McQuay International

a member of DAIKIN group

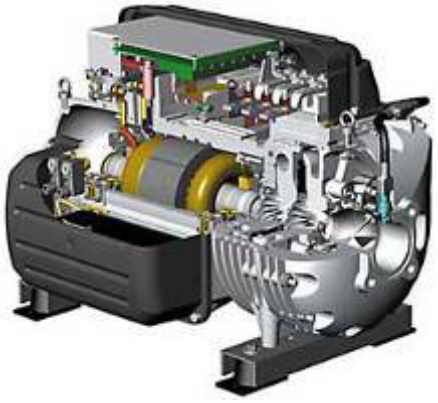
Magnitude™ Frictionless Centrifugal Chillers Catalog 602-1

Model WMC • 145 to 400 tons • 500 to 1400 kW

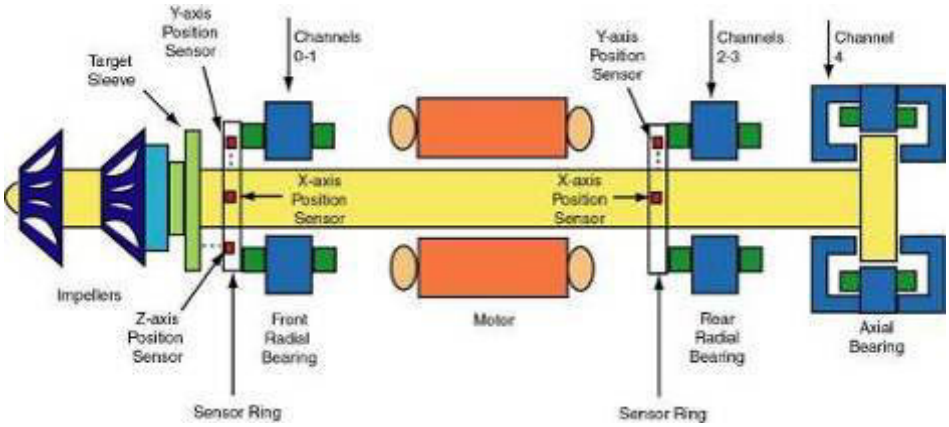
R-134a • 3/60/460 • 3/50/400

Engineered for flexibility and performance™

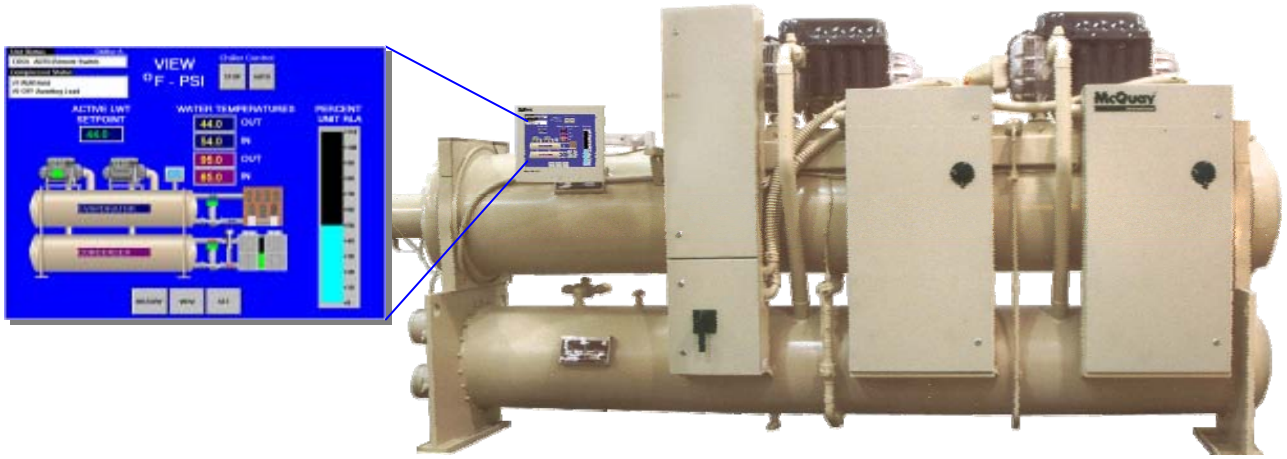
Cutaway View of Magnetic Bearing Compressor



Compressor Major Running Gear Components



MicroTech II® Controller Operator Interface, Home Screen



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*Unit Controllers are LONMARK certified with an optional LONWORKS communication module

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Manufactured in an ISO Certified Facility

The New Compressor Technology

Next Generation Centrifugal – Here Today

The industry's next generation of centrifugal chillers is here today with McQuay Magnitude chillers. The new technology begins with centrifugal compressors utilizing frictionless magnetic bearings for oil-free operation, integral variable-frequency drives, and high-speed direct drive technology. The high efficiency compressor is matched with highly efficient heat exchange vessels to make an impressive chiller. The control system is based on McQuay's MicroTech family to provide the optimum chiller control system. We invite you to look at how the features and benefits compare to older compressor technologies.

Benefit Summary

- **Highest Efficiency**- in its size range; as low as 0.33 kW/ton.
- **Increased Reliability** This frictionless magnetic bearing design needs no oil management system. With no oil to coat the heat transfer surfaces, a gain in heat exchanger efficiency can be realized.
- **Ultra Quiet** A compressor sound level as low as 73 dBA, with virtually no structure-borne vibration, eliminates the need for expensive sound attenuation accessories.
- **Easy to handle** The compressor weight of 264 lbs. (120 kg.) is less than 20% of the weight of competitive compressors and approximately 50% smaller, so it can mount on lighter and smaller frames.
- **Smart refrigerant choice** The compressor is optimized for HFC 134a, the positive pressure refrigerant with no phase-out schedule and no ozone depletion.
- **Smart controls** Onboard digital electronics provide smart controls. The compressor is totally self-correction and incorporates a system of sophisticated self-diagnostics, monitoring and controls.
- **Safe power interruption** In the event of a power failure, the compressor motor acts as a generator, providing power for the bearing control system during coast down. It also has a system to gently de-levitate the shaft.

The Compressor Technology

The advanced, magnetic bearing, permanent magnet synchronous motor technology used in Magnitude chillers offers many owner benefits.

Totally Oil-Free Operation

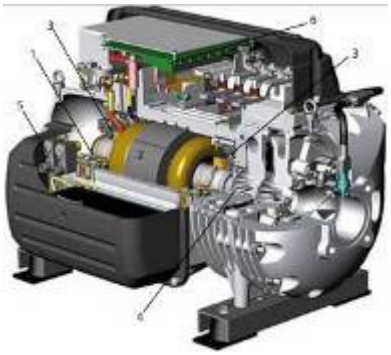
The friction losses and the oil management hardware and controls associated with conventional oil-lubricated bearings are now totally eliminated.

Modern magnetic bearing technology enables outstanding energy efficiency and reliable, long-life frictionless operation.

The compressor's one moving part (rotor shaft and impellers) is levitated during rotation by a digitally controlled magnetic bearing system consisting of two radial and one axial magnetic bearing. Position sensors at each magnetic bearing provide real-time feedback to the bearing control system.

Figure 1, Compressor Cutaway

1. Magnetic Bearings and Bearing Sensors
2. Permanent Magnet Synchronous Motor
3. Touchdown Bearings
4. Shaft and Impellers
5. Compressor Cooling
6. VFD



VFD = Ultra-Low IPLV

The well-proven energy performance advantages of large central plant type variable-speed centrifugal chiller compressors now benefit mainstream, middle-market applications through the use of high-speed, centrifugal compression with integral variable-speed drive.

The compressor speed reduces as the condensing temperature and/or cooling load reduces, optimizing energy performance through the entire operating range. Movable inlet guide vanes redirect gas flow into the first stage impeller during low loads, after the compressor has reached minimum speed.

Ultra-Smart

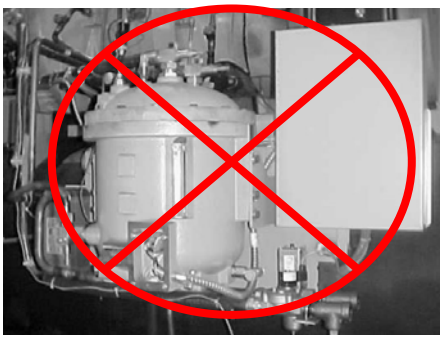
The chillers utilize digital control electronics to proactively manage unit operation and providing control of external chilled water and cooling tower pumps.

Greater Reliability

Oil Handling Equipment Removed

With magnetic bearings operating in a magnetic electrical field instead of oil lubricated ball or roller friction type bearings as the basis of design, the oil handling equipment is removed.

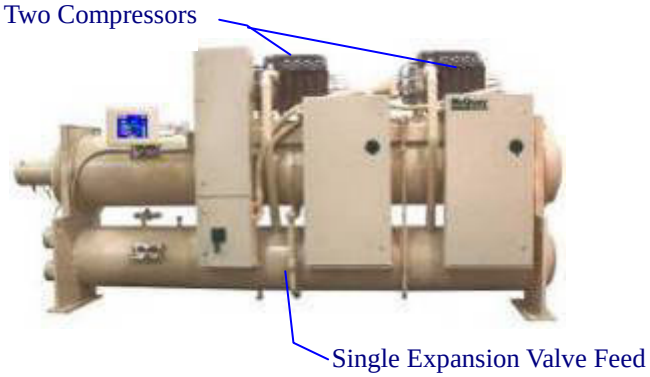
There is no need for oil pumps, oil reservoirs, controls, starter, piping, heaters, oil coolers, oil filters, water regulating valves or oil relief valves that are needed to maintain oil quality. These devices can be a source of problems in traditional chillers, and removing them significantly increases unit reliability.



Dual Compressors - One Refrigerant Circuit

All Magnitude chillers, except Model WMC 145S, have two compressors on a common refrigerant circuit, greatly improving system reliability. In the event of a mechanical or electrical problem, one of the two compressors will continue to operate until repairs can be made. The chiller can continue to provide up to sixty percent of full load tons.

The two compressors in a single refrigerant circuit are one of the secrets for the tremendous part-load efficiency. At part load, where most of the operating hours occur, the entire vessel surface is active providing extremely efficient operation.



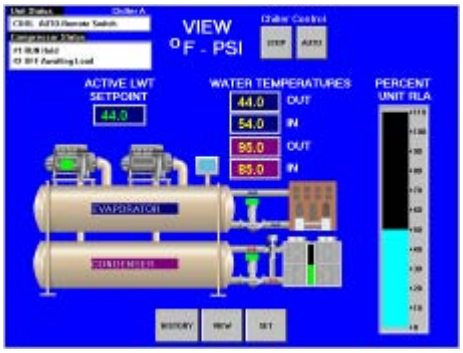
Exceptional Control

User-Friendly Touch Screen Panel

Every Magnitude chiller is provided with the user-friendly operator interface touch screen panel mounted on the moveable positioning arm for easy viewing and operation.

View chiller status, clear faults and change parameters by merely touching the screen.

For added convenience, the unit operating and maintenance manual is viewable on the screen and can be downloaded and printed via the USB port located in the control panel.



Flexible BAS Interface Modules

Every Magnitude chiller with MicroTechII controls and the Open Choices™ feature can be provided with LONWORKS®, BACnet®, or Modbus® communications modules for an easy, low cost connection to the building automation system of your choice. Expensive and complex interface gateways are not required.

Modules can also be easily retrofitted after installation.

Variable Frequency Drives

Compressor unloading and subsequent chiller capacity reduction is accomplished by a compressor-mounted variable frequency drive. It operates in conjunction with the inlet guide vanes.

The VFDs are an important factor in providing the tremendous energy savings at part load operation.

Low Operating Costs

Shrink Your Utility Costs with Ultra Efficient Part-Load Performance

The Magnitude chiller Integrated Part Load Value (IPLV) is as low as 0.375 kW/Ton. Compare this with most screw compressor chillers - approximately 0.575 kW/Ton. There is a potential for up to 40% energy savings at part load compared to other chillers.

Virtually Eliminate Maintenance Costs

With oil removed from the system, oil samples, oil change-outs, oil system maintenance, oil filter changes are eliminated. The bearing system, shafting and impellers are shown here.

Environmental Responsibility

Long Term Refrigerant Solution

The Magnitude chiller uses R-134a refrigerant, which does not have a phase-out date and does not attack the ozone layer.

Ultra Quiet Sound Levels

The Magnitude chiller is the quietest chiller in the industry for its size range. It is perfect for sound sensitive applications, with sound pressure levels as low as 75 dBA at one meter from the unit and 75% load.

The best way to appreciate how quiet these units are is to hear one operate. It is important to compare the sound data in this catalog to other offerings. Remember that a sound pressure difference of only two to three dBA is a very noticeable difference. A number of owners have asked for a large indicating light on the unit so they can tell when it's on!

Extremely Low Vibration Levels

As a result of the high-speed design, the compressor vibration levels are extremely low, minimizing vibration that could be transmitted to the structure.

The unit is shipped with rubber mounting pads and spring vibration isolators are not required.

Unit Control Features

Magnitude Chillers Feature MicroTech

It is only fitting that the world's most revolutionary chiller design be matched with the advanced McQuay MicroTech control technology to give you the ultimate in chiller performance and control. The control includes many energy-saving features and interface enhancements not found in any other unit controller system on the market today. MicroTech controller's innovative design will help keep your chiller running efficiently . . . day in, day out, for years to come.

Control Architecture

The Magnitude chiller takes advantage of McQuay's 30 years of experience in designing and manufacturing their highly regarded WDC line of conventional, dual centrifugal compressor chillers. Distributed control components provide flexibility and redundancy.

The operator interface panel has a 15-inch Super VGA touch-screen, utilizing graphics to provide clear and concise information on the chiller status, (see page 10) alarms, trends, and setpoint adjustment. Should the touch-screen become inoperable, the unit and compressor controllers will continue uninterrupted operation of the chiller.

The unit controller minds those functions that are common to the chiller as a whole (pumps, cooling tower, valves, etc.) and is the interface point for BAS connection and other control inputs to the chiller, as well as outputs such as operation of the electronic expansion valve.

Each of the two compressor controllers is dedicated to a compressor and controls its operation, as well as providing data for use by other system component.

Figure 2, Major Control Components

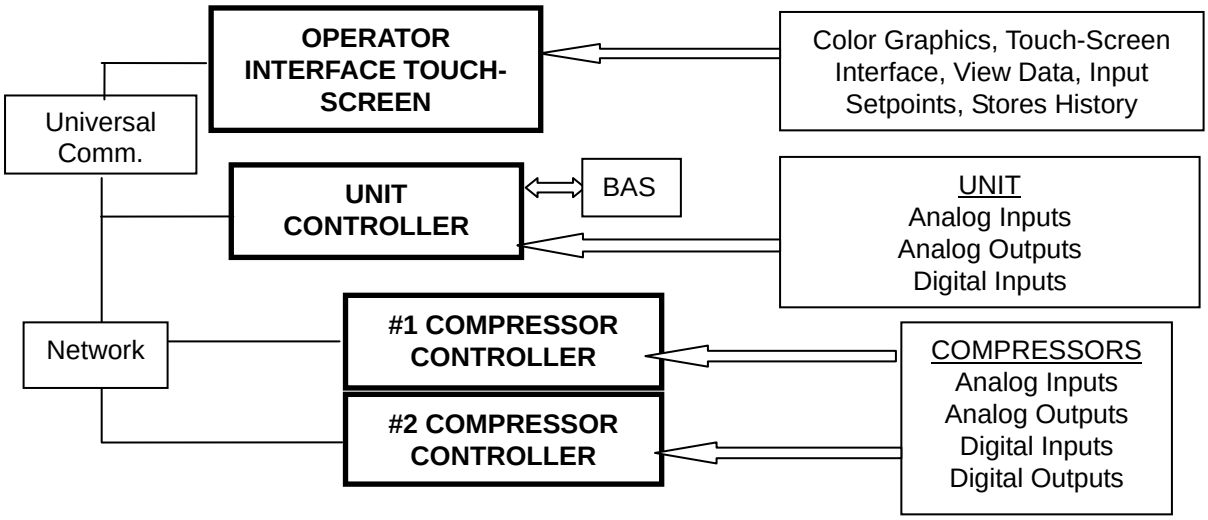
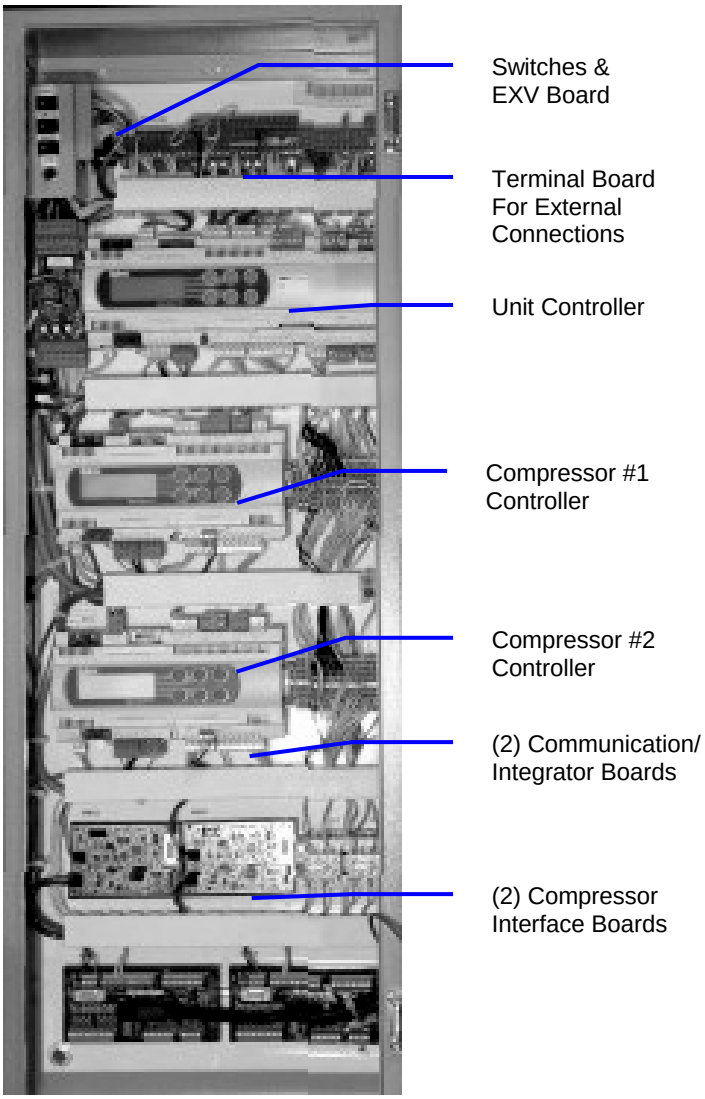


Figure 3, Control Panel

The controls and power equipment are contained in NEMA 1 enclosures designed for indoor use. The control system of the Magnitude chiller consists of two major components: the unit control panel, as shown to the right, and the operator interface panel as shown on the extreme left of the unit featured on the cover. Note that the touch screen panel is on an adjustable arm so that it can be positioned comfortably for the operator. The control panel contains a USB port for downloading the unit's fault history, major parameter trends, and the unit operating manual that is stored in the microprocessor. These design features built into this control system optimize ease of operation, reliability, and efficient operation.

The photo to the right shows the unit's control panel with the two compressor controllers below and the unit controller mounted above them. The unit controller is responsible for functions involving the entire unit (controlling the electronic expansion valve, for instance) and is the interface point for devices and signals external to the unit. The compressor controllers' job is to operate and control the compressors. A terminal strip is provided for connection of external input signals such as load limit and reset commands and output signals such as alarms and cooling tower commands.



MicroTech® II Control Features and Benefits

FEATURE	BENEFIT
Easy integration into Building Management System via McQuay's exclusive Open Choice™ communication module	Designer can select any BAS supplier using standard open protocols and know the MicroTech II control will interface with it.
Easy to read, adjustable, 15 inch, Super VGA color touch screen operator interface	Operators can observe chiller operation at a glance and easily select various data screens and change setpoints
Historic trend data-downloadable	Water temperatures, refrigerant pressures, and motor load plots can provide valuable information for energy conservation
Precise ± 0.2 °F chilled water control	Provides stability in chilled water system
Proactive pre-shutdown correction of "unusual conditions" allows chiller to stay	Activates alarm and modifies chiller operation to provide maximum possible cooling
Automatic control of chilled water and condenser water pumps	Integrated lead/lag and automatic engagement of backup pump
Controls up to four stages of tower fans and modulation of tower fan and/or bypass valve	Optimum integrated, efficient, control of cooling tower water based on system conditions
Twenty-five previous alarm descriptions are stored in memory	Valuable asset for trouble shooting
Operating and maintenance manual	Information instantly available (downloadable) for the life of the unit.
Multiple language capability metric, in-lb	Valuable for world-wide applications

Designed with the Operator in Mind

Reliable, economic use of any chiller depends largely on an easy operator interface. That's why operation simplicity was one of the main considerations in the development of the MicroTech controller. The operator's interface with the chiller is through a 15-inch, Super VGA color monitor with touch-screen capability. The operator can clearly see the entire chiller graphically displayed with the key operating parameters viewable on the screen. Pressing a single on-screen button will access the set screens where setpoints can be reviewed and changed, if necessary. Other screens, such as alarm history, are easily accessed through touch screen buttons. See the following page for some typical screens.

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

The MicroTech controller's memory retains a record of faults and the time/date stamp. The controller's memory (no batteries required) can retain and display the cause of the current fault and the last twenty-five fault conditions. This method for retaining the fault is extremely useful for trouble shooting and maintaining an accurate record of unit performance and history. The controller features a two-level password security system to provide protection against unauthorized use.

The Home Screen shown in Figure 4 is usually used as the primary viewing screen. It provides real time data on unit status, water temperatures, chilled water set point and motor amp draw. In other words, it very clearly answers the vital question; is the chiller doing what it is supposed to do?

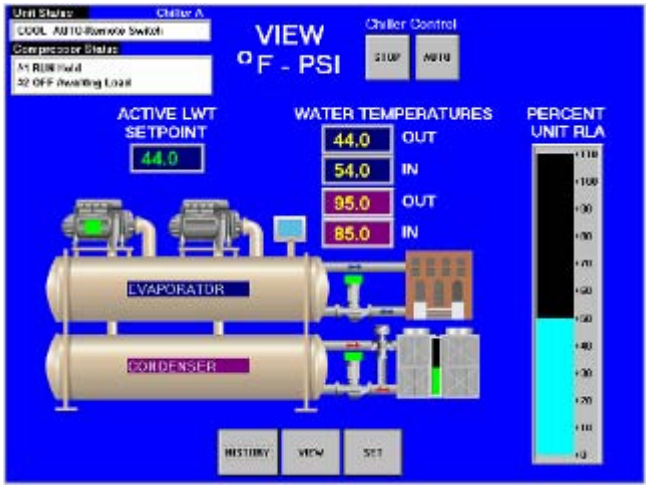


Figure 4, MicroTech II Home Screen

If an alarm occurs, a red button appears on the screen (a remote signal is also available). Pressing this button immediately accesses the Active Fault Screen that gives complete fault information. The problem can be fixed and the fault can be quickly and easily cleared at this point.

Changing Setpoints

The mystery of changing set points is a thing of the past. Look at how easy the job becomes with the McQuay MicroTech. For example, to change the chilled water set point, press SET from any screen, then press the WATER button and this screen appears, press button #1, Leaving Water Temperature, and you are ready to input a new value. Selected setpoints can also be changed by the BAS.

Figure 5, MicroTech II Setpoints Screen

Trend Logging

Ever wonder how your chiller performed last week? Were you holding the required chilled water temperature? What kind of cooling load did the chiller have?

The McQuay MicroTech controller can record and plot water temperatures, refrigerant pressures, and motor load in order to trend performance. These values can also be downloaded through a convenient USB port in the control panel, and exported into a spreadsheet for further evaluation and record purposes.

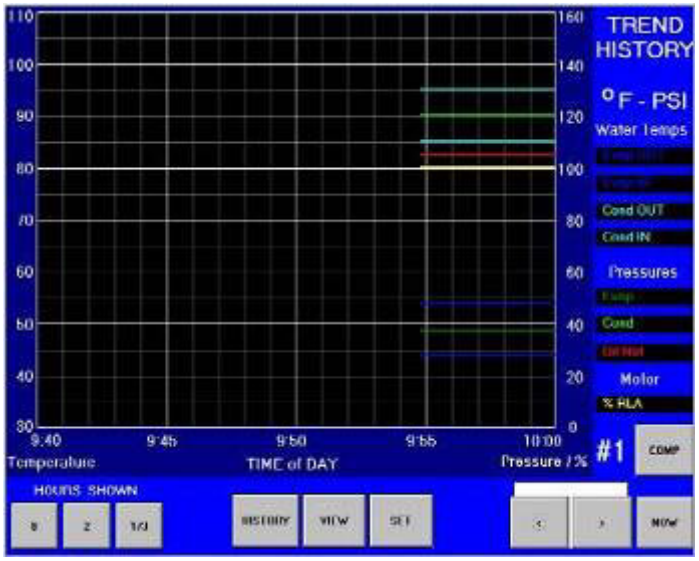


Figure 6, Trend Logging Screen

MicroTech Controller Increases Chiller Operating Economy

Many standard features have been incorporated into MicroTech control in order to maintain the operating economy of McQuay centrifugal chillers. In addition to replacing normal relay logic circuits, we've enhanced the controller's energy saving capabilities with the following features:

- Direct control of water pumps. Optically isolated, digital output relays provide automatic lead-lag of the evaporator and condenser pumps, permitting pump operation only when required.
- User-programmable compressor soft loading. Prevents excessive power draw during pull down from high unoccupied chilled water temperature conditions.
- Chilled-water reset. Accomplished directly on the unit by resetting the leaving water temperature based on the return water temperature. A remote 4-20 ma or 1-5 VDC BAS signal can also be used to reset the leaving water. Raising the chilled water setpoint during periods of light loads dramatically reduces electrical consumption.
- Demand limit control. Maximum motor current draw can be set on the panel, or can be adjusted from a remote 4-20 ma or 1-5 VDC BAS signal. This feature controls maximum demand charges during high usage periods.
- Condenser water temperature control. Capable of four stages of tower fan control plus an optional analog control of either a three-way tower-bypass valve or variable speed tower-fan motor. Stages are controlled from condenser-water temperature. The three-way valve can be controlled to a different water temperature or track the current tower stage. This allows optimum chilled water plant performance based upon specific job requirements.
- Staging Options (Multiple Chiller Installations). Lead-lag and load-balance: the MicroTech II controller is capable of compressor lead-lag decisions and balancing compressor loads between two compressors on one unit or two separate Magnitude chillers, using defaults or operator defined staging. For example, in the 30 to 60 percent load segment, one compressor running on each of two chillers will provide better efficiency than two compressors running on one chiller.
- Plotting Historic Trends. Past operation of the chiller can be plotted as trend lines and even downloaded to spread sheets for evaluation - a valuable tool for optimizing efficiency.

Versatile Communications Capabilities Give You Even More Control

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

1. Direct entry and readout locally at the operator interface panel on the unit.
2. Direct entry as above plus digital and analog input/output signals for certain functions such as: enable run input, alarm signal output, 4-20 ma or 0-5 VDC inputs for chilled water reset and load limiting, pump and tower fan control, analog output for variable speed fan and tower bypass.
3. Interface with BACnet, LONWORKS, or Modbus.
4. Direct communication between two Magnitude chillers.

Building Automation Systems

All MicroTech II controllers are capable of communications providing seamless integration and comprehensive monitoring, control, and two-way data exchange with industry standard protocols LonTalk® or BACnet™ or Modbus™.

Open Choice Benefits

- Easy to integrate into your building automation system supplier of choice
- Factory- or field-installed communications module
- Provides efficient equipment operation
- Integrated control logic for factory options
- Easy-to-use local user interface
- Owner/designer can select the BAS that best meets building requirements
- Comprehensive data exchange

Figure 7, Sample System Architecture

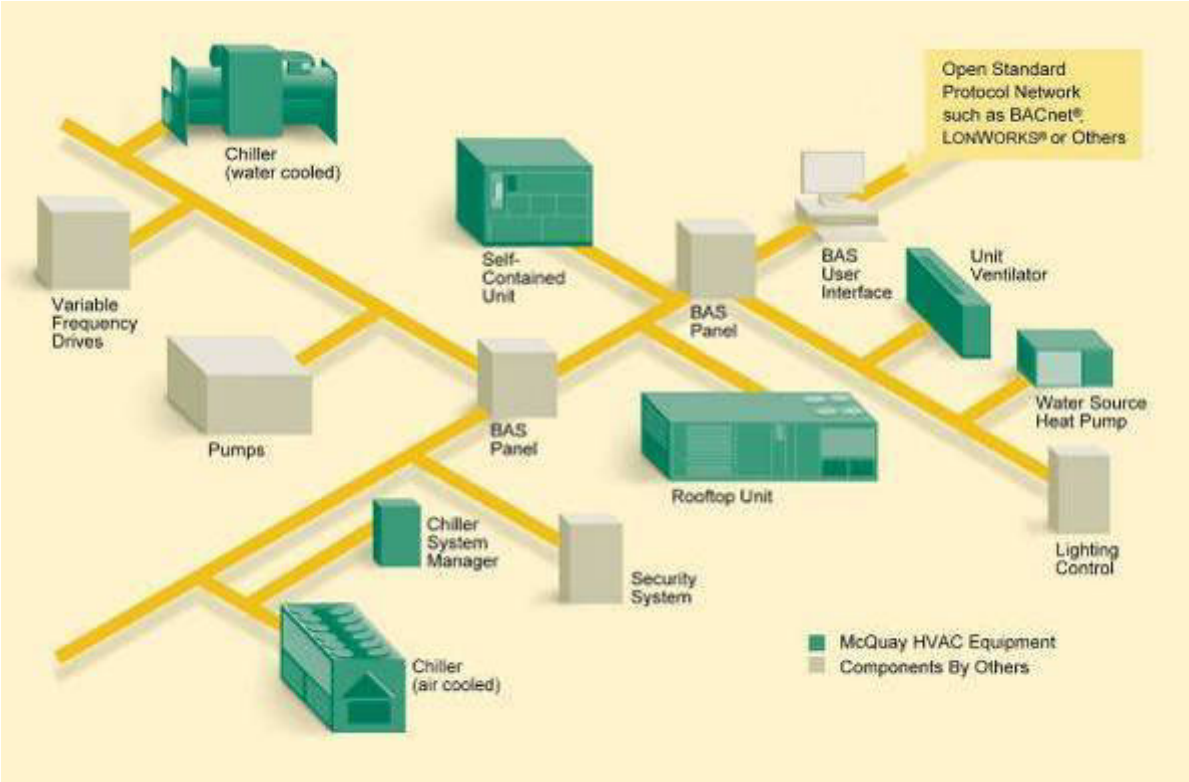


Table 1, Typical Data Point Availability

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

Notes: Data points available are dependent upon options selected

Network Protocol Options

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

Unit Design Features

Variable Frequency Drive

Efficiency: The standard variable frequency drive is a technology that has been used for decades to control motor speed on a wide variety of motor-drive applications. When applied to centrifugal compressor motors, significant gains in part load performance can be realized. The improvement in efficiency and reduction of annual energy cost is maximized when there are long periods of part load operation, combined with low compressor lift (lower condenser water temperatures).

The attributes of VFD drives and the efficient dual centrifugal chiller produces one of the industry's most efficient chiller based on the all-important IPLV value. See “IPLV/NPLV Defined” on page 15 for details on the ARI IPLV efficiency rating.

Starting Inrush: The use of a VFD on centrifugal chillers also provides an excellent method of reducing motor starting inrush-even better than "solid state" starters. Starting current can be closely controlled since both the frequency and voltage are regulated. This can be an important benefit to a building's electrical distribution system. The low inrush feature, combined with two one-half size compressors having a staggered start, is particularly attractive where chillers will be asked to operate on emergency generators. Since inrush has much to do with sizing the generators, much smaller generators can be used.

HFC-134a

McQuay Positive Pressure Design:

- **No Purge**
- **No Vacuum Prevention System**
- **No Contaminants**

HFC-134a operates above atmospheric pressure in the entire refrigerant circuit and at normal temperatures. All McQuay centrifugal chillers use a positive pressure refrigerant, with the following benefits:

- No absorption of impurities into the refrigerant circuit
- No breakdown of motor insulation, refrigerant or lubricant
- No increase in operating cost due to displacement of heat transfer surface by non-condensables
- No crevice corrosion and tube failure due to moisture in the system
- No annual service expense to maintain and rebuild purge unit
- No abnormal annual service expense for oil, filter, and refrigerant replacement
- No periodic emissions of refrigerant into the atmosphere

Heat Exchangers

McQuay Magnitude chillers are equipped with high performance heat exchangers. The unique design greatly increases heat transfer and reduces unit footprint and refrigerant charge. Vessels are designed, constructed and tested in accordance with ASME Section VIII, ASHRAE Standard 15 requirements and TEMA recommendations.

The replaceable water tubes are internally rifled and externally enhanced copper, and are mechanically bonded to steel tube sheets. Standard tubes are 0.025-inch wall thickness. Consult factory for other options.

Vessels are available for 1, 2 or 3 pass water flow. A 3/4" or 1-1/2 thick layer of vinyl/nitrate polymer evaporator insulation is optional. All seams are glued to form an effective vapor barrier. Detailed information on the insulation can be found under “Physical Data” on page 29.

Pumpdown

Pumpout systems provide a means to collect and contain the refrigerant charge without loss when access to internal chiller components is required for service.

McQuay condensers and evaporators are sized to hold the entire unit refrigerant charge when not more than 90% full and at 90°F (32°C) ambient temperature. They are equipped with valves in the compressor discharge lines, suction lines, and in the liquid line. These valves, coupled with the vessel design, satisfy the stringent requirements of the U.S. Department of Transportation for refrigerant shipping containers, as well as ASME vessel codes. When service is required, the refrigerant charge can be pumped down into either the condenser or evaporator by compressor operation and use of a refrigerant transfer unit.

Elimination of the cost and space requirements of an external pumpout system on most jobs is a major McQuay advantage.

Electronic Expansion Valve

Controlled refrigerant flow over the entire capacity range saves energy and dollars. Cooling loads and condenser water temperatures can change constantly. On Magnitude chillers, a modern electronic expansion valve meters refrigerant flow in direct response to the unit controller input, which looks at unit kW and lift (discharge minus suction pressure) to set the valve position. The controller then balances suction superheat and liquid subcooling to reach the optimum efficiency, regardless of changing load or condensing temperatures. In doing so, full utilization of compressor, evaporator, and condenser efficiency over the entire operating range is achieved.

Flow Switch

All chiller units must be provided with flow switches for the evaporator and condenser. McQuay furnishes factory-installed and wired, thermal dispersion-type flow switches as standard equipment on Magnitude chillers. This eliminates the expense of field mounting and wiring conventional paddle or differential pressure switches.

The flow switches prevent the unit from starting without sufficient water flow through the vessels. They also serve to shut down the unit in the event that water flow is interrupted to guard against evaporator freeze-up or excessive discharge pressure.

Additionally, for a higher margin of protection, normally open auxiliary contacts in the pump starters can be wired in series with the flow switches as shown in the Field Wiring Diagram.

Factory Performance Test

Fast and trouble free startup and operation. *All* McQuay centrifugal chillers are factory-tested on ARI certified microprocessor-controlled test stands. The test stand microprocessors interface with the chiller MicroTech II controls, allowing monitoring of all aspects of the test stand and chiller operation.

The test procedure starts with dehydration and evacuation of the refrigerant circuit and charging with refrigerant. This is followed by a run test at job conditions of flow and temperature. Compressors must meet a stringent vibration limit and the entire unit must pass a moisture limit of 30 ppm.

The testing helps ensure correct operation prior to shipment and allows factory calibration of chiller operating controls.

Optional Certified Test

A McQuay engineer oversees the testing, certifies the accuracy of the computerized results, and translates the test data onto an easy-to-read spreadsheet. The tests are run to ARI tolerance of capacity and power. 50 Hertz units are tested using an on-site 50 Hertz generator.

Optional Witness Test

A McQuay engineer oversees the testing in the presence of the customer or their designate and translates the test data onto an easy-to-read spreadsheet. It takes two to three hours of test time per load point specified. Tests are run to ARI tolerances of capacity and power. 50 Hertz units are tested using an on-site 50 Hertz generator.

McQuay Factory Service Startup

All McQuay centrifugal chillers are commissioned by McQuay Factory Service personnel or by authorized McQuay startup technicians. This procedure helps assure that proper starting and checkout procedures are employed and helps in a speedy commissioning process.

Part Load Efficiency

According to ASHRAE, chillers usually spend 99% of their operating hours under part load conditions and most of this time at less than 60% of design capacity. One compressor of a dual chiller operates with the full heat transfer surface of the entire unit. For example, one 75-ton compressor on a 150-ton dual chiller utilizes 150 tons of evaporator and condenser surface. This results in very high unit efficiency and also increases the compressor's capacity.

The inclusion of VFDs, as standard, to the dual compressor chiller can produce astonishing ARI Certified IPLVs, in the range of 0.375 kW/ton. Specific selections can vary up or down from this example.

Compliance with ASHRAE Std. 90.1

With the Magnitude chiller capacity range of 145 to 400 tons, they fall into three ASHRAE Std. 90.1 efficiency groups and revisions.

Table 2, ASHRAE 90.1 Requirements (kW/ton)

Std. 90.1 Capacity Range	2007 through 2009		Starting 2010 (See Note)	
	Full Load	IPLV	Full Load-Path B	IPLV-Path B
< 150 Tons	0.703	0.669	0.639	0.450
≥ 150 Tons < 300 Tons	0.634	0.596	0.639	0.450
≥ 300 Tons < 600 Tons	0.576	0.549	0.600	0.400

NOTE: Beginning in 2010, the efficiency requirements will be divided into two groups, designated as Path A and Path B. Path B is essentially a new category for units with VFD compressor drives that by nature have excellent part load efficiencies. Magnitude units, with their built-in VFD, fall into Path B. The IPLV values for 2010 are close to 30 percent less than the 2007 equivalent value. Also beginning in 2010, the minimum efficiency values will be formula derived instead tabular so that they can take flows and temperatures other than ARI standard into account.

For 150 tons and larger, some care may be required in the system design to meet the full load requirement. The standard requires 0.633 kW/ton (5.55 C.O.P.) for both full load and the IPLV. The Magnitude's excellent part load performance easily meets the part load requirements with IPLV's as low as 0.365 kW/ton (approximately 40% lower than required). The unit will meet full load efficiency at the ARI standard rating point could slightly exceed the standard.

ARI Certification

McQuay International has an on-going commitment to supply chillers that perform as specified. To this extent, McQuay centrifugal chillers are part of the ARI Certification Program. On-going performance verification of chiller capacity and power input plus ARI certified computerized selection output provide the owner with specified performance in accordance with the latest version of ARI Standard 550/590.

All chillers that fall within the scope of the certification program have an ARI certification label at no cost to the owner. Equipment covered by the ARI certification program includes all water-cooled centrifugal and screw water chilling packages rated up to 2500 tons (8800 kW) at ARI standard rating conditions, hermetic or open drive, with electric driven motor not exceeding 5000 volts, and cooling water (not glycol).

Published certified ratings verified through testing by ARI include:

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

The ARI Standard 550/590 for Centrifugal or Screw Water-Chilling Packages and associated manuals define certification and testing procedures and performance tolerances of all units that fall within the application rating conditions.

Leaving chilled water temp.: 40°F to 48°F (44°F standard)

Entering condenser water temp.: 60°F to 95°F

Leaving chilled water temp.: 44°F

Evap. waterside field fouling allowance: 0.0001

Chilled water flow rate: 2.4 gpm/ton

Entering condenser water temp.: 85°F

Condenser waterside field fouling allowance: 0.00025

Condenser water flow rate: 3.0 gpm/ton

IPLV/NPLV Defined

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

Using kW/ton:

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

Where:

A = kW/ton at 100%
B = kW/ton at 75%
C = kW/ton at 50%
D = kW/ton at 25%

Or, using COP values:

$$IPLVorNPLV = 0.01A + 0.42B + 0.45C + 0.12D$$

Where:

A = COP at 100%
B = COP at 75%
C = COP at 50%
D = COP at 25%

Weighting

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

100% Load at 1%

75% Load at 42%

50% Load at 45%

25% Load at 12%

Note that the vast majority of hours are at the operating range where dual compressor chillers excel.

Tolerances

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

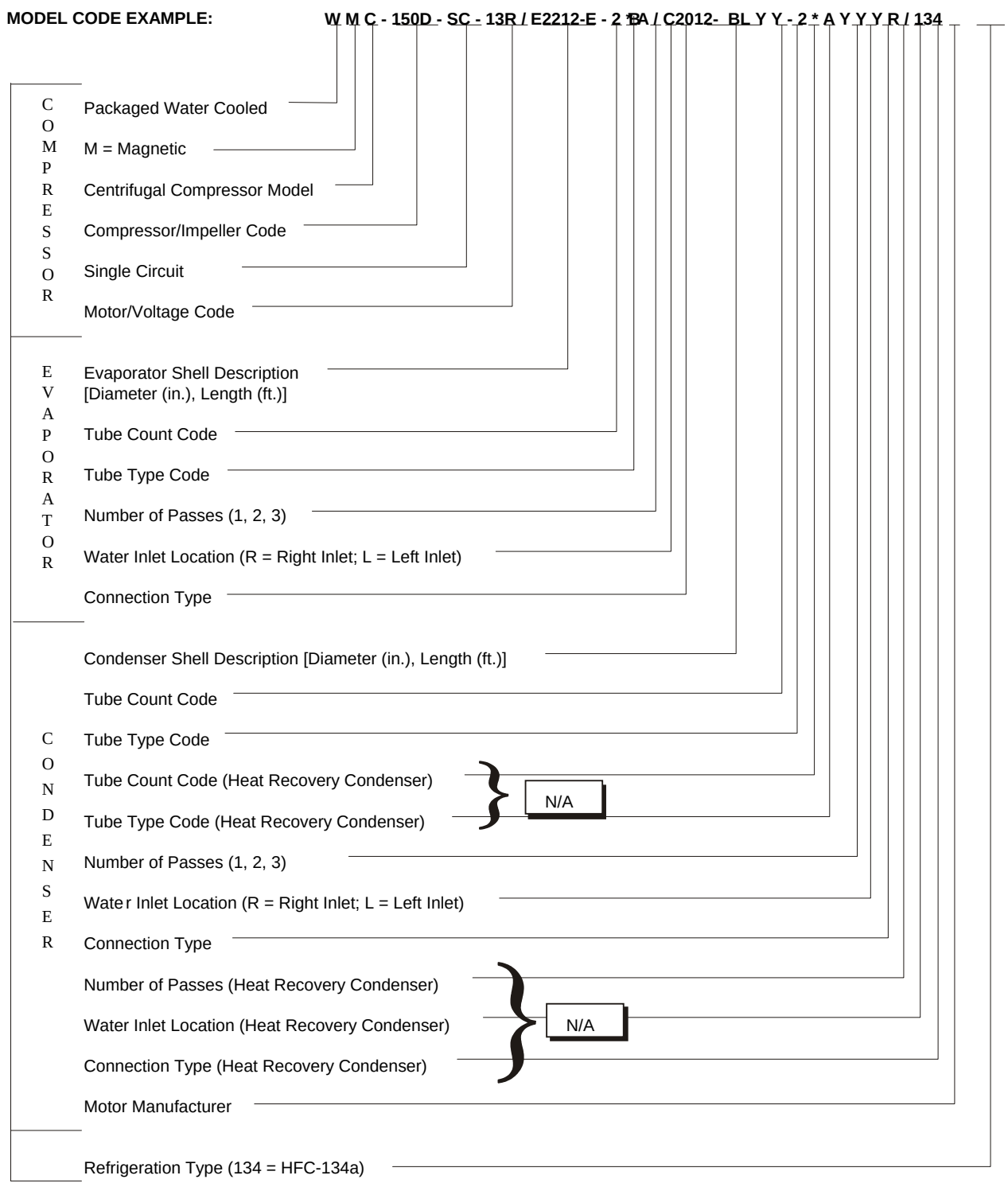
$$\%Tolerance = 10.5 - (0.07x\%FL) + \left(\frac{1500}{DTFLx\%FL}\right)$$

Where:
FL = Full Load
DTFL = Chilled Water Delta-T at Full Load
This formula results in a ±5% tolerance on tons and kW/ton at the 100% load point and ARI conditions.

Chiller Identification

Magnitude centrifugal chillers are selected by computer and identified by their components on the selection printout as a Model #. The unit model code is as follows:

Figure 8, Chiller Identification



Sound Data

The following sound pressure ratings are for measurements one meter from the unit and in accordance with ARI Standard 575. The ratings are for the various part loads shown and at the center bands. Note that there is a considerable lowering of sound level as the units unload. Ratings are "A" weighted measured at one-meter from the unit. The 25 percent values are with one compressor running.

Eight-Octave Band

Table 3, WMC 145S Sound Pressure (dB), 50/60 Hz

Percent Load	Octave Band								A-Weighted
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
100	37.0	50.0	61.0	67.0	74.5	71.5	73.0	75.5	80.5
75	39.5	49.0	60.5	66.0	72.5	69.0	71.0	72.0	78.0
50	37.0	47.5	60.0	64.5	66.5	68.0	69.5	68.0	75.0
25	38.0	50.0	58.0	66.5	68.5	70.0	69.5	70.0	76.5

Table 4, WMC 145D/150D, Sound Pressure (dB), 50/60 Hz

Percent Load	Octave Band								A-Weighted
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
100	37.5	49.5	56.0	65.0	72.0	70.0	66.5	64.0	75.5
75	39.5	48.5	55.0	61.0	69.5	64.5	64.0	60.0	72.5
50	35.5	48.0	54.5	58.0	66.0	61.0	58.5	53.5	68.5
25	36.0	48.5	54.5	57.5	65.5	60.5	57.5	52.0	68.0

Table 5, WMC 250D/290D, Sound Pressure (dB), 50/60 Hz

Percent Load	Octave Band								A-Weighted
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
100	37.5	51.5	59.5	72.0	75.0	72.5	76.5	75.0	81.5
75	37.0	50.5	62.5	66.5	70.0	69.5	74.0	70.5	78.0
50	37.5	50.0	60.0	65.0	65.5	66.0	71.5	66.0	75.0
25	37.5	49.0	59.0	63.0	65.0	66.0	69.5	64.0	73.5

Table 6, WMC 400D, Sound Pressure (dB), 50/60 Hz

Percent Load	Octave Band								A-Weighted
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
100	46.0	55.5	65.5	70.5	74.5	76.0	80.0	74.5	83.5
75	45.5	55.5	65.5	69.5	73.5	76.5	79.0	72.5	82.5
50	45.0	54.5	64.0	69.0	71.0	74.5	77.5	70.0	81.0
25	44.5	51.5	61.0	64.5	67.5	73.0	73.0	62.0	77.0

One-Third Octave Band

Table 7, WMC 145S, One-Third Octave Band Sound Ratings

Percent Load	Octave Band												
	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
100	33.5	32.0	30.5	38.0	46.5	46.5	49.0	59.0	56.0	60.5	63.0	63.0	69.5
75	34.0	36.0	33.0	39.0	45.0	45.5	49.5	58.5	54.5	58.5	60.0	63.5	71.0
50	31.5	33.5	31.5	37.5	44.5	43.5	48.0	58.5	54.0	53.0	57.0	63.5	58.0

25	32.0	32.5	34.5	37.0	47.0	46.5	49.5	55.5	53.0	55.0	59.0	65.0	59.5

Table 7, continued

Percent Load	Octave Band												A-Weighted
	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	
100	64.0	72.5	66.0	67.5	66.5	66.5	68.0	69.5	72.0	71.0	69.5	67.5	80.5
75	64.0	65.5	64.5	65.5	63.0	64.0	66.0	68.0	69.5	66.5	64.5	62.0	78.0
50	60.5	64.0	63.5	64.5	61.0	61.5	65.5	65.5	65.5	62.5	60.0	58.5	75.0
25	62.5	66.5	65.0	66.5	64.0	63.5	65.0	66.0	67.0	64.5	62.5	60.0	76.5

Table 8, WMC 145D/150D, One-Third Octave Band Sound Ratings

Percent Load	Octave Band											
	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
100	32.5	32.0	34.0	38.0	48.0	42.0	46.0	53.5	51.0	53.0	62.5	60.5	61.0
75	32.0	32.0	37.5	37.0	47.0	41.0	45.5	52.5	50.0	53.5	58.0	55.5	62.5
50	26.5	30.5	33.0	36.5	47.0	39.0	43.5	52.5	48.5	52.0	53.5	54.5	62.0
25	31.5	30.5	32.0	36.5	47.5	40.5	43.5	52.5	49.5	50.5	52.5	54.5	57.5

Table 8, continued

Percent Load	Octave Band												A-Weighted
	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	
100	70.5	65.0	68.0	62.0	63.0	62.5	61.0	61.5	60.0	59.0	59.0	58.0	75.5
75	67.5	61.5	59.5	58.5	60.5	59.0	60.0	58.0	55.0	54.0	56.5	57.5	72.5
50	57.5	62.5	57.0	55.5	55.5	54.5	55.5	50.0	48.0	45.5	51.0	50.5	68.5
25	63.5	58.0	56.5	56.0	54.0	53.5	54.0	49.5	48.0	45.0	47.5	48.0	68.0

Table 9, WMC 250D/290D, One-Third Octave Band Sound Ratings

Percent Load	Octave Band												
	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
100	32.0	32.5	33.0	38.0	49.0	47.5	50.5	56.0	56.0	70.0	65.5	65.0	71.0
75	32.0	32.5	32.5	37.5	48.0	46.0	48.5	54.0	61.5	60.5	58.0	64.0	63.0
50	33.0	33.0	32.0	37.0	48.5	43.5	47.5	53.0	58.5	52.5	57.5	64.0	57.5
25	33.0	33.0	31.5	35.5	48.0	42.0	45.5	56.0	56.0	49.5	58.5	61.0	59.0

Table 9, continued

Percent Load	Octave Band											A- Weighted
	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	
100	67.0	71.0	68.0	67.0	68.5	69.5	71.5	73.0	71.0	72.0	67.0	64.5	81.5
75	66.0	65.5	64.5	64.5	64.5	67.5	69.5	70.5	66.5	67.0	63.5	60.5	78.0
50	60.0	63.0	60.5	61.0	62.0	65.0	68.5	66.5	62.0	62.0	59.0	57.5	75.0
25	58.5	62.0	60.5	61.0	62.0	63.5	66.0	64.5	59.5	61.0	55.5	54.4	73.5

Table 10, WMC 400D, One-Third Octave Band Sound Ratings

Percent Load	Octave Band												
	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
100	36.0	42.5	42.5	45.5	52.0	52.0	56.0	60.0	63.5	64.5	65.5	67.0	69.5
75	35.5	42.5	42.0	45.5	51.5	52.0	55.5	60.0	63.5	64.0	65.0	65.0	70.5
50	34.0	41.5	42.0	43.5	49.0	52.5	56.0	61.5	58.5	63.5	65.0	64.0	66.0
25	34.0	41.5	41.0	41.5	45.5	50.0	57.0	55.5	55.5	58.5	59.0	61.0	62.0

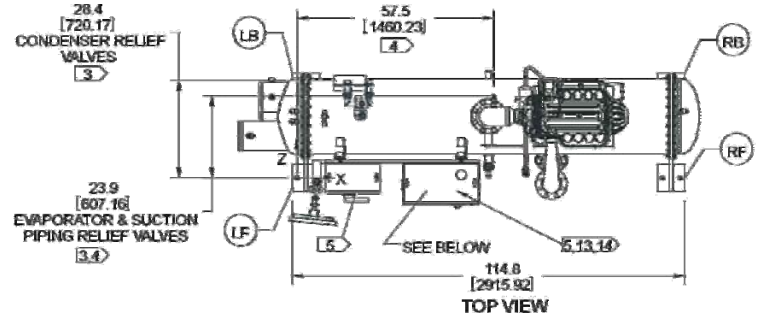
Table 11, Continued

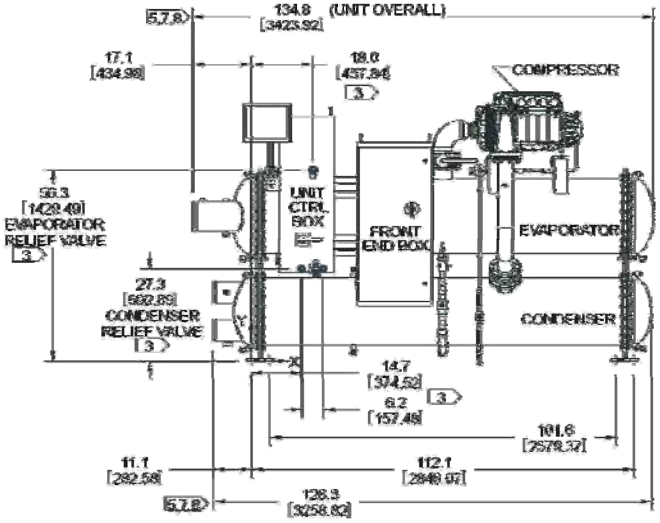
Percent Load	Octave Band											A-Weighted
	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	
100	71.0	68.5	70.0	72.0	72.0	72.0	75.0	77.5	71.5	69.5	66.0	63.0	83.5
75	68.0	67.5	69.5	71.0	73.5	72.0	74.5	75.5	69.5	68.0	65.0	61.5	82.5
50	65.5	66.5	68.0	69.0	71.5	70.0	73.0	74.5	67.0	65.0	63.5	57.5	81.0

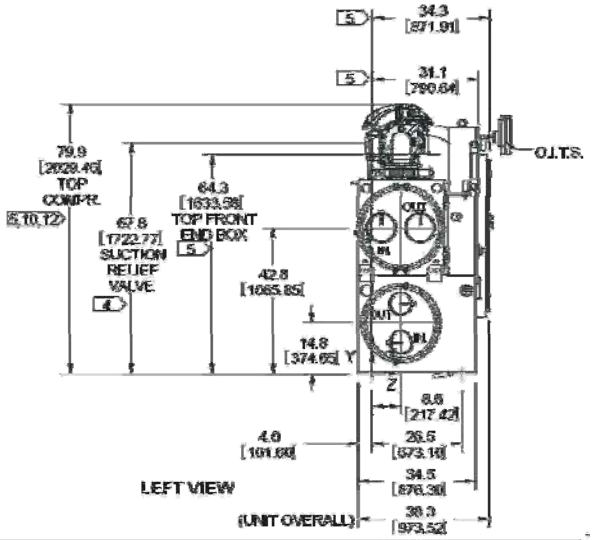
25	62.0	63.5	65.5	71.5	64.5	66.0	71.0	64.0	59.5	57.0	53.5	49.0	77.0

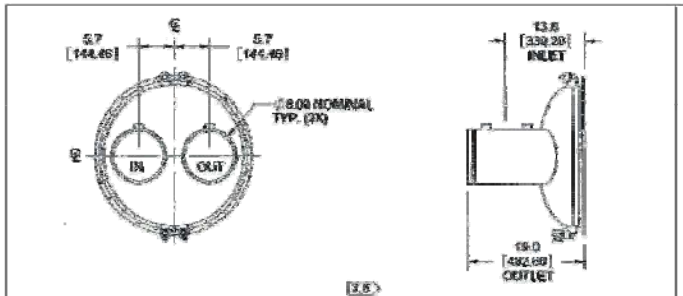
Dimensions

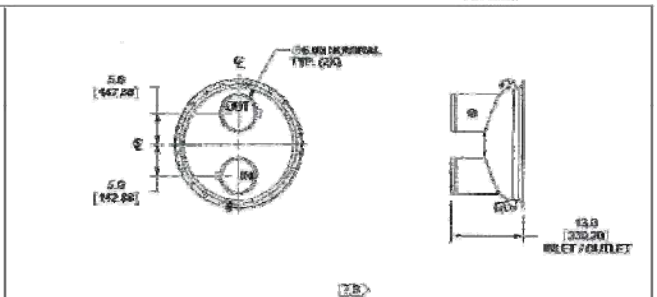
Figure 9, WMC 145S, 2-Pass (See page 28 for notes.)











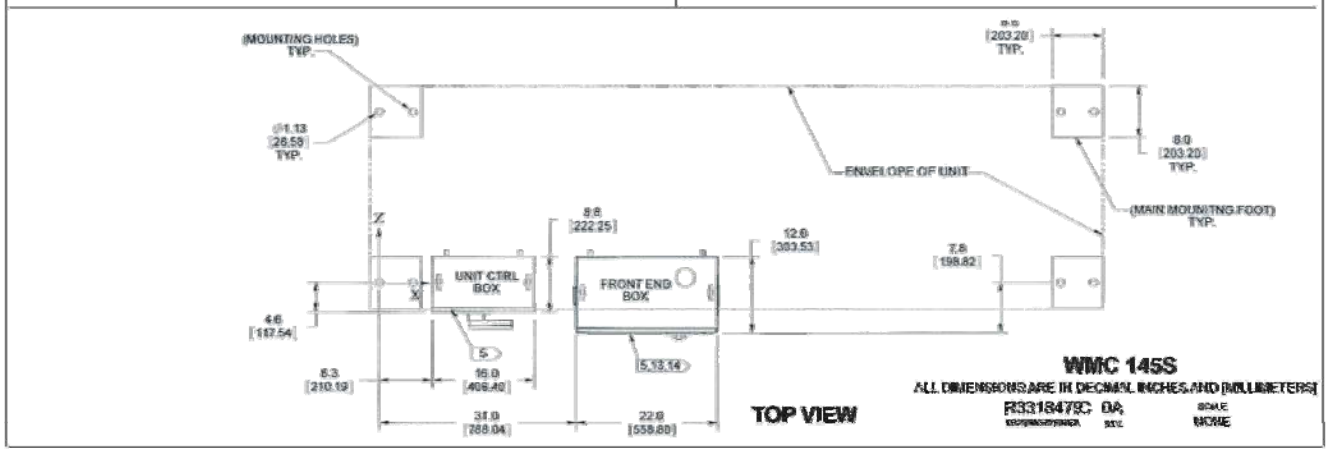
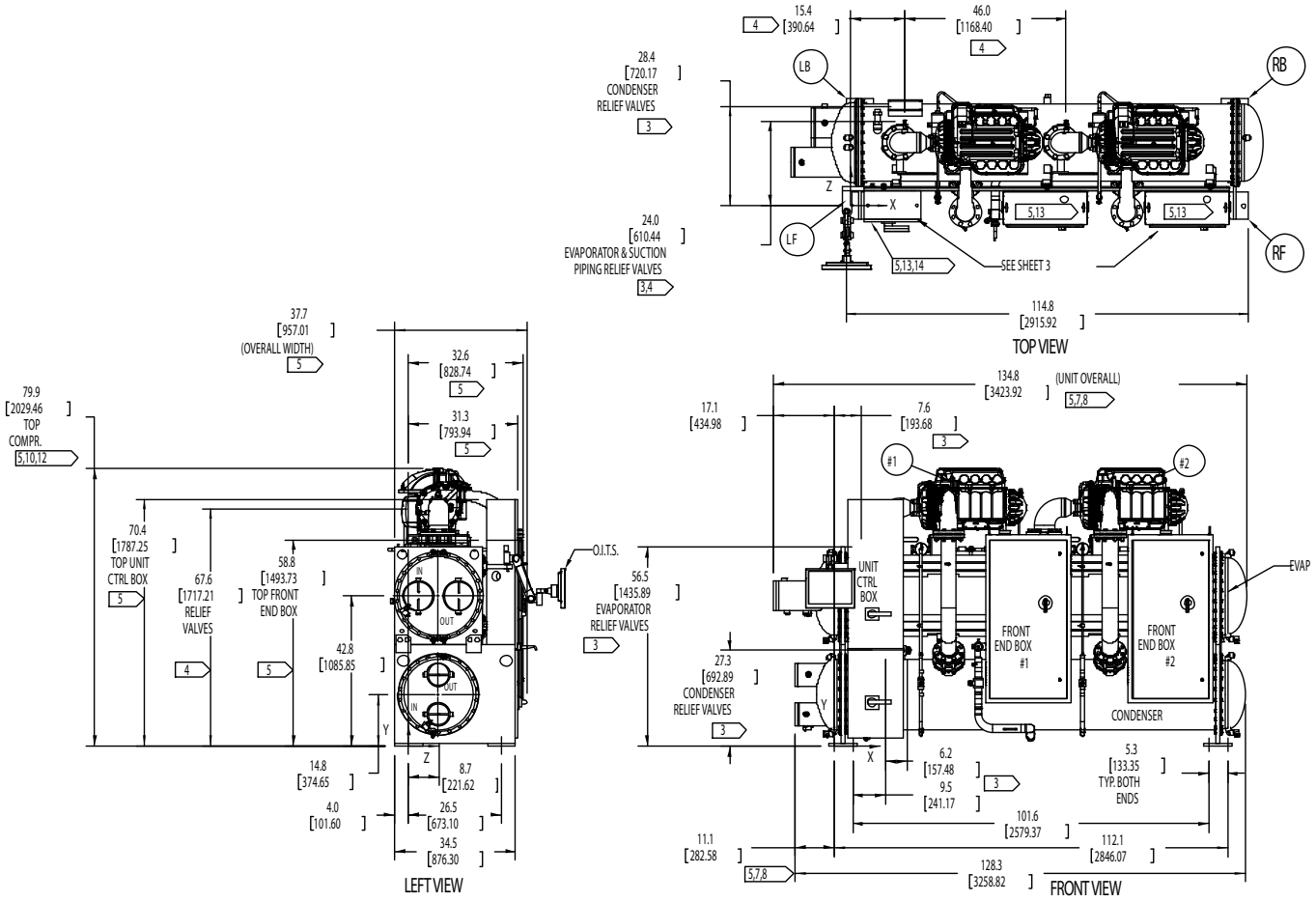
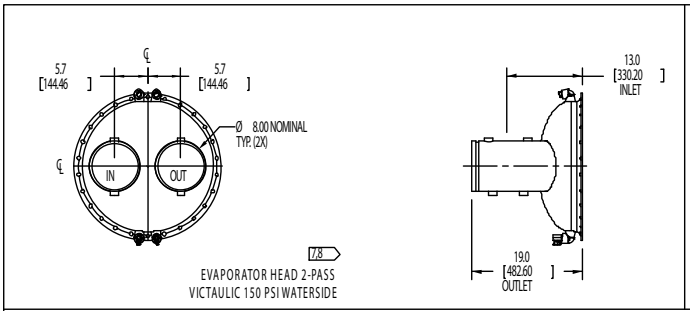
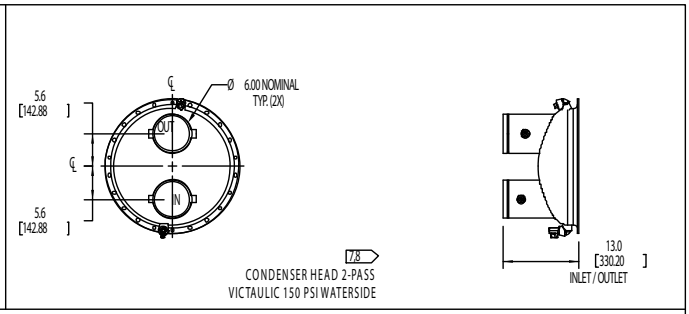


Figure 10, WMC 145D, 2-Pass (See page 28 for notes.)







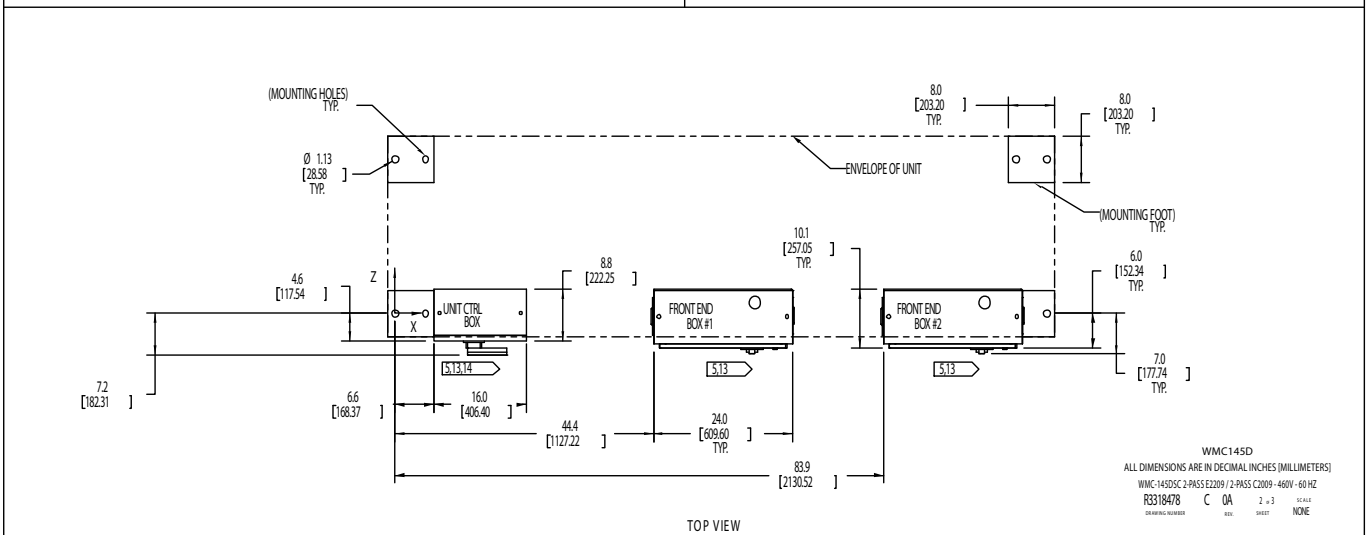
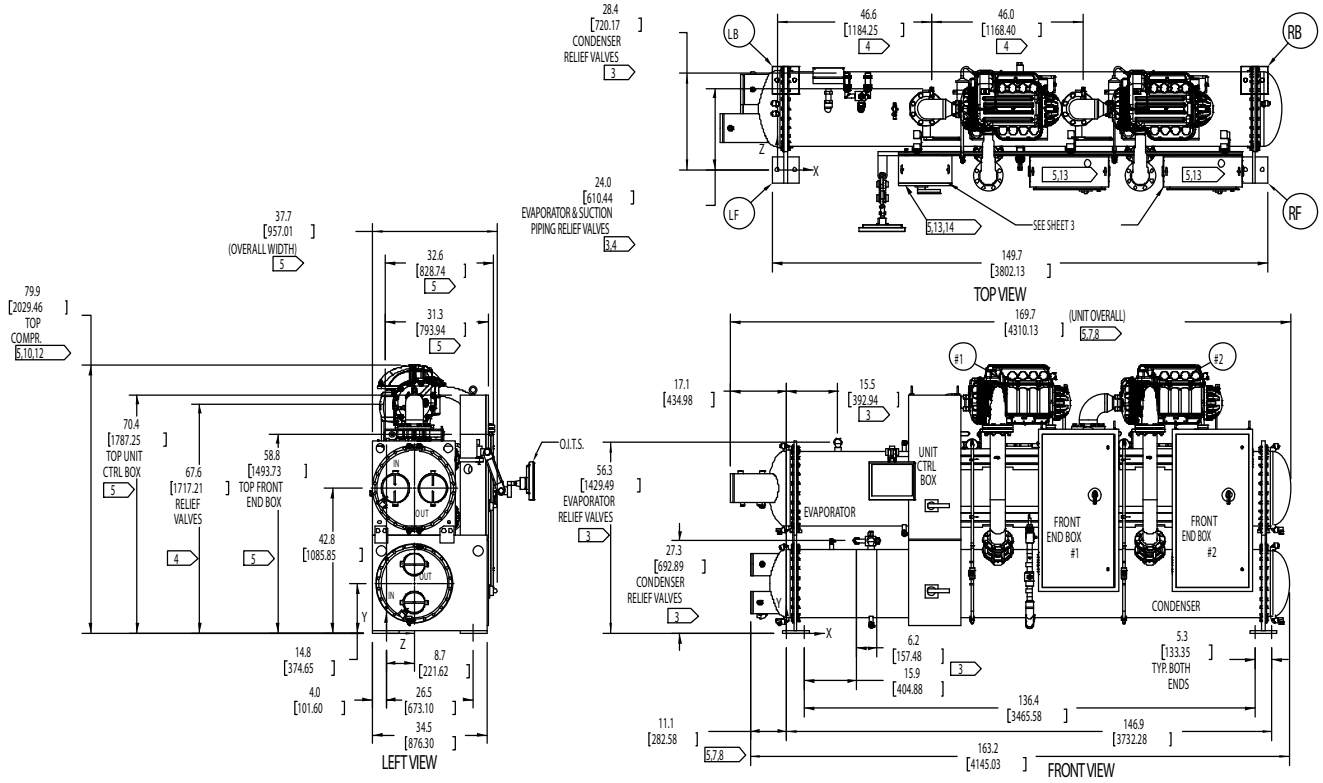
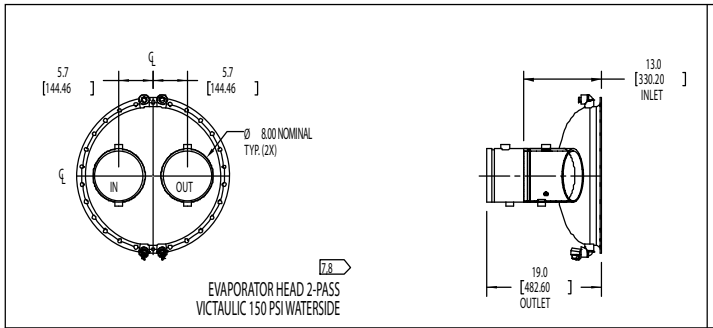
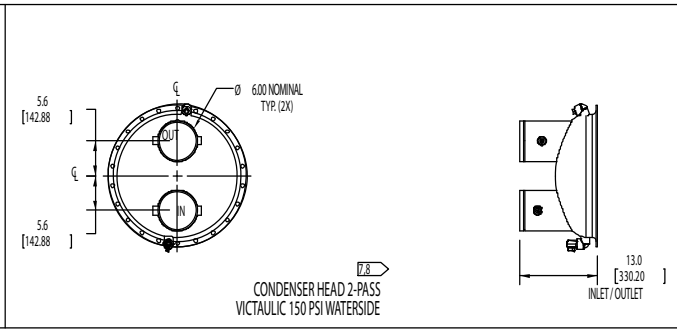


Figure 11, WMC 150D, 2-Pass (See page 28 for notes.)







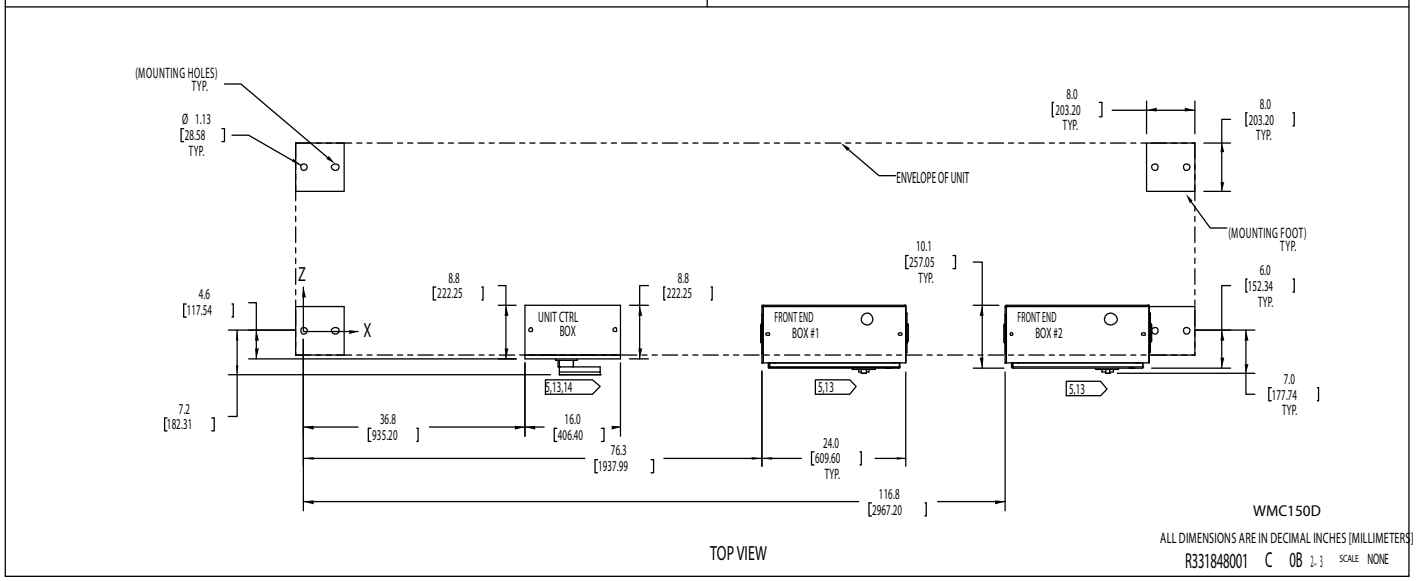


Figure 12, WMC 250D, 2-Pass (See page 28 for notes.)

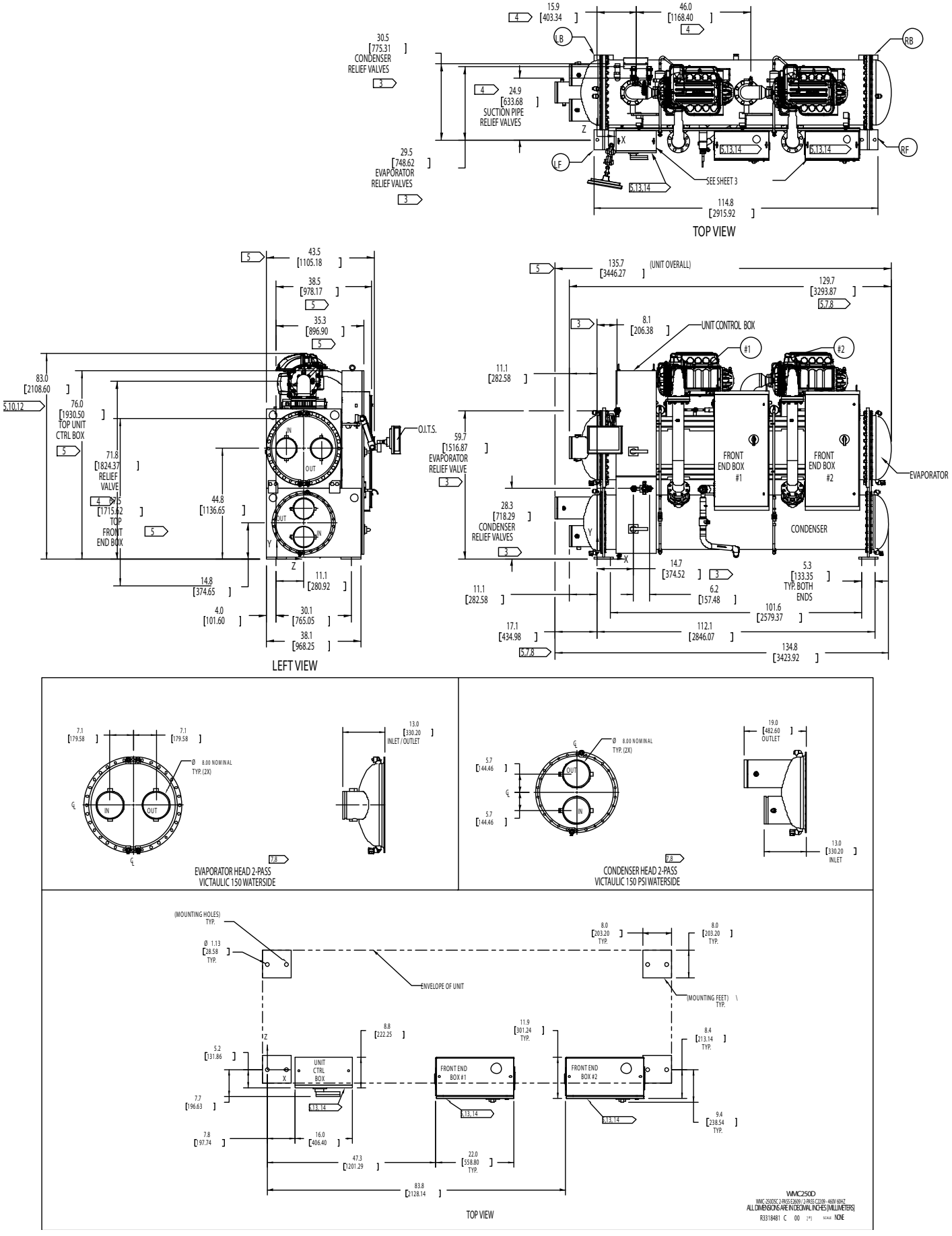


Figure 13, WMC 290D, 2-Pass (See page 28 for notes.)

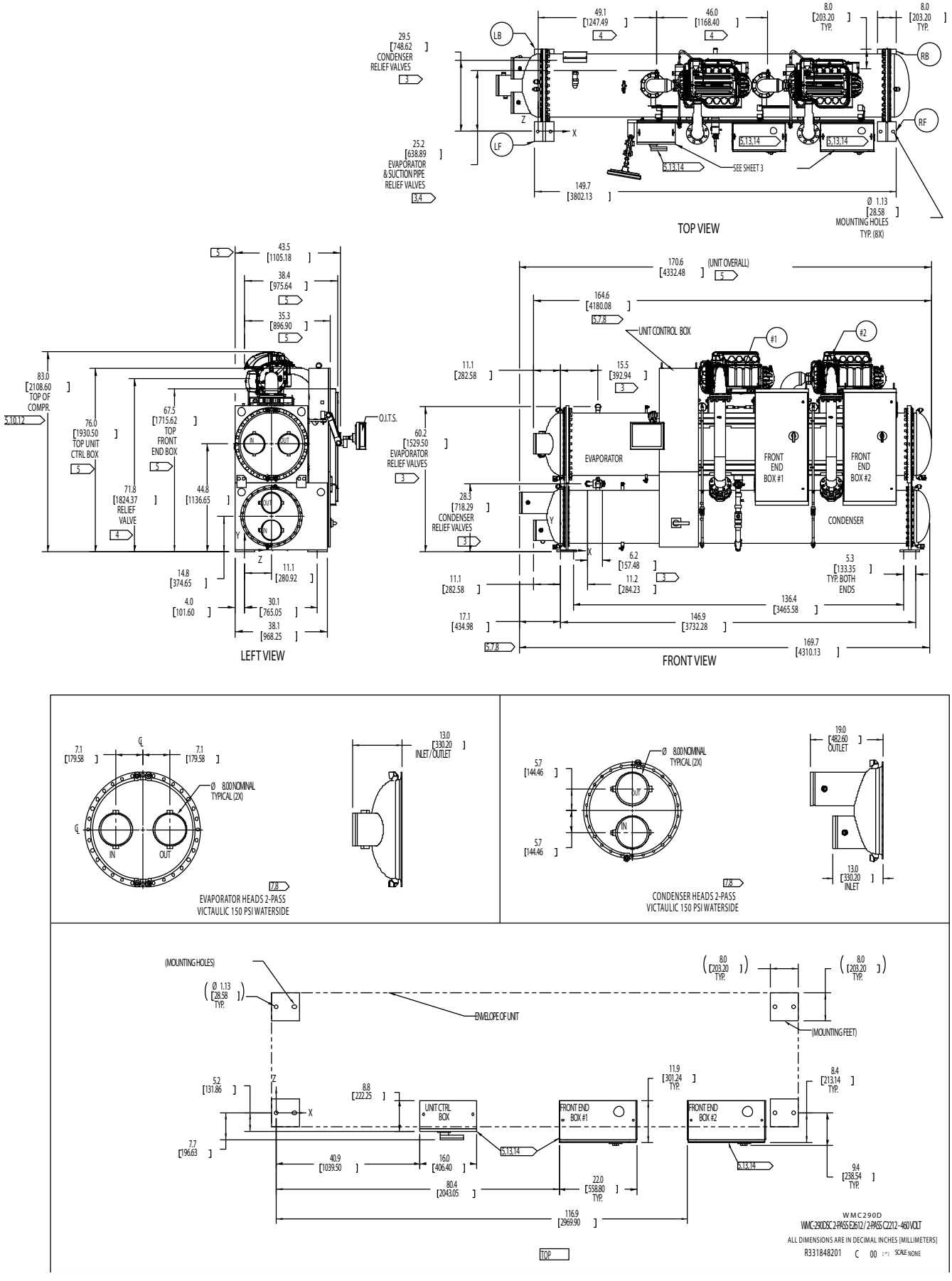
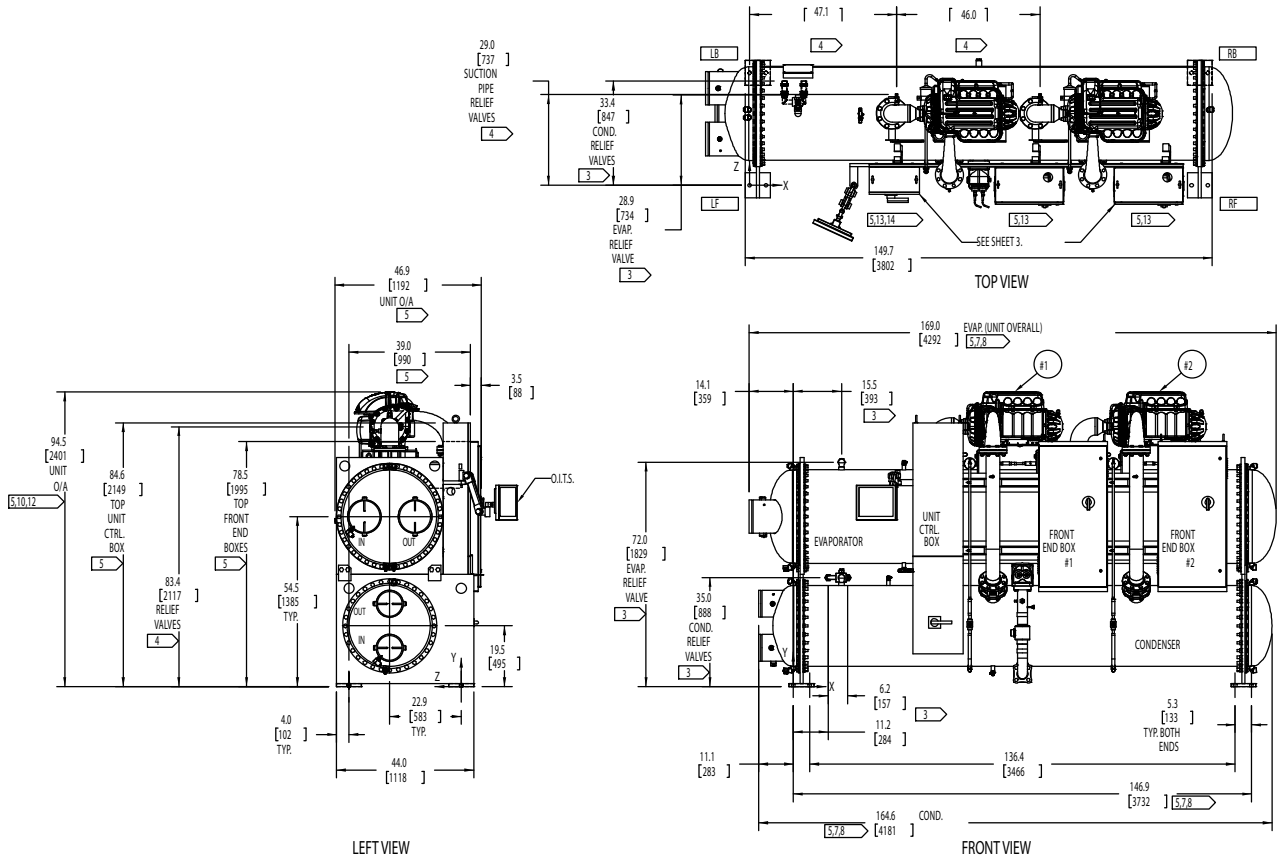
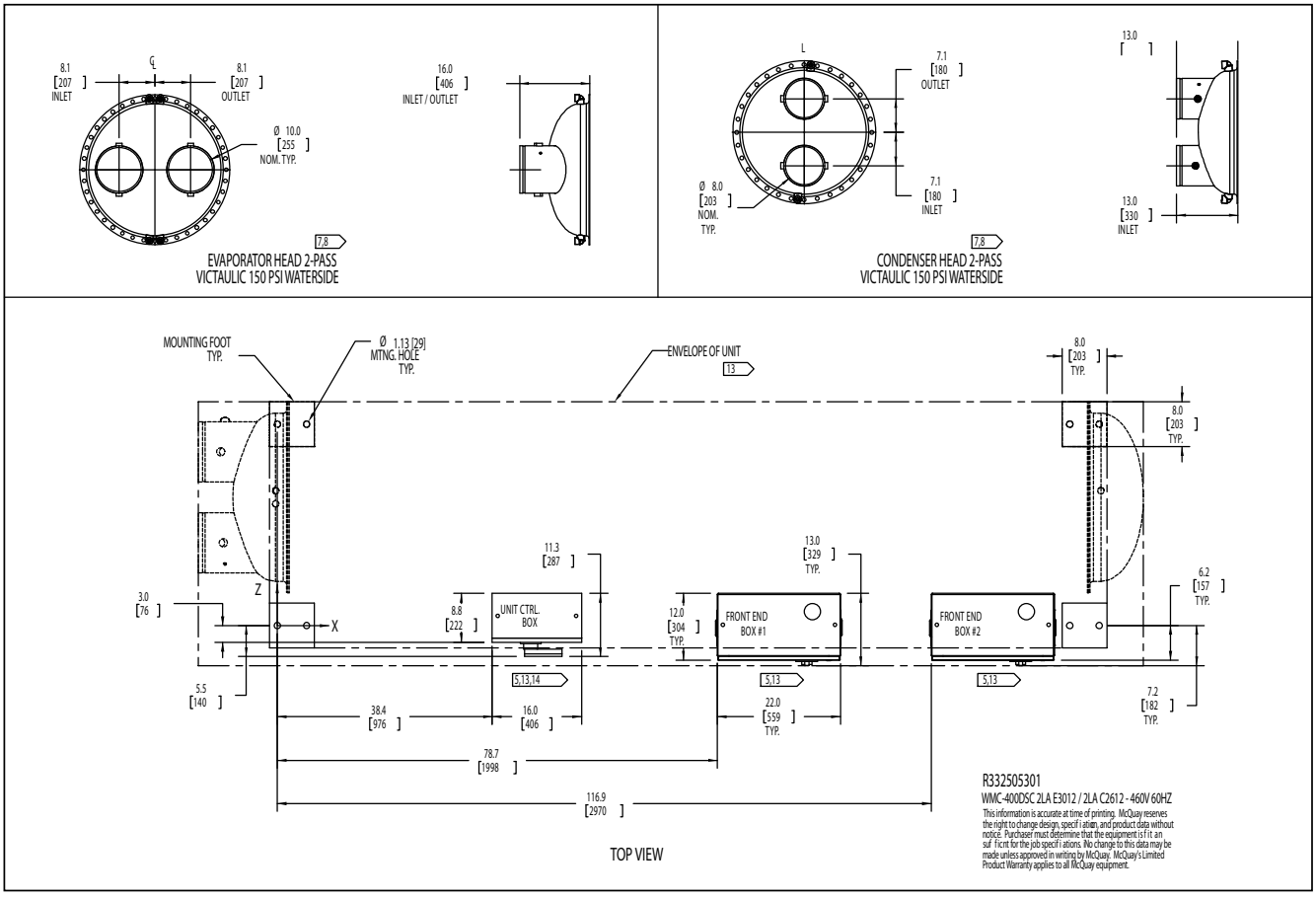


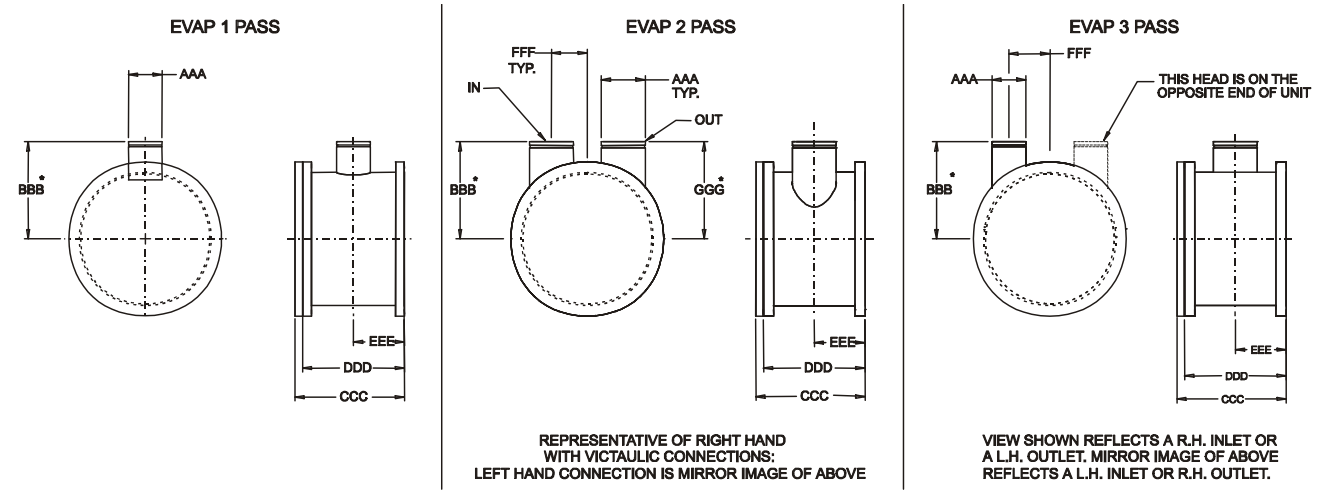
Figure 14, WMC 400D, 2-Pass (See page 28 for notes.)



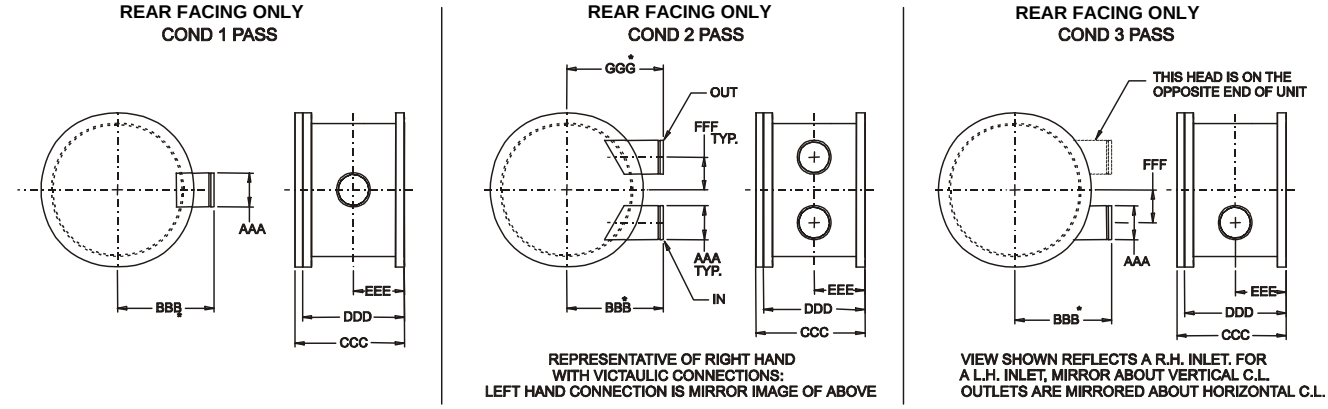


Marine Water Box Dimensions with Victaulic or Flanged Connections

Marine water boxes are an available option on all evaporator and condenser sizes. Caution: There is some nomenclature confusion in the industry. McQuay refers to our standard dished heads as “dished heads”. Some manufacturers refer to them, or similar devices as “water boxes”. They are not “*marine* water boxes” with removable end covers as illustrated below.



NOTE: * ADD .500 INCH FOR FLANGED CONNECTION.



150 PSI Non-ASME - Victaulic Connection

Evap. Dia.	1 PASS					2 PASS							3 PASS					
	'AAA'	'BBB'	'CCC	'DDD'	'EEE'	'AAA'	'BBB'	'CCC'	'DDD'	'EEE'	'FFF'	'GGG'	'AAA'	'BBB'	'CCC'	'DDD'	'EEE'	'FFF'
E22	10.75	17.00	21.25	20.00	10.00	8.625	17.00	21.00	20.00	10.00	5.59	23.00	5.563	17.00	21.25	20.00	10.00	7.12
E26	10.75	19.00	21.25	20.00	10.00	8.625	19.00	21.25	20.00	10.00	7.07	19.00	6.625	19.00	21.25	20.00	10.00	8.07
E30	14.00	21.00	28.50	26.50	13.25	10.75	21.00	28.50	26.50	13.25	8.13	21.00	6.625	21.00	28.50	26.50	13.25	10.19

Cond. Dia.	1 PASS					2 PASS							3 PASS					
	'AAA'	'BBB'	'CCC	'DDD'	'EEE'	'AAA'	'BBB	'CCC'	'DDD'	'EEE'	'FFF'	'GGG'	'AAA'	'BBB'	'CCC'	'DDD'	'EEE'	'FFF'
C20	8.62	16.00	19.00	18.00	9.00	6.625	16.00	19.00	18.00	9.00	5.63	16.00	Consult McQuay Sales Office					
C22	10.75	17.00	21.25	20.00	10.00	8.625	17.00	21.00	20.00	10.00	5.59	23.00						
C26	10.75	19.00	21.25	20.00	10.00	8.625	19.00	21.25	20.00	10.00	7.07	19.00						

Notes:

1. Dimensions in inches.
2. Flanges are ANSI raised face. Mating flanges by others.
3. Some condensers with flanges can have staggered connections due to flange interference. Consult factory.
4. Flanges add 0.5 inches to the distance from the vertical centerline to the flange face compared to Victaulic.

Drawing Notes

NOTES:

1. All dimensions are in Inches and [millimeters] unless noted otherwise.
2. Final connections must allow for .500 inch +/- [12.7mm] manufacturing tolerances.
3. 1.00-inch FPT [25.4 mm] evaporator and condenser relief valves must be piped per ANSI / ASHRAE 15. Number of relief valves is 1 per evaporator and 2 per condenser.
4. .375 inch [9 mm] suction nozzle relief valve must be piped per ANSI / ASHRAE 15.
5. Clearances:
   Ends — 108 inches (2743 mm) on WMC 145S/D and WMC 250D at one end
   144 inches (3658 mm) on WMC 150D, WMC 290, and WMC 400D at one end
   plus 36 inches (910 mm) is required at the opposite end. If tube pull and cleaning clearance is at the connection end, do not bloc tube access with piping, pumps, etc.
   Sides — 36 inches (914 mm) is recommended on all other sides and top for service clearance.
   Electric Panels — Most codes require 48 inches (1219 mm) clearance in front of the control boxes and electrical panels.
6. 3.25-inch [83mm] diameter lifting holes are provided. See installation manual for lifting instructions.
7. All water connections are given in standard U.S. pipe sizes. Standard connections are suitable for welding or victaulic couplings.
8. Unit shown has standard left-hand water connections. Right-hand connections are available for either vessel. For right hand evaporator the inlet and outlet nozzles are reversed. ANSI-flanged connections are available upon request. When using ANSI-flanged connections add .500 inch [13 mm] to each flanged end.
9. Dimensions shown are for units (evaporator / condenser) with standard design pressures. The refrigerant side design pressure is 200 PSI {1380 kPa} and the waterside design pressure is 150 PSI {1034 kPa}. Consult the factory for unit dimensions with higher design pressures.
10. The unit vibration isolator pads are provided for field installation. When fully loaded are 0.250 inches [6 mm] thick.
11. These values are for units with standard wall thickness copper tubing only.
12. The shipping skid, when used, adds 4.00 inches [105 mm] to the overall unit height.
13. If main power wiring is brought up through the floor, this wiring must be outside the envelope of the unit.
14. The unit control box has a lower section that contains a disconnect switch for the standard single-point connection and is the landing point for the power connection. Otherwise it is empty. Optional multi-power wiring is into the top of each compressor power panel.
15. The unit is shipped with an operating charge of refrigerant.
16. Optional marine water box connections are available upon request.

Table 12, Overall Dimensions, 2-Pass Vessels

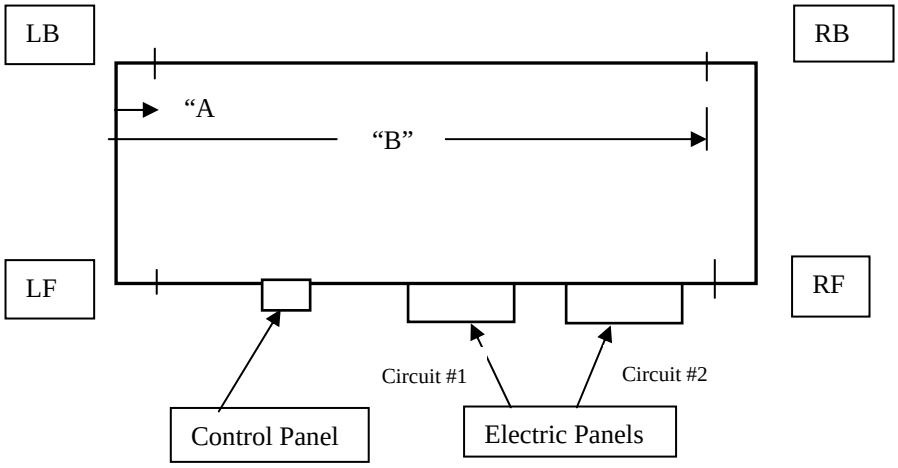
In. (mm)	WMC 145S, WMC 145D		WMC 150		WMC 250	
	Same End	Opp. End	Same End	Opp. End	Same End	Opp. End
Length	135 (3429)	141 (3581)	171 (4343)	177 (4496)	135 (3429)	141 (3581)
Width	39 (991)	39 (991)	38 (965)	38 (965)	44 (1117)	44 (1117)
Height	80 (2032)	80 (2032)	80 (2032)	80 (2032)	83 (2108)	83 (2108)

In. (mm)	WMC 290		WMC 400	
	Same End	Same End	Same End	Opp. End
Length	171 (4343)	171 (4343)	169 (4292)	172 (4368)
Width	44 (1117)	44 (1117)	47 (737)	47 (737)
Height	83 (2108)	83 (2108)	93 (2351)	93 (2351)

Physical Data and Weights

Mounting/Lifting Weights

Figure 15, Corner Identification



WMC Model	Vessel Models (Size)	Lifting (Shipping) Weight, lbs (kg)					Lifting Location inch (mm)	
		LF	RF	LB	RB	Total	"A"	"B"
145S	E2209/C2009	1238 (561)	1146 (520)	1565 (710)	1450 (6580	5399 (2449)	4.0 (102)	112.0 (2845)
145D	E2209/C2009	1438 (652)	1440 (653)	1685 (765)	1688 (766)	6252 (2836)	4.0 (102)	112.0 (2845)
150D	E2212/C2012	1619 (735)	1750 (794)	1927 (874)	2083 (945)	7380 (3347)	4.0 (102)	147.0 (3734)
250D	E2609/C2209	1850 (839)	1829 (830)	1933 (877)	1911 (867)	7525 (3414)	4.0 (102)	112.0 (2845)
290D	E2612/C2212	2793 (1242)	2105 (955)	3399 (1542)	2611 (1184)	10,953 (4923)	4.0 (102)	147.0 (3734)
400D	E3012/C2612	2680 (1216)	2762 (1253)	3539 (1605)	3648 (1655)	12,629 (5728)	4.0 (102)	147.0 (3734)

WMC Model	Vessel Models (Size)	Mounting (Operating) Weight, lbs (kg)				
		LF	RF	LB	RB	Total
145S	E2209/C2009	1346 (611)	1260 (572)	1811 (821)	1695 (769)	6113 (2773)
145D	E2209/C2009	1518 (689)	1421 (645)	2042 (926)	1912 (867)	6894 (3127)
150D	E2212/C2012	1756 (797)	1883 (854)	2222 (1008)	2382 (1080)	8242 (3739)
250D	E2609/C2209	2015 (9140	1995 (905)	2236 (1544)	2213 (1004)	8459 (3837)
290D	E2612/C2212	3022 (1371)	2401 (1090)	3901 (1770)	3099 (1406)	12,422 (5635)
400D	E3012/C2612	2982 (1353)	3063 (1389)	4068 (1845)	4179 (1895)	14,292 (6483)

NOTES:

1. The block shown above is the mounting footprint, not the entire unit footprint.
2. Lifting holes in the top of the tube sheets are 3.25-inch (83 mm) diameter.
3. Mounting holes in the feet are 1.125-inch diameter.

Physical Data

Evaporator

Refrigerant-side design pressure is 200 psi (1379 kPa). Water-side is 150 psi (1034 kPa).

Approximate total square footage of insulation surface required for individual packaged chillers is tabulated by evaporator code and can be found below. The suction elbow and compressor also require insulation.

Table 13, Evaporator Physical Data

WMC Model	Evaporator Model	Tube Length	Unit Refrigerant Charge lb. (kg)	Evaporator Water Volume, gal (L)	Insulation Area sq. ft. (m^2)	Number of Relief Valves
145S,	**E2209**	9 ft.	550 (250)	38 (145)	66 (6.1)	1
150D	**E2212**	12 ft.	800 (363)	45 (170)	90 (8.3)	1
250D	**E2609**	9 ft.	600 (272)	61 (231)	76 (7.1)	1
290D	**E2612**	12 ft.	1100 (500)	72 (273)	102 (9.4)	1
400D	**E3012**	12 ft.	1240 (562)	88 (336)	114 (11)	1

Notes:
1. Refrigerant charge is approximate since the actual charge will depend on other variables. Actual charge will be shown on the unit nameplate and is tabulated below.
2. Water capacity is based on standard tube configuration and standard dished heads.

Condenser

With positive pressure systems, the pressure variance with temperature is always predictable and the vessel design and pressure relief protection are based upon pure refrigerant characteristics. R-134a requires ASME vessel design, inspection and testing and uses spring-loaded pressure relief valves. When an over-pressure condition occurs, spring-loaded relief valves purge only that quantity of refrigerant required to reduce system pressure to the valve's set pressure, and then close.

Refrigerant-side design pressure is 200 psi (1380 kPa). Water-side design is 150 psi (1034 kPa).

Table 14, Condenser Physical Data

WMC Model	Condenser Model	Tube Length	Maximum Pumpdown Capacity lb. (kg)	Water Volume gal. (L)	Number of Relief Valves
145S, 145D	**C2009**	9 ft.	728 (330)	47 (147)	2
150D	**C2012**	12 ft.	971 (440)	62 (236)	2
250D	**C2209**	9 ft.	883 (401)	50 (223)	2
290D	**C2212**	12 ft.	1174 (533)	72 (273)	2
400D	**C2612**	12 ft.	1676 (760)	111 (419)	2

Notes:
1. Condenser pumpdown capacity based on 90% full at 90°F.
2. Water capacity based on standard configuration and standard heads and can be less with lower tube counts.
3. See Relief Valves section for additional information.

Relief Valves

Vessel Relief Valves

Relief valve connection sizes are 1 inch FPT and are in the quantity shown in Table 13 and Table 14. Relief valves must be piped to the outside of the building in accordance with ANSI/ASHRAE 15-2001. The new 2001 standard has revised the calculation method compared to previous issues.

Twin relief valves, mounted on a transfer valve, are used on the condenser so that one relief valve can be shut off and removed for testing or replacement, leaving the other in operation. Only one of the two valves is in operation at any time.

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

$$D_{Common} = \left(D_1^2 + D_2^2 .... D_n^2 \right)^{0.5}$$

Table 15. Relief Valve Piping Sizes

Pipe Size inch (NPT)	1 1/4	1 1/2	2	2 1/2	3
Moody Factor	0.0209	0.0202	0.0190	0.0182	0.0173
Equivalent length (ft)	2.2	18.5	105.8	296.7	973.6

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

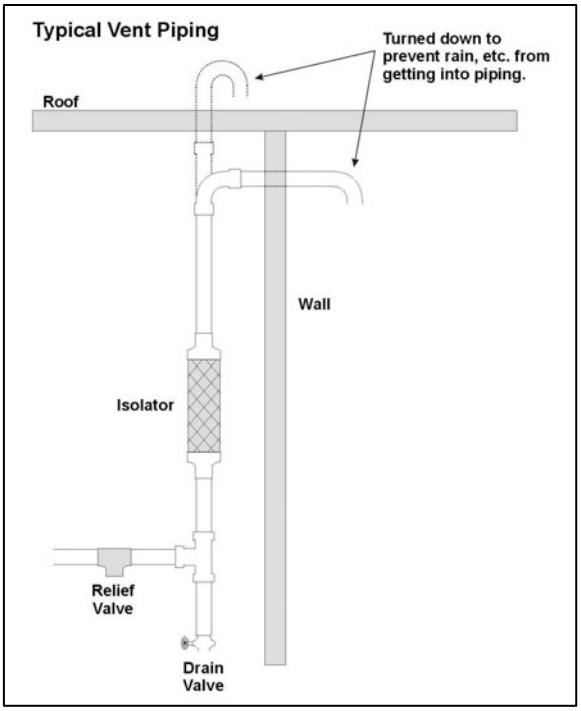
Relief Pipe Sizing (ASHRAE Method)

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

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

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

Figure 16, Typical Vent Piping



Electrical Data

General Note: The RLA for use in the following tables is obtained by the selection of a specific unit by McQuay. When shipped, a unit will bear the specific RLA, stamped on the nameplate, for the selected operating conditions. The tables below are for 60 Hz, 460 volts and 50 Hz, 400 volts.

⚠CAUTION

The RLA stamped on the unit may be lower than the minimum shown in the following tables, in which case the minimum table value must be used for wire sizing.

WMC 145S (Single Compressor)

Table 16, Standard Single Point Connection,

1 Compressor Only

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
79 to 80 Amps	110	97 to 100	3	3 GA	175 Amps
81 to 88 Amps	110	101 to 110	3	2 GA	175 Amps
89 to 92 Amps	110	111 to 115	3	2 GA	200 Amps
93 to 99 Amps	110	116 to 123	3	1 GA	200 Amps
100 Amps	110	125	3	1 GA	225 Amps
101 to 104 Amps	132	126 to 130	3	1 GA	225 Amps
105 to 111 Amps	132	131 to 138	3	1/0	225 Amps
112 to 120 Amps	132	140 to 150	3	1/0	250 Amps
121 to 133 Amps	154	151 to 166	3	2/0	250 Amps
134 to 140 Amps	154	167 to 175	3	2/0	300 Amps
141 to 150 Amps	165	176 to 187	3	3/0	300 Amps

Table 17, Disconnect Switch Size

RLA	Single Point Connection Disconnect Switch only
79 to 100 Amps	175 Amps
101 to 150 Amps	225 Amps

NOTE: Disconnect Switch will also be a Circuit Breaker.

WMC 145D & 150D (Dual Compressors)

Multi-point Connection, Standard

Table 18, WMC 145D, 150D Electrical Data

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
52 to 55 Amps	72	65 to 69	3	4 GA	110 Amps
56 to 65 Amps	72	70 to 82	3	4 GA	125 Amps
68 to 77 Amps	94	85 to 97	3	3 GA	150 Amps
78 to 85 Amps	94	98 to 107	3	2 GA	175 Amps
89 to 91 Amps	124	112 to 114	3	2 GA	200 Amps
92 to 103 Amps	124	115 to 129	3	1 GA	200 Amps
104 to 110 Amps	124	130 to 138	3	1/0	225 Amps
111 to 113 Amps	124	139 to 142	3	1/0	250 Amps

NOTES

1. Data is for each of two circuits – 1 compressor per circuit

Single-point Connection, Optional

Table 19, WMC 145D, 150D Electrical Data

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
52 to 53 Amps	72	117 to 120	3	1 GA	150 Amps
54 to 57 Amps	72	122 to 129	3	1 GA	175 Amps
58 to 61 Amps	72	131 to 138	3	1/0	175 Amps
62 to 65 Amps	72	140 to 147	3	1/0	200 Amps
68 to 69 Amps	94	153 to 156	3	2/0	200 Amps
70 to 76 Amps	94	158 to 171	3	2/0	225 Amps
77 to 85 Amps	94	174 to 192	3	3/0	250 Amps
89 to 92 Amps	124	201 to 207	3	4/0	250 Amps
93 to 102 Amps	124	210 to 230	3	4/0	300 Amps
103 to 107 Amps	124	232 to 241	3	250	300 Amps
108 to 113 Amps	124	243 to 255	3	250	350 Amps

NOTES

1. Data is for each of two circuits – 1 compressor per circuit

Single Point and Multi-point Connection

Table 20, WMC 145D, 150D Single and Multi-Point Connections

RLA (Per Compressor)	Multi-Point Connection Disconnect Switch only	Single Point Connection	
		Power Block	Disconnect Switch
52 to 65 Amps	100 Amps	335 Amps	400 Amps
68 to 85 Amps	150 Amps		
89 to 113 Amps	175 Amps		

NOTES:

1. Disconnect switch will also be a circuit breaker.
2. On single-point connection, a circuit breaker is supplied in each circuit after the power block or molded case disconnect switch.

WMC 250D & 290D (Dual Compressors)

Table 21, Multi-Point Connection, Standard

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
79 to 80 Amps	110	97 to 100	3	3 GA	175 Amps
81 to 88 Amps	110	101 to 110	3	2 GA	175 Amps
89 to 92 Amps	110	111 to 115	3	2 GA	200 Amps
93 to 99 Amps	110	116 to 123	3	1 GA	200 Amps
100 Amps	110	125	3	1 GA	225 Amps
101 to 104 Amps	132	126 to 130	3	1 GA	225 Amps
105 to 111 Amps	132	131 to 138	3	1/0	225 Amps
112 to 120 Amps	132	140 to 150	3	1/0	250 Amps
121 to 133 Amps	154	151 to 166	3	2/0	250 Amps
134 to 140 Amps	154	167 to 175	3	2/0	300 Amps
141 to 150 Amps	165	176 to 187	3	3/0	300 Amps

NOTES

1. Data is for each of two circuits – 1 compressor per circuit

Table 22, Single Point Connection, Optional

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
79 to 88 Amps	110	176 to 199	3	4/0	250 Amps
89 to 92 Amps	110	201 to 208	3	250 MCM	250 Amps
93 to 100 Amps	110	210 to 226	3	250 MCM	300 Amps
101 to 107 Amps	132	228 to 241	3	250 MCM	300 Amps
108 to 113 Amps	132	244 to 255	3	250 MCM	350 Amps
114 to 120 Amps	132	257 to 271	3	300 MCM	350 Amps
121 to 123 Amps	154	273 to 277	3	300 MCM	350 Amps
124 to 126 Amps	154	280 to 284	3	300 MCM	400 Amps
127 to 137 Amps	154	286 to 309	3	350 MCM	400 Amps
138 Amps	154	311	3	400 MCM	400 Amps
139 to 140 Amps	154	313 to 316	3	400 MCM	450 Amps
141 to 149 Amps	165	318 to 335	3	400 MCM	450 Amps
150 Amps	165	338	3	500 MCM	450 Amps

NOTES

1. Data is for each of two circuits – 1 compressor per circuit

Table 23, Single Point and Multi-point Connection

RLA (Per Compressor)	Multi-Point Connection	Single Point Connection	
	Disconnect Switch only	Power Block	Disconnect Switch
79 to 100 Amps	175 Amps	335 Amps	250 Amps
101 to 150 Amps	225 Amps	380 Amps	400 Amps

NOTES:

1. Disconnect switch will also be a circuit breaker.
2. On single-point connection, a circuit breaker is supplied in each circuit after the power block or molded case disconnect switch.

WMC 400D (Dual Compressors)

Table 24, WMC 400D, Optional Multi-Point Connection

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
126 to 133 Amps	176	157 to 166	3	2/0	250 Amps
134 to 140 Amps	176	167 to 175	3	2/0	300 Amps
141 to 155 Amps	176	176 to 193	3	3/0	300 Amps
156 to 160 Amps	176	195 to 200	3	3/0	350 Amps
161 to 170 Amps	187	201 to 213	3	4/0	350 Amps

NOTES:

1. Data is for each circuit – 1 compressor per circuit

Table 25, WMC 400D, Standard Single Point Connection

RLA (Per Compressor)	LRA	Minimum Circuit Ampacity (MCA)	Field Wire		Max Fuse Size
			Quantity	Wire GA	
126 Amps	176	284	3	300 MCM	400 Amps
127 to 137 Amps	176	286 to 309	3	350 MCM	400 Amps
138 Amps	176	311	3	400 MCM	400 Amps
139 to 148 Amps	176	313 to 334	3	400 MCM	450 Amps
149 to 153 Amps	176	336 to 345	3	500 MCM	450 Amps
154 to 160 Amps	176	347 to 361	3	500 MCM	500 Amps
161 to 168 Amps	187	363 to 379	3	500 MCM	500 Amps
169 to 170 Amps	187	381 to 383	6	(2) 3/0	500 Amps

NOTES:

1. Data is for each circuit – 2 compressors per unit

Table 26, Single Point and Multi-point Connection

RLA (Per Compressor)	Multi-Point Connection	Single Point Connection	
	Disconnect Switch only	Power Block	Disconnect Switch
126 to 160 Amps	250 Amps	380 Amps	400 Amps
161 to 170 Amps	250 Amps	380 Amps	400 Amps

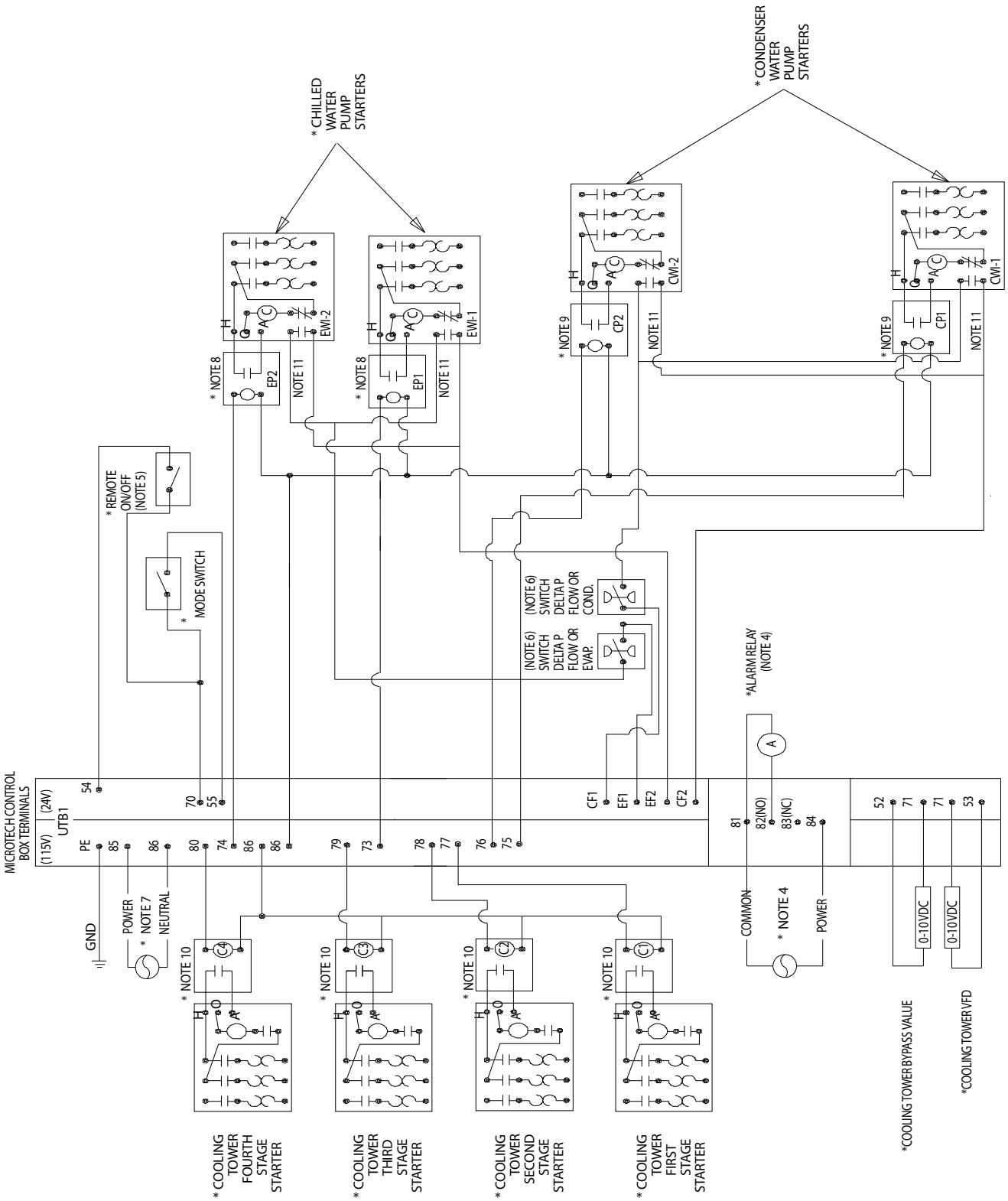
NOTES:

1. Disconnect switch will also be a circuit breaker.
2. On single-point connection, a circuit breaker is in each circuit after power block or molded disconnect switch.

Notes for following field wiring diagram

1. Compressor front end boxes are factory mounted and wired. All line side wiring must be in accordance with the NEC and shall be made with copper wire and copper lugs only. Use only copper supply wires with ampacity based on 75°c conductor rating. Main power wiring between the front end box and compressor terminals is factory installed.
2. Minimum wire size for 115 VAC is 12 ga. for a maximum length of 50 feet. If greater than 50 feet refer to McQuay for recommended wire size minimum. Wire size for 24 VAC is 18 ga. All wiring to be installed as NEC Class 1 wiring system. All 24 VAC wiring must be run in separate conduit from 115 VAC wiring. Wiring must be wired in accordance with NEC and connection to be made with copper wire and copper lugs only..
3. Voltage unbalance not to exceed 2% with a resultant current unbalance of 6 to 10 times the voltage unbalance per NEMA MG-1, 1998 Standard. Voltage variation is +/- 10% of nameplate voltage.
4. A customer furnished 24 or 120 VAC power for alarm relay coil may be connected between UTB1 terminals 84 power and 81 neutral of the control panel. For normally open contacts wire between 82 & 81. For normally closed wire between 83 & 81. The alarm is operator programmable. Maximum rating of the alarm relay coil is 25 VA.
5. Remote on/off control of unit can be accomplished by installing a set of dry contacts between terminals 70 and 54.
6. If field supplied flow switches are used in addition to the factory-mounted flow switches, they must be wired as shown and be suitable for 24vac and low current application.
7. Customer supplied 115 VAC 20 amp power for optional evaporator and condenser water pump control power and tower fans is supplied to unit control terminals (UTB1) 85 power / 86 neutral, PE equipment ground.
8. Optional customer supplied 115 VAC, 25 VA maximum coil rated, chilled water pump relay (ep1 & 2) may be wired as shown. This option will cycle the chilled water pump in response to chiller demand.
9. The condenser water pump must cycle with the unit. A customer supplied 115 VAC 25 VA maximum coil rated, condenser water pump relay (CP1 & 2) is to be wired as shown. Units with free-cooling must have condenser water above 60°F before starting.
10. Optional customer supplied 115 VAC 25 VA maximum coil rated cooling tower fan relays (C1 - C2 standard, C3-C4 optional) may be wired as shown. This option will cycle the cooling tower fans in order to maintain unit head pressure.
11. Auxiliary 24 VAC rated contacts in both the chilled water and condenser water pump starters may be wired as shown.
12. A 4-20 mA external signal for chilled water reset can be wired to terminals 71 and 51 on the unit controller; load limit is wired to terminals 71 and 58 on the unit controller.

Figure 17, Field Wiring Diagram



Power Factor

The full load power factor exceeds 0.90 for all capacity selections.

VFD Line Harmonics

Despite their many benefits, care must be taken when applying VFDs due to the effect of line harmonics on the building electric system. VFDs cause distortion of the AC line because they are nonlinear loads, that is, they don't draw sinusoidal current from the line. They draw their current from only the peaks of the AC line, thereby flattening the top of the voltage waveform. Some other nonlinear loads are electronic ballasts and uninterruptible power supplies.

Line harmonics and their associated distortion can be critical to ac-drives for three reasons:

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

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

Current Harmonics

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

1. Mount the drive far from the source transformer.
2. Add line reactors. They are standard equipment on Magnitude chillers.
3. Use an isolation transformer.
4. Use a harmonic filter.

Voltage Harmonics

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

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

Line Reactors

Five-percent line reactors are standard equipment on Magnitude chillers and located in each compressors power panel. They are employed to improve the power factor by reducing the effects of harmonics.

Harmonic Filter

The harmonic filter is an option for field mounting and wiring outside of the power panel. It works in conjunction with the line reactor to further minimize harmonic distortion. IEEE 519-1991 Standard defines acceptable limits.

See the Magnitude certified drawings for harmonic filter dimensions and wiring information.

EMI (Electro Magnetic Interference) and RFI (Radio Frequency Interference) Filter

This filter is a factory-installed option. The terms EMI and RFI are often used interchangeably. EMI is actually any frequency of electrical noise, whereas RFI is a specific subset of electrical noise on the EMI spectrum. There are two types of EMI. Conducted EMI is unwanted high frequencies that ride on the AC wave form.

EMI-Radiated EMI is similar to an unwanted radio broadcast being emitted from the power lines. There are many pieces of equipment that can generate EMI, variable frequency drives included. In the case of variable frequency drives, the electrical noise produced is primarily contained in the switching edges of the pulse width modulation (PWM) controller.

As the technology of drives evolves, switching frequencies increase. These increases also increase the effective edge frequencies produced, thereby increasing the amount of electrical noise.

The power line noise emissions associated with variable frequency and variable speed drives can cause disturbances in nearby equipment. Typical disturbances include:

- Dimmer and ballast instability
- Lighting disturbances such as flashing
- Poor radio reception
- Poor television reception
- Instability of control systems
- Flow meter totalizing
- Flow metering fluctuation
- Computer system failures loss of data
- Radar disruption
- Sonar disruption
- Thermostat control problems

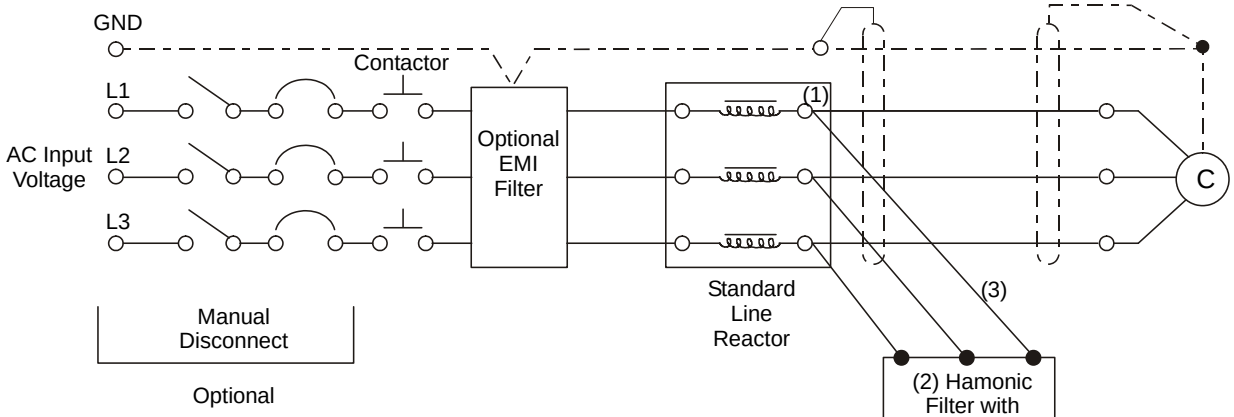
The IEEE 519-1991 Standard

The Institute of Electrical and Electronics Engineers (IEEE) has developed a standard that defines acceptable limits of system current and voltage distortion. A simple form is available from McQuay that allows McQuay to determine compliance with IEEE 519-1991.

Line reactors, isolation transformers, or phase-shifting transformers can be required on some installations.

Figure 18, Typical Magnitude Power Wiring

WMC Wiring



Notes:
(1) Single hole, crimp type compression terminal required.
(2) Connect to filter circuit breaker lugs.
(3) Conductors to be sized for 125 minimum circuit ampacity. Size 1 AWG, 75°C wire recommended.

Application Considerations

Location

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

Optimum Water Temperatures and Flow

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

Higher leaving chilled water temperatures

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

Evaporator temperature drop

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

Condenser entering water temperature

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

Condenser water temperature rise

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

Chilled Water Temperature

The maximum temperature of water entering the chiller on standby must not exceed 110° F (43° C). Maximum temperature entering on start-up must not exceed 90°F (32.2°C). Minimum chilled water leaving temperature without antifreeze is approximately 36°F (2.2°C).

Piping

Piping must be adequately supported to remove weight and strain on the chiller's fittings and connections. Be sure piping is adequately insulated. Install a cleanable 20-mesh water strainer upstream of the evaporator and condenser. Install enough shutoff valves to permit draining water from the evaporator or condenser without draining the complete system.

Location

The units are for indoor installation not subject to freezing temperatures.

Condenser Water Temperature

When the ambient wet bulb temperature is lower than design, the entering condenser water temperature can be allowed to fall, improving chiller performance.

McQuay chillers will *start* with entering condenser water temperature as low as 55°F (12.8°C) providing the chilled water temperature is below the condenser water temperature, the chiller MicroTech II controller controls the tower water temperature and other conditions in the section are met.

⚠ CAUTION

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

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

To obtain lower than 55°F (12.8°C) entering condenser water temperature with a tower selected to produce 85°F (29.4°C) water temperature at design ambient air temperatures, cooling tower fans must continue to operate at 100% capacity at low wet bulb temperatures. As chillers are selected for lower kW per ton, the cooling tower fan motor power becomes a higher percentage of the peak load chiller power. The offsets of compressor power and fan power must be examined. On the other hand, the low condenser water temperatures can be easy and economical to achieve in mild climates with low wet bulb temperatures.

Even with tower fan control, some form of water flow control such as tower bypass must be used. The MicroTech II control is capable of controlling tower fans and bypass valve.

Figure 19 and Figure 20 illustrate two temperature actuated tower bypass arrangements. The “Cold Weather” scheme, Figure 21, provides better startup under cold ambient air temperature conditions. The bypass valve and piping are indoors and thus warmer, allowing for warmer water to be immediately available to the condenser. The check valve may be required to prevent air at the pump inlet.

Figure 19, Tower Bypass Valve, Pressure Actuated

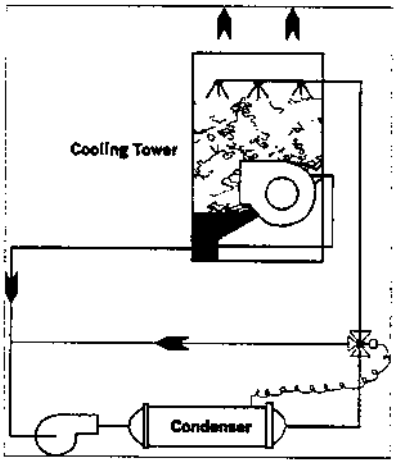


Figure 20, Tower Bypass, Mild Weather Operation

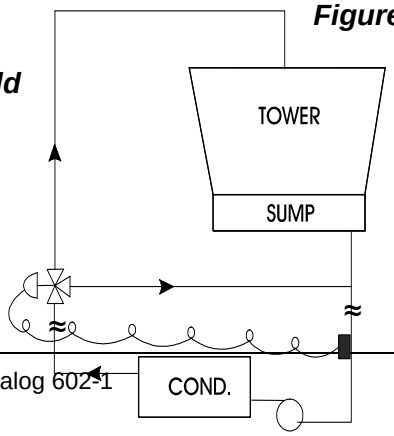
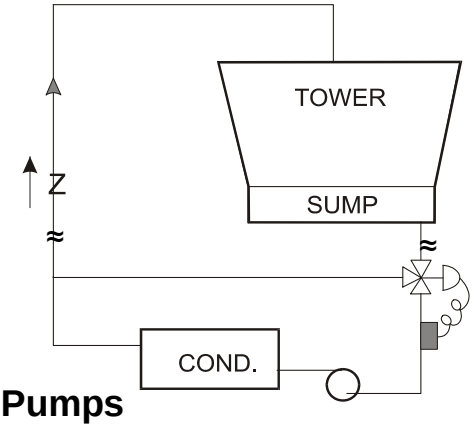


Figure 21, Tower Bypass, Cold Weather Operation (Bypass Indoors)



Pumps

To avoid the possibility of objectionable harmonics in the system piping, 4-pole, 1800/1500 rpm system pumps should be used. The condenser water pump(s) must be cycled off when the last chiller of the system cycles off. This will keep cold condenser water from migrating refrigerant to the condenser. Cold liquid refrigerant in the condenser can make start up difficult. In addition, turning off the condenser water pump(s) when the chillers are not operating will conserve energy.

Include thermometers and pressure gauges at the chiller inlet and outlet connections and install air vents at the high points of piping. Where noise and vibration are critical and the unit is mounted on spring isolators, flexible piping and conduit connections are necessary. Install a flow switch or pressure differential switch in the leaving chilled water line, if one is not factory installed.

Variable Speed Chilled Water Pumping

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

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

Second, the water velocity in the vessels must be 3 to 10 fps (0.91 and 3.0 m/sec). Below 3 fps

(0.91 m/sec), laminar flow occurs which reduces heat transfer and causes erratic operation. Above 10 fps (3.0 m/sec), excessively high pressure drops and tube erosion occur. These flow limits can be determined from the McQuay selection program.

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

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

Vibration Mounting

The Magnitude chillers are almost vibration-free. Consequently, floor mounted spring isolators are not usually required. Rubber mounting pads are shipped with each unit. It is wise to continue to use piping flexible connectors to reduce sound transmitted into the pipe and to allow for expansion and contraction.

System Water Volume

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

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

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

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

System Pumps

Operation of the chilled water pump can be to 1) cycle the pump with the compressor, 2) operate continuously, or 3) start automatically by a remote source.

The cooling tower pump must cycle with the machine. The holding coil of the cooling tower pump motor starter must be rated at 115 volts, 60 Hz, with a maximum volt-amperage rating of 100. A control relay is required if the voltage-amperage rating is exceeded. See the Field Wiring Diagram on page 37 or in the cover of control panel for proper connections.

All interlock contacts must be rated for no less than 10 inductive amps. The alarm circuit provided in the control center utilizes 115-volts AC. The alarm used must not draw more than 10-volt amperes.

System analysis

Although McQuay is a proponent of analyzing the entire system, it is generally effective to place the chiller in the most efficient mode because it is a large energy consumer.

The McQuay Energy Analyzer™ program is an excellent tool to investigate the entire system efficiency, quickly and accurately. It is especially good at comparing different system types and operating parameters. Contact you local McQuay sales office for assistance on your particular application.

Operating Limits:

Leaving chilled water, 36°F to 60°F (2.2°C to 15°C), ice duty not available
Maximum operating evaporator inlet fluid temperature, 66°F (19°C)
Maximum startup evaporator inlet fluid temperature, 90°F (32°C)
Maximum non-operating inlet fluid temperature, 100°F (38°C)
Minimum condenser water entering temperature, 55°F (12.8°C)
Maximum entering condenser water temperature, 105°F (40.1°C)
Maximum leaving condenser water temperature, 115°F (46.1°C)

Retrofit Knockdown

It is estimated that fifty percent of retrofit applications require partial or complete disassembly of the chiller. McQuay offers two solutions to the disassembly and reassembly effort on Magnitude chillers.

Magnitude chillers are relatively easy to disassembly due to the small compressor size, simplified refrigerant piping and the absence of a lubrication system with its attendant components and piping. Two knockdown arrangements are available as options

Contact local McQuay Factory Service for pricing and scheduling of required installation supervision.

TYPE IV: The compressor(s), control panel, and compressor power panel(s) are removed at the factory and put on skids. The stripped vessel stack is shipped as a single piece. Discharge piping, liquid line and the compressor cooling line(s) are removed and crated. All associated wiring and piping possible will remain on the vessel stack. The unit is shipped without refrigerant, which must be furnished and charged by the contractor.

Type IV reduces the height and weight of the unit. The width is determined by the evaporator tube sheet and is not decreased with this arrangement, nor is the overall unit length. If further weight or size reduction is required, the vessels can be separated by unbolting them.

TYPE V: The unit ships fully assembled and charged with refrigerant and is ready for field knockdown. This option allows components to be removed as required at the site. The unit dimension drawing gives sufficient dimensions to determine what components should be removed.

Type V gives the installing contractor the option to remove only those components necessary to complete the installation. The refrigerant is pumped down into the condenser and depending on the degree of knockdown, can remain there, decreasing the leak testing, evacuation and charging required in the field.

Table 27, Component Weight

WMC Model	Compressor Each	Power Panel	Control Panel	Evaporator		Condenser	
				Model	Weight	Model	Weight
145S	282	295	100	E2209	2490	C2009	2142
145D	262	230	195	E2209	2490	C2009	2142
150D	262	230	195	E2212	2857	C2012	2615
250D	282	295	265	E2609	3259	C2209	2392
290D	282	295	265	E2612	3812	C2212	2942
400D	282	295	265	E3012	5075	C2612	3900

NOTES:

1. All weights in pounds.
2. “S” models have one compressor; “D” models have two compressors.

Table 28, Component Dimensions, (Length x Width x Height)

WMC Model	Compressor	Power Panel	Control Panel	Evaporator		Condenser		Stack
				Model		Model		
145S	32 x 22 x 18	22 x 12 x 48	16 x 9 x 74	E2209	135 x 28 x 29	C2009	128 x 36 x 33	135 x 36 x 62
145D	32 x 18 x 18	22 x 12 x 48	16 x 9 x 68	E2209	135 x 28 x 29	C2009	128 x 36 x 33	135 x 36 x 62
150D	32 x 18 x 18	22 x 12 x 48	16 x 9 x 68	E2212	170 x 28 x 29	C2012	164 x 36 x 33	170 x 36 x 62
250D	32 x 22 x 18	22 x 12 x 48	16 x 9 x 74	E2609	130 x 32 x 33	C2209	135 x 39 x 33	135 x 39 x 66
290D	32 x 22 x 18	22 x 12 x 48	16 x 9 x 74	E2612	165 x 32 x 33	C2212	170 x 39 x 33	170 x 39 x 66
400D	32 x 22 x 18	22 x 12 x 48	16 x 9 x 74	E3012	169 x 36 x 36	C2612	165 x 44 x 36.	169 x 44 x 72

NOTE: All dimensions in inches.

Pressure Drop Curves

NOTE: The Evaporator and Condenser Model Codes are shown on page 29. The -B and -C designations shown on the curves refer to vessel tube count, which is determined by the computer selection program.

Figure 22, Single Pass Evaporators

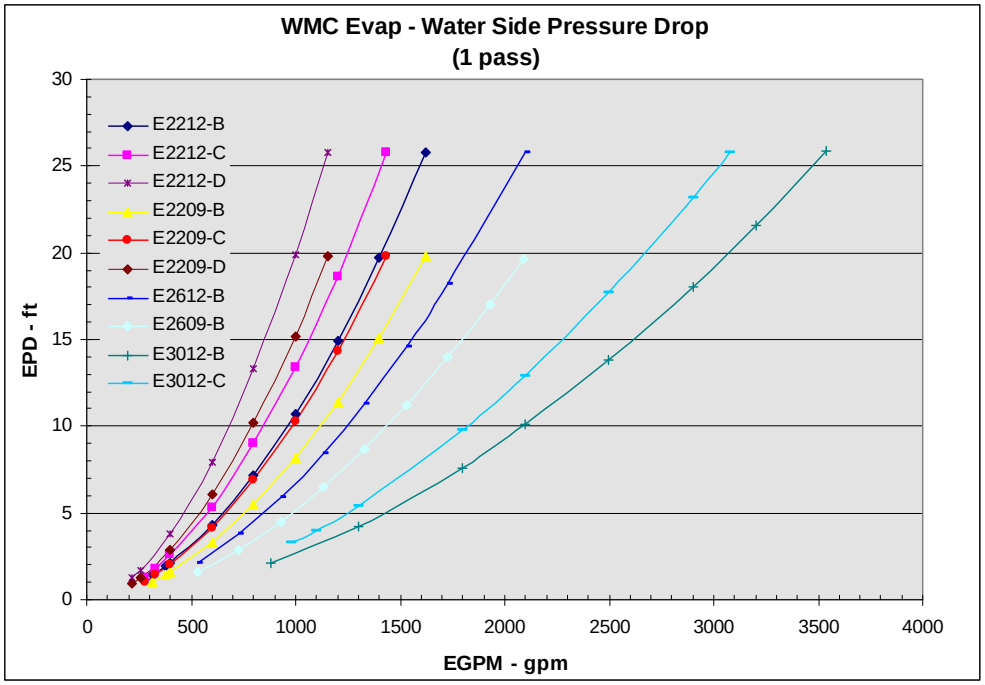


Figure 23, Single Pass Condensers

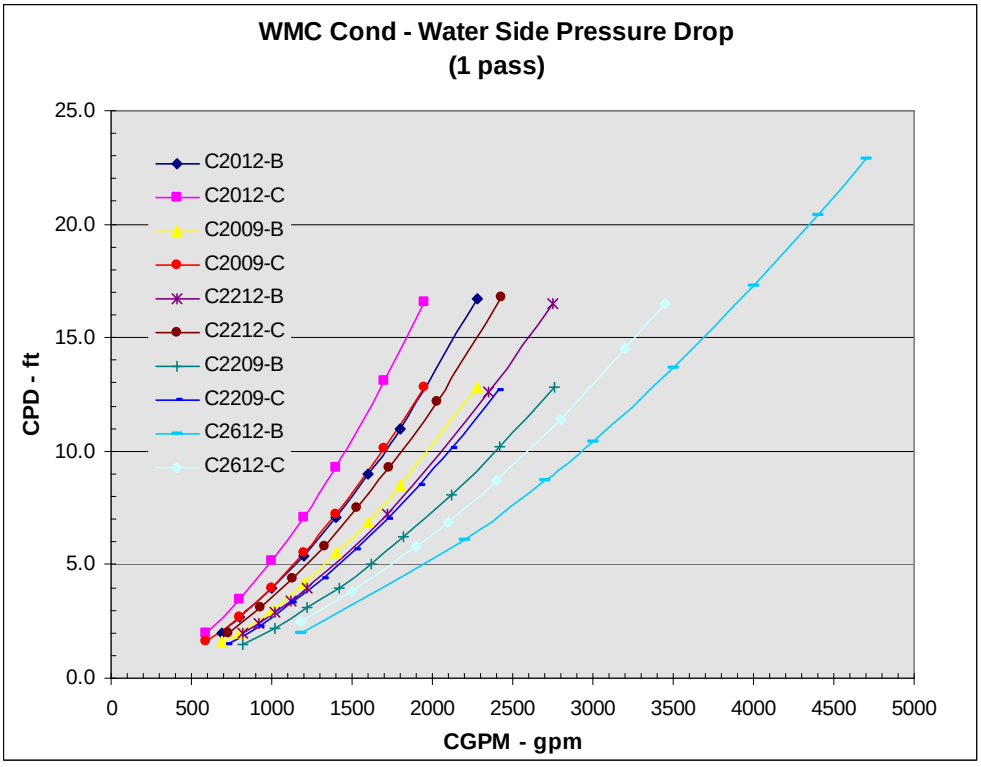


Figure 24, 2-Pass Evaporators

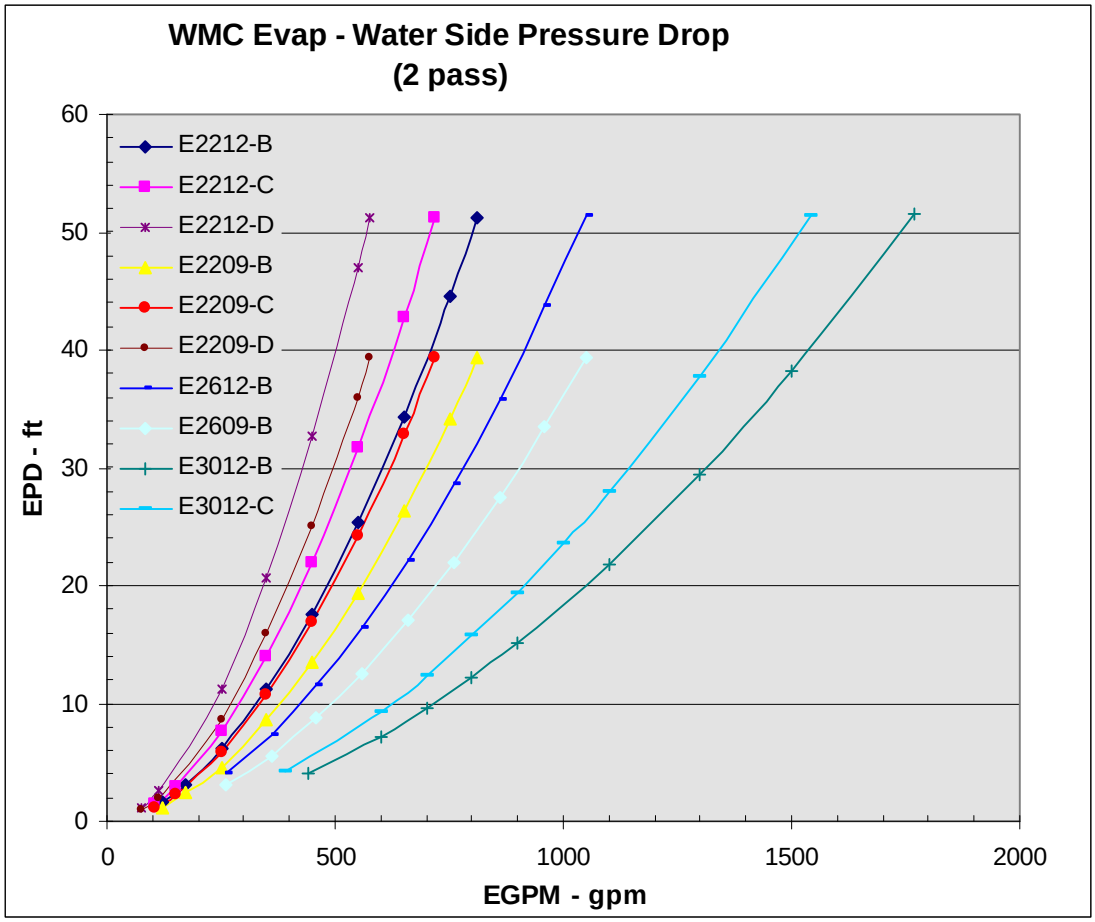


Figure 25, 2-Pass Condensers

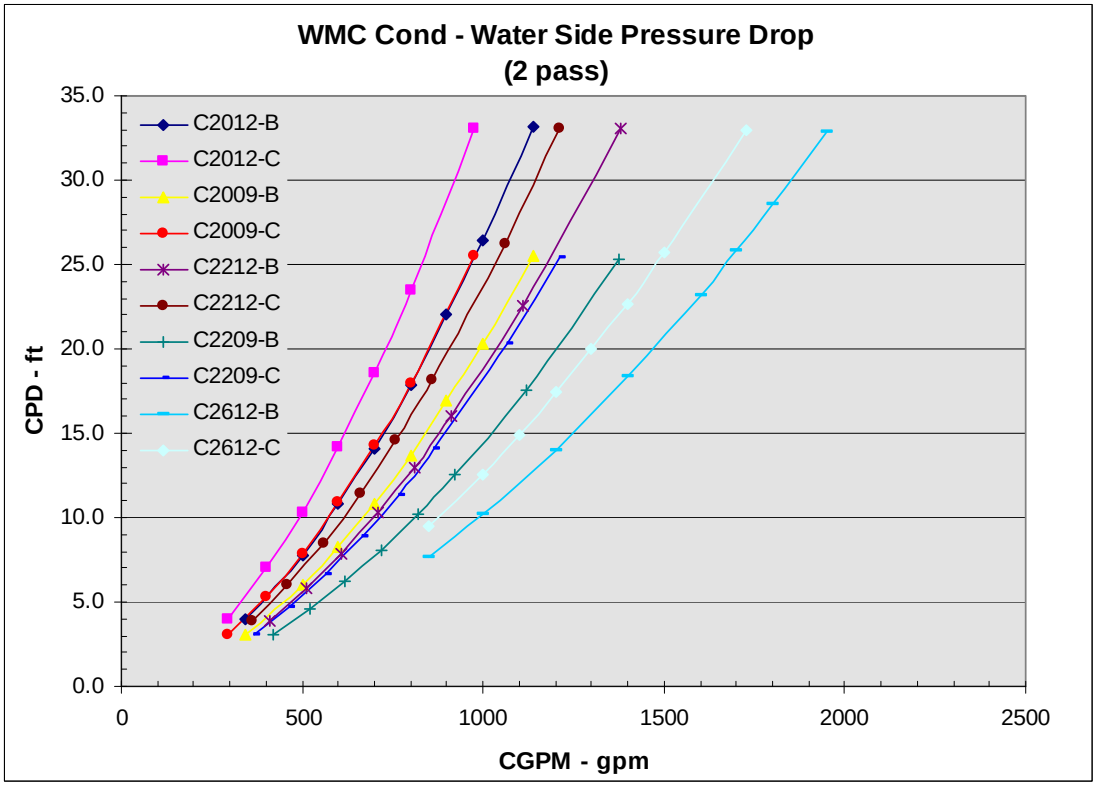


Figure 26, 3-Pass Evaporators

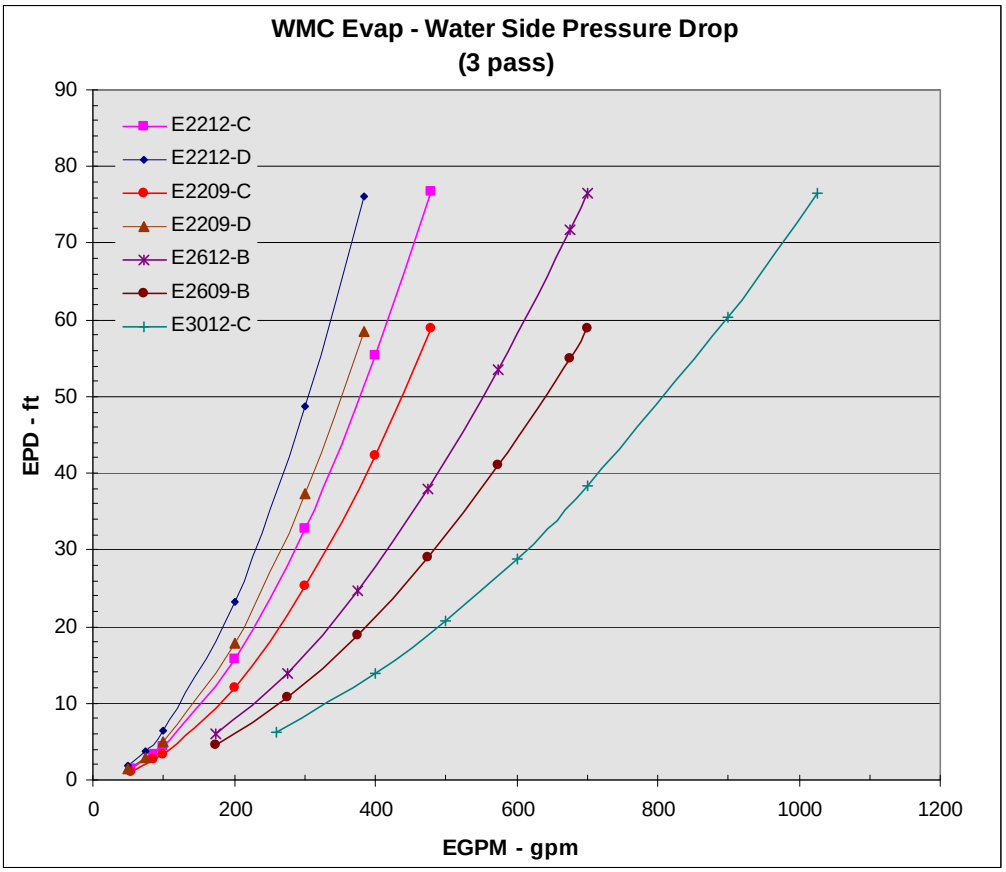
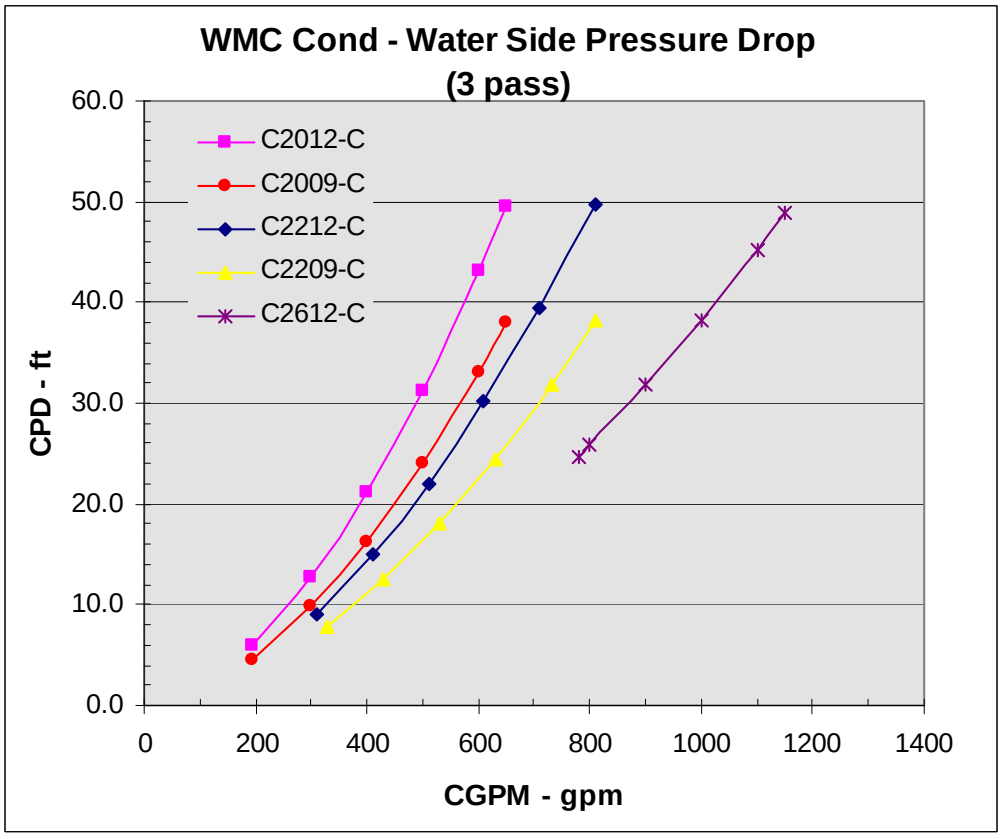


Figure 27, 3-Pass Condensers



Options and Accessories

Vessels

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

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

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

Single insulation, 3/4 inch, on evaporator (including heads) and suction piping
Insulation, either optional factory-installed or field-installed is generally required on all installations.

Double insulation, 1-½ inch, on evaporator (including heads) and suction piping
For high humidity locations and ice making applications.

Special vessel codes
Including Chinese and Canadian Registration (CRN).

Controls

BAS interface module.
Factory-installed on the unit controller for the applicable protocol being used. (Can also be retrofit)

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

Unit

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

Shipping bag
Shrink-wrap bag covers entire unit and protects it from possible dirt and grime accumulation during transit.

Pumpout Unit, with or without storage vessel
Available in a variety of sizes. Details are in Catalog WSCWDC.

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

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

Spring Vibration Isolators
Spring isolators for use in special situations. The unit has extremely low vibration and sound levels without isolators

Witness performance test
The standard full load run test is performed in the presence of the customer under the supervision of a McQuay engineer, includes compilation of the test data. Travel and local expenses are not included.

Certified performance test
The standard run test is performed under the supervision of a McQuay engineer; data is compiled and certified.

Approvals/listings
ARI Approval and ETL/CETL listing is standard. MEA is optional.

Electrical

Multi-point power connection

Provides separate power leads to each compressor power panel on two compressor units in lieu of standard single-point power to the unit terminal box.

High short circuit current rating

65 kA (at 460 V) panel rating available only on single point connection with either power block or disconnect switch. Applies to the two main unit power panels.

Harmonic filter

Field-installed option. See page 38 for details.

EMI filter

Factory-installed option. Radio interference filter. See page 38 for details.

Ground Fault Protection

Protects equipment from arcing ground fault damage from line-to-ground fault currents less than those required for conductor protection.

Refrigerant Recovery Units

Although McQuay chillers can pump the entire refrigerant charge into the condenser and valve it off, there are occasions when pumpout units are required, due purely to specification requirements or unusual job considerations.

McQuay offers two sizes of refrigerant recovery units (Model RRU) and one recovery unit that is factory mounted on a storage vessel (Model PRU). Recovery units are ETL listed. Capacities for R-22 are ARI certified. The storage tank is designed, constructed and stamped in accordance with ASME standards.

Model RRU Refrigerant Recovery Units

Model	(1) R-22 Liquid Transfer Rate lb/m (kg/m)	(1) R 22 Vapor Transfer Rate lb/m (kg/m)	Comp. HP	(2) Chiller Tons (kW)	Weight lbs (kg)	Dimensions L x W x H Inch (cm)	Electrical
RRU134-5	55 (25)	1.56 (0.71)	1.5	300 (1050)	115 (52)	21 x 14 x 19 (53 x 36 x 68)	1/50-60/110-115
RRU134-3	55 (25)	1.56 (0.71)	1.5	300 (1050)	115 (52)	21 x 14 x 19 (53 x 36 x 68)	1/50-60/220-230
RRU570-3	325 (148)	6.0 (2.7)	3	1000 (3500)	190 (86)	26 x 25 45 (66 x 63 x 114)	1/50-60/220-230
RRU570-V	325 (148)	6.0 (2.7)	3	1000 (3500)	190 (86)	26 x 25 45 (66 x 63 x 114)	3/50-60/220-230
RRU570-R	325 (148)	6.0 (2.7)	3	1000 (3500)	190 (86)	26 x 25 45 (66 x 63 x 114)	3/50-60/360-460
RRU570-D	325 (148)	6.0 (2.7)	3	1000 (3500)	190 (86)	26 x 25 45 (66 x 63 x 114)	3/60/575

Size and Specifications

NOTES:
1. Transfer rate for R-22 is ARI certified. R-134a capacity is given below in each unit's description.
2. Suggested maximum chiller capacity.

Refrigerant Compatibility

Units are suitable for use with the following refrigerants normally found on McQuay chillers; R-12, R-22, R-134a, R-410A, and R-500.

Standard Equipment

Equipment	Model	
	RRU134	RRU570
Power Cord	X	X
Filter-Driers	(2) 30 cu. in.	(1) 48 cu. in
Electromechanical Control	X	X
Hoses	(4) 10 ft.	(1) 10 ft + (2) 20 ft
Reducing Fittings		X
12 ft. Tank Float Switch Cable		X
Connection Sizes	½ in. Flare	¾ in. Flare

Model RRU134

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

MODEL RRU570

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

Model PRU Packaged Recovery Units

The Model RRU134 transfer unit can be factory-mounted on a storage vessel providing a packaged unit with a R-134a transfer capacity of 55 lb/min liquid and 1.34 lb/min of vapor combined with a storage vessel with a capacity of 2105 pounds of R-134a. Includes (2) 20-ft. hoses.

Model	R-22 Liquid Transfer Rate lb/m (kg/m)	R-22 Vapor Transfer Rate lb/m (kg/m)	Unit				Electrical
			Weight lb (kg)	Length in (cm)	Width in (cm)	Height in (cm)	
PRU134-5	55 (25)	1.56 (0.71)	770 (349)	94 (239)	30 (76)	55 (139)	1/50-60/110-115
PRU134-3	55 (25)	1.56 (0.71)	770 (349)	94 (239)	30 (76)	55 (139)	1/50-60/220-230

Accessories

RHK-120 1.25 in. x 10 ft. hose with ball valves

RHK-240 1.25 in. x 20 ft. hose with ball valves

Refrigerant Monitors

- Detects all halogen based refrigerants
- Optional analog output for remote monitoring
- Visual alarm indication
- Fresh air inlet for automatic re-zeroing
- ETL listed
- Continuous digital display of system status
- System malfunction detection and indication
- Can sample up to 250 feet (76 meters) away
- Multi-unit capability in a single monitor
- UL STD 3101-1 and CAN/CSA 1010.1

MODELS

Model RM-1 1 Zone Monitor

Model RM-4 4 Zone Monitor

Model RM-8 8 Zone Monitor

Model RM-16 16 Zone Model

SPECIFICATIONS

Sensitivity: As low as 1 PPM

Range: 0 to 1000 PPM

Weight: 25 lbs. (11 kg)

Power: 120/240 Volt, 50/60 Hz

Operating Environment: 32°F-125°F

Size: W=16.5in. D=6.75in. H=15in.

Alarm Trip Points (Percent of Full Scale): Low Alarm=0 to 100, Main Alarm=0 to 100, High Alarm=100

Alarm Outputs: Indicator Light, Alarm Relays, RS232 Computer Interface

OPTIONS and ACCESSORIES

Analog Output, 4-20 ma (RMA-AO)

Remote Horn, 120V (RMA-H)

Plastic Pick-up Tubing, ¼ inch OD, 250 ft. Reel (RMA-T)

Course Replacement Filter (RMA-CF) *

Remote Strobe Light, 120 V (RMA-L)

Remote Light and Horn Set (RMA-LH)

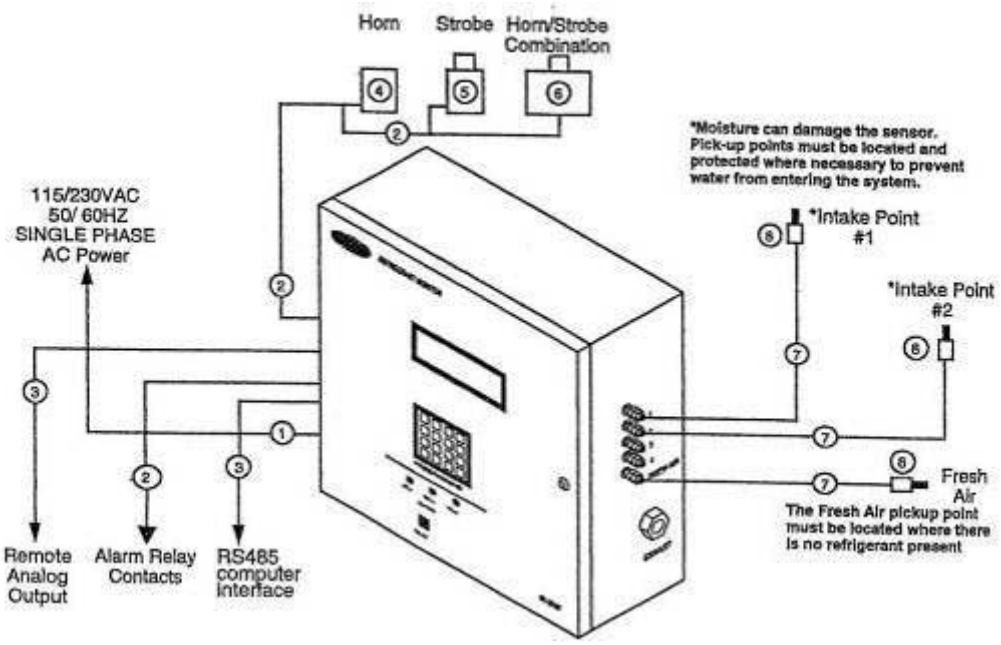
Diaphragm Pump (RMA-P) *

5 Micron Replacement Filter (RMA-F) *

(*) Replacement parts. Original pump and filters are shipped with unit.

SYSTEM DESCRIPTION							
Item	**Description**	**Required**	**Supplied with Unit**	**Supplied by Customer**	**Optional**	**Available from McQuay**	**Comments**
1	16 gauge 3 conductor wire	Yes	No	Yes		No	
2	18 or 22 gauge 2 conductor cable	No			Yes	No	Required for horn, strobe, or combination
3	2 conductor twisted pair shielded cable	No			Yes	No	Required for remote analog output
4	Remote horn	No			Yes	Yes	
5	Remote strobe light	No			Yes	Yes	
6	Remote horn and strobe light set	No			Yes	Yes	
7	1/4 in. x 1/8 in. ID plastic pick-up tubing	Yes	No			Yes	Available in 250 foot reels
8	Course filter	Yes	Yes				For mounting at the end of the tubing

Figure 28, Refrigerant Monitor Diagram



Specifications

SECTION 15XXX
MAGNETIC BEARING CENTRIFUGAL CHILLERS

PART 1 — GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

Comply with the following codes and standards

ARI 550/590	NEC
ANSI/ASHRAE 15	OSHA as adopted by the State
	ASME Section VIII

1.3 SUBMITTALS

Submittals shall include the following:

A. Dimensioned plan and elevation view, including required clearances, and location of all field piping and electrical connections.

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

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

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

E Installation and Operating Manuals.

1.4 QUALITY ASSURANCE

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

B. Chiller manufacturer plant shall be ISO Certified.

C. The chiller shall be tested to job conditions at the manufacturer's plant.

1.5 DELIVERY AND HANDLING

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

-- Or --

A. (For Type IV Knockdown) The compressor(s), control panel, and compressor power panel(s) shall be removed at the factory and shipped on skids. The stripped vessel stack shall be shipped as a single piece. Discharge piping, liquid line and the compressor cooling line(s) shall be removed and crated. All associated wiring and piping possible will remain on the vessel stack. The unit shall be shipped without refrigerant, which must be furnished and charged by the installing contractor.

-- Or --

A. (For Type V Knockdown) The unit shall be delivered to the job site completely assembled and charged with refrigerant (pumped down into condenser) and ready for field knockdown, as determined by the installing contractor.

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

1.6 WARRANTY

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

1.7 MAINTENANCE

A. Maintenance of the chillers shall be the responsibility of the owner.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. McQuay International

B. (Approved Equal)

2.2 UNIT DESCRIPTION

Provide and install as shown on the plans a factory assembled, charged, water-cooled packaged chiller. Each unit shall be complete with two (one on Model WMC 145) multi-stage, oil-free, magnetic bearing, hermetic centrifugal compressors. Each compressor shall have variable frequency drive operating in concert with inlet guide vanes for optimized unit part load efficiency. The evaporator, condenser, and expansion valve shall be common to both of the compressors. Two-compressor chiller units shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.

Each chiller shall be factory run-tested on an AHRI certified test stand with water at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply. Any deviation in performance or operation shall be remedied prior to shipment and the init retested if necessary to confirm repairs or adjustments.

2.3 DESIGN REQUIREMENTS

A. General: Provide a complete water-cooled, dual hermetic compressor centrifugal water chiller as specified herein. Machine shall be provided according to standards, Section 1.2. In general, unit shall consist of two magnetic bearing, completely oil-free, compressors, refrigerant condenser and evaporator, and control systems including variable frequency drive, operating controls and equipment protection controls. Note: Chillers shall be charged with a refrigerant such as HFC-134a, not subject to phase-out by the Montreal Protocol and the U. S. Clean Air Act.

B. Performance: Refer to schedule on the drawings.

C. Acoustics: Sound pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to ARI Standard 575-87 and shall be in dB. Data shall be the highest levels recorded at all load points.

Octave Band

63	125	250	500	1000	2000	4000	8000	dBa
____	____	____	____	____	____	____	___	____

2.4 CHILLER COMPONENTS

A. Compressors:

1. The unit shall have one or two, two-stage, magnetic bearing, oil-free, hermetic centrifugal compressors. The compressor drive train shall be capable of coming to a controlled, safe stop in the event of a power failure.
2. Movable inlet guide vanes, acting together with variable speed, shall provide unloading. A microprocessor controller, dedicated to each compressor shall coordinate the vane and speed control to provide optimum unit efficiency.

B. Refrigerant Evaporator and Condenser:

1. Evaporator and condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports at a maximum of 18 inch spacing.
2. Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed with Locktite® or equal sealer. The tubes shall be individually replaceable and secured to the intermediate supports without rolling.
3. Provide sufficient isolation valves and condenser volume to hold full refrigerant charge in the condenser during servicing or provide a separate pumpout system and storage tank sufficient to hold the charge of the largest unit being furnished.
4. The water sides shall be designed for a minimum of 150 psig **OR** 300psig or as specified elsewhere. Water vents and drains shall be provided.
5. Evaporator minimum refrigerant temperature shall be 33°F when cooling water.
6. An electronic expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have a moisture indicating sight glass.

7. The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.
8. Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.
9. The evaporator, including water heads, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch **OR** 1 ½ inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.
10. Provide factory-mounted and wired, thermal dispersion water flow switches on each vessel to prevent unit operation with no water flow.
11. Water connections shall be arranged for Victaulic connections **OR** flanged.
12. The evaporator shall have dished heads with valved drain and vent connections **OR** shall be equipped with marine water boxes with removable covers and vent and drain connections.
13. The condenser shall have dished heads with valved drain and vent connections **OR** shall be equipped with marine water boxes with removable covers and vent and drain connections.

C. Prime Mover: Permanent-magnet, synchronous motor of the hermetic type, of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with variable frequency drive operation.

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

E. CHILLER CONTROL

Chiller controls and power equipment shall be located in NEMA 1 enclosures. The unit shall have distributed microprocessor-based control architecture consisting of a 15-inch VGA touch-screen operator interface, a controller for each compressor and a unit controller.

The touch-screen shall display the unit operating parameters, accept setpoint changes (password protected) and be capable of resetting faults and alarms. The following trended parameters shall be displayed:

- Entering and leaving chilled water temps
- Entering and leaving condenser water temps
- Evaporator saturated refrigerant pressure
- Condenser saturated refrigerant pressure
- Percent of 100% speed (per compressor)
- % rated load amps for entire unit

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

Complete fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. The last 25 faults shall be downloadable from the unit's USB port drive. An operating and maintenance manual specific for the unit shall be viewable on the screen and downloadable.

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

System specific, chiller plant architecture software shall be employed to display the chiller, piping, pumps and cooling tower. Chiller plant optimization software for up to 2 chillers shall also be available to provide automatic control of: evaporator and condenser pumps (primary and standby), up to 4 stages of cooling tower fans and a cooling tower modulating bypass valve or cooling tower variable frequency drives.

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

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

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

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

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

F. Power connection shall be single point to a factory-mounted disconnect switch **OR** shall be multipoint to each compressor power panel

2.5. OPTIONAL ITEMS

The following optional items shall be furnished:

1. Export packaging
2. Shipping bag
3. Pumpout unit, with or without storage vessel
4. Refrigerant monitor
5. Extended warranties
6. Witness performance test

PART 3 — EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's requirements, shop drawings, and Contract Documents.
B. Adjust chiller alignment on foundations, or subbases as called for on drawings.
C. Arrange piping to allow for dismantling to permit head removal and tube cleaning.
D. Coordinate electrical installation with electrical contractor.
E. Coordinate controls with control contractor.
F. Provide all material required for a fully operational and functional chiller.

3.2 START-UP

A. Units shall be factory charged with the proper refrigerant.
B. Factory Start-Up Services: Provide for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

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