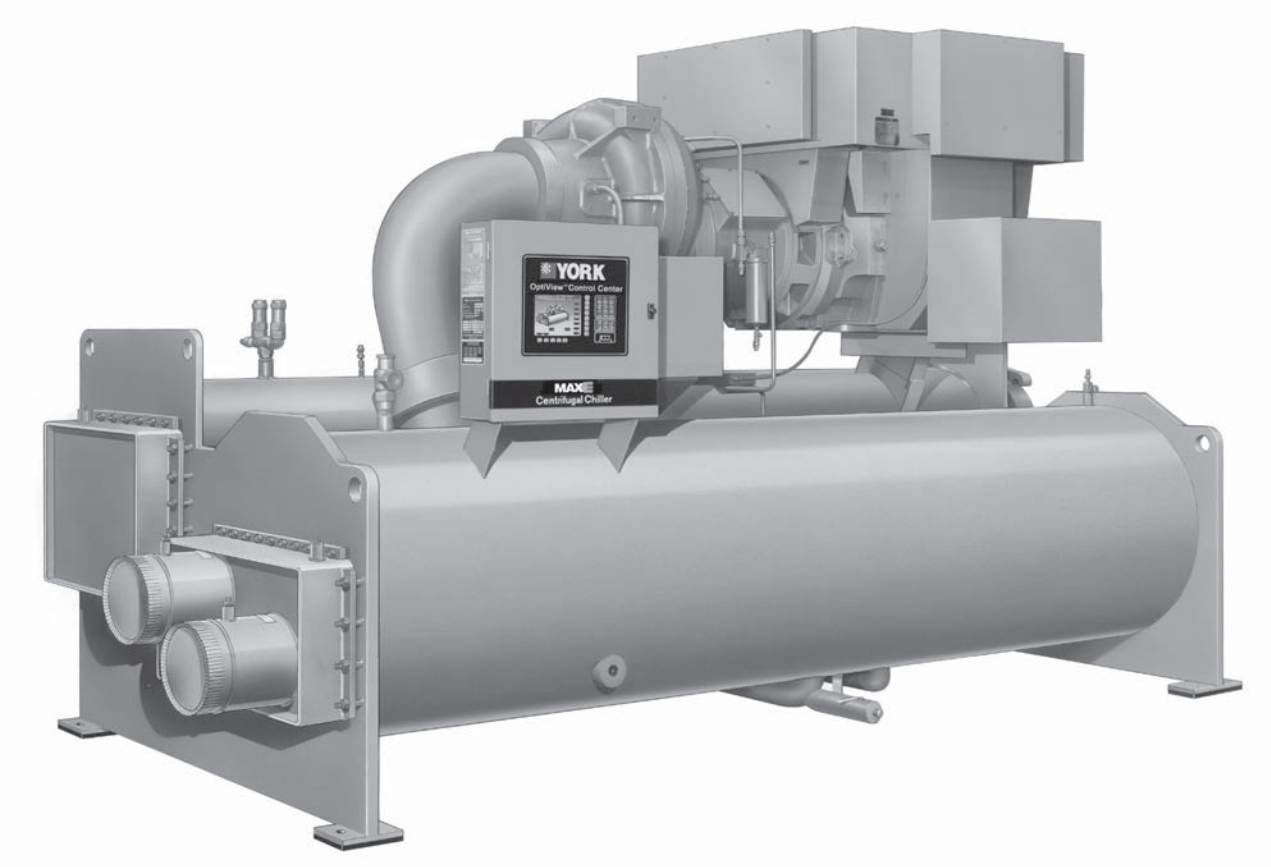
FORM 160.75-EG1 (1011)

YORK®

BY JOHNSON CONTROLS



Model YK Centrifugal Liquid Chillers
Design Level G

250 THROUGH 3000 TONS
(879 through 10,500 kW)
Utilizing HFC-134a
Heat Recovery
Flooded Evaporator & Hybrid Falling Film Evaporator

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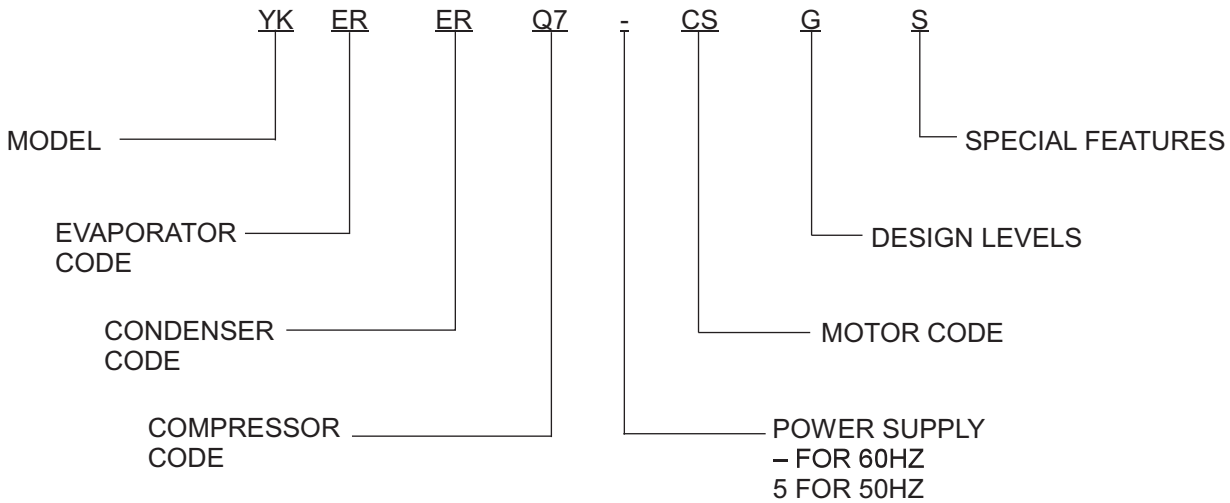
NOMENCLATURE



Introduction

The YORK YK Chillers, manufactured by Johnson Controls, offer a complete combination of features for total owner satisfaction.

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 chiller technology matches chiller system components to provide maximum chiller efficiency under actual – not just theoretical – operating conditions.

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.

The YORK YK 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.

YORK YK 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 YK 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.

HIGH EFFICIENCY HEAT EXCHANGERS

YORK YK 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

Designed to be the most reliable chillers we’ve ever made, YORK YK centrifugal chillers incorporate single-stage compressor design. With fewer moving parts and straightforward, efficient engineering, YORK single-stage compressors have proven durability records in hospitals, chemical plants, gas processing plants, the U.S. Navy, 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 YORK YK chillers feature a variable speed drive oil pump, monitoring and providing the right amount of oil flow to the 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 YK centrifugal chillers are designed to keep installation costs low. Where installation access is not a problem, the unit can be shipped completely packaged, requiring minimal piping and wiring to complete the installation.

For those units utilizing Variable Speed Drive or a factory-installed Solid-State Starter, the three power leads provide all power to the chiller and its auxiliaries.

Ratings

TAKE ADVANTAGE OF COLDER COOLING TOWER WATER TEMPERATURES

YORK YK 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 low load, as some chillers require.

U.L. COMPLIANCE – YOUR ASSURANCE OF RELIABILITY

YORK YK 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 to-day building operation.

AHRI CERTIFICATION PROGRAM

The performance of YORK YK chillers has been certified to the Air Conditioning and Refrigeration Insti-tute (AHRI) as complying with the certification sections of the latest issue of AHRI Standard 550/590. Under this Certification Program, chillers are regularly tested in strict compliance with this Standard. This provides an independent, third-party verification of chiller performance.

COMPUTERIZED PERFORMANCE RATINGS

Each chiller is custom matched to meet the individual building load and energy requirements. A large number of standard heat exchangers 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, and are part of the AHRI Certification Program.

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, and provide a more accurate indication of chiller performance than the previous IPLV/APLV formula. 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 YK chiller employs one 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.

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 CFC's and HCFC's with phase out schedule 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 HCFC's to HFC's in accordance with the Montreal Protocol treaty. Markets in developing countries are already seeing a transition away from HCFC's ahead of legislative requirements.

HCFC's 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.

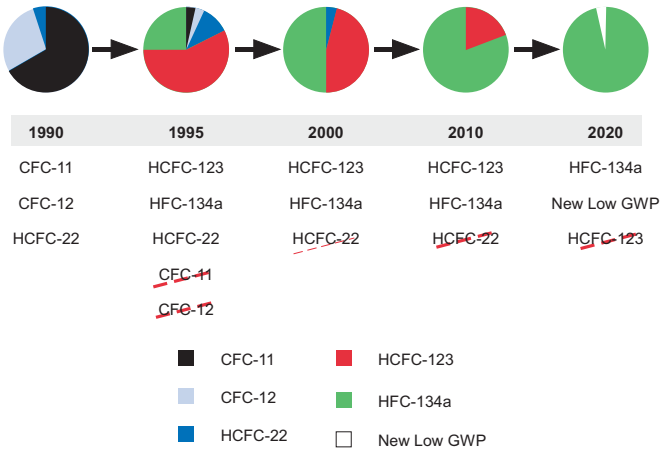
The Montreal Protocol does not extend to HFC's as they have no ODP nor does it extend to natural refrigerants for the same reason.

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-1234YF	CENTRIFUGALS	-	4	NO PHASE OUT	
HC (NATURAL REFR.)	HC-717 (NH_3)	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 (CO_2)		-	1	NO PHASE OUT	

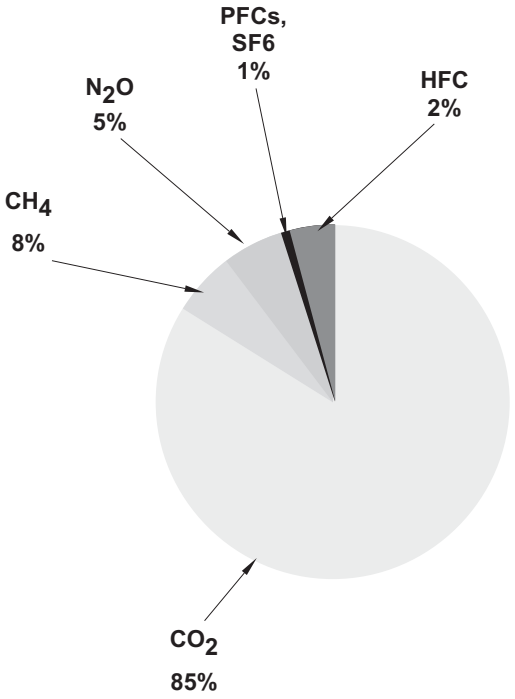
Sustainability Focus - continued

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 HCFC's.



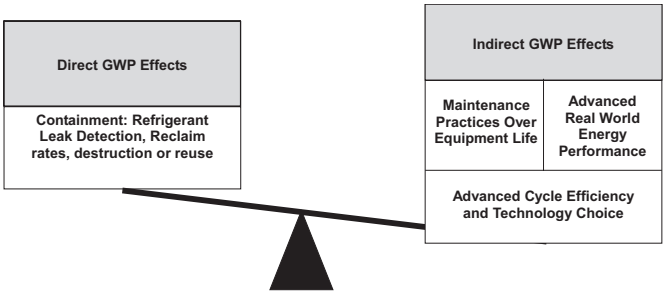
GLOBAL WARMING POTENTIAL (GWP)

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 CO2 emissions, while only about 2% is related to HFC's.

However, when we talk about the direct impact our YORK YK 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.

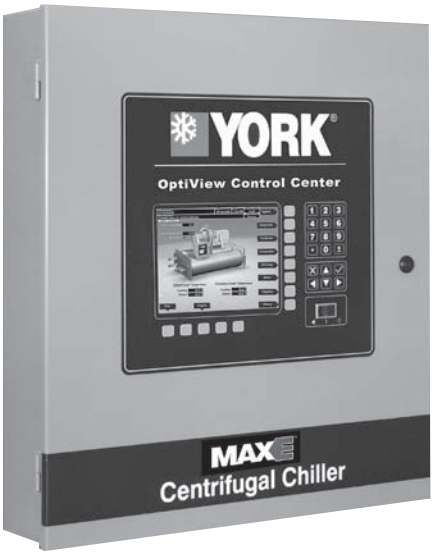


DIRECT & INDIRECT GLOBAL WARMING POTENTIAL

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 YK centrifugal chiller and its superior efficiency levels dramatically reduces the indirect GWP. 2% 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.

OptiView Control Center



YK OPTIVIEW CONTROL CENTER

The YORK OptiView™ Control Center, furnished as standard on each chiller, provides the ultimate in efficiency, monitoring, data recording, chiller protection and operating ease. The Control Center is a factory-mounted, wired and tested state-of-the-art microprocessor based control system for R134a centrifugal chillers. The panel is configured with a 10.4-in. (264 mm) diagonal color Liquid Crystal Display (LCD) surrounded by “soft” keys, which are redefined with one keystroke based on the screen displayed at that time. This revolutionary development makes chiller operation quicker and easier than ever before. Instead of requiring keystroke after keystroke to hunt for information on a small monochrome LCD screen, a single button reveals a wide array of information on a large, full-color illustration of the appropriate component, which makes information easier to interpret. This is all mounted in the middle of a keypad interface and installed in a locked enclosure.

The LCD display allows graphic animated display of the chiller, chiller sub-systems and system parameters; this 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. A Status Bar is displayed at all times on all screens. It contains the System - Status Line and Details Line, the Control Source, Access Level, Time and Date.

During pre-lube and coast-down, the system status will include a countdown timer indicating the time remaining. The control panel is compatible with the YORK Variable Speed Drive (VSD) (Optional), YORK Solid-State Starter (optional), or any Electro-Mechanical (E-M) starter that complies with the YORK R-1132 standard. The locations of various chiller parameters are clearly marked and instructions for specific operations are provided for on many of the screens. The panel verbiage is available in eight languages as standard and can be changed on the fly without having to turn off the chiller. Data can be displayed in either English or Metric units plus keypad entry of setpoints to 0.1 increments.

Security access is provided to prevent unauthorized changes of setpoints. This is accomplished with three different levels of access and passwords for each level. There are certain screens, displayed values, programmable setpoints and manual controls not shown that are for servicing the chiller. They are only displayed when logged in at service access level. Included in this is the Advanced Diagnostics and troubleshooting information for the chiller and the panel.

The panel is fused through a 1-1/2 or 2 KVA transformer in the compressor motor starter to provide individual over-current protected power for all controls. Numbered terminal strips for wiring such as Remote Start/Stop, Flow Switches, Chilled Water Pump and Local or Remote Cycling devices are provided. The Panel also provides field interlocks that indicate the chiller status. These contacts include a Remote Mode Ready-to-Start, a Cycling Shutdown, a Safety Shutdown and a chiller Run contact. Pressure transducers sense system pressures and thermistors sense system temperatures. The output of each transducer is a DC voltage that is analogous to the pressure input. The output of each thermistor is a DC voltage that is analogous to the temperature it is sensing.

Setpoints can be changed from a remote location via 0-10VDC, 4-20mA, contact closures or through serial communications. The adjustable remote reset range [up to 20°F (11.1°C)] provides flexible, efficient use of remote signal depending on reset needs. Serial data interface

OptiView Control Center - continued

to the Building Automation System (BAS) is through the optional microgateway, which can be mounted inside the Control Center.

This printed circuit board requests the required data from the microboard and makes it available for the Johnson Controls Metasys® network. This optional board is available through the Johnson Controls Building Efficiency group. The operating program is stored in non-volatile memory (EPROM) to eliminate chiller failure due to AC power failure/battery discharge. Programmed setpoints are retained in lithium battery-backed RTC memory for 10 years minimum.

Smart Freeze Point Protection will run the chiller at 36°F (2.2°C) leaving chilled water temperature, and not permit nuisance trips on Low Water Temperature. The sophisticated program and sensor will monitor the chiller water temperature to prevent freeze up. Every programmable point has a pop-up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

When the power is applied to the chiller, the HOME screen is displayed. This screen displays a visual representation of the chiller and a collection of data detailing important operations and parameters. When the chiller is running the flow of chilled liquid is animated by the alternating shades of color moving in and out of the pipe nozzles. The primary values that need to be monitored and controlled are shown on this screen. They are as follows:

Display Only

- Chilled Liquid Temperature – Leaving
- Chilled Liquid Temperature – Return
- Condenser Liquid Temperature – Return
- Condenser Liquid Temperature – Leaving
- Motor Run (LED)
- % Full Load Amps
- Operating Hours
- Input Power (kW) (VSD Only)
- Heating Condenser Liquid Temperature – Leaving (Heat Recovery only)
- Heating Condenser Liquid Temperature – Return (Heat Recovery only)

With the “soft” keys the operator is only one touch away from the 8 main screens that allows access to the major information and components of the chiller. The 8 screens are the **SYSTEM, EVAPORATOR, CONDENSER, COMPRESSOR, OIL SUMP, MOTOR, SETPOINTS** and the **HISTORY**. Also on the Home screen is the ability to Log IN, Log Out and Print. Log In and Log Out is the means by which different security levels are accessed.

The **SYSTEM** screen gives a general overview of common chiller parameters for both shells. This is an end view of the chiller with a 3D cutaway of both the shells. From this screen you can view the following.

Display Only

- Discharge Temperature
- Chilled Liquid Temperature – Leaving
- Chilled Liquid Temperature – Return
- Chilled Liquid Temperature – Setpoint
- Evaporator Pressure
- Evaporator Saturation Temperature
- Condenser Liquid Temperature – Leaving
- Condenser Liquid Temperature – Return
- Condenser Pressure
- Condenser Saturation Temperature
- Oil Sump Temperature
- Oil Pressure
- % Full Load Amps
- Current Limit
- Heating Condenser Liquid Temperature – Leaving – (Heat Recovery only)
- Heating Condenser Liquid Temperature – Entering – (Heat Recovery only)
- Heating Condenser Leaving Liquid Temperature – Setpoint – (Heat Recovery only)

The **EVAPORATOR** 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 **RUN** condition (bubbling) and liquid flow in the pipes is indicated by alternating shades of color moving in and out of the pipes. Adjustable limits on the low water temperature setpoints allow the chiller to cycle on and off for greater efficiency and less chiller cycling. The chiller cycles off when the leaving chilled water temperature is below the setpoint and is adjustable from 1°F (0.55°C) below to a minimum of 36°F (2.2°C). Restart is adjustable from the setpoint up to a max of 80°F (44.4°C). The panel will check for flow to avoid freeze up of the tubes. If flow is interrupted shutdown will occur after a minimum of two seconds. From this screen you can perform the following.

Display Only

- Chilled Liquid Flow Switch (Open/Closed)
- Chilled Liquid Pump (Run/Stop)
- Evaporator Pressure

- Evaporator Saturation Temperature
- Return Chilled Liquid Temperature
- Leaving Chilled Liquid Temperature
- Evaporator Refrigerant Temperature
- Small Temperature Difference
- Leaving Chilled Liquid Temperature Setpoints – Control Setpoint
- Leaving Chilled Liquid Temperature Setpoints – Shutdown
- Leaving Chilled Liquid Temperature Setpoints – Restart

Programmable

- Local Leaving Chilled Liquid Temperature – Range
- Local Leaving Chilled Liquid Temperature – Setpoint
- Leaving Chilled Liquid Temperature Cycling Offset – Shutdown
- Leaving Chilled Liquid Temperature Cycling Offset – Restart

The **CONDENSER** screen displays a cutaway view of the chiller condenser. The liquid flow is animated to indicate flow through the condenser. All setpoints relating to the condenser side of the chiller are maintained on this screen. With the proper access level, this screen also serves as a gateway to controlling the Refrigerant Level. From this screen you can view the following:

Display Only

- Leaving Condenser Liquid Temperature
- Return Condenser Liquid Temperature
- Condenser Pressure
- Condenser Saturation Temperature
- Small Temperature Difference
- Drop Leg Refrigerant Temperature
- Sub-Cooling Temperature
- High Pressure Switch (Open/Closed)
- Condenser Liquid Flow Switch
- Condenser Liquid Pump (Run/Stop)
- Refrigerant Level Position
- Refrigerant Level Setpoint
- Ramp Up Time Remaining
- Return Heating Condenser Liquid Temperature (Heat Recovery only)
- Leaving Heating Condenser Liquid Temperature (Heat Recovery only)

HEAT RECOVERY

The **HEAT RECOVERY** screen displays a cutaway view of the chiller condenser. The liquid flow is animated to indicate flow when there is flow in either the lower tower bundle or upper heating bundle. All setpoints relating to the upper heating bundle are maintained on this screen. From this screen you can view the following:

Display Only

- Return heating condenser liquid temperature
- Leaving heating condenser liquid temperature
- Return condenser liquid temperature
- Leaving condenser liquid temperature
- How water active setpoint

The **COMPRESSOR** screen displays a cutaway view of the compressor; this reveals the impeller and shows all the conditions associated with the compressor. When the compressor impeller is spinning this indicates that the chiller is presently in **RUN** condition. With the proper access level, the pre-rotation vanes may be manually controlled. This screen also serves as a gateway to sub-screens for calibrating the pre-rotation vanes, the proximity probe, configuring the Hot Gas Bypass, or providing advanced control of the compressor motor Variable Speed Drive. From this screen you can view the following:

Display Only

- Oil Pressure
- Oil Sump Temperature
- Discharge Temperature
- High Speed Thrust Bearing Oil Drain Temperature
- High Speed Thrust Bearing Proximity Differential
- High Speed Thrust Solenoid (LED)
- Vane Motor Switch (LED)
- Oil Return Solenoid (LED)
- Vent Line Solenoid (LED)
- Liquid Line Solenoid (LED)
- Oil Pump Drive Command Frequency (VS OIL Pump Only)

The **OIL SUMP** screen displays a close-up view of the chiller oil sump and provides all the necessary setpoints for maintaining the Variable Speed Oil Pump (VSOP). This screen also allows manual control of the frequency command sent to the VSOP. From this screen you can perform the following:

Display Only

- Oil Sump Temperature
- Sump Oil Pressure (LOP)

OptiView Control Center - continued

- Pump Oil Pressure (HOP)
- Oil Pressure
- Oil Pump Run Output (LED)
- Oil Return Solenoid (LED)
- Oil Heater (LED – VSOP Only)
- Target/Setpoint Oil Pressure (VSOP Only)
- Pulldown Time Remaining (VSOP Only)
- Variable Speed Oil Pump Control Mode (VSOP Only)
- Oil pump Drive Command Frequency (VSOP Only)
- Manual Oil Pump Operation Time Left

Programmable

- Manual Pump

The **MOTOR** "soft" key on the Home screen when pressed shows a picture of a YORK Electro-Mechanical Starter, Solid-State Starter or a Variable Speed Drive Screen depending on chiller configuration. Programmable pulldown demand to automatically limit motor loading for minimizing building demand charges is provided. Pulldown time period control over four hours, and verification of time remaining in pulldown cycle from display readout. Separate digital setpoint for current limiting between 30 and 100%.

The **ELECTRO-MECHANICAL STARTER** – (E-M) screen displays a picture of the starter and the following values, the ones below are common among all three offerings and the values will be displayed on all types of starter screens. From this screen you can perform the following:

Display Only

- 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

The **SOLID-STATE STARTER** – (SSS) screen displays a picture of the starter and following values that are displayed in addition to the common ones listed above.

Display Only

- Scale/Model
- Voltage – Phase A, B, C
- Current – Phase A, B, C
- Input Power
- Kilowatt hours

The **VARIABLE SPEED DRIVE** - (VSD) screen displays a picture of the VSD and the following values that are in addition to the common ones listed above. From this screen you can view the following:

Display Only

- Output Voltage
- Output Frequency
- Current – Phase A, B, C
- Input Power
- kW Hours
- Pre-Rotation Vane Position
- Harmonic Filter Data (filter option only)
- Supply KVA
- Total Power-factor
- Voltage Total Harmonic Distortion – L1, L2, L3
- Supply Current Total Demand Distortion – L1, L2, L3

There are two additional screens (sub-screens) that have further VSD information. From these screens you can view the following:

1. Variable Speed Drive Details:

Display Only

- Water Pump Output (LED)
- Precharge Relay Output (LED)
- Trigger SCR Output (LED)
- DC Bus Voltage
- DC Inverter Link Current
- Internal Ambient Temperature
- Converter Heat-sink Temperature
- Heat-sink Temperature – Phase A, B, C
- Motor HP
- 100% Full Load Amps

2. Harmonic Filter Details (Filter option only)

Display Only

- Operating Mode (Run/Stop)
- DC Bus Voltage
- Supply Contactor (LED)
- Precharge Contactor (LED)
- Phase Rotation
- Total Supply KVA
- Base Plate Heat-sink Temperature
- Voltage Peak (N-L1, N-L2, N-L3)
- RMS Voltage (L1, L2, L3)
- Voltage Total Harmonic Distortion (L1, L2, L3)

- RMS Filter Current (L1, L2, L3)
- Supply Current Total Demand Distortion
- RMS Supply Current L1, L2, L3

The **SETPOINTS** screen provides a convenient location for programming the most common setpoints involved in the chiller control. The Setpoints are shown on other individual screens but to cut down on needless searching they are on this one screen. This screen also serves as a gateway to a sub-screen for defining the setup of general system parameters. From this screen you can perform the following:

Display Only

- Leaving Chilled Liquid Temperature – Setpoint
- Leaving Chilled Liquid Temperature Cycling – Shutdown
- Leaving Chilled Liquid Temperature Cycling – Restart

Programmable

- Local Leaving Chilled Liquid Temperature – Range
- Local Leaving Chilled Liquid Temperature – Setpoint
- Leaving Chilled Liquid Temperature Cycling Offset – Shutdown
- Leaving Chilled Liquid Temperature Cycling Offset – Restart
- Motor Current Limit
- Pulldown Demand Limit
- Pulldown Demand Time
- Print

The **SETUP** 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 microboard program jumpers and program switches is displayed. From this screen you can perform the following:

Display Only

- Chilled Liquid Pump Operation: (displays standard or enhanced)
- Motor Type: (displays fixed speed or variable speed)
- Refrigerant Selection: (displays R-22 or R134a)
- Anti-Recycle: (displays Disabled or Enabled)
- Power Failure Restart: (displays Manual or Automatic)
- Liquid Type: (Water or Brine)
- Coastdown: (displays Standard or Enhanced)
- Pre-Run: (Displays Standard or Extended)
- Oil Pump Package: (displays Fixed Speed or Variable Speed)
- Power Line Frequency (VSD only): (displays 60 Hz or 50 Hz)

Programmable

- Set Date
- Set Time
- Clock (Enabled/Disabled)
- 12/24 Hr

The following 6 sub-screens can be accessed from the setup screen:

The **SCHEDULE** screen contains more programmable values than a normal display screen. Each programmable value is not linked to a specific button; instead the select key is used to enable the cursor arrows and check key to program the Start/Stop times for any day of the week up to 6 weeks in advance. The user 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.

Programmable

- Exception Start/Stop Times
- Schedule (Enable/ Disabled)
- Repeat Sunday Schedule
- Standard Week Start/Stop Times
- Reset All Exception Days
- Select
- Print

The **USER** screen allows definition of the language for the chiller to display and defines the unit of measure.

Programmable

- System Language
- English/Metric Units

The **COMMS** screen allows definition of the necessary communications parameters.

Programmable

- Chiller ID
- Com 2 Baud Rate
- Com 2 Data Bit(s)
- Com 2 Parity Bit(s)
- Com 2 Stop Bit(s)
- Printer Baud Rate

OptiView Control Center - continued

- Printer Data Bit(s)
- Printer Parity Bit(s)
- Printer Stop Bit(s)

The **PRINTER** screen allows Definition of the necessary communications Parameters for the printer.

Display Only
- Time Remaining Until Next Print

Programmable
- Log Start Time
- Output Interval
- Automatic Printer Logging (Enabled/Disabled)
- Print Type
- ACC Auto Map Print (Enable/Disabled)
- ACC Map Report
- Print Report
- Print All Histories

The **SALES ORDER** screen allows definition of the order parameters.

Note: This information is loaded at the factory or by the installation/ service technician.

Display Only
- Model Number
- Panel Serial Number
- Chiller Serial Number
- Johnson Controls Order Number
- System Information
- Condenser and Evaporator Design Load Information
- Nameplate Information

The **OPERATIONS** screen allows definition of parameters related to the operation of the chiller. What is defined is whether the control of the chiller will be Local, Digital Remote, Analog Remote, Modem Remote or Metasys™ Remote.

Programmable
- Control Source

The **HISTORY** 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. (See Display Messages for Color Code meanings.)
Display Only
- Last Normal Shutdown
- Last Fault While Running
- Last Ten Faults

Programmable
- Print History
- Print All Histories

By pressing the **VIEW DETAILS** key you will move to the **HISTORY DETAILS** screen. From these screens you are able to see an on-screen printout of all the system parameters at the time of the selected shutdown.

Display Only
- History Printout

Programmable
- Page Up
- Page Down
- Print History

Also under the History screen is the **TRENDING** screen, accessible by the key marked the same. On this screen up to six operator-selected parameters, selected from a list of over 140, can be plotted in an X/Y 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.

Display Only
- This screen allows the user to view the graphical trending of the selected parameters and is a gateway to the graph setup screens.

Programmable
- Start
- Stop
- Y-axis
- X-axis

The **TREND SETUP** screen is used to configure the trending screen. The parameters to be trended are selected from the Trend Common Slots Screen accessed from the Slot #s button or the Master Slot Numbers List found in the operating manual. The interval at which all the parameters are sampled is selected under the Collection Interval but-

ton. The data point min. and max. values may be adjusted closer within the range to increase viewing resolution.

Programmable

- Chart Type (select Continuous or One Screen)
- Collection Interval
- Select
- Data Point Slot # (1-6)
- Data Point Min (1-6)
- Data Point Max (1-6)

The **TREND COMMON SLOTS** screen displays the Master Slot Numbers List of the monitored parameters.

Display Only

- Slot Numbers

Programmable

- Page Up
- Page Down

DISPLAY MESSAGES

The 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 to aid in identifying problems quickly.

Status Messages include:

- System Ready to Start
- Cycling Shutdown – Auto Restart
- Safety Shutdown – Manual Restart
- System Pre-lube (with countdown timers)
- System Run (with countdown timers)
- System Coastdown (with countdown timers)
- Start Inhibit
- Vanes Closing Before Shutdown

Run Messages include:

- Leaving Chilled Liquid Control
- Current Pulldown Limit

Start Inhibit Messages include:

- Anti-Recycle XX Min/Sec
- Vane Motor Switch Open
- Motor Current >15% FLA

Warning Messages include:

- Real Time Clock Failure
- Condenser or Evaporator Transducer Error
- Refrigerant level Out-of-Range
- Standby Lube – Low Oil Pressure
- Setpoint Override
- Condenser – High Pressure Limit
- Evaporator – Low Pressure Limit
- Motor – High Current Limit (E-M and SSS options only)
- Vane Uncalibrated – Fixed Speed (VSD option only)

(Filter option only)

- Harmonic Filter – Operation Inhibited
- Harmonic Filter – Data Loss
- Harmonic Filter – Input Frequency Range

Routine Shutdown Messages include:

- Remote Stop
- Local Stop
- Place Compressor Switch in Run Position

Cycling Shutdown Messages 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
- Condenser – Flow Switch Open
- Motor Controller – Contacts Open
- Motor Controller – Loss of Current
- Power Fault
- Control Panel – Schedule
- Starter – Low Supply Line Voltage (SSS option only)
- Starter – High Supply Line Voltage (SSS option only)
- Proximity Probe – Low Supply Voltage
- Oil – Variable Speed Pump – Drive Contacts Open

Compressor Motor Variable Speed Drive: Cycling Shutdown Messages include (VSD only):

OptiView Control Center - continued

- VSD Shutdown – Requesting Fault Data
- VSD – Stop Contacts Open
- VSD – Initialization Failed
- 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 – Logic Board Power Supply
- VSD – Low DC Bus Voltage
- VSD – DC Bus Voltage Imbalance
- VSD – Precharge – DC Bus Voltage Imbalance
- VSD – High Internal Ambient Temperature
- VSD – Invalid Current Scale Selection
- VSD – Low Phase A, B, C Inverter Heat-sink Temperature
- VSD – Low Converter Heat-sink Temperature
- VSD – Precharge – Low dc Bus Voltage
- VSD – Logic Board Processor
- VSD – Run Signal
- VSD – Serial Communications

(Filter option only)

- 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 – Precharge – Low DC Bus Voltage
- Harmonic Filter – 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

Safety Shutdown Messages include:

- Evaporator – Low Pressure
- Evaporator – Transducer or Leaving Liquid Probe
- Evaporator – Transducer or Temperature Sensor
- Condenser – High Pressure Contacts Open
- Condenser – High Pressure
- Condenser – Pressure Transducer Out-of-Range
- Auxiliary Safety – Contacts Closed
- Discharge – High Temperature
- Discharge – Low Temperature
- Oil – High Temperature
- Oil – Low Differential Pressure
- Oil – High Differential Pressure
- Oil – Pump Pressure Transducer Out-of-Range
- Transducer Out-of-Range
- Oil – Differential Pressure Calibration
- Oil – Variable Speed Pump – Setpoint Not Achieved
- Control Panel – Power Failure
- Motor Or Starter – Current Imbalance (SSS option only)
- Thrust Bearing – Proximity Probe Clearance (K Compressor)
- Thrust Bearing – Proximity Probe Out Of Range (K Compressor)
- Thrust Bearing – Position Switch (P, Q, & H9 Compressors)
- Watchdog – Software Reboot

Compressor Motor VSD: Safety Shutdown Messages include: (VSD only)

- VSD Shutdown – Requesting Fault Data
- VSD – Stop contacts Open
- VSD – 105% Motor Current Overload
- VSD – High Phase A, B, C Inverter Heat-sink Temperature
- VSD – High Converter Heat-sink Temperature
- VSD – Precharge Lockout

(Filter option only)

- Harmonic Filter – High Heat-sink Temperature
- Harmonic Filter – High Total Demand Distortion

Mechanical Specifications

GENERAL

YORK YK chillers are completely factory-packaged including the evaporator, condenser, compressor, motor, lubrication system, control center, and all interconnecting unit piping and wiring.

The initial charge of refrigerant and oil is supplied for each chiller. When the optional condenser isolation valves are ordered, most units may ship fully charged with refrigerant and oil. Actual shipping procedures will depend on a number of project-specific details.

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

COMPRESSOR

The 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 assembled as part of 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.

CAPACITY CONTROL

Pre-rotation vanes (PRV) modulate chiller capacity from 100% to 15% 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.

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 coastdown. A gravity fed oil reservoir is built into the top of the compressor to provide lubrication during coastdown in the event of a power failure.

An oil reservoir, separate from the compressor, contains the submersible oil pump, 2 HP (1.5 kW) pump motor and 3000 watt immersion type oil heater. The oil heater is thermostatically controlled to remove refrigerant from the oil. Oil is filtered by an externally mounted 1/2 micron replaceable cartridge oil filter equipped with service valves. Oil is cooled via a refrigerant-cooled oil cooler, eliminating the requirement for field water piping. The oil side of the oil cooler is provided with service valves. An automatic oil return system recovers any oil that may have migrated to the evaporator. Oil piping is completely factory-installed.

WATER-COOLED OIL COOLER

Optional condenser water-cooled oil cooler is offered for units with Q3 compressors C-D shells only. This oil cooler is a shell and tube heat exchanger. Water from condenser supply waterbox circulates through the tube side of the heat exchanger and discharges back into the return side of the waterbox. Hot oil circulates through the tubes within the oil cooler, and is cooled by the cold condenser water. The cooled oil is then sent back to the compressor through a temperature regulator valve and oil filters. Both the oil and water piping are completely factory-installed, eliminating the requirement for field piping.

MOTOR DRIVELINE

The compressor motor is an open drip proof, squirrel cage, induction type constructed to YORK design specifications. The 60 hertz motors operate at 3570 rpm and the 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. For units utilizing remote electro mechanical starters, a large, steel terminal box with gasketed front access cover is provided 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. For units furnished with factory-packaged Solid-State Starters or Variable Speed Drive, refer to the Accessories and Modifications Section.

HEAT EXCHANGERS

Shells

Evaporator and condenser shells are fabricated from rolled carbon steel plates with fusion welded seams or carbon steel pipe. Carbon steel tube sheets, drilled and reamed to accommodate the tubes, are welded to the end of each shell. Intermediate tube supports are fabricated

Mechanical Specifications - continued

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" (19 mm) O.D. standard [or 1" (25.4 mm) optional in some shells] 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.

Evaporator
The evaporator is a shell and tube type with customer process fluid flowing inside the tubes and refrigerant removing heat on the shell side via evaporation. Evaporator codes A_ to K_ utilize a hybrid falling film design. It contains a balance of flooded and falling film technology to optimize efficiency, minimize refrigerant charge, and maintain reliable control. A specifically designed spray distributor provides uniform distribution of refrigerant over the entire length to yield optimum heat transfer. The hybrid falling film evaporator design has suction baffles around the sides and above the falling film section to prevent liquid refrigerant carryover into the compressor.

Evaporators codes M_ thru Z_ are flooded type, with a liquid inlet distributor trough underneath the tube bundle which provides uniform distribution of refrigerant over the entire shell length to yield optimum heat transfer. Flooded evaporator designs have a suction baffle on M_ shells with H9 compressors and an aluminum mesh eliminator on K_ - Z_ shells with K compressors located above the tube bundle to prevent liquid refrigerant carryover into the compressor.

A 1-1/2" (38 mm) 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 dual refrigerant relief valve arrangement set at 180 psig (12.4 barg) on H and K compressor models; 235 psig (16.2 barg) on P and Q compressor models; or single-relief valve arrangement, if the chiller is supplied with optional refrigerant isolation valves. A 1" (25.4 mm) refrigerant charging valve is provided.

Condenser
The condenser is a shell and tube type, with a discharge gas baffle to prevent direct high velocity impingement on the tubes. The baffle is also used to distribute the refrigerant gas flow properly for most efficient heat transfer. An optional cast steel condenser inlet diffuser may be offered, on "M" and larger condensers, in lieu of the baffle, to 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).

Waterboxes
The removable waterboxes 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 waterbox to provide the required pass arrangements. Stub out water nozzle connections with ANSI/AWWA C-606 grooves are welded to the waterboxes. These nozzle connections are suitable for ANSI/AWWA C-606 couplings, welding or flanges, and are capped for shipment. Plugged 3/4" (19 mm) drain and vent connections are provided in each waterbox.

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.

OPTIVIEW CONTROL CENTER

General
The chiller is controlled by a stand-alone microprocessor based control center. The chiller control panel provides control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

Control Panel
The control panel includes a 10.4-in. (264 mm) diagonal color liquid crystal display (LCD) surrounded by “soft” keys which are redefined based on the screen displayed at that time, mounted in the middle of a keypad interface and installed in a locked enclosure. The screen details all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage is available in eight languages and can be changed on the fly without having to turn off the chiller. Data can be displayed in either English or Metric units. Smart Freeze Point Protection will 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 monitors the chiller water temperature to prevent freeze-up. When needed, Hot Gas Bypass is available as an option. The panel displays countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point has 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 also provides:

1. System operating information including:
   - A. Return and leaving chilled water temperature
   - B. Return and leaving condenser water temperature
   - C. Evaporator and condenser saturation pressure
   - D. Differential oil pressure
   - E. Percent motor current
   - F. Evaporator and condenser saturation temperature
   - G. Compressor discharge temperature
   - H. Oil reservoir temperature
   - I. Compressor thrust bearing positioning (K compressors only)
   - J. Operating hours
   - K. Number of compressor starts

2. Digital programming of setpoints through the universal keypad including:
   - A. Leaving chilled water temperature
   - B. Percent current limit
   - C. Pulls-down demand limiting
   - D. Six-week schedule for starting and stopping the chiller, pumps and tower
   - E. Rremote reset temperature range

3. Status messages indicating:
   - A. System ready to start
   - B. System running
   - C. System coastdown
   - D. System safety shutdown – manual restart
   - E. System cycling shutdown – auto restart
   - F. System pre-lube
   - G. Start inhibit

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

5. 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 with a fixed-speed-drive include:
   - A. Evaporator – low pressure
   - B. Evaporator – transducer or leaving liquid probe
   - C. Evaporator – transducer or temperature sensor
   - D. Condenser – high pressure contacts open
   - E. Condenser – high pressure
   - F. Condenser – pressure transducer out-of-range
   - G. Auxiliary safety – contacts closed
   - H. Discharge – high temperature
   - I. Discharge – low temperature
   - J. Oil – high temperature
   - K. Oil – low differential pressure
   - L. Oil – high differential pressure
   - M. Oil – sump pressure transducer out-of-range
   - N. Oil – differential pressure calibration
   - O. Oil – variable speed pump – pressure setpoint not achieved
   - P. Control panel – power failure
   - Q. Motor or starter – current imbalance
   - R. Thrust bearing – proximity probe clearance (K compressors only)
   - S. Thrust bearing – proximity probe out-of-range (K compressors only)
   - T. Thrust bearing – position switch (P, Q & H9 compressors)
   - U. Watchdog – software reboot

5.1. Safety shutdowns with a VSD include:
   - A. VSD shutdown – requesting fault data
   - B. VSD – stop contacts open
   - C. VSD – 105% motor current overload
   - D. VSD – high phase A, B, C inverter heat-sink temp.
   - E. VSD – high converter heat-sink temperature

(Filter Option Only)
   - F. Harmonic filter – high heat-sink temperature
   - G. Harmonic filter – high total demand distortion

6. 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 with a fixed speed drive include:
   - A. Multi unit cycling – contacts open
   - B. System cycling – contacts open

Mechanical Specifications - continued

C. Oil – low temperature differential
D. Oil – low temperature
E. Control panel – power failure
F. Leaving chilled liquid – low temperature
G. Leaving chilled liquid – flow switch open
H. Motor controller – contacts open
I. Motor controller – loss of current
J. Power fault
K. Control panel – schedule
L. Starter – low supply line voltage (SSS option)
M. Starter – high supply line voltage (SSS option)
N. Proximity probe – low supply voltage (K Compressor)
O. Oil – variable speed pump – drive contacts open

6.1 Cycling shutdowns with a VSD include:
A. VSD shutdown – requesting fault data
B. VSD – stop contacts open
C. VSD – initialization failed
D. VSD – high phase A, B, C instantaneous current
E. VSD – phase A, B, C gate driver
F. VSD – single phase input power
G. VSD – high DC bus voltage
H. VSD – precharge DC bus voltage imbalance
I. VSD – high internal ambient temperature
J. VSD – invalid current scale selection
K. VSD – low phase A, B, C inverter heat-sink temp.
L. VSD – low converter heat-sink temperature
M. VSD – precharge – low DC bus voltage
N. VSD – logic board processor
O. VSD – run signal
P. VSD – serial communications (Filter Option Only)
Q. Harmonic filter – logic board or communications
R. Harmonic filter – high DC bus voltage
S. Harmonic filter – high phase A, B, C current
T. Harmonic filter – phase locked loop
U. Harmonic filter – precharge – low DC bus voltage
V. Harmonic filter – DC bus voltage imbalance
W. Harmonic filter – 110% input current overload
X. Harmonic filter – logic board power supply
Y. Harmonic filter – run signal
Z. Harmonic filter – DC current transformer 1
AA. Harmonic filter – DC current transformer 2

7. 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 is through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

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

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints are retained in lithium battery-backed RTC memory for a minimum of 5 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over-current protected power for all controls.

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

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

13. The capability to interface with a building automation system via hard-wired connections to each feature to provide:
A. Remote chiller start and stop
B. Remote leaving chiller liquid temperature adjust
C. Remote current limit setpoint adjust
D. Remote ready to start contacts
E. Safety shutdown contacts
F. Cycling shutdown contacts
G. Run contacts

CODES AND STANDARDS

- ASME Boiler and Pressure Vessel Code – Section VIII Division 1.
- AHRI Standard 550/590

- 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

ISOLATION MOUNTING

The unit is provided with four 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.

IBC/OSHPD SEISMIC CERTIFICATION

YORK YK chillers meet the IBC seismic requirements. YORK YK chillers also meet the California Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproval (SSCP). To earn the SSCP, several models within a product line are required to successfully demonstrate functional operation after a shaker-table test. All Johnson Controls equipment is engineered and manufactured for the highest level of safety. Contact a Johnson Controls sales office to obtain a specific selection for a seismic compliance application.

REFRIGERANT CONTAINMENT

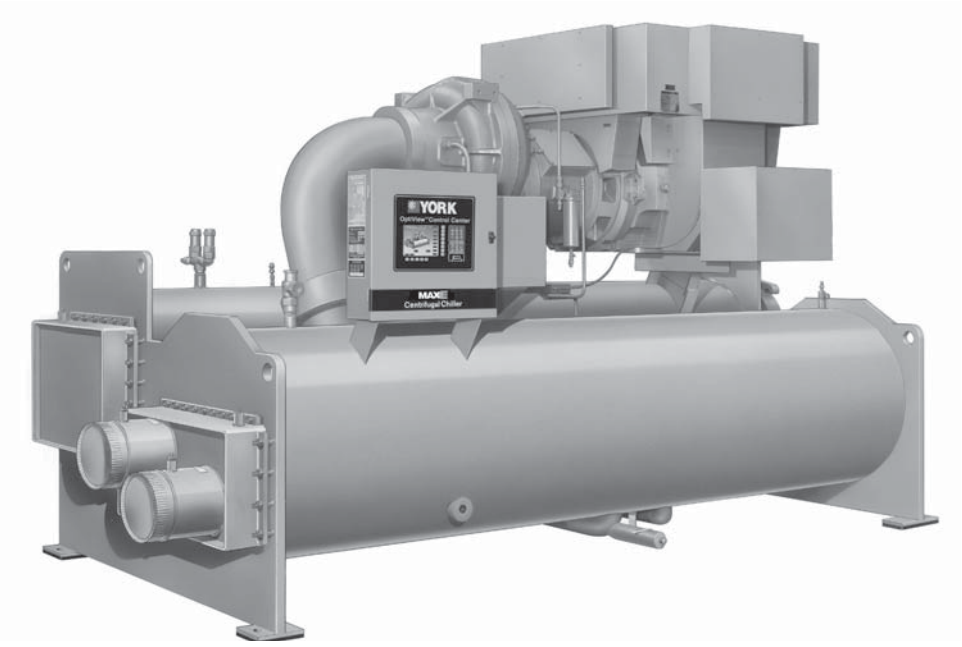
The standard unit has been designed as a complete and compact factory-packaged chiller. As such, it has minimum joints from which refrigerant can leak. The entire assembly has been thoroughly leak tested at the factory prior to shipment. The YORK YK chiller includes service valves conveniently located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

PAINT

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

SHIPMENT

A protective covering is furnished on the motor starter, Control Center VSD and unit mounted controls. Water nozzles are capped with fitted plastic caps. The entire unit is protected with a industrial-grade, reinforced shrink-wrapped covering.



S_{DS} level of 1.6g mounted on neoprene pads.

FIGURE 1 – SPECIAL SEISMIC CERTIFICATION PREAPPROVAL

YORK YK Centrifugal Chillers meet the Special Seismic Certification Preapproval of California OSHPD.
(Note: S_{DS} = design spectral response acceleration at short periods [g], per IBC-2009.)

Accessories and Modifications

STARTERS

JOHNSON CONTROLS OPTISPEED™ DRIVE STARTER

When a YORK YK chiller is equipped with a variable speed drive, it incorporates advanced Adaptive Capacity Control logic, which continually optimizes chiller operation. It closely examines critical operating parameters, and then determines the most efficient way to operate. In addition, it allows optimized savings when using intelligent control strategies, such as chilled-water reset. Adaptive Capacity Control logic also accommodates the characteristics of the refrigerant used in the chiller — today and tomorrow.

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).

LOW VOLTAGE OPTISPEED DRIVE

The Low Voltage OptiSpeed variable speed drive is factory-packaged and mounted on the YORK YK chiller. It is designed to vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive 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.

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

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 comply with the guidelines of IEEE Std. 519-1992. 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

TABLE 1 – OPTISPEED DRIVE STARTER OPTION

Low Voltage Starters								
	60 Hz				**50 Hz**			
OptiSpeed Variable Speed Drive Unit Mounted	380V	460V	575V	600V	380V	400V	415V	
	X	X	X	X	X	X	X	
60 Hz Medium Voltage Starters								
OptiSpeed Variable Speed Drive Floor Mounted	2300V	3300V	4000V	4160V	6000V	6600V	12470V	13800V
	X	X	X	X	Y	Y	Y	Y
50 Hz Medium Voltage Starters								
OptiSpeed Variable Speed Drive Floor Mounted	2300V	3000V	3300V	6000V	6600V	10000V	11000V	
			X	Y	Y	Y	Y	

Y=Available by Special Quotes (SQ)

- 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

LOW VOLTAGE OPTISPEED DRIVE WITH QUICK START OPTION

The Quick Start feature is targeted towards data centers and process control applications where the goal is to re-establish process cooling as fast as possible after a power failure event. The Quick Start feature does this by reducing the time cycle for chiller restart and by loading the chiller as fast as possible. Once running, its goal is to rapidly achieve the leaving chilled water temperature setpoint. The main objective is to provide minimum downtime and the fastest restart/loading as possible. After the chiller is running and close to setpoint, it will return to standard YK control to minimize risk.

The Quick Start Feature can be used with a UPS (supplied by others) or without a UPS. In order to start the most quickly, the OptiView control panel and VSD control circuit (except the trigger board) must be on a UPS. If a slightly longer restart time can be tolerated, the UPS is not required.

Depending on the compressor and the horsepower of the drive, a 3 kVA or 4 kVA UPS (supplied by others) with sine wave output is required to power the OptiView and required portions of the VSD control circuit to 115V – 1 Ø – 60 Hz.
Please refer to Form 160.75-TD4; Quick Start Feature for YK Mod G Chillers for additional information.

Quick Start Feature Availability - This feature applies only to YK chillers with Low Voltage Variable Speed Drives.

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 adaptive 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 power-factor correction to 0.98 or better at all load conditions. Separate power-factor correction capacitors are not required. See Table 3 for additional advantages of the variable speed drive.

Standard features include: a lockable door interlocked disconnect switch; UL listed ground fault protection; over-

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 1992 compliant if used with an optional harmonic filter.

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 1992 compliant with a harmonic filter. • Multi-level PWM output closely simulates a true sine wave, allowing the use of standard motors and bearings.

Accessories and Modifications - continued

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 electrical the power supply distortion from the variable speed drive to comply with the guidelines of IEEE Std. 519-1992.

LOW VOLTAGE SOLID-STATE STARTER

The Low Voltage Solid-State Starter is compact and mounted on the unit. Power and control wiring between the starter and the chiller are factory-installed. Available for 200 - 600 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 provided.

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

Display Only

- 3-phase input voltage
- 3-phase current
- Input Power (kW)
- Killowatt-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 cooled by a closed-loop, fresh-water-circuit consisting of a water-to-water heat exchanger and a fractional horsepower circulating pump. All interconnecting water piping is factory-installed and rated for 150 psig (10.3 barg) working pressure. Optional electronic trip circuit UL listed circuit breaker with integral ground fault protection is available with short circuit withstand ratings of:

- 65KA for 460V 200V, 400V models
- 50KA for 33L 575V models
- 35KA for 14L 575V models
- 22KA for 7L 575V models

A non-fused disconnect switch is also available. Both options are lockable.

See Table 6 for additional advantages of Solid-State Starters

TABLE 4 – LOW VOLTAGE SOLID-STATE STARTER

LV SOLID-STATE STARTER (UNIT MOUNTED)	60 HZ										50 HZ				
	200V	208V	230V	240V	380V	440V	460V	480V	575V	600V	346V	380V	400V	415V	440V
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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. Power and control wiring between the starter and the chiller for the unit mounted version is factory-installed. Available for 2300 - 4160 volts (see Table 5), the starter enclosure is NEMA-1, with a hinged access door with lock and key. Electrical lugs for incoming power wiring are not provided.

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

Display Only

- 3-phase input voltage
- 3-phase current
- Input Power (kW)
- Killowatt-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 6 for additional advantages of Solid-State Starters.

ELECTRO-MECHANICAL STARTER - (FIELD-INSTALLED)

A. 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,

TABLE 5 – MEDIUM VOLTAGE SOLID-STATE STARTER

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

* UNIT MOUNTED VERSION AVAILABLE FOR COMPRESSOR H9 OR LARGER

** FOR HIGHER VOLTAGE CONTACT APPLICATION ENGINEERING DEPARTMENT FOR A SPECIAL QUOTE (SQ)

TABLE 6 – SOLID-STATE STARTER (LOW AND MEDIUM VOLTAGE)

Starter Type	Advantages
SOLID-STATE Starter	• Smooth, controlled start profile. • Unit mounted, factory wired and tested. • Rugged and reliable with no moving parts. • Adjustable acceleration times. • Reduces compressor sound levels at most operating conditions. • Rugged and reliable with no moving parts. • Application-specific designs enable seamless integration with equipemnt control panel and BAS.

Accessories and Modifications - continued

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-1132) for Starters.

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 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 that occurs as the contacts make or break may result in rapid and excessive erosion of the contacts, causing prematurely short contact life.

B. 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 driveline. 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.

TABLE 7 – ELECTRO-MECHANICAL STARTER

STARTER OPTIONS	LOW VOLTAGE / FREQUENCY															
LV ACROSS THE LINE (DOL) (FLOOR MOUNTED)	60HZ											50HZ				
	200V	208V	230V	240V	380V	416V	440V	460V	480V	575V	600V	346V	380V	400V	415V	440V
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LV STAR-DELTA CLOSED (FLOOR MOUNTED)	60HZ											50HZ				
	200V	208V	230V	240V	380V	416V	440V	460V	480V	575V	600V	346V	380V	400V	415V	440V
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
STARTER OPTIONS	MEDIUM VOLTAGE / FREQUENCY															
MV ACROSS THE LINE (DOL) (FLOOR MOUNTED)	60HZ							50HZ								
	2300	3300	4000	4160	6600	12470	13800	2300	3000	3300	6600	10000	11000			
	X	X	X	X	Y	Y	Y	X	X	X	Y	Y	Y			
MV AUTOTRANS-FORMER 65% (FLOOR MOUNTED)	60HZ							50HZ								
	2300	3300	4000	4160	6600	12470	13800	2300	3000	3300	6600	10000	11000			
	X	X	X	X	Y	Y	Y	X	X*	X*	Y	Y	Y			
MV AUTOTRANS-FORMER 80% (FLOOR MOUNTED)	60HZ							50HZ								
	2300	3300	4000	4160	6600	12470	13800	2300	3000	3300	6600	10000	11000			
	X	X	X	X	Y	Y	Y	X	X	X	Y	Y	Y			

*= NOT AVAILABLE WITH 5DJ MOTOR / Y= AVAILABLE BY SPECIAL QUOTE (SQ)

Star-Delta starting creates some stresses for the starter's switchgear, building electrical system, power grid, and chiller mechanical driveline. Although these stresses are 1/3 of the stresses generated by an ACL starter, they cause wear on the system. As a result, Johnson Controls recommends using a Solid State Starter or Variable Speed Drive instead of a Star-Delta starter.

GENERAL ACCESSORIES AND MODIFICATIONS

MEDIUM VOLTAGE MOTORS

Medium voltage motors (4160V/60Hz to 13800V/60Hz and 3300V/50Hz to 11000V/50Hz) are available for YK units; Contact JCI Sales Office for special rating.

SPECIAL MOTORS ENCLOSURES

There are job applications, primarily in manufacturing, comfort cooling 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 JCI 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.

BAS REMOTE CONTROL

A communication interface permitting complete exchange of chiller data with any BAS system is available with an optional E-Link gateway. The E-Link also allows the BAS system to issue commands to the chiller to control its operation. E-Link gateways come in four models, depending on the communication protocol and the mounting arrangement.

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, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. Not included is the insulation of compact waterboxes and nozzles. This insulation will normally prevent condensation in environments with relative humidifies 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 humidifies up to 90% and dry bulb temperatures ranging from 50° to 90°F (10° to 32.2°C).

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.

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.

MARINE WATERBOXES

Marine waterboxes 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 nozzle connections are standard; flanges are optional. Marine waterboxes are available for condenser and/or evaporator.

Accessories and Modifications - continued

HINGED WATERBOXES

Hinged waterboxes allow fast and safe service access for cleaning heat exchanger tubes. Hinged waterboxes on a non-nozzle end give access to the tubes without having to disconnect the water piping. Hinged waterboxes are available for condenser and/or evaporator for compact and marine waterboxes.

KNOCK-DOWN SHIPMENT

The chiller 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.

REFRIGERANT ISOLATION VALVES

Optional factory-installed isolation valves in the compressor discharge line and refrigerant liquid line are available. This allows isolation and storage of the refrigerant charge in the chiller condenser during servicing, eliminating time-consuming transfers to remote storage vessels. Both valves are positive shut-off, assuring integrity of the storage system.

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. A storage receiver is typically not required if optional unit isolation valves are provided.

HIGH AMBIENT TEMPERATURE

Chiller modifications are available to allow for installation in high ambients of up to 122°F (50°C). Special drive motors are required above 104°F (40°C). H9 and K compressor evaporator design pressures must be increased for ambient temperatures above 112.8°F (45°C). The OptiView panel and low voltage VSD are suited for 122°F (50°C) ambient. Low and medium voltage Solid-State Starters must be derated and/or modified above 110°F (43.3°C). The free standing MVVSD option must be derated above its standard 104°F (40°C) limit.

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. See Figure 1.

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.

Johnson Controls recommends the OptiSound Control for chiller applications with elevated entering condenser-water temperatures (high-head) or applications requiring low-load operation with constant condenser temperature. At high-head conditions, improved chiller operation is visible at all load points.

OptiSound Control Availability
Standard: Compressors P8, P9, H9, K1, K2, K3, K4, K7
Optional: Compressors Q3, Q4, Q5, Q6, Q7, P7

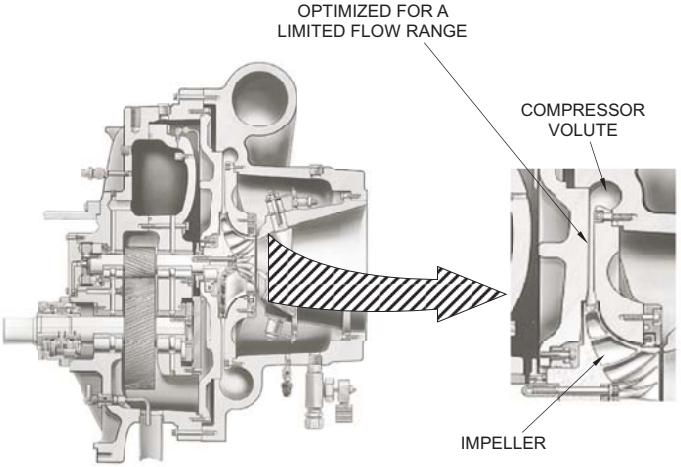


FIGURE 1 – TYPICAL CENTRIFUGAL COMPRESSOR

Application Data

The following discussion is a user's guide in the application and installation of YK 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

YK 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 low voltage VSD or low voltage SSS 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 VSD or SSS cabinet. Other areas susceptible to water vapor condensate are outside of the condenser shell and condenser water boxes. Example applications include cooling condenser water using chilled water, wells, river or other low temperature fluids.

For outdoor applications, please contact Large Tonnage Application Team.

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 fps (0.91 m/s) [3.3 fps (1.0 m/s) for condensers] and 12 fps (3.66 m/s). Two pass units are also limited to 45 ft H_20 (134 kPa) water pressure drop. The three pass limit is 67.5 ft H_20 (201 kPa).

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 1 for flow limits at design conditions.

There is increasing interest to use variable primary flow (VPF) systems in large chilled water plants. VPF systems can offer lower installation and operating costs in many cases, but do require more sophisticated control and flow monitoring.

YORK YK Style G chillers will operate successfully in VPF systems. With a minimum allowable evaporator tube velocity of 1-1/2 fps (0.5 m/s) for standard tubes at part-load rating conditions, YK chillers will accommodate the wide variation in flow required by many chilled water VPF applications.

The chillers can tolerate a 50% flow rate change in one minute that is typically associated with the staging on or off of an additional chiller, however a lower flow rate change is normally used for better system stability and set point control. Proper sequencing via the building automation system will make this a very smooth transition.

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) for water temperature ranges between 3°F and 30°F (1.7°C and 16.7°C).

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.

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

Application Data - continued

TABLE 8 – WATER FLOW RATE LIMITS (GPM) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
AP	329	1316	164	587	110	380	AP	479	1727	240	856	160	576
AQ	403	1613	202	713	134	460	AQ	612	2205	306	1068	204	732
AR	493	1973	247	861	164	552	AR	681	2455	341	1173	227	812
AS	602	2408	301	1032	201	655	AS	770	2773	385	1300		
AC	705	2819	352	1194	235	825							
AD	882	3527	441	1436	294	1018							
A3	674	2695	337	1347	225	898							
A4	812	3248	406	1624	271	1083							
CP	648	2594	324	1151	216	755	CP	779	2807	389	1397	260	922
CQ	729	2917	365	1286	243	844	CQ	896	3228	448	1590	299	1050
CR	866	3463	433	1509	289	992	CR	1120	4035	560	1941	373	1285
CS	1043	4170	521	1787	348	1176	CS	1397	5035	699	2340		
CC	796	3186	398	1410	265	945							
CD	999	3995	499	1734	333	1178							
CE	1270	5082	635	2140	423	1484							
C3	746	2983	373	1492	249	994							
C4	938	3753	469	1877	313	1251							
C5	1221	4884	611	2442	407	1628							
DP	648	2594	324	988	216	648	DP	779	2807	389	1203	260	793
DQ	729	2917	365	1106	243	725	DQ	896	3228	448	1372	299	906
DR	866	3463	433	1301	289	854	DR	1120	4035	560	1685	373	1114
DS	1043	4170	521	1547	348	1017	DS	1397	5035	699	2048		
DC	796	3186	398	1214	265	809							
DD	999	3995	499	1501	333	1010							
DE	1270	5082	635	1865	423	1275							
D3	746	2983	373	1463	249	982							
D4	938	3753	469	1803	313	1228							
D5	1221	4884	611	2261	407	1578							
EP	859	3438	430	1535	286	1009	EP	1120	4035	560	2017	373	1337
EQ	1046	4183	523	1853	349	1220	EQ	1344	4842	672	2394	448	1590
ER	1232	4927	616	2164	411	1428	ER	1583	5705	792	2779	528	1853
ES	1452	5809	726	2519	484	1667	ES	1750	6308	875	3037	583	2031
ET	1676	6702	838	2865	559	1903	ET	1946	7012	973	3328		
EC	980	3919	490	1758	327	1168							
ED	1296	5183	648	2289	432	1537							
EE	1637	6548	819	2831	546	1929							
E3	986	3946	493	1973	329	1315							
E4	1233	4932	617	2466	411	1644							
E5	1522	6087	761	3044	507	2029							
FQ	1046	4183	523	1591	349	1046	FQ	1344	4842	672	2064	448	1368
FR	1232	4927	616	1862	411	1226	FR	1583	5705	792	2405	528	1599
FS	1452	5809	726	2175	484	1436	FS	1750	6308	875	2636	583	1756
FT	1676	6702	838	2482	559	1643	FT	1946	7012	973	2898		
FC	980	3919	490	1508	327	998							
FD	1296	5183	648	1972	432	1316							

TABLE 8 – WATER FLOW RATE LIMITS (GPM) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
FE	1637	6548	819	2452	546	1654							
F3	986	3946	493	1956	329	1304							
F4	1233	4932	617	2410	411	1622							
F5	1522	6087	761	2914	507	1989							
GQ	1443	5771	721	2504	481	1657	EV	1583	5705	792	2779	528	1853
GR	1629	6516	814	2794	543	1855	EW	1750	6308	875	3037	583	2031
GS	1843	7372	922	3115	614	2075	EX	1946	7012	973	3328		
GC	1293	5170	646	2284	431	1533							
GD	1618	6472	809	2802	539	1907	E3	1416	5101	708	2551	472	1700
GE	2108	8432	1054	3521	703	2455	E4	1738	6263	869	3131		
G3	1269	5077	635	2538	423	1692							
G4	1588	6352	794	3176	529	2117							
G5	1973	7892	986	3946	658	2631							
HQ	1443	5771	721	2162	481	1427	FV	1583	5705	792	2405	528	1599
HR	1629	6516	814	2419	543	1600	FW	1750	6308	875	2636	583	1756
HS	1843	7372	922	2707	614	1796	FX	1946	7012	973	2898		
HC	1293	5170	646	1967	431	1312							
HD	1618	6472	809	2426	539	1635	F3	1416	5101	708	2551	472	1700
HE	2108	8432	1054	3075	703	2112	F4	1738	6263	869	3131		
H3	1269	5077	635	2474	423	1668							
H4	1588	6352	794	3025	529	2072							
H5	1973	7892	986	3637	658	2546							
JP	1545	6181	773	2735	515	1807	JP	1583	5705	792	2779	528	1899
JQ	1918	7670	959	3349	639	2224	JQ	1892	6819	946	3249	631	2253
JR	2395	9582	1198	4098	798	2742	JR	2479	8933	1239	4054	826	2903
JS	2616	10463	1308	4427	872	2974	JS	2756	9933	1378	4395		
KP, KT	1545	6181	773	2522	515	1664	KP	1583	5705	792	2574	528	1750
KQ,KV	1918	7670	959	3094	639	2051	KQ	1892	6819	946	3019	631	2078
KR,KW	2395	9582	1198	3797	798	2533	KR	2479	8933	1239	3790	826	2684
KS,KX	2616	10463	1308	4109	872	2750	KS	2756	9933	1378	4121		
K2,K5	1844	7374	922	3687	615	2458	K2	1617	5829	809	2914	539	1943
K3,K6	2163	8651	1081	4325	721	2884	K3	1927	6946	964	3473	642	2315
K4,K7	2488	9951	1244	4903	829	3312	K4	2584	9313	1292	4657		
KC	2117	8470	1059	3424	706	2305							
KD	2784	11137	1392	4378	928	3004							
K8	1540	6159	770	3080	513	2053							
K9	2057	8228	1029	4114	686	2743							
K0	2695	10779	1347	5316	898	3593							
LQ	1918	7670	959	2886	639	1910	LQ	1892	6819	946	2827	631	1936
LR	2395	9582	1198	3550	798	2363	LR	2479	8933	1239	3567	826	2504
LS	2616	10463	1308	3845	872	2567	LS	2756	9933	1378	3888		
							MP	2192	7899	1096	3626	731	2391
MQ	2426	9706	1213	3906	809	2606	MQ	2570	9263	1285	4206	857	2776
MR	2830	11319	1415	4499	943	3022	MR	2949	10626	1474	4765	983	3149
MS	3246	12982	1623	5088	1082	3444	MS	3271	11786	1635	5225		

Application Data - continued

TABLE 8 – WATER FLOW RATE LIMITS (GPM) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
M2	2003	8013	1002	4006	668	2671	M2	2131	7678	1065	3839	710	2559
M3	2375	9502	1188	4751	792	3167	M3	2639	9510	1319	4755	880	3170
M4	2949	11794	1474	5837	983	3931	M4	3246	11699	1623	5849		
							NP	2192	7899	1096	3381	731	2229
NQ	2426	9706	1213	3644	809	2426	NQ	2570	9263	1285	3927	857	2591
NR	2830	11319	1415	4205	943	2815	NR	2949	10626	1474	4456	983	2943
NS	3246	12982	1623	4763	1082	3210	NS	3271	11786	1635	4892		
N2	2003	8013	1002	3870	668	2580	N2	2131	7678	1065	3839	710	2559
N3	2375	9502	1188	4527	792	3040	N3	2639	9510	1319	4755	880	3170
N4	2949	11794	1474	5484	983	3731	N4	3246	11699	1623	5849		
PQ	2755	11021	1378	4391	918	2946	PQ	3662	13195	1831	5954	1221	4003
PR	3131	12523	1565	4928	1044	3328	PR	4097	14763	2048	6587	1366	4452
PS	3360	13441	1680	5246	1120	3558	PS	4545	16377	2272	7216		
P2	2523	10093	1262	5046	841	3364	P2	3229	11635	1614	5817	1076	3878
P3	2960	11842	1480	5857	987	3947	P3	3917	14114	1958	7057	1306	4705
P4	3356	13425	1678	6499	1119	4475	P4	4760	17152	2380	8576	1587	5717
QQ	2755	11021	1378	4103	918	2744	QQ	3662	13195	1831	5563	1221	3731
QR	3131	12523	1565	4611	1044	3102	QR	4097	14763	2048	6163	1366	4152
QS	3360	13441	1680	4913	1120	3318	QS	4545	16377	2272	6762		
Q2	2523	10093	1262	4780	841	3221	Q2	3229	11635	1614	5817	1076	3878
Q3	2960	11842	1480	5503	987	3745	Q3	3917	14114	1958	7057	1306	4705
Q4	3356	13425	1678	6121	1119	4207	Q4	4760	17152	2380	8576		
QT	3602	14410	1801	5225	1201	3544							
QV	4142	16569	2071	5893	1381	4037							
RQ	3770	15080	1885	5689	1257	3737	RQ	4907	17684	2454	7428	1636	4917
RS	4605	18418	2302	6863	1535	4517	RR	5390	19423	2695	8086	1797	5360
RV	5405	21621	2703	7946	1802	5240	RS	5753	20730	2876	8570		
R3	3870	15482	1935	7403	1290	4872	R2	4228	15235	2114	7618	1409	5078
R5	4603	18413	2302	8650	1534	5708	R3	4996	18005	2498	9002	1665	6002
R7	5241	20965	2621	9682	1747	6404	R4	5914	21311	2957	10655		
RP	3103	12411	1551	4722	1034	3098							
RR	3829	15316	1914	5774	1276	3793							
RT	4633	18530	2316	6902	1544	4542							
R2	3800	15198	1900	7278	1267	4789							
R4	4296	17183	2148	8135	1432	5362							
R6	4816	19263	2408	9000	1605	5943							
SQ	3770	15080	1885	5345	1257	3510	SQ	4907	17684	2454	6992	1636	4626
SS	4605	18418	2302	6457	1535	4247	SR	5390	19423	2695	7619	1797	5047
SV	5405	21621	2703	7487	1802	4933	SS	5753	20730	2876	8081		
S3	3870	15482	1935	6975	1290	4588	S2	4228	15235	2114	7549	1409	4993
S5	4603	18413	2302	8166	1534	5384	S3	4996	18005	2498	8795	1665	5832
S7	5241	20965	2621	9157	1747	6050	S4	5914	21311	2957	10192		
							TP	5396	19446	2698	8095	1799	5470
							TQ	5973	21525	2987	8859	1991	6020
							TR	6576	23696	3288	9629	2192	6583
							TS	6929	24969	3464	10067		
							T2	4607	16602	2304	8301	1536	5534

TABLE 8 – WATER FLOW RATE LIMITS (GPM) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
							T3	5710	20578	2855	10289	1903	6859
							T4	6299	22700	3150	11300	2100	7567
							T5	7093	25559	3546	12421		
							VP	5396	19446	2698	7628	1799	5140
							VQ	5973	21525	2987	8358	1991	5660
							VR	6576	23696	3288	9097	2192	6194
							VS	6929	24969	3464	9518		
							V2	4607	16602	2304	8143	1536	5497
							V3	5710	20578	2855	9865	1903	6749
							V4	6299	22700	3150	10725	2100	7395
							V5	7093	25559	3546	11818		
WP	3103	12411	1551	3973	1034	2605	WQ	5368	19343	2684	6844	1789	4591
WR	3829	15316	1914	4871	1276	3197	WR	5891	21230	2946	7456	1964	5020
WT	4633	18530	2316	5842	1544	3840	WS	6415	23117	3207	8054		
W1	3173	12693	1587	5209	1058	3419	W1	4250	15314	2125	6785	1417	4540
W2	3800	15198	1900	6180	1267	4062	W2	5260	18955	2630	8290	1753	5603
W4	4296	17183	2148	6929	1432	4559	W3	6140	22127	3070	9526	2047	6502
W6	4816	19263	2408	7693	1605	5069	W4	6785	24450	3392	10386		
XQ	4769	19076	2385	7089	1590	4667	XQ	6241	22491	3121	9429	2080	6272
XR	5272	21087	2636	7769	1757	5121	XR	6967	25105	3483	10411	2322	6943
XS	5740	22961	2870	8386	1913	5534	XS	7900	28470	3950	11627		
X2	4769	19074	2384	8923	1590	5891	X2	4969	17905	2484	8952	1656	5968
X3	5637	22549	2819	10296	1879	6820	X3	6487	23378	3244	11689	2162	7793
X4	6281	25125	3141	11250	2094	7470	X4	8099	29185	4049	14441		
ZQ	4769	19076	2385	6671	1590	4390	ZQ	6241	22491	3121	8878	2080	5899
ZR	5272	21087	2636	7318	1757	4820	ZR	6967	25105	3483	9814	2322	6536
ZS	5740	22961	2870	7907	1913	5214	ZS	7900	28470	3950	10978		
Z1	3959	15836	1980	7122	1320	4686	Z1	4138	14912	2069	7435	1379	4914
Z2	4769	19074	2384	8427	1590	5559	Z2	4969	17905	2484	8866	1656	5880
Z3	5637	22549	2819	9748	1879	6450	Z3	6487	23378	3244	11332	2162	7567
Z4	6281	25125	3141	10672	2094	7077	Z4	8099	29185	4049	13715		

Application Data - continued

TABLE 8A – WATER FLOW RATE LIMITS (L/S) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
AP	21	83	10	37	7	24	AP	30	109	15	54	10	36
AQ	25	102	13	45	8	29	AQ	39	139	19	67	13	46
AR	31	124	16	54	10	35	AR	43	155	22	74	14	51
AS	38	152	19	65	13	41	AS	49	175	24	82		
AC	44	178	22	75	15	52							
AD	56	223	28	91	19	64							
A3	43	170	21	85	14	57							
A4	51	205	26	102	17	68							
CP	41	164	20	73	14	48	CP	49	177	25	88	16	58
CQ	46	184	23	81	15	53	CQ	57	204	28	100	19	66
CR	55	218	27	95	18	63	CR	71	255	35	122	24	81
CS	66	263	33	113	22	74	CS	88	318	44	148		
CC	50	201	25	89	17	60							
CD	63	252	31	109	21	74							
CE	80	321	40	135	27	94							
C3	47	188	24	94	16	63							
C4	59	237	30	118	20	79							
C5	77	308	39	154	26	103							
DP	41	164	20	62	14	41	DP	49	177	25	76	16	50
DQ	46	184	23	70	15	46	DQ	57	204	28	87	19	57
DR	55	218	27	82	18	54	DR	71	255	35	106	24	70
DS	66	263	33	98	22	64	DS	88	318	44	129		
DC	50	201	25	77	17	51							
DD	63	252	31	95	21	64							
DE	80	321	40	118	27	80							
D3	47	188	24	92	16	62							
D4	59	237	30	114	20	77							
D5	77	308	39	143	26	100							
EP	54	217	27	97	18	64	EP	71	255	35	127	24	84
EQ	66	264	33	117	22	77	EQ	85	305	42	151	28	100
ER	78	311	39	137	26	90	ER	100	360	50	175	33	117
ES	92	366	46	159	31	105	ES	110	398	55	192	37	128
ET	106	423	53	181	35	120	ET	123	442	61	210		
EC	62	247	31	111	21	74							
ED	82	327	41	144	27	97							
EE	103	413	52	179	34	122							
E3	62	249	31	124	21	83							
E4	78	311	39	156	26	104							
E5	96	384	48	192	32	128							
FQ	66	264	33	100	22	66	FQ	85	305	42	130	28	86
FR	78	311	39	117	26	77	FR	100	360	50	152	33	101
FS	92	366	46	137	31	91	FS	110	398	55	166	37	111
FT	106	423	53	157	35	104	FT	123	442	61	183		
FC	62	247	31	95	21	63							
FD	82	327	41	124	27	83							
FE	103	413	52	155	34	104							
F3	62	249	31	123	21	82							
F4	78	311	39	152	26	102							
F5	96	384	48	184	32	125							
GQ	91	364	45	158	30	105	EV	100	360	50	175	33	117
GR	103	411	51	176	34	117	EW	110	398	55	192	37	128

TABLE 8A – WATER FLOW RATE LIMITS (L/S) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS - CONT.

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
GS	116	465	58	197	39	131	EX	123	442	61	210		
GC	82	326	41	144	27	97							
GD	102	408	51	177	34	120	E3	89	322	45	161	30	107
GE	133	532	66	222	44	155	E4	110	395	55	198		
G3	80	320	40	160	27	107							
G4	100	401	50	200	33	134							
G5	124	498	62	249	42	166							
HQ	91	364	45	136	30	90	FV	100	360	50	152	33	101
HR	103	411	51	153	34	101	FW	110	398	55	166	37	111
HS	116	465	58	171	39	113	FX	123	442	61	183		
HC	82	326	41	124	27	83							
HD	102	408	51	153	34	103	F3	89	322	45	161	30	107
HE	133	532	66	194	44	133	F4	110	395	55	198		
H3	80	320	40	156	27	105							
H4	100	401	50	191	33	131							
H5	124	498	62	229	42	161							
JP	97	390	49	173	32	114	JP	100	360	50	175	33	120
JQ	121	484	61	211	40	140	JQ	119	430	60	205	40	142
JR	151	605	76	259	50	173	JR	156	564	78	256	52	183
JS	165	660	83	279	55	188	JS	174	627	87	277		
KP, KT	97	390	49	159	32	105	KP	100	360	50	162	33	110
KQ,KV	121	484	61	195	40	129	KQ	119	430	60	190	40	131
KR,KW	151	605	76	240	50	160	KR	156	564	78	239	52	169
KS,KX	165	660	83	259	55	173	KS	174	627	87	260	0	0
K2,K5	116	465	58	233	39	155	K2	102	368	51	184	34	123
K3,K6	136	546	68	273	45	182	K3	122	438	61	219	41	146
K4,K7	157	628	78	309	52	209	K4	163	588	82	294		
KC	134	534	67	216	45	145							
KD	176	703	88	276	59	190							
K8	97	389	49	194	32	130							
K9	130	519	65	260	43	173							
K0	170	680	85	335	57	227							
LQ	121	484	61	182	40	121	LQ	119	430	60	178	40	122
LR	151	605	76	224	50	149	LR	156	564	78	225	52	158
LS	165	660	83	243	55	162	LS	174	627	87	245		
	0	0	0	0	0	0	MP	138	498	69	229	46	151
MQ	153	612	77	246	51	164	MQ	162	584	81	265	54	175
MR	179	714	89	284	59	191	MR	186	670	93	301	62	199
MS	205	819	102	321	68	217	MS	206	744	103	330		
M2	126	506	63	253	42	169	M2	134	484	67	242	45	161
M3	150	599	75	300	50	200	M3	166	600	83	300	56	200
M4	186	744	93	368	62	248	M4	205	738	102	369		
	0	0	0	0	0	0	NP	138	498	69	213	46	141
NQ	153	612	77	230	51	153	NQ	162	584	81	248	54	163
NR	179	714	89	265	59	178	NR	186	670	93	281	62	186
NS	205	819	102	300	68	203	NS	206	744	103	309		
N2	126	506	63	244	42	163	N2	134	484	67	242	45	161
N3	150	599	75	286	50	192	N3	166	600	83	300	56	200
N4	186	744	93	346	62	235	N4	205	738	102	369		
PQ	174	695	87	277	58	186	PQ	231	832	116	376	77	253
PR	198	790	99	311	66	210	PR	258	931	129	416	86	281
PS	212	848	106	331	71	224	PS	287	1033	143	455		

Application Data - continued

TABLE 8A – WATER FLOW RATE LIMITS (L/S) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS - CONT.

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
P2	159	637	80	318	53	212	P2	204	734	102	367	68	245
P3	187	747	93	370	62	249	P3	247	890	124	445	82	297
P4	212	847	106	410	71	282	P4	300	1082	150	541	100	361
QQ	174	695	87	259	58	173	QQ	231	832	116	351	77	235
QR	198	790	99	291	66	196	QR	258	931	129	389	86	262
QS	212	848	106	310	71	209	QS	287	1033	143	427		
Q2	159	637	80	302	53	203	Q2	204	734	102	367	68	245
Q3	187	747	93	347	62	236	Q3	247	890	124	445	82	297
Q4	212	847	106	386	71	265	Q4	300	1082	150	541		
QT	227	909	114	330	76	224							
QV	261	1045	131	372	87	255							
RQ	238	951	119	359	79	236	RQ	310	1116	155	469	103	310
RS	291	1162	145	433	97	285	RR	340	1225	170	510	113	338
RV	341	1364	171	501	114	331	RS	363	1308	181	541		
R3	244	977	122	467	81	307	R2	267	961	133	481	89	320
R5	290	1162	145	546	97	360	R3	315	1136	158	568	105	379
R7	331	1323	165	611	110	404	R4	373	1345	187	672		
RP	196	783	98	298	65	195							
RR	242	966	121	364	81	239							
RT	292	1169	146	435	97	287							
R2	240	959	120	459	80	302							
R4	271	1084	136	513	90	338							
R6	304	1215	152	568	101	375							
SQ	238	951	119	337	79	221	SQ	310	1116	155	441	103	292
SS	291	1162	145	407	97	268	SR	340	1225	170	481	113	318
SV	341	1364	171	472	114	311	SS	363	1308	181	510		
S3	244	977	122	440	81	289	S2	267	961	133	476	89	315
S5	290	1162	145	515	97	340	S3	315	1136	158	555	105	368
S7	331	1323	165	578	110	382	S4	373	1345	187	643		
							TP	340	1227	170	511	113	345
							TQ	377	1358	188	559	126	380
							TR	415	1495	207	607	138	415
							TS	437	1575	219	635		
							T2	291	1047	145	524	97	349
							T3	360	1298	180	649	120	433
							T4	397	1432	199	713	132	477
							T5	447	1613	224	784		
							VP	340	1227	170	481	113	324
							VQ	377	1358	188	527	126	357
							VR	415	1495	207	574	138	391
							VS	437	1575	219	600		
							V2	291	1047	145	514	97	347
							V3	360	1298	180	622	120	426
							V4	397	1432	199	677	132	467
							V5	447	1613	224	746		
WP	196	783	98	251	65	164	WQ	339	1220	169	432	113	290
WR	242	966	121	307	81	202	WR	372	1339	186	470	124	317
WT	292	1169	146	369	97	242	WS	405	1458	202	508		
W1	200	801	100	329	67	216	W1	268	966	134	428	89	286
W2	240	959	120	390	80	256	W2	332	1196	166	523	111	353
W4	271	1084	136	437	90	288	W3	387	1396	194	601	129	410
W6	304	1215	152	485	101	320	W4	428	1543	214	655		

TABLE 8A – WATER FLOW RATE LIMITS (L/S) – BASED UPON STANDARD TUBES @ DESIGN FULL LOAD CONDITIONS - CONT.

EVAPORATOR							CONDENSER						
MODEL	1 PASS		2 PASS		3 PASS		MODEL	1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX	MIN	MAX
XQ	301	1204	150	447	100	294	XQ	394	1419	197	595	131	396
XR	333	1330	166	490	111	323	XR	440	1584	220	657	146	438
XS	362	1449	181	529	121	349	XS	498	1796	249	734		
X2	301	1203	150	563	100	372	X2	313	1130	157	565	104	377
X3	356	1423	178	650	119	430	X3	409	1475	205	737	136	492
X4	396	1585	198	710	132	471	X4	511	1841	255	911		
ZQ	301	1204	150	421	100	277	ZQ	394	1419	197	560	131	372
ZR	333	1330	166	462	111	304	ZR	440	1584	220	619	146	412
ZS	362	1449	181	499	121	329	ZS	498	1796	249	693		
Z1	250	999	125	449	83	296	Z1	261	941	131	469	87	310
Z2	301	1203	150	532	100	351	Z2	313	1130	157	559	104	371
Z3	356	1423	178	615	119	407	Z3	409	1475	205	715	136	477
Z4	396	1585	198	673	132	446	Z4	511	1841	255	865		

Application Data - continued

TABLE 8B – WATER FLOW RATE LIMITS (GPM) – BASED UPON STANDARD TUBES

MODEL	HEAT RECOVERY CONDENSER - TOWER BUNDLE						HEAT RECOVERY CONDENSER - HEATING BUNDLE					
	1 PASS		2 PASS		3 PASS		1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
BW	1435	5171	717	2392	478	1590	555	2000	278	1000	185	665
BX	1435	5171	717	2392	478	1590	861	3103	430	1529	287	1010
IW	2123	7649	1061	3579	708	2409	763	2750	382	1367	254	917
IX	2123	7649	1061	3579	708	2409	1344	4842	672	2260	448	1586
OW	3129	11274	1564	4892	1043	3322	940	3387	470	1571	313	1038
OX	3129	11274	1564	4892	1043	3322	1984	7149	992	3138	661	2102
O8	3053	11002	1527	5501	1018	3667	1122	4043	561	2021	374	1348
O9	3053	11002	1527	5501	1018	3667	1791	6455	896	3228	597	2152
UW	3293	11865	1646	5256	1098	3477	1069	3853	535	1799	356	1188
UX	3293	11865	1646	5256	1098	3477	2091	7535	1045	3415	697	2281
U8	3403	12263	1701	6131	1134	4088	1178	4244	589	2122	393	1415
U9	3403	12263	1701	6131	1134	4088	1891	6813	945	3406	630	2271
YW	7705	27765	3852	10738	2568	7169	2596	9353	1298	3797	865	2513
YX	7705	27765	3852	10738	2568	7169	4917	17718	2458	6991	1639	4693
Y8	7963	28696	3982	13330	2654	8951	3236	11660	1618	5830	1079	3887
Y9	7963	28696	3982	13330	2654	8951	5244	18897	2622	9287	1748	6299

TABLE 8C – WATER FLOW RATE LIMITS (L/S) - BASED UPON STANDARD TUBES

MODEL	HEAT RECOVERY CONDENSER - TOWER BUNDLE						HEAT RECOVERY CONDENSER - HEATING BUNDLE					
	1 PASS		2 PASS		3 PASS		1 PASS		2 PASS		3 PASS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
BW	91	326	45	151	30	100	35	126	18	63	12	42
BX	91	326	45	151	30	100	54	196	27	96	18	64
IW	134	483	67	226	45	152	48	174	24	86	16	58
IX	134	483	67	226	45	152	85	305	42	143	28	100
OW	197	711	99	309	66	210	59	214	30	99	20	65
OX	197	711	99	309	66	210	125	451	63	198	42	133
O8	193	694	96	347	64	231	71	255	35	128	24	85
O9	193	694	96	347	64	231	113	407	57	204	38	136
UW	208	749	104	332	69	219	67	243	34	113	22	75
UX	208	749	104	332	69	219	132	475	66	215	44	144
U8	215	774	107	387	72	258	74	268	37	134	25	89
U9	215	774	107	387	72	258	119	430	60	215	40	143
YW	486	1752	243	677	162	452	164	590	82	240	55	159
YX	486	1752	243	677	162	452	310	1118	155	441	103	296
Y8	502	1810	251	841	167	565	204	736	102	368	68	245
Y9	502	1810	251	841	167	565	331	1192	165	586	110	397

and condenser waterboxes 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.

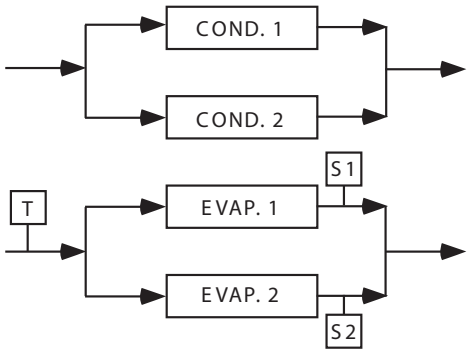
Connections – The standard chiller is designed for 150 psig (10.3 barg) design working pressure in both the chilled water and condenser water circuits. The connections (water nozzles) to these circuits are furnished with grooves to ANSI/AWWA C-606 Standard for grooved and shouldered joints. Piping should 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.

Chilled Water – A water strainer of maximum 1/8" (3.2 mm) perforated holes must be field-installed in the chilled water inlet line as close as possible to the chiller. If located close enough to the chiller, the chilled water pump may be protected by the same strainer. The strainer is important to protect the chiller from debris or objects which could block flow through individual heat exchanger tubs. 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 water flow during operation.

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

The minimum entering condenser water temperature for other full and part load conditions is provided by the following equation:

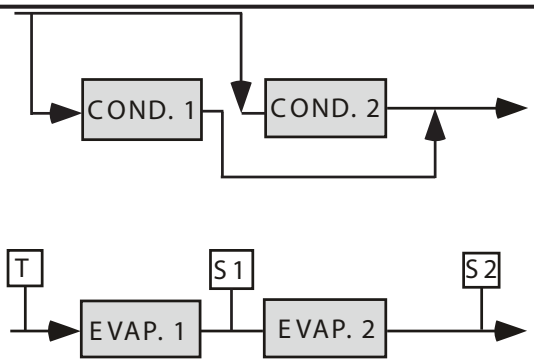
$$\text{Min. ECWT} = \text{LCHWT} - \text{C RANGE} + 5°\text{F} + 12\left(\frac{\%\text{Load}}{100}\right)$$



S – Temperature Sensor for Chiller Capacity Control

T – Thermostat for Chiller Capacity Control

FIGURE 2 – PARALLEL EVAPORATORS PARALLEL CONDENSERS



S – Temperature Sensor for Chiller Capacity Control

T – Thermostat for Chiller Capacity Control

FIGURE 3 – SERIES EVAPORATORS PARALLEL CONDENSERS

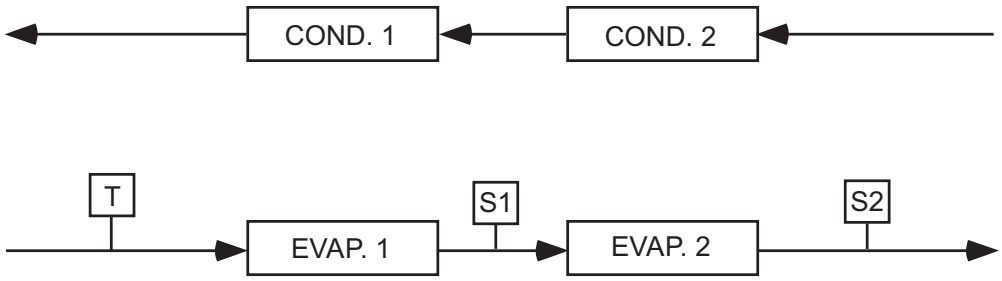


FIGURE 4 – SERIES EVAPORATORS SERIES-COUNTER FLOW CONDENSERS

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

where:

ECWT = entering condensing water temperature
LCHWT = leaving chilled water temperature
C RANGE = condensing water temperature range at the given load condition.

At initial startup, entering condensing water temperature may be as much as 25°F (13.9°C) colder than the standby chilled water temperature.

BRINE APPLICATIONS

Various types of brine can be used in both the evaporator and condenser in lieu of water. The OptiView Control 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 percent (%) concentration and type of brine solution.

When the chiller is not running, brine should not be run through the evaporator. However, if there is brine running 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 YK chiller has been designed to be readily adapted to the requirements of these various arrangements.

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. 1 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.

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.

Series Counter Flow 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 counter flow. 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).

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.

HEAT RECOVERY

Heat recovery may be used in buildings, where there is a need for heating and cooling loads concurrently. By utilizing some or all of the heat rejection of a normal vapor-compression cycle cooling system, overall operating energy savings result. Heat recovery uses available heat as a byproduct of the cooling function, which differs from heat pumps where the heating can be considered the primary process. Also, the heat recovery usage is often a winter seasonal duty, where the chiller may be expected to operate in summer using heat rejection to a conventional cooling tower. As heating loops and cooling tower water circuits are separate in the majority of buildings, this dictates the need for two water circuits in the condenser of a heat recovery chiller.

Very simply, heat recovery allows you to utilize the heat, [which would otherwise be "wasted" (to the cooling tower)], to serve a useful purpose. This heat of rejection can be used to:

- Pre-heat domestic hot water needs like in hotels or hospitals for use in:
- Laundry, showers, swimming pools, cooking/dishwashing, hot tub.
- Comfort heating (perimeter heating).
- Reheating of air.

- Preheating of boiler makeup water or process hot water.

The main difference between a cooling only chiller and a heat recovery chiller is in the heat recovery chiller's added ability to reject the "free condenser heat" to the cooling tower and/or the heating system. Since heat is being removed from the area to be cooled, the cooling load supports the heating load. There must be a simultaneous cooling and heating load in the building.

When using a Solid-State Starter or Variable Speed Drive for a heat recovery application, the starters will be chilled water cooled.

Please refer to Form 160.75-AD2; YK Mod G Heat Recovery Application Data for additional information.

Heat Recovery Availability
Standard: Compressors Q4, Q7, H9, K2, K7

REFRIGERANT RELIEF PIPING

Each chiller is equipped with dual pressure relief valves on the condenser and two dual relief valves on the evaporator, or two single relief valves on the evaporator if the optional refrigerant isolation valves are ordered. 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 one flexible connection.

SOUND AND VIBRATION CONSIDERATIONS

A YK 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.

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

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 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 waterboxes 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 YK chiller motor is air-cooled, ventilation should allow for the removal of heat from the motor.

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.

ELECTRICAL CONSIDERATIONS

Motor Voltage – Low voltage motors (200 to 600 volts) are furnished with six leads. Medium voltage (2300 to 13800 volts) 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 6 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 – A separate starter is not required if the chiller is equipped with a Variable Speed Drive (VSD). The YK Chillers are also available with a factory mounted and wired York Solid-State Starter for low and medium voltage applications. Other types of remote mounted starters are available. Electromechanical starters must be furnished in accordance with YORK Standard Specifications (R-1132). This will ensure that starter components, controls, circuits, and terminal markings will be suitable for required overall

Application Data - continued

system performance. Remote-mounted medium voltage York Solid-State Starters are also available.

Controls – A 115 volt, single-phase, 60 or 50 Hertz 2 KVA power supply must be furnished to the chiller from a separate, fused disconnect or from a control transformer included as an option with electro mechanical starters. No field control wiring is required when the low voltage YORK Variable Speed Drive or Solid-State Starter is supplied.

Oil Pump Power Supply – A separate 3 phase power supply with a fused disconnect for the factory-mounted oil pump variable speed drive is required unless the low voltage VSD or SSS is supplied. Power can also be supplied through an electro mechanical starter, remote mounted Medium Voltage Solid-State Starter (MVSSS) or Medium Voltage Variable Speed Drive (MVVSD).

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.

Power-factor Correction Capacitors – When the chiller is equipped with a VSD, automatic power-factor correction to a minimum of 0.95 is provided at all operating conditions, so additional capacitors are not required. For other starting methods, capacitors can be applied to a 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. For YORK Solid-State Starters the capacitors must be located on the line 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 the chiller is based on the minimum unit ampacity. For Solid-State Starters or Variable Speed Drive, this wiring is done at the factory. 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 = .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 only additional load on the circuit for the chiller would be the control transformer and oil pump motor 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. See Table 9.

TABLE 9 – MOTOR VOLTAGE VARIATIONS

FREQ.	RATED VOLTAGE	NAME-PLATE VOLTAGE*	OPERATING VOLTAGE	
			MIN.	MAX.
60 HZ	200	200/208	180	220
	230	220/240	208	254
	380	380	342	415
	416	416	375	457
	460	440/460/480	414	508
	575	575/600	520	635
	2300	2300	2070	2530
	3300	3300	2970	3630
	4000	4000/4160	3600	4576
50 HZ	346	346	311	381
	380	380/400	342	423
	415	415	374	440
	3300	3300	2970	3630

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

MOTOR ELECTRICAL DATA

The smallest motor available which equals or exceeds the Input power (kW) from the chiller rating program is selected from Tables 10. The full load amperes (FLA) listed in the tables is maximum values and corresponds 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:

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

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 Table 10 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). Inrush amperes (IRA) depend on LRA and the type of starter applied. The inrush can be calculated using a percentage of LRA shown in Tables 13 to 17.

TABLE 10 - 60 HZ ELECTRICAL DATA

MOTOR CODE		CF	CG	CH	CJ	CK	CL	CM	CN	CP	CR	CS	CT	CU	CV	CW
SHAFT HP (MAX)		154	177	201	237	270	302	327	351	385	424	468	503	554	608	655
INPUT KW (MAX)		123	140	161	190	214	240	257	276	302	333	367	395	435	477	514
F.L. EFF. - %		93.6	94.5	93.3	93	94	94	95	95	95	95	95	95	95	95	95
F.L. POWER FACTOR		0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87	0.87
VOLTS		AMPERES (MAX.)														
200	FLA	405	465	527	618	707	787	831	921	1014	1085	1208	-	-	-	-
	LRA	2598	3111	3111	3810	4550	4900	5470	5780	5780	7350	7794	-	-	-	-
208	FLA	389	447	507	594	680	757	799	886	975	1043	1162	-	-	-	-
	LRA	2702	3235	3235	3962	4732	5096	5689	6011	6011	7644	8106	-	-	-	-
230	FLA	352	404	464	540	610	685	749	804	882	944	1050	1130	-	-	-
	LRA	2598	2598	2865	3460	3788	4260	4755	5162	5780	5780	6900	7400	-	-	-
240	FLA	337	387	445	518	585	656	718	771	845	905	1006	1083	-	-	-
	LRA	2711	2711	3120	3610	3953	4445	4962	5386	6031	6031	7200	7722	-	-	-
380	FLA	217	249	285	336	378	421	453	487	534	571	636	684	756	817	879
	LRA	1385	1385	1730	2153	2500	2577	2955	3254	3637	3810	4179	4480	4671	5326	5780
416	FLA	199	228	260	307	346	385	412	445	488	522	581	625	691	747	810
	LRA	1385	1385	1638	1967	2190	2356	2700	2976	3536	3637	3810	3810	4270	4869	5640
440	FLA	184	211	238	281	319	358	392	397	461	493	549	591	646	706	759
	LRA	1177	1301	1320	1655	1865	2037	2485	2485	2976	2976	3300	3644	3644	4209	4783
460	FLA	176	202	228	269	305	342	375	380	441	472	525	565	618	675	726
	LRA	1230	1360	1380	1730	1950	2130	2598	2598	3111	3111	3450	3500	3810	4400	4880
480	FLA	169	194	219	258	292	328	359	364	423	452	503	541	592	647	696
	LRA	1283	1419	1440	1805	2035	2223	2711	2711	3246	3246	3600	3976	3976	4591	5217
575	FLA	141	162	185	216	250	274	300	318	353	377	420	452	500	540	581
	LRA	909	909	1100	1384	1556	1700	1900	2066	2078	2413	2760	2960	3089	3550	4039
600	FLA	135	155	177	207	240	263	288	305	338	361	403	433	479	518	557
	LRA	949	949	1148	1444	1624	1774	1983	2156	2168	2518	2880	3089	3223	3704	4215
2300	FLA	36	41.1	46	55	63	70	73.9	80	87	95	106	113	124	135	146
	LRA	240	267	298	340	397	435	480	520	543	590	669	719	791	867	935
3300	FLA	25.5	29	33	39	44	49	52	55.3	61	67	72.8	79	86.1	94.4	102
	LRA	160	175	210	240	280	310	310	343	382	415	466	501	551	576	652
4000	FLA	21	24	26.7	32	36	40	42.5	46	50.1	55	60.1	65.2	71	77.9	84
	LRA	135	154	166	195	230	240	270	283	315	340	384	413	455	499	538
4160	FLA	20.2	23	25.7	30.8	34.6	38.5	40.9	44.2	48.2	52.9	57.8	62.7	68.3	74.9	80.8
	LRA	140	160	173	203	239	250	270	294	328	328	399	430	473	519	560

TABLE 10A - 50 HZ ELECTRICAL DATA [1]

MOTOR CODE		5CC	5CD	5CE	5CF	5CG	5CH	5CI	5CJ	5CK	5CL	5CM	5CN	5CO	5CP	5CQ	5CR	5CS
SHAFT HP (MAX)		148	168	198	225	252	272	292	321	353	390	419	462	507	546	575	617	658
INPUT KW (MAX)		119	135	158	179	201	215	231	254	279	309	332	363	398	429	451	484	516
F.L. EFF. - %		93	93	93.4	93.7	93.7	94.2	94.2	94.2	94.2	94.2	94.2	95	95	95	95	95	95
F.L. POWER FACTOR		0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.88
VOLTS		AMPERES (MAX.)																
346	FLA	230	261	306	347	389	418	448	493	536	592	636	696	763	822	866	929	979
	LRA	1385	1721	1790	2208	2467	2598	2840	3081	3350	3706	3810	4177	4830	4944	5373	5780	5780
380	FLA	210	238	278	316	354	380	408	449	488	539	579	633	695	748	788	846	892
	LRA	1385	1385	1640	1890	2144	2464	2590	2806	3050	3375	3700	3810	4400	4500	4892	5600	5491
400	FLA	200	226	264	300	336	361	388	427	464	512	550	601	660	711	749	904	847
	LRA	1458	1458	1726	1990	2257	2594	2726	2954	3211	3533	3895	4011	4632	4737	5149	5895	5780
415	FLA	192	218	255	290	324	348	374	411	447	494	530	580	636	685	722	774	817
	LRA	1283	1385	1490	1700	2031	2175	2366	2569	2794	3088	3402	3478	3810	4117	4480	5130	5108
3300	FLA	24.1	27.4	32.2	36.4	40.8	43.8	47	51.7	56.2	62.1	66.7	72.9	80	86.2	90.8	97.4	103
	LRA	159	162	209	236	241	274	294	318	317	388	423	455	499	516	572	614	644

NOTE: 1. Chiller performance for 50 Hertz applications is outside the scope of the AHRI Certification Program.

Application Data - continued

TABLE 10 - 60 HZ ELECTRICAL DATA - CONT.

CX	CY	CZ	CA	CB	DA	DB	DC	DD	DE	DF	DH	DJ	DK	DL	MOTOR CODE	
690	740	790	845	900	1000	1100	1200	1300	1400	1500	1750	2000	2250	2500	SHAFT HP (MAX)	
542	578	618	660	703	781	859	937	1015	1093	1171	1359	1554	1748	1942	INPUT KW (MAX)	
95	95.5	95.3	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	96	96	96	96	F.L. EFF. - %	
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	F.L. POWER FACTOR	
AMPERES (MAX.)																VOLTS
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FLA	200
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LRA	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FLA	208
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LRA	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FLA	230
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LRA	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FLA	240
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LRA	
942	997	1065	1126	1200	1364	1500	1636	-	-	-	-	-	-	-	FLA	380
5780	5780	6644	7610	7513	7794	8491	9431	-	-	-	-	-	-	-	LRA	
860	911	973	1029	1096	1246	1370	1495	-	-	-	-	-	-	-	FLA	416
5670	5694	6069	6900	6863	7120	7755	8618	-	-	-	-	-	-	-	LRA	
813	861	920	973	1036	1178	1295	1413	-	-	-	-	-	-	-	FLA	440
5357	4783	5249	5791	5529	6160	6709	7455	-	-	-	-	-	-	-	LRA	
778	824	880	931	991	1127	1239	1352	-	-	-	-	-	-	-	FLA	460
4960	5280	5330	6054	5780	6440	7014	7794	-	-	-	-	-	-	-	LRA	
746	790	843	892	950	1080	1187	1296	-	-	-	-	-	-	-	FLA	480
5843	5217	5727	6317	6031	6720	7319	8133	-	-	-	-	-	-	-	LRA	
622	659	704	744	793	901	991	1081	-	-	-	-	-	-	-	FLA	575
4100	4200	4200	5225	4963	5148	5610	6232	-	-	-	-	-	-	-	LRA	
596	632	675	713	760	863	950	1036	-	-	-	-	-	-	-	FLA	600
4633	4487	4383	5452	5179	5372	5854	6503	-	-	-	-	-	-	-	LRA	
154	165	176	186	198	225	248	267	290	312	334	383	438	493	548	FLA	2300
960	1008	1100	1172	1230	1234	1592	1592	1592	2031	2031	2390	2879	2908	3012	LRA	
108	115	123	130	138	157	173	186	202	217	233	267	306	344	382	FLA	3300
682	719	744	744	858	861	1110	1110	1110	1416	1416	1661	2011	2027	2100	LRA	
88.6	94.8	101	107	114	130	143	154	166	179	192	220	252	283	315	FLA	4000
540	554	631	674	713	715	923	923	923	1177	1177	1386	1669	1842	2047	LRA	
85.2	91.1	97.1	102	110	125	137	148	160	172	185	212	242	273	303	FLA	4160
562	576	656	701	742	744	960	960	960	1224	1224	1441	1736	1772	1968	LRA	

TABLE 10A - 50 HZ ELECTRICAL DATA [1] - CONT.

5CT	5CU	5CV	5CW	5CX	5DA	5DB	5DC	5DD	5DE	5DF	5DG	5DH	*5DJ	5DK	5DL	MOTOR CODE	
704	750	800	850	900	1000	1100	1200	1300	1400	1500	1650	1750	2000	2250	2500	SHAFT HP (MAX)	
553	589	628	667	706	785	863	942	1015	1093	1171	1288	1359	1554	1748	1942	INPUT KW (MAX)	
95	95	95	95	95	95	95	95	95.5	95.5	95.5	95.5	96	96	96	96	F.L. EFF. - %	
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	F.L. POWER FACTOR	
AMPERES (MAX.)																	VOLTS
1048	1104	1177	1251	1325	1488	1656	-	-	-	-	-	-	-	-	-	FLA	346
6615	6931	7356	7794	8319	8559	9346	-	-	-	-	-	-	-	-	-	LRA	
954	1005	1072	1139	1206	1355	1508	-	-	-	-	-	-	-	-	-	FLA	380
5491	6313	6694	7113	7404	7794	8511	-	-	-	-	-	-	-	-	-	LRA	
906	955	1018	1082	1146	1287	1433	-	-	-	-	-	-	-	-	-	FLA	400
5780	6645	7046	7487	7794	8204	8959	-	-	-	-	-	-	-	-	-	LRA	
874	920	982	1043	1104	1241	1381	-	-	-	-	-	-	-	-	-	FLA	415
5512	5780	6131	6513	6938	7138	7794	-	-	-	-	-	-	-	-	-	LRA	
110	116	123	131	139	156	174	187	202	217	233	256	267	306	344	382	FLA	3300
693	725	744	819	875	871	1135	1135	1135	1415	1415	1415	1667	1591	2233	2481	LRA	

*Min. reduced voltage tap 80%.

** High voltage and special motor designs may not meet efficiency and P. F. shown for standard motors

TABLE 11 - 60 HZ ELECTRICAL DATA - PREMIUM EFFICIENCY

MOTOR CODE		EF	EG	EH	EJ	EK	EL	EM	EN	EP	ER	ES	ET	EU	EV
SHAFT HP (MAX)		154	177	201	237	270	302	327	351	385	424	468	503	554	608
INPUT KW (MAX)		122	139	158	185	211	236	256	274	300	330	364	392	431	473
F.L. EFF. - %		94.5	95	95	95.4	95.4	95.4	95.4	95.4	95.8	95.8	95.8	95.8	95.8	95.8
F.L. POWER FACTOR		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
VOLTS	AMPERES (MAX.)														
200	FLA	399	456	518	608	692	774	838	900	983	1083	1195	-	-	-
	LRA	2598	3128	3128	3979	4550	4900	5470	5865	5865	7350	7935	-	-	-
208	FLA	383	438	498	584	666	745	806	865	945	1041	1149	-	-	-
	LRA	2702	3235	3235	4138	4732	5096	5689	6100	6100	7644	8252	-	-	-
230	FLA	347	396	450	528	602	673	729	783	855	941	1039	1117	-	-
	LRA	2598	2720	2865	3460	3788	4260	4755	5162	5780	6200	6900	8513	-	-
240	FLA	332	380	431	506	577	645	699	750	819	902	996	1070	-	-
	LRA	2711	2838	2990	3610	3953	4445	4962	5386	6031	6470	7200	8883	-	-
380	FLA	210	240	272	320	364	408	441	474	517	570	629	676	745	817
	LRA	1385	1646	1730	2153	2500	2578	2955	3254	3637	3810	4179	4480	4671	5326
416	FLA	192	219	249	292	333	372	403	433	473	521	575	617	680	746
	LRA	1385	1504	1638	1967	2190	2356	2700	2976	3536	3637	3815	3815	4270	4869
440	FLA	181	207	235	276	315	352	381	409	447	492	543	584	643	706
	LRA	1177	1301	1320	1655	1865	2037	2485	2485	2976	2976	3300	3348	3644	4209
460	FLA	173	198	225	264	301	337	365	391	427	471	520	558	615	675
	LRA	1230	1360	1380	1730	1950	2130	2598	2598	3111	3111	3450	3500	3810	4400
480	FLA	166	190	216	253	288	323	349	375	410	451	498	535	589	647
	LRA	1283	1419	1440	1805	2035	2223	2711	2711	3246	3246	3600	3652	3976	4591
575	FLA	139	159	180	211	241	269	292	313	342	377	416	447	492	540
	LRA	909	1088	1100	1384	1556	1704	1900	2066	2078	2413	2760	2960	3089	3550
600	FLA	133	152	173	203	231	258	279	300	328	361	398	428	472	517
	LRA	949	1135	1148	1444	1624	1778	1983	2156	2168	2518	2880	3089	3223	3704

TABLE 11A - 50 HZ ELECTRICAL DATA - PREMIUM EFFICIENCY

MOTOR CODE		5EC	5ED	5EE	5EF	5EG	5EH	5EI	5EJ	5EK	5EL	5EM	5EN	5EO
SHAFT HP (MAX)		148	168	198	225	252	272	292	321	353	390	419	462	507
INPUT KW (MAX)		117	133	156	177	198	214	229	252	277	305	328	361	396
F.L. EFF. - %		94.3	94.5	94.7	94.9	95	95	95	95	95	95.4	95.4	95.4	95.4
F.L. POWER FACTOR		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
VOLTS	AMPERES (MAX.)													
346	FLA	222	251	296	335	375	405	435	478	525	578	621	685	751
	LRA	1521	1721	1790	2208	2467	2706	2840	3081	3350	3706	3810	4177	4830
380	FLA	202	229	269	305	342	369	396	435	478	526	565	623	684
	LRA	1385	1385	1640	1890	2144	2464	2590	2806	3050	3375	3700	3810	4400
400	FLA	192	217	256	290	324	350	376	413	454	500	537	592	650
	LRA	1458	1458	1726	1989	2257	2594	2726	2954	3211	3533	3895	4011	4632
415	FLA	185	210	246	280	313	338	362	398	438	482	518	571	627
	LRA	1283	1385	1502	1700	2031	2175	2366	2569	2794	3088	3402	3478	4027

Application Data - continued

TABLE 12 – MOTOR STARTERS

TYPE STARTER	SOLID-STATE STARTER	STAR DELTA	AUTO TRANSFORMER			ACROSS-THE-LINE	PRIMARY REACTOR	
VOLTAGE	LOW/MEDIUM	LOW	LOW	LOW/MEDIUM	LOW/MEDIUM	LOW/MEDIUM	MEDIUM	MEDIUM
60 HZ	200-4160	200-600	200-600	200-4160	200-4160	200-4160	2300-4160	2300-4160
50 HZ	380-3300	346-415	346-415	346-3300	346-3300	346-3300	2300-3300	2300-3300
TRANSITION	—	CLOSED	CLOSED	CLOSED	CLOSED	—	CLOSED	CLOSED
% TAP INRUSH	—	—	57.7	65	80	—	65	80
AS A % OF LRA	45	33	33	42.3	64	100	65	80

NOTE: Inrush less than 100% of full load amps (FLA).

TABLE 13 – LOW VOLTAGE VARIABLE SPEED MODELS

FRAME LV-VSD	MAX. LRA	MAX. MOTOR HP	MIN. FLA	MAX. FLA	RATED VOLT-AGE	ACTUAL VOLTAGE	PHASE	HZ
I	2361	270	80	360	380	380	3	60
II	3637	385	120	517				
III	5326	608	200	817				
IV	7610	845	300	1126				
I	2598	351	80	380	460	440/ 460/ 480		
II	3652	503	120	565				
III	5777	790	200	880				
IV	7014	1048	300	1180				
I	2413	424	80	377	575	575/600		
II	3550	608	120	540				
I	2727	292	80	380	380	380/400	3	50
II	2895	419	120	565				
III	5780	658	200	880				
IV	8205	917	300	1180				
I	2366	292	80	362	415	415		
II	3402	419	120	518				
III	5512	704	200	876				
IV	6938	900	300	1108				

MEDIUM VOLTAGE VARIABLE SPEED DRIVE NOMENCLATURE

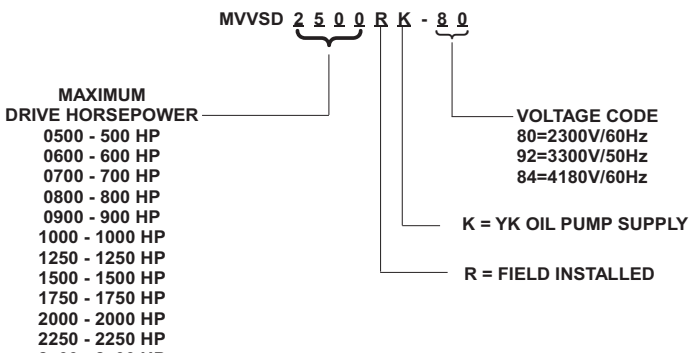


TABLE 14 – MEDIUM VOLTAGE VARIABLE SPEED-DRIVE MODELS

MV-VSD	MAX. MOTOR HP	MAX. FLA	VOLT-AGE	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			

TABLE 15 – LOW VOLTAGE SOLID-STATE STARTER MODELS

MODEL SSS-	MAX. LRA	MIN. FLA	MAX. FLA	RATED VOLT-AGE	ACTUAL VOLTAGE	PHASE	HZ
7L-46B	1556	35	260	460	440/460/480	3	60
7L-40B	1556	35	260	380	380	3	60
7L-50B	1556	35	260	400	380/440/415	3	50
7L-58B	1556	35	260	575	575/600	3	60
14L-17B	3111	65	510	200	200/208	3	60
14L-28B	3111	65	510	230	230/240	3	60
14L-40B	3111	65	510	380	380	3	60
14L-46B	3111	65	510	460	440/460/480	3	60
14L-50B	3111	65	510	400	380/400/415	3	50
14L-58B	3111	65	510	575	575/600	3	60
26L-17B	5780	125	850	200	200/208	3	60
26L-28B	5780	125	850	230	230/240	3	60
26L-40B	5780	125	850	380	380	3	60
26L-46B	5780	125	850	460	440/460/480	3	60
26L-50B	5780	125	850	400	380/400/415	3	50
26L-58B	5780	125	850	575	575/600	3	60
33L-17B	7333	215	1050	200	200/240	3	60
33L-40B	7333	215	1050	380	380	3	60
33L-46B	7333	215	1050	230	230/240	3	60
33L-50B	7333	215	1050	400	380/400/415	3	50
33L-58B	7333	215	1050	460	440/460/480	3	60

TABLE 16 – MEDIUM VOLTAGE FLOOR MOUNTED SOLID-STATE STARTER MODELS

MODEL FLOOR MOUNTED MV-SSS	MAX. LRA	MAX. FLA
36" CABINET UNIT MODEL REFERENCE CHART		
MVSSS0853R_042-V	42	1896
MVSSS0853R_050-V	50	1896
MVSSS0853R_065-V	65	1896
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

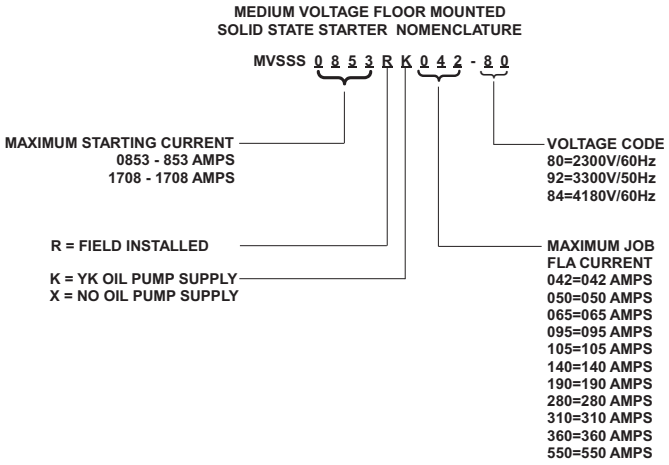
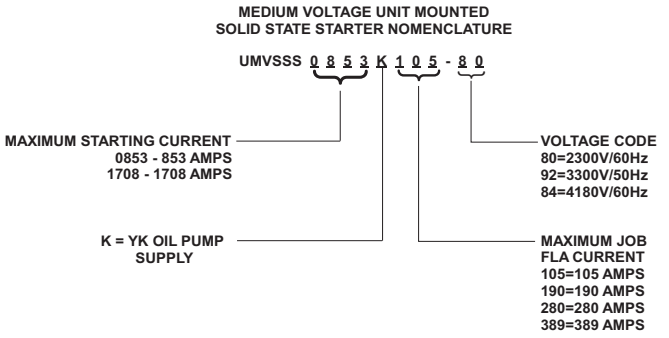


TABLE 17 – MEDIUM VOLTAGE UNIT MOUNTED SOLID-STATE STARTER MODELS

MODEL UNIT MOUNTED MV-SSS	MAX. LRA	MAX. FLA	RATED VOLTAGE & FREQUENCY		
UMVSSS0853K105-V V	105	1896			
UMVSSS0853K190-V V	190	1896			
UMVSSS0853K280-V V	280	1896	2300/60HZ	3300/50HZ	4160/60HZ
UMVSSS0853K389-V V	389	1896			
UMVSSS1708K389-V V	389	3796			



Application Data - continued

TABLE 18 – AVAILABLE COMPRESSOR/SHELL/MOTOR COMBINATIONS

YK MOD G COMBINATIONS

COMPRESSOR CODES	EVAPORATOR CODES	CONDENSER CODES	MOTOR CODES	
			60 HZ	50 HZ
Q3	AP TO AS	AP TO AS	CF-CT EF-ET	5CC-5CO 5EC-5EO
Q3, Q4	CP TO CS	CP TO CS		
	DP TO DS	DP TO DS		
Q4	EP TO ET	EP TO ET		
Q5	CP TO CS	CP TO CS	CH-CT EH-ET	5CE-5CO 5EE-5EO
	DP TO DS	DP TO DS		
Q5, Q6, Q7	EP TO ET	EP TO ET		
	FQ TO FT	FQ TO FT		
P7	EP TO ET	EP TO ET	CU-CY EU-EV	5CP-5CU
	FQ TO FT	FQ TO FT		
P8	GQ TO GS	EV TO EX	CH-CZ EH-EV	5CE-5CU 5EE-5EO
P8, P9	HQ TO HS	FV TO FX		
	JP TO JS	JP TO JS		
	LQ TO LS	LQ TO LS		
H9	KP TO KS, K2 TO K4	KP TO KS, K2 TO K4	CN-CA EN-EV	5CK-5CW 5EK-5EO
	MQ TO MS, M2 TO M4	MP TO MS, M2 TO M4		
K1	KT TO KX, K5 TO K7	KP TO KS, K2 TO K4	CS-DC ES-EV	5CN-5DC 5EN-5EO
K1, K2	MQ TO MS, M2 TO M4	MP TO MS, M2 TO M4		
	NQ TO NS, N2 TO N4	NP TO NS, N2 TO N4		
	PQ TO PS, P2 TO P4	PQ TO PS, P2 TO P4		
	QQ TO QS, Q2 TO Q4	QQ TO QS, Q2 TO Q4		
K3	NQ TO NS, N2 TO N4	NP TO NS, N2 TO N4	DA-DJ	5DA-5DH
	QQ TO QV, Q2 TO Q4	QQ TO QS, Q2 TO Q4		
	RQ, RS, RV, R3, R5, R7	RQ TO RS, R2 TO R4		
K4	RP, RR, RT, R2, R4, R6	RQ TO RS, R2 TO R4	DA-DJ	5DA-5DJ
	SQ, SS, SV, S3, S5, S7	SQ TO SS, S2 TO S4		
		VP TO VS, V2 TO V5		
	XQ TO XS, X2 TO X4	TP TO TS, T2 TO T5		
		XQ TO XS, X2 TO X4		
K7	WP-WT, W1, W2, W4, W6	WQ TO WS, W1 TO W4	DD-DL	5DD-5DL
	ZQ TO ZS, Z1 TO Z4	ZQ TO ZS, Z1 TO Z4		

TABLE 18 – AVAILABLE COMPRESSOR/SHELL/MOTOR COMBINATIONS - CONT.

YK MOD G HEAT RECOVERY COMBINATIONS

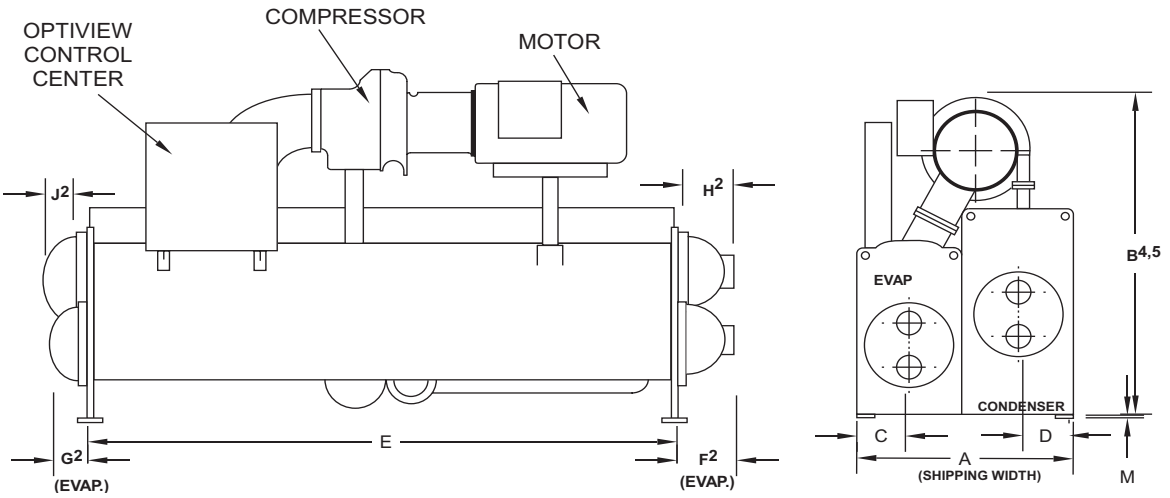
COMPRESSOR CODES	EVAPORATOR CODES	CONDENSER CODES	MOTOR CODES	
			60 HZ	50 HZ
Q4	CP TO CS	BW, BX	CF-CT EF-ET	5CC-5CO 5EC-5EO
Q7	EP TO ET	IW, IX		
H9	KP TO KS, K2 TO K4	OW, OX, O8, O9	CN-CA EN-EV	5CK-5CW 5EK-5EO
K2	MQ TO MS, M2 TO M4	UW, UX, U8, U9	CS-DC ES-EV	5CN-5DC 5EN-5EO
K7	ZQ TO ZS, Z1 TO Z4	YW, YX, Y8, Y9	DD-DL	5DD-5DL

YK MOD G HYBRID FALLING FILM COMBINATIONS

COMPRESSOR CODES	HYBRID FALLING FILM EVAPORATOR CODES	CONDENSER CODES	MOTOR CODES	
			60 HZ	50 HZ
Q3	AC, AD, A3, A4	AP TO AS	CF-CT EF-ET	5CC-5CO 5EC-5EO
	CC TO CE, C3 TO C5	CP TO CS		
Q4	CC TO CE, C3 TO C5	CP TO CS		
	DC TO DE, D3 TO D5	DP TO DS		
Q5	CC TO CE, C3 TO C5	CP TO CS	CH-CT EH-ET	5CE-5CO 5EE-5EO
	DC TO DE, D3 TO D5	DP TO DS		
Q5, Q6, Q7	EC TO EE, D3 TO E5	EP TO ET		
	FC TO FE, F3 TO F5	FQ TO FT		
P7	EC TO EE, D3 TO E5	EP TO ET	CU-CY EU-EV	5CP-5CU
	FC TO FE, F3 TO F5	FQ TO FT		
P8, P9	GC TO GE, G3 TO G5	EV TO EX, E3 TO E4	CH-CZ EH-EV	5CE-5CU 5EE-5EO
	HC TO HE, H3 TO H5	FV TO FX, F3 TO F4		
H9	KC, KD, K8, K9, K0	KP TO KS, K2 TO K4	CN-CA EN-EV	5CK-5CW 5EK-5EO

Dimensions (Ft. - In.) - Unit

P & Q COMPRESSOR UNITS



ADDITIONAL OPERATING HEIGHT CLEARANCE TO FLOOR	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1-3/4"
SPRING ISOLATORS 1" DEFLECTION	1"
DIRECT MOUNT	3/4"

P7, Q7 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

	E-E	E-I	F-F
A	6'-2"	7'-1 3/4"	6'-2"
B	8'-0 5/8"	8'-8"	8'-0 5/8"
C	1'-7 1/2"	1'-7 1/2"	1'-7 1/2"
D	1'-5 1/2"	1'-11 3/8"	1'-5 1/2"
E	12'-0"	12'-0"	16'-0"

P8 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

	G-E	H-F	J-J	L-L
A	6'-11"	6'-11"	7'-6 1/2"	7'-6 1/2"
B	10'-6"	10'-6"	10'-11"	10'-11"
C	2'-0"	2'-0"	2'-1 1/4"	2'-1 1/4"
D	1'-5 1/2"	1'-5 1/2"	1'-8"	1'-8"
E	12'-0"	16'-0"	12'-0"	16'-0"

P9 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

	H-F	J-J	L-L
A	6'-11"	7'-6 1/2"	7'-6 1/2"
B	10'-3"	10'-8 1/2"	10'-8 1/2"
C	2'-0"	2'-1 1/4"	2'-1 1/4"
D	1'-5 1/2"	1'-8"	1'-8"
E	16'-0"	12'-0"	16'-0"

Q3 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

	A-A	C-C	D-D
A	5'-1"	5'-6"	5'-6"
B	7'-0"	7'-3 3/4"	7'-3 3/4"
C	1'-3 1/2"	1'-5 1/2"	1'-5 1/2"
D	1'-3"	1'-3 1/2"	1'-3 1/2"
E	12'-0"	12'-0"	16'-0"

Q4 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODE

	C-B	C-C	D-D	E-E
A	6'-4 3/4"	5'-6"	5'-6"	7'-0"
B	7'-11 3/8"	7'-2 1/2"	7'-2 1/2"	7'-8 1/2"
C	1'-5 1/2"	1'-5 1/2"	1'-5 1/2"	1'-7 1/2"
D	1'-8 7/8"	1'-3 1/2"	1'-3 1/2"	1'-5 1/2"
E	12'-0"	12'-0"	16'-0"	12'-0"

Q5 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

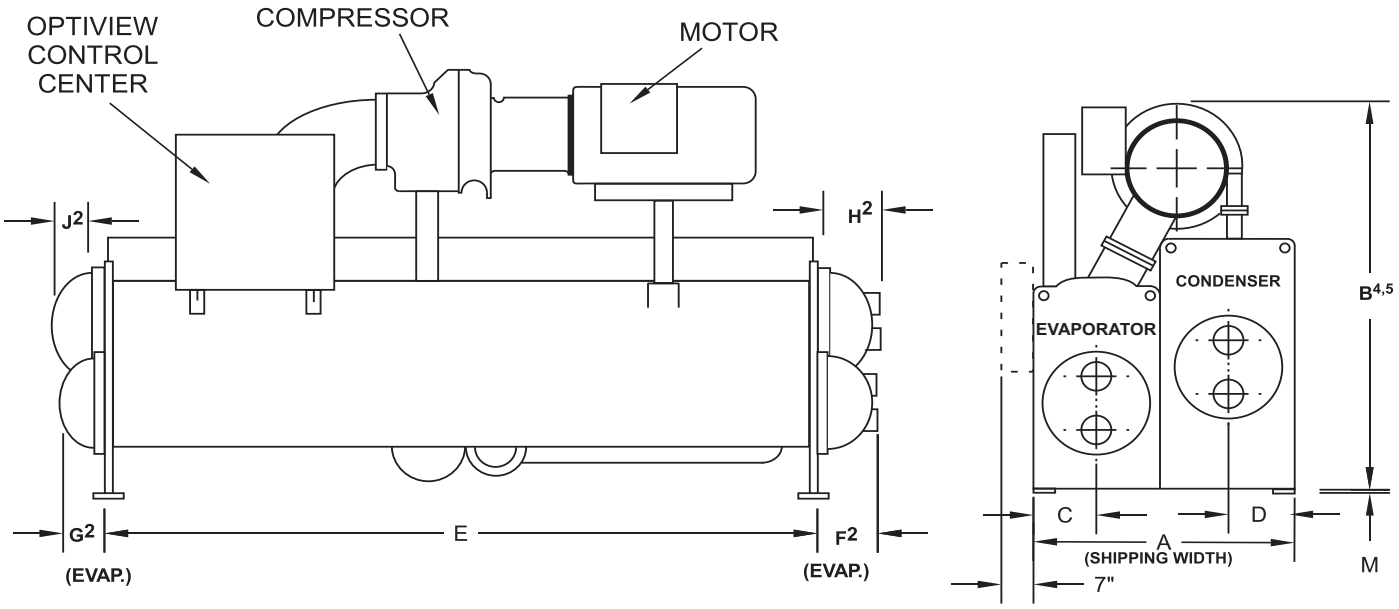
	C-C	D-D	E-E	F-F
A	5'-6"	5'-6"	7'-0"	7'-0"
B	7'-10 5/8"	7'-10 5/8"	8'-3"	8'-3"
C	1'-5 1/2"	1'-5 1/2"	1'-7 1/2"	1'-7 1/2"
D	1'-3 1/2"	1'-3 1/2"	1'-5 1/2"	1'-5 1/2"
E	12'-0"	16'-0"	12'-0"	16'-0"

Q6 COMPRESSOR

EVAPORATOR-CONDENSER SHELL CODES

	E-E	F-F
A	7'-0"	7'-0"
B	8'-3"	8'-3"
C	1'-7 1/2"	1'-7 1/2"
D	1'-5 1/2"	1'-5 1/2"
E	12'-0"	16'-0"

H COMPRESSOR UNITS



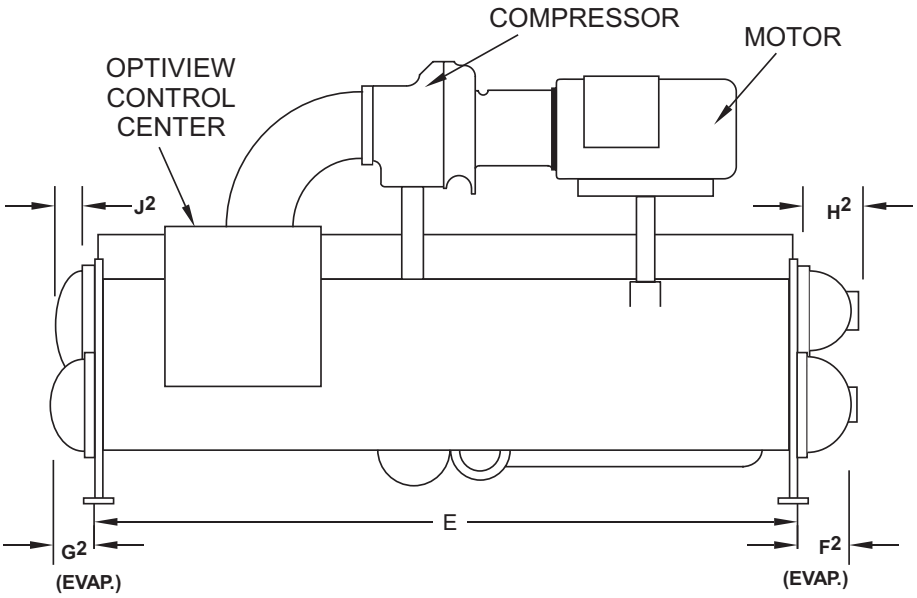
ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	**M**
NEOPRENE PAD ISOLATORS	1-3/4"
SPRING ISOLATORS 1" DEFLECTION	1"
DIRECT MOUNT	3/4"

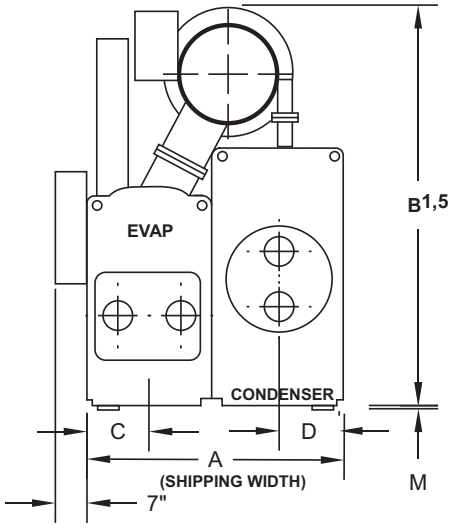
H9 COMPRESSORS			
EVAP.-COND. SHELL CODES			
	K-K	**K-O**	**M-M**
A	7'-6 1/2"	8'-9 1/4"	8'-7"
B	10'-4"	10'-7 5/8"	10'-10 1/2"
C	2'-1 1/4"	2'-1 1/4"	2'-4 1/2"
D	1'-8"	2'-3 3/8"	1'-11"
E	14'-0"	14'-0"	14'-0"

NOTES:
1. All dimensions are approximate. Certified dimensions are available on request.
2. For all waterboxes (compact shown above), determine overall unit length by adding waterbox depth to tube sheet length.
3. Water nozzles can be located on either end of unit. Add 1/2" to nozzle length for flanged connections.
4. To determine overall height, add dimension "M" for the appropriate isolator type.
5. Use of motors with motor hoods may increase overall unit dimensions.

Dimensions (Ft. - In.) - Unit - continued

K COMPRESSOR UNITS





K1 COMPRESSOR, EVAPORATOR-CONDENSER SHELL CODES					
	K-K	M-M	N-N	P-P	Q-Q
A	7'-6 1/2"	8'-7"	8'-7"	9'-1 1/2"	9'-1 1/2"
B	9'-7"	11'-4"	11'-4"	11'-5 1/2"	11'-5 1/2"
C	2'-1 1/4"	2'-4 1/2"	2'-4 1/2"	2'-5 1/2"	2'-5 1/2"
D	1'-8"	1'-11"	1'-11"	2'-1 1/4"	2'-1 1/4"
E	14'-0"	14'-0"	16'-0"	14'-0"	16'-0"

K2 COMPR., EVAPORATOR-CONDENSER SHELL CODES					
	M-M	M-U	N-N	P-P	Q-Q
A	8'-7"	9'-6"	8'-7"	9'-1 1/2"	9'-1 1/2"
B	11'-4"	11'-10"	11'-4"	11'-5"	11'-5"
C	2'-4 1/2"	2'-4 1/2"	2'-4 1/2"	2'-5 1/2"	2'-5 1/2"
D	1'-11"	2'-4 1/2"	1'-11"	2'-1 1/4"	2'-1 1/4"
E	14'-0"	14'-0"	16'-0"	14'-0"	16'-0"

K4 COMPRESSOR, EVAPORATOR-CONDENSER SHELL CODES					
	R-R	S-S	S-V	X-T	X-X
A	9'-9"	9'-9"	10'-3"	10'-10"	11'-3"
B	11'-11"	11'-11"	12'-4"	12'-4"	12'-4"
C	2'-8"	2'-8"	2'-8"	2'-11 1/2"	2'-11 1/2"
D	2'-3 1/2"	2'-3 1/2"	2'-5 1/2"	2'-5 1/2"	2'-8"
E	16'-0"	18'-0"	18'-0"	16'-0"	16'-0"

ADDITIONAL OPERATING HEIGHT CLEARANCE TO FLOOR	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	1 3/4"
SPRING ISOLATORS 1" DEFLECTION	1"
DIRECT MOUNT	3/4"

K3 COMPR., EVAP.-COND. SHELL CODES			
	N-N	Q-Q	R-R
A	8'-7"	9'-1 1/2"	9'-9"
B	10'-8"	11'-6"	11'-10"
C	2'-4 1/2"	2'-5 1/2"	2'-8"
D	1'-11"	2'-1 1/4"	2'-3 1/2"
E	16'-0"	16'-0"	16'-0"

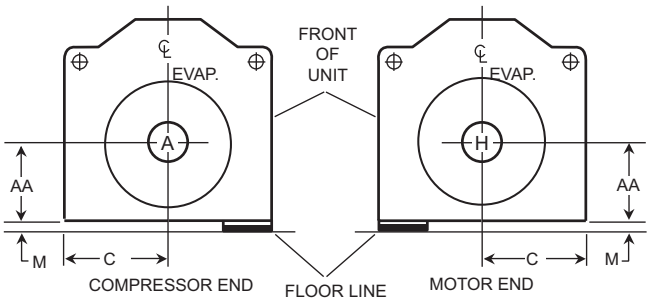
K7 COMPR., EVAP.-COND SHELL CODES			
	W-W	Z-Y	Z-Z
A	10'-3"	12'-7"	11'-3"
B	12'-2"	14'-1 5/8"	12'-10"
C	2'-8"	2'-11 1/2"	2'-11 1/2"
D	2'-5 1/2"	3'-4"	2'-8"
E	22'-0"	18'-0"	18'-0"

NOTES:
1. All dimensions are approximate. Certified dimensions are available on request.
2. For all waterboxes (compact boxes shown above), determine overall unit length by adding waterbox depth to tube sheet length.
3. Water nozzles can be located on either end of unit. Add 1/2" to nozzle length for flanges connections.
4. Add dimension "M" as shown on page 41 for the appropriate isolator type.
5. Use of motors with motor hoods may increase overall unit dimensions.
6. Tubesheets are provided with jacking point notches on the P and larger shells.

Dimensions (Ft. - In.) - Nozzle Arrangements

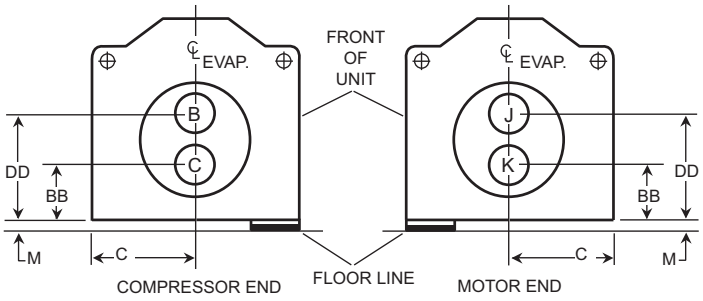
EVAPORATORS – COMPACT WATERBOXES – A THRU L EVAPORATORS

1-PASS



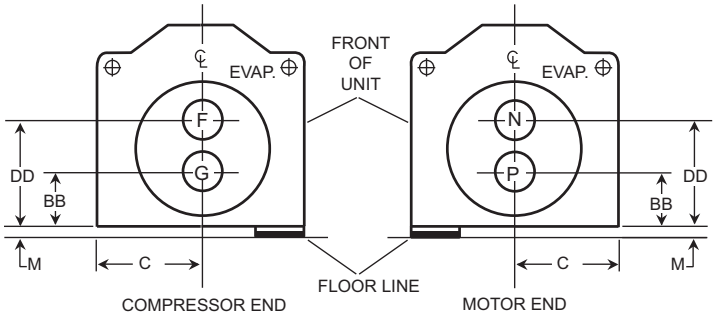
NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
1	A	H
	H	A

2-PASS



NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
2	C	B
	K	J

3-PASS



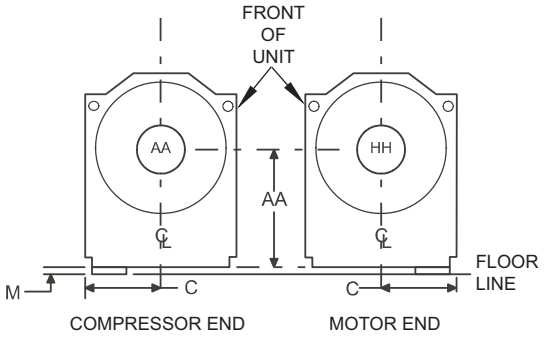
NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
3	G	N
	P	F

COMPACT WATER BOXES - 150 PSI ROUND									
EVAPORATOR SHELL CODE	NOZZLE PIPE SIZE (IN)			EVAPORATOR NOZZLE DIMENSIONS (FT-IN.)					
	NO. OF PASSES				1-PASS	2-PASS		3-PASS	
	1	2	3	C	AA[5]	BB[5]	DD[5]	BB[5]	DD[5]
A	8	6	4	1'-3 1/2"	1'-10"	1'-2"	2'-6"	1'-2"	2'-6"
C,D	10	8	6	1'-5 1/2"	2'-0"	1'-3"	2'-9"	1'-3"	2'-9"
E,F	14	10	8	1'-7"	2'-2"	1'-4"	3'-0"	1'-4"	3'-0"
G,H	14	10	8	2'-0"	2'-3 1/2"	1'-3 1/2"	3'-3 1/2"	1'-3 1/2"	3'-3 1/2"
J,K,L	16	12	10	2'-1 1/4"	2'-6"	1'-5"	3'-7"	1'-5"	3'-7"

Dimensions (Ft. - In.) - Nozzle Arrangements - cont.

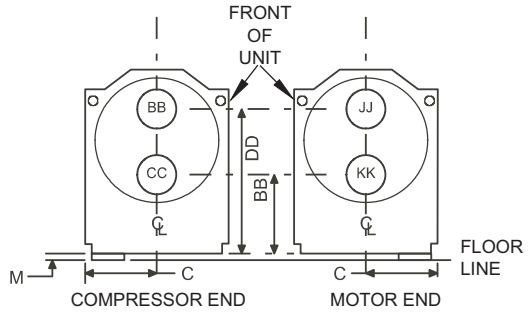
EVAPORATORS – COMPACT WATERBOXES – M THRU Z EVAPORATORS

1-PASS

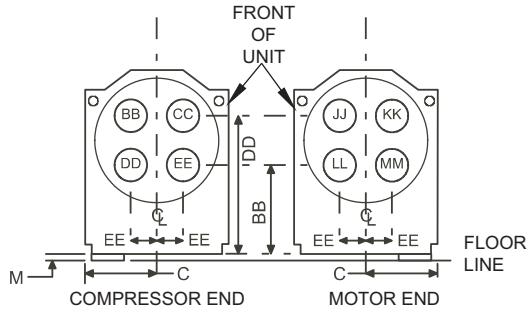


SHELL CODE	1 PASS	
	IN	OUT
M–Z	AA	HH
	HH	AA

2-PASS

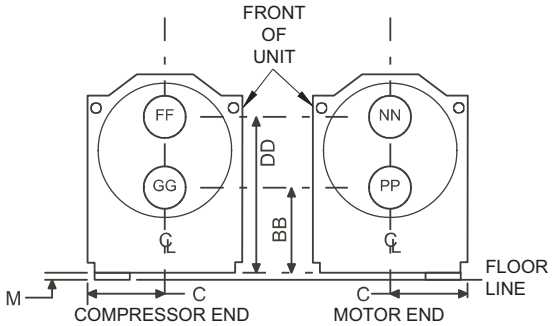


SHELL CODE	2 PASS	
	IN	OUT
M,N,P,Q	CC	BB
	KK	JJ



SHELL CODES	2 PASS	
	IN	OUT
R, S, W X & Z	DD	CC
	EE	BB
	LL	KK
	MM	JJ

3-PASS



SHELL CODES	3 PASS	
	IN	OUT
M–Z	GG	NN
	PP	FF

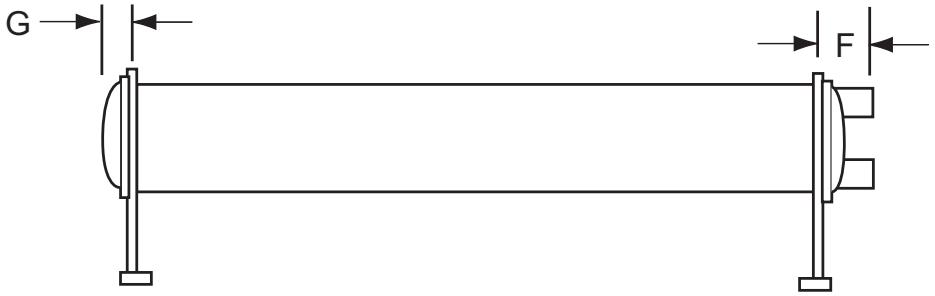
COMPACT WATER BOXES - 150 PSI

EVAP SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES			EVAPORATOR NOZZLE DIMENSIONS (FT-IN.)						
					1-PASS	2-PASS			3-PASS	
	1	2	3	C	AA[5]	BB[5]	DD[5]	EE	BB[5]	DD[5]
M,N	18	14	12	2'-4 1/2"	3'-0"	1'-8 1/2"	4'-3 1/2"	-	1'-8 1/2"	4'-3 1/2"
P,Q	18	14	12	2'-5 1/2"	3'-1 1/2"	1'-10"	4'-5"	-	1'-10"	4'-5"
QV, QT	20	16	12	2'-5 1/2"	3'-1 1/2"	1'-11 1/2"	4'-3 1/2"	-	1'-11 1/2"	4'-3 1/2"
R,S,W	20	18	14	2'-8"	3'-5 1/4"	2'-4 1/2"	4'-6 1/2"	0'-10 1/2"	2'-1"	4'-10"
X,Z	20	18	14	2'-11 1/2"	3'-9 3/4"	2'-8 3/4"	4'-10 3/4"	0'-11"	2'-2 7/8"	5'-4 5/8"

See Notes on pg 42

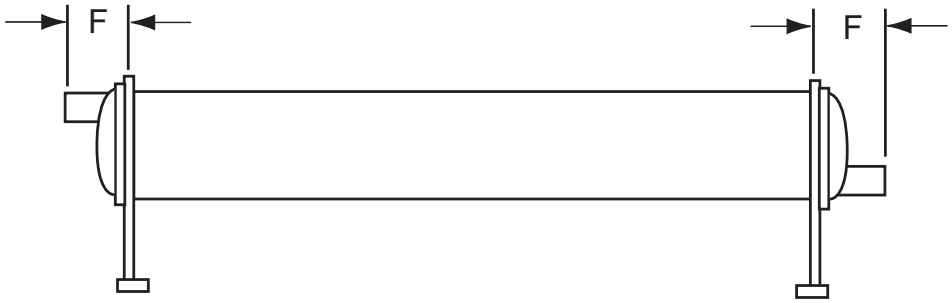
ONE PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	R,S,W	X,Z
F	1'-2 1/4"	1'-3"	1'-3 1/2"	1'-3 3/4"	1'-5 1/2"	1'-11 5/8"	1'-11 5/8"	2'-0 5/8"	2'-1 3/4"



TWO PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	R,S,W	X,Z
F	1'-2 1/4"	1'-3"	1'-3 1/2"	1'-3 3/4"	1'-5 1/2"	1'-11 5/8"	1'-11 5/8"	2'-0 5/8"	2'-1 3/4"
G	0'-6 1/2"	0'-7"	0'-7 1/2"	0'-7 3/4"	0'-9 1/2"	1'-3 5/8"	1'-3 5/8"	1'-4 3/4"	1'-5 3/4"



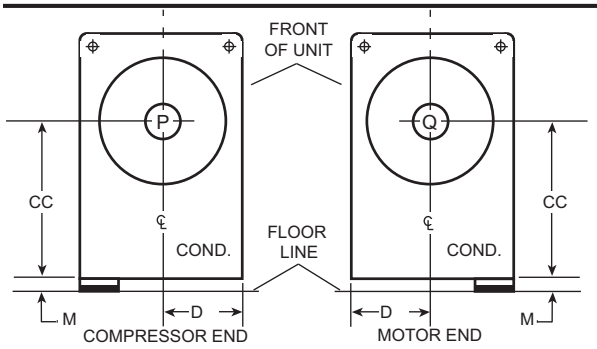
THREE PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	R,S,W	X,Z
F	1'-2 1/4"	1'-3"	1'-3 1/2"	1'-3 3/4"	1'-5 1/2"	1'-11 5/8"	1'-11 5/8"	2'-0 5/8"	2'-1 3/4"

Dimensions (Ft. - In.) - Nozzle Arrangements - cont.

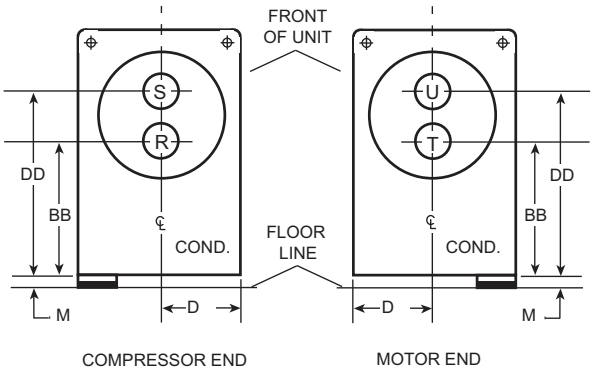
CONDENSERS – COMPACT WATERBOXES

1-PASS



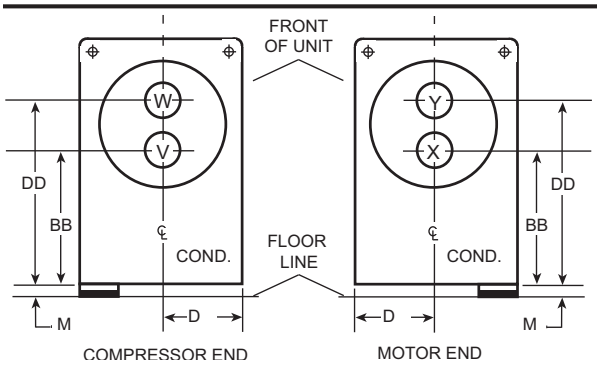
NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
1	P	Q
	Q	P

2-PASS



NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
2	R	S
	T	U

3-PASS



NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
3	V	Y
	X	W

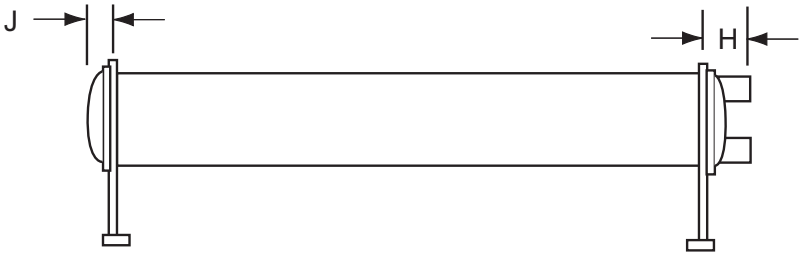
COMPACT WATER BOXES - 150 PSI ROUND

CONDENSER SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS		3-PASS	
	1	2	3	D	CC[5]	BB[5]	DD[5]	BB[5]	DD[5]
A	10	6	6	1'-3"	2'-4"	1'-9 1/2"	2'-10 1/2"	1'-9 1/2"	2'-10 1/2"
C,D	12	8	6	1'-3 1/2"	2'-6"	1'-10 3/8"	3'-1 5/8"	1'-10 3/8"	3'-1 5/8"
E,F	14	10	8	1'-5 1/2"	2'-8"	1'-11 3/4"	3'-4 1/4"	1'-11 3/4"	3'-4 1/4"
J,K,L	16	10	10	1'-8"	3'-0"	2'-3"	3'-9"	2'-3"	3'-9"
M,N	20	14	10	1'-11"	3'-6"	2'-6 3/8"	4'-5 5/8"	2'-6 3/8"	4'-5 5/8"
P,Q	20	16	14	2'-1 1/4"	3'-8"	2'-7"	4'-9"	2'-7"	4'-9"
R,S	20	18	14	2'-3 1/2"	3'-10 1/2"	2'-9 1/2"	4'-11 1/2"	2'-9 1/2"	4'-11 1/2"
T,V,W	24	18	16	2'-5 1/2"	3'-11 1/2"	2'-9"	5'-2"	2'-9"	5'-2"
X,Z	24	20	16	2'-8"	4'-1 1/4"	2'-9 1/4"	5'-5 1/4"	2'-9 1/4"	5'-5 1/4"

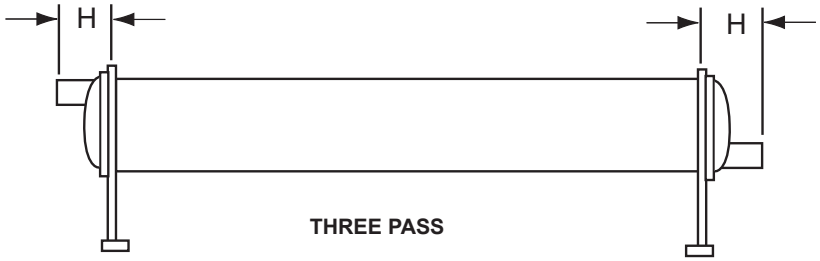
NOTES:

1. Standard water nozzles are furnished as welding stub-outs with ANSI/AWWA C-606 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. 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.
3. Evaporator and condenser water must enter the waterbox through the bottom connection to achieve rated performance.
4. Connected piping should allow for removal of compact waterboxes for tube access and cleaning.
5. Add dimension "M" as shown on page 41 for the appropriate isolator type.
6. Standard 150 PSI design pressure boxes shown.
7. Shell codes R,S,T,V,W,X, & Z use double letter nozzle codes in the same orientation as the single letter e.g. P = PP.

ONE PASS



TWO PASS



THREE PASS

SINGLE BUNDLE CONDENSERS, CODES									
DIM.	**A**	**C,D**	**E,F**	**J,K,L**	**M,N**	**P,Q**	**R,S**	**T,V,W**	**X,Z**
H	1'-1 7/8"	1'-1 7/8"	1'-3"	1'-3 1/2"	1'-3 3/8"	1'-5 1/2"	1'-8 3/4"	1'-10 1/2"	1'-11 5/8"
J	0'-5 7/8"	0'-6 1/2"	0'-7"	0'-7 1/2"	0'-7 3/4"	0'-9 1/2"	1'-2 3/8"	1'-3 3/8""	1'-4 3/8"

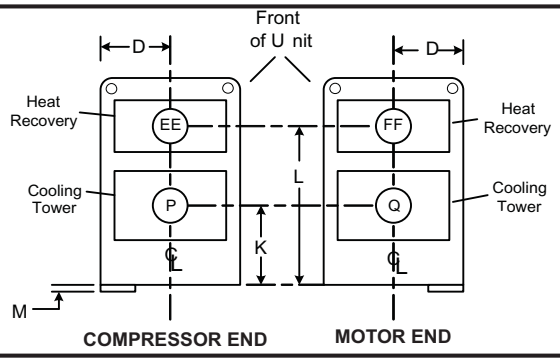
DOUBLE BUNDLE HEAT RECOVERY CONDENSERS, CODES										
	B		**I**		**O**		**U**		**Y**	
DIM.	**TOWER**	**HEATING**	**TOWER**	**HEATING**	**TOWER**	**HEATING**	**TOWER**	**HEATING**	**TOWER**	**HEATING**
H	1'-6 1/2"	1'-5"	1'-7 1/2"	1'-4 3/4"	1'-9 1/2"	1'-6"	1'-10 1/4"	1'-8"	2'-4 3/4"	1'-10 1/2"
J	0'-10 1/2"	0'-9"	0'-11 1/2"	0'-8 3/4"	1'-1 1/2"	0'-10"	1'-2 1/4"	1'-0"	1'-8 3/4"	1'-2 1/2"

See Notes on page 42.

Dimensions (Ft. - In.) - Nozzle Arrangements - cont.

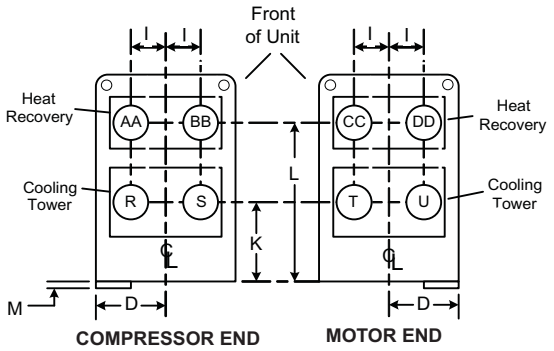
HEAT RECOVERY UNITS

1-PASS



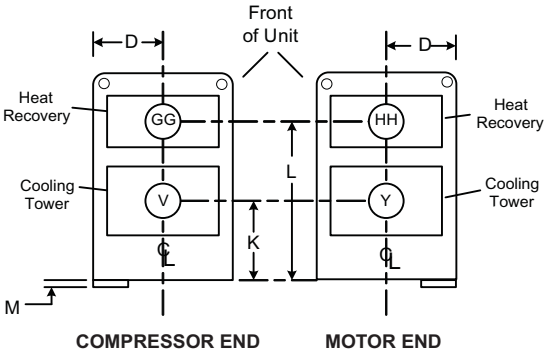
1 PASS NOZZLE ARRANGEMENTS		
	IN	**OUT**
HEAT RECOVERY	EE	FF
	FF	EE
COOLING TOWER	P	Q
	Q	P

2-PASS



2 PASS NOZZLE ARRANGEMENTS		
	IN	**OUT**
HEAT RECOVERY	AA	BB
	BB	AA
	CC	DD
	DD	CC
COOLING TOWER	R	S
	S	R
	T	U
	U	T

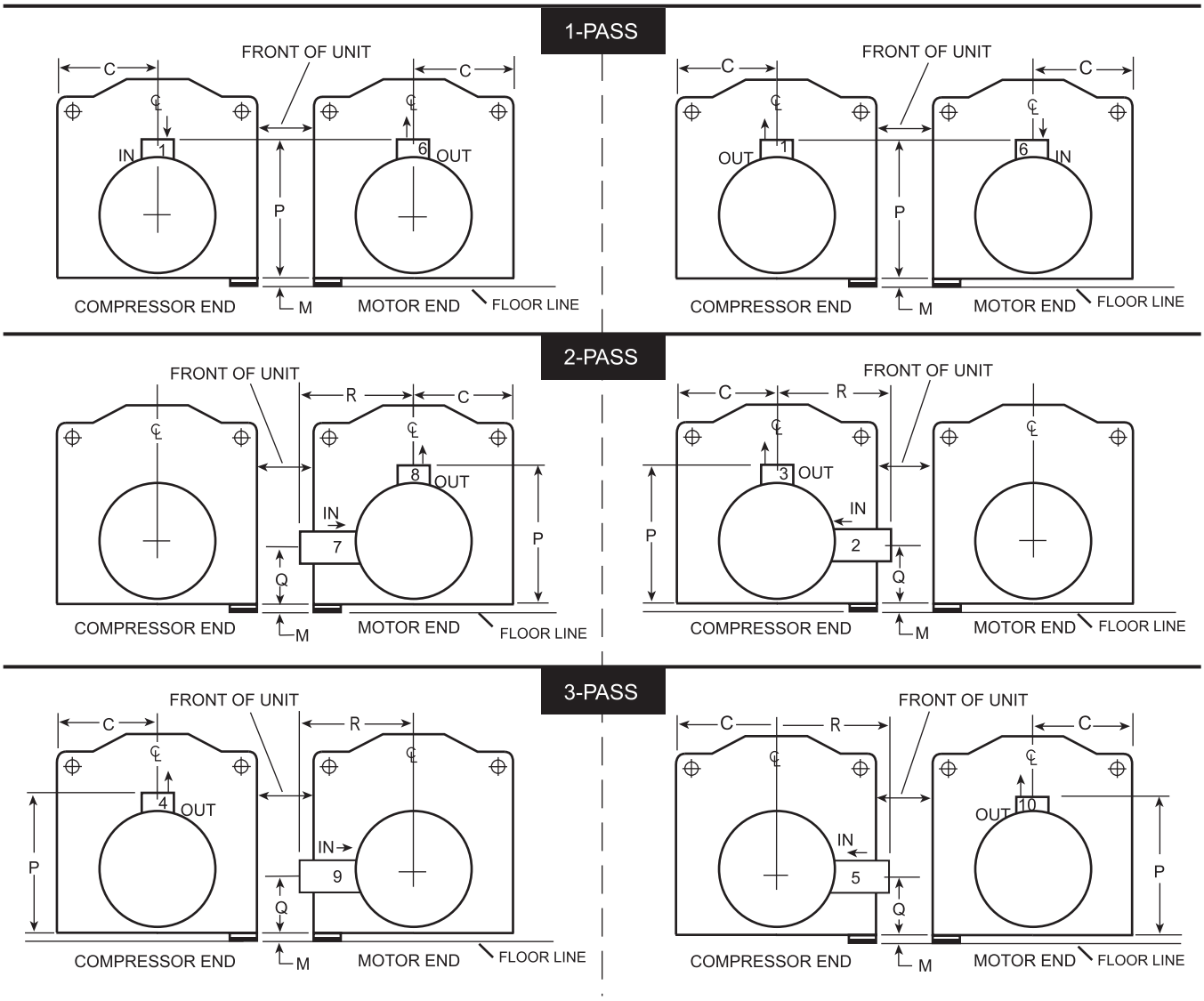
3-PASS



3 PASS NOZZLE ARRANGEMENTS		
	IN	**OUT**
HEAT RECOVERY	GG	HH
	HH	GG
COOLING TOWER	V	Y
	Y	V

COMPACT WATER BOXES - 150 PSI (RECTANGULAR)							
CONDENSER SHELL CODE	**NOZZLE PIPE SIZE (IN) NUMBER OF PASSES**			**1, 2 OR 3 PASS**			**2 PASS**
	1	**2**	**3**	**D**	**K**	**L**	**I**
B	10	8	6	1'-8 7/8"	1'-9 1/4"	3'-6 1/2"	0'-9 1/16"
I	14	10	8	1'-11 3/8"	1'-10 1/4"	3'-8 1/8"	0'-10 1/8"
O	16	12	10	2'-3 3/8"	2'-0 3/8"	4'-1 1/8"	0'-11 13/16"
U	18	14	10	2'-4 1/2"	2'-11 3/16"	5'-2 13/16"	1'-0 3/8"
Y	24	20	16	3'-4"	3'-3 15/16"	6'-3 7/8"	1'-5 7/8"

EVAPORATORS – MARINE WATERBOXES

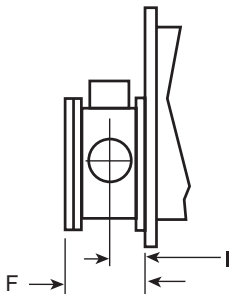


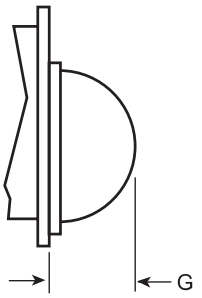
EVAPORATOR SHELL CODE				MARINE WATER BOXES - 150 PSI ROUND							
EVAP SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS			3-PASS		
	1	2	3	C	P[5]	P[5]	Q[5]	R	P[5]	Q[5]	R
A	8	6	4	1'-3 1/2"	3'-7"	3'-7"	0'-11"	1'-3 1/4"	3'-7"	0'-11"	1'-3 1/4"
C,D	10	8	6	1'-5 1/2"	3'-11"	3'-11"	0'-10"	1'-6 1/2"	3'-11"	0'-10"	1'-6 1/2"
E,F	14	10	8	1'-7 1/2"	4'-3"	4'-3"	0'-11"	1'-9 1/2"	4'-3"	0'-11"	1'-9 1/2"
G,H	14	10	8	2'-0"	4'-7 3/8"	4'-7 3/8"	0'-10 1/2"	1'-11 1/2"	4'-7 3/8"	0'-10 1/2"	1'-11 1/2"
J,K,L	16	12	10	2'-1 1/4"	5'-0 3/8"	5'-0 3/8"	0'-10 1/2"	2'-2 1/2"	5'-0 3/8"	0'-10 1/2"	2'-2 1/2"
M,N	18	14	12	2'-4 1/2"	5'-8 1/2"	5'-8 1/2"	1'-2"	2'-2 1/2"	5'-8 1/2"	1'-2"	2'-4 3/4"
P,Q	18	14	12	2'-5 1/2"	6'-0 1/8"	6'-0 1/8"	1'-3"	2'-6 1/2"	6'-0 1/8"	1'-3"	2'-6 1/2"
QT,QV	20	16	12	2'-5 1/2"	6'-0 1/8"	6'-0 1/8"	1'-4 1/2"	2'-6 1/2"	6'-0 1/8"	1'-4 1/2"	2'-6 1/2"
R,S	20	18	14	2'-8"	6'-5 7/8"	6'-5 7/8"	1-3 3/4"	3'-0 1/8"	6'-5 7/8"	1-3 3/4"	3'-0 1/8"
W	20	18	14	2'-8"	6'-5 7/8"	6'-5 7/8"	1-3 3/4"	3'-0 1/8"	6'-5 7/8"	1-3 3/4"	3'-0 1/8"
X,Z	20	18	14	2'-11 1/2"	7'-1 3/8"	7'-1 3/8"	1'-9 1/4"	3'-0 3/4"	7'-1 3/8"	1'-9 1/4"	3'-0 3/4"

See Notes on page 46.

Dimensions (Ft. - In.) - Nozzle Arrangements - cont.

EVAPORATOR 1-PASS	
IN	OUT
1	6
6	1





(2-PASS RETURN HEAD)

EVAPORATOR 2-PASS	
IN	OUT
2	3
7	8

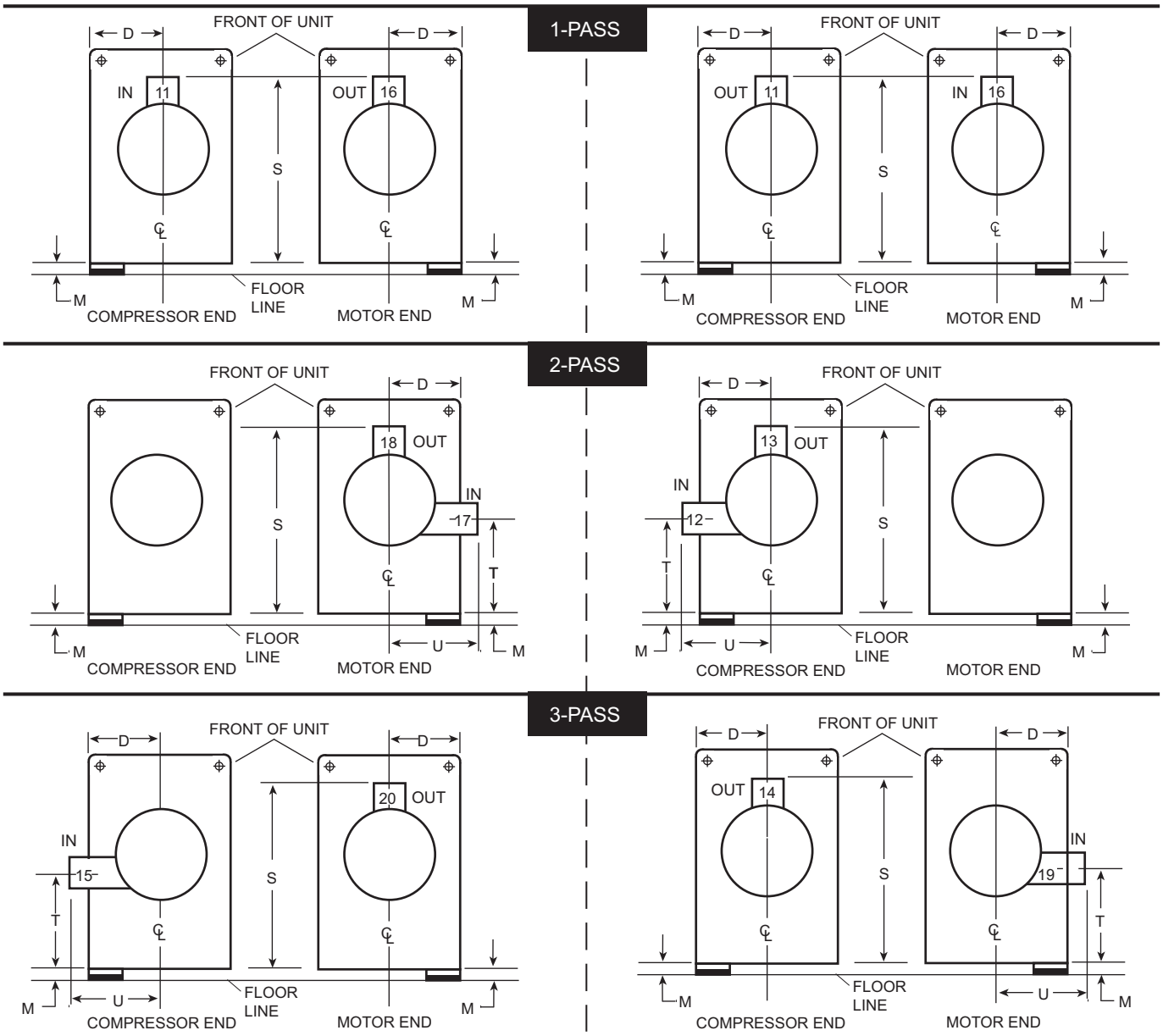
EVAPORATOR 3-PASS	
IN	OUT
5	10
9	4

EVAP SHELL CODE	1-PASS		2-PASS			3-PASS	
	F	I	F	G	I	F	I
A	1'-7"	0'-8 3/4"	1'-5"	0'-6 1/2"	0'-7 3/4"	1'-5"	0'-7 3/4"
C,D	1'-10 3/4'	0'-10 5/8""	1'-8 5/8"	0'-7"	0'-9 1/2"	1'-8 5/8"	0'-9 1/2"
E,F	2'-1 3/4"	1'-0 1/8"	1'-10"	0'-7 1/2"	0'-10 1/4"	1'-10"	0'-10 1/4"
G,H	2'-2"	0'-11 7/8"	1'-10 1/2"	0'-11 1/4"	0'-10 1/4"	1'-10 1/2"	0'-10 1/4"
J,K,L	2'-3"	1'-0 3/8"	1'-11 1/2"	0'-9 1/2"	0'-10 9/16"	1'-11 1/2"	0'-10 1/2"
M,N	2'-6"	1'-1 1/2"	2'-2"	1'-0 1/8"	0'-11 1/2"	2'-2"	0'-11 1/2"
P,Q	2'-6"	1'-1 1/2"	2'-2"	1'-1 1/2"	0'-11 1/2"	2'-2"	0'-11 1/2"
QT,QV	2'-8"	1'-2 1/2"	2'-4"	1'-1 1/2"	1'-0 1/2"	2'-4"	1'-0 1/2"
R,S,W	2'-8"	1'-2 5/8"	2'-6"	1'-2 1/2"	1'-1 5/8"	2'-6"	1'-1 5/8"
X,Z	2'-9"	1'-2 5/8"	2'-6"	1'-3 1/2"	1'-1 5/8"	2'-6"	1'-1 5/8"

NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 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 waterboxes on one heat exchanger may be used with Marine Waterboxes on the other heat exchanger.
4. Condenser water must enter the waterbox through the bottom connection for proper operation of the sub-cooler to achieve rated performance.
5. Add dimension "M" as shown on page 41 for the appropriate isolator type.

CONDENSERS – MARINE WATERBOXES



MARINE WATER BOXES - 150 PSI ROUND

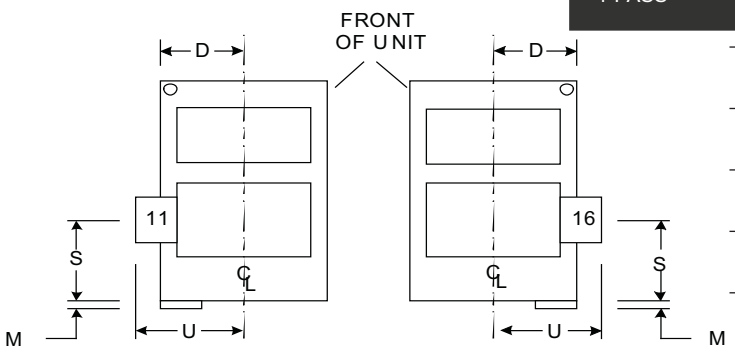
CONDENSER SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS			3-PASS		
	1	2	3	D	S[5]	S[5]	T[5]	U	S[5]	T[5]	U
A	10	6	6	1'-3"	3'-11"	3'-11"	1'-8"	1'-3 3/8"	3'-11"	1'-8"	1'-3 3/8"
C,D	12	8	6	1'-3 1/2"	4'-3"	4'-3"	1'-8"	1'-6 1/2"	4'-3"	1'-8"	1'-6 1/2"
E,F	14	10	8	1'-5 1/2"	4'-7"	4'-7"	1'-10"	1'-9"	4'-7"	1'-10"	1'-9"
J,K,L	16	10	10	1'-8"	5'-1"	5'-1"	1'-9"	1'-9 1/2"	5'-1"	1'-9"	1'-9 1/2"
M,N	20	14	10	1'-11"	5'-9 7/8"	5'-9 7/8"	2'-4"	2'-1 1/2"	5'-9 7/8"	2'-4"	2'-1 1/2"
P,Q	20	16	14	2'-1 1/4"	6'-2 3/8"	6'-2 3/8"	2'-4 1/2"	2'-5 1/2"	6'-2 3/8"	2'-4 1/2"	2'-5 1/2"
R,S	20	18	14	2'-3 1/2"	6'-7"	6'-7"	2'-6 1/2"	2'-8 1/2"	6'-7"	2'-6 1/2"	2'-8 1/2"
T,V,W	24	18	16	2'-5 1/2"	6'-10 1/4"	6'-10 1/4"	2'-6"	2'-10"	6'-10 1/4"	2'-6"	2'-10"
X,Z	24	20	16	2'-8"	7'-2"	7'-2"	2'-7 3/4"	2'-11 1/2"	7'-2"	2'-7 3/4"	2'-11 1/2"

See Notes on page 50.

Dimensions (Ft. - In.) - Nozzle Arrangements - cont.

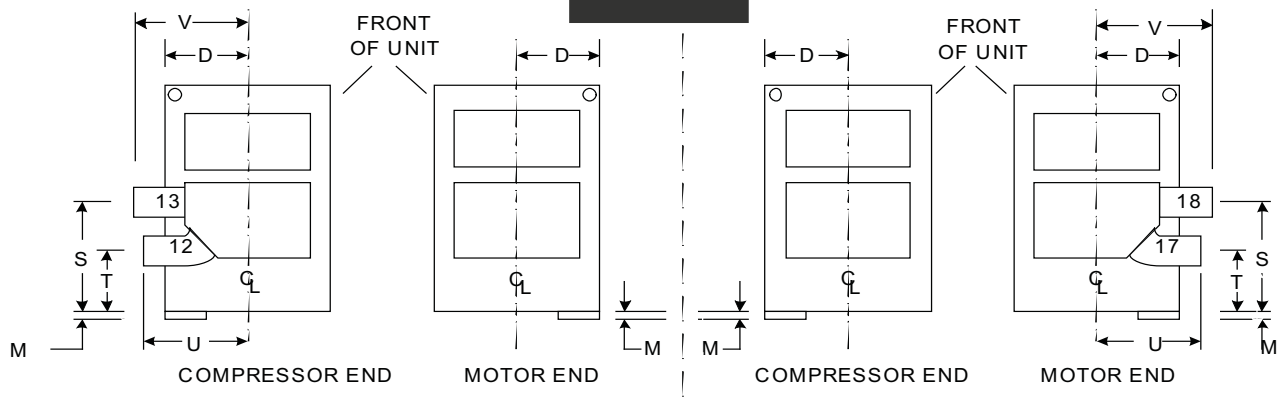
CONDENSERS – MARINE WATERBOXES
Heat Recovery Units - Main (Tower) Circuit Only

1-PASS

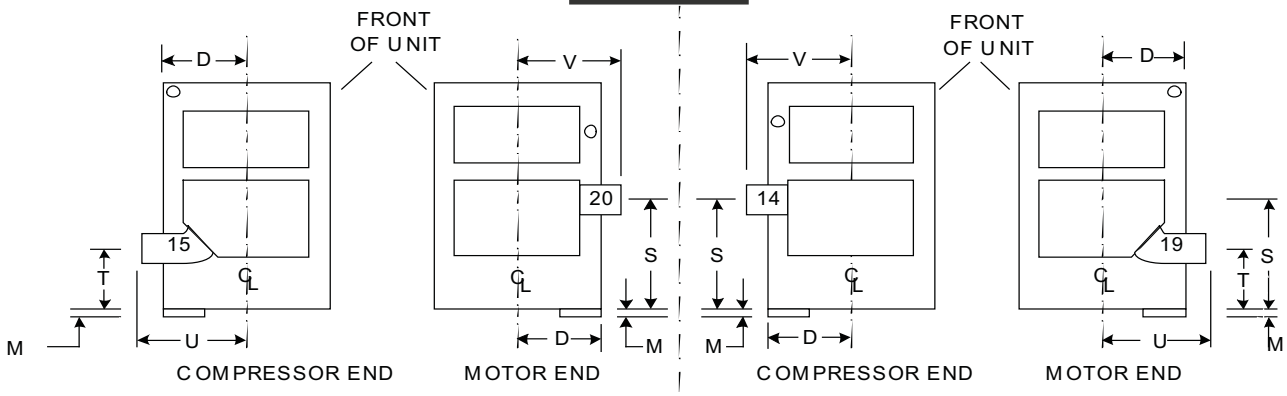


CONDENSER NOZZLE OPTIONS	COOLING WATER	
	IN	OUT
1 PASS	11	16
	16	11
2 PASS	12	13
	17	18
3 PASS	15	20
	19	14

2-PASS



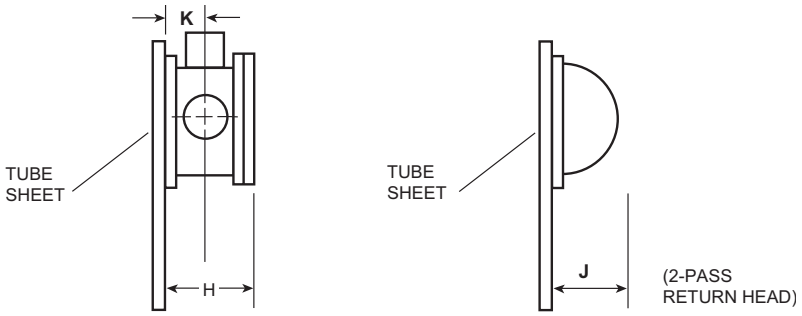
3-PASS



MARINE WATER BOXES - 150 PSI (RECTANGULAR)

CONDENSER SHELL CODE	NOZZLE PIPE SIZE (IN) NO. OF PASSES				1 PASS		2 PASS				3 PASS			
	1	2	3	D	S	U	S	T	U	V	S	T	U	V
B	10	8	6	1'-8 7/8"	1'-9 1/4"	2'-6 3/4"	2'-3 7/16"	1'-1 15/16"	2'-4 3/4"	2'-7 1/8"	2'-4 1/2"	1'-5 1/2"	2'-6 3/4"	2'-6 3/4"
I	14	10	8	1'-11 3/8"	1'-10 1/4"	2'-9 3/8"	2'-4 1/2"	1'-1"	2'-5 1/8"	2'-10 5/8"	2'-5 1/2"	1'-6 3/8"	2'-9 1/8"	2'-9 1/8"
O	16	12	10	2'-3 3/8"	2'-0 3/8"	3'-2 3/8"	2'-7 1/8"	1'-1 3/8"	2'-10 1/4"	3'-4 1/2"	2'-8 3/8"	1'-7 5/8"	3'-1 7/8"	3'-1 7/8"
U	18	14	10	2'-4 1/2"	2'-11 3/16"	3'-5 9/16"	3'-6 9/16"	1'-11 3/16"	3'-1 7/8"	3'-7 1/2"	3'-8 3/16"	2'-5 15/16"	3'-0 11/16"	3'-3"
Y	24	20	16	3'-4"	3'-3 15/16"	4'-7 9/16"	4'-2 5/16"	1'-10 5/16"	4'-4 3/4"	4'-11 11/16"	4'-4 5/16"	2'-7 7/16"	4'-2 1/16"	4'-6 13/16"

CONDENSER 1-PASS	
IN	**OUT**
11	16
16	11



CONDENSER 2-PASS	
IN	**OUT**
12	13
17	18

CONDENSER 3-PASS	
IN	**OUT**
15	20
19	14

COND SHELL CODE	1-PASS		2-PASS			3-PASS	
	H	**K**	**H**	**J**	**K**	**H**	**K**
A	1'-9"	0'-9 7/8"	1'-4 3/4"	0'-6"	0'-7 3/4"	1'-4 3/4"	0'-7 3/4"
B6	1'-10 1/2"	0'-10 1/2"	1'-8"	0'-10 1/2"	0'-9 1/4"	1'-8"	0'-9 1/4"
C,D	2'-0"	0'-11 1/8"	1'-7 1/2"	0'-6 3/8"	0'-9"	1'-7 1/2"	0'-9"
E,F	2'-0 1/2"	0'-11 1/2"	1'-10 1/4"	0'-7"	0'-9 7/8"	1'-10 1/4"	0'-9 7/8"
I6	2'-3"	1'-0 3/4"	1'-10 1/2"	0'-11 1/2"	0'-10 1/2"	1'-10 1/2"	0'-10 1/2"
J,K,L	2'-3"	1'-0 1/2"	1'-11"	0'-7 1/2"	0'-10 1/4""	1'-11"	0'-10 1/4"
M,N	2'-8"	1'-2 7/8"	2'-2"	0'-8""	1'-0"	2'-2"	1'-0"
O6	2'-6 1/4"	1'-2 1/4"	2'-1 3/4"	1'-1 1/2"	1'-0"	2'-1 3/4"	1'-0"
P,Q	2'-8"	1'-2 1/2"	2'-4"	0'-9 1/2"	1'-0 1/2"	2'-4"	1'-0 1/2"
R,S	2'-8"	1'-2 1/2"	2'-6"	1'-0"	1'-1 1/2"	2'-6"	1'-1 1/2"
T,V,W	3'-0"	1'-4 1/2"	2'-6"	0'-11"	1'-1 1/2"	2'-6"	1'-1 1/2"
U6	2'-8"	1'-3"	2'-4"	1'-2 1/4"	1'-1"	2'-4"	1'-1"
X,Z	3'-0"	1'-4 5/8"	2'-8"	0'-11"	1'-2 5/8"	2'-8"	1'-2"
Y6	3'-4 3/4"	1'-7 1/4"	3'-0 1/4"	1'-8 3/4"	1'-5"	3'-0 1/4"	1'-5"

NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 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 waterboxes on one heat exchanger may be used with Marine Waterboxes on the other heat exchanger.
4. Condenser water must enter the waterbox through the bottom connection for proper operation of the sub-cooler to achieve rated performance.
5. Add dimension "M" as shown on page 41 for the appropriate isolator type.
6. Heat recovery units offer marine waterbox option for tower (lower) bundle only.

Weights - English

TABLE 19 – APPROXIMATE UNIT WEIGHT INCLUDING MOTOR[2]

SHELLS	COMPRESSOR	SHIPPING WEIGHT (LBS.)	OPERATING WEIGHT (LBS.)	EST. REFRIGERANT CHARGE (LBS.)[1]
A-A	Q3	13,100	15,000	828
C-B	Q4	18,023	22,323	1,525
C-C	Q3, Q4	14,920	17,940	1,221
C-C	Q5	15,330	18,350	1,221
D-D	Q3, Q4	17,215	21,100	1,628
D-D	Q5	17,625	21,510	1,628
E-E	Q3, Q4	17,950	22,160	1,710
E-E	Q5,Q6,Q7,P7	18,360	22,570	1,710
E-I	Q7	23,567	29,384	1,805
F-F	Q5,Q6,Q7,P7	18,720	23,880	2,175
G-E	P8	20,300	24,200	1,990
H-F	P8,P9	23,100	28,000	2,610
J-J	P8,P9	24,000	29,100	2,550
L-L	P8,P9	27,400	33,900	3,165
K-K	H9	28,530	36,000	2,925
K-K	K1	31,100	36,200	3,248
K-O	H9	34,483	44,776	3,260
M-M	H9	34,200	43,600	3,665
M-M	K1,K2	38,300	47,100	3,665
M-U	K2	45,178	58,017	3,540
N-N	K1,K2	40,893	50,800	4,225
N-N	K3	48,000	54,100	4,225
P-P	K1,K2	41,500	51,900	3,855
Q-Q	K1,K2	45,300	56,800	4,255
Q-Q	K3	46,000	60,200	4,255
R-R	K3	52,800	70,300	4,600
R-R	K4	53,000	70,600	4,600
S-S	K4	59,000	76,300	4,815
S-V	K4	60,100	81,300	5,467
X-T	K4	59,200	80,000	5,338
X-X	K4	66,000	87,000	5,875
W-W	K7	79,500	104,000	8,002
Z-Y	K7	95,230	123,015	7,175
Z-Z	K7	80,500	105,000	6,984

[1] Refrigerant charge quantity and weights will vary based on tube count.

[2] Refer to product drawings for detailed weight information.

TABLE 20 – APPROXIMATE UNIT WEIGHT INCLUDING MOTOR

UNIT WITH HYBRID FALLING FILM EVAPORATOR

SHELLS	COMPRESSOR	SHIPPING WEIGHT (LBS.)	OPERATING WEIGHT (LBS.)	EST. REFRIGERANT CHARGE (LBS.)[1]
A-A	Q3	12,850	14,419	695
C-C	Q3, Q4	14,570	16,848	875
C-C	Q5	15,000	17,278	875
D-D	Q4	17,000	20,051	1,180
D-D	Q5	17,410	20,461	1,180
E-E	Q5,Q6,Q7,P7	18,700	21,700	1,120
F-F	Q5,Q6,Q7,P7	19,220	23,142	1,415
G-E	P8, P9	20,640	24,036	1,320
H-F	P8, P9	23,540	28,083	1,775
K-K	H9	28,850	34,079	1,820

[1] Refrigerant charge quantity and weights will vary based on tube count and configuration. Use for reference only.

TABLE 21 – EVAPORATOR MARINE WATERBOX WEIGHTS (LBS.) (TO BE ADDED TO STANDARD UNIT WEIGHTS SHOWN ON TABLE 19)

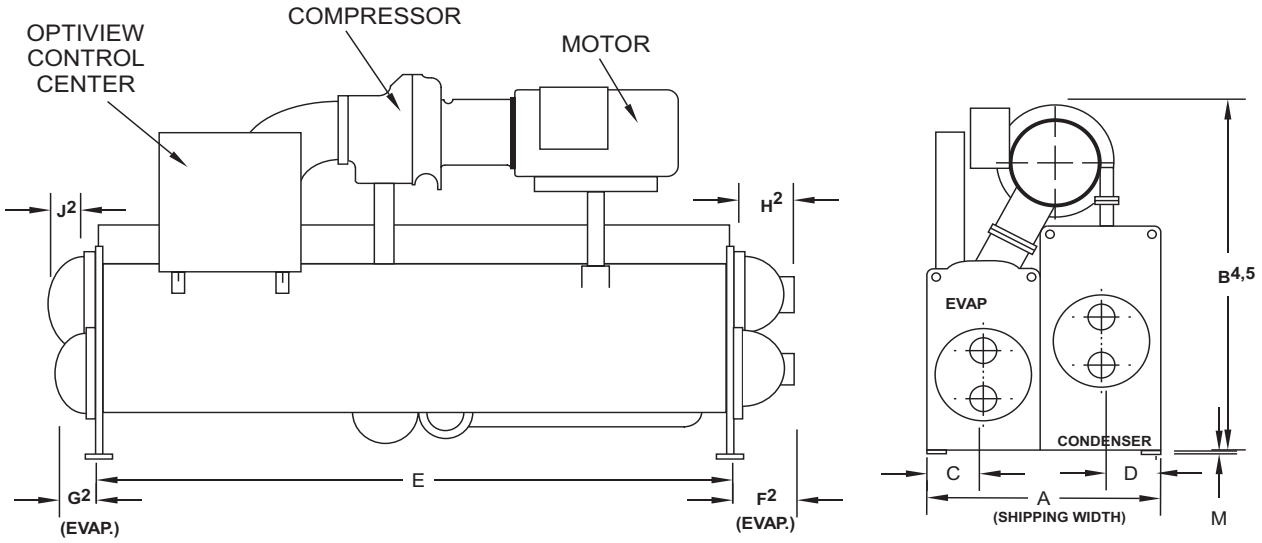
EVAP. CODE	SHIPPING WEIGHT INCREASE - LBS.			OPERATING WEIGHT INCREASE - LBS.		
	1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS
A	924	744	978	1,468	1,288	1,522
C,D	1,352	1,114	1,480	2,224	1,986	2,352
E,F	1,878	1,260	2,080	3,378	2,760	3,580
G,H	1,213	1,296	1,293	2,655	2,738	2,735
J,K,L	1,751	1,843	1,856	3,864	3,956	3,969
M,N	4,290	2,036	4,140	7,535	3,264	6,300
P,Q	4,662	2,250	4,646	7,746	3,486	7,392
R,S,W	4,804	2,700	4,912	8,522	4,516	8,187
X,Z	7,088	3,660	7,244	11,552	5,507	11,243

TABLE 22 – CONDENSER MARINE WATERBOX WEIGHTS (LBS.) (TO BE ADDED TO STANDARD UNIT WEIGHTS SHOWN ON TABLE 19)

COND. CODE	SHIPPING WEIGHT INCREASE - LBS.			OPERATING WEIGHT INCREASE - LBS.		
	1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS
A	762	566	810	1,274	1,078	1,322
B	1,569	874	1,677	2,113	1,094	2,071
C,D	946	778	1,046	1,692	1,524	1,792
E,F	726	811	791	1,337	1,722	1,702
I	2,066	1,070	2,032	3,017	1,416	2,738
J,K,L	1,029	1,167	1,151	2,309	2,447	2,431
M,N	2,466	1,330	2,324	4,863	2,448	4,582
O	2,985	1,443	2,987	4,435	2,172	3,979
P,Q	3,700	1,858	3,752	6,561	3,132	5,991
R,S	3,806	1,946	3,960	6,657	3,195	6,352
V,T,W	5,196	2,565	5,204	9,161	4,012	8,219
U	3,641	1,893	3,609	5,350	2,556	4,770
X,Z	5,840	2,953	5,380	9,900	4,649	8,100
Y	9,094	4,762	9,058	13,326	6,524	12,049

Dimensions (mm) - Unit

P & Q COMPRESSOR UNITS



ADDITIONAL OPERATING HEIGHT CLEARANCE TO FLOOR	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	45
SPRING ISOLATORS 1" DEFLECTION	25
DIRECT MOUNT	19

P7, Q7 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	E-E	E-I	F-F
A	1880	2178	1880
B	2454	2642	2454
C	495	495	495
D	445	594	445
E	3658	3658	4877

P8 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	G-E	H-F	J-J	L-L
A	2108	2108	2299	2299
B	3200	3200	3327	3327
C	610	610	641	641
D	445	445	508	508
E	3658	4877	3658	4877

P9 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	H-F	J-J	L-L
A	2108	2299	2299
B	3124	3264	3264
C	610	641	641
D	445	508	508
E	4877	3658	4877

Q3 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	A-A	C-C	D-D
A	1549	1676	1676
B	2134	2229	2229
C	394	445	445
D	381	394	394
E	3658	3658	4877

Q4 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODE

	C-B	C-C	D-D	E-E
A	1949	1676	1676	2134
B	2423	2197	2197	2350
C	445	445	445	495
D	530	394	394	445
E	3658	3658	4877	3658

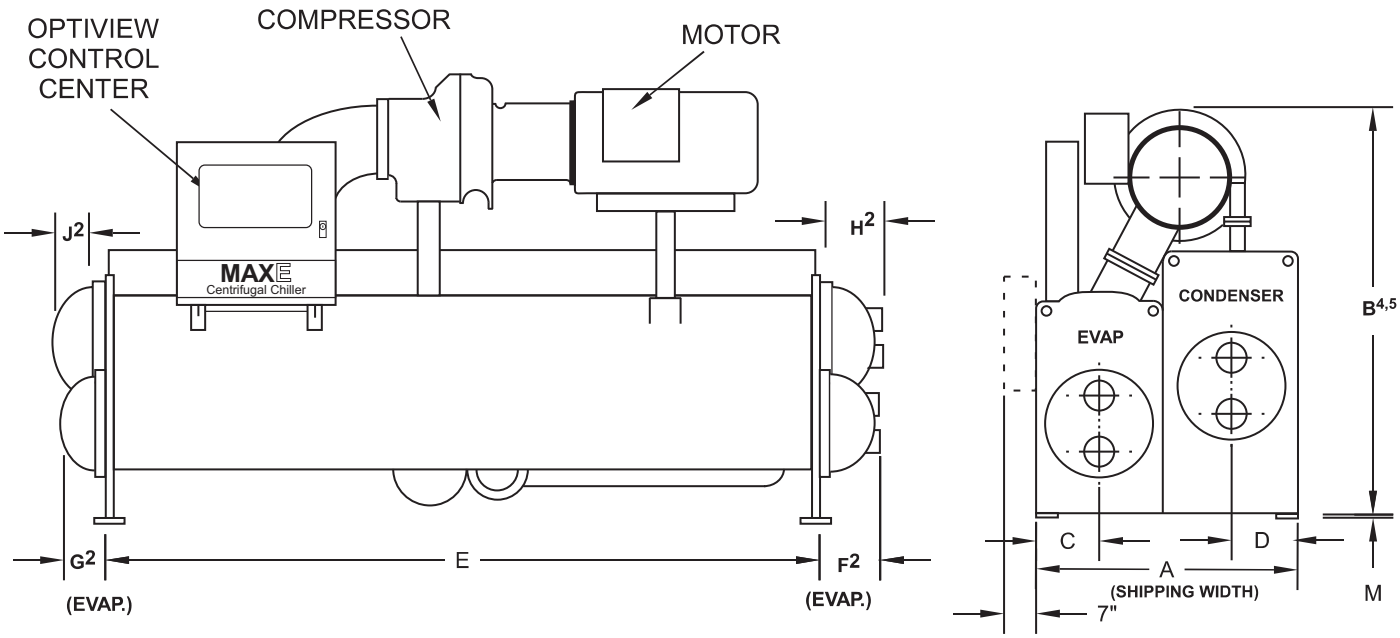
Q5 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	C-C	D-D	E-E	F-F
A	1676	1676	2134	2134
B	2403	2403	2578	2578
C	445	445	495	495
D	394	394	445	445
E	3658	4877	3658	4877

Q6 COMPRESSOR
EVAPORATOR-CONDENSER SHELL CODES

	E-E	F-F
A	2134	2134
B	2515	2515
C	495	495
D	445	445
E	3658	4877

H COMPRESSOR UNITS



ADDITIONAL OPERATING HEIGHT CLEARANCE	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	44
SPRING ISOLATORS 25MM DEFLECTION	25
DIRECT MOUNT	19

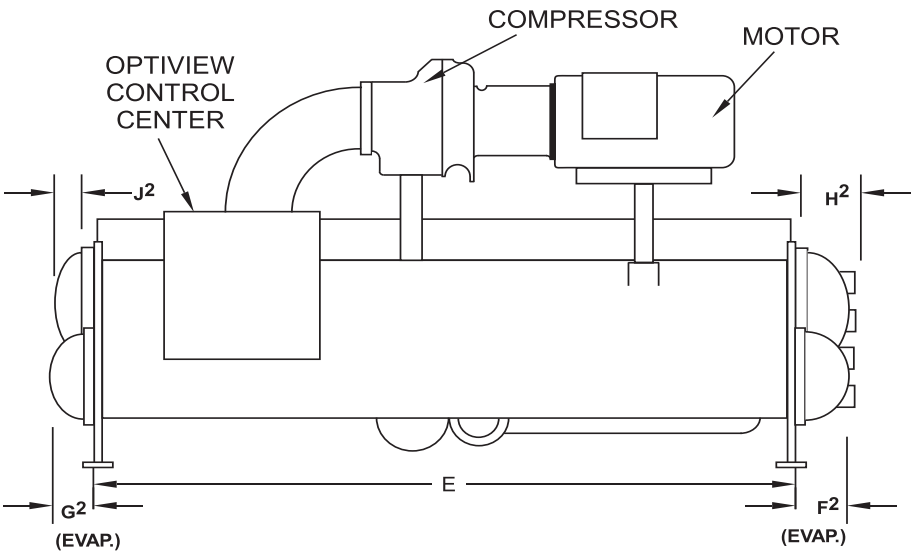
H9 COMPRESSORS			
EVAP.-COND. SHELL CODES			
	K-K	K-O	M-M
A	2299	2673	2616
B	3150	3242	3315
C	641	641	724
D	508	695	584
E	4267	4267	4267

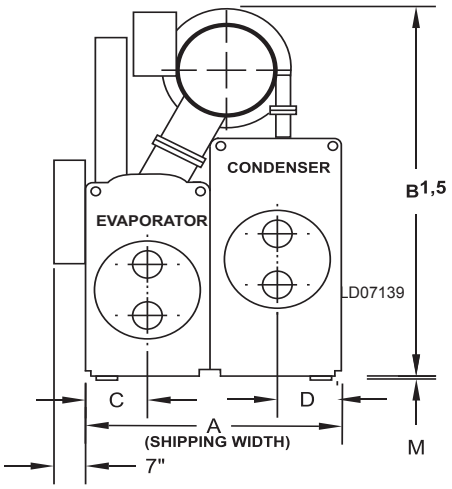
NOTES:

1. All dimensions are approximate. Certified dimensions are available on request.
2. For all waterboxes (compact shown above), determine overall unit length by adding waterbox depth to tube sheet length.
3. Water nozzles can be located on either end of unit. Add 13 mm to nozzle length for flanged connections.
4. To determine overall height, add dimension "M" for the appropriate isolator type.
5. Use of motors with motor hoods may increase overall unit dimensions.

Dimensions (mm) - Nozzle Arrangements

K COMPRESSOR UNITS





K1 COMPRESSOR, EVAPORATOR-CONDENSER SHELL CODES					
	K-K	M-M	N-N	P-P	Q-Q
A	2299	2616	2616	2781	2781
B	2921	3454	3454	3493	3493
C	641	724	724	749	749
D	508	584	584	641	641
E	4267	4267	4877	4267	4877

K2 COMPR., EVAPORATOR-CONDENSER SHELL CODES					
	M-M	M-U	N-N	P-P	Q-Q
A	2616	2896	2616	2781	2781
B	3454	3607	3454	3480	3480
C	724	724	724	749	749
D	584	724	584	641	641
E	4267	4267	4877	4267	4877

K4 COMPRESSOR, EVAPORATOR-CONDENSER SHELL CODES					
	R-R	S-S	S-V	X-T	X-X
A	2972	2972	3124	3302	3429
B	3632	3632	3759	3759	3759
C	813	813	813	902	902
D	699	699	749	749	813
E	4877	5486	5486	4877	4877

ADDITIONAL OPERATING HEIGHT CLEARANCE TO FLOOR	
TYPE OF CHILLER MOUNTING	M
NEOPRENE PAD ISOLATORS	44
SPRING ISOLATORS 1" DEFLECTION	25
DIRECT MOUNT	19

K3 COMPR., EVAP.-COND. SHELL CODES			
	N-N	Q-Q	R-R
A	2616	2781	2972
B	3251	3505	3607
C	724	749	813
D	584	641	699
E	4877	4877	4877

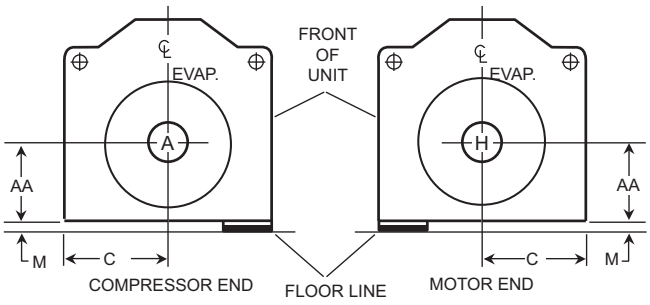
K7 COMPR., EVAP.-COND SHELL CODES			
	W-W	Z-Y	Z-Z
A	3124	3835	3429
B	3708	4308	3912
C	813	902	902
D	749	1016	813
E	6706	5486	5486

NOTES:

1. All dimensions are approximate. Certified dimensions are available on request.
2. For all waterboxes (compact shown above), determine overall unit length by adding waterbox depth to tube sheet length.
3. Water nozzles can be located on either end of unit. Add 13 mm to nozzle length for flanged connections.
4. Add dimension "M" as shown on page 57 for the appropriate isolator type.
5. Use of motors with motor hoods may increase overall unit dimensions.
6. Tubesheets are provided with jacking point notches on P and larger shells.

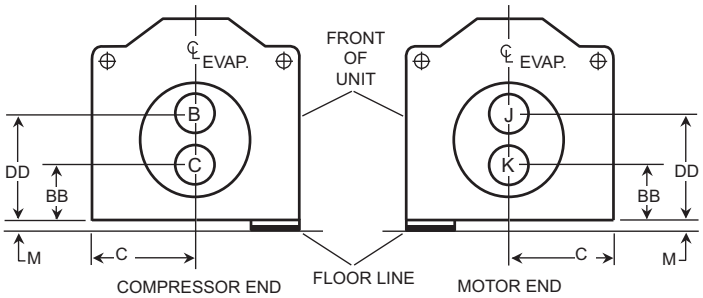
EVAPORATORS – COMPACT WATER BOXES – A THRU K EVAPORATORS

1-PASS



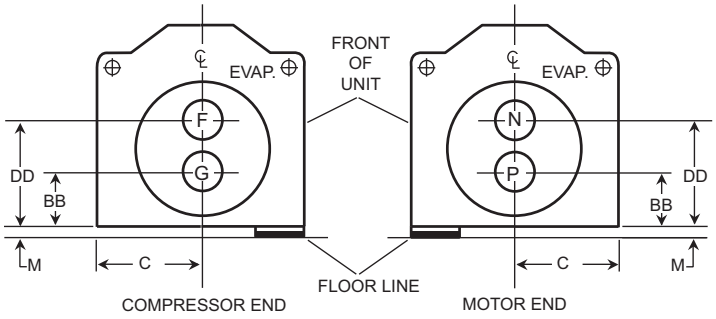
NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
1	A	H
	H	A

2-PASS



NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
2	C	B
	K	J

3-PASS



NOZZLE ARRANGEMENTS		
NO. OF PASSES	EVAPORATOR	
	IN	OUT
3	G	N
	P	F

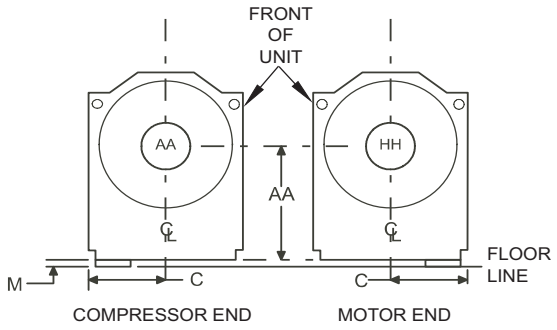
COMPACT WATER BOXES - 150 PSI ROUND

CONDENSER SHELL CODE	NOZZLE PIPE SIZE(IN)			EVAPORATOR NOZZLE DIMENSIONS (MM)					
	NO. OF PASSES				1-PASS	2-PASS		3-PASS	
	1	2	3	C	AA5	BB5	DD5	BB5	DD5
A	8	6	4	394	559	356	762	356	762
C,D	10	8	6	445	610	381	838	381	838
E,F	14	10	8	483	660	406	914	406	914
G,H	14	10	8	610	699	394	1003	394	1003
J,K,L	16	12	10	641	762	432	1092	432	1092

Dimensions (mm) - Nozzle Arrangements - continued

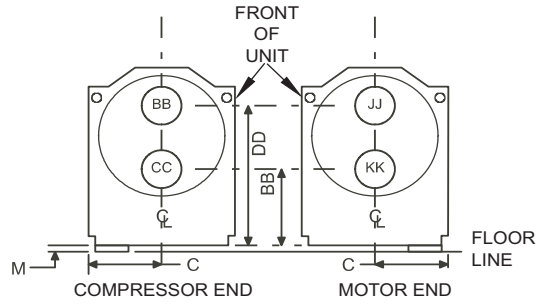
EVAPORATORS – COMPACT WATER BOXES – M THRU Z EVAPORATORS

1-PASS

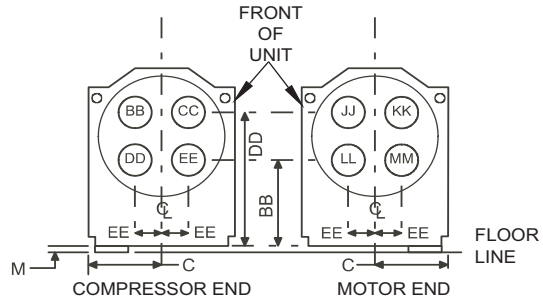


SHELL CODE	1 PASS	
	IN	OUT
M–Z	AA	HH
	HH	AA

2-PASS

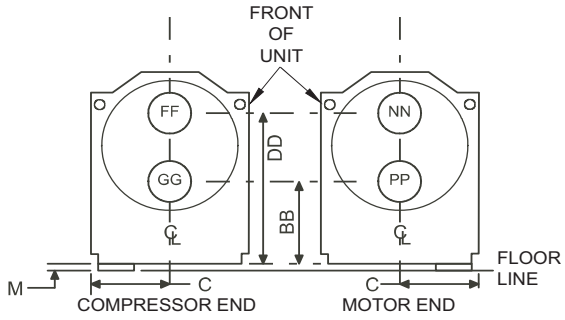


SHELL CODE	2 PASS	
	IN	OUT
M,N,P,Q	CC	BB
	KK	JJ



SHELL CODES	2 PASS	
	IN	OUT
R, S, W, X & Z	DD	CC
	EE	BB
	LL	KK
	MM	JJ

3-PASS



SHELL CODES	3 PASS	
	IN	OUT
M–Z	GG	NN
	PP	FF

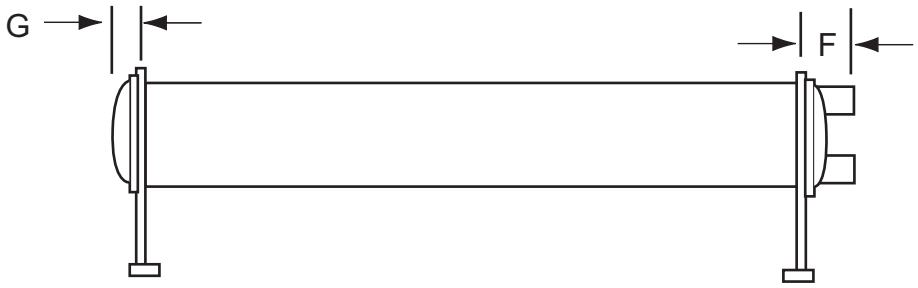
COMPACT WATER BOXES - 150 PSI

EVAP SHELL CODE	NOZZLE PIPE SIZE(IN)			EVAPORATOR NOZZLE DIMENSIONS (MM)						
	NO. OF PASSES				1-PASS	2-PASS			3-PASS	
	1	2	3	C	AA[5]	BB[5]	DD[5]	EE	BB[5]	DD[5]
M,N	18	14	12	724	914	521	1308	-	521	1308
P,Q	18	14	12	749	953	559	1346	-	559	1346
QV, QT	20	16	12	749	953	597	1308	-	597	1308
R,S,W	20	18	14	813	1048	724	1384	267	635	1473
X,Z	20	18	14	902	1162	832	1492	279	683	1641

See Notes on page 58.

ONE PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	QT,QV	R,S,W	X,Z
F	362	381	394	400	445	565	600	613	600	635



TWO PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	QT,QV	R,S,W	X,Z
F	362	381	394	400	445	565	600	613	600	635
G	165	178	191	197	241	365	391	391	416	464

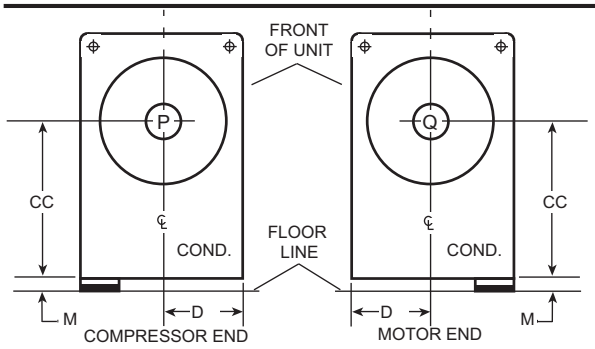
THREE PASS EVAPORATORS, CODES

DIM.	A	C,D	E,F	G,H	J,K,L	M,N	P,Q	QT,QV	R,S,W	X,Z
F	362	381	394	400	445	565	600	613	600	635

Dimensions (mm) - Nozzle Arrangements - continued

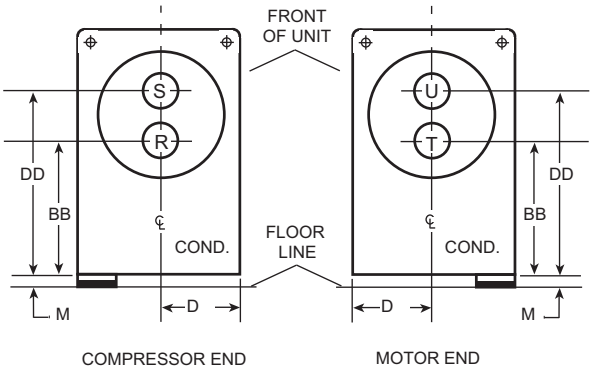
CONDENSERS – COMPACT WATER BOXES

1-PASS



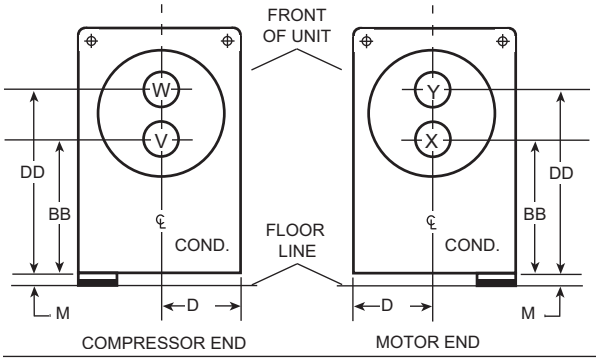
NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
1	P	Q
	Q	P

2-PASS



NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
2	R	S
	T	U

3-PASS



NOZZLE ARRANGEMENTS[7]		
NO. OF PASSES	CONDENSER	
	IN	OUT
3	V	Y
	X	W

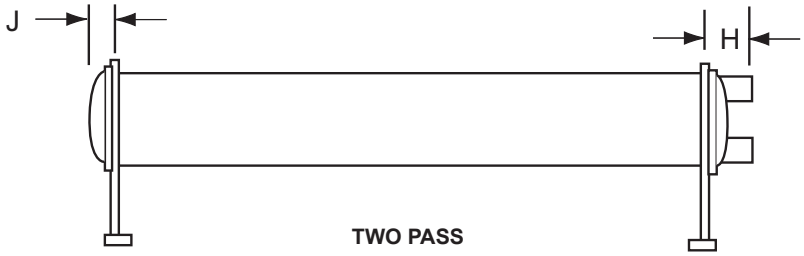
COMPACT WATER BOXES - 150 PSI ROUND

CONDENSER SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS		3-PASS	
	1	2	3	D	CC[5]	BB[5]	DD[5]	BB[5]	DD[5]
A	10	6	6	381	711	546	876	546	876
C,D	12	8	6	394	762	568	956	568	956
E,F	14	10	8	445	813	603	1022	603	1022
J,K,L	16	10	10	508	914	686	1143	686	1143
M,N	20	14	10	584	1067	772	1362	772	1362
P,Q	20	16	14	641	1118	787	1448	787	1448
R,S	20	18	14	699	1181	851	1511	851	1511
T,V,W	24	18	16	749	1207	838	1575	838	1575
X,Z	24	20	16	813	1251	845	1657	845	1657

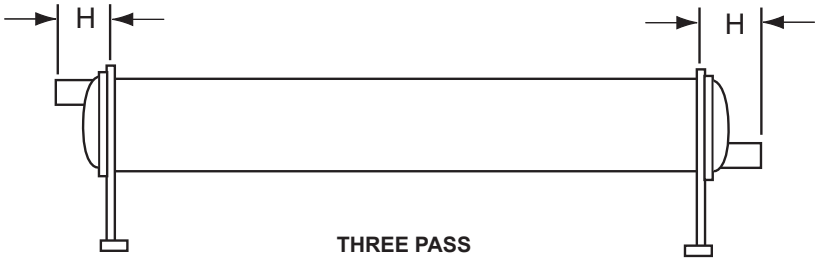
NOTES:

1. Standard water nozzles are furnished as welding stub-outs with ANSI/AWWA C-606 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 1.6 mm raised face), water flanges nozzles are optional (add 13 mm to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. 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.
3. Evaporator and condenser water must enter the water box through the bottom connection to achieve rated performance.
4. Connected piping should allow for removal of compact water boxes for tube access and cleaning.
5. Add dimension "M" as shown on page 57 for the appropriate isolator type.
6. Standard 150 psi (1034 kPa) design pressure water boxes shown.
7. Shell codes R,S,T,V,W,X, & Z use double letter nozzle codes in the same orientation as the single letter e.g. P = PP.

ONE PASS



TWO PASS



THREE PASS

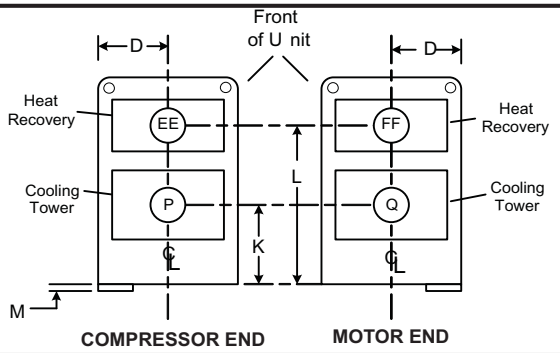
SINGLE BUNDLE CONDENSERS, CODES									
DIM.	A	C,D	E,F	J,K,L	M,N	P,Q	R,S	T,V,W	X,Z
H	352	352	381	394	391	445	527	572	600
J	149	165	178	191	197	241	365	391	416

DOUBLE BUNDLE HEAT RECOVERY CONDENSERS, CODES										
	B		I		O		U		Y	
DIM.	TOWER	HEATING	TOWER	HEATING	TOWER	HEATING	TOWER	HEATING	TOWER	HEATING
H	470	432	495	425	546	457	565	508	730	572
J	267	229	292	222	343	254	362	305	527	368

Dimensions (mm) - Nozzle Arrangements - continued

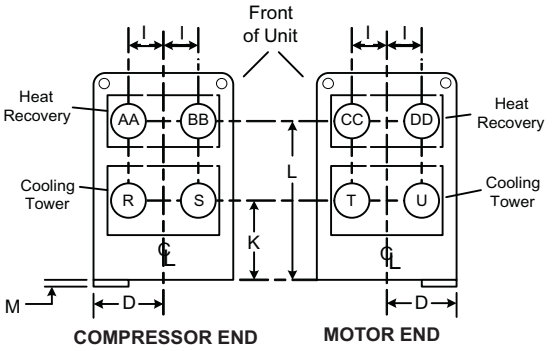
HEAT RECOVERY UNITS

1-PASS



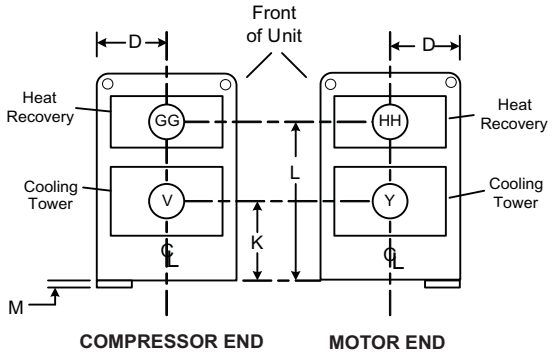
1 PASS NOZZLE ARRANGEMENTS		
	IN	OUT
HEAT RECOVERY	EE	FF
	FF	EE
COOLING TOWER	P	Q
	Q	P

2-PASS



2 PASS NOZZLE ARRANGEMENTS		
	IN	OUT
HEAT RECOVERY	AA	BB
	BB	AA
	CC	DD
	DD	CC
COOLING TOWER	R	S
	S	R
	T	U
	U	T

3-PASS

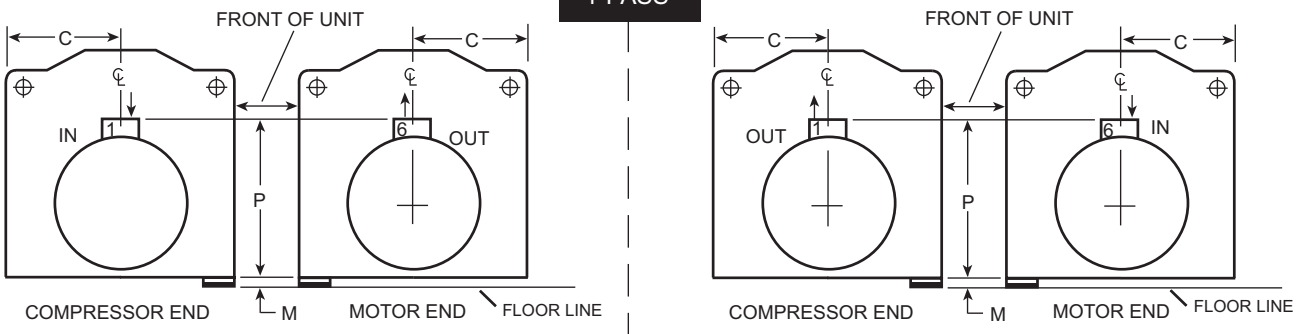


3 PASS NOZZLE ARRANGEMENTS		
	IN	OUT
HEAT RECOVERY	GG	HH
	HH	GG
COOLING TOWER	V	Y
	Y	V

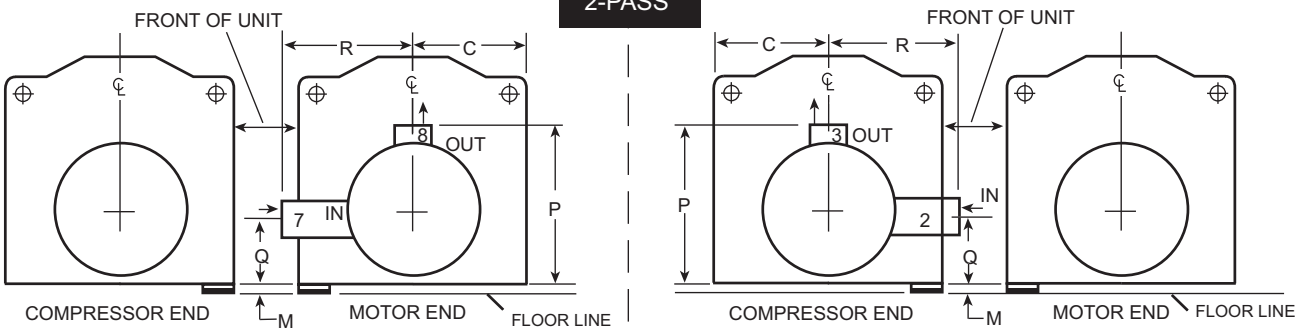
COMPACT WATER BOXES - 150 PSI (RECTANGULAR)							
CONDENSER SHELL CODE	NOZZLE PIPE SIZE (IN) NUMBER OF PASSES			1, 2 OR 3 PASS			2 PASS
	1	2	3	D	K	L	I
B	10	8	6	530	540	1080	230
I	14	10	8	594	565	1121	257
O	16	12	10	695	619	1248	300
U	18	14	10	724	894	1595	314
Y	24	20	16	1016	1014	1927	454

EVAPORATORS – MARINE WATER BOXES

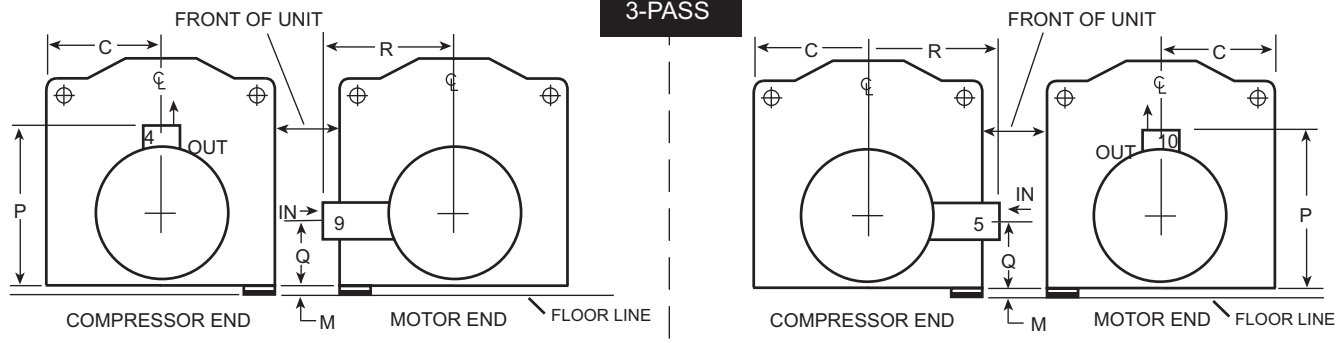
1-PASS



2-PASS



3-PASS

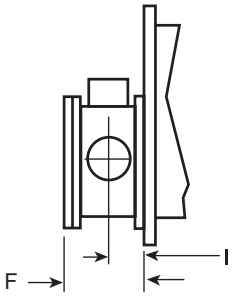


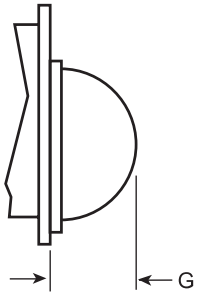
CONDENSER SHELL CODE				MARINE WATER BOXES - 150 PSI ROUND							
EVAP SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS			3-PASS		
	1	2	3	C	P[5]	P[5]	Q[5]	R	P[5]	Q[5]	R
A	8	6	4	394	1092	1092	279	387	1092	279	387
C,D	10	8	6	445	1194	1194	254	470	1194	254	470
E,F	14	10	8	495	1295	1295	279	546	1295	279	546
G,H	14	10	8	610	1407	1407	267	597	1407	267	597
J,K,L	16	12	10	641	1534	1534	267	673	1534	267	673
M,N	18	14	12	724	1740	1740	356	673	1740	356	730
P,Q	18	14	12	749	1832	1832	381	775	1832	381	775
QT,QV	20	16	12	749	1832	1832	419	775	1832	419	775
R,S	20	18	14	813	1978	1978	57	918	1978	57	918
W	20	18	14	813	1978	1978	57	918	1978	57	918
X,Z	20	18	14	902	2169	2169	540	933	2169	540	933

See Notes on pg 62.

Dimensions (mm) - Nozzle Arrangements - continued

EVAPORATOR	
1-PASS	
IN	OUT
1	6
6	1





(2-PASS RETURN HEAD

EVAPORATOR	
2-PASS	
IN	OUT
2	3
7	8

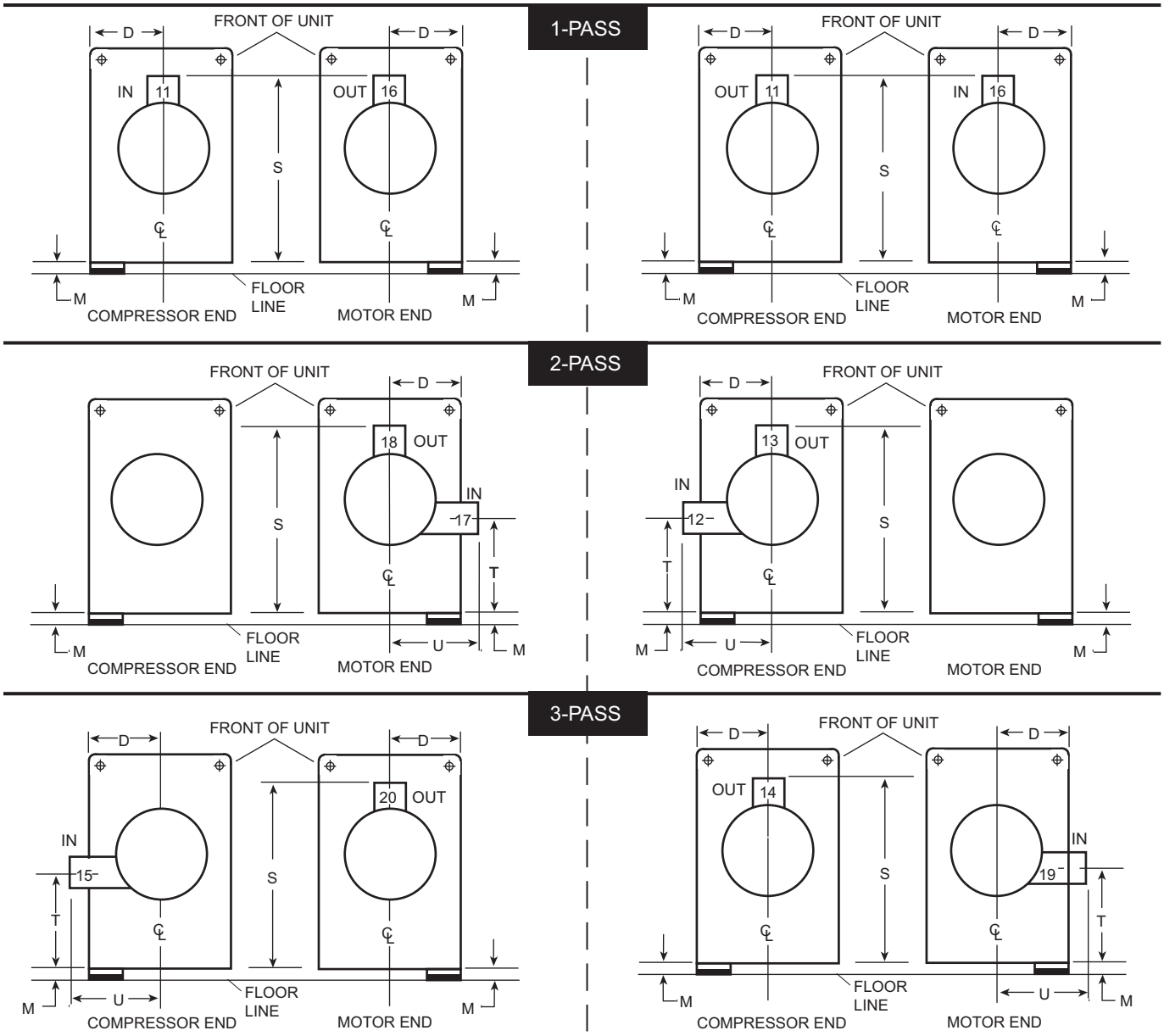
EVAPORATOR	
3-PASS	
IN	OUT
5	10
9	4

EVAP SHELL CODE	1-PASS		2-PASS			3-PASS	
	F	I	F	G	I	F	I
A	483	222	432	165	197	432	197
C,D	578	270	524	178	241	524	241
E,F	654	308	559	191	260	559	260
G,H	660	302	572	286	260	572	260
J,K,L	686	314	597	241	268	597	267
M,N	762	343	660	308	292	660	292
P,Q	762	343	660	343	292	660	292
QT,QV	813	368	711	343	318	711	318
R,S,W	813	371	762	368	346	762	346
X,Z	838	371	762	394	346	762	346

NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 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 1.6 mm raised face), water flanged nozzles are optional (add 13 mm 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 waterboxes on one heat exchanger may be used with Marine Waterboxes on the other heat exchanger.
4. Water must enter the waterbox through the bottom connection to achieve rated performance.
5. Add dimension "M" as shown on page 57 for the appropriate isolator type.

CONDENSERS – MARINE WATER BOXES



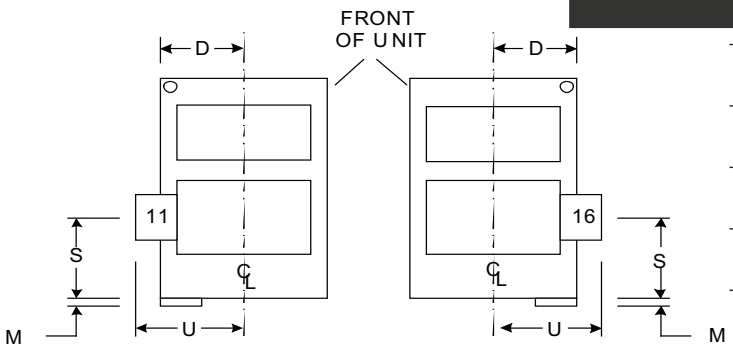
MARINE WATER BOXES - 150 PSI ROUND

CONDENSER SHELL CODE	NOZZLE PIPE SIZE(IN) NO. OF PASSES				1-PASS	2-PASS			3-PASS		
	1	2	3	D	S[5]	S[5]	T[5]	U	S[5]	T[5]	U
A	10	6	6	381	1194	1194	508	391	1194	508	391
C,D	12	8	6	394	1295	1295	508	470	1295	508	470
E,F	14	10	8	445	1397	1397	559	533	1397	559	533
J,K,L	16	10	10	508	1549	1549	533	546	1549	533	546
M,N	20	14	10	584	1775	1775	711	648	1775	711	648
P,Q	20	16	14	641	1889	1889	724	749	1889	724	749
R,S	20	18	14	699	2007	2007	775	826	2007	775	826
T,V,W	24	18	16	749	2089	2089	762	864	2089	762	864
X,Z	24	20	16	813	2184	2184	806	902	2184	806	902

Dimensions (mm) - Nozzle Arrangements - continued

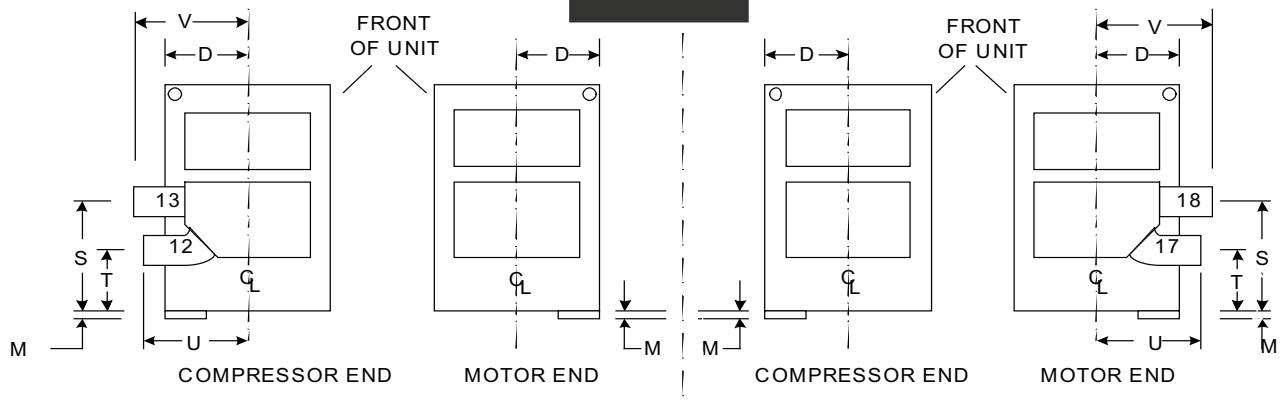
CONDENSERS – MARINE WATER BOXES
Heat Recovery Units - Main (Tower) Circuit Only

1-PASS

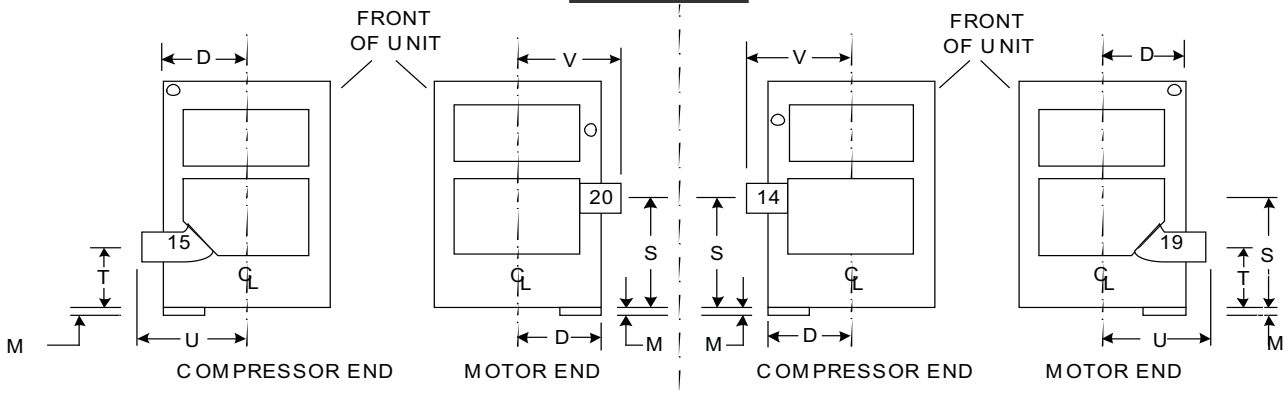


CONDENSER NOZZLE OPTIONS	COOLING WATER	
	IN	OUT
1 PASS	11	16
	16	11
2 PASS	12	13
	17	18
3 PASS	15	20
	19	14

2-PASS



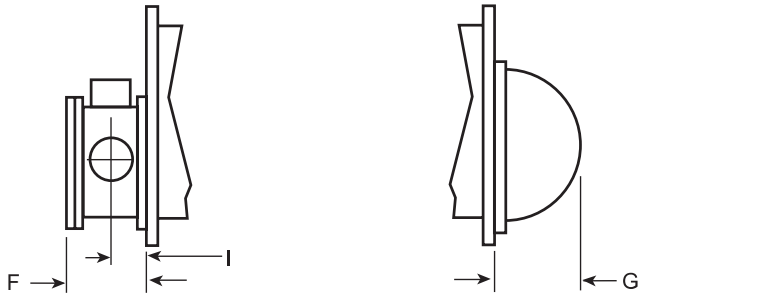
3-PASS



MARINE WATER BOXES - 150 PSI (RECTANGULAR)

CONDENSER SHELL CODE	NOZZLE PIPE SIZE (IN) NO. OF PASSES				1 PASS		2 PASS				3 PASS			
	1	2	3	D	S	U	S	T	U	V	S	T	U	V
B	10	8	6	530	540	781	697	354	730	791	724	445	781	781
I	14	10	8	594	565	848	724	330	740	879	749	467	841	841
O	16	12	10	695	619	975	791	340	870	1029	822	498	962	962
U	18	14	10	724	894	1056	1081	589	962	1105	1122	760	932	991
Y	24	20	16	1016	1014	1411	1278	567	1340	1516	1329	799	1272	1392

CONDENSER 1-PASS	
IN	OUT
11	16
16	11



(2-PASS RETURN HEAD)

CONDENSER 2-PASS	
IN	OUT
12	13
17	18

CONDENSER 3-PASS	
IN	OUT
15	20
19	14

COND SHELL CODE	1-PASS		2-PASS			3-PASS	
	H	K	H	J	K	H	K
A	533	251	425	152	197	425	197
B[6]	572	267	508	267	235	508	235
C,D	610	283	495	162	229	495	229
E,F	622	292	565	178	251	565	251
I[6]	686	324	572	292	267	572	267
J,K,L	686	318	584	191	260	584	260
M,N	813	378	660	203	305	660	305
O[6]	768	362	654	343	305	654	305
P,Q	813	368	711	241	318	711	318
R,S	813	368	762	305	343	762	343
T,V,W	914	419	762	279	343	762	343
U[6]	813	381	711	362	330	711	330
X,Z	914	422	813	279	371	813	356
Y6	1035	489	921	527	432	921	432

NOTES:
1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 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 1.6 mm raised face), water flanged nozzles are optional (add 13 mm 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 waterboxes on one heat exchanger may be used with Marine Waterboxes on the other heat exchanger.
4. Condenser water must enter the waterbox through the bottom connection for proper operation of the sub-cooler to achieve rated performance.
5. Add dimension "M" as shown on page 57 for the appropriate isolator type.
6. Heat recovery units offer marine waterbox option for tower (lower) bundle only.

Weights - SI

TABLE 23– APPROXIMATE UNIT WEIGHT INCLUDING MOTOR[2]

SHELLS	COMPRESSOR	SHIPPING WEIGHT (KGS.)	OPERATING WEIGHT (KGS.)	EST. REFRIGERANT CHARGE (KGS.) [1]
A-A	Q3	5,942	6,804	376
C-B	Q4	8,175	10,126	692
C-C	Q3, Q4	6,768	8,138	554
C-C	Q5	6,954	8,324	554
D-D	Q3, Q4	7,809	9,571	738
D-D	Q5	7,995	9,757	738
E-E	Q3, Q4	8,142	10,052	776
E-E	Q5,Q6,Q7,P7	8,328	10,238	776
E-I	Q7	10,690	13,328	819
F-F	Q5,Q6,Q7,P7	8,491	10,832	987
G-E	P8	9,208	10,977	903
H-F	P8,P9	10,478	12,701	1,184
J-J	P8,P9	10,886	13,200	1,157
L-L	P8,P9	12,429	15,377	1,436
K-K	H9	12,941	16,329	1,327
K-K	K1	14,107	16,420	1,473
K-O	H9	15,641	20,310	1,479
M-M	H9	15,513	19,777	1,662
M-M	K1,K2	17,373	21,364	1,662
M-U	K2	20,493	26,316	1,606
N-N	K1,K2	18,549	23,043	1,916
N-N	K3	21,773	24,540	1,916
P-P	K1,K2	18,824	23,542	1,749
Q-Q	K1,K2	20,548	25,764	1,930
Q-Q	K3	20,865	27,307	1,930
R-R	K3	23,950	31,888	2,087
R-R	K4	24,041	32,024	2,087
S-S	K4	26,762	34,609	2,184
S-V	K4	27,261	36,877	2,480
X-T	K4	26,853	36,288	2,421
X-X	K4	29,937	39,463	2,665
W-W	K7	36,061	47,174	3,630
Z-Y	K7	43,196	55,799	3,255
Z-Z	K7	36,515	47,628	3,168

[1] Refrigerant charge quantity and weights will vary based on tube count.

[2] Refer to product drawings for detailed weight information.

TABLE 24 – APPROXIMATE UNIT WEIGHT INCLUDING MOTOR

UNIT WITH HYBRID FALLING FILM EVAPORATOR

SHELLS	COMPRESSOR	SHIPPING WEIGHT (KGS.)	OPERATING WEIGHT (KGS.)	EST. REFRIGERANT CHARGE (KGS.) [1]
A-A	Q3	5,829	6,540	315
C-C	Q3, Q4	6,609	7,642	397
C-C	Q5	6,804	7,837	397
D-D	Q4	7,711	9,095	535
D-D	Q5	7,897	9,281	535
E-E	Q5,Q6,Q7,P7	8,482	9,843	508
F-F	Q5,Q6,Q7,P7	8,718	10,497	642
G-E	P8, P9	9,362	10,903	599
H-F	P8, P9	10,678	12,738	805
K-K	H9	13,086	15,458	826

[1] Refrigerant charge quantity and weights will vary based on tube count and configuration. Use for reference only.

TABLE 25 – EVAPORATOR MARINE WATERBOX WEIGHTS (KGS.) (TO BE ADDED TO STANDARD UNIT WEIGHTS SHOWN ON TABLE 23)

EVAP. CODE	SHIPPING WEIGHT INCREASE - KGS.			OPERATING WEIGHT INCREASE - KGS.		
	1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS
A	419	337	444	666	584	690
C,D	613	505	671	1,009	901	1,067
E,F	852	572	943	1,532	1,252	1,624
G,H	550	588	587	1,204	1,242	1,241
J,K,L	794	836	842	1,753	1,794	1,800
M,N	1,946	924	1,878	3,418	1,481	2,858
P,Q	2,115	1,021	2,107	3,514	1,581	3,353
R,S,W	2,179	1,225	2,228	3,866	2,048	3,714
X,Z	3,215	1,660	3,286	5,240	2,498	5,100

TABLE 26 – CONDENSER MARINE WATERBOX WEIGHTS (KGS.) (TO BE ADDED TO STANDARD UNIT WEIGHTS SHOWN ON TABLE 23)

COND. CODE	SHIPPING WEIGHT INCREASE - KGS.			OPERATING WEIGHT INCREASE - KGS.		
	1-PASS	2-PASS	3-PASS	1-PASS	2-PASS	3-PASS
A	346	257	367	578	489	600
B	712	396	761	958	496	939
C,D	429	353	474	767	691	813
E,F	329	368	359	606	781	772
I	937	485	922	1,369	642	1,242
J,K,L	467	529	522	1,047	1,110	1,103
M,N	1,119	603	1,054	2,206	1,110	2,078
O	1,354	655	1,355	2,012	985	1,805
P,Q	1,678	843	1,702	2,976	1,421	2,717
R,S	1,726	883	1,796	3,020	1,449	2,881
V,T,W	2,357	1,163	2,361	4,155	1,820	3,728
U	1,652	859	1,637	2,427	1,159	2,164
X,Z	2,649	1,339	2,440	4,491	2,109	3,674
Y	4,125	2,160	4,109	6,045	2,959	5,465

Guide Specifications

GENERAL

Furnish and install where indicated on the drawings____ YORK YK Centrifugal Liquid Chilling Unit(s). Each unit shall produce a capacity ____ tons, cooling ____ GPM of ____ from ____ °F to ____ °F when supplied with ____ GPM of condenser water at ____ °F. Power input shall not exceed ____ kW with an IPLV (NPLV) of ____. The evaporator shall be selected for a ____ fouling factor and a maximum liquid pressure drop of ____ ft. The 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. The waterside shall be designed for 150 psig working pressure. Power shall be supplied to the compressor motor at ____ volts- 3 phase-60 Hertz and controls at 115 volts -1-phase-60 Hertz.

Or

Furnish and install where indicated on the drawings ___ YORK YK Centrifugal Liquid Chilling Unit(s). Each unit shall produce a capacity of kW, cooling ____ l/s of ____ from ____ °C to ____ °C when supplied with ____ l/s of condenser water at ____°C. Power input shall not exceed ____ kW with an IPLV (NPLV) of ____. The evaporator shall be selected for ____m^2 C/W fouling factor and maximum liquid pressure drop of ____kPa. The waterside shall be designed for 10.3 barg working pressure. The condenser shall be selected for ____ fouling factor and maximum liquid pressure drop of ____ kPa. The waterside shall be designed for 10.3 barg working pressure. Power shall be supplied to the compressor motor at ____ volts - 3-phase-50 Hertz and controls at 115 volts -1-phase-50 Hertz.

(Or)

FOR DOUBLE BUNDLE HEAT RECOVERY UNIT:

In cooling mode, each unit shall produce a capacity of ___ tons, cooling ____ gpm of _____ from _____ °F to _____ °F when supplied with ____ gpm of condenser water at _____°F. Power input shall not exceed ___ KW with an NPLV of _____. The cooler shall be selected for _____ fouling factor and a maximum liquid pressure drop of _____ ft. The waterside shall be designed for ____ psig working pressure. The condenser shall be selected for _____ fouling factor and maximum liquid pressure drop of _____ ft. Tower condenser bundle water side shall be designed for psig working pressure.

In heating mode, each unit shall produce a capacity of ___ tons, cooling ____ gpm of _____ from _____ to _____ °F while providing heating through the heat recovery bundle of ____ gpm of _____ from _____ °F to _____ °F . Power input shall not exceed ____ kW. The heat recovery bundle shall be selected for _____ fouling factor and maximum liquid pressure drop of ____ ft. Heating condenser bundle water side shall be designed for ____ psig working pressure.

Power shall be supplied to the compressor motor at ___ volts – __ phase - __ Hertz and controls at ____ volts – __ - phase - __ Hertz.

Or

In cooling mode, each unit shall produce a capacity of ___ kW, cooling ____ l/s of _____ from _____ °C to _____ °C when supplied with ____ l/s of condenser water at _____°C. Power input shall not exceed ___ kW with an NPLV of _____. The cooler shall be selected for _____ fouling factor and a maximum liquid pressure drop of _____ kPa. The waterside shall be designed for ____ barg working pressure. The condenser shall be selected for _____ fouling factor and maximum liquid pressure drop of _____ kPa. Tower condenser bundle waterside shall be designed for ___ barg working pressure.

In heating mode, each unit shall produce a capacity of ___ tons, cooling ____ l/s of _____ from _____ to _____ °C while providing heating through the heat recovery bundle of ____ l/s of _____ from _____ °C to _____ °C . Power input shall not exceed ____ kW. The heat recovery bundle shall be selected for _____ fouling factor and maximum liquid pressure drop of ____ kPa. The heating condenser bundle water side shall be designed for ____ barg working pressure.

Power shall be supplied to the compressor motor at ___ volts – __ phase - __ Hertz and controls at ____ volts – __ - phase - __ Hertz.

Performance shall be certified or rated in accordance with the latest edition of AHRI Standard 550/590 as applicable. Only chillers that are listed in the AHRI Certification Program for Water Chilling Packages Using the Vapor Compression Cycle are acceptable.

Each unit shall be completely factory packaged including evaporator, condenser, sub cooler, compressor, open motor, lubrication system, OptiView Control Center, Variable Speed Drive or Solid-State Starter, and all interconnecting unit piping and wiring. The chiller shall be painted prior to shipment.

The initial charge of oil and refrigerant shall be supplied factory charged in the chiller or shipped in containers and cylinders for field installation.

COMPRESSOR

The 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 (16.2 barg)

working pressure and hydrostatically pressure tested at a minimum of 352 psig (24.3 barg). The rotor assembly shall consist of a heat treated steel alloy drive shaft and impeller shaft with 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.

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 as a double bellows, double-seal, cartridge type. A gravity-fed oil reservoir shall be built into the top of the compressor to provide lubrication during coastdown in the event of a power failure.

(Fixed Speed Drive) Capacity control shall be achieved by use of pre-rotation vanes to provide fully modulating control from full load to minimum load. (Variable Speed Drive) Capacity control shall be accomplished by the Adaptive Capacity Control (ACC), providing optimal relationship between compressor speed and inlet pre-rotation vane position for maximum energy efficiency. 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 ECWT at all load conditions as outlined on the equipment schedule. An external electric actuator shall automatically control pre-rotation vane position.

LUBRICATION SYSTEM

Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external variable speed oil pump. The oil pump shall vary oil flow to the 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 coastdown. Compressor shall have an auxiliary reservoir to provide lubrication during coastdown in the event of a power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP oil pump and a 3000 watt oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be listed as part of the chiller by a nationally recognized testing laboratory and shall be factory air strength tested at 1.1 times design working pressure.

Oil shall be filtered by an externally-mounted 1/2 micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via refrigerant cooled oil cooler, with all piping factory-installed. Oil side of the oil cooler shall be provided 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.

WATER-COOLED OIL COOLER

Optional condenser water-cooled oil cooler is offered for units with Q3 compressors only. The four tube pass and one shell pass oil cooler is by API Basco, Model 05036 (shell diameter 5" OD, tube length 36"). The shell is steel pipe or tubing and tube sheets are steel to ASME specification. Bafflers are precision hot-rolled, punched, carbon steel to assure effective circulation by providing minimum clearances between the tubes and tube holes. The cooler is a straight-tube type and has 180 plain copper tubes of 1/4" OD with 24 BWG.

The heat exchanger has either cast iron bonnets to be used for 150 psig (10.3 barg) condenser waterboxes or carbon steel bonnets to be used for 300 psig (20.6 barg) condenser waterboxes. Condenser water is the cooling medium and water circulation is obtained by the water pressure drop across the condenser shell. The minimum requirement of 7 to 8 gpm (0.4 to 0.5 l/s) water for this oil cooler is provided at a pressure drop as low as 3ft with the Q3 piping arrangement.

MOTOR DRIVELINE

The compressor motor shall be an open drip proof, squirrel cage, induction type operating at 3570 rpm for 60Hz operation and 2975 rpm for 50 Hz operation.

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

The motor drive shaft shall be directly connected to the compressor shaft with a flexible disc coupling. 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 electro-mechanical starters, 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. (For units furnished with factory-packaged Solid-State Starters or Variable Speed Drive, refer to the "**Options**" section.)

Guide Specifications - continued

EVAPORATOR

Evaporator shall be a shell and tube type, hybrid falling film (evaporator codes A* to K*) or flooded type (evaporator codes M* to Z*) designed for a minimum of 180 psig (12.4 barg) on H & K compressor models, 235 psig (16.2 barg) on P & Q compressor models; 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 1, 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" (~1 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. (3.7 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 hybrid falling film evaporator design has suction baffles around the sides and above the falling film section to prevent liquid refrigerant carryover into the compressor. Flooded evaporator designs have a suction baffle on M shells with H9 compressors and an aluminum mesh eliminator on K - Z shells with K compressors located above the tube bundle to prevent liquid refrigerant carryover into the compressor. The evaporator shall have a refrigerant relief device sized to meet the requirements of the ASHRAE 15 Safety Code for Mechanical Refrigeration.

Waterboxes shall be removable to permit tube cleaning and replacement. Stub-out water connections having ANSI/AWWA C-606 grooves to ANSI/AWWA C-606 Standard for Grooved End Shoulder Joints shall be provided. Waterboxes shall be designed for 150 psig (10.3 barg) design working pressure and be tested at 225 psig (15.5 barg). Vent and drain connections with plugs shall be provided on each waterbox. 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.

CONDENSER

Condenser shall be of the shell-and-tube type, designed for a minimum of 235 psig (16.2 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, are welded to the end of each shell. Intermediate tube supports, fabricated from carbon steel plates, are drilled and reamed to eliminate sharp edges. 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" (~1 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. (3.7 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.

(Option) The condenser shall be provided with positive shutoff valves in the compressor discharge line to the condenser and in the liquid line leaving the condenser. This will allow pumpdown 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.

Waterboxes shall be removable to permit tube cleaning and replacement. Stubout water connections having ANSI/AWWA C-606 grooves shall be provided. Waterboxes shall be designed for 150 psig (10.3 barg) design working pressure and be tested at 225 psig (15.5 barg). Vent and drain connections with plugs shall be provided on each waterbox.

REFRIGERANT FLOW CONTROL

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

OPTIVIEW CONTROL CENTER

General – The chiller shall be controlled by a stand-alone, microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

Control Panel – The control panel shall include a 10.4-in. (264 mm) 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. The panel verbiage is available in eight languages as standard and can be changed on the fly without having to turn off the chiller. Data shall be displayed in either English or Metric units. Smart Freeze Point Protection shall run the chiller at 36°F (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. When needed, Hot Gas Bypass is available as an option.

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:

1. System operating information including:
   - A. Return and leaving chilled water temperature
   - B. Return and leaving condenser water temperature
   - C. Evaporator and condenser saturation temperature
   - D. Differential oil pressure
   - E. Percent motor current
   - F. Compressor discharge temperature
   - G. Oil reservoir temperature
   - H. Compressor thrust bearing positioning and oil temperature
   - I. Operating hours
   - J. Number of unit starts
2. Digital programming of setpoints through the universal keypad including:
   - A. Leaving chilled water temperature
   - B. Percent current limit
   - C. Pull-down demand limiting
   - D. Six-week schedule for starting and stopping the chiller, pumps and tower
   - E. Remote reset temperature range
3. Status messages indicating:
   - A. System ready to start
   - B. System running
   - C. System coastdown
   - D. System safety shutdown – manual restart
   - E. System cycling shutdown – auto restart
   - F. System pre-lube
   - G. Start inhibit
4. The text displayed within the system status and system details field shall be displayed as a color-coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.
5. 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 with a fixed speed drive shall include:
   - A. Evaporator – low pressure
   - B. Evaporator – transducer or leaving liquid probe
   - C. Evaporator – transducer or temperature sensor
   - D. Condenser – high pressure contacts open
   - E. Condenser – high pressure
   - F. Condenser – pressure transducer out-of-range
   - G. Auxiliary safety – contacts closed
   - H. Discharge – high temperature
   - I. Discharge – low temperature
   - J. Oil – high temperature
   - K. Oil – low differential pressure
   - L. Oil – high differential pressure
   - M. Oil – sump pressure transducer out-of-range
   - N. Oil – differential pressure calibration
   - O. Oil – variable speed pump – pressure setpoint not achieved
   - P. Control panel – power failure
   - Q. Motor or starter – current imbalance
   - R. Thrust bearing – proximity probe clearance (K compressors only)
   - S. Thrust bearing – proximity probe out-of-range (K compressors only)
   - T. Thrust bearing – position switch (P, Q & H9 compressors)
   - U. Watchdog – software reboot

Guide Specifications - continued

5.1 Safety shutdowns with a VSD shall include:

A. VSD shutdown – requesting fault data
B. VSD – stop contacts open
C. VSD – 105% motor current overload
D. VSD – high phase A, B, C inverter heat-sink temp.
E. VSD – high converter heat-sink temperature

(Filter Option Only)

F. Harmonic filter – high heat-sink temperature
G. Harmonic filter – high total demand distribution

6. 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 with a fixed speed drive shall include:

A. Multi-unit cycling – contacts open
B. System cycling – contacts open
C. Oil – low temperature differential
D. Oil – low temperature
E. Control panel – power failure
F. Leaving chilled liquid – low temperature
G. Leaving chilled liquid – flow switch open
H. Motor controller – contacts open
I. Motor controller – loss of current
J. Power fault
K. Control panel – schedule
L. Starter – low supply line voltage (SSS option)
M. Starter – high supply line voltage (SSS option)
N. Proximity probe – low supply voltage (K compressors)
O. Oil – variable speed pump – drive contacts open

6.1 Cycling shutdowns with a VSD shall include:

A. VSD shutdown – requesting fault data
B. VSD – stop contacts open
C. VSD – initialization failed
D. VSD – high phase A, B, C instantaneous current
E. VSD – Phase A, B, C gate driver
F. VSD – single phase input power
G. VSD – high DC bus voltage
H. VSD – pre charge DC bus voltage imbalance
I. VSD – high internal ambient temperature
J. VSD – invalid current scale selection
K. VSD – low phase A, B, C inverter heat-sink temp.
L. VSD – low converter heat-sink temperature
M. VSD – pre-charge – low DC bus voltage
N. VSD – logic board processor
O. VSD – run signal
P. VSD – serial communications

(Filter Option Only)

Q. Harmonic filter – logic board or communications
R. Harmonic filter – high DC bus voltage
S. Harmonic filter – high phase A, B, C current
T. Harmonic filter – phase locked loop
U. Harmonic filter – pre-charge – low DC bus voltage
V. Harmonic filter – DC bus voltage imbalance
W. Harmonic filter – 110% input current overload
X. Harmonic filter – logic board power supply
Y. Harmonic filter – run signal
Z. Harmonic filter – DC current transformer 1
AA. Harmonic filter – DC current transformer 2

7. 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.
8. 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.
9. 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 10 years with power removed from the system.
10. A fused connection through a transformer in the compressor motor starter to provide individual overcurrent protected power for all controls.
11. A numbered terminal strip for all required field interlock wiring.
12. An RS-232 port to output all system operating data, shutdown/cycling message, and a record of the last 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.
13. The capability to interface with a building automation system via hard-wired connections to each feature to provide:

A. Remote chiller start and stop

B. Remote leaving chiller liquid temperature adjust
C. Remote current limit setpoint adjust
D. Remote ready to start contacts
E. Safety shutdown contacts
F. Cycling shutdown contacts
G. Run contacts

VARIABLE SPEED DRIVE

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 adaptive capacity control logic shall automatically adjust motor speed and compressor prerotation 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 (10.3 barg) working pressure.

The following features shall be provided: a door interlocked circuit breaker, capable of being padlocked; U.L. 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 of IEEE Std. 519 1992 shall be provided. The filter shall be unit mounted within the same NEMA 1 enclosure and shall be U.L. 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.

FACTORY-INSTALLED COMPRESSOR MOTOR STARTER [OPTION THROUGH 900 HP (671 KW) 200 600 VOLTS]

The chiller manufacturer shall furnish a reduced voltage Solid-State Starter for the compressor motor. Starter shall be factory mounted and wired on the chiller. The starter shall provide, through the use of silicon-controlled rectifiers, a smooth acceleration of the motor without current transitions or transients. The starter enclosure shall be NEMA 1, with a hinged access door with lock and key. Electrical lugs for incoming power wiring shall be provided.

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

Display Only

- 3-phase voltage A, B, C
- 3-phase current A, B, C
- Input Power (kW)
- kW Hours
- 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; 115-volt control transformer; three-leg sensing overloads; phase rotation and single-phase failure protection; high temperature safety protection; motor current imbalance and under volt-

age safeties; open and close SCR protection; momentary power interruption protection. The Solid-State Starter 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 (10.3 barg) working pressure.

(Optional) Unit-mounted circuit breaker includes ground fault protection and provides 65,000 amps. Short circuit withstand rating in accordance with U.L. Standard 508. A non-fused disconnect switch is also available. Both options are lockable.

FACTORY-INSTALLED COMPRESSOR MOTOR STARTER (2300V & 4160V/3/60Hz or 3300V/3/50Hz-Unit Mounted for H9 compressor or larger only)

The chiller manufacturer shall furnish a reduced-voltage, Medium Voltage Solid-State Starter, in accordance with the chiller manufacturer's starter specifications. The starter shall be of modular construction with complete access to all parts. The starter shall be tested and the design starting current and overload settings adjusted at the factory. The starter shall provide, through the use of six in-line (not inside the Delta) silicon controlled rectifiers (2 per phase), a smooth acceleration of the motor without current transitions or transients.

The following protective devices and convenience items shall be factory mounted and wired to the starter:

a. 3-leg sensing electronic overloads – shuts unit down if current exceeds 105% of FLA to protect the motor windings.
b. Phase rotation protection circuit – denies start-up when detecting incorrect power wiring phase sequence to the starter which could cause reverse motor rotation and damage the equipment.
c. Single-phase failure protection circuit – ensures against motor burnout by shutting the unit down if power loss occurs in any of the incoming lines during start-up.
d. High temperature safety protection system – temperature activated switches on heat sinks will shut the unit down if the SCR temperature exceeds acceptable limits.
e. 3-phase digital ammeter and digital voltmeter readout via control center – easily cross-check design current and voltage limitations against supply characteristics.
f. Starter mounted load break rated input disconnect switch with interlocked padlockable handle. Positive disconnecting means shall be visible from outside the enclosure, in operator area. All doors shall be interlocked with the disconnecting means.
g. Open/Shorted SCR Protection – Failed semiconductor devices are automatically detected and reported via the Control Center.
h. Power Fault Protection – momentary power interruption protection detects power interruptions within 3 line cycles and interrupts power to the compressor motor within 1 additional line cycle.
i. Electrical connections – these tin-plated or copper bus bars provide easy connection to incoming copper power lines.
k. Wattmeter – An instantaneous wattmeter tells the customer how much power the chiller is consuming. A kilowatt-hour energy meter is also provided to measure power consumption over a period of time.
l. Shut down History – The Medium Voltage Solid-State Starter shall provide the system control panel with ten histories of previous unit shutdowns initiated by the starter.

In addition, the Starter shall include as standard, the following convenience items already mounted and wired to the starter at the factory:

- Auxiliary control supply transformer – eliminates the need for running separate 115V - 1 ph - 50/60 Hz power source wiring to the chiller Control Center.

REMOTE ELECTRO MECHANICAL COMPRESSOR MOTOR STARTER (OPTION)

A remote electro mechanical starter of the R-1132 type shall be furnished for each compressor motor. The starter shall be furnished in accordance with the chiller manufacturer's starter specifications and as specified elsewhere in these specifications.

PORTABLE REFRIGERANT STORAGE/RECYCLING SYSTEM

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.

EFFICIENCY

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

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

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

$$\text{COP} = \frac{\text{kW refrigeration effect}}{\text{kW input}}$$

kW / ton and COP are related as follows:

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

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

FOULING FACTOR

ENGLISH L-P (FT^2 °F HR/BTU)	EQUIVALENT SL METRIC (M^2 K/KW)
0.0001	**0.018**
0.00025	**0.044**
0.0005	**0.088**
0.00075	**0.132**

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