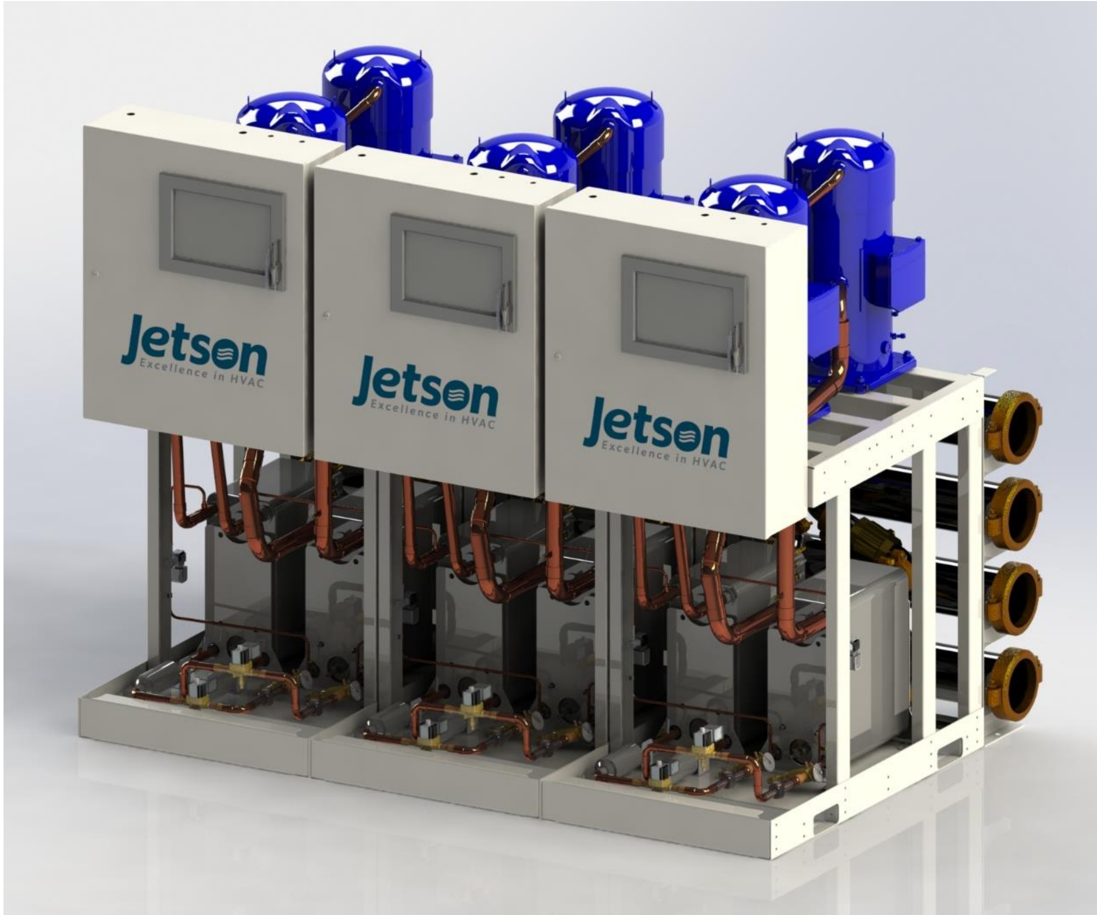
FWCD Series Chillers

Installation, Operation, & Maintenance



Jetson
Excellence in HVAC

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

Attention should be paid to the following statements:

NOTE - Notes are intended to clarify the unit installation, operation and maintenance.

⚠ **CAUTION** - Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.

⚠ **WARNING** - Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ **DANGER** - Danger statements are given to prevent actions that will result in equipment damage, property damage, severe personal injury or death.

WARNING

ELECTRIC SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in dangerous operation, serious injury, death or property damage.
Improper servicing could result in dangerous operation, serious injury, death, or property damage.

- Before servicing, disconnect all electrical power to the furnace. More than one disconnect may be provided.
- When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.
- Verify proper operation after servicing. Secure all doors with key-lock or nut and bolt.

WARNING

QUALIFIED INSTALLER

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a trained service technician. A copy of this manual should be kept with the unit.

CAUTION

PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-410A and other refrigerants, even in trace amounts, in a PVC or CPVC piping system will result in stress cracking of the piping and fittings and complete piping system failure.

WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.

When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.

If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.

1. Startup and service must be performed by a trained service technician.

2. Every unit has a unique equipment nameplate with electrical, operational, and unit clearance specifications. Always refer to the unit nameplate for specific ratings unique to the model you have purchased.

3. READ THE ENTIRE INSTALLATION, OPERATION AND MAINTENANCE MANUAL. OTHER IMPORTANT SAFETY PRECAUTIONS ARE PROVIDED THROUGHOUT THIS MANUAL.

4. Keep this manual and all literature safeguarded near or on the unit.

Contents

Model Number Descriptions

Digits 1 to 4— Model
FWCD

Digits 5 to 7 — Nominal Capacity
020 = 20 Nominal Tons
030 = 30 Nominal Tons
045 = 45 Nominal Tons
055 = 55 Nominal Tons
065 = 65 Nominal Tons
075 = 75 Nominal Tons
085 = 85 Nominal Tons

Digit 8 — Unit Voltage
A = 208 V/60 Hz/3 Phase
B = 230 V/60 Hz/3 Phase
F = 460 V/60 Hz/3 Phase
G = 575 V/60 Hz/3 Phase

Digits 9 — Unit Application
A = Water-Cooled Chiller
B = Compressor Chiller with Remote Condenser (40°F to 115°F)
D = Compressor Chiller with Remote Condenser (20°F)

Digit 10 — Refrigeration Style
A = R-410A Scroll

Digit 11 — Number of Circuits
1 = Single Circuit
2 = Dual Circuit

Digit 12 — Efficiency/Capacity
1 = Standard Efficiency
2 = High Capacity Evaporator (allows 40F leaving water)

Digit 13 — Design Sequence
0 = Factory Assigned

Digit 14 — Array System
0 = Non-Array System
1 = Array System

Digit 15 — Evaporator Heat Exchanger Type
0 = Brazed Plate

Digit 16 — Evaporator Fluid Type
0 = Water
2 = Ethylene Glycol
3 = Propylene Glycol

Digit 17 — Evaporator Flow
0 = Constant Flow Primary
1 = Variable Flow Primary

Digit 18 — Evaporator Temperature Range
0 = Standard Cooling
40 to 65°F [5.5 to 18.3°C]
1 = Standard Cooling/Ice Making
20 to 65°F [-6.7 to 18.3°C]

Digit 19 — Evaporator Control Valves
0 = No Valves (Standalone Chiller)
1 = Manual Balancing Isolating Valves
2 = Motorized Chilled Water Isolating Valve

Digit 20 — Condenser Heat Exchanger Type
0 = Brazed Plate
1 = Shell and Tube
5 = Remote Condenser

Digit 21— Condenser Fluid Type
0 = Water
2 = Ethylene Glycol
3 = Propylene Glycol
9 = Not Applicable — Compressor-Chiller

Digit 22 — Condenser Heat Recovery
0 = No Heat Recovery
1 = Heat Recovery

Digit 23 — Condenser Corrosion Resistance
0 = Standard
1 = Cupro-Nickel (Avail. Shell and Tube Only)

Digit 24 — Condenser Control Valves
0 = No Valves (Standalone Chiller)
1 = Manual Valve
2 = Motorized Head Pressure Control Valve

Digit 25 — Power Feed
0 = Single Point Power (5 kA Rating)
A = Single Point Power (5 kA Rating) + Phase and Voltage Monitor
B = Single Point Power (100 kA Rating)
C = Single Point Power (100 kA Rating) + Phase and Voltage Monitor
D = Power Feed to Each Unit (5 kA Rating)
E = Power Feed to Each Unit (5 kA Rating) + Phase and Voltage Monitor
F = Power Feed to Each Unit (100 kA Rating)
G = Power Feed to Each Unit (100 kA Rating) + Phase and Voltage Monitor

Digit 26 — Power Connection
0 = Terminal Block
A = Non-Fused Disconnect Switch
B = Fused Disconnect Switch
C = High SCCR Fuse Block
D = Distribution Panel Connection = Terminal Block; Module Power Connection = Circuit Breaker

Digit 27 — Service Options
0 = None
A = LED Lighted Control Cabinet

Digit 28 — Panel Ampere Rating
0 = None
D = 250 Amp
E = 400 Amp
F = 600 Amp
G = 800 Amp
H = 1200 Amp

Digit 29 — Control Style
0 = Master Secondary Controller w/ Single Controller per Array
A = Supervisory Array Controller w/ Controller per Module
B = Non-Array, Single Unit Controller

Digit 30 — Local Unit Controller Interface
0 = Keypad with Dot Pixel Display
B = 15.4-in. Color Touchscreen

Digit 31 — Remote BMS Interface (Digital Comm)
0 = None
2 = Lon Talk®
4 = BACnet® MS/TP
5 = BACnet® IP
6 = MODBUS®
8 = Johnson N2

Digit 32 — Blank
0 = Blank

Digit 33 — Blank
0 = Blank

Digit 34 — Refrigeration Options
1 = Active Freeze Protection (All Circuits)
2 = Hot Gas Bypass (All Circuits)

Digit 35 — Refrigeration Accessories
0 = Moisture Indicating Sight Glass
A = Moisture Indicating Sight Glass + Compressor Isolation Valves
B = Moisture Indicating Sight Glass + Replaceable Core Filter Driers
C = Moisture Indicating Sight Glass + Replaceable Core Filter Driers + Compressor Isolation Valves

Digit 36 — Water Connection
0 = Grooved Pipe Connection, Standard Header Length
A = Grooved Pipe Connection, Extended Header Length
D = No Header Piping (Heat Exchangers Only)

Digit 37 — Water Side Pressure
0 = 150 psi
A = 300 psi

Digit 38 — Water Strainer(s)
0 = None
A = Chilled Water Flow Wye Strainer
B = Chilled Water Wye Strainer with Installation Kit
C = Condenser Water Flow Wye Strainer
D = Condenser Water Wye Strainer with Installation Kit
E = Chilled and Condenser Water Nominal Flow Wye Strainer
F = Chilled and Condenser Water Wye Strainer with Installation Kit

Digit 39 — Water Accessories
0 = Chilled Water Flow Switch
A = Condenser Water Flow Switch
B = Analog Water Temperature Gauge
C = Analog Water Pressure Gauge
D = Chilled Water Flow Switch + Condenser Water Flow Switch
E = Chilled Water Flow Switch + Analog Water Temperature Gauge
F = Chilled Water Flow Switch + Analog Water Pressure Gauge
G = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Temperature Gauge
H = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Pressure Gauge
J = Chilled Water Flow Switch + Analog Water Temperature Gauge + Analog Water Pressure Gauge
K = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Temperature Gauge + Analog Water Pressure Gauge

Digit 40 — Blank
0 = Blank

Digit 41 — Sound Attenuator
0 = None
A = Compressor Sound Blankets
B = Factory Sound Enclosure Cabinet
C = Compressor Sound Blankets + Factory Sound Enclosure Cabinet

Digit 42 — Unit Mounting
0 = None
A = Neoprene Pads
B = Leveling Kit
C = Casters/Wheels
D = Neoprene Pads and Casters/Wheels
E = Neoprene Pads and Leveling Kit

Digit 43 — Exterior Finish and Shipping Splits
0 = Standard Paint, Each Module Packaged Separately
B = Custom Paint, Each Module Packaged Separately

Digit 44 — Shipping Options
A = Framed Crate with Plastic Wrap (Non-Shrink)
D = Fully Enclosed Crate

Digit 45 — Warranty
0 = Standard Warranty

Digit 46 — Special Options
0 = None
X = With Specials

Digits 5 to 7 — Nominal Capacity

The first numbers of the model string designate nominal tons cooling. Actual capacities will vary with conditions.

Table 1 - Model Sizes

<table>
<tr><th>Model</th><th>Nominal Tons at AHRI</th><th>Compressors</th><th>Circuits</th></tr>
<tr><td>FWCD-020</td><td>20.5</td><td rowspan="7">2</td><td rowspan="5">1 or 2</td></tr>
<tr><td>FWCD-030</td><td>31.5</td></tr>
<tr><td>FWCD-045</td><td>42.7</td></tr>
<tr><td>FWCD-055</td><td>52.4</td></tr>
<tr><td>FWCD-065</td><td>65.6</td></tr>
<tr><td>FWCD-075</td><td>75.1</td><td>2</td></tr>
<tr><td>FWCD-085</td><td>84.8</td><td>2</td></tr>
</table>

**Note: The nominal capacities reflect the use of R-410A refrigerant and a standard heat exchanger.*

Digit 8 — Unit Voltage

All units have single point power blocks with grounding lugs and 12V control circuits.
A = *208 V/60 Hz/3 Phase*
B = *230 V/60 Hz/3 Phase*
F = *460 V/60 Hz/3 Phase*
G = *575 V/60 Hz/3 Phase*

Digit 9 — Unit Application

A = Water-Cooled Chiller – Standard water-cooled chiller with optional shell and tube condenser or brazed plate condenser and brazed plate evaporator.
B = Compressor Chiller with Remote Condenser – FWCD chillers can be configured without a condenser and mated with an air-cooled condenser.

Digit 10 — Refrigerant Style

A = *R-410A Scroll*

Digit 11 — Number of Circuits

1 = Single Circuit – Two compressors per module are piped on a single, tandem circuit to single circuit evaporators and condenser.
2 = Dual Circuit – Two compressors per module are piped independently to dual circuit evaporator and condenser.

Digit 12 — Efficiency/Capacity

1 = Standard Efficiency – Standard sized evaporator.
2 = High Capacity Evaporator – High capacity evaporator for glycol applications or for 40F leaving water applications.

Digit 13 — Design Sequence

0 = Factory Assigned

Digit 14 — Array System

0 = Non-Array System – FWCD chillers can be applied in standalone applications needing between 20 to 75 tons of cooling. In standalone applications, chiller headers are not required and the “no header” option can be selected in Digit 36.
1 = Array System - More than one FWCD modular chiller may be piped together (to form an array of chillers) for higher capacity and/or redundant chiller applications, an array controller package must be provided from the factory. The number of modular chillers that can be physically piped together to form an array and share a common header is limited to approximately 300 total tons or 900 gpm.

Digit 15 — Evaporator Heat Exchanger Type

0 = Brazed Plate - Brazed plate heat exchangers are one of the most efficient ways to transfer heat. They are designed to provide unparalleled performance with the lowest life-cycle cost.

Digit 16 — Evaporator Fluid Type

0 = Water
2 = Ethylene Glycol
3 = Propylene Glycol

Digit 17 — Evaporator Flow

0 = Constant Flow Primary - Constant flow pumping systems utilize a staged cooling system and a constant flow water pumping system. No modules are isolated at part load. Flow from “off” chillers mixes with the flow from active chillers in creating the leaving array temperature. The load may not be less than 25% of the full load in constant flow applications.
1 = Variable Flow Primary - Variable flow systems utilize compressor staging and motorized isolation valves with a variable flow water pumping system to modulate cooling and water flow to meet chilled water needs and save operating energy costs. Cooling capacity is modulated by staging

compressors and isolating modules based on the desired leaving water temperature. Water flow control is field provided and is usually modulated with VFD controlled variable flow primary pumps based on the differential pressure across the water system.

Digit 18 — Evaporator Temperature Range

0 = Standard Cooling 40 to 65°F [5.5 to 18.3°C] – The chiller with *standard* evaporator must not be operated with a leaving water temperature of less than 42°F for a plain water application. The chiller with *high capacity* evaporator must not be operated with a leaving water temperature of less than 40°F for a plain water application.
1 = Standard Cooling/Ice Making 20 to 65°F [-6.7 to 18.3°C] - The dual roles of an ice-making chiller can substantially reduce the installed cost of the system. An ice-making chiller is NOT a conventional chiller with two different leaving-fluid temperature setpoints. An ice-making chiller operates at maximum capacity when in ice-making mode. It continues to operate at maximum capacity until the leaving-fluid temperature reaches the target setpoint. At a 10°F delta across the evaporator, this limit indicates that all of the water inside the ice storage tanks has been frozen. An external signal can be sent to the chiller to reset the chilled water setpoint back to conventional chilled water leaving fluid temperature and the chiller will return to traditional chiller operation.

Digit 19 — Evaporator Control Valves

0 = No Valves (Standalone Chiller) – Balancing / isolating valves are not required when chiller is used in single unit configuration.
1 = Manual Balancing Isolating Valves - For a proper hydronic balance in a constant flow system, manual balancing valves are factory installed in array headers. These valves can also be used to isolate a module in an array for service or cleaning.
2 = Motorized Chilled Water Isolating Valve - Variable flow systems isolate modules not needed to meet current cooling or heating capacity by isolating modules with a factory installed motorized on-off valve.

Digit 20 — Condenser Heat Exchanger Type

0 = Brazed Plate – Brazed plate heat exchanger with grooved pipe water connections.
1 = Shell and Tube - Shell and tube heat exchanger with grooved pipe water connections.
5 = Remote Condenser – Water-cooled condenser is removed and discharge and liquid line connections are provided for connection to remote air-cooled condenser.

Digit 21— Condenser Fluid Type

0 = Water
2 = Ethylene Glycol
3 = Propylene Glycol
9 = Not Applicable — Compressor-Chiller

Digit 22 — Condenser Heat Recovery

0 = No Heat Recovery – Chiller operates to maintain chilled water temperature. Condenser water temperature is unmonitored.
1 = Heat Recovery - Instead of rejecting heat to the cooling tower, heat is recovered from the condenser water and can be used in many commercial facilities for preheating incoming air, washing, showering, and other everyday usage. Such facilities include:

- Hospitals, laundry, showers, and sterilization (often separate from other systems)
- Dormitories: laundry, showers, and general usage
- Hotels: laundry, showers, pool heat, and general usage

All of these facilities require large quantities of makeup water that must be heated.

Digit 23 — Condenser Corrosion Resistance

0 = Standard
1 = Cupro-Nickel (Avail. Shell and Tube Only) - In applications that can cause chemical corrosion, galvanic corrosion and erosion, the FWCD Series chiller is available with a shell and tube condenser that has high-resistance material tubes consisting of cupro-nickel (Cu/Ni 90/10).

Digit 24 — Condenser Control Valves

0 = No Valves (Standalone Chiller) – Balancing / isolating valves are not required when chiller is used in single unit configuration.
1 = Manual Valve - For a proper hydronic balance in a constant flow system, manual balancing valves are factory installed in array headers. These valves can also be used to isolate a module in an array for service or cleaning.
2 = Motorized Head Pressure Control Valve - The integral condenser water regulating valve option is available to stabilize and maintain the refrigerant condensing pressure within the operating limits of the FWCD Series modular chiller. The valve will replace one of the manual isolating valves that come standard on every chiller and can also be used to isolate the condenser from the cooling water circuit when needed.

Digit 25 — Power Feed

0 = Single Point Power (5 kA Rating) - This option reduces the amount of installation labor by eliminating the need to run separate power to each module in the chiller array. A single connection point is provided to power the array. With this option, the array of chillers is delivered with a separate power panel enclosure. This separate enclosure includes the electrical lug to land the incoming power cables. The cabinet has circuit breakers for each module in the array. Power wiring will be distributed to each chiller module through a wire chase that is part of each individual chiller control panel. Upon installation, the factory supplied electrical whips will be routed to each module through control panels. Conduits are also factory provided to encase the power wiring as it is routed between one chiller module and the next.

A = Single Point Power (5 kA Rating) + Phase and Voltage Monitor - This option includes the single-point power distribution panel. A factory-installed phase/power monitor designed to protect the chiller from premature failure and damage due to common voltage faults such as voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling is included.
B = Single Point Power (100 kA Rating) - Short-circuit current ratings provide the level of fault current that a component or piece of equipment can safely withstand (based on a fire and shock hazard external to the enclosure). A 100kA SCCR can have significant impact in meeting safety and insurance requirements.
C = Single Point Power (100 kA Rating) + Phase and Voltage Monitor - This option includes the single-point power distribution panel and each unit is rate for 100ka SCCR. A factory-installed phase/power monitor designed to protect the chiller from premature failure and damage due to common voltage faults such as voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling is included.
D = Power Feed to Each Unit (5 kA Rating) – Power is field provided to each chiller module in the array. This is beneficial in applications where redundancy or dual point power is desirable or to allow for smaller electrical feeds instead of a large single electrical feed.
E = Power Feed to Each Unit (5 kA Rating) + Phase and Voltage Monitor - This option includes field provided power and an additional factory-installed phase/power monitor designed to protect the chiller from premature failure and damage due to common voltage faults such as voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling.
F = Power Feed to Each Unit (100 kA Rating) - Short-circuit current ratings provide the level of fault current that a component or piece of equipment can safely withstand (based on a fire and shock hazard external to the enclosure). A 100kA SCCR can have significant impact in meeting safety and insurance requirements.
G = Power Feed to Each Unit (100 kA Rating) + Phase and Voltage Monitor - This option includes field provided power and an additional factory-installed phase/power monitor designed to protect the chiller from premature failure and damage due to common voltage faults such as voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling.

Digit 26 — Power Connection

0 = Terminal Block - Terminal Block to land incoming power wiring.
A = Non-Fused Disconnect Switch - Non-fusible disconnect switches do not incorporate fuses into their enclosure and provide no circuit protection capability. The purpose of a non-fusible safety switch is to provide an easy means to open and close a circuit.
B = Fused Disconnect Switch - Fusible disconnect switches combine fuses with the switch in a single enclosure, providing an easy means to manually open and close the circuit while the fuses protect against overcurrent.
C = High SCCR Fuse Block - Short-circuit current ratings provide the level of fault current that a component or piece of equipment can safely withstand (based on a fire and shock hazard external to the enclosure). A 100kA SCCR can have significant impact in meeting safety and insurance requirements.
D = Distribution Panel Connection = Terminal Block; Module Power Connection = Circuit Breaker – This feature is used for the single point power options in Digit 25. Factory provided panelboard serves as a power distribution panelboard for chiller array.

Digit 27 — Service Options

0 = None
A = LED Lighted Control Cabinet - LED lights provide bright lighting inside enclosure offer with long service life and can provide improve safety and visibility when service inside the enclosure is needed.

Digit 28 — Panel Ampere Rating

Panelboard rating for single point power. Panel is factory sized and provide when single point power option is selected.
0 = None
D = 250 Amp
E = 400 Amp
F = 600 Amp
G = 800 Amp
H = 1200 Amp

Digit 29 — Control Style

0 = Master Secondary Controller w/ Single Controller per Array - This option allows up to six (6) FWCD modular chillers to be controlled and operated. The Master-Secondary Array Controller requires only a single controller for the array. This option is beneficial in replacement applications where a single larger chiller, with one controller, is replaced by modular chillers controlled with one controller.
A = Supervisory Array Controller w/ Controller per Module - This option allows up to ten (10) FWCD modular chillers to be controlled and operated. The Supervisory Array Controller requires each module have an individual unit controller. This option is beneficial in applications requiring seven (7) or more modules to be controlled and in applications where chiller uptime is critical. If communication between the individual FWCD modular chiller unit controller(s) and the Supervisory Array Controller is lost, or the Supervisory Array Controller fails, the individual FWCD modular chillers can be shifted into manual mode to operate independent from the Supervisory Array Controller and will maintain a “manual mode” default chilled leaving water temperature set point.
B = Non-Array, Single Unit Controller – Standalone Controller has control board with twelve 0-5vdc sensor inputs, four 5vdc digital inputs, ten 230vac 6.3amp relay outputs, four 0-10vdc analog outputs, keypad, 128 x 64 dot pixel STN monochrome graphics LCD with 2.8" diagonal viewing area, real time clock, MCS-I/O, RS-232, RS-485 and Ethernet communication ports.

Digit 30 — Local Unit Controller Interface

0 = Keypad with Dot Pixel Display - keypad, 128 x 64 dot pixel STN monochrome graphics LCD with 2.8" diagonal viewing area

B = 15.4-in. Color Touchscreen - Information and graphics are shown on high resolution (1280x800) LCD display with LED back lighting. The high-resolution screen makes it easy for the user to manage complex installations without losing the overall view or requiring a separate laptop. Pages can be navigated in a fast and straightforward manner.

Digit 31 — Remote BMS Interface (Digital Comm)

0 = None
2 = Lon Talk®
4 = BACnet® MS/TP
5 = BACnet® IP
6 = MODBUS®
8 = Johnson N2

Digit 32 — Blank

0 = Blank

Digit 33 — Blank

0 = Blank

Digit 34 — Refrigeration Options

1 = Active Freeze Protection (All Circuits) – Active freeze protection is a suction pressure-based freeze protection. Active Freeze Protection is standard on all FWCD Series chillers. The chiller's unit controller continually monitors the saturated suction pressure and will open (energize) the Active Freeze Protection solenoid if the suction pressure falls to approximately 101 psig (32°F). The solenoid closes (de-energizes) when the pressure climbs to approximately 105 psig (34°F) and the freezing potential no longer exists.
2 = Hot Gas Bypass (All Circuits) - Hot gas bypass can stabilize the system balance point by diverting hot, high- pressure refrigerant vapor from the discharge line directly to the low-pressure side of the system. This tactic keeps the compressor more fully loaded while the evaporator satisfies the part-load condition. The Jetson Active Freeze Protection can be configured to function as Hot Gas Bypass by configuring the controller to monitor both the leaving water temperature and the suction temperature. In Hot Gas Bypass operating mode, the Active Freeze Protection provides an additional step of capacity.

Digit 35 — Refrigeration Accessories

0 = Moisture Indicating Sight Glass - The sight glass shows if the liquid line has a full line of liquid or if it has bubbles which shows it's a liquid/vapor mix. It should not be used to determine

proper charge. The moisture indicator shows if the system is dry or if it has harmful moisture content.
A = Moisture Indicating Sight Glass + Compressor Isolation Valves – In addition to the Moisture Indicating Sight Glass, ball type Compressor Isolation Valves are mounted on the cooling circuit discharge and liquid lines permitting isolation of the compressors and filter driers for service or replacement. The valves are located close to the compressors. The valve works through a quarter turn from open to closed. Teflon seals and gaskets are used with a nylon cap gasket to prevent accidental loss. This option reduces the amount of refrigerant that must be recovered during compressor service or replacement.
B = Moisture Indicating Sight Glass + Replaceable Core Filter Driers - In addition to the Moisture Indicating Sight Glass, Replaceable Core Filter Driers allow for easy changeout of the filter-drier element.
C = Moisture Indicating Sight Glass + Replaceable Core Filter Driers + Compressor Isolation Valves

Digit 36 — Water Connection

0 = Grooved Pipe Connection, Standard Header Length
A = Grooved Pipe Connection, Extended Header Length – To provide additional spacing beyond the standard ¾” between modules, **t**he Grooved Pipe Connection, Extended Header Length Kit consists of grooved pipe couplings and spacer pipe to allow for easy installation of water manifold units.
D = No Header Piping (Heat Exchangers Only) – When chiller is used in standalone operation (i.e., single module) an array header is not necessary. It is a cost savings to use the 6” array header only when needed for array applications or it is desirable to keep field piping to a minimum. Field piping can be connected to heat exchangers instead of factory provided header.

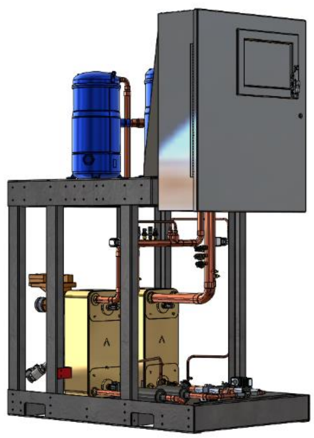


Figure 1 - No Header, Heat Exchangers Only Configuration

Digit 37 — Water Side Pressure

0 = 150 psi
A = 300 psi

Digit 38 — Water Strainer(s)

0 = None
A = Chilled Water Flow Wye Strainer – Factory provided, field installed wye strainer can be placed in a horizontal or vertical pipeline as long as the screen is in a downward position. Straining is accomplished via a 20-mesh lined straining element.
B = Chilled Water Wye Strainer with Installation Kit - Wye strainer installation kits provide piping transitions need to easily attach the wye strainer to the chiller.
C = Condenser Water Flow Wye Strainer – Factory provided, field installed wye strainer can be placed in a horizontal or vertical pipeline as long as the screen is in a downward position. Straining is accomplished via a 20-mesh lined straining element.
D = Condenser Water Wye Strainer with Installation Kit - Wye strainer installation kits provide the piping transitions needed to easily attach the wye strainer to the chiller.
E = Chilled and Condenser Water Nominal Flow Wye Strainer
F = Chilled and Condenser Water Wye Strainer with Installation Kit

Digit 39 — Water Accessories

0 = Chilled Water Flow Switch - An evaporator flow-proving device is required for all FWCD Series chiller applications. A paddle style liquid flow switch is available with a NEMA Type 4X enclosure for field-installation.
A = Condenser Water Flow Switch - A paddle style liquid flow switch is available with a NEMA Type 4X enclosure for field-installation.
B = Analog Water Temperature Gauge - Temperature gauges are factory installed on water lines to indicate water temperature.
C = Analog Water Pressure Gauge - Pressure gauges are factory installed on water lines to indicate pressure drop across heat exchangers.
D = Chilled Water Flow Switch + Condenser Water Flow Switch
E = Chilled Water Flow Switch + Analog Water Temperature Gauge
F = Chilled Water Flow Switch + Analog Water Pressure Gauge
G = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Temperature Gauge
H = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Pressure Gauge
J = Chilled Water Flow Switch + Analog Water Temperature Gauge + Analog Water Pressure Gauge
K = Chilled Water Flow Switch + Condenser Water Flow Switch + Analog Water Temperature Gauge + Analog Water Pressure Gauge

Digit 40 — Blank

0 = Blank

Digit 41 — Sound Attenuator

0 = None
A = Compressor Sound Blankets - Factory installed Compressor Sound Blankets provide insulated sound covers on each compressor. These blankets dampen compressor generated sound. The blankets can be used alone or in combination with a sound cabinet.
B = Factory Sound Enclosure Cabinet - The sound enclosure is a factory installed option. The panels completely encase the chiller module. The panels, lined with sound absorbing insulation, can be removed for access in case of service and provide a streamlined appearance to the product while in place.
C = Compressor Sound Blankets + Factory Sound Enclosure Cabinet

Digit 42 — Unit Mounting

0 = None
A = Neoprene Pads - In applications that are sensitive to noise and vibration, optional neoprene isolator pads can be provided for load bearing points on a FWCD Series modular chiller.
B = Leveling Kit – A height adjustment mechanism located in each corner of the unit to aid in leveling the chiller and to facilitate connections to existing piping.
C = Casters/Wheels - This option is factory-supplied for field installation and includes swivel wheels for easy unit mobility during installation.
D = Neoprene Pads and Casters/Wheels
E = Neoprene Pads and Leveling Kit

Digit 43 — Exterior Finish and Shipping Splits

0 = Standard Paint, Each Module Packaged Separately – Standard Jetson paint is industrial two-part epoxy direct-to-metal paint.
B = Custom Paint, Each Module Packaged Separately – Custom colors are available for applications requiring FWCD Series chiller to match existing color palettes.

Digit 44 — Shipping Options

A = Framed Crate with Plastic Wrap (Non-Shrink)
D = Fully Enclosed Crate

Digit 45 — Warranty

0 = Standard Warranty – Warranty period is a period of twelve (12) months from date of start-up or eighteen (18) months from date of original shipment, whichever may occur first.

Digit 46 — Special Options

0 = None
X = With Specials

General Information

Unit Description

Model FWCD Series water-cooled chillers are designed for installation on a prepared surface in a suitable, weatherproof location above freezing (32°F). Each unit consists of one or two independent refrigerant circuits, two scroll compressors, a single or dual circuited brazed plate evaporator, a single or dual circuited brazed plate or shell-and-tube condenser and control box with integral control panel—all mounted on a common frame.

Each unit is a completely assembled package that is factory-piped, wired, leak-tested, dehydrated, charged and run-tested for proper control operation before shipment. Water inlet and outlet openings are covered before shipment. FWCD units are shipped with an operating charge of refrigerant and oil.

General Data

Table 2 - General Unit Information

	Unit Size (Nominal Tons)						
	20	30	45	55	65	75	85
Compressors							
Compressor - Quantity/Nominal Size (Tons)	2 / 10 Ton	2 / 15 Ton	2 / 20 Ton	2 / 25 Ton	2 / 30 Ton	1 / 30, 1/40 Ton	2 / 40 Ton
Capacity Steps	2						
Compressor Sound Data (dbA)	81	84	88	89	92	93	94
Compressor Sound Data with Sound Blankets Only (dbA)	75	78	84	85	88	89	90
Number of Circuits	1 or 2						
Evaporator							
Standard – Brazed Plate: Single Circuit - Quantity	1						
Connection Size (Inch)	2 ½						
Max GPM (**Single** Refrigerant Circuit)	72	108	144	180	216	252	288
Min GPM (**Single** Refrigerant Circuit)	24	36	48	60	72	84	96
Optional - Oversize Brazed Plate: Single Circuit - Quantity	1						
Connection Size (Inch)	2 ½						
Max GPM (**Single** Refrigerant Circuit)	72	108	144	180	216	252	NA
Min GPM (**Single** Refrigerant Circuit)	24	36	48	60	72	84	NA
Max Water Pressure (psig)	300						
Standard – Brazed Plate: Dual Circuit - Quantity	1						
Connection Size (Inch)	2 ½						

Max GPM (**Dual** Refrigerant Circuit)	72	108	144	180	216	252	288
Min GPM (**Dual** Refrigerant Circuit)	24	36	48	60	72	84	96
Optional - Oversize Brazed Plate: Dual Circuit - Quantity	1						
Connection Size (Inch)	2 ½						
Max GPM (**Dual** Refrigerant Circuit)	72	108	144	180	216	252	NA
Min GPM (**Dual** Refrigerant Circuit)	24	36	48	60	72	84	NA
Max Water Pressure (psig)	300						

	Unit Size (Nominal Tons)						
	20	30	45	55	65	75	85
Condenser							
Brazed Plate: Single Circuit - Quantity	1						
Connection Size (Inch)	2 ½						
Max GPM (**Single** Refrigerant Circuit)	90	135	180	225	273	273	273
Min GPM (**Single** Refrigerant Circuit)	30	45	60	75	90	105	120
Max Water Pressure (psig)	300						
Brazed Plate: Dual Circuit - Quantity	1						
Connection Size (Inch)	2 ½						
Max GPM (**Dual** Refrigerant Circuit)	90	135	180	225	273	273	273
Min GPM (**Dual** Refrigerant Circuit)	30	45	60	75	90	105	120
Max Water Pressure (psig)	300						
Shell and Tube: Dual Circuit - Quantity	1						
Connection Size (Inch)	2 ½	2 ½	2 ½	3	3	4	4
Max GPM (**Dual** Refrigerant Circuit)	90	135	150	245	245	250	250
Min GPM (**Dual** Refrigerant Circuit)	35	35	35	60	60	85	85
Max Water Pressure (psig)	250						

Unit Components

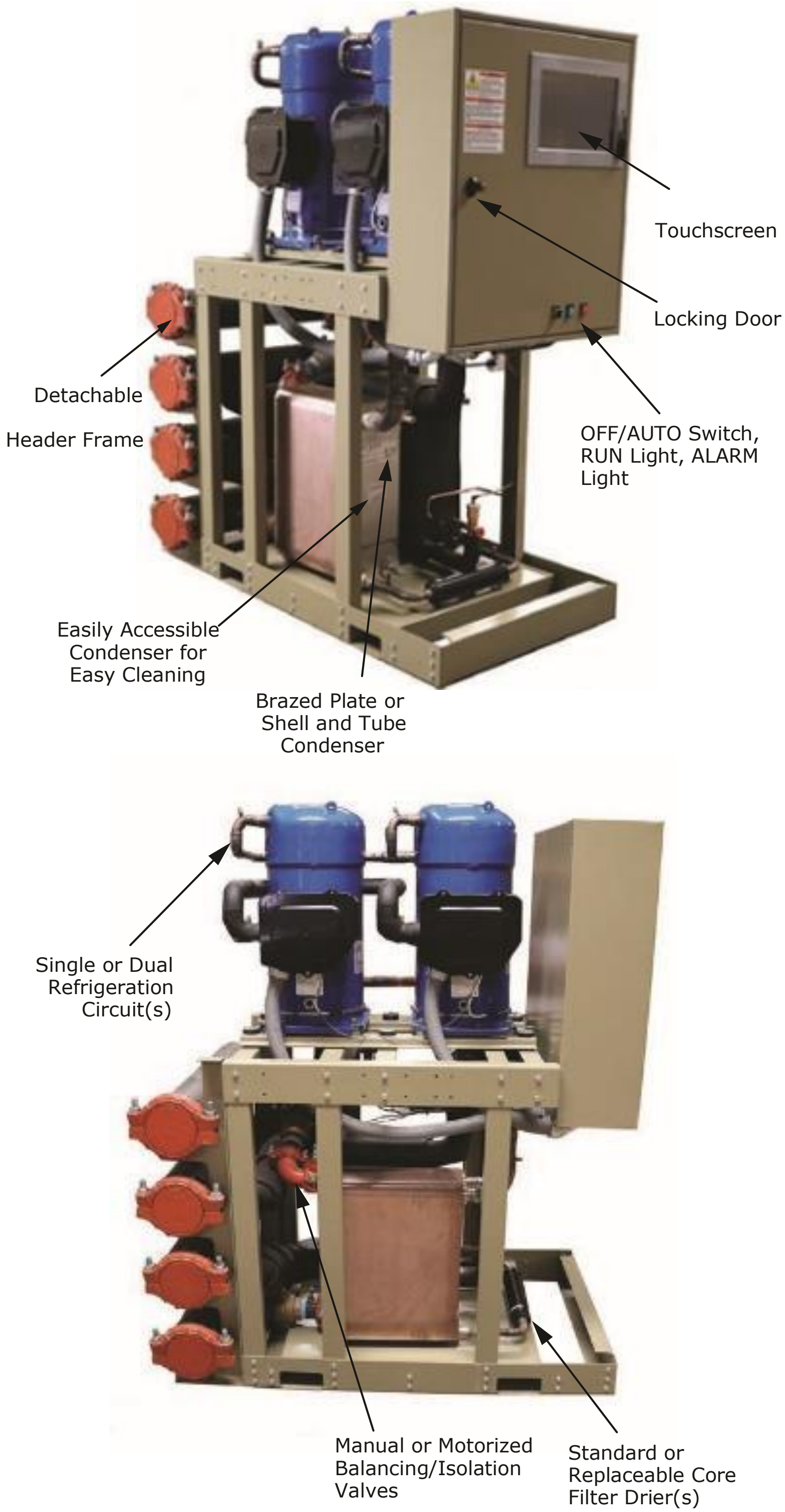


Figure 2 Unit Components

Pre-Installation

To protect against loss due to damage incurred in transit, complete the following checklist upon receipt of the unit. A more in-depth list is included with the packing list adhered to the side of the shipping crate.

- Inspect the individual pieces of the shipment before accepting the unit. Check for obvious damage to the unit or packing material.
- Inspect the unit for concealed damage as soon as possible after delivery and before it is stored. Concealed damage must be reported within 15 days.
- If concealed damage is discovered, stop unpacking the shipment. Do not remove damaged material from the receiving location. Take photos of the damage, if possible. The owner must provide reasonable evidence that the damage did not occur after delivery.
- Notify the carrier's terminal of the damage immediately, by phone and by mail. Request an immediate, joint inspection of the damage with the carrier and the consignee.
- Notify the Jetson sales representative and arrange for repair. However, do not repair the unit until damage is inspected by the carrier's representative.

After completing the inspection checklist, identify the unit with the unit nameplate, packing list and ordering information. The unit nameplate is mounted inside the control box.

Check all items against the shipping list. Verify that it is the correct unit and that it is properly equipped. If optional neoprene pads (or other ship-loose items) are ordered, they are secured in place on the shipping skid or inside the unit control box.

This Installation, Operation and Maintenance manual, the Controls IOM, checklists and other pertinent documents can also be found in the unit control box. Be sure to read all of this literature before installing and operating the unit.

Electrical Service Sizing Data

Use the following table to correctly size the electrical service wiring for the unit(s).

Table 3 FWCD Electrical Data

Unit Size	Voltage	Comp #1 MCC	Comp #2 MCC	Comp #1 LRA	Comp #2 LRA	Comp #1 RLA	Comp #2 RLA	Unit MCA	Unit Max Fuse	Unit Rec. Fuse
20	200-230/3/60	61	61	267	267	39.10	39.10	88	125	100
	460/3/60	29	29	142	142	18.59	18.59	42	60	50
	575/3/60	24	24	103	103	15.38	15.38	35	50	40
30	200-230/3/60	75	75	351	351	48.08	48.08	108	150	125
	460/3/60	39	39	197	197	24.74	24.74	56	80	60
	575/3/60	35	35	135	135	22.44	22.44	51	70	60
45	200-230/3/60	105	105	485	485	67.31	67.31	151	200	175
	460/3/60	51	51	215	215	32.69	32.69	74	100	80
	575/3/60	41	41	175	175	26.28	26.28	59	80	70
55	200-230/3/60	128	128	560	560	82.05	82.05	185	250	225
	460/3/60	62	62	260	260	39.74	39.74	89	125	100
	575/3/60	45	45	210	210	28.85	28.85	65	90	70
65	200-230/3/60	170	170	717	717	108.97	108.97	245	350	250
	460/3/60	79	79	320	320	50.64	50.64	114	150	125
	575/3/60	60	60	235	235	38.46	38.46	87	125	100
75	208/230/3/60	170	190	717	1010	108.97	121.79	261	350	300
	460/3/60	79	106	320	344	50.64	67.95	136	200	150
	575/3/60	60	71	235	327	38.46	45.51	95	125	110
85	208/230/3/60	190	190	1010	1010	121.79	121.79	274	350	300
	460/3/60	106	106	344	344	67.95	67.95	153	200	175
	575/3/60	71	71	327	327	45.51	45.51	102	125	125

Notes:

1. Use copper conductors only.
2. Local codes may take precedence.
3. Voltage Utilization Range: ± 10% of rated voltage. Rated voltage (use range): 200-230/60/3 (180-253), 460/60/3 (414-506), 575/60/3 (517-632).

To size a field supplied distribution panel for an array of chillers, use the following steps.

1. **The Max Fuse or Maximum Overcurrent Protection Device (MOCP) of the electrical distribution panel is as follows:**
    a. To find the MOCP of the electrical distribution panel associated with a bank of chillers follow these steps:
        i. Find the component with the Largest RLA (usually the largest compressor of all of the chillers).
        ii. Calculate MOCP using this formula: MOCP = (2.25 x Largest RLA) + sum of all of the other RLAs. Select the next size down fuse from this value.

    b. <u>Standard Ampere Ratings for Fuses (From NEC Handbook, 240-6)</u>
    The standard ratings for fuses shall be considered 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000 and 4000 amperes.

2. **The recommended fuse size in amps (RFA) is calculated as follows:**
    a. RFA = 1.75* (largest RLA) + (Smallest RLA) for the given bank of chillers.

3. **The MCA of the electrical distribution panel is calculated as follows:**
    a. To find the MCA of the electrical distribution panel associated with a bank of chillers follow these steps:
        i. Find the component with the Largest RLA (usually the largest compressor of all of the chillers).
        ii. Calculate MCA using this formula: MCA = (1.25 x Largest RLA) + sum of all of the other RLAs.
4. **Wiring for main field supply must be rated 75 C.**

Dimensions

Figure 3. FWCD dimensions, brazed plate condenser

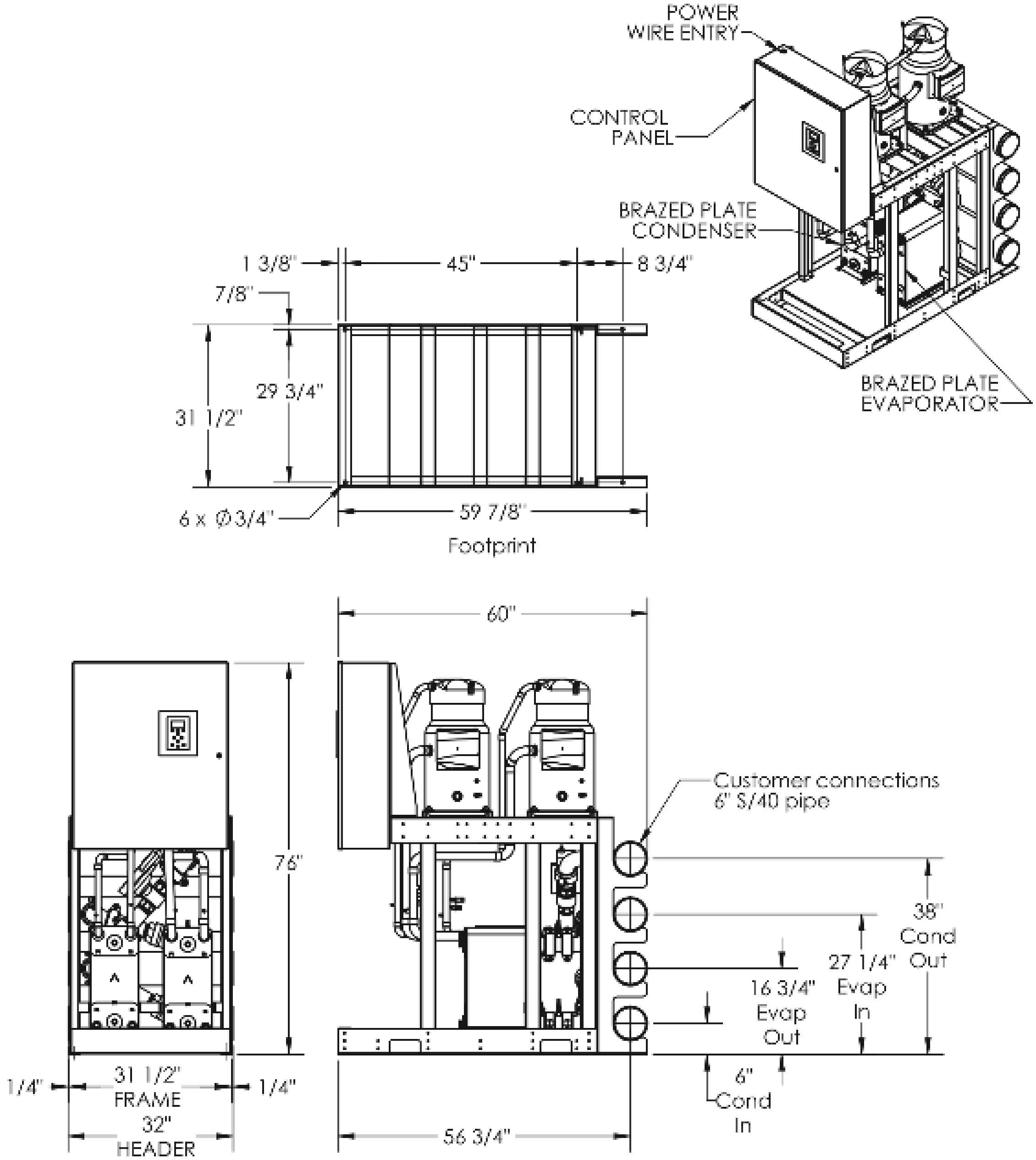


Figure 4. FWCD array dimensions, brazed plate condenser

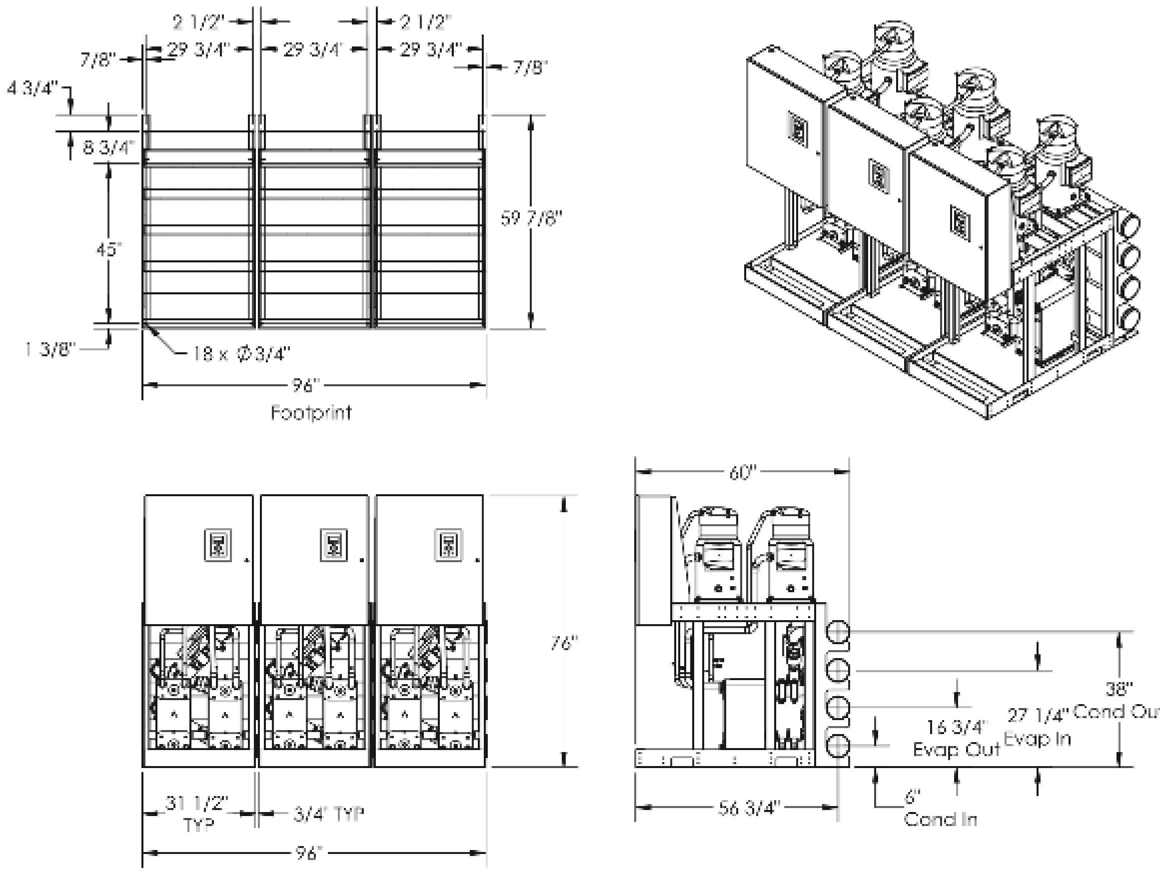


Figure 5. FWCD dimensions, shell and tube condenser

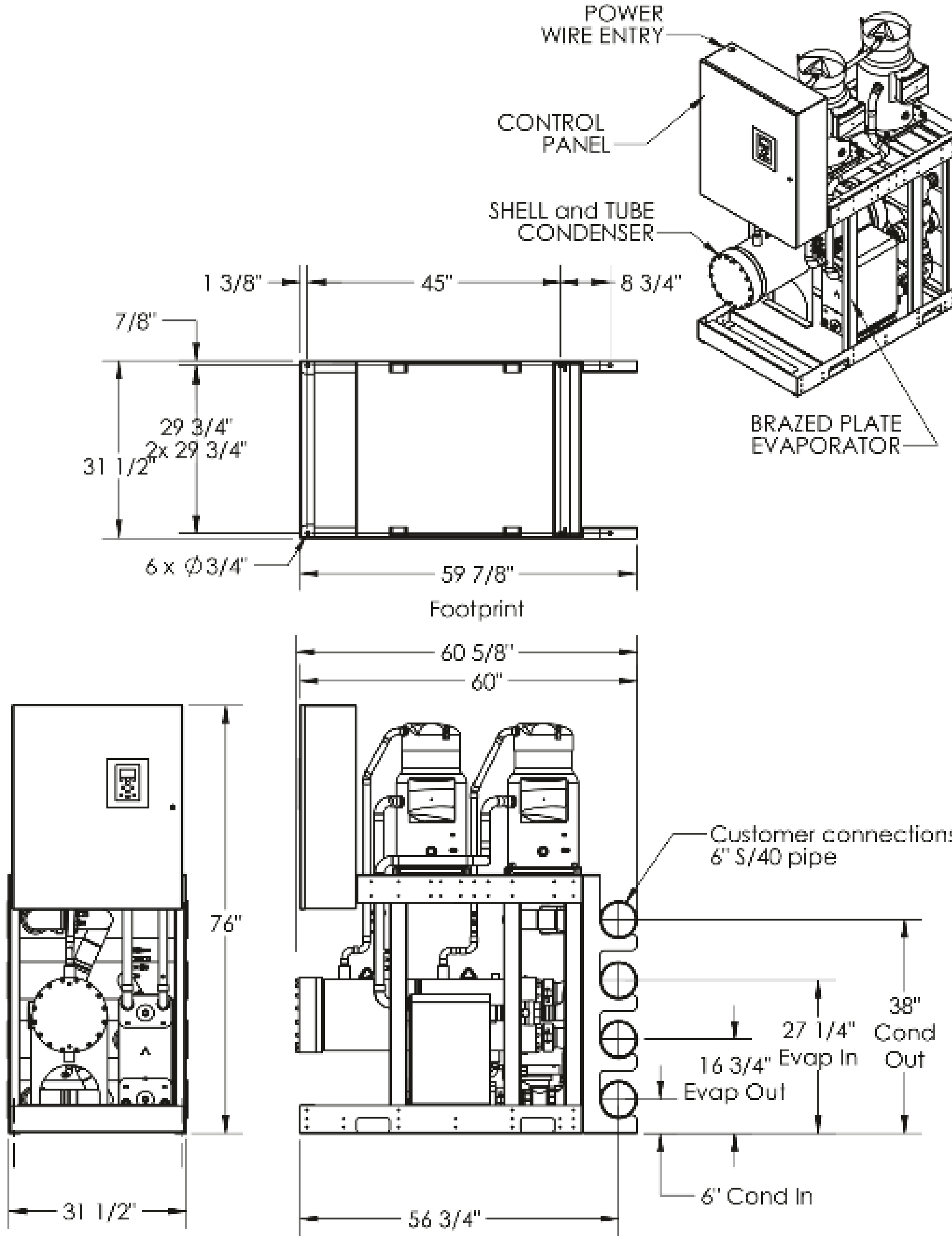


Figure 6. FWCD array dimensions, shell and tube condenser

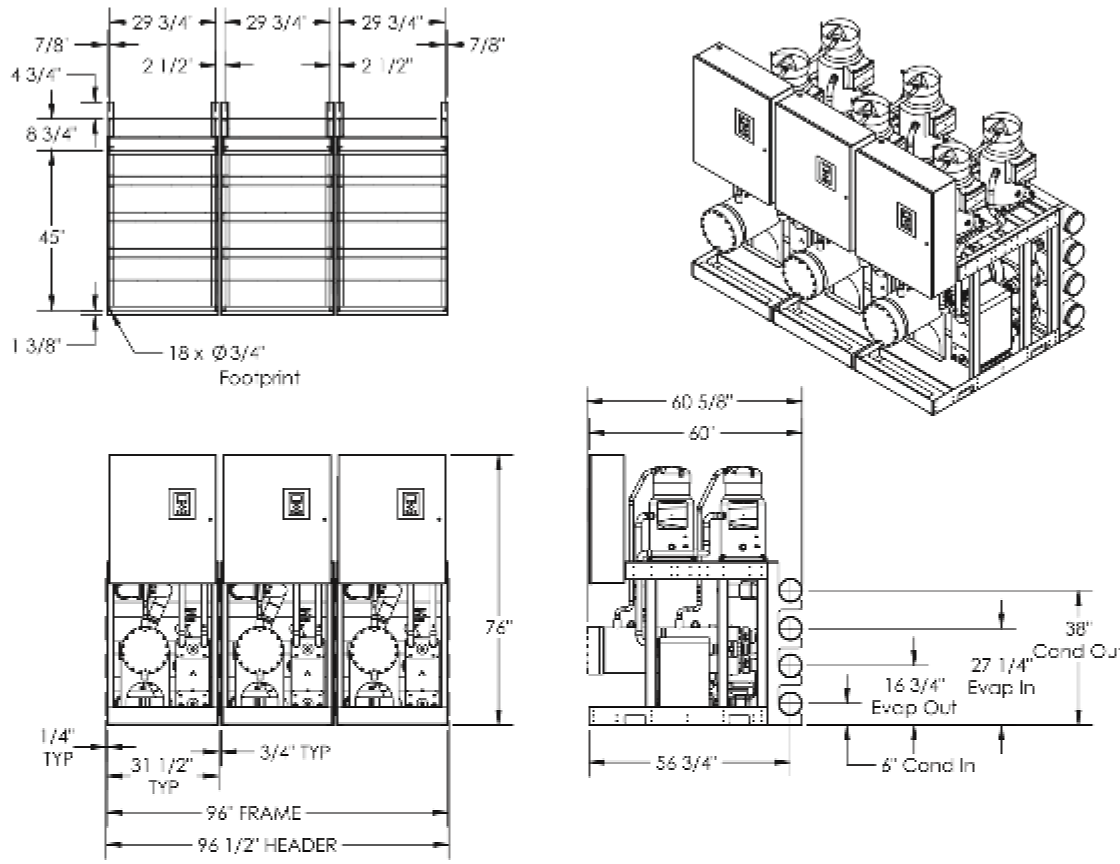


Figure 7. FWCD dimensions, remote condenser

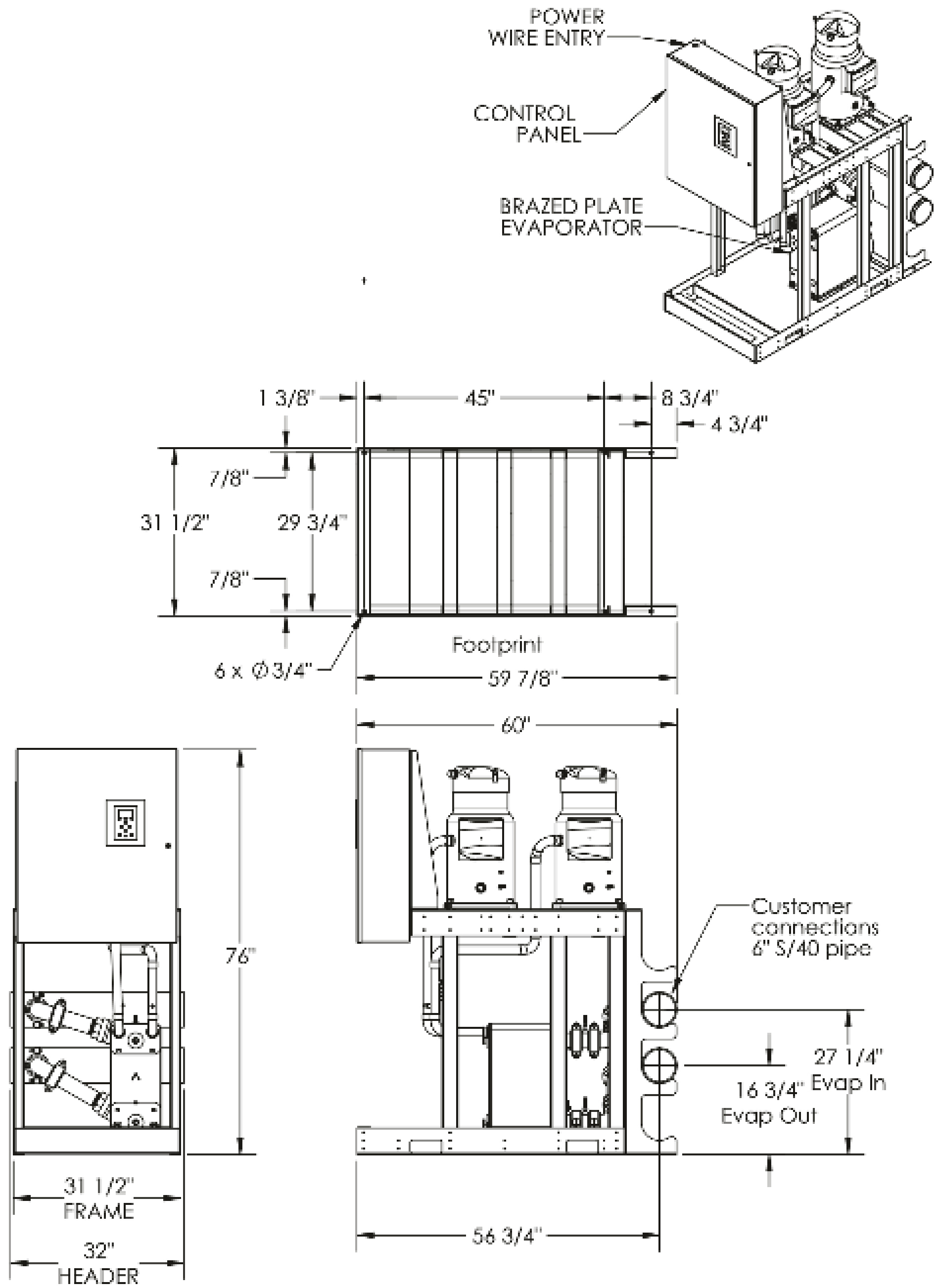
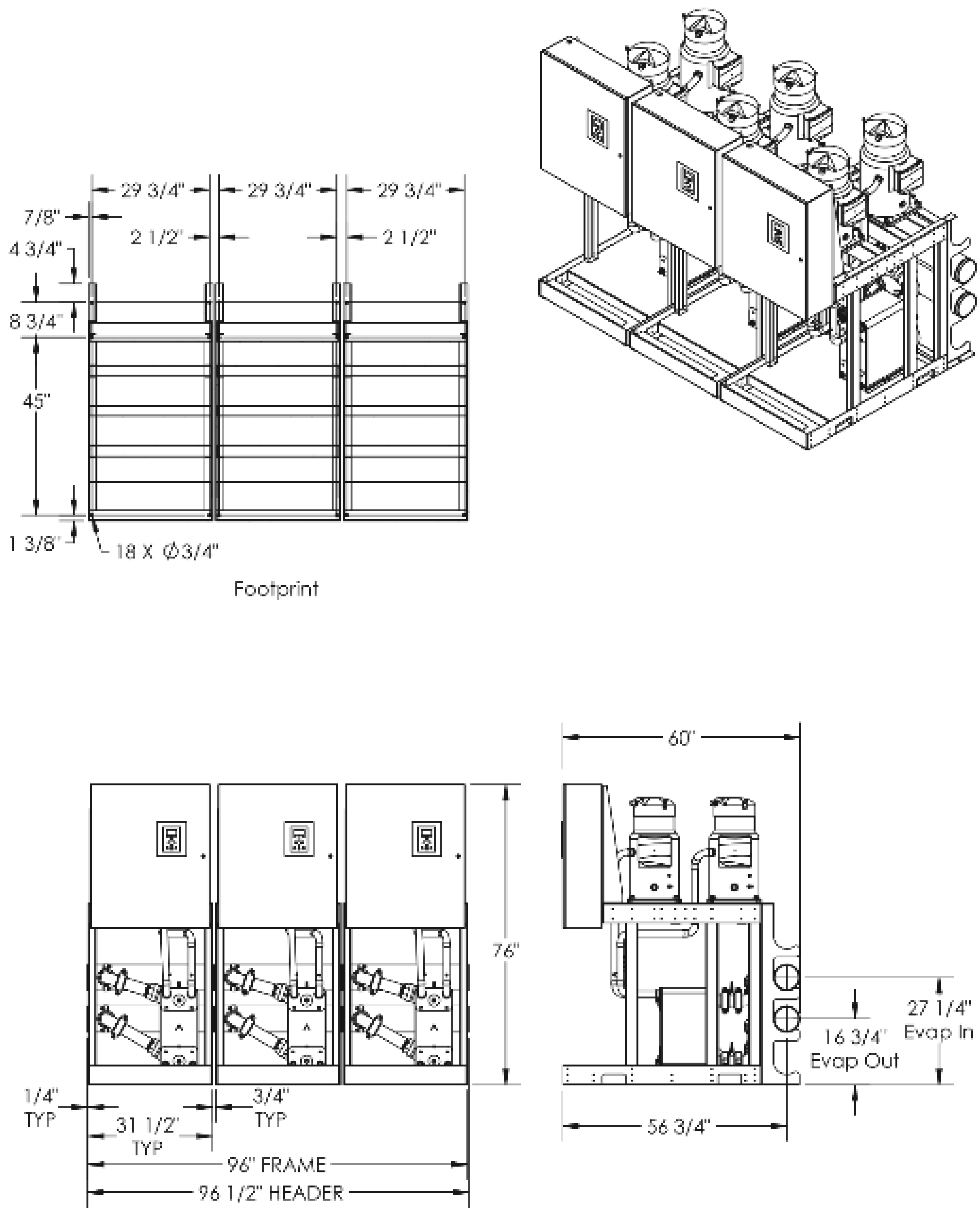


Figure 8. FWCD array dimensions, remote condenser



Clearances

Notes:

- Clearance of 42 inch is required in front of chiller to other electrically grounded parts.
- Two units facing each other or other live parts require a clearance of 48 inches.
- 36-inch clearance is recommended above the chiller
- See Figure 9 and Figure 10, p. 18 for recommended clearance requirements for array installations.

Figure 9. Clearance — FWCD single chiller application (all condenser options)

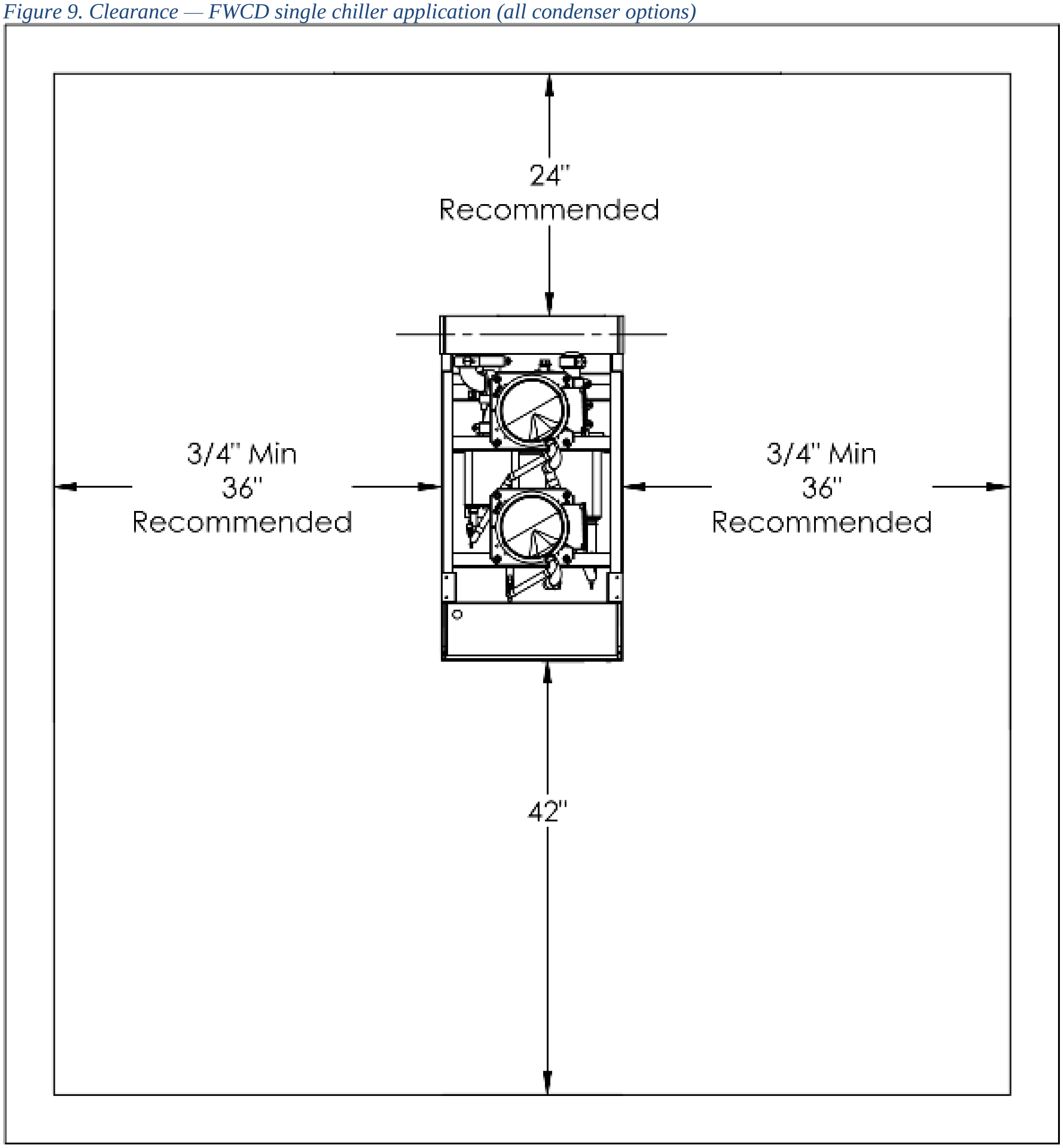


Figure 10. Clearance – FWCD array chiller application (all condenser options)

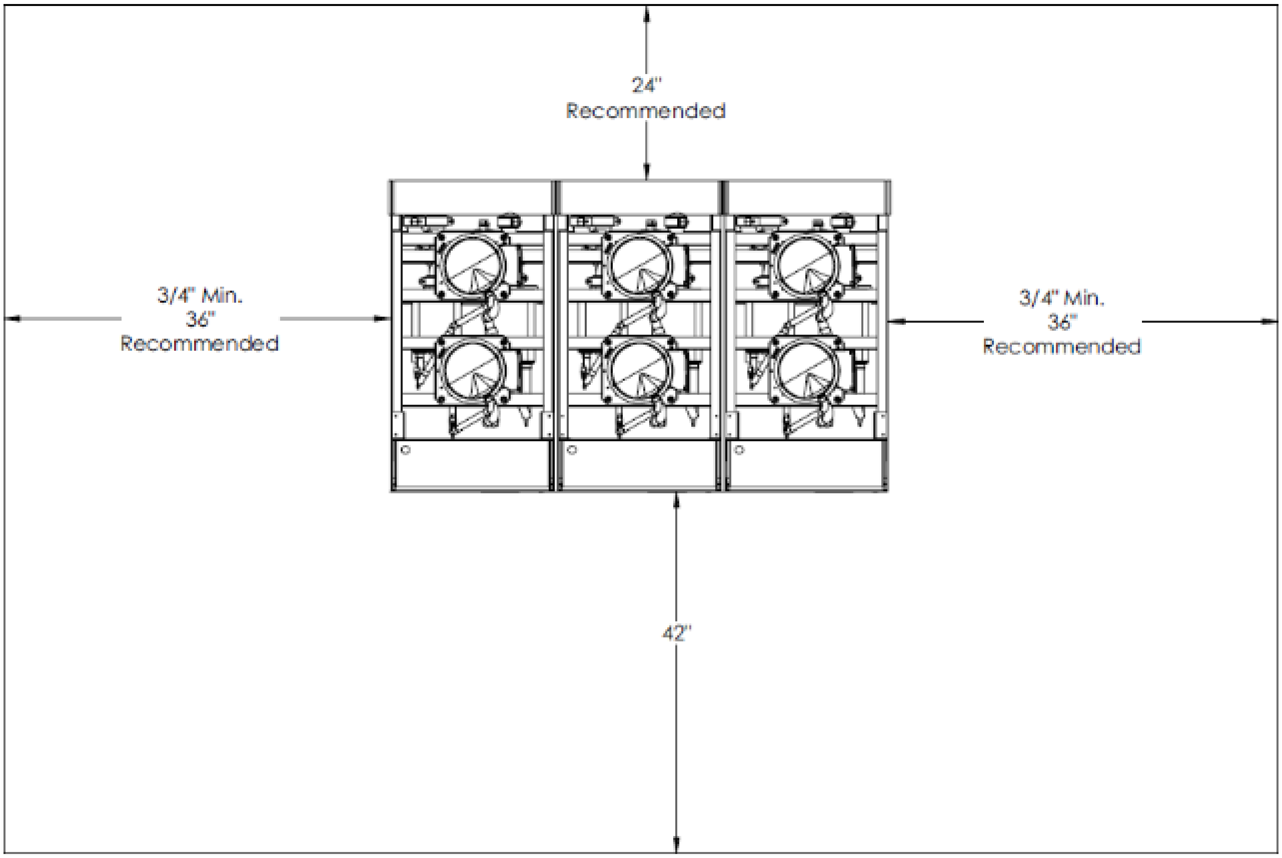


Figure 11. Clearance needed to remove chiller from array – FWCD array chiller application (all condenser options)

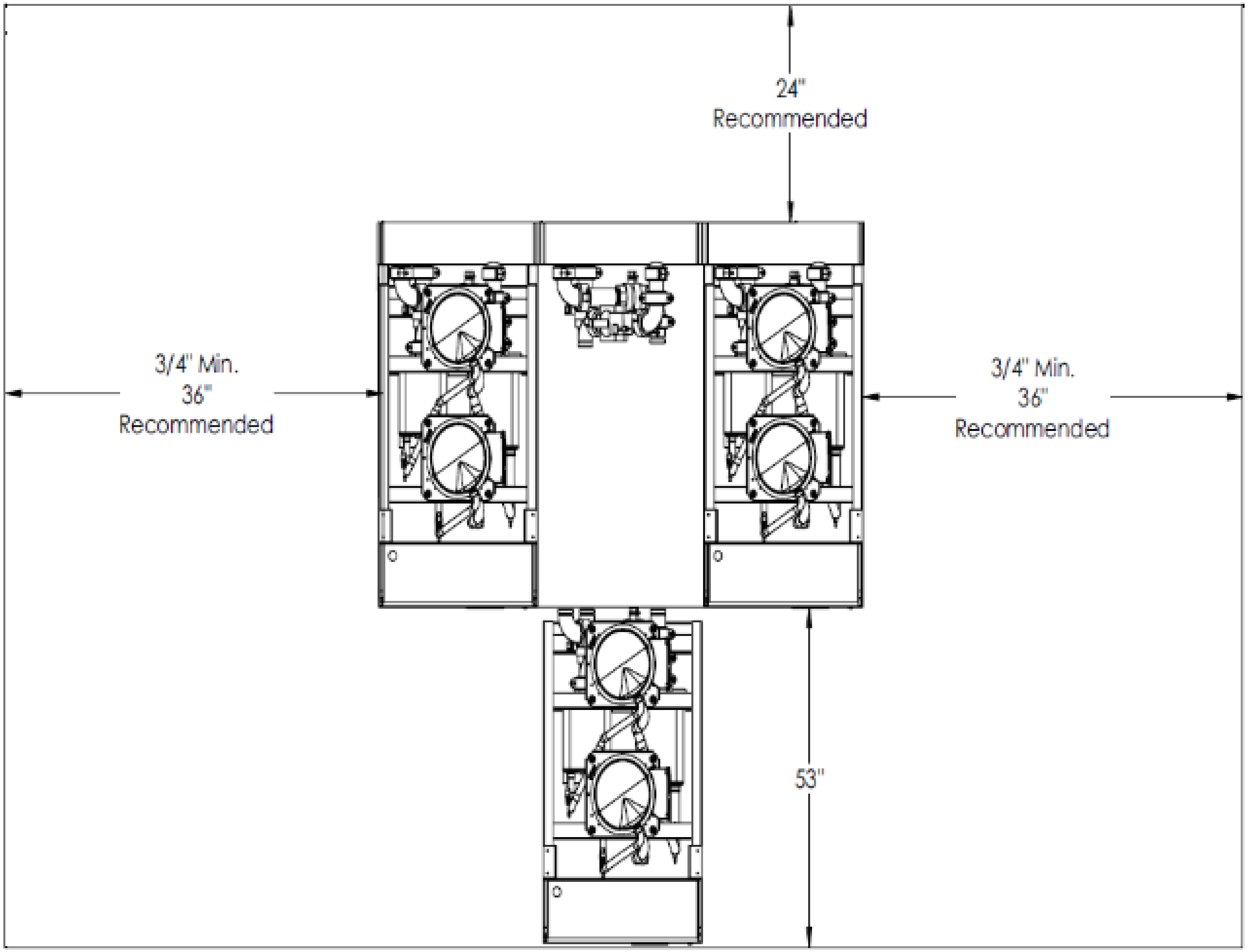
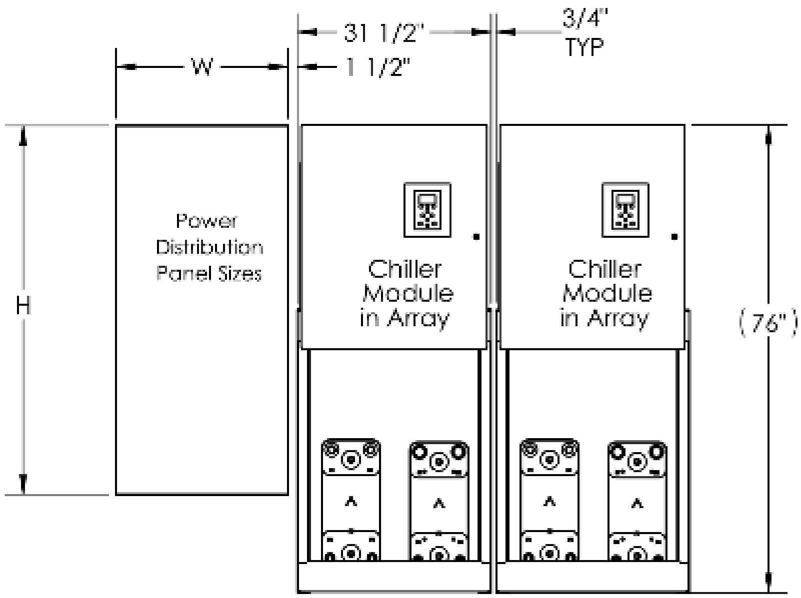


Figure 12. Single point power distribution panel dimensions



Power distribution panel dimensions depend on quantity of units, supply voltage and capacity of units. Contact your sales representative if dimensions are required.

Weights

Table 4. FWCD unit weights

	Shipping Weight						Operating Weight					
	Brazed Plate Condenser		Shell-and-Tube Condenser		Remote Condenser		Brazed Plate Condenser		Shell-and-Tube Condenser		Remote Condenser	
Size	lbs.	kg	lbs.	kg	lbs.	kg	lbs.	kg	lbs.	kg	lbs.	kg
20	1326	601	1467	665	1069	485	1525	692	1688	766	1168	530
30	1495	678	1760	798	1205	547	1720	780	2025	919	1320	599
45	1775	805	1970	894	1420	644	2040	925	2265	1027	1550	703
55	1795	814	1970	894	1410	639	2065	937	2265	1027	1545	701
65	2230	1012	2640	1197	1770	803	2565	1163	3035	1377	1940	880
75	2235	1014	2640	1197	1775	805	2570	1166	3035	1377	1945	882
85	2487	1128	2925	1327	1963	890	2860	1297	3362	1525	2152	976

Application Information

Evaporator Design Data

The system can start and pull down with up to 90°F entering fluid temperature. For continuous operation, it is recommended that the entering fluid temperature not exceed 75°F. The maximum sustained leaving chilled-fluid temperature is 65°F. The chiller with *standard* evaporator must not be operated with a leaving water temperature of less than 42°F for a plain water application. The chiller with *high-capacity* evaporator must not be operated with a leaving water temperature of less than 40°F for a plain water application. For evaporator loops containing the appropriate amount of glycol, the chilled water leaving temperature range can be shifted to 15°F to 65°F. When lower leaving fluid temperatures are required, an appropriate glycol solution must be used. The solution must have a freezing point at least 15°F lower than the design leaving fluid temperature. The brine solution must also be properly inhibited to provide suitable corrosion protection.

The evaporator minimum and maximum flow rates are listed in General Data Table. In general, the listed flow rate ranges will develop temperature differentials across the evaporator between 7°F to 20°F. If your application conditions do not fit these requirements, please contact Jetson Innovations.

For all FWCD Series chiller applications, the flow to the evaporator must be proven using a chilled water flow-proving device. A factory-provided paddle style liquid flow switch is provided with a NEMA Type 4X enclosure for field-installation.

Condenser Design Data

Standard condenser entering water temperature range for the FWCD Series chiller is 65°F to 125°F. The condenser leaving water temperature (LWT) maximum is 125°F for shell-and-tube condensers and 140°F for brazed-plate condensers, and the condenser LWT minimum is 70°F. When the condenser LWT is lower than 70°F, the refrigerant condensing temperature can drop below 80°F and fall outside of the FWCD Series compressor's operating envelope. For these applications, provisions must be made to control the condenser water that results in a stable refrigerant condensing temperature / pressure that remains above 80°F (235 psig) throughout all steady state, part load and transient operating conditions. The integral factory-installed condenser water regulating valve option is ideal for these applications and is highly recommended.

The condenser minimum and maximum flow rates are listed in the General Data table. In general, the listed flow rate ranges will develop temperature differentials across the condenser between 5°F to 30°F. If your application conditions do not fit these requirements, please contact the Jetson Innovations.

All Jetson modular chillers have two compressors in each individual module. Both of these compressors are served by common water flow. In a typical water-cooled application with nominal water flows of 2.4 gpm/ton through the evaporator BPHE (brazed plate heat exchanger) and 3.0 gpm/ton through the condenser, the delta temperature entering and leaving both heat exchangers will be 10°F with both compressors running, and 5°F with one compressor running.

Condenser Heat Recovery Operation

At a time when energy costs are high and continue to rise, reducing energy usage has become increasingly important. By using a FWCD Series chiller with heat recovery, utilization of energy can be improved by using heat from the condenser that would otherwise be wasted.

The use of heat recovery should be considered in any building with simultaneous heating and cooling requirements or in facilities where heat can be stored and used at a later time. Buildings with high year-round internal cooling loads are excellent opportunities for heat recovery. Heat recovery can be accomplished with the FWCD Series by recovering heat from the water leaving the standard condenser and using it in conjunction with a third-party heat exchanger as shown in Figure 13 - Heat Recovery.

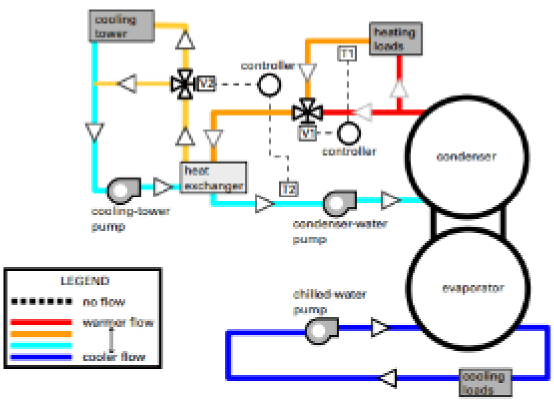


Figure 13 - Heat Recovery

Heat recovery is designed to capture a portion of the heat that is normally rejected to the cooling tower and put it to beneficial use. With the addition of a heat recovery cycle, heat removed from the building cooling load can be transferred to any heating application. The heat recovery cycle is only possible if a cooling load exists to act as a heat source.

The FWCD Series chiller uses smart control logic to switch the control point between the cooling set point and heating set point, based on the smaller of the loads. This allows the machine to operate in heat recovery mode longer - maximizing the energy saved. In the heat recovery cycle, the unit can control to a hot water set point. During the heat recovery cycle, the unit operates just as it does in the cooling-only mode except that the leaving hot water is the control point instead of the leaving chilled water. Water circulated through the heat recovery heat exchanger (condenser) absorbs cooling load heat from the compressed refrigerant gas discharged by the compressors. The heated water is then used to satisfy heating requirements.

Hospitals, dormitories, computer centers, and hotels are opportunities for economical heat recovery due to their needs for hot water for reheat and domestic use, coupled with air-side economizer operation, or in some cases, winter operation of chillers. Heat recovery provides hot water and tight control that minimizes operating costs for the chilled water plant and boiler/hot water heater, while also providing consistent dehumidification. The heat recovery heat exchanger cannot operate alone without a load on the chiller.

Units with a brazed plate heat recovery heat exchanger can produce up to 140°F leaving water temperature and units with the shell and tube heat recovery heat exchanger can produce up to 125°F leaving temperature.

Fluid Volume

Consideration must be given to the total volume of fluid in the system. In close coupled, low volume systems, the leaving fluid temperature will change quickly with steps of capacity control. This is not acceptable if close control is desired for a conditioned space or an industrial process. In order to accurately determine the fluid volume needed for the application, you must resolve and agree on the amount of swing in fluid temperature that can be tolerated. This will depend on the control system, the terminal equipment operation, and use. For applications utilizing constant flow evaporators, 25% of the design load is the minimum array turndown allowed. If further turndown is required, the system must have variable primary flow and motorized isolation valves on each chiller module.

The FWCD Series chillers contain 2 compressors per module, and can be configured in arrays containing up to 20 compressors. Use the following example as a guide to determine swing in fluid temperature tolerable.

Use the information in Table 1 that lists the maximum step of capacity in each array and a factor for that model.

FLUID VOLUME EXAMPLE

Problem: An array of three (3) FWCD 45-ton units has a total rated tonnage of 42.7 x 3 = 128.1 tons at the operating conditions. The chilled water flow is constant volume. It is desired to have no greater than a +/- 3°F leaving water temperature variation due to compressor unloading. What is the minimum water volume required in the chilled water loop?

Solution: We use the following equation to determine the minimum allowable water loop volume.

Minimum Water Loop Volume = Actual Tons x (Min. Volume Gal-°F Swing/Ton) / Allowable °F Swing

Allowable °F Swing is specified in the problem statement. With a tolerance of +/- 3°F, the total allowable swing is 6°F.

We select the value of Min. Volume Gal-°F Swing/Ton from Table 5 Minimum Volume based on the number of modules in the array and the type of flow.

Table 5 Minimum Volume

Number of Modules in Array	Maximum % Capacity Step	Minimum Volume (Gal-°F Swing)/ton
1	50.00	60.0
2*	**25.00**	**30.0**
3	16.67	20.0
4	12.50	15.0
5	10.00	12.0
6	8.33	10.0
7	7.14	8.6
8	6.25	7.5
9	5.56	6.7
10	5.00	6.0

**** 25% is the lowest capacity step allowed for constant flow arrays.***

For a constant flow system, the minimum capacity step is 25%, therefore the Minimum Volume = 30 (Gal - °F deg F Swing)/ton

Thus, we can compute the minimum water loop volume with the known performance of 128.1 tons of cooling at the application conditions:

Minimum Water Loop Volume = 128.1 tons x (30 Gal - °F Swing)/ton / 6 °F swing = 641 gallons.

Using the minimum turndown of 25% for constant volume systems, this equation can be generalized to a commonly used guideline: *gallons per ton* loop volume. By tabularizing different allowable °F swings the minimum volume on a gallon per ton basis can be displayed.

Table 6 Minimum Volume (Gallon/Ton)

Allowable temp. swing above & below setpoint (+/-°F)	Minimum Volume (gallon/ton)
5.0	3.00
4.5	3.33
4.0	3.75
3.5	4.29
3.0*	5.00
2.5*	6.00
2.0*	7.50
1.5	10.00
1.0	15.00
0.5	30.00

* *Common value used in HVAC industry*

This same detailed equation can be generalized to another common loop volume sizing method: *loop time*. As a general guideline, a minimum 3-minute loop time is required for the evaporator chilled water system. In a typical water-cooled application, the nominal fluid flow through the evaporator is 2.4 gpm/ton.

At nominal flows, a 3-minute loop time is equivalent to a minimum loop volume of 7.2 gallon/ton (2.4 gpm/ton x 3 min = 7.2 gallon/ton) and would have an allowable leaving fluid temperature swing of +/- 4.2°F

At nominal flows, a 2-minute loop time is equivalent to a minimum loop volume of 4.8 gallon/ton. (2.4 gpm/ton x 2 min = 4.8 gallon/ton) and would have an allowable leaving fluid temperature swing of +/- 6.25°F.

Notice, in the preceding example, if this system was selected for a 45°F leaving water temperature, the temperature will vary between 42°F to 48°F (recall the variation tolerance +/- 3°F) with the cycling of the compressors at the water loop volume of 641 gallons. The final selection should ensure the leaving water temperature does not drop below 42°F (or 40°F if using a high-capacity evaporator). If a leaving water temperature below 42°F (or 40°F if using a high-capacity evaporator) is indicated then the loop volume should be increased or glycol should be included with the design.

Glycol

If the fluid loop contains glycol, the required water loop volume should be multiplied by the correction factor in Table 3.

Table 7 Glycol Correction Factors

% by Weight	Glycol Volume Correction Factor	
	Ethylene	Propylene
10	1.038	1.017
20	1.066	1.033
30	1.100	1.058
40	1.140	1.092
50	1.192	1.142

It may be necessary to install a storage tank in the system to provide the necessary volume for close temperature control. When this is done, the tank should be installed in the loop between the fluid leaving from the load and the return to the chiller. *Figure 14 Expansion Tank Usage* illustrates a proper expansion tank usage.

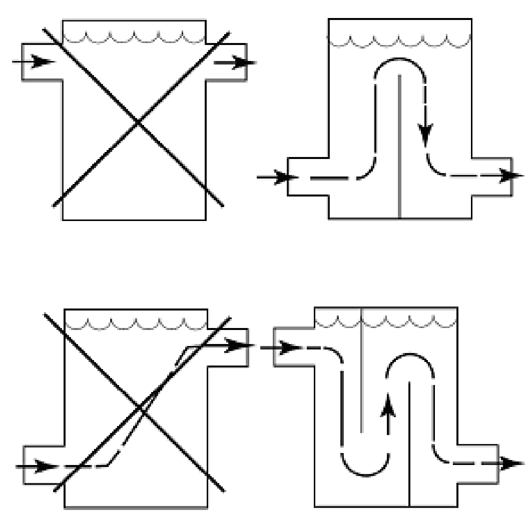


Figure 14 Expansion Tank Usage

Variable Flow

FWCD Series chillers can be applied in variable flow applications where the flow is varied and controlled by others. The flow being delivered to the chiller must not go outside the stated minimum and maximum flow rates in General Data Table. Also, the chilled water system volume should be calculated using the highest evaporator flow rate to be delivered to the chiller, and the rate of change in flow rate must not exceed 10% of design flow gpm per minute.

In FWCD Series chiller arrays, the chillers are piped with a common header. Notice in *Figure 15. Variable Flow with Parallel Pumps* this common header arrangement allows the ability to operate the system in several ways depending on the load and/or current situation. For instance, the system can be operated with two pumps and one chiller so that flow out into the system can be increased, without needing to stage on an additional chiller.

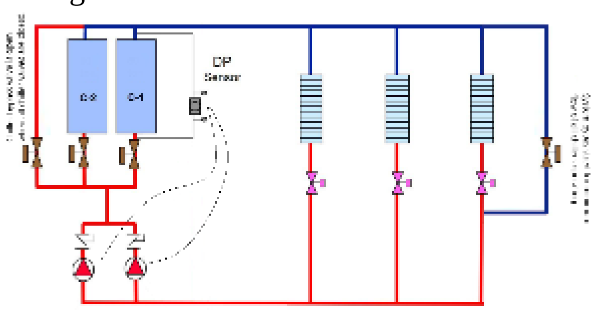


Figure 15. Variable Flow with Parallel Pumps

This configuration also allows flexible redundancy with commonly headered pumps and chillers. If a pump goes down, the remaining pump can serve one or both chillers and still meet the required load. If a chiller needs service or is turned off, the system can compensate for some of the loss in capacity by increasing flow through the remaining chiller while operating both pumps. However, the flow being delivered to any chiller must not go outside the stated minimum and maximum flow rates.

By maintaining the flow between the minimum and maximum flow rates, the chiller is able to provide proper heat transfer and stable operation at lower flows and avoid eroding the pipes at higher flows.

Variable Flow Bypass Valves

A bypass valve is required at the chillers and the load (air handlers, terminal devices, etc.) in systems with variable flow pumping. The bypass must be piped so the temperature and differential pressure sensors are always sensing active flow.

Load Bypass Valve

If a single load side bypass valve is used, it should be sized to bypass the minimum water flow at *maximum* chiller load. This size is required because there can be a lag between the load measured at the system load and at the FWCD Series chiller bank. This lag can create different flow requirements at the load versus the chiller(s).

An example of this lag is when a building becomes occupied in the morning and the chillers are in a pull-down situation. The air handlers serving the occupied space reach the desired occupied temperature and simultaneously drive their control valves closed. At the same time, the chillers are still in a pull-down mode and running at full capacity to reach the desired leaving water temperature. As a result, the chiller(s) require more flow than the rest of the system until the chiller controls unload the chiller to match the new system load condition. Without a system bypass vale, the system pump(s) will either provide too much flow to the load (air handlers, terminal devices, etc.) or not enough flow the chiller array. The bypass valve also ensures that there is an adequate minimum flow thru the pump if all the valves in the load system are closed, otherwise the pumps can deadhead.

Bypass valves at the end of the loop/system, as shown in *Figure 16. Example Load Bypass Valve Arrangements*, promotes keeping the overall active loop volume high. Some systems may not allow for an end-of-loop bypass. In these situations, the bypass valve may be installed closer to the chiller, provided the minimum system volume equaling a minimum of a 2-3 minute loop time is maintained to ensure proper operation. (See section on "Loop Time" in this catalog for more information.)

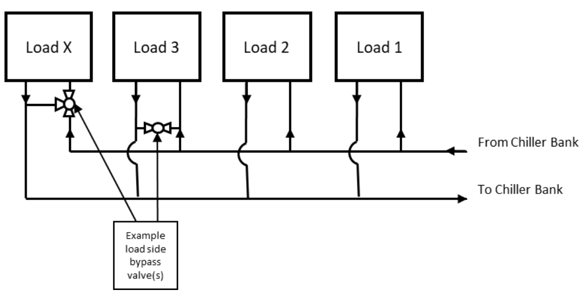


Figure 16. Example Load Bypass Valve Arrangements

External Chiller Array Bypass Valve

A bypass valve for the chiller array is required so that when the chiller array has reached the desired leaving water temperature, and the motorized valves for each module have closed, system flow remains through the external chiller array bypass valve. The chiller bypass should be sized for the minimum flow of one chiller module or the minimum flow of the system's pumping system, whichever is greater. This bypass is only required to be open when all motorized valves in the chiller array are closed. After the first module is active and the motorized valves are the open, the external chiller array bypass valve can be closed because the active module now provides the water flow path.

Water Circuit Requirements

FWCD Series modular chillers are equipped with brazed plate evaporators. The water/fluid circuits to be used with these chillers should be designed and installed following sound engineering practices and procedures as well as any applicable local and industry standards. For the brazed plate heat exchanger circuits, focus on proper filtration and water quality is necessary. Prior to connecting a FWCD Series modular chiller into a newly installed or existing water piping system, it is required to flush the system with a detergent and hot water mixture to remove previously accumulated dirt and other organics. In old piping systems with heavy encrustation of inorganic materials, a water treatment specialist should be consulted for proper passivation and/or removal of these contaminants.

Filtration

Particulate fouling is caused by suspended solids (foulants) such as mud, silt, sand or other particles in the heat transfer medium. The best way to avoid particulate fouling is to have good water treatment and keep all system water clean and with open loop system water, maintain proper bleed rates and make up water. A strainer with a 20-mesh screen (or screen with 0.5 mm sized openings or less) is required to be installed at the individual compact chiller (or compact chiller array) inlet to protect the brazed plate heat exchangers. Wye-strainers are available as a factory-provided, field-installed option. If an application is highly susceptible to foulant contamination, additional filtration methods should be investigated.

Water quality

Poor water quality can cause another type of fouling called scaling. Scaling is caused by inorganic salts in the water circuit of the heat exchangers. Scaling increases pressure drop and reduces heat transfer efficiency. The likelihood of scaling increases with increased temperature, concentration and pH. In addition to scaling, poor water quality can cause other issues like biological growths and corrosion. Therefore, water quality and water quality control need to be an application consideration. Please review the water quality requirements for use with the brazed plate heat exchangers on the FWCD Series modular chiller.

Table 8 Water Property Limits

Water Property	Concentration Limits
Alkalinity (HCO3-)	70-300 ppm
Sulfate (SO42-)	Less than 70 ppm
HCO3- / SO42-	Greater than 1.0
Electrical Conductivity	10 - 500 µS/cm
pH	7.5 – 9.0
Ammonia (NH3)	Less than 2 ppm
Chlorides (Cl-)	Less than 300 ppm
Free Chlorine (Cl2)	Less than 1 ppm
Hydrogen Sulfide (H2S)	Less than 0.05 ppm
Free (aggressive) Carbon Dioxide (CO2)	Less than 5 ppm
Total Hardness (°dH)	4.0 - 8.5
Nitrate (NO3)	Less than 100 ppm
Iron (Fe)	Less than 0.2 ppm
Aluminum (Al)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm

Oversizing Chillers

Generally speaking, fully loaded equipment operates more efficiently than large equipment running at or near minimum capacity. When selecting a chiller, the anticipated part load operation of the system should be evaluated with respect to the NPLV rating of the equipment under consideration. Larger future loading requirements may cause temporary oversizing of equipment that is initially selected and installed. This should be done with care, although the FWCD Series array chiller, with multiple scroll compressors, is more tolerant than designs that use a single compressor or a few larger compressors.

Chiller Placement

The FWCD Series water-cooled chillers are designed for indoor installations that remain above 32°F and below 125°F at all times. Locate the chiller away from sound-sensitive areas on a level foundation or flooring strong enough to support 150 percent of the operating weight and large enough to keep with service clearances. Also, the chiller foundation or flooring must be rigid enough to minimize vibration transmission. Please see General Data chapter for compressor sound data and Dimension and Weights information for unit operating weights and clearances. If necessary, options are available for sound attenuation and vibration reduction.

Be sure to observe the dimensions that are on the rating plate of the chiller for operational and service clearances. For proper unit operation, the immediate area must remain free of debris Table A4 displays the typical clearances found on the rating plate of each unit.

Table 9 Service Clearances

Location	Required	Recommended
Back	0”	24”
Front	42”	53”
Left	0”	36"
Right	0”	36"
Top	36”	36”

Mounting Isolation
Anytime vibration transmission may be a factor, vibration isolators may be considered. Rubber isolators are available as factory provided options.

Electrical Power Supply
A disconnect switch that is accessible from the outside of the cabinet is an available option factory installed. The microprocessor controller furnished with the unit is supplied with its own power supply factory wired to the main power of the chiller. The voltage to the chiller must be within plus or minus 10% of the nameplate rating value on the unit. All FWCD Series chiller arrays are available with a single point power supply or each module may be powered individually. The largest capacity single point power supply terminal supplied from Jetson is rated at 1200 amps.

Optional Oversized Evaporator
These heat exchangers are available on all model sizes except the 85 ton. They may be selected for improved performance with water or they may be selected for use with systems that contain glycol to aid in offsetting the decreased capacity due to the thermal properties of glycol. Oversized evaporators also allow a 40F leaving water temperature without the requirement for glycol.

Air-Cooled Condenser Applications
The FWCD Series chillers can be paired with remote air-cooled condensers. The minimum outdoor ambient temperature for operation of a FWCD Series compressor chiller in combination with an outdoor condenser is 20°F. This minimum is driven by compressor chiller starting considerations and not by effectiveness of condenser ambient controls once the system is up and running. Fan cycling and optional low ambient dampers do *not* mitigate the low ambient starting problem. On a cold day with outdoor ambient temperature below 20°F the liquid line pressure at the expansion valve inlet is extremely low. On start, the suction pressure may plunge into the freezing range causing a nuisance fault. The maximum ambient temperature limit for the FWCD is 110°F.

Line Sizing Guidelines

Liquid Lines
Pressure drop should not be so large as to cause gas formation in the liquid line, insufficient liquid pressure and the liquid feed device, or both. Systems are normally designed so that pressure drop in the liquid line from friction is not greater than that corresponding to 1 to 2°F change in saturation temperature.

Sufficient sub-cooling must be maintained at the expansion valve. To provide proper operation throughout the range of operating conditions, the liquid-line pressure drop should not exceed the unit’s minimum sub-cooling value less 5°F. To achieve this objective, keep these liquid line considerations in mind:

1. Select the smallest, practical line size for the application. Limiting the refrigerant charge improves compressor reliability.
2. When designing the liquid line for a typical air conditioning application (i.e., one with an operating range of 40°F to 110°F), remember that every 10 feet of vertical rise will reduce sub-cooling by 2.8°F, while every 10 feet of vertical drop will add 1.1°F of subcooling.
3. Provide a 1-inch pitch toward the evaporator for every 10 feet of run.
4. If the liquid line must be routed through an area warmer than outdoor air temperature, insulate the line to prevent the refrigerant from flashing. A liquid line filter drier must be installed as close as possible to the compressor chiller. The filter drier should be

changed whenever the system is opened for service. FWCD Series compressor chillers do not include a filter-drier as standard, but one may be ordered if the installing contractor desires a factory type.

5. A moisture-indicating sight glass permits a visual check of the liquid column for bubbles. Sight glasses are included on the FWCD Series compressor-chiller. Never use the sight glass to determine whether the system is properly charged! Instead, either charge the system based on the required sub-cooling or calculate the amount of refrigerant needed and add it based on weight.

Discharge (Hot Gas) Line

Limit the pressure drop in the discharge line to 6 psig whenever possible to minimize the adverse effect on unit capacity and efficiency. While a pressure drop of as much as 10 psig is usually permissible, note that a 6-psig pressure drop reduces unit capacity by 0.9 percent and efficiency by 3.0 percent.

Pitch discharge lines in the direction of hot gas flow at the rate of 1/2-inch per each 10 feet of horizontal run. Discharge line sizing is based on required velocity to provide good oil movement. Basic discharge line parameters are:

- Maximum allowable pressure drop 6 psig (°F)
- Maximum Velocity 3500 fpm
- Minimum Velocity (at minimum load)
    - Horizontal lines 500 fpm
    - Vertical lines (up flow) 1000 fpm

To design the discharge line properly, follow the recommended guidelines:

1. Choose the shortest route from the compressor to the condenser.
2. Use different pipe sizes for horizontal and vertical lines to make it easier to match line pressure drop and refrigerant velocity to discharge-line requirements.
3. To assure proper oil entrainment and avoid annoying sound levels, size the discharge line so refrigerant velocity equals or exceeds the minimum velocity in Table 10 Minimum discharge line velocities for oil entrainment and remains below 3500 fpm.
4. Prevent oil and condensed refrigerant from flowing back into the compressor during "off" cycles by:
    a. pitching the discharge line toward the condenser, and
    b. routing the discharge line so that it rises to the top of the condenser, then drops to the level of the condenser inlet, creating an inverted trap.
5. Double risers are generally unnecessary. The scroll compressors in FWCD Series chillers unload to the extent that a single, properly sized riser can transport oil at any load condition.
6. Riser traps are also unnecessary. Avoid using riser traps. If the discharge riser is sized to maintain the proper refrigerant velocity, adding a trap will only increase the pressure drop.

Table 10 Minimum discharge line velocities for oil entrainment

Nominal Pipe Size (in.)	Riser Refrigerant Velocity (fpm)	Horizontal Refrigerant Velocity (fpm)
7/8	375	285
1-1/8	430	325
1-3/8	480	360
1-5/8	520	390
2-1/8	600	450

Line Sizing Charts

Table 11 Single Circuit FWCD

Unit Nom. Tons	Chiller Connection Size (od)		0-50 Equiv. Pipe Length (ft)		50-100 Equiv. Pipe Length (ft)		100 - 150 Equiv. Pipe Length (ft)	
	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)
20	3/4	1-1/8	3/4	1-1/8	3/4	1-3/8	3/4	1-3/8
30	7/8	1-3/8	7/8	1-3/8	7/8	1-3/8	7/8	1-5/8
45	1-1/8	1-3/8	1-1/8	1-5/8	1-1/8	1-5/8	1-1/8	1-5/8
55	1-1/8	1-3/8	1-1/8	1-5/8	1-1/8	1-5/8	1-1/8	1-5/8
65	1-1/8	2-1/8	1-1/8	1-5/8	1-1/8	2-1/8	1-1/8	2-1/8
75	NA							
85								

Note: Line sizes may differ if unit is equipped with hot gas bypass or unit has operation below 40°F leaving fluid temperature.

Table 12 Dual Circuit FWCD Series

Unit Nom. Tons	Chiller Connection Size (od)		0-50 Equiv. Pipe Length (ft)		50-100 Equiv. Pipe Length (ft)		100 - 150 Equiv. Pipe Length (ft)	
	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)	Liquid (in.)	Discharge (in.)
20	5/8	1-1/8	5/8	1-1/8	5/8	1-1/8	5/8	1-1/8
30	3/4	1-1/8	3/4	1-1/8	3/4	1-1/8	3/4	1-1/8
45	3/4	1-1/8	3/4	1-1/8	3/4	1-3/8	3/4	1-3/8
55	7/8	1-1/8	7/8	1-3/8	7/8	1-3/8	7/8	1-5/8
65	7/8	1-3/8	7/8	1-3/8	7/8	1-5/8	7/8	1-5/8
75	1-1/8	1-3/8	1-1/8	1-3/8	1-1/8	1-5/8	1-1/8	1-5/8
85	1-1/8	1-3/8	1-1/8	1-5/8	1-1/8	1-5/8	1-1/8	2-1/8

Note: Line sizes may differ if unit is equipped with hot gas bypass or unit has operation below 40°F leaving fluid temperature.

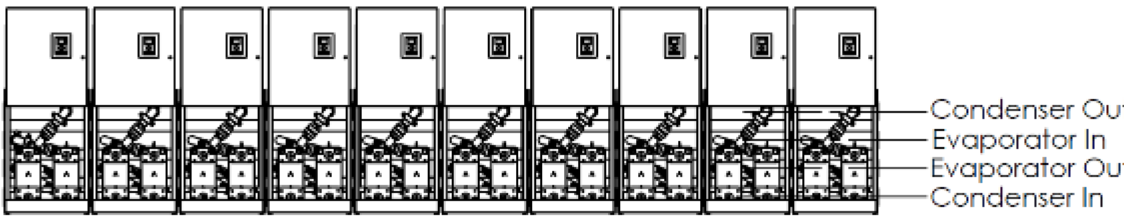
Multiple Chiller Applications
When more than one (1) FWCD Series chiller is piped together (to form an array of chillers) for higher capacity and/or redundant chiller applications, an array controller package must be provided
from the factory. A Master-Secondary controller can control up to six (6) units in an array. A Supervisor controller can control up to ten (10) units in an array.

The number of compact chillers that can be physically piped together to form an array and share
a common header is limited to approximately 300 total tons or 900 gpm. In general, if the total tonnage is 300 tons or less or 900 gpm or less, one common evaporator supply/return line and one

common condenser supply/return line can be used. If the total tonnage needed is greater than 300 tons or 900 gpm, the flow from these common lines can be split between two arrays of chillers. Array water line sizing is based on a 3 gpm ton condenser flow and a velocity limitation of 10 feet per second.

Figure 17 - Array Piping shows examples of acceptable array piping configurations. For help with determining the most effective array configuration for your application, please contact the factory.

COMMON SUPPLY/RETURN



SPLIT SUPPLY/RETURN

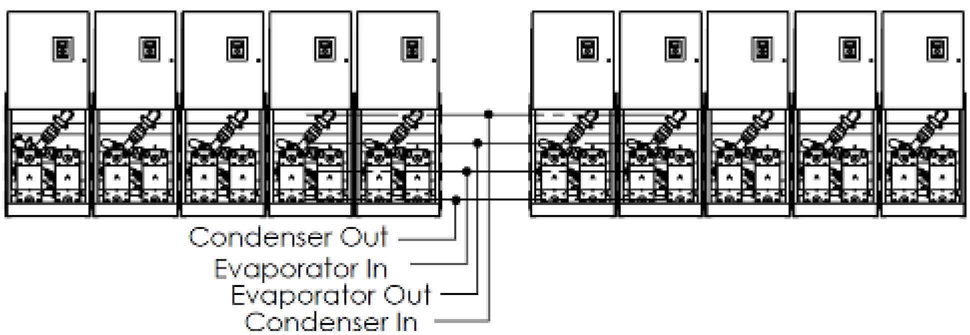


Figure 17 - Array Piping

** With split header array piping, the limitation of 10 units is based on the controller capability, not the flow velocity limit of 10fps.*

Nominal Capacity (tons)	Maximum number of units operating on COMMON supply / return line	Maximum number of units operating on SPLIT supply / return line*
20	10	10
30	10	10
45	8	10
55	6	10
65	5	10
75	4	8

Installation Mechanical

General Installation Information

- Please read and take heed of the water piping system flushing procedure and water treatment requirements found in Appendix that are necessary to prepare and maintain an efficient and healthy chiller system that utilizes brazed plate heat exchangers.
- Valves in the water piping upstream and downstream of the evaporator and condenser are installed on each FWCD chiller to isolate the heat exchangers for maintenance and to balance/trim the system.
- Supply and install condenser water control valve(s). Provisions must be made for the control of condenser water that results in stable saturated condensing temperature between 80°F and 145°F through all steady state, part load and transient operating conditions. Jetson recommends the optional factory-installed integral water regulating valve controlled by the unit controller.
- Supply and install flow switch or other approved flow proving device in the chilled water piping. Interlock this switch with the controller to ensure that the unit can only operate when water flow is established. See wiring diagram for connection point. A switch may be ordered with the unit if desired. It will be shipped loose for field installation.
- When appropriate and needed, supply and install drain valves and vent cocks in the water system piping. Evaporator vent cocks are factory-installed on all FWCD chillers.
- Where specified, supply and install strainers ahead of all pumps and control valves.
  Note: *FWCD chillers may be ordered with cleanable, factory-selected wye-strainers to be installed in the field by others for protection of the brazed plate evaporators.*
- Supply and install suitable refrigerant pressure relief piping to the atmosphere if required. Follow ANSI/ ASHRAE 15 guidelines, relief manufacturer's guidelines, and industry standards when working with relief valve, fusible plugs and/or piping.
- Start the unit under supervision of a qualified service technician.
- Where specified, supply and insulate the chilled water piping as required, to prevent sweating under normal operating conditions. Jetson provides factory insulation on evaporator and related components.

Storage

NOTICE
Store Units Above Freezing! **Store these units in a protected area above freezing (32°F) only. Do not store outdoors with a protective covering such as a plastic shroud. This can result in excessive water condensation that could damage controls and other components.**

Noise Considerations

Locate the unit away from sound-sensitive areas. If necessary, install isolators under the unit. Install vibration isolators in all piping and use flexible electrical conduit. Consult an acoustical engineer for critical applications.

Foundation

A base or foundation is recommended for most installations. Provide a level surface strong enough to support the unit. See Dimension and Weights chapter for dimensions and weights. A flexible (isolated) concrete foundation or footings at each loading point will reduce transmission of vibration. Install anchor bolts in the concrete to secure the unit.

Note: *Use only anchor bolts that are flush with the top of the foundation, not a drive-in stud type. An example of an acceptable anchor bolt is Red Head*

– Multi-Set II Drop In Shell Type. Using a flush type anchor bolt will make removal of a unit easier if required.

If the floor is warped, uneven or in poor condition, make necessary repairs before positioning the unit. Once the unit is in place, it should be level within 1/8 inch side-to-side (width) and 1/8-inch front-to-back (depth).

Clearances
Provide adequate space around each unit for unrestricted Spreader Bar access for installation and maintenance. Unit dimensions
are given in the Dimensions and Weights chapter. It is critical that adequate space is provided for service and maintenance of evaporator, condenser and compressor. A minimum of 36 inches above the unit is recommended for effective compressor service. A minimum clearance of 3 ft.-6 inches is required to open the control panel door.

Important: *In all cases, local codes will take precedence over these recommendations.*

Ventilation
Provisions must be made to remove heat generated by unit operation from the equipment room. Ventilation must be adequate to maintain an ambient temperature lower than 125°F.

Drainage
Locate the unit near a large capacity drain for drain-down during shutdown or repair.

Handling
FWCD units are shipped stretch-wrapped and bolted to a shipping skid unless special packaging is arranged. The skidded unit can be moved by using a fork truck of suitable capacity. See Dimensions and Weights chapter for unit weights.

When moving the unit, the lifting forks must be positioned under the shipping skid as wide as possible. Lift the unit and move it to the desired location.
Once the unit is at the installation location, remove the stretch wrap. Inspect the unit for damage and report if damage is found.
Optional “ship loose” items may be inside the control box, attached to the skid or shipped separately depending on options selected.

Forklifting Procedure

Important:
Step 1 through 4 must be followed to lift unit using a forklift.

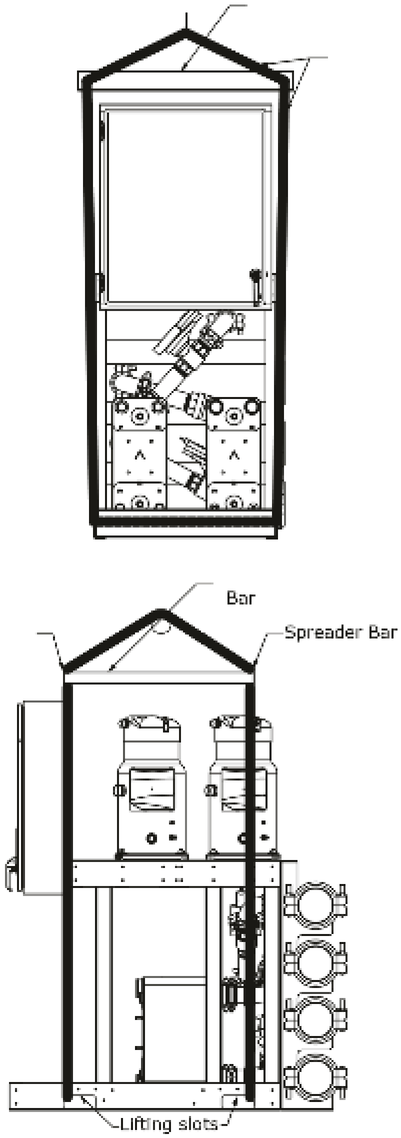


Figure 18. FWCD rigging, fork lift pockets

Steps to be taken when forklift is used:

1. Remove the stretch wrap from the unit as described previously, leaving the unit mounted to the skid.
2. Remove the bolts that secure the unit to the shipping skid.
3. Using a forklift, raise the unit enough to slightly clear the skid, making sure the unit is level when lifting.
4. If the unit is level, lift the unit off of the skid and place in the installation location.

Rigging Procedure

WARNING
Heavy Objects!

Failure to follow instructions or properly lift unit could result in unit dropping and possibly crushing operator/technician which could result in death or serious injury, and equipment or property-only damage. Ensure that all the lifting equipment used is properly rated for the weight of the unit being lifted. Each of the cables (chains or slings), hooks, and shackles used to lift the unit must be capable of supporting the entire weight of the unit. Lifting cables (chains or slings) may not be of the same length. Adjust as necessary for even unit lift.

WARNING
Improper Unit Lift!

Failure to properly lift unit could result in unit dropping and possibly crushing operator/technician which could result in death or serious injury, and equipment or property-only damage. Test lift unit approximately 24 inches to verify proper center of gravity lift point. To avoid dropping of unit, reposition lifting point if unit is not level.

Note: *Do not lift unit from above unless spreader bars are used.*

Each module should be lifted using lift straps threaded through the steel base cutouts and a spreader bar.

Note: *If no, or improperly sized, spreader bar is used, damage to the unit may occur.*

CAUTION

Equipment Damage!
To prevent damage, position the spreader bar and straps so that they do not contact unit piping or control panel.

Access Restrictions
All FWCD units are designed to pass through a standard 36-inch doorway. See outline drawings for other important dimensions.

Compressor Mounting
All compressors are rigidly bolted with compressor isolation mounts to the same compressor mounting frame (rails). No additional isolation or leveling is required. Inspect prior to start up to ensure bolts are present and tight, and that no shipping damage has occurred.

Direct Mounting
The unit can be installed directly on an isolated, rigid mounting surface as long as the surface is level and will support the weight of the unit. A mounting hole is provided at each of the unit mounting locations. See Foundation for more details. Provide a means of securely anchoring the unit to the mounting surface. Level the unit carefully.

Unit Leveling
Before tightening the mounting bolts, level the unit. Check unit level front-to-back (depth) by using a level, or by placing a level on the top surface of the unit frame. Unit should be level within 1/8-inch front-to-back (depth). Place the level on the unit frame and check side to side level. Adjust to within 1/8 inch of level side-to-side. Use shims as required to properly level the unit.
The serial number information is also on record at the factory.

Typical Water Piping
All building water piping must be flushed prior to making final connections to the chiller. To reduce heat loss and prevent condensation, insulation should be applied. Expansion tanks are also usually required so that chilled water volume changes can be accommodated.

Avoidance of Short Water Loops
Adequate water volume is an important system design parameter because it provides for stable chilled water temperature control and helps limit unacceptable short cycling of chiller compressors. The chiller's temperature control sensor is located in the supply (outlet) water connection or pipe. This location allows the building to act as a buffer to slow the rate of change of the system water temperature. If there is not sufficient water volume in the system to provide an adequate buffer, temperature control can suffer, resulting in erratic system operation and excessive compressor cycling.

Typically, a three-minute water loop circulation time is sufficient to prevent short water loop issues. Therefore, as a guideline, ensure the volume of water in the chilled water loop is greater than or equal to three times the evaporator flow rate. For systems with a rapidly changing load profile the volume should be increased.

If the installed system volume does not meet the above recommendations, the following items should be given careful consideration to increase the volume of water in the system and, therefore, reduce the rate of change of the return water temperature.

- A volume buffer tank located in the return water piping.
  Larger system supply and return header piping (which also reduces system pressure drop and pump energy use).

Minimum Water Volume for a Process Application
If a chiller is attached to an on/off load such as a process load, it may be difficult for the controller to respond quickly enough to the very rapid change in return solution temperature if the system has only the minimum water volume recommended. Such systems may cause chiller low temperature safety trips or in the extreme case evaporator freezing. In this case, it may be necessary to add or increase the size of the mixing tank in the return line.

Unit Piping
See "Piping System Flushing Procedure," for information on piping system flushing procedure, and water treatment requirements.

Exchanger Water Pressures

CAUTION

Vessel Damage!
To prevent pressure vessel damage, do not exceed unit nameplate water-side pressures.

If field installed gauges are used, provide shutoff valves in the line(s) to the gauge(s) to isolate the gauges when not in use.

Flow Sensing Devices

CAUTION

Unexpected Chiller Start!
Failure to follow instructions could cause the chiller to start unexpectedly which could result in equipment or property damage. An external source (EMS, time clock or any other means) should not be allowed to bring on a pump that would trigger the flow switch to start the chiller. The flow switch is meant to act as a safety switch and not a start/stop mechanism.

Chilled water flow switch, or other factory approved flow proving device is mandatory; field installation by contractor is required. Flow switch is to be installed and maintained per manufacturer's recommendations and interconnected to the control panel as described on the wiring diagram. To provide additional chiller protection, install and wire the flow switch in series with chilled water pump interlock for the chilled water circuits. Specific connection and schematic wiring diagrams ship with the unit inside the control box.

Water Piping Recommendations
All water piping must be cleaned and flushed according to Piping System Flushing Procedure later in this manual prior to circulating any water through unit.

Make sure water piping connections to the evaporator and condenser are isolated, and confirm that all piping to unit is supported independently to prevent any load being transferred to the unit. Use unions, flanges or grooved lock type fittings to facilitate service procedures. Use a pipe sealant such as Teflon® tape on all threaded water connections. Use vibration eliminators to prevent transmitting vibrations through the water lines.

Construct and install piping in accordance with all local, state and national codes.

Supply and insulate the chilled water piping as required, to prevent sweating and minimize heat gain under normal operating conditions. Chilled water piping must rise above the chiller to ensure the evaporator is full of water and void of air at all times. Install thermometers in the lines to monitor evaporator entering and leaving water temperatures.

FWCD chillers have manual balancing ball-valves in the entering water lines. They may be used to establish a balanced water flow. Both the entering and leaving water lines have valves that can be used to shutoff/isolate the evaporator and condenser for service.

CAUTION

Equipment Damage!

To prevent equipment damage, you MUST follow instructions below:

- Bypass unit when using a flushing agent.
- Chilled water piping must rise above the chiller to ensure the evaporator is full of water and void of air at all times.
- Do not over tighten connections.

Water Flow Rates

Establish balanced water flow through both the evaporator and condenser. Flow rates should fall between the minimum and maximum values given in General Data Table. Flow rates above or below these values can cause equipment damage or improper unit operation. The evaporator and condenser water pressure drop can be read manually using the factory-installed condenser inlet and outlet pressure gauge service ports. Readings should approximate those shown by the pressure drop charts for the individual chillers

Note: *Pressure drop is an approximation and is to be used as a tool to estimate flow rate and as an aid to waterside system piping design. If an accurate measurement of flow rate is required, an accurate flow meter must be installed in the system.*

Chilled Water System Volume

Minimum system volume requirements are indicated in the following table. Special applications may deviate from these numbers as directed by Jetson engineering. Operation below these volumes will cause unacceptable system control problems and the potential for evaporator failure.

Table 13 Recommended Minimum required system volume

Unit Size (tons)	Volume (gal)
20	144
30	216
45	324
55	396
65	468
75	540
85	612

Pressure Drop Curves

Figure 19 Evaporator Flow (heat exchanger only) vs. Pressure Drop

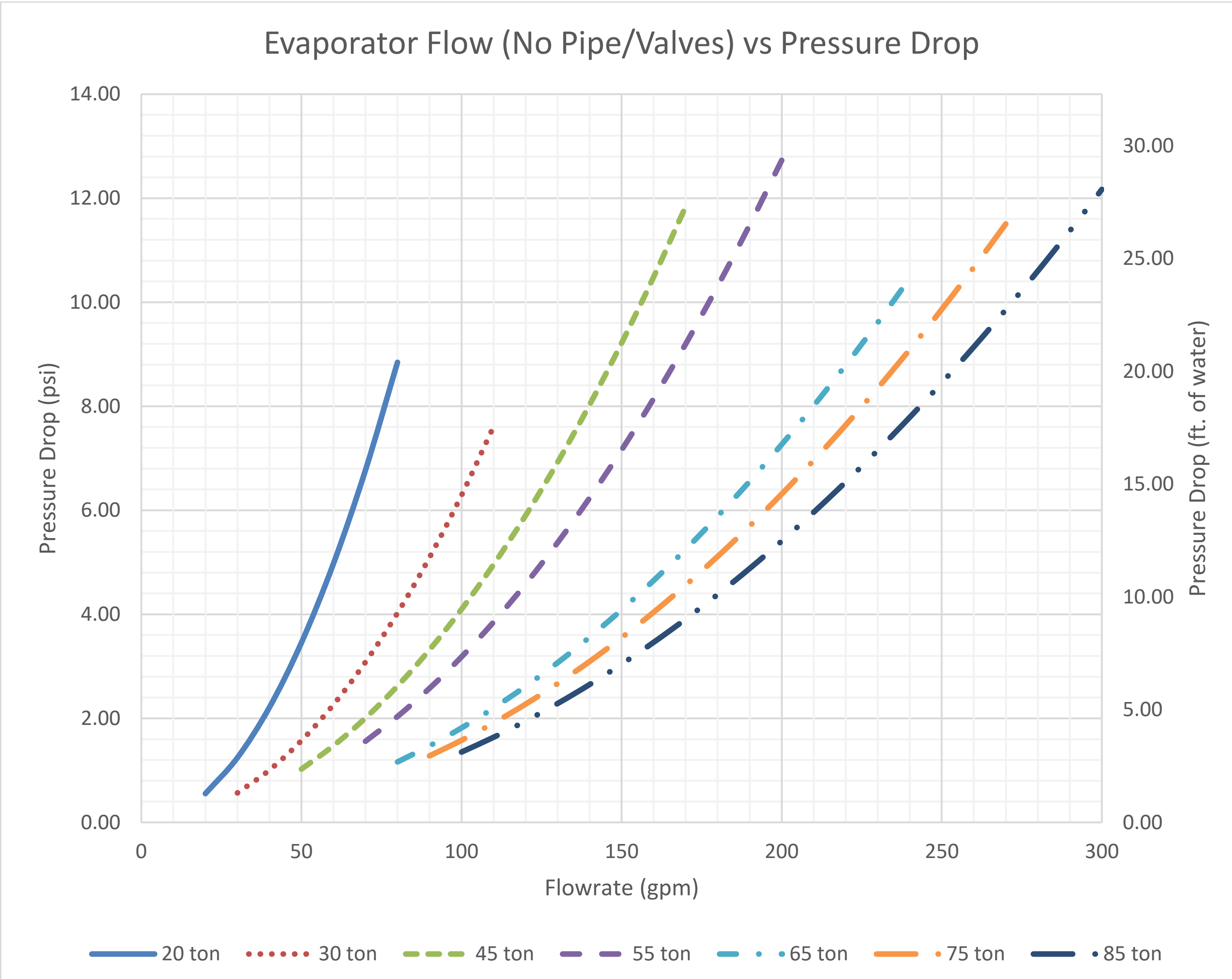


Figure 20 Evaporator Flow (including header and valves) vs. Approximate Pressure Drop

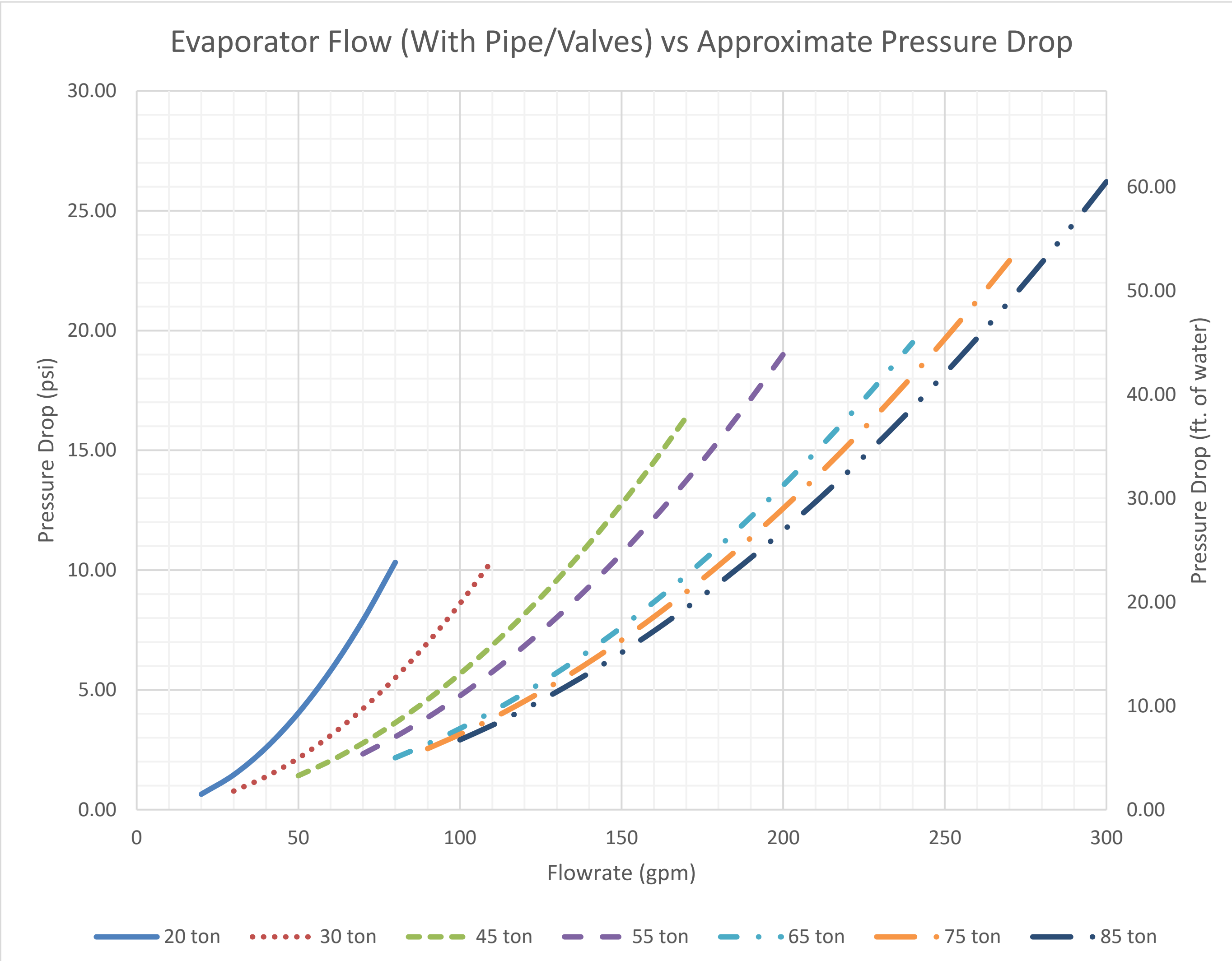


Figure 21 Brazed Plate Reheat Condenser Flow (heat exchanger only) vs. Pressure Drop

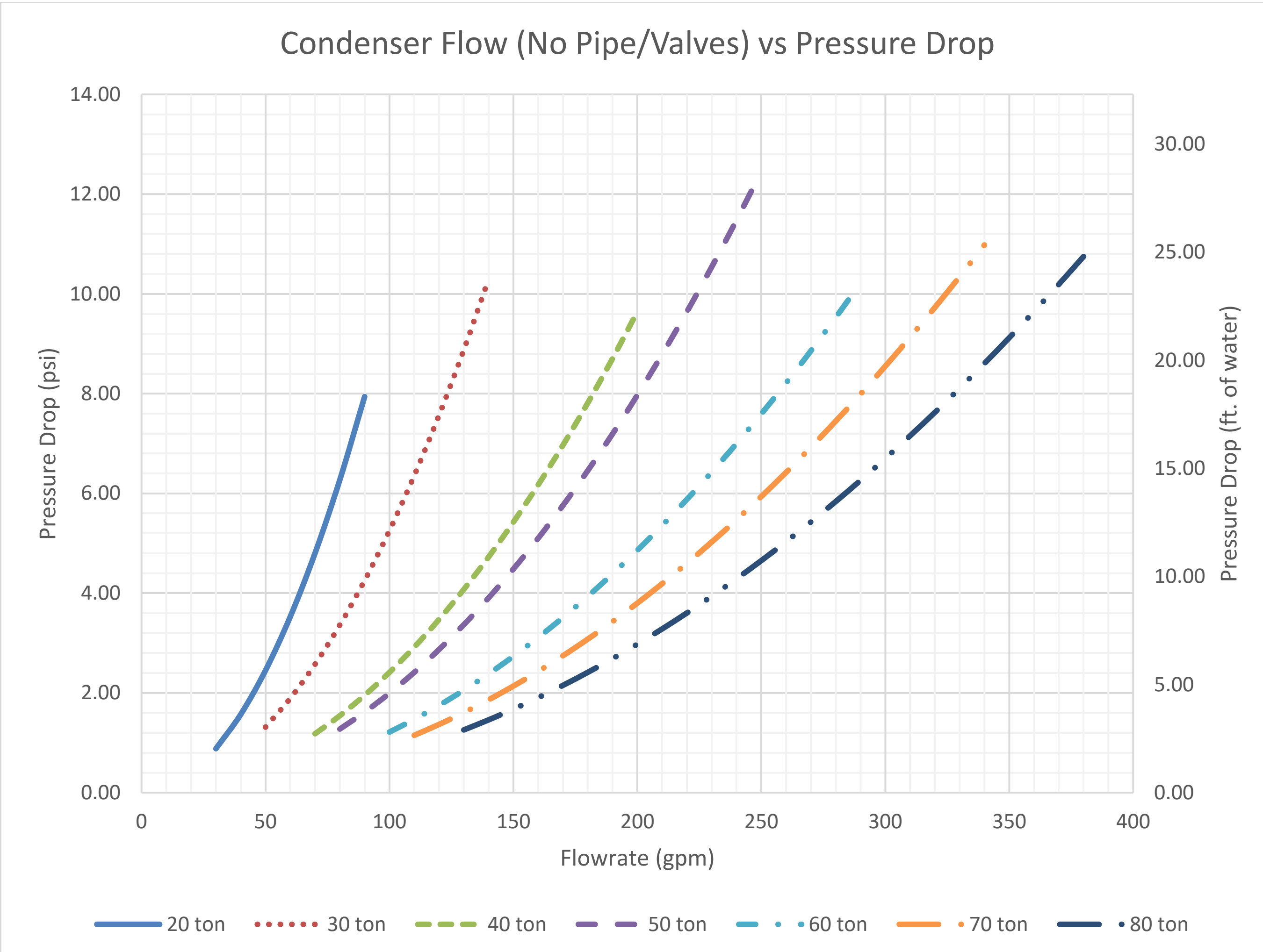


Figure 22 Brazed Plate Reheat Condenser Flow (including header and valves) vs. Approximate Pressure Drop

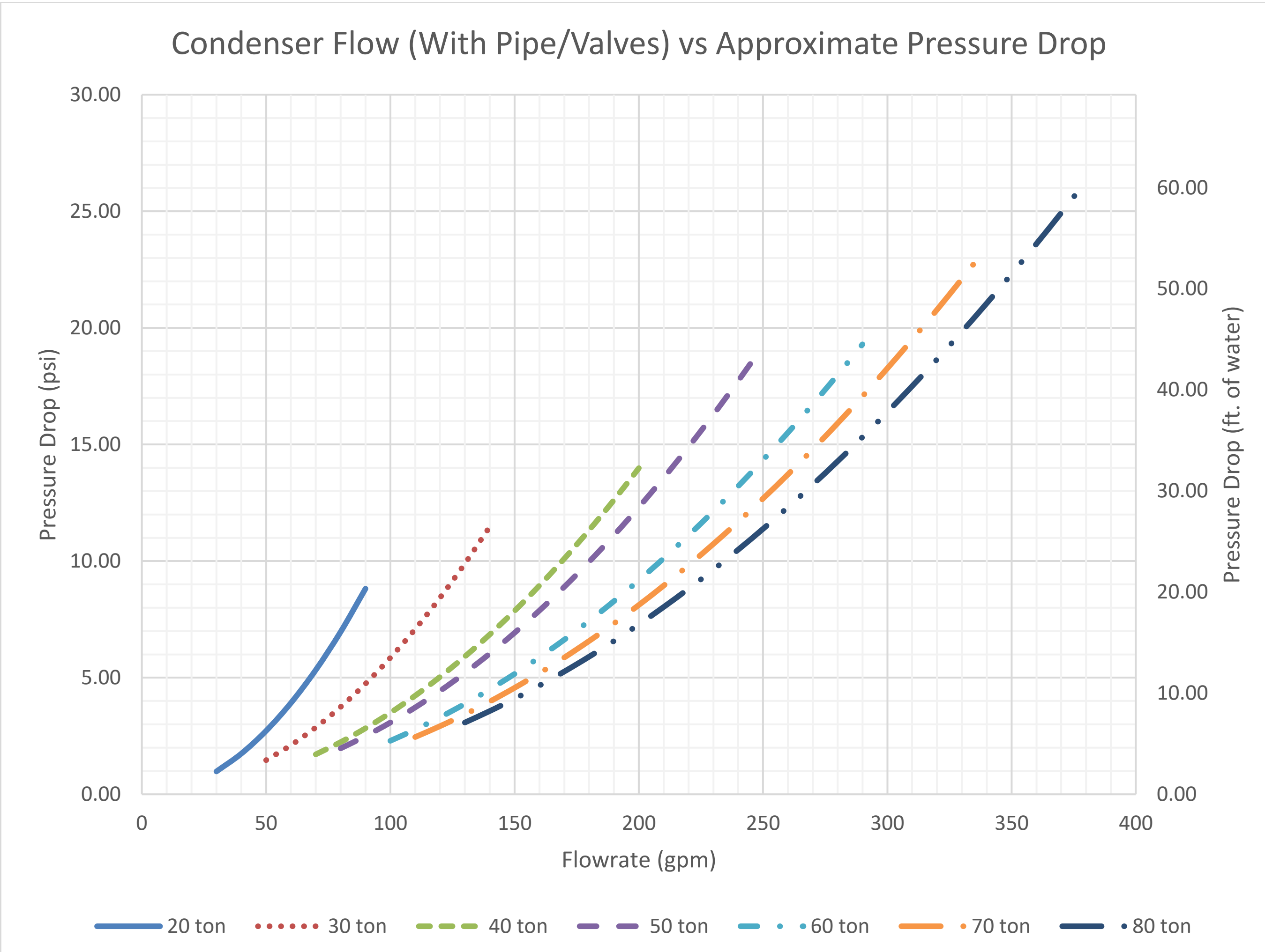
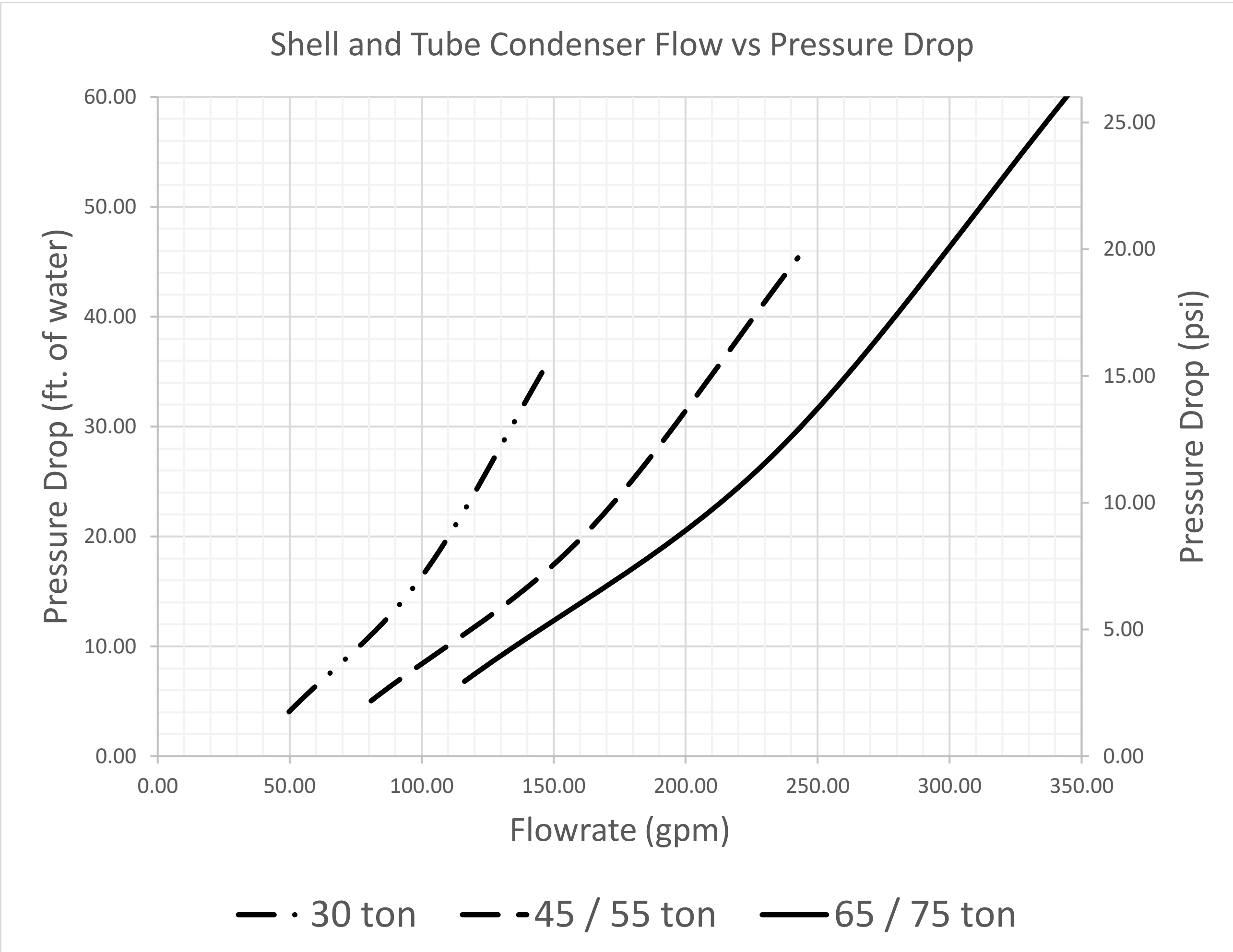


Figure 23 Shell and Tube Flow (including header and valves) vs. Approximate Pressure Drop



Water Treatment

CAUTION

Proper Water Treatment!

The use of untreated or improperly treated water could result in scaling, erosion, corrosion, algae or slime. It is recommended that the services of a qualified water treatment specialist be engaged to determine what water treatment, if any, is required. Jetson assumes no responsibility for equipment failures which result from untreated or improperly treated water, or saline or brackish water.

Using untreated or improperly treated water in these units may result in inefficient operation and possible heat exchanger damage. Consult a qualified water treatment specialist to determine if treatment is needed. See Appendix for water treatment requirements.

Evaporator and Water Piping

CAUTION

Water Born Debris!

To prevent evaporator or condenser damage, pipe strainers must be installed in the water supplies to protect components from waterborne debris. Jetson is not responsible for equipment-only-damage caused by water born debris. Failure to install the shipped-loose supplied Y-strainers or screens will void the warranty on the brazed plate evaporator and condenser.

FWCD chillers are equipped with brazed plate heat exchangers made of stamped stainless-steel plates, furnace brazed together with copper-based joints. Because of the small complex geometry of the flow passages, it is imperative customers take all precautions to ensure these evaporators are not fouled by large particles or mineral deposits. Chillers must have a factory provided, or field provided, 20-mesh evaporator inlet wye strainer that must be field installed. The screen may be removed for cleaning. Operation of chiller without screen in place will void warranty. Chemical treatment of the chilled water loop is required and must be performed by a qualified water treatment specialist.

Chilled water inlets and outlets are grooved-type with the locations provided in Dimension and Weights chapter. Under full-load standard AHRI conditions, the chilled water temperature change should be approximately 10°F, producing a flow rate in the range of 2.4 gpm/ton. Minimum outlet water is 42°F, with standard evaporator and without freeze inhibitor. Minimum outlet water temperature is 40° F with high-capacity evaporator and without freeze inhibitor.

Chilled water piping must be in accordance with all local, state and national codes.

Figure 24. Chilled water piping

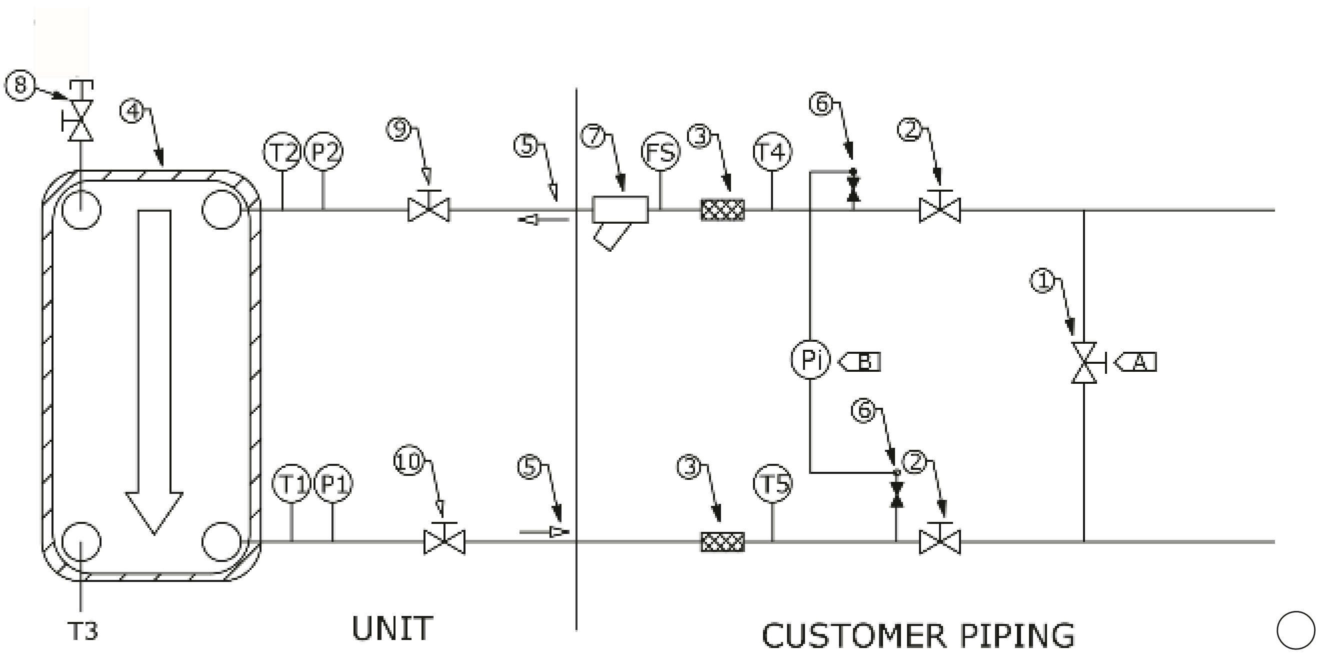


Table 14 Chilled water piping components

Item	Description	Item	Description
1	Bypass Valve	A	Isolator Unit for initial water loop cleaning
2	Isolation Valves	B(a)	Arrangement for Measuring Differential Pressure
3	Vibration Eliminators	FS(b)	Water Flow Switch
4	Evaporator Heat Exchanger	Pi	Pressure Gauge
5	Inlet & Outlet Chilled Water Lines	T1	Evaporator Outlet Temperature Sensor
6	Valves for Pressure Measurement	T2	Evaporator Inlet Temperature Sensor
7(c)	Strainer with 20 Mesh Screen	T3	Evaporator Core Temperature Sensor
8	Evaporator Manual Air Vent Valve w/ Plug	T4	Chiller Inlet Temperature Gauge
9	Evaporator Manual Ball Valve	T5	Chiller Outlet Temperature Gauge
10	Evaporator Manual Ball Valve (Motorized On/Off Valve, optional)	P1	Evaporator Outlet Pressure Sensor
		P2	Evaporator Inlet Pressure Sensor

(a)Must account for water head difference when calculating total unit pressure differential.
(b)Chilled water flow-proving device is required.
(c) Strainer is factory supplied and field installed.

Condenser Piping

CAUTION

Waterborne Debris!

To prevent condenser damage, pipe strainers must be installed in the water supplies to protect components from waterborne debris. Jetson is not responsible for equipment-only-damage caused by water born debris. Failure to install the shipped-loose supplied Y-strainers or screens will void the warranty on the brazed plate evaporator and condenser.

Condenser piping components and layout vary depending on the water source and connection locations, however a means of maintaining stable discharge pressure through full-, part-load, and transient conditions is required. Saturated discharge temperature must be maintained between 80°F and 145°F. Jetson offers an optional factory installed water regulating valve that is controlled by unit controller. The optional water regulating valve maintains condensing pressure and temperature by throttling water flow leaving the condenser in response to compressor discharge pressure. Field supplied water regulating valves must be adjusted for proper operation during start-up. Under full load "standard AHRI conditions" the water temperature rise should be 10° F, producing a flow rate in the range of 3 gpm per ton. Minimum inlet condenser water temperature is 65°F. Condenser piping must be in accordance with all local and national codes. Condenser piping components generally function identically to those in the evaporator piping system. In addition, cooling tower systems may include a manual or automatic bypass valve that can alter water flow rate to maintain condensing pressure. Well (city) water condensing systems should include a pressure reducing valve and water regulating valve. A pressure reducing valve should be installed to reduce water pressure entering the condenser. This is required only if water pressure exceeds nameplate maximums. This is also necessary to prevent damage to the disc and seat of the water regulating valve that can be caused by excessive pressure drop through the valve.

Installation Electrical

WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.

General Recommendations

WARNING

Hazardous Service Procedures!

Failure to follow all precautions in this manual and on the tags, stickers, and labels could result in death or serious injury.
Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the following instructions: Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks.

CAUTION

Use Copper Conductors Only!
Failure to use copper conductors could result in equipment damage as unit terminals are not designed to accept other types of conductors.

The wiring procedures, as described in this portion of the manual, must be accomplished to obtain proper operation of the unit.

All wiring must comply with National Electrical Code (NEC) and state and local requirements. Outside the United States, the national and/or local electrical requirements of other countries shall apply. The installer must provide properly sized system interconnecting and power supply wiring with appropriate fused disconnect switches. Type and locations of disconnects must comply with all applicable codes.

Minimum circuit ampacity, recommended fuse sizes and other unit electrical data are provided in the Electrical Data table and on the unit nameplate.

Checking the Power Supply

Electrical power to the unit must meet stringent requirements for the unit to operate properly. Total voltage supply and voltage imbalance between phases should be within the tolerances listed in this manual.

Total Supply Voltage

WARNING

Live Electrical Components!

Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks.

Measure each leg of the supply voltage at the line voltage disconnect switches. For units with a nameplate voltage of 208/230 volt, the readings must fall within the range of 180253 volts. For units with a nameplate voltage of 460 volts, the readings must fall within the range of 414-506 volts. If voltage on any leg does not fall within tolerance, notify the power company and request correction of this situation before connecting to or operating the unit. Inadequate voltage to the unit will shorten the life of relay contacts and compressor motors.

Voltage Imbalance Between Phases

Excessive voltage imbalance between phases in a three- phase system will cause motors to overheat and eventually fail. Maximum allowable imbalance is 2 percent. Voltage imbalance is defined as 100 times the maximum deviation of the three voltages (three phases) subtracted from the average (without regard to sign), divided by the average voltage.

EXAMPLE:

If the three voltages measured at the line voltage fused disconnect are 221 volts, 230 volts and 227 volts, the average would be:

$$\frac{221 + 230 + 227}{3} = 226\ volts$$

The percentage of imbalance is then:

$$\frac{100\ (226 - 221)}{226} = 2.2\%$$

In the preceding example, 221 is used because it is the farthest from the average. The 2.2 percent imbalance that exists exceeds maximum allowable imbalance by 0.2 percent. This much imbalance between phases can equal as much as 20 percent current imbalance with a resulting increase in winding temperature that will decrease compressor motor life.

Equipment Grounding

CAUTION

Use Copper Conductors Only!

Failure to use copper conductors could result in equipment damage as unit terminals are not designed to accept other types of conductors.

Provide proper grounding at the connection point provided in the unit control panel.

Unit Power Wiring

WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized.

The installing contractor must connect appropriate power wiring (with fused disconnects) to the unit-mounted, non-fused disconnect in the power section of the unit control panel. Electrical schematics and component location drawings are also mounted on the inside of the control panel door.

The unit power fused disconnect switch should be located in the general area of the unit, to comply with NEC or local codes. Some codes require line-of-sight disconnect locations. The unit mounted non-fused disconnect can be used as an emergency shutdown device.

Scroll Compressor Electrical Phasing

CAUTION

Compressor Damage!
Operating compressors in reverse rotation will cause damage or failure of the compressor.

It is critical that proper rotation of the scroll compressors be established before the machine is started. Proper motor rotation requires confirmation of the electrical phase sequence of the power supply. The motor is internally connected for clockwise rotation with the inlet power supply phased "ABC" or "L1, L2, L3".

The order in which the three voltage waveforms of a three-phase system succeed one another is called phase sequence or phase rotation. When rotation is clockwise, phase sequence is usually called "ABC" and when counterclockwise, "CBA".

This direction may be reversed by interchanging any two of the line wires. The possibility of interchanging the wiring makes a phase sequence indicator necessary to quickly determine the proper phase rotation.

Setting the Proper Electrical Phase Sequence

Proper compressor motor electrical phasing can be quickly determined and, if necessary, corrected before starting the unit. Use a quality instrument, such as an Associated Research Model 45 Phase Sequence indicator or equivalent and follow this procedure:

1. Verify that all operating controls for the unit are in the "Off" position.
2. Turn power to FWCD unit "Off" using supply power disconnect to the unit. Verify that power to FWCD unit is "Off" and that there is no voltage on "Line" or entering side of the FWCD panel mounted unit disconnect.
3. Connect the phase sequence indicator leads to the "Load" or leaving side of the FWCD unit panel mounted disconnect as follows:

Phase Sequence Lead	Terminal ID
Black (Phase A)	L1
Red (Phase B)	L2
Yellow (Phase C)	L3

4. Turn power to FWCD unit "On" using the supply power disconnect to the unit
5. Read the phase sequence displayed on the indicator. The "ABC" LED on the face of the phase indicator will glow if phase sequence is ABC.
6. If the "CBA" indicator glows instead, turn power to FWCD unit "Off" using the supply power disconnect to the unit, then verify that the power to the FWCD unit is "Off" and that there is no voltage on the "Line" side of the FWCD panel mounted unit disconnect. Reverse two wires on the "Line" or entering side of the FWCD panel mounted disconnect switch. Turn power to FWCD unit "On" and recheck phase sequence (Step 5 preceding).
7. If phase sequence is correct, turn power to FWCD unit "Off" using the supply power disconnect to the unit. Verify that power to the FWCD unit is "Off" and that there is no voltage on "Line" or entering side of the FWCD panel mounted unit disconnect. Remove the phase indicator and restore power to the FWCD unit.

Control Power Supply

A fused, panel-mounted control power transformer is standard. Replacement fuse information is listed on the "Fuse Schedule" decal located adjacent to the transformer inside the control box.

External Contacts and Peripherals

The following peripheral control features and program logic come standard on all FWCD compact chillers. Designated terminals on the field connection terminal strip in the control panel are provided for field connection of each. Consult the field wiring diagram and wiring schematic diagram provided in this manual for the connection points. The wiring schematic diagram is also attached to the inside of the control panel door.

Required Chilled Water Flow Switch

WARNING

Unexpected Chiller Start!

Failure to follow instructions could cause the chiller to start unexpectedly which could result in equipment or property damage. An external source (EMS, time clock or any other means) should not be allowed to bring on a pump that would trigger the flow switch to start the chiller. The flow switch is meant to act as a safety switch and not a start/stop mechanism.

The FWCD controller has a required input that accepts a contact closure from a proof-of-flow device such as a flow switch or other factory approved flow proving device. When this input does not prove flow within a fixed time relative to transition from enabled to run modes of the chiller, or if the flow is lost while the chiller is in the running mode of operation, the chiller will be prohibited from running. The installer must provide and install this flow proving device. Failure to provide this flow proving device voids unit warranty.

Condenser Water Loss of Flow Protection

The FWCD controller logic will sense a loss of flow through the condenser. No condenser water flow switches are necessary with the standard standalone FWCD controller configuration.

Required Pump Control

FWCD units have one dry contact relay which is required to start the chilled water pump. These chillers also have one dry contact relay to start a condenser pump. These features are standard but only the chilled water pump control is required.

Remote Off/Auto

The FWCD controller has an input that accepts a contact closure from a remote device such as a toggle switch that can enable or disable the chiller to run. It would be wired in series with the Off/Auto switch located on the control panel door. This feature is standard but not required.

Remote Alarm

FWCD units have one dry contact relay to indicate with a remote light or bell or other device that at least one compressor in the unit has been locked out for whatever reason and needs attention. This feature is standard but not required.

Smart Controls

Every model is furnished with a microprocessor controller that cycles the compressors to maintain the leaving water temperature over a wide range of operating conditions. A convenient alphanumeric LCD display that is updated once per second. Inputs are made using large function keys with menu driven prompts. Schedules are available with a seven-day built-in time clock. Terminals are provided for remote stop-start and for remote reset of the leaving water temperature setpoint. The controller features 12 analog and 4 digital inputs as well as 4 analog outputs. Nonvolatile memory is used for all control functions. Additional optional features include diagnostic sensors for pressure and temperature on each refrigerant circuit, current sensors for each compressor, and a RS-485 port allowing communication with other manufacturer's control systems.

Figure 25 -Keypad Controller Display

Building Communications
When the FWCD Series chiller is used in conjunction with a building management system (BMS), the chiller can be monitored and given input from a remote location. The chiller can be set up to fit into the overall building control strategy by using remote run/stop input, remote demand limit reset and/or remote chilled water reset functions.

As standard, the unit controller Ethernet port is always ready to talk BACnet® IP and Modbus™ TCP/IP (Modbus RTU uses the RS485 network port). BACnet® MS/TP, Johnson N2 and LonTalk® are optional protocols that can be factory-installed. The unit controller can facilitate hundreds of control points, including the following popular BMS communications:

- Remote Off/Auto signal (input from BMS)
- Demand Limit Reset signal (input from BMS)
- Chilled Water Temperature Reset signal (input from BMS)
- Customer Alarm relay (view only)
- Chiller Run Indication (view only)
- Entering Chilled Water Temperature (view only)
- Leaving Chilled Water Temperature (view only)
- Chilled Water Flow Switch input (view only)
- Condenser Pump relay (view only)
- Chilled Water Pump relay (view only)

System Protection
A complete safety lockout system with alarms protects the FWCD Series chiller operation to potentially avoid compressor and evaporator failures. The unit controller directly senses pressures, temperatures, amperage, motor faults, etc. All control variables that govern the operation of the chiller are evaluated every second for exact control and protection. The following is an abbreviated list of safeties that are incorporated into the standard chiller algorithm control.

- **No Flow Protection** – To protect the chiller from no water flow to the evaporator, the chiller is enabled to run only if the required flow proving device indicates there is flow present. If the chiller is active and flow is lost; the chiller will lock out and an alarm is generated.

- **Low Suction Pressure** – To protect the compressors and evaporator, if the refrigerant suction pressure drops below the set point value for a specified period of time, a safety trip occurs. This safety is bypassed when the compressor is in a Pump Down state.

- **Unsafe Suction Pressure –** To protect the compressors and evaporator, if the refrigerant suction pressure drops below the set point value for a specified period of time, the chiller will immediately lock out, and an alarm is generated.

- **Heat Exchanger Freeze Protection** – To protect the evaporator from low water temperatures, the chilled water temperature is monitored inside the core of the evaporator and leaving the evaporator. If these temperatures fall below their set point temperatures for the set period of time, the entire system will lock out and an alarm is generated.

- **Active Freeze Protection System** – Working in conjunction with the low suction pressure and freeze protection safeties to avoid nuisance safety trips, the active freeze protection valve is opened when the suction pressure goes below the lower set point value and warms the evaporator until the freeze conditions are abated. The valve will stay open until the suction pressure rises safely above the upper set point level.

- **High and Low Discharge Pressure, High and Low Superheat, High and Low Compressor Amps** – The compressors will be locked out if any one of these control variables rises above the upper set point value or falls below the lower set point value for the set amount of time for each, and an alarm is generated.

- **Optional Phase/Power Monitor** – The factory-installed phase/power monitor continuously monitors the incoming power supply to the chiller for low voltage, phase rotation reversal, loss of phase and phase imbalance. Should one of these parameters be incorrect, the phase/power monitor relay will lock out (de-energize) and the fault LED on the monitor will blink. The unit controller will indicate the lockout, and an alarm is generated.

As an additional layer of system protection, mechanical high- and low-pressure switches are used in conjunction with the refrigerant circuit high- and low-pressure transducers and unit controller.

Standard Peripheral Control Features
The following peripheral control features and program logic come standard on all FWCD Series chillers. Designated terminals on the field connection terminal strip in the control panel are provided for field connection of:

- **Remote Off/Auto** (dry contact closure from a remote device - input)
- **Required Chilled Water Flow Proving Device** (dry contact closure from a remote device - input)
- **Remote Alarm** (dry contact closure to a remote device - output)
- **Required Chilled Water Pump Enable** (dry contact closure for 1 chilled water pump - output)
- **Condenser Water Pump Enable** (dry contact closure for 1 condenser water pump - output)

Standard Capacity Control
Standard capacity control on the FWCD Series chillers is accomplished by staging the scroll compressors on and off. The unit controller will maintain a set point leaving chilled water temperature within a control zone using proportional, integral derivative (PID) logic. If the leaving chilled water temperature starts to decrease and falls below the set point, the unit controller will turn one stage off. A further reduction in temperature will result in a second stage being turned off. The reverse is true as the leaving chilled water temperature increases. Lead/lag logic is used to even the run time on the individual compressors.

Optional Capacity Control
Chilled water temperature reset can be accomplished in two ways. In buildings with a building management system, the FWCD Series unit controller allows the BMS to communicate an offset to the chilled water temperature set point. If a BMS is not being used, the unit controller can accept a field provided 0 to 5 VDC analog input signal. As the input voltage varies away from center (2.5V), the chilled water temperature set point will be offset proportionally.

Note: *This control logic is factory-installed and must be denoted at the time of ordering.*

Demand limiting is a form of capacity control that limits the number of capacity steps the compact chiller is allowed to operate. It can be accomplished in the same two ways as the chilled water temperature reset: through BMS or field-provided 0 to 5 VDC input signal.

Note: *This control logic is factory-installed and must be denoted at the time of ordering.*

Array Control
The array controller option allows the FWCD Series chiller to be an ideal solution for facilities with growing occupancy and structural expansion plans because chillers can be added as capacity needs increase or applications where convenient redundancy is needed.

FWCD Series water-cooled chiller arrays can be controlled by two different array controller configurations, depending on the needs of the application. Both options allow the array to be controlled and operated like a single, higher capacity, multistage chiller. Capacity modulation and equalization of compressor run time is managed by the array controller. The array controller uses the same standard capacity control logic as an individual FWCD unit controller but with more stages of capacity.

Supervisory Array Controller
This option allows up to ten (10) FWCD Series chillers to be controlled and operated. The Supervisory Array Controller requires each module have an individual unit controller. This option is beneficial in applications requiring seven (7) or more modules to be controlled and in applications where chiller uptime is critical.

Power (115VAC) must be provided to a circuit breaker inside the Supervisory Array Controller enclosure panel to power the Supervisory Array Controller. The Supervisory Array Controller enclosure also contains a field connection terminal strip and door-mounted off/auto switch, run indicator light and alarm indicator light.

The Supervisory Array Controller is accessed in the same manner as the unit controller, through the keypad display or PC/laptop. If communication between the individual FWCD Series chiller unit controller(s) and the Supervisory Array Controller is lost, or the Supervisory Array Controller fails, the individual FWCD Series chillers can be shifted into manual mode to operate independent from the Supervisory Array Controller and will maintain a “manual mode” default chilled leaving water temperature set point.

N+1 logic can be utilized with the Supervisory Array Controller when each chiller in an array is equipped with optional chilled water motorized on-off valve, optional condenser water regulating valve and a standby chiller is installed in the array.

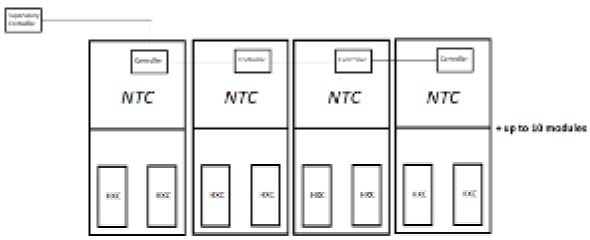


Figure 26 - Supervisor Controller Layout

Master-Secondary Array Controller

This option allows up to six (6) FWCD Series chillers to be controlled and operated. The Master-Secondary Array Controller requires only a single controller for the array. This option is beneficial in replacement applications where a single larger chiller, with one controller, is replaced by modular chillers controlled with one controller. The Master-Secondary Array Controller is also applicable for chiller applications that do not require redundant operation and first cost is considered an important factor.

The Master-Secondary Array Controller is powered from the unit supply power and factory provided transformer. The Master-Secondary array control panel also contains a field connection terminal strip and door-mounted off/auto switch, run indicator light and alarm indicator light.

The Master-Secondary Array Controller is accessed through the keypad display, touchscreen display or PC/laptop. If communication between the individual FWCD Series chiller modules and the Master-Secondary Array Controller is lost, that module will be inoperable until communication to the module is restored. The Master-Secondary Controller will continue to control the other modules in the array. If Master-Secondary Array Controller fails, the array will be down until the controller is repaired or replaced.

N+1 logic can be utilized with the Master-Secondary Array Controller, via the demand limit function, when each chiller in an array is equipped with optional chilled water motorized on-off valve, optional condenser water regulating valve and a standby chiller is installed in the array.

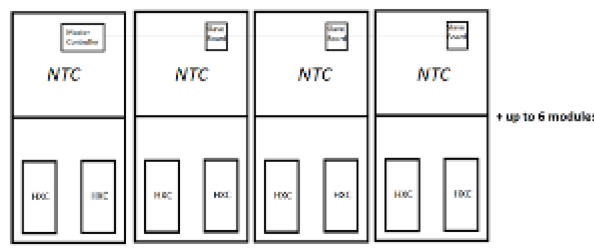


Figure 27 - Master-Secondary Controller Layout

Controls Interface

Unit Controller — General

The FWCD controller is a rugged microprocessor-based controller designed for the hostile environment of the HVAC/R industry. It is designed to be the primary manager of the FWCD product.

The controller provides flexibility with setpoints and control options that can be selected prior to commissioning a system or when the unit is live and functioning. Unit display presents pressure, temperature and alarm information with history in a clear and simple language format, informing the user of the chiller status. See wiring diagram in the wiring section of this manual and attached to the inside of the control panel door.

A password is required to access chiller setpoints. Use password code 2112 to access many of these features. A factory code may be required to allow access to critical areas, and can only be entered by a factory representative.

An RS-485 port is provided for communication with other manufacturers' systems.

Additionally, a built-in RS-485 to RS-232 converter allows communication over the RS-485 network via the RS-232 port.

Other features include the integration of BACnet IP® and MODBUS® into the unit controller. Optional communication cards are available for communication via LONWORKS®, Johnson N2 and BACnet MS/TP®. This should be ordered with the chiller if required. An ethernet connection is also provided on each unit. While field changes can be made, please ensure that the unit is ordered set up for required communications to ensure that factory testing includes end user configuration.

A complete software support package is available for your PC allowing for system configuration, dynamic on-line display screens, remote communication, graphing and more. Downloads for the MCS-Connect software are available at www.mcscontrols.com at no charge. All information needed to run the unit is available from the unit display; however, a laptop computer is invaluable for ease of use of diagnosing or changing the unit setpoints.

Note: *Not all setpoints can be changed with MCS-Connect; some require a configuration change.*

A serial cable is included in each shipment for the convenience of the field technician. If you do not have a laptop with a serial port, you will require a converter such as a Black Box item number #IC199A-R3 serial-to-USB adaptor.

The FWCD standard configuration allows for the unit to start at the lowest stage possible, and then add compressors as needed to meet demand.

Important: *All configuration changes need to be done by factory representatives to ensure proper operation of the unit within design parameters.*

Unit Controller

Software Installation and Setup

Downloading and Installing Unit Controller (MCS-Connect) Software

Go to www.mcscontrols.com.

Go to the software page and select MCS-CONNECT. Select SAVE. After downloading, open and select RUN. Follow prompts and software will be installed on your computer.

If your computer does not have a serial port, you will need to purchase a USB to Serial adapter. (Computer stores should have this.) Install the software for the adapter. If your computer has a serial port, you will not need an adapter.

Start the MCS-CONNECT software. Select SETUP>COMMUNICATIONS and then change LOCAL COM PORT to match your computer. Select SAVE and then OK.

Connecting to the Chiller
Connect the supplied NULL MODEM cable between your USB adapter or serial port to the chiller. A standard serial cable will not work.

Connection directly through the 100 MBPS Ethernet port on the FWCD unit controller or array controller to a PC requires a crossover Ethernet cable. If all controllers in the array are connected to an Ethernet switch, then an Ethernet patch (straight) cable will be used to connect the PC to the Ethernet switch.

Start the MCS-CONNECT software and select LOCAL SERIAL. The site info page will appear. The software should scan and find the chiller. (If you see a Failed to open comm port error, or it scans and does not find the chiller, your comm port settings are not correct.) Click the tab next to the "Site Info" tab. The screen shows real time data.

Setpoint Changes
Click the VIEW ONLY button. Enter the password code 2112. Select OK. Button should say SERVICE. Go to setpoints and double-click on a value. Change and select OK.

Viewing and Troubleshooting ALARMS
The unit controller will record and store 120 seconds of sensor input data prior to and up to any LOCKOUT ALARM. Select the ALARM tab, then INFO next to the alarm you want to analyze. This will pop up a screen that shows operating conditions just prior to the trip allowing the user to determine if the fault was caused by a sudden or gradual change. For instance, a sudden increase in discharge pressure might suggest a condenser pump or fan failure etc. (This data can also be viewed from the chiller LCD screen. Select LOCKOUT ALARMS.)

Downloading and Viewing Graphs
The unit controller continuously records and stores sensor input and relay/analog output data. This data is collected in 10-second (default) intervals. The controller stores 1008 packets of data replacing the oldest with the newest. With the time interval set at 10 seconds, graph data can be downloaded with a time span of 168 minutes. The time interval is adjustable.

In the MCS-CONNECT software, select GRAPH. Data will be downloaded and then a graph setup page will appear. Select the input and output data to be viewed. Type in Y-axis parameters and select OK. Use the scroll bar at the bottom of the graph to view. Return to the setup page at any time to change selections. The graph may be saved. The saved graph will be located in a folder called GRAPH inside another folder called MCS on the C: drive.

To change the default 10-second interval, make changes and select SAVE and then OK on the setup page. The controller will now record data at this new interval.

To view a saved graph, select LOAD A GRAPH FILE. These files can be e-mailed for analysis if needed.

Updating Chiller Software and Configuration Files
FWCD chillers are programmed, set up, and tested prior to shipment. Sometimes after a unit arrives at the jobsite, the customer may want to enable an option such as 0–5 Vdc target reset, etc. These options require a configuration change. The configuration file must be downloaded and electronically sent to the factory for the changes to be made or the factory may modify a default configuration file and electronically send the modified default configuration to the customer. Modifying a configuration file will save any setpoint changes that have been made on site. Otherwise, the controller will be set back to default factory settings.

To e-mail a copy of the chiller's configuration file, in the MCS-CONNECT software, establish communication with the chiller and select RECEIVE CFG.

- Name it "Unit (*serial number*)" and e-mail to sales@jetsonhvac.com.

To load a configuration file, turn off circuit enable switches and select TRANSMIT CFG. Locate the new file and press OPEN. The file will be uploaded to the controller. The controller will reboot itself.

Routine software (HEX FILE) updates are NOT necessary. However, if a software update is necessary to resolve an operating issue, a hex file in a zipped folder will be provided. Save the zipped folder to the computer's desktop. Right click folder and select EXTRACT ALL. This will create another folder by the same name on the computer's desktop. Inside this folder will be the hex file. It should be about 2300 KB. In the MCS-CONNECT software, select TRANSMIT SW. Locate the extracted hex file and select Transmit. Watch the chiller LCD screen. After the file is uploaded, the FWCD unit controller will verify that it's a valid file and then erase the flash memory. Next, it will write the new hex to memory. When completed, the controller will reboot itself. This process may take 15 or 20 minutes. After the reboot is completed, close and restart the MCS-CONNECT software to reestablish communication with the chiller.

Unit Start-Up Procedures

Start-up and commissioning must be performed by a factory authorized Jetson service technician.

Pre-Start

Complete each step in the "Pre-Start Up Procedures" included in the *FWCD Individual Chiller Start-up Check List* and check off each step as completed.

WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized.

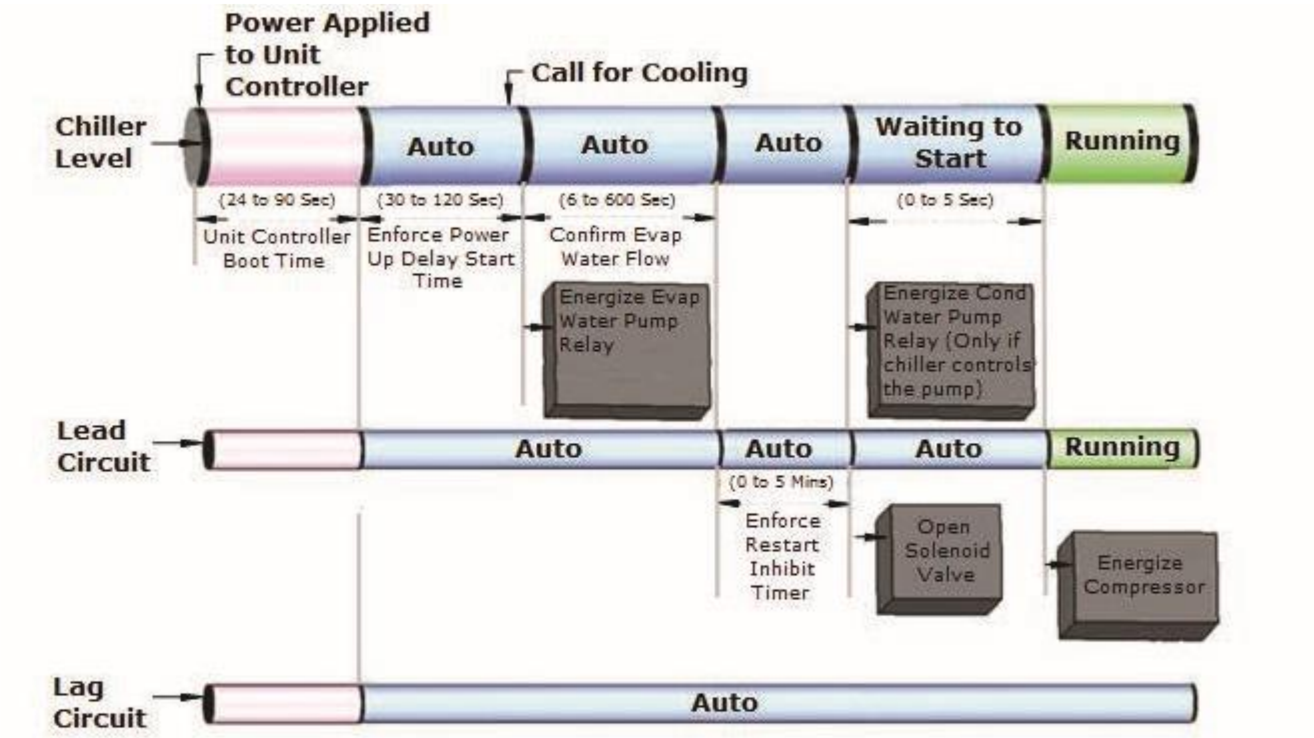
CAUTION

Equipment Damage!

- To prevent overheating at connections and under- voltage conditions at the compressor motor, check tightness of all connections in the compressor power circuit.
- To prevent compressor damage, do not operate the unit with discharge or liquid line service valves closed.
- The use of untreated or improperly treated water in a Chiller may result in scaling, erosion, corrosion, algae or slime. It is recommended that the services of a qualified water treatment specialist be engaged to determine what water treatment, if any, is required. Jetson assumes no responsibility for equipment failures which result from untreated or improperly treated water, or saline or brackish water.
- To prevent evaporator or condenser damage, pipe strainers must be installed in the water supplies to protect components from water born debris. Jetson is not responsible for equipment damage caused by water born debris.

Sequence of Operation

Figure 28 Unit power-up



Checking Operating Conditions

> **CAUTION**
>
> **Evaporator/Condenser Damage!**
>
> Water (fluid) flow must be established in evaporator and condenser before adding refrigerant, removing refrigerant, or pulling vacuum to protect heat exchangers from freezing.

> **CAUTION**
>
> **Compressor Damage!**
>
> Do not allow liquid refrigerant to enter the suction line as excessive liquid accumulation in the liquid lines could result in compressor damage.

To prevent compressor damage and ensure full cooling capacity, only use refrigerant specified on unit nameplate.

- If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove refrigerant at the liquid line Schrader fitting. Do not discharge refrigerant into the atmosphere.
- Once proper unit operation is confirmed, inspect for debris, misplaced tools, etc. Secure control panel doors in place.

Once the unit has been operating for about 10 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

- Recheck evaporator water and condenser water flow and pressure drop. These readings should be stable at proper levels.
- Check suction pressure and discharge pressure.
- **Discharge pressure:** Take at Schrader fitting provided on the discharge line. Normal discharge pressures are:

- 90°F to 120°F Condenser LWT: 275 to 430 psig
- 120°F to 140°F Condenser LWT: 430 to 560 psig
- **Suction pressure:** Take at Schrader fitting provided on the suction line. Normal suction pressures are:
- 42°F to 60°F LWT: 104 to 155 psig
- 15°F to 39°F LWT: 60 to 103 psig
- Check compressor oil level. At full load, oil level should be visible in the oil level sight glass on the compressor. If it is not, add or remove oil as required.
- Check the liquid line sight glass. Refrigerant flow past the sight glass should be clear. Bubbles in the liquid line indicate either low refrigerant charge or excessive pressure drop in the liquid line. Such a restriction can often be identified by a noticeable temperature differential on either side of the restricted area. Frost often forms on the outside of the liquid line at this point also.

Important: *The system may not be properly charged although the sight glass is clear. Also consider superheat, sub-cooling and operating pressure.*

- Once oil level, amp draw and operating pressures have stabilized, measure system suction superheat.
- Measure system liquid line sub-cooling.
- If operating pressure, sight glass, superheat and sub- cooling readings indicate refrigerant shortage, charge refrigerant into each circuit. Refrigerant shortage is indicated if operating pressures are low and sub- cooling is also low.

Important: *If suction and discharge pressures are low but subcooling is normal, no refrigerant shortage exists. Adding refrigerant, will result in overcharging.*

- Add refrigerant with the unit running by metering liquid refrigerant through the Schrader valve between the expansion valve and the evaporator refrigerant inlet until operating conditions are normal.

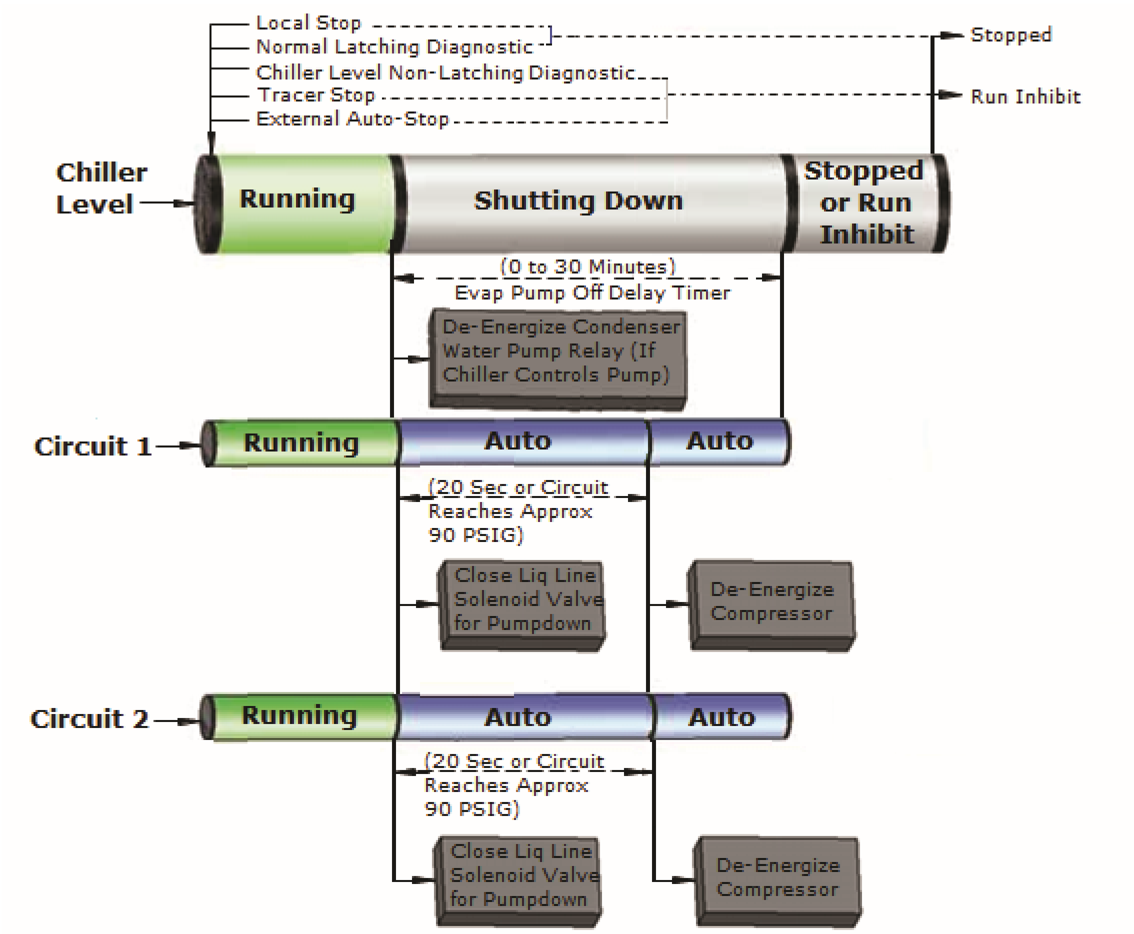
System Superheat
Normal superheat is 10°F to 16°F at full load. Expansion valve superheat is factory set. Contact factory before making any adjustment.

System Subcooling
Normal subcooling is 5°F to 10°F at full load where saturated discharge pressure and liquid line temperature are measured at chiller liquid line.

Shut Down

Normal Unit Shutdown

Figure 29 Normal unit shutdown



Extended Shutdown Procedure

If the system is taken out of operation for long periods of time, use this procedure to prepare the system for shutdown.

1. Test condenser and high side piping for refrigerant leakage.
2. Open electrical disconnect switches for evaporator water pump. Lock the disconnect in an open position.
3. Open the unit main electrical disconnect and unit- mounted disconnect and lock in open position.

Unit Restart

Unit Restart After Extended Shutdown

Use this procedure to prepare the system for restart after an extended shutdown.

CAUTION

Compressor Failure!

To protect compressors from premature failure the unit must be powered and crankcase heaters energized at least 24 hours BEFORE compressors are started.

CAUTION

Compressor Damage!
To prevent compressor damage, be certain that all refrigerant valves are open before starting the unit.

1. Close the unit main disconnect(s) and the unit mounted disconnect.
2. Check compressor crankcase oil levels. Oil should be visible in the compressor oil level sight glass
3. Fill the chilled water circuit if drained during shutdown. Vent the system while filling it.
4. Close the fused disconnect switches for the water pumps.
5. Start the water pumps. With water pumps running, inspect all piping connections for leakage. Make any necessary repairs.
6. With water pumps running, adjust chilled water flow and check water pressure drop through the evaporator.
7. Check the flow switch on the evaporator outlet piping for proper operation.
8. Stop the water pumps.
9. Energize crankcase heaters. (Heaters must be energized a minimum of 24 hours before startup.)

Maintenance

WARNING

Hazardous Service Procedures!

Failure to follow all precautions in this manual and on the tags, stickers, and labels could result in death or serious injury.
Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the following instructions: Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks.

Periodic Maintenance

Perform all of the indicated maintenance procedures at the intervals scheduled. This will prolong the life of the unit and reduce the possibility of costly equipment failure. All maintenance tasks other than recording data must be performed by a qualified service technician.

Weekly Maintenance

Ensure the unit has been operating for about 10 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

- Check compressor oil levels. Oil should be visible in the sight glass when the compressor is running. Operate the compressors for a minimum of three to four hours when checking oil level, and check level every 30 minutes. If oil is not at proper level after this period, have a qualified service technician add or remove oil as required.
- Check suction pressure and discharge pressure.
- Check the liquid line sight glasses.
- If operating pressures and sight glass conditions seem to indicate refrigerant shortage, measure system superheat and system sub-cooling.
- If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove refrigerant at the liquid line service valve. Do not release refrigerant to the atmosphere.
- Inspect the entire system for unusual conditions. Use an operating log to record weekly operating conditions history for the unit. A complete operating log is a valuable diagnostic tool for service personnel.

Monthly Maintenance

Ensure the unit has been operating for about 10 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

- Check compressor oil levels. Oil should be visible in the sight glass when the compressor is running. Operate the compressors for a minimum of three to four hours when checking the oil level, and check level every 30 minutes. If oil is not at proper level after this period, have a qualified service technician add or remove oil as required.
- Check refrigerant superheat at the compressor suction line. Superheat should be in the range of 10°F–20°F.

Note: *A superheat calculated value is incorporated into the unit controller.*

- Check the liquid line sight glasses.
- If operating pressures and sight glass conditions seem to indicate refrigerant shortage, measure system superheat and system sub-cooling.
- If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove

refrigerant at the liquid line service valve. Do not release refrigerant to the atmosphere.

- Inspect the entire system for unusual conditions. Review the weekly operating log for conditions history for the unit and take note of any unusual trends in performance. Take appropriate preventative actions if necessary.

Annually

Perform all weekly and monthly maintenance procedures.

- Have a qualified service technician check the setting and function of each control and inspect the condition of and replace compressor and control contacts if needed.
- If chiller is not piped to drain facilities, make sure drain is clear to carry away system water.
- Drain water from condenser and evaporator and associated piping systems. Inspect all piping components for leakage, damage, etc. Clean out evaporator and condenser supply strainers.
- Clean and repaint any corroded surface.

Compressor Maintenance

Compressor Oil

The R-410A scroll compressor uses POE oil as required by the manufacturer of the compressor. Refer to compressor manufacturer for exact type and amount of oil in the specific model in question.

Oil Level

While the compressor is running, the oil level may be below the sight glass but still visible through the sight glass. The oil level should NEVER be above the sight glass!

Oil Appearance

If the oil is dark and smells burnt, it was overheated because of compressor operation at extremely high condensing temperatures, a compressor mechanical failure, or occurrence of a motor burnout. If the oil is black and contains metal flakes, a mechanical failure has occurred. This symptom is often accompanied by a high amperage draw at the compressor motor.

Notes:

- *If a motor burnout is suspected, use an acid test kit to check the condition of the oil. If a burnout has occurred, test results will indicate an acid level exceeding 0.05 mg KOH/g.*
- *The use of commercially available oil additives is not recommended. Liability for any detrimental effects that the use of non-approved products may have on equipment performance or longevity must be assumed by the equipment owner, equipment service technician, or the oil additive manufacturer.*

Scroll Compressor Functional Test

Since the scroll compressor does not use discharge or suction valves, it is not necessary to perform a pump- down capability test, i.e., a test where the liquid line valve is closed and the compressor is pumped in a vacuum to see if it will pump-down and hold. In fact, this kind of test may actually damage the scroll compressor.

CAUTION

Compressor Damage!

Do not pump the scroll compressor into a vacuum. Scroll compressors can pull internal low vacuums when the suction side is closed or restricted. This, in turn, can lead to compressor failure due to internal arcing and instability in the scroll wraps

The proper procedure for checking scroll compressor operation is outlined below:

1. Verify that the compressor is receiving supply power of the proper voltage.
2. With the compressor running, check suction pressure and discharge pressure.

Discharge pressure: Take at Schrader fitting provided on the discharge line. Normal discharge pressures are:

- 90°F to 120°F Condenser LWT: 275 to 430 psig
- 120°F to 140°F Condenser LWT: 430 to 560 psig

Suction pressure: Take at Schrader fitting provided on the suction line. Normal suction pressures are:

- 42°F to 60°F LWT: 104 to 155 psig
- 15°F to 39°F LWT: 60 to 103 psig

Compressor Operational Noises

At low ambient startup: When the compressor starts up under low ambient conditions, the initial flow rate of the compressor is low. Under these conditions, it is not unusual to hear the compressor rattle until the suction pressure climbs and the flow rate increases. These sounds are normal and do NOT affect the operation or reliability of the compressor.

Excessive Amp Draw

Excessive Amp Draw occurs either because the compressor is operating at an abnormally high condensing temperature OR because of low voltage at the compressor motor.

Motor amp draw may also be excessive if the compressor has internal mechanical damage. In this situation, vibration and discolored oil can also be observed.

Low Suctions

Continuous low suction pressures are most likely caused by low evaporator load coupled with a system anomaly such as low chilled water flow.

Note: *Operation of the chiller with saturated suction temperatures below freezing will cause damage to the evaporator. If this occurs immediately stop the machine, diagnose and correct the problem.*

Heat Exchanger Maintenance

When to Clean a Brazed Plate Heat Exchanger (BPHE)

A temperature difference, less than specified, indicates a sign of scaling because fouling of the channel plate surface decreases the heat transfer. Hence the inlet and outlet temperatures of the BPHE should be measured continuously. Pressure drops larger than specified indicate scaling since it restricts the channel passage and thus increases velocity. Make sure that readings follow water flow rate corresponding to the specification, since changes in flow rate effect temperatures and pressure drops. By removing the scale build-ups, the operating efficiencies of the equipment and heat transfer surfaces are restored. Other benefits from removing the scale are that it lowers the pressure drops, reduces the power consumption and extends the lifetime of the equipment.

How to Clean a Brazed Plate Heat Exchanger (BPHE)

FWCD chiller BPHEs are cleaned quickly and easily with Cleaning in Place (CIP), a method used for the interior surfaces of closed systems, such as pipes, vessels, process equipment, and filters. A chemical fluid is circulated through the BPHE, without the need for disassembly. The chemicals dissolve or loosen deposits from process equipment and piping, giving uniform removal and lower overall operating costs. Following is a general description of the system setup, the CIP procedure, and the various cleaning fluids.

Cleaning in Place (CIP) Procedure

Start

1. Shut off relevant pumps
2. Shut off the primary side's valves
3. Shut off the secondary side's valves
4. Empty the BPHE
5. Wash it with water to remove loose contamination
6. Connect the machine via inlet/outlet at front or backside
7. Mix chemical and water according to instructions such as for Scale 132 Copper
8. Heat the solution to 120-140F, make use of primary side heat if possible

9. Pump the solution in the BPHE using the lower opening to ventilate air. A flow rate corresponding to 1.5 times the normal flow rate is suitable. Reverse the flow direction every 30 min if possible. Monitor the pressure differential. A pressure differential equal to design criteria indicates a clean BPHE. Alternatively, monitor pH. Constant pH value for 30 minutes indicates a clean BPHE. For Scale 132 Copper pH of 3 indicates the need to renew the cleaning solution, then empty the BPHE and restart at point 5. The cleaning time varies, but is estimated to 4-8 hours.

Stop

10. Flush from the lower opening for 5 minutes before changing direction. Repeat this operation until no more dirt is flushed out
11. Empty the BPHE and the machine, handle the used solution properly
12. Flush the BPHE with water starting from the lower opening until pH 7
13. To pickle and passivate steel use 2% phosphoric acid at 50°C (120°F) for 4-6 h.
14. Flush the BPHE with water starting from the lower opening until pH 7

CIP Fluids

Bio Gen Active – Scale 132 Copper

Commercially available Scale 132 Copper removes lime scale and other carbonates as well as rust and other metal oxides without the risk of corrosion.

Organic Acids

Organic acids are less hazardous than mineral acids, which makes them a good choice for BPHE cleaning. Organic acids include formic, acetic, and citric acids, among others, and are commonly applied at concentrations between 1 and 5 volume percent.

Formic Acid

Formic acid alone is unable to remove iron oxide when it's used as a mixture with citric acid or HCl. Formic acid can be used on stainless steels, it's relatively inexpensive and can be disposed by incineration.

Acetic Acid

Dissolves lime scale, but doesn't remove iron oxide deposits. Since it's weaker than formic acid, it is preferred where long contact times are necessary.

Citric Acid

Mild iron contamination can be removed by using a mixture of 1% each of citric acid and HNO_3. For more persistent contaminations, stronger solutions must be used.

Bases

Bases have the ability of removing oil, grease and biological deposits from the heat exchanger surface and may be applied as a complement during cleaning. They may also be added at the end of the cleaning procedure, before the last rinse with water, to neutralize any acid content left in the system. A solution of 1-2% sodium hydroxide (NaOH) or sodium bicarbonate ($NaHCO_3$) before the last rinse ensures that all acid is neutralized.

CIP Pumps

Important features:

- The reservoir should be made in acid- and alkali resistant material.
- The hoses should be made in PVC.
- A reverse flow device enables attack of lime scale from both directions.
- A heating device enables the CIP solution to reach much better effect.
- The flow rate capacity depends on the size of the BPHE.

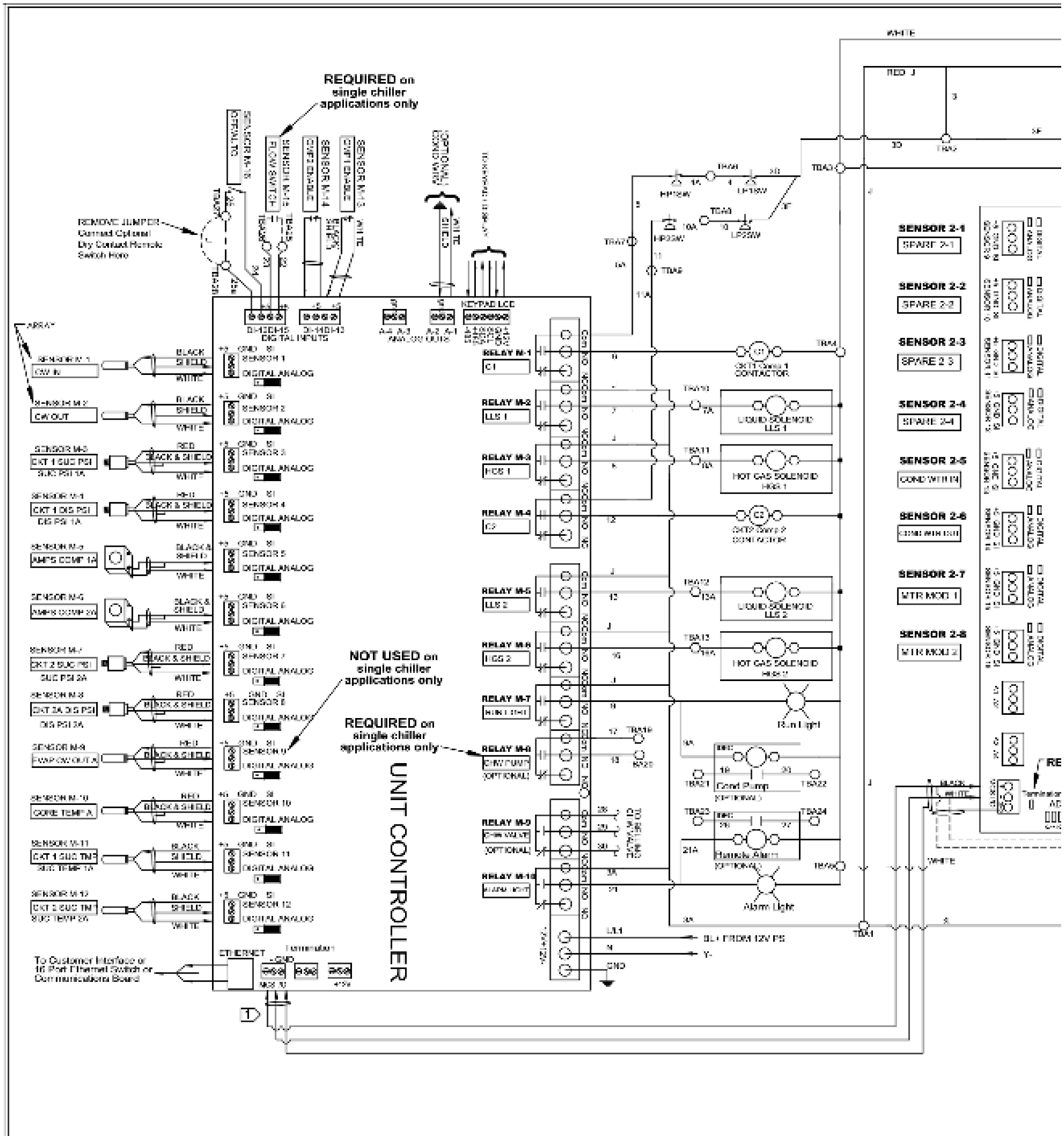
COMMERCIALLY AVAILABLE CIP FLUIDS

Bio Gen Active – Scale 132 Copper

Description: Scale 132 effectively removes lime scale and metal oxides (e.g., rust) without etching the material. It's used for reconditioning of waterborne systems. The product is mild to user, material and the environment.

Wiring

Figure 30. FWCD wiring schematic



Notes:

1. Only this module, the "Master" in the Array, is connected from the Unit Controller MCS I/O port to the Expansion Board MCS I/O port.
2. Consecutive modules, "slaves" in array are daisy-chained through Expansion Board MCS I/O ports.

Figure 31. FWCD wiring schematic (continued)

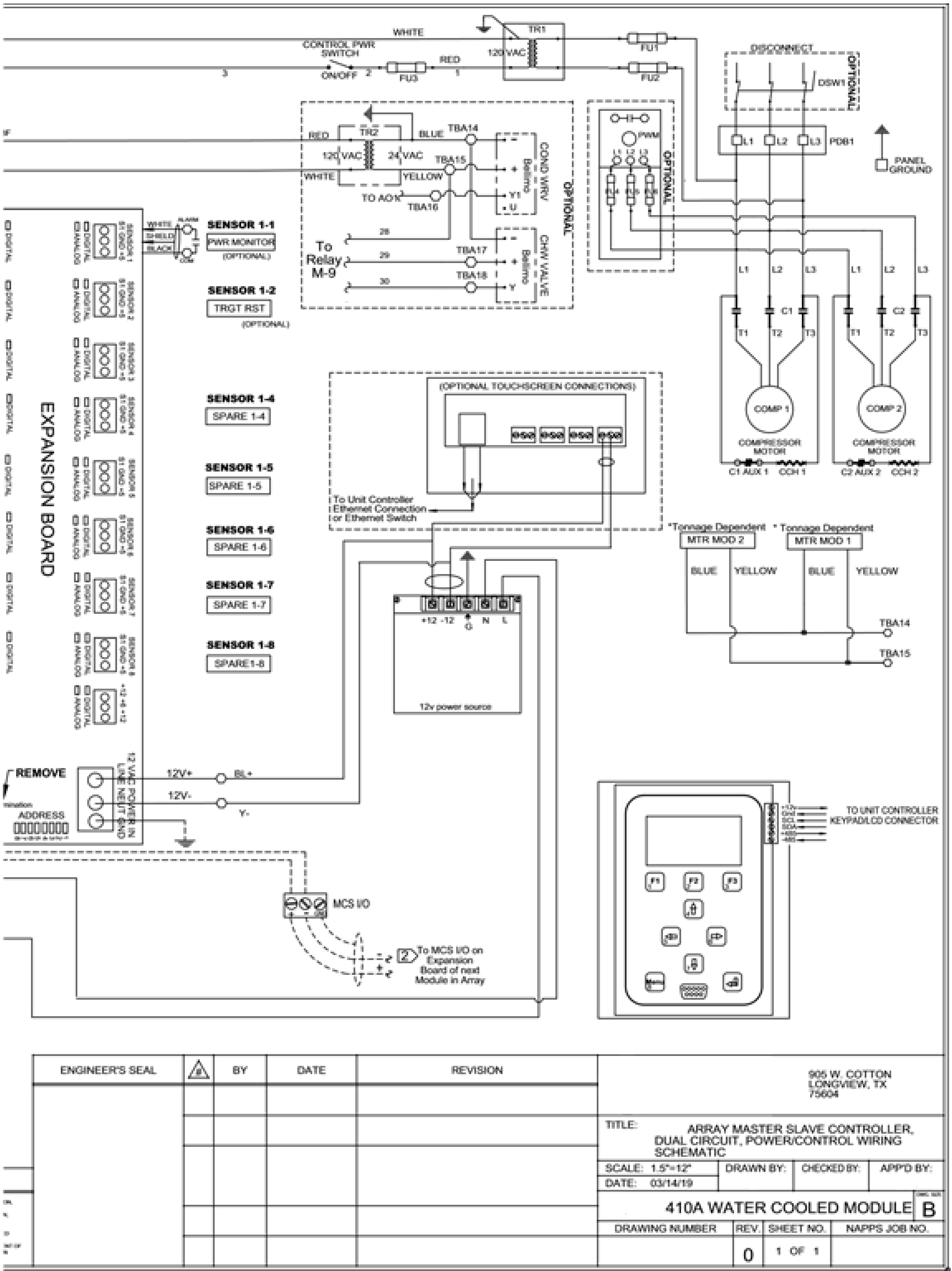
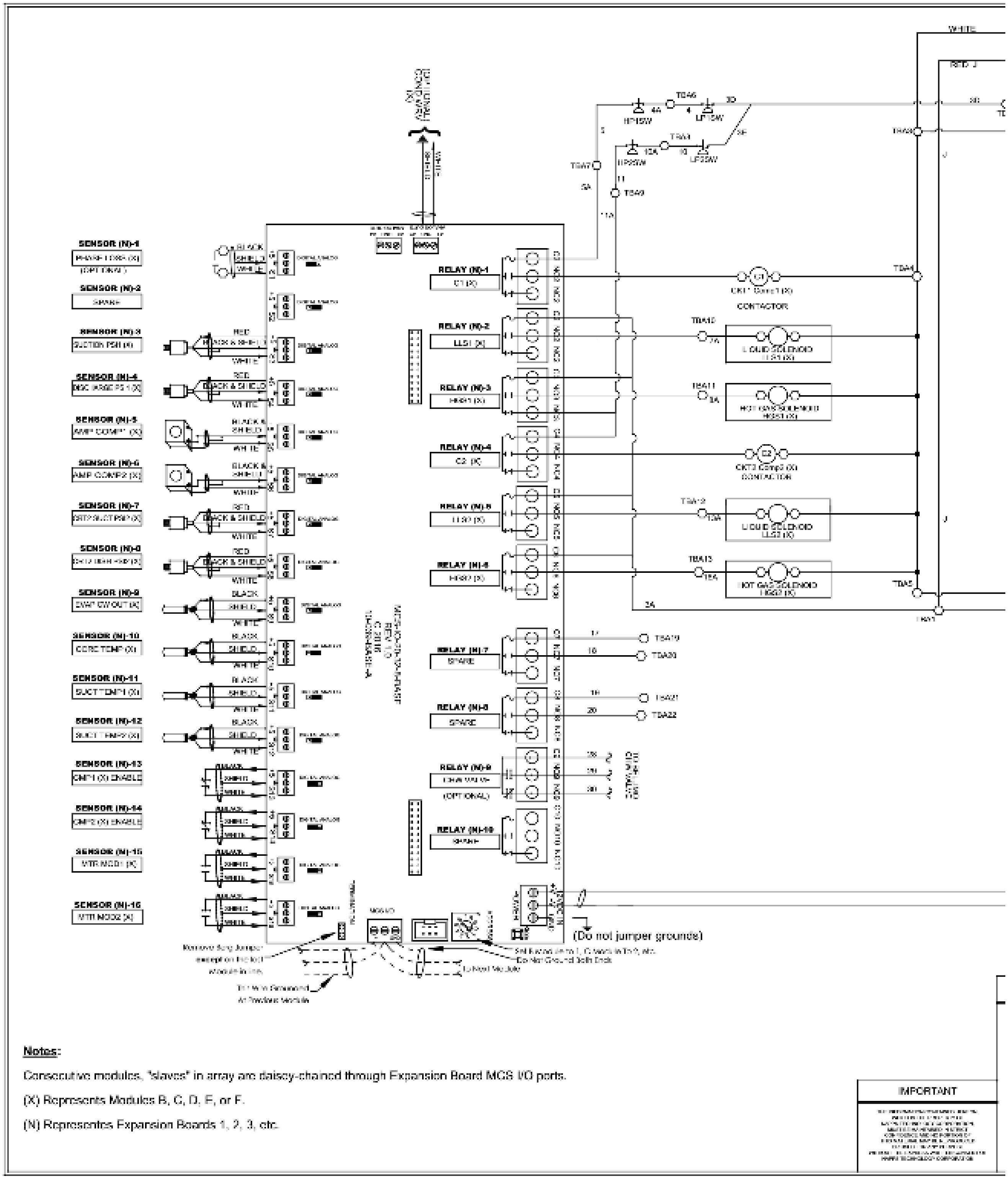


Figure 32. FWCD dual circuit secondary wiring schematic



Notes:

Consecutive modules, "slaves" in array are daisy-chained through Expansion Board MCS I/O ports.

(X) Represents Modules B, C, D, E, or F.

(N) Representes Expansion Boards 1, 2, 3, etc.

Figure 33. FWCD dual circuit secondary wiring schematic (continued)

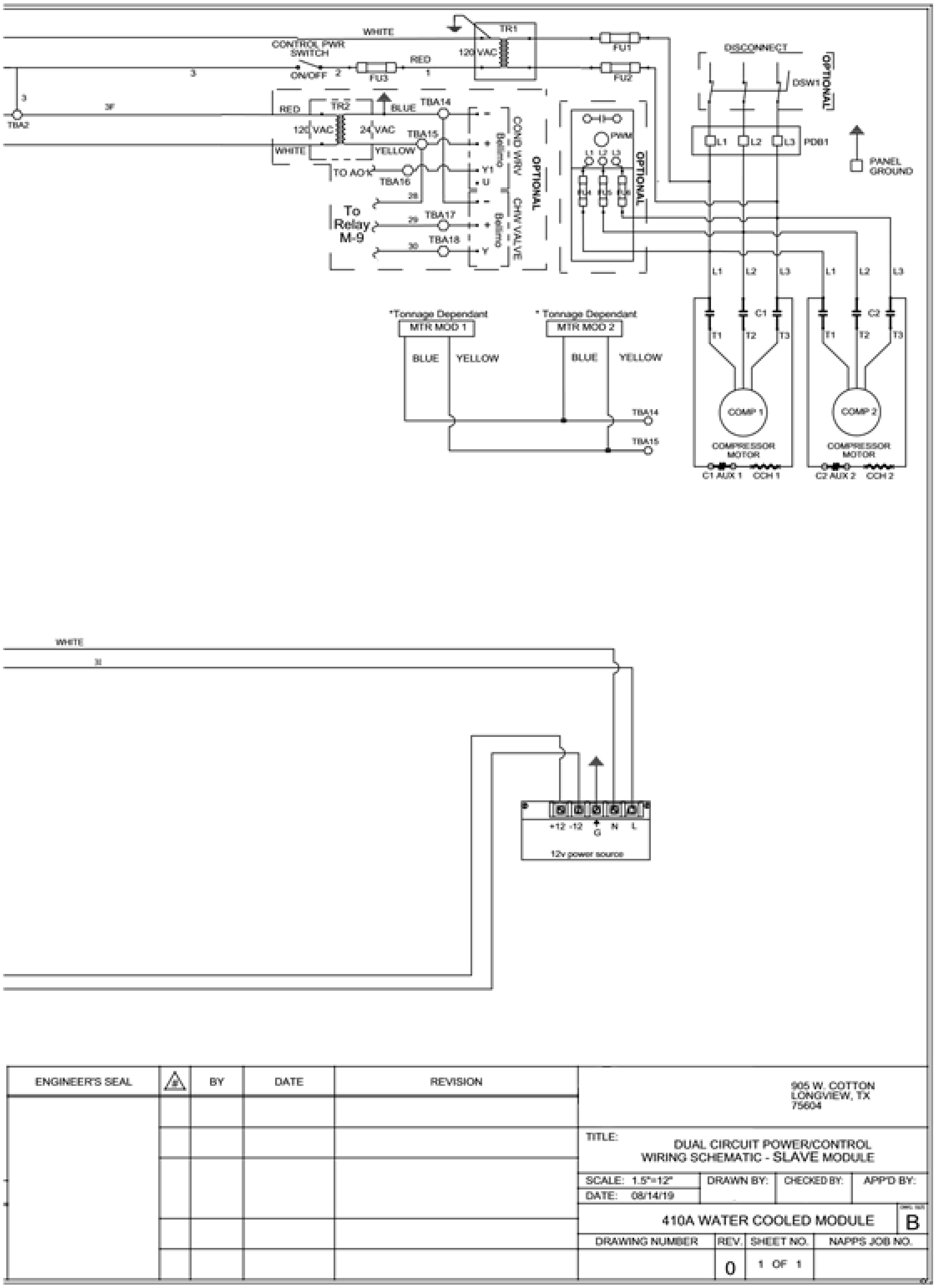
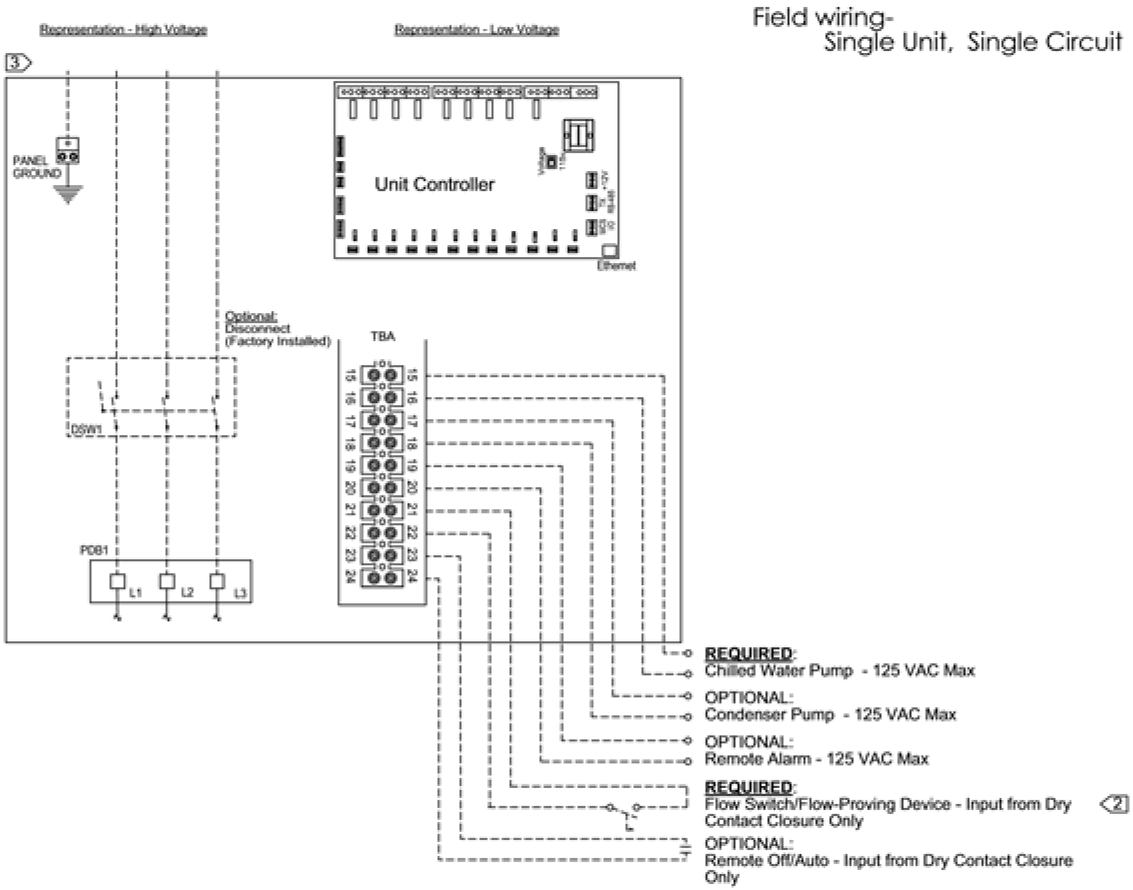


Figure 34. Field wiring – FWCD single unit, single circuit



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/ tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

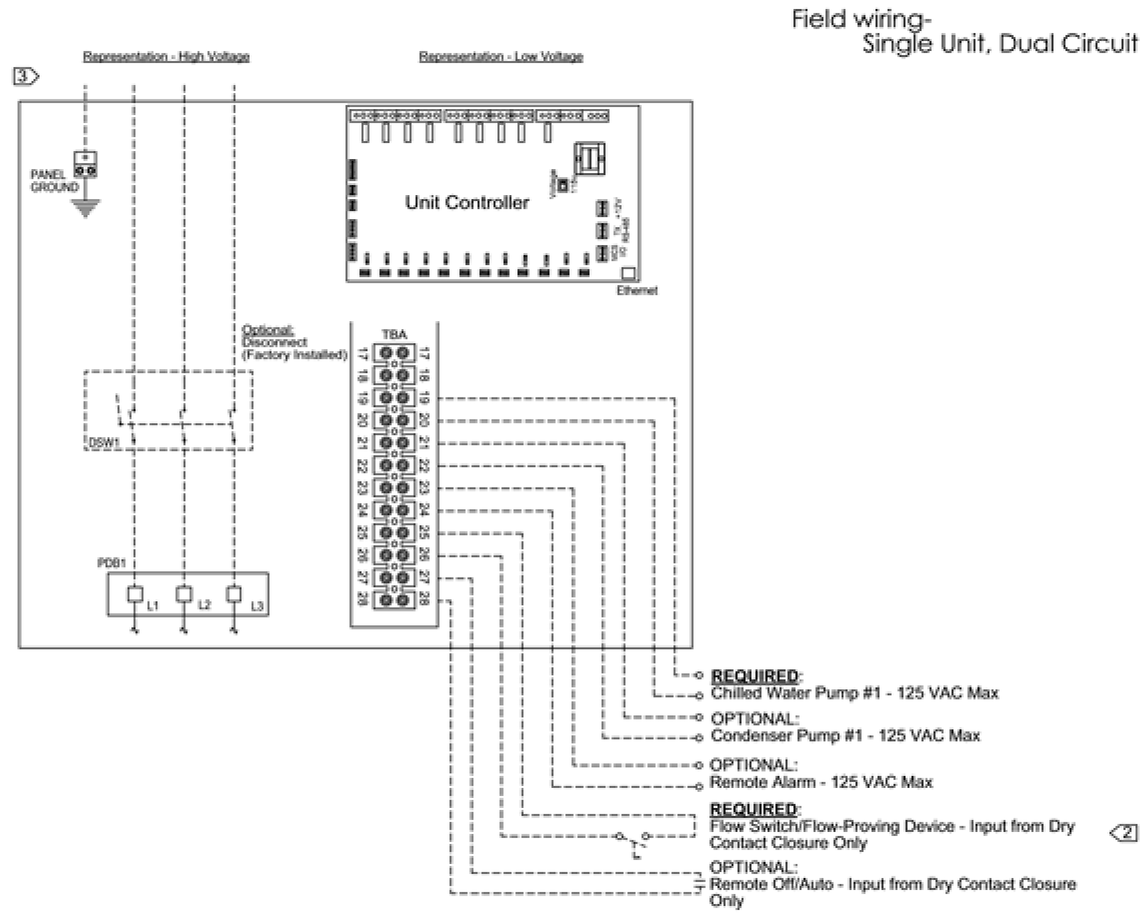
CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V.
2. (Required) Factory supplied or approved alternate field installed flow proving device connection.
3. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.

Figure 35. Field wiring – FWCD single unit, dual circuit



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

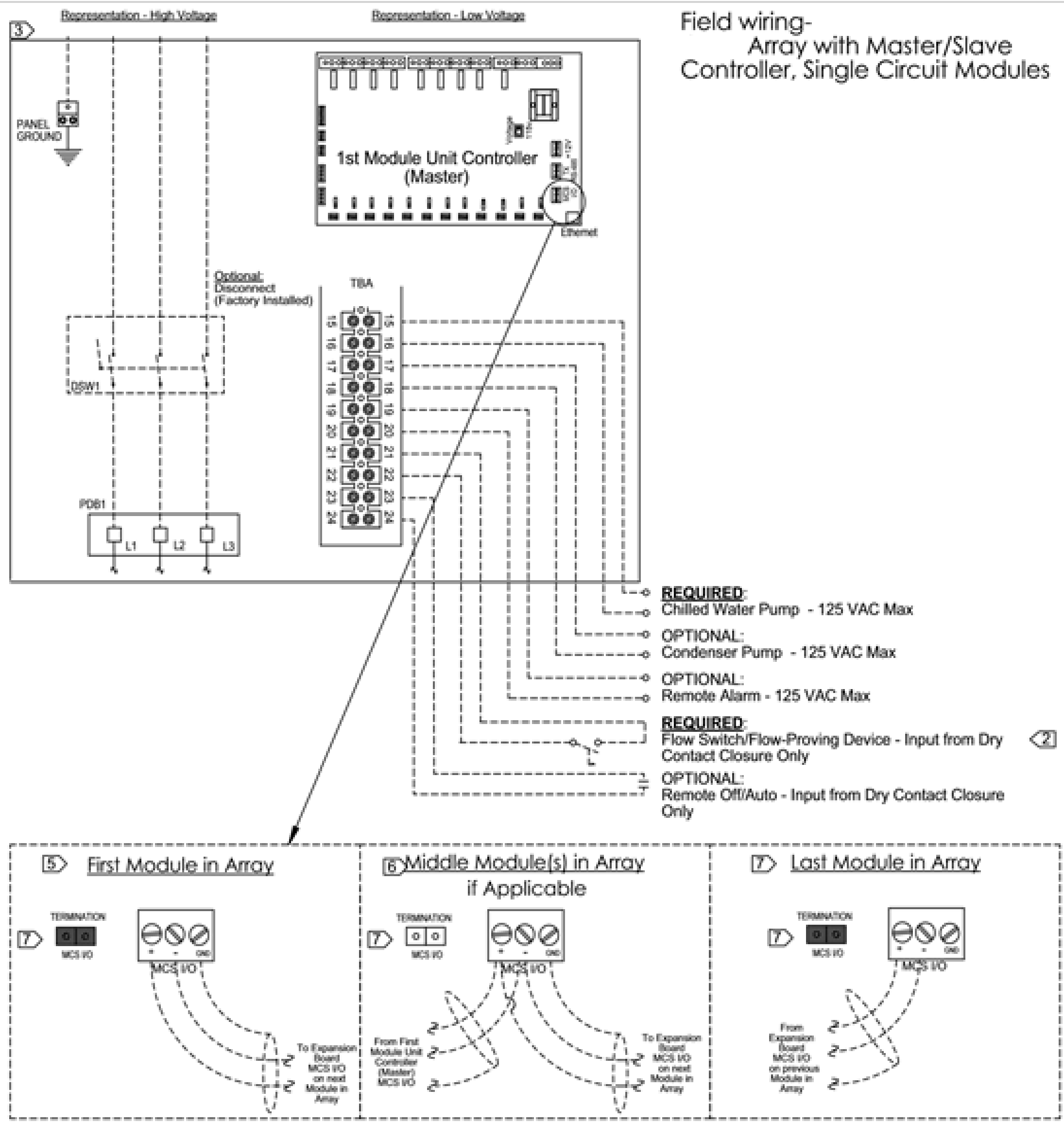
Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V.

2. (Required) Factory supplied or approved alternate field installed flow proving device connection.

3. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.

Figure 36. Field wiring – FWCD array with master-secondary controller, single circuit modules



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/ tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

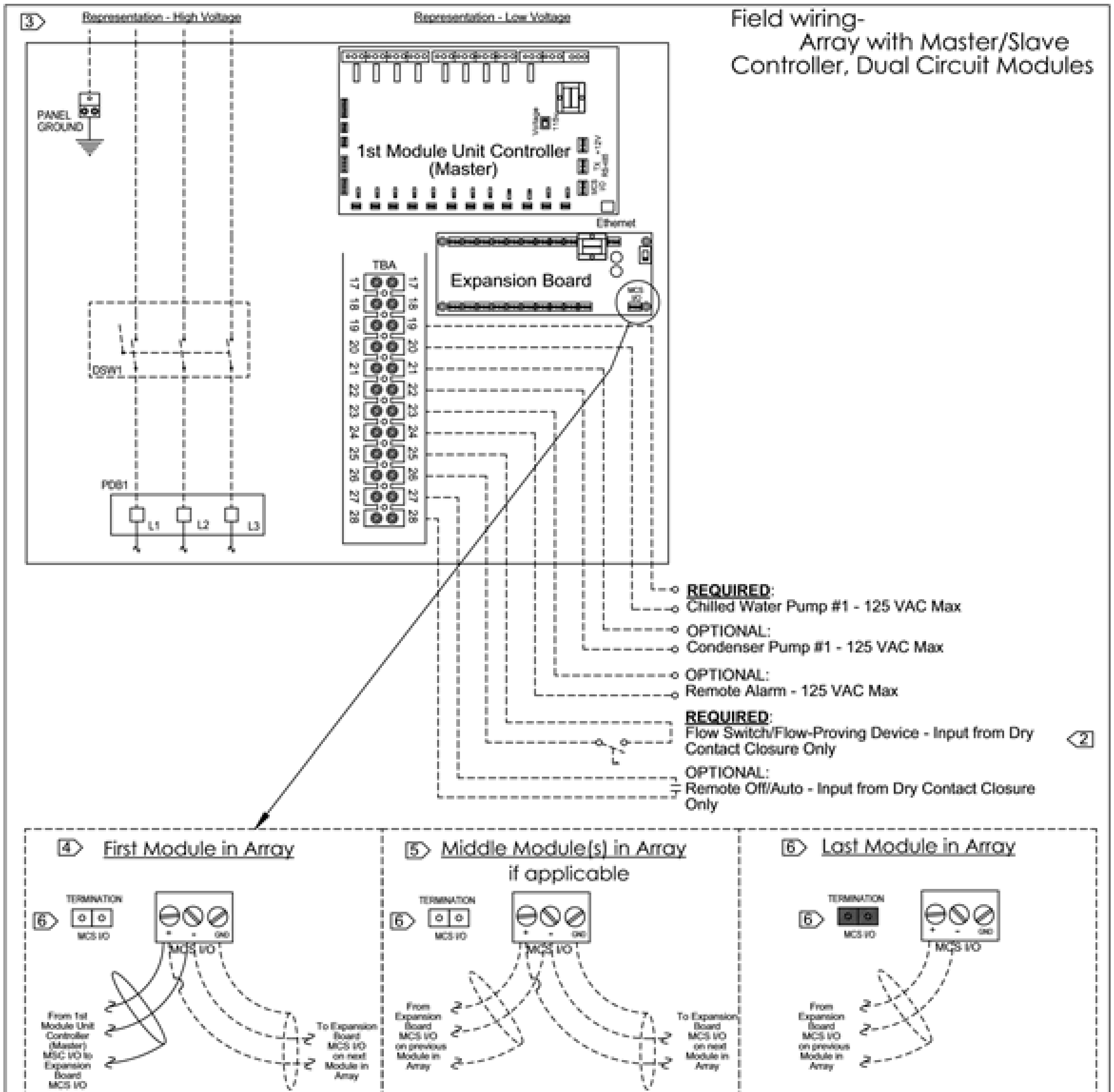
CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V.
2. (Required) Factory supplied or approved alternate field installed flow proving device connection.
3. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.
4. Only the first Module in an Array application is connected from the First Module Unit Controller MCS I/O.
5. Consecutive Modules in an Array are daisy-chained to the next Module's Expansion Board MCS I/O.
6. Ensure all MCS I/O Berg Termination Jumpers are removed EXCEPT on the FIRST and LAST Module in the array.

Figure 37. Field wiring – FWCD array with master-secondary controller, dual circuit modules



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

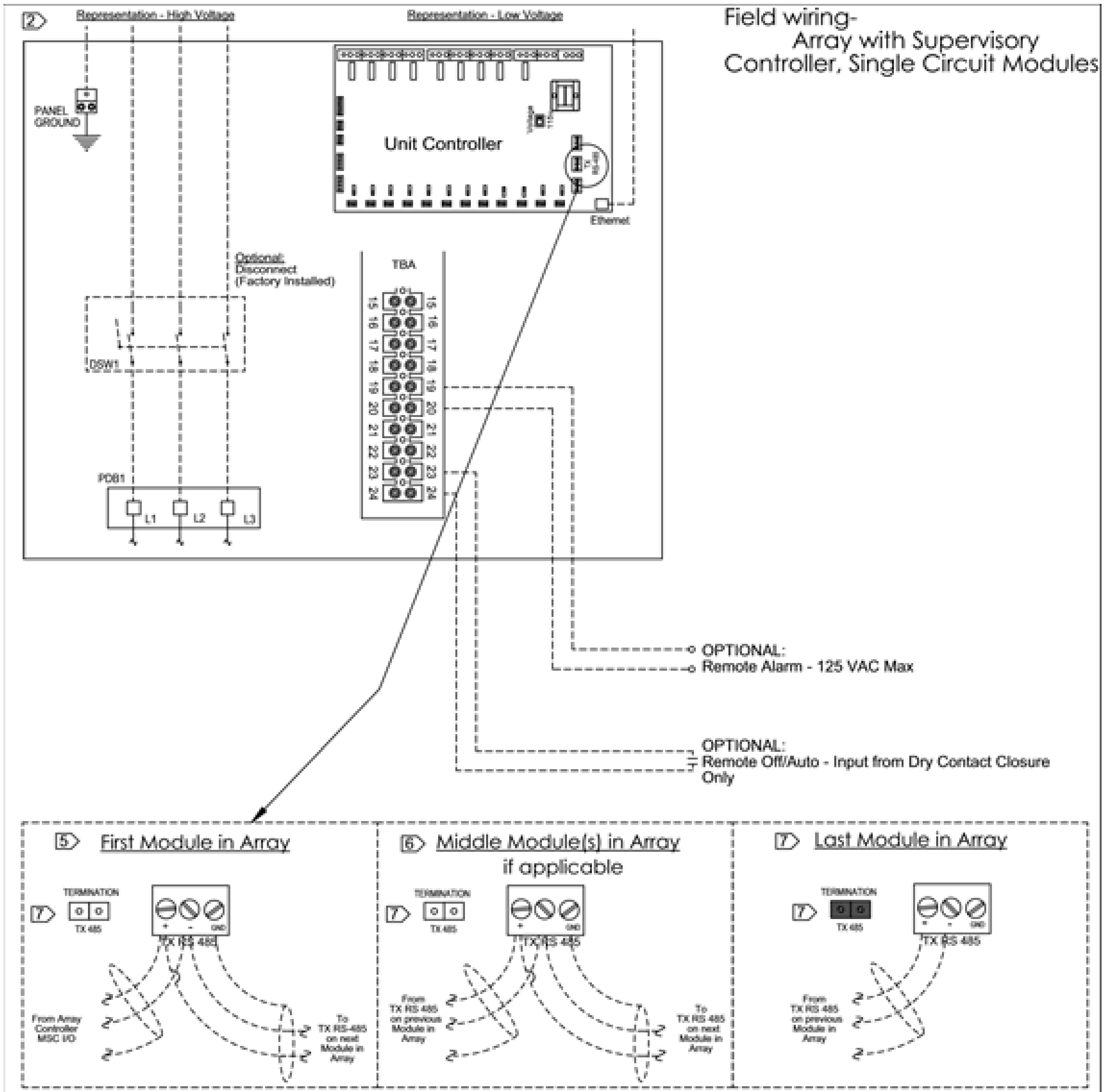
CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V.
2. (Required) Factory supplied or approved alternate field installed flow proving device connection.
3. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.
4. The first Module in the Array is connected from the Unit Controller MCS I/O to the Expansion Board MCS I/O.
5. Consecutive Modules in the Array are daisy-chained to the next Modules's Expansion Board MCS I/O.
6. Ensure all MCS I/O Berg Termination Jumpers are removed EXCEPT on the LAST Module in the array.

Figure 38. Field wiring – FWCD array with supervisory controller, single circuit modules



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/ tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

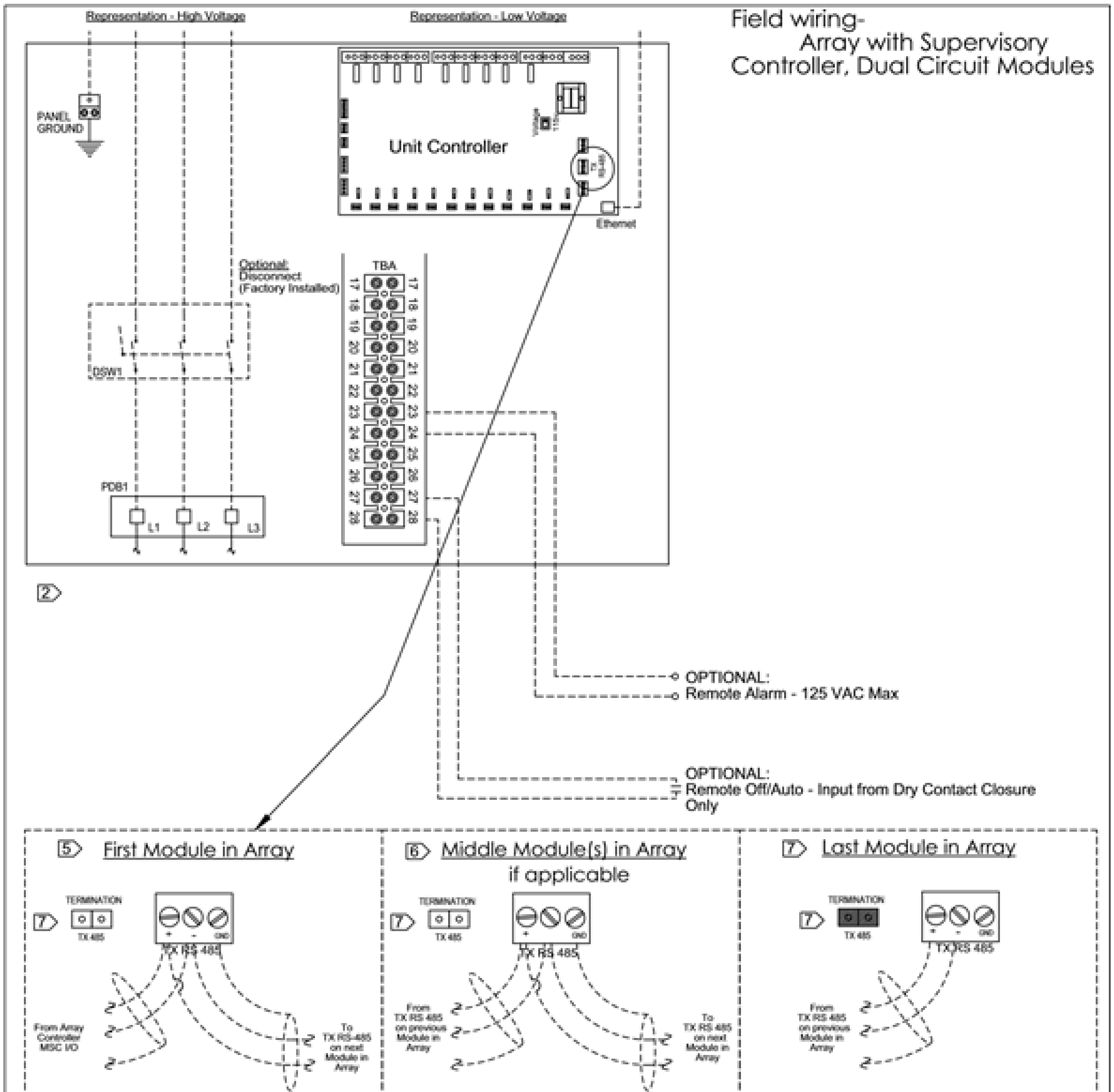
CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V
2. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.
3. All field provided RS-485 network cable must be 24 GA, shielded, 2-conductor with drain wire (Belden 9841 or equivalent).
4. All field provided ethernet cables must be Cat 5 or higher ethernet straight (patch) cables.
5. Only the first Module in the Array is connected from TX RS 485 port to the Array Controller MCS I/O port in the Array Control Panel.
6. Consecutive Modules in the Array are daisy-chained through TX RS-485 ports.
7. Ensure all TX RS-485 Berg Termination Jumpers are removed EXCEPT on the LAST Module in the array.

Figure 39. Field wiring – FWCD array with supervisory controller, single circuit modules



WARNING
Hazardous voltage!
Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/ tagout procedures to ensure power cannot be inadvertently energized. Failure to do so can cause death or serious injury.

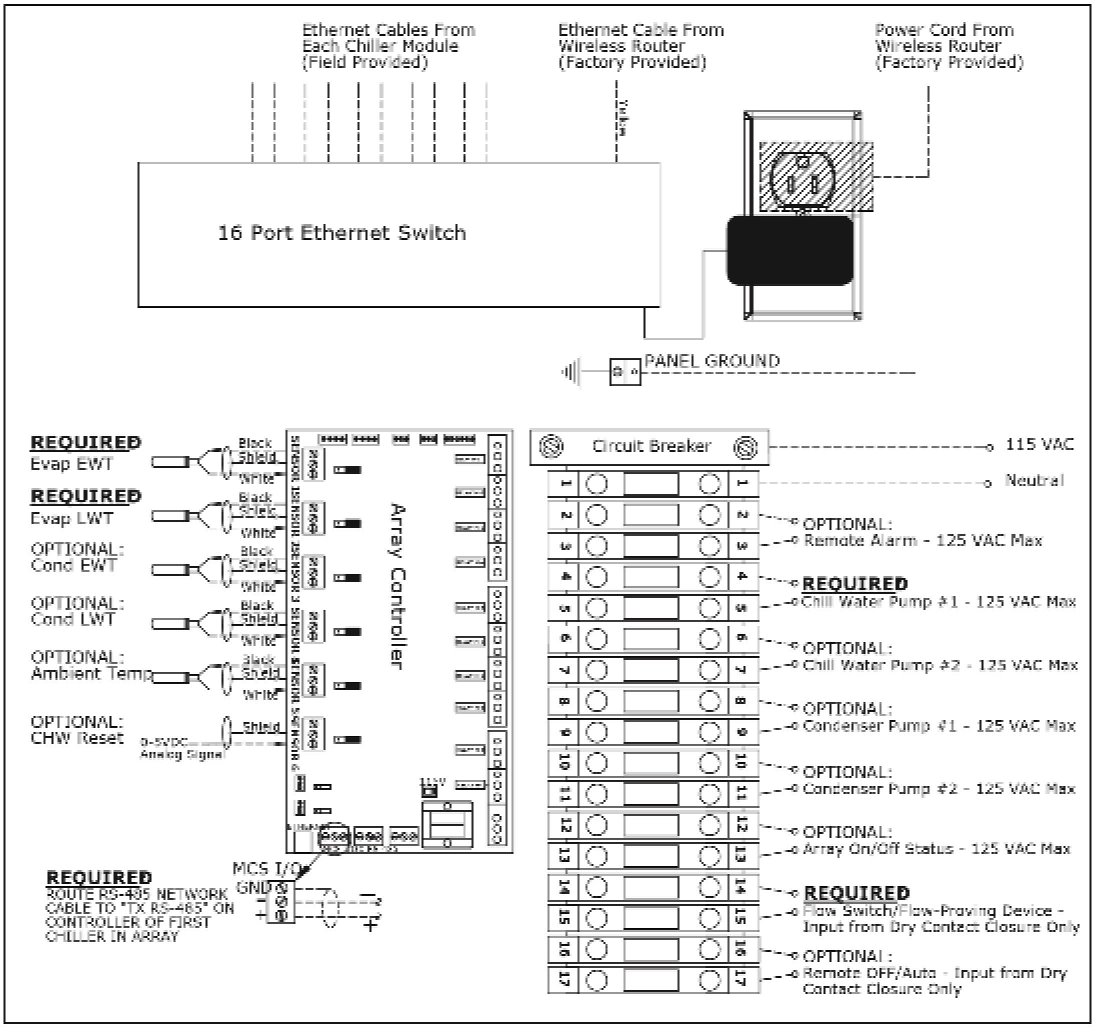
CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until check-out and start-up procedures have been completed.

Notes:

1. All customer control-circuit wiring must have a minimum rating of 150V
2. Line voltage options: Single or dual source power may be specified. Drawing covers single source power only. All field wiring must be in accordance with National Electric Code and State & Local requirements.
3. All field provided RS-485 network cable must be 24 GA, shielded, 2-conductor with drain wire (Belden 9841 or equivalent).
4. All field provided ethernet cables must be Cat 5 or higher ethernet straight (patch) cables.
5. Only the first Module in the Array is connected from TX RS 485 port to the Array Controller MCS I/O port in the Array Control Panel.
6. Consecutive Modules in the Array are daisy-chained through TX RS-485 ports.
7. Ensure all TX RS-485 Berg Termination Jumpers are removed EXCEPT on the LAST Module in the array.

Figure 40. Field wiring – FWCD array with supervisory controller, single circuit modules



WARNING
Hazardous voltage! Disconnect all electrical power including remote disconnects before servicing unit. Follow proper lockout/ tagout procedures to ensure power cannot be inadvertently energized. Failure to do so cause death or serious injury.

CAUTION
Use copper conductors only!
Unit terminals are not designed to accept other type conductors. Failure to use copper conductors may cause equipment damage.

CAUTION
Do not energize the unit until checkout and start-up procedures have been completed.

NOTES:

1. All field provided control-circuit wiring must have a minimum rating of 150V.
2. All field wiring must be in accordance with NEC, State & Local requirements.
3. All field provided ethernet cables must be Cat 5 or higher ethernet straight (patch) cables.
4. All field provided RS-485 network cable must be 24 GA, shielded, 2conductor with drain wire (Belden 9841 or equivalent)

START-UP CHECK LIST

FWCD Compact Chiller and Compact Chiller Arrays

Sales Order Number: ______________________________ Job Name: ______________________________

Work Order Number: ______________________________ Location: ______________________________

Model Number: ______________________________ Serial Number: ______________________________

Start-up Date: ______________________________

WARNING

Safety Alert!

In addition to the following tasks, you MUST:

- **Follow all instructions in the Installation, Operation, and Maintenance manual and Product Catalog including warnings, cautions, and notices.**
- **Perform all required tasks in any applicable service alerts and bulletins.**
- **Review and understand all information provided in Submittals and Design Specifications.**

Failure to do so could result in death or serious injury.

WARNING

Hazardous Procedures!

The following procedures could result in exposure to electrical, mechanical or other potential safety hazards. Always refer to the safety warnings provided throughout the FWCD Compact Scroll Liquid Chiller Installation, Operation, and Maintenance (IOM) manual and herein concerning these procedures. Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks. Failure to follow all of the safety warnings provided, could result in death or serious injury.

WARNING

Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

Important:

- *Note that compact chiller startup when non-compliance conditions exist can result in catastrophic damage to the compact chiller and will void all warranties. Manufacturer will have no responsibility of any kind or type for any resulting damage to either the compact chiller and/or property of the project owner due to non-compliance conditions or improper compact chiller installation.*

Notes:

- *Startup must be performed by Jetson or an authorized agent of Jetson specifically authorized to perform startup and warranty of Jetson products. Contractor shall provide Jetson (or an agent of Jetson specifically authorized to perform startup) with notice of the scheduled start-up at least two weeks prior to scheduled startup. This process is required to validate compact chiller warranty.*
- *FWCD Installation Completion Check List and Request for Jetson Service must be completed and submitted prior to giving notice of scheduled startup*
- *The Installation, Operation, and Maintenance manual(s), including warning and cautions, and applicable service alerts and bulletins, submittals, and design specifications must be used in conjunction with this check list.*
- *To properly start-up a single compact chiller or a compact chiller array, the Jetson Technician must have an approved laptop computer with up-to-date MCS Connect software. A null modem cable is also required for starting a single standalone compact chiller.*
- *To properly start-up a compact chiller array, the Jetson Technician will also need to add a router or switch with Category 5 or 6 cabling from the router or switch to the Ethernet port on the array controller and compact chiller unit controllers. Cabling will also need to be added to optional array controller BMS card if provided. Router or switch may have been provided and shipped with the array controller panel.*
- *For a compact chiller array configuration, use a start-up check list for each compact chiller. Submit a start-up check list and a unit data log for each compact chiller. See instructions on pages 6 and 7 of this check list.*

I. Pre-Startup Procedures

A. *Obtain Installation Completion Check Sheet and Request for Jetson Service*

This must be prepared by installed for each compact chiller, verifying it is ready for start-up. *Use FWCD Compact Chiller and Compact Chiller Array Installation Completion Check List and Request for Jetson Service.*

- Is the Installation Completion Checklist and Request for Jetson Service complete and signed? ☐ Yes ☐ No

Note: *If the Installation Completion Check List and Request for Jetson Service is not complete, start-up of the compact chiller should be delayed until it is completed. Delays and additional work by Jetson Service Technician is not considered part of the start-up responsibilities and is not covered by Jetson as part of the startup allowance.*

B. *Obtain Design (Order) Specification Data*

This indicates the design criteria of the particular compact chiller. A compact chiller cannot be properly started unless this data is known. It is the responsibility of the selling office to furnish this data.

- Does the Jetson Service Technician have access to the compact chiller submittal information? ☐ Yes ☐ No

C. *General Installation Observations*

1. Receiving

- Does the compact chiller nameplate and data correspond to the ordering information? ☐ Yes ☐ No
- Is there any shipping damage or shortage of materials? ☐ Yes ☐ No

Record and report any damages to the carrier.

2. Compact Chiller Location and Mounting

- Has proper drainage for evaporator water been provided? ☐ Yes ☐ No
- Has proper drainage for condenser water been provided? ☐ Yes ☐ No

- Have optional isolators been installed, if required? ☐ Yes ☐ No
- Is compact chiller level within 1/8-inch front-to-back (depth) and 1/8 inch side-to-side (width)? ☐ Yes ☐ No
- Have proper clearances around the compact chiller been maintained per submittal and/ or *Installation, Operation, and Maintenance* guidelines? ☐ Yes ☐ No
- Is compact chiller installed in location where ambient temperature stays above freezing 32°F? ☐ Yes ☐ No
- Does installation meet foundation requirements? ☐ Yes ☐ No

3. Individual Compact Chiller (or Compact Chiller Array) Piping

- Chilled water loop has a minimum 3-minute loop time? ☐ Yes ☐ No
- Was all water piping flushed before making final connections to the compact chiller per IOM flushing procedure? ☐ Yes ☐ No
- Is the water strainer installed correctly in the chilled water line and condenser water line? ☐ Yes ☐ No
- Is the water piping installed correctly? ☐ Yes ☐ No
- Flanges/grooved pipe couplings installed correctly? ☐ Yes ☐ No
- Chilled water flow proving device installed properly? ☐ Yes ☐ No
- Isolation Valves installed correctly? ☐ Yes ☐ No
- Thermometer wells installed correctly? ☐ Yes ☐ No
- Cooling tower piping installed correctly? ☐ Yes ☐ No
- Water piping properly supported not transferring any load to compact chiller? ☐ Yes ☐ No
- Chilled water supply and return lines rise above compact chiller evaporator? ☐ Yes ☐ No
- Flow balancing valves installed correctly? ☐ Yes ☐ No
- Pressure gauges installed correctly? ☐ Yes ☐ No
- Heat tape on piping if needed? ☐ Yes ☐ No
- If applicable, compact chiller array entering and leaving chilled water temperature sensors located and installed correctly? ☐ Yes ☐ No
- Is there are method in place to control condenser water for stabilizing saturated condensing temperature/head pressure? ☐ Yes ☐ No
- Is there a minimum of 20 mesh wye strainer on condenser and evaporator inlet water? ☐ Yes ☐ No
- Have all chiller coupling connections been leak tested? ☐ Yes ☐ No

4. Electrical Wiring

- Have all electrical terminal connections been checked and tightened? ☐ Yes ☐ No
- Are compact chiller power supply wires (connected to compact chiller circuit breaker disconnect or terminal blocks) copper conductors? ☐ Yes ☐ No
- For 208/230V units, have transformers been properly taped for the measured incoming power supply? ☐ Yes ☐ No
- Is power wiring of adequate size? ☐ Yes ☐ No
- Is 3-phase power to the compact chiller within the voltage utilization range listed on the compact chiller nameplate and is within a 2% voltage imbalance? ☐ Yes ☐ No

- Have the low voltage circuits been properly isolated for the higher voltage control and power circuits? ☐ Yes ☐ No
- Is the power supply wiring connected to the chiller water pump and required pump control wiring connected to the correct terminals? ☐ Yes ☐ No

Note: *The compact chiller (or compact chiller array) is required to enable/disable the chilled water pump. The programming is standard and set at the factory.*

- Is the chilled water flow switch (proof of flow device) wired in series with the chilled water pump, N/O pump auxiliary contact and connected to the correct terminals and tested? ☐ Yes ☐ No
- If applicable, is array controller wiring to compact chillers complete and correct? ☐ Yes ☐ No
- If applicable, has the RS-485 Berg jumper been removed from all of the compact chillers except the last compact chiller in the array? ☐ Yes ☐ No
- If applicable, is the optional ice making function wiring installed to correct terminals as directed by the manufacturer? ☐ Yes ☐ No

Note: *Ice making function is available on standalone compact chiller applications, but is not available on compact chiller array applications?*

5. Mechanical Room

- Does the equipment room have a working refrigerant monitor capable of detecting the refrigerant in the compact chiller(s) ☐ Yes ☐ No
- Does the equipment room have proper ventilation (mechanical or other)? ☐ Yes ☐ No
- **If required by local code:** Is there self-contained breathing apparatus available? ☐ Yes ☐ No

D. *Compressor Crankcase Heaters and Oil Level*

1. **Critical:** Have compressor crankcase heaters been energized 24 hours prior to startup? ☐ Yes ☐ No
2. Check oil level in each compressor sight glass. The oil level can be at the bottom limit of the sight glass, but **must** be visible. ☐ Yes ☐ No

E. Comments

____
____
____
____
____

II. START-UP PROCEDURES

A. Pre-start Questions

NOTICE:

Compressor Damage!
This compact chiller uses scroll compressors, which can only operate in one direction. Failure to verify proper phase sequence (L1, L2, L3, ABC, or clockwise) prior to start-up could lead to compressor failure.

NOTICE:

Evaporator and Condenser Damage!
Serious damage to the evaporator and/or condenser can occur if the associated water pump is not running and if flow is not established through the evaporator and/or condenser while refrigerant is being added to or removed from the compact chiller.

⚠ WARNING

Hazardous Voltage!
Disconnect all electrical power including remote disconnects before servicing. Follow proper lockout/tag-out procedures to ensure the power cannot be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

Power/Electrical Circuit

- ☐ **1.** Verify power source to each compact chiller control-panel matches the compact chiller and compressor nameplate voltage
- ☐ **2.** Isolate all power sources - lockout/tagout. Verify no power is present on line side of disconnect.
- ☐ 3. **3.** Verify that all field power and control wiring connections to the compact chiller are landed properly and that the terminals are clean and tight.
- ☐ **4.** Connect Phase Rotation meter to circuit L1, L2, L3.
- ☐ **5.** Remove lockout/tagout.
- ☐ **6.** Restore power. Verify A, B, C / clockwise rotation.
- ☐ **7.** Power circuit down.
- ☐ **8.** Isolate all power sources - lockout/tagout. Verify no power is present on line side of contactor with multimeter.
- ☐ **9.** Remove Phase Rotation Meter from circuit.
- ☐ **10.** Remove lockout/tagout for circuit.
- ☐ **11.** Restore power to circuit.

Service Computer

- ☐ 1. Boot up Service Computer.

  Tools: Laptop computer must have latest software version of MCS Connect software, RS232 null modem cable.
- ☐ 2. Connect laptop to compact chiller controller/array controller and establish connection. For instructions, see Installation, Operation, and Maintenance manual(s).
- ☐ 3. Access **Site Info Page** and verify model and serial number matches compact chiller.
- ☐ 4. Select the unit tab to the right of the **Site Info** tab, then select the **View Only** button and enter **2112** service password.
- ☐ 5. Check **Alarms** then **Reset/Clear** as necessary.
- ☐ 6. Confirm configuration and set points match submittal data. Leave computer active and collecting data while checking refrigeration circuits.

Individual Compact Chillers and Compact Chiller Arrays

- ☐ 1. Start and confirm operation of chilled water pump.
- ☐ 2. Bleed air from chilled water circuit including valve at top of evaporator.
- ☐ 3. Start and confirm operation of condenser water pump.
- ☐ 4. Verify that chilled water flow rate and pressure drop matches submittal for each compact chiller

NOTICE:

Evaporator and Condenser Damage!

Serious damage to the evaporator and/or condenser can occur if the associated water pump is not running and if flow is not established through the evaporator and/or condenser while refrigerant is being added to or removed from the compact chiller.

- ☐ 5. Confirm water flow per submittal.
- ☐ 6. Confirm operation of chilled water flow proving device.
- ☐ 7. Check for adequate oil level in compressor sight glasses.

B. Start Questions

☐ 1. Start compact chiller. Listen for any unusual noises, note any excessive vibrations, or leaks.

☐ 2. The first compressor will start and a flow of refrigerant will be observed in the sight glass. After several minutes of operation, the vapor in the sight glass will clear and there should be a solid column of liquid when the EXV/TXV stabilizes.

☐ 3. Check for adequate oil level in compressor sight glasses.

☐ 4. Check the system operating parameters. Do this by selecting various displays such as pressures and temperatures and comparing these readings to pressures and temperatures taken with manifold gauges and temperature sensors.

☐ 5. **Check and verify liquid subcooling on each refrigerant circuit:** At full load conditions, verify a minimum of 5°F subcooling at the compact chiller and there are no bubbles in the liquid line sight glass at Expansion Valve. Subcooling can be determined by measuring the pressure and temperature of the liquid line at the compact chiller. Subcooling is the difference between the saturated discharge temperature associated with the measured pressure and the actual liquid line temperature. As an example, if the measured pressure is 416.4 psig and the measured temperature is 115°F the subcooling would be 5°F. The saturated discharge temperature associated with 416.4 psig is 120°F. When you subtract 115°F from 120°F the result is 5°F subcooling.

Record liquid line pressure ________________________________,
liquid line temperature __________________________,
and subcooling _______________________________.

☐ 6. **Check and verify suction superheat on each refrigerant circuit:** Superheat value can be viewed on the controller LCD display. At full load stable design conditions, verify that the suction superheat is in the range of 10°F to 16°F.

☐ 7. **Check and verify compressor oil levels:** The compressor oil level should be maintained so that an oil level is visible in the sight glass. The oil level can only be tested when the compressor is running in stabilized conditions, guaranteeing that there is no liquid refrigerant in the lower shell of the compressor. In this case, the oil should be between 1/4 and 3/4 in the sight glass. At shutdown, the oil level can fall to the bottom limit of the oil sight glass, but remain visible.
Note: It is not unusual for tandem compressor oil levels to be dissimilar during full load operation

☐ 8. **Unit Data Log:** After the compact chiller has been operating normally, preferably at full load, create a Unit Data Log file. To create this file, select the **Print** button, **Select All**, then **OK**. Name this file the compact chiller's serial number (for example, **1201-A01**). Save in a folder created for the jobsite. This serves as an accurate record of compact chiller performance while new, for future reference. This information can be used to diagnose future problems such as a fouled condenser.

☐ 9. Disconnect computer from compact chiller.

☐ 10. Acquire a signature from responsible person for completion and acceptance of the startup where indicated below.

☐ 11. For warranty to be validated, E-mail the following to techsupport@nappstech.com
- Fully executed FWCD Compact Chiller and Compact Chiller Array Installation Completion Check List and Request for Jetson Service for EACH compact chiller.
- Fully executed and signed copy of this document (Start-up Check List FWCD Compact Chiller and Compact Chiller Arrays) for EACH compact chiller.
- Unit Data Log referred to above for EACH compact chiller.

Startup Conditions

Fluid Flow

Flow of fluid being heated or cooled by machine ________ gallons per minute

Compressors/DX Cooling

☐ Check Rotation

Number	Model #	L1	L2	L3	Head Pressure **psig**	Suction Pressure **psig**	Crankcase Heater **amps**
1							
2							
3							
4							

Chiller Operation

Chilled Water In Temperature ________°F   Chilled Water Out Temperature ________°F

Refrigeration System 1 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 2 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Heat Recovery Operation

Hot Water In Temperature ________°F Hot Water Out Temperature ________°F

Refrigeration System 1 - Heating Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 2 - Heating Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Integrated Pumping Package

Number	hp	L1	L2	L3	Flow (gpm)
1					
2					

C. Comments and/or Recommendations:

____
____
____
____
____
____
____
____

Service Technician:

Name (print)	Signature (where required)	Date

Customer acknowledgement of startup completion and acceptance:

Name (print)	Signature (where required)	Date

Literature Change History

01/03/22 - Updated digit 29 isolation valve description to move second valve from suction line to liquid line. Added variable flow bypass text.
01/05/22 – Updated evaporator and condenser control valve digits
01/28/22 – Corrected text referring to ACC chillers
02/16/22 – Corrected text referring to buffer tank location
11/16/2022 – Added additional pressure drop charts for “heat exchanger” only. Updated charts with heat exchanger and valves/piping.
02/15/2023 – Added unit startup checklist
07/31/2023 – Update 75ton, 460V unit max fuse from 175 to 200 amp. Updated text for calculating array MOP and MCA for distribution panels.

LIMITED WARRANTY

I. LIMITED PRODUCT WARRANTY & SERVICE POLICY

Napps Technology Corporation (NAPPS) warrants for a period of twelve (12) months from date of original shipment that all products, manufactured by NAPPS, with the exception of packaged refrigeration products, are free from defects of material and workmanship when used within the service, range, and purpose for which they were manufactured. Packaged refrigeration products shall be so warranted for a period of twelve (12) months from date of start-up or eighteen (18) months from date of original shipment, whichever may first occur. Service Parts shall be so warranted for a period of ninety (90) days from date of installation, or twelve (12) months from date of original shipment, whichever may first occur.

In case material is rejected on inspection by the buyer as defective, NAPPS shall be notified in writing within ten (10) days from receipt of said material. NAPPS will then have the option of re-inspection at the buyer's plant or its own plant before allowing or rejecting the buyer's claim. Expenses incurred in connection with claims for which NAPPS is not liable may be charged back to the buyer. No claim for correction will be allowed for work done in the field except with the written consent of NAPPS. Defects that do not impair service shall not be cause for rejection. NAPPS assumes no liability in any event for consequential damages. No claim will be allowed for material damaged by the buyer or in transit. Defective equipment or parts shall be returned to NAPPS freight prepaid.

NAPPS will, at its option, repair, replace or refund the purchase price of products found by NAPPS to be defective in material or workmanship provided that written notice of such defect requesting instruction for repair, replacement or refund is received by NAPPS within ten (10) days of determination of said defect, but not more than one (1) year after the date of shipment, and provided that any instructions given thereafter by NAPPS are complied with.

Any products covered by this order found to NAPPS' satisfaction to be defective upon examination at NAPPS' factory will, at NAPPS' option, be repaired or replaced and returned to Buyer via lowest cost common carrier, or NAPPS may, at its option, grant Buyer a credit for the purchase price of the defective article.

This warranty does not cover and does not apply to:

- Fuses, refrigerant, fluids, oil.
- Products relocated after initial installation.
- Any portion or component of the system that is not supplied by NAPPS, regardless of the cause of the failure of such portion or component.
- Products on which the unit's identification tags or labels have been removed or defaced.
- Products on which payment to NAPPS is or has been in default.
- Products which have defects or damage which result from improper installation, wiring, electrical imbalance characteristics or maintenance (including, without limitation, defects or damages caused by voltage surges, inadequate voltage conditions, phase imbalance, any form of electrical disturbances, inadequate or improper electrical circuit installation or protection, failure to perform common maintenance, etc.); or are caused by accident, misuse or abuse, fire, the elements, shock, vibration, flood, alteration, misapplication of the product or to any other service, range or environment of greater severity than that for which the products were designed
- Products which have defects or damage which result from a contaminated or corrosive air or liquid supply, operation at abnormal temperatures, or unauthorized opening of refrigerant circuit.
- Products subjected to corrosion or abrasion or chemicals.
- Mold, fungus or bacteria damage.
- Products manufactured or supplied by others.
- Products which have been subjected to misuse, negligence, vandalism or accidents.
- Products which have been operated in a manner contrary to NAPPS' printed instructions.
- Products which have defects, damage or insufficient performance as a result of insufficient or incorrect system design or the improper application of NAPPS' products.
- Products which have defects or damages due to freezing of the water supply, an inadequate or interrupted water supply, corrosives or abrasives in the water supply, or improper or inadequate filtration or treatment of the water or air supply.
- water-to-refrigerant heat exchanger for any damage resulting from freezing, fouling, corrosion or clogging. NAPPS is not responsible for:
- The costs of any fluids, oils refrigerant or other system components, or the associated labor to repair or replace the same, which is incurred as a result of a defective part covered by NAPPS' Limited Product Warranty.
- The costs of labor, refrigerant, materials or service incurred in removal of the defective part, or in obtaining and replacing the new or repaired part; or,
- Transportation costs of the defective part from the installation site to NAPPS or the return of any part not covered by NAPPS' Limited Product Warranty.

Additional charges, which may be incurred through the substitution of other than identical replacements, are not covered by this warranty. Evaporator failure due to fluid freezing that is the result of low fluid flow or inadequate fluid freeze protection, for applications with leaving fluid temperatures below 40° F, is not covered by this warranty

THE WARRANTY PROVIDED ABOVE IS THE ONLY WARRANTY MADE BY NAPPS WITH RESPECT TO ITS PRODUCTS OR ANY PARTS THEREFORE AND IS MADE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, BY

COURSE OF DEALING, USAGES OF TRADE OR OTHERWISE, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF FITNESS FOR ANY PARTICULAR PURPOSE OR OF MERCHANTABILITY UNDER THE UNIFORM COMMERCIAL CODE. IT IS AGREED THAT THIS WARRANTY IS IN LIEU OF AND BUYER HEREBY WAIVES ALL OTHER WARRANTIES, GUARANTEES OR LIABILITIES ARISING BY LAW OR OTHERWISE. NAPPS SHALL NOT INCUR ANY OTHER, OBLIGATIONS OR LIABILITIES OR BE LIABLE TO BUYER OR ANY CUSTOMER OF BUYER FOR ANY ANTICIPATED OR LOST PROFITS, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR ANY OTHER LOSSES OR EXPENSES INCURRED BY REASON OF THE PURCHASE, INSTALLATION, REPAIR, USE OR MISUSE BY BUYER OR THIRD PARTIES OF ITS PRODUCTS (INCLUDING ANY PARTS REPAIRED OR REPLACED); AND NAPPS DOES NOT AUTHORIZE ANY PERSON TO ASSUME FOR NAPPS ANY OTHER LIABILITY IN CONNECTION WITH THE PRODUCTS OR PARTS THEREFORE. NAPPS SHALL NOT BE RESPONSIBLE FOR THE LOSS OR REPLACEMENT OF OR THE ADDITION OF COMPRESSOR OIL, OR REFRIGERANT. THIS WARRANTY CANNOT BE EXTENDED, ALTERED OR VARIED EXCEPT BY A WRITTEN INSTRUMENT SIGNED BY NAPPS AND BUYER.

II. LIMITATION OF LIABILITY

NAPPS shall not be liable, in contract or in tort, for any special, indirect, incidental or consequential damages, such as, but not limited to, loss of profits, or injury or damage caused to property, products, or persons by reason of the installation, modification, use, repair, maintenance or mechanical failure of any NAPPS product.

Appendix A

Piping System Flushing Procedure

Prior to connecting the chiller to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130°F) mixture to remove previously accumulated dirt and other organics. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

During the flushing, 20 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of on-board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one (1) hour to ensure that all residual cleaning chemicals have been flushed out.

Prior to supplying water to the chiller, the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

Water Treatment Requirements

Supply water for both the chilled water and condenser water circuits shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for compact chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters.

Figure 41. Water property limits

Water Property	Concentration Limits
Alkalinity (HCO_3^-)	70-300 ppm
Sulfate (SO_4^{2-})	Less than 70 ppm
HCO3- / SO42-	Greater than 1.0
Electrical Conductivity	10 - 500 µS/cm
pH	7.5 – 9.0
Ammonia (NH3)	Less than 2 ppm
Chlorides (Cl^-)	Less than 300 ppm
Free Chlorine (Cl_2)	Less than 1 ppm
Hydrogen Sulfide (H_2S)	Less than 0.05 ppm
Free (aggressive) Carbon Dioxide (CO2)	Less than 5 ppm
Total Hardness (°dH)	4.0 - 8.5
Nitrate (NO3)	Less than 100 ppm
Iron (Fe)	Less than 0.2 ppm
Aluminum (Al)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm

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Revision 230731