition of the refrigerant charge. The condenser shall have dual refrigerant relief devices; each sized to meet the requirements of the ASHRAE 15 Safety Code for Mechanical Refrigeration. Arrangement shall allow either valve to be isolated and replaced without removing the unit refrigerant charge.

Guide Specifications (Cont'd)

The condenser shall be provided with positive shutoff valves in each compressor discharge line to the condenser. Additional tight closing valves shall be included in the liquid line leaving the condenser and the refrigerant liquid line to the oil coolers. This will allow pump down and storage of the refrigerant charge in the condenser. Due to the possibility of not seating properly, check valves are not acceptable for isolation purposes. If a check valve is used, a positive shutoff valve must be provided in series with the check valve.

Water boxes shall be removable to permit tube cleaning and replacement. Stub out water connections having ANSI/AWWA C 606 couplings grooves shall be provided. Water boxes shall be designed for 150 PSIG (1030 kPa) design working pressure and be tested at 225 PSIG (1550 kPa). Vent and drain connections with plugs shall be provided on each water box. Low flow protection shall be provided by a thermal type water flow sensor, factory mounted in the water nozzle connection and wired to the chiller control panel.

REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator shall be controlled by a variable orifice control valve. The variable orifice control shall automatically adjust to maintain proper refrigerant level in the condenser and evaporator. This shall be controlled by monitoring refrigerant liquid level in the condenser, assuring optimal subcooler performance.

CONTROL CENTER

General – The chiller shall be controlled by a single microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches. The chiller panel shall provide capacity control operation of the two parallel compressors, and shall provide cycling of compressors in response to load requirements.

Control Panel – The control panel shall include a 10.4 in. diagonal color liquid crystal display (LCD) surrounded by "soft" keys which are redefined based on the screen displayed at that time. This shall be mounted in the middle of a keypad interface and installed in a locked enclosure. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option, with English always available. Data shall be displayed in either English or Metric units. Smart Freeze Point Protection shall run the chiller at 36°F (2.2°C) leaving chilled water temperature, and not have nuisance trips on low water temperature. The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

A. System operating information including:

- Return and leaving chilled water temperature
- Return and leaving condenser water temperature
- Evaporator and condenser saturation temperature
- Differential oil pressure (both compressors)
- Percent motor current (both motors)

Guide Specifications (Cont'd)

- Compressor discharge temperature (both compressors)
- Oil reservoir temperature
- Compressor thrust bearing positioning (both compressors)
- Chiller operating hours, and operating hours
- Number of unit starts, and number of starts each compressor

B. Digital programming of setpoints through the universal keypad including:

- Leaving chilled water temperature
- Percent current limit
- Pull down demand limiting
- Six week schedule for starting and stopping the chiller, pumps and tower
- Remote reset temperature range

C. Status messages indicating:

- System ready to start
- System running
- System coast down
- System safety shutdown – manual restart
- System cycling shutdown – auto restart
- System prelube
- Start inhibit

D. The text displayed within the system status and system details field shall be displayed as color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.

E. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include:

- Evaporator – low pressure
- Evaporator – transducer or leaving liquid probe
- Evaporator – transducer or temperature sensor
- Discharge – high pressure contacts open (each compressor)
- Condenser – high pressure
- Condenser – pressure transducer out of range
- Auxiliary safety – contacts closed
- Discharge – high temperature (each compressor)

Guide Specifications (Cont'd)

- Discharge – low temperature (each compressor)
- Oil – high temperature
- Oil – low differential pressure (each compressor)
- Oil – high differential pressure (each compressor)
- Oil – sump pressure transducer out of range
- Oil – differential pressure calibration (each compressor)
- Oil – variable speed pump – pressure setpoint not achieved (two)
- Thrust bearing – proximity probe clearance (each compressor)
- Thrust bearing – proximity probe out of range (each compressor)
- Thrust bearing – proximity probe uncalibrated (each compressor)
- Watchdog – software reboot
- Surge detection – excess surge

F. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns shall include:

- Multi unit cycling – contacts open
- System cycling – contacts open
- Oil – low temperature differential
- Oil – low temperature
- Control panel – power failure
- Leaving chilled liquid – low temperature
- Leaving chilled liquid – flow switch open
- Motor controller – contacts open (each motor)
- Motor controller – loss of current (each motor)
- Power fault for each motor
- Control panel – schedule
- Proximity probe – low supply voltage
- Oil – variable speed pump – drive contacts open (each pump)

G. Cycling shutdowns with a VSD shall include (each vsd):

- VSD shutdown – requesting fault data
- VSD – stop contacts open
- VSD – initialization failed

Guide Specifications (Cont'd)

- VSD – high phase A, B, C instantaneous current
- VSD – Phase A, B, C gate driver
- VSD – single phase input power
- VSD – high DC bus voltage
- VSD – pre charge DC bus voltage imbalance
- VSD – high internal ambient temperature
- VSD – invalid current scale selection
- VSD – invalid current scale selection
- VSD – low phase A, B, C inverter heat-sink temp.
- VSD – low converter heat-sink temperature
- VSD – pre-charge – low DC bus voltage
- VSD – logic board processor
- VSD – run signal
- VSD – serial communications

  (Filter Option only for each low voltage VSD)
- Harmonic filter – logic board or communications
- Harmonic filter – high DC bus voltage
- Harmonic filter – high phase A, B, C current
- Harmonic filter – phase locked loop
- Harmonic filter – pre-charge – low DC bus voltage
- Harmonic filter – DC bus voltage imbalance
- Harmonic filter – 110% input current overload
- Harmonic filter – logic board power supply
- Harmonic filter – run signal
- Harmonic filter – DC current transformer 1
- Harmonic filter – DC current transformer 2

H. Security access to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the pre rotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

I. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend up to 6 different parameters from a list of over 140, without the need of an external monitoring system.

Guide Specifications (Cont'd)

J. The operating program stored in non volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery backed RTC memory for a minimum of 11 years with power removed from the system.

K. A fused connection through a transformer mounted on the variable speed oil pump panel shall provide individual over current protected power for all controls.

L. A numbered terminal strip for all required field interlock wiring.

M. An RS 232 port to output all system operating data, shutdown/cycling message, and a record of the last alarm.

N. 10 cycling or safety shutdowns to a field supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print from 1 minute to 1 day.

O. The capability to interface with a building automation system to provide:

- Remote chiller start and stop
- Remote leaving chiller liquid temperature adjust
- Remote current limit setpoint adjust
- Remote ready to start contacts
- Safety shutdown contacts
- Cycling shutdown contacts
- Run contacts

LOW VOLTAGE VARIABLE SPEED DRIVE (OPTION)

A variable speed drive shall be factory-installed on the chiller. It shall vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive shall be PWM type utilizing IGBTs with a power-factor of 0.95 or better at all loads and speeds. The variable speed drive shall be unit-mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory-installed, including power to the chiller oil pump. Field power wiring shall be a single-point connection and electrical lugs for incoming power wiring shall be provided. The entire chiller package shall be certified to standard UL-1995 by a nationally recognized testing laboratory.

The variable speed drive is cooled by a closed loop, fresh water circuit consisting of a water-to-water heat exchanger and circulating pump. All interconnecting water piping is factory installed and rated for 150 psig (1550 kPa) working pressure.

Guide Specifications (Cont'd)

The following features shall be provided: a door interlocked circuit breaker, capable of being padlocked; UL listed ground fault protection; overvoltage and under voltage protection; 3-phase sensing motor overcurrent protection; single phase protection; insensitive to phase rotation; over temperature protection; digital readout at the chiller unit control panel of:

- Output Frequency
- Output Voltage
- 3-phase output current
- Input Kilowatts (kW) and Kilowatt-hours (kWh)
- Self diagnostic service parameters
- Separate meters for this information shall not be acceptable.

(Optional) A harmonic filter that limits electrical power supply distortion for the variable speed drive to comply with the guidelines ofI EEE- 519 2014 shall be provided. The filter shall be unit mounted within the same NEMA 1 enclosure and shall be UL listed. The following digital readouts shall be provided at the chiller unit control panel as part of the filter package:

- Input KVA
- Total power-factor
- 3-phase input voltage
- 3-phase input current
- 3-phase input voltage total harmonic distortion (THD)
- 3-phase input current total demand distortion (TDD)
- Self diagnostic service parameters
- Separate meters for this information shall not be acceptable.

REMOTE ELECTRO-MECHANICAL COMPRESSOR MOTOR STARTER (OPTION)

A remote mounted electro-mechanical starter shall be furnished for each compressor motor. The starter shall be furnished in accordance with the chiller manufacturer's starter specifications R 1137, and as specified elsewhere in these specifications.

MEDIUM VOLTAGE VARIABLE SPEED STARTER (OPTION)

The Variable Speed Drive will be remote floor mounted. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Guide Specifications (Cont'd)

Definitions

For the purpose of this Specification, the following definitions apply:

- **VSD** - Variable speed drive is a device that is used to vary the speed of a previously fixed speed motor.
- **NPC** - Neutral Point Clamp is an VSD topology that has the advantage of reducing the high line to neutral voltage that can occur in other traditional drive designs that can reach 2.7 to 3.3 times normal levels.
- **PWM** - Pulse Width Modulation is a method of controlling power devices to convert voltage levels. PWM is a popular method of control for converting DC voltage to AC voltage.
- **IGBT**- Insulated Gate Bipolar Transistor is a high speed electrical switching power device. It is very efficient requiring very low power for control circuits
- **HCT** - Hall Effect Current Transformer are used for detection of currents over a frequency range of DC to high frequency without direct contact or shunts.
- **CPT**- Control Power Transformer is typically used to power control circuits and relays for the VSD.
- **FLA** - Full Load Amps.

Components

The VSD shall consist of the following components:

- Incoming Disconnect
- A 24 pulse input Isolation Transformer with Rectifier that limits electrical power supply distortion.
- Frequency Converter/Inverter
- VSD Protective System/Devices
- Output filter or reactor (when required to limit reflected voltage)
- Output Disconnect(s) or bypass (when specified on Data Sheet)
- Diagnostics and Control Circuits
- Two control power transformers, for the Control Center and for chiller oil pump operation.

Features

The following features will be provided:

- PWM type utilizing IGBT’s with a power factor of 0.95 or better at all loads and speeds.
- Door interlocked circuit breaker capable of being padlocked.
- UL listed ground fault protection.
- Over voltage and under voltage protection.

Guide Specifications (Cont'd)

- 3-phase sensing motor over current protection.
- Single phase protection.
- Insensitive to phase rotation.
- Over temperature protection.
- Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self-diagnostic service parameters, Elapsed Time Meter.
- Separate meters for this information will not be acceptable.

General Design and Fabrication

The VSD inverter/chopper shall be of the pulse width modulated (PWM) Neutral Point Clamp (NPC) type. The output devices shall be Insulated Gate Bipolar Transistors (IGBT's) with a minimum voltage rating of 3300V. Use of lower rated devices is unacceptable due to the quantity of devices required in the design.

- All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- The equipment shall be completely factory built, assembled, wired, and tested. When it is necessary to disassemble the units for ease of transportation, adequate materials and instructions shall be provided for easy field reassembling.
- For VSD applications where the line voltage is higher than 6600V and the drive uses an input voltage of 6600 V or less then any transformer used to reduce the line voltage from greater than 6600V to less than 6600V must have the transformer inefficiencies included in the chiller energy analysis.
- The VSD shall be capable of continuous operation up to altitudes of 5000 ft.

Enclosures and Cooling

The VSD enclosure shall be suitable for installation in an indoor, unclassified area.

All enclosure openings exceeding 0.25 inch (6 mm) in width shall be provided with screens to prevent the entrance of snakes, rodents, etc. The maximum screen mesh opening width shall be 0.25 inch (6 mm).

A "loss of cooling" fault shutdown shall be furnished with this forced cooled equipment. In the event of clogged filters or fan failure, the drive will shut down safely without electronic component failure.

Air filters shall be of a reusable type that can be easily cleaned. All doors or front panels will be fully gasketed. Air exhaust from cooling fans will be at the top of the enclosure away from personnel in front of the equipment.

Fan motors shall be protected by an input circuit breaker. Metal squirrel cage ball bearing 460V three phase fan motors are to be used in the drive design. Plastic muffin fans are not acceptable. As specified on the data sheet, fan power will be obtained from a remote 460V three-phase power or from the primary 2300 /3300/ 4160V power through a tap on the input transformer.

Guide Specifications (Cont'd)

The maximum noise level of the unit shall not exceed 80 dBA at a distance of 1 meter from the unit and at a height of 1.5 meters from the floor.

Painting

Use Manufacturer's standard finish.

Operational Controls

All operator controls and adjustments are through the Chiller control center.

The VSD shall include necessary components to protect the VSD and motor against motor overload, internal faults in either the motor or VSD and disturbances in the incoming AC line.

The following conditions shall cause the VSD to be shut down with the output voltage reduced to zero. The failure shall be annunciated on the Chiller control center.

- Cooling fan loss
- Input transformer over temperature
- Heatsink over temperature
- Motor current overload
- Output current imbalance
- High output frequency
- Input phase loss
- DC Link Voltage imbalance
- DC Link Voltage overvoltage
- DC Link Voltage undervoltage
- Ground fault
- Power supply fault
- IGBT gate drive fault
- Communications fault
- Cabinet doors interlock

Input Power Transformer and Rectifier

The VSD shall contain an incoming isolation transformer whose primary voltage shall be as specified on the Data Sheet.

The transformer shall contain 12 three phase secondary windings that provide the proper phase shifting to develop a 24-pulse rectification to reduce harmonic currents and voltages reflected to the primary power system.

The transformer shall be copper wound and shall have a 220°C insulation system to operate at 115° C rise at full load conditions.

Guide Specifications (Cont'd)

The transformer and rectifier shall be an integral part of the VSD assembly along with primary disconnect switch, input vacuum contactor and secondary fusing eliminating the need for separate components field installation or wiring.

Soft charge of the DC bus capacitors is accomplished by use of an input reactor on the primary of the input transformer. A vacuum contactor rated for drive full load amps will short the reactor after charge is accomplished.

Control Power Transformers

An 115V single phase nominal 2.0KVA transformer will be supplied for chiller controls.

A 400/460V three phase 50/60Hz up to 3KVA transformer will be supplied for chiller oil pump operation.

Operator Panel Displays:

All operator displays are through the Chiller control center.

The following items will be monitored and displayed:

- Output frequency
- Output voltage
- Motor current
- Input voltage
- Input power
- Energy consumption KWH

Power Requirements

The VSD shall be capable of providing rated output for continuous voltage deviations of +10%.

The VSD input short circuit withstand rating shall be 50,000A.

The VSD shall be able to ride through voltage dips down to 10% of minimum, such as those experienced during motor starting.

The VSD 40 second overload current rating shall be set at 105% of rated compressor current.

The VSD shall comply with the requirements of IEEE- 519 2014.

Voltage distortion shall not exceed 3% and current distortion shall not exceed 5% at the input lugs of the VSD over an operating power range of 30% to 100% of rated power with phase voltage imbalance per the 3% specification.

The VSD converter section shall be configured as a 24 pulse or greater to eliminate the need for harmonic filters.

Power Bus

All power bus bars, when part of the standard design and other current carrying parts shall be tin-plated copper for corrosion resistance. Power bus bar joints shall be tin plated.

Guide Specifications (Cont'd)

Bus bars shall be braced to withstand short circuit currents shown on the Data Sheet with a minimum of 50KAIC.

Input and output connections shall be either top or bottom access in the standard design.

Inverter Section Design

The VSD inverter section shall consist of three cells where each cell has two series DC power supplies per phase. Each DC supply is derived from a phase shifted secondary of the input transformer that cancels reflected harmonics back to the power line. The DC power supply is filtered by long lasting oil filled capacitors. Electrolytic capacitors are not permitted.

Each cell has eight 3300V Insulated Gate Bipolar Transistors (IGBT's) in a single phase bridge connection such that when in combination with the other bridges, a 5 level output voltage is constructed to the motor. A bridge neutral point is jumpered to each of the three cells. This configuration called Neutral Point Clamp (NPC) provides a normal phase to ground level voltages that are superior to other direct PWM or multi-level twelve cell VSD designs that can cause 1.8 to 3.3 times normal line to ground voltage.

Each power device communicates to the microprocessor with fiber optic communications. No other isolation method is allowed.

A high resistance ground detection circuit at the neutral point is used for system shut-downs in the event the load has a ground fault.

Two Hall Effect Current Transformers (HCT) are used for current feedback on the VSD output.

PWM firing pulses will result in an output voltage and current waveform that will result in less than 2% torque ripple over a 20 to 1 speed range on the motor.

Disconnects

The VSD shall include a main disconnect device with an interlocked and padlockable handle mechanism. The disconnecting device shall be a medium voltage vacuum contactor with a bolted pressure disconnect switch whose blades are externally visible from outside the enclosure. The disconnect device shall have a momentary withstand rating greater than the available fault current indicated on the Data Sheet.

When multiple doors are supplied, all doors shall be electrically interlocked with the disconnect device. The interlocks shall include provisions to manually override for test and repair.

Wiring and Terminations

Bus bar with standard four-hole pattern to be supplied for input and output shall be provided for connection of external wiring and shall be conveniently located, clearly numbered, and identified.

Control wire terminal blocks for external wiring terminations shall be compression screw type, designed to accommodate stripped insulation bare wire ends, and shall accept a minimum of two No. 14 AWG wires.

Connection points for inputs and outputs of different voltage levels shall be segregated to reduce possibility of electrical noise. If necessary, this may be accomplished through the use of terminal barriers and covers.

Guide Specifications (Cont'd)

Where wiring is run through sheet metal or any barrier, bushings, grommets or other mechanical protection around the sheet or barrier opening shall be provided.

All internal wiring shall be terminated with no more than two (2) conductors per terminal block point.

The VSD shall have an internal mechanical ground connection suitable for terminating a stranded copper ground conductor of the same size as the incoming phase conductors. Ground connections shall be near the incoming and outgoing power cable termination points and control wiring connections.

Minimum wire bending space shall meet or exceed the value shown in NEC Table 430 10 (b) for termination of the power cable and shall be documented on Manufacturer's drawings.

Inspection and Testing

Manufacturer's standard tests shall be performed. Minimum testing shall include:

Power semiconductors shall be thermally cycled and printed circuit boards shall be burned in prior to final assembly into the VSD.

Individual power cells shall undergo a visual inspection, an electrical inspection, and a complete full load test prior to final assembly into the VSD. A test record for each power cell shall be furnished as part of the final data requirements if requested on the data sheets.

Mechanical operation tests shall be performed for each VSD to verify satisfactory operation. These tests shall include checking operating mechanisms and interlock devices.

Electrical function tests shall be performed to ensure proper operation of all devices and components including operation of the VSD at full load conditions. Instrumentation, software, and monitoring tests shall be included.

The final assembly will be tested at full load and voltage by a power back method that returns drive output power to the power line. An unloaded full voltage motor will also be used during testing.

Shipping

Preparation for shipment shall be in accordance with Manufacturer's standards.

Loose equipment shall be appropriately packaged and secured for shipment inside the enclosure or shipping container. These items shall be properly tagged for easy identification.

Guide Specifications (Cont'd)

Documentation

Manufacturer Drawings and Data

Equipment shall be shipped with one set of installation, operation, and maintenance manuals.

PORTABLE REFRIGERANT STORAGE / RECYCLING SYSTEM (OPTION)

A portable, self contained refrigerant storage/recycling system shall be provided consisting of a refrigerant compressor with oil separator, storage receiver, water cooled condenser, filter drier and necessary valves and hoses to remove, replace and distill refrigerant. All necessary controls and safety devices shall be a permanent part of the system.

SI Metric Conversion

Values provided in this manual are in the English inch-pound (I-P) system.
The following factors can be used to convert from English to the most common SI Metric values.

MEASUREMENT	MULTIPLY THIS ENGLISH VALUE	BY	TO OBTAIN THIS METRIC VALUE
CAPACITY	TONS REFRIGERANT EFFECT (ton)	3.516	KILOWATTS (kW)
POWER	KILOWATTS (kW)	NO CHANGE	KILOWATTS (kW)
	HORSEPOWER (hp)	0.7457	KILOWATTS (kW)
FLOW RATE	GALLONS / MINUTE (gpm)	0.0631	LITERS / SECOND (L/s)
LENGTH	FEET (ft)	304.8	MILLIMETERS (mm)
	INCHES (in)	25.4	MILLIMETERS (mm)
WEIGHT	POUNDS (lb)	0.4536	KILOGRAMS (kg)
VELOCITY	FEET / SECOND (fps)	0.3048	METERS / SECOND (m/s)
PRESSURE DROP	FEET OF WATER (ft)	2.989	KILOPASCALS (kPa)
	POUNDS / SQ. INCH (psi)	6.895	KILOPASCALS (k Pa)

TEMPERATURE

To convert degrees Fahrenheit (°F) to degrees Celsius (°C), subtract 32° and multiply by 5/9 or 0.5556.

To convert a temperature range (i.e., 10°F or 12°F chilled water range) from Fahrenheit to Celsius, multiply by 5/9 or 0.5556.

FOULING FACTOR

ENGLISH I-P (fT^2 °F hr/Btu)	EQUIVALENT SI METRIC (m^2 k/kW)
0.0001	0.018
0.00025	0.044
0.0005	0.088
0.00075	0.132

EFFICIENCY

In the English I-P system, chiller efficiency is measured in kW / ton:

$$\text{kW/ton} = \frac{\text{kW input}}{\text{tons refrigeration effect}}$$

In the SI Metric system, chiller efficiency is measured in Coefficient of Performance (COP).

$$\text{kW/ton} = \frac{\text{kW input}}{\text{kW refrigeration effect}}$$

kW / ton and COP are related as follows:

$$\text{kW/ton} = \frac{3.516}{\text{COP}}$$

$$\text{COP} = \frac{3.516}{\text{kW/ton}}$$

Notes

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