FIRE OR EXPLOSION HAZARD

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

Be sure to read and understand the installation, operation and service instructions in this manual.

Improper installation, adjustment, alteration, service or maintenance can cause serious injury, death or property damage.

A copy of this IOM should be kept with the unit.

WHAT TO DO IF YOU SMELL GAS

Do not try to light any appliance.
Do not touch any electrical switch; do not use any phone in your building.
Leave the building immediately.
Immediately call your gas supplier from a phone remote from the building. Follow the gas supplier’s instructions.
If you cannot reach your gas supplier call the fire department.

Startup and service must be performed by a Factory Trained Service Technician.
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Safety

Attention should be paid to the following statements:

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

⚠️ CAUTION - Caution statements are given to prevent actions that may result in equipment damage, property damage, or personal injury.

⚠️ WARNING - Warning statements are given to prevent actions that could result in equipment damage, property damage, personal injury or death.

⚠️ 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 Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠️ CAUTION

WHAT TO DO IF YOU SMELL GAS

➢ Do not try to turn on unit.
➢ Shut off main gas supply.
➢ Do not touch any electric switch.
➢ Do not use any phone in the building.
➢ Never test for gas leaks with an open flame.
➢ Use a gas detection soap solution and check all gas connections and shut off valves.
**WARNING**

**FIRE, EXPLOSION OR CARBON MONOXIDE POISONING HAZARD**

Failure to replace proper controls could result in fire, explosion or carbon monoxide poisoning. Failure to follow safety warnings exactly could result in serious injury, death or property damage. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this appliance.

**WARNING**

**ELECTRIC SHOCK HAZARD**

Before servicing, shut off all electrical power to the unit, including remote disconnects, to avoid shock hazard or injury from rotating parts. Follow proper Lockout-Tagout procedures.

**WARNING**

**DURING INSTALLATION, TESTING, SERVICING, AND TROUBLESHOOTING OF THE EQUIPMENT**

It may be necessary to work with live electrical components. Only a qualified licensed electrician or individual properly trained in handling live electrical components shall perform these tasks.

Standard NFPA-70E, an OSHA regulation requiring an Arc Flash Boundary to be field established and marked for identification of where appropriate Personal Protective Equipment (PPE) be worn, should be followed.

**WARNING**

**GROUNDING REQUIRED**

All field installed wiring must be completed by qualified personnel. Field installed wiring must comply with NEC/CEC, local and state electrical code requirements. Failure to follow code requirements could result in serious injury or death. Provide proper unit ground in accordance with these code requirements.

**WARNING**

**VARIABLE FREQUENCY DRIVES**

Do not leave VFDs unattended in hand mode or manual bypass. Damage to personnel or equipment can occur if left unattended. When in hand mode or manual bypass mode VFDs will not respond to controls or alarms.

**CAUTION**

**ELECTRIC MOTOR OVER-CURRENT PROTECTION AND OVERLOAD PROTECTION MAY BE A FUNCTION OF THE VARIABLE FREQUENCY DRIVE TO WHICH THE MOTORS ARE WİRED. NEVER DEFEAT THE VFD MOTOR OVERLOAD FEATURE. THE OVERLOAD AMPERE SETTING MUST NOT EXCEED 115% OF THE ELECTRIC MOTORS FLA RATING AS SHOWN ON THE MOTOR NAMEPLATE.**
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.

**CAUTION**

UNIT HANDLING
To prevent injury or death lifting equipment capacity shall exceed unit weight by an adequate safety factor. Always test-lift unit not more than 24 inches high to verify proper center of gravity lift point to avoid unit damage, injury or death.

**CAUTION**

Always use a pressure regulator, valves and gauges to control incoming pressures when pressure testing a system. Excessive pressure may cause line ruptures, equipment damage or an explosion which may result in injury or death.

**CAUTION**

Rotation must be checked on all MOTORS AND COMPRESSORS of 3 phase units at startup by a qualified service technician. Scroll compressors are directional and can be damaged if rotated in the wrong direction. Compressor rotation must be checked using suction and discharge gauges. Fan motor rotation should be checked for proper operation. Alterations should only be made at the unit power connection.

**CAUTION**

Door compartments containing hazardous voltage or rotating parts are equipped with door latches to allow locks. Door latch are shipped with nut and bolts requiring tooled access. If you do not replace the shipping hardware with a pad lock always re-install the nut & bolt after closing the door.

**WARNING**

Do not use oxygen, acetylene or air in place of refrigerant and dry nitrogen for leak testing. A violent explosion may result causing injury or death.

**CAUTION**

To prevent damage to the unit, do not use acidic chemical coil cleaners. Do not use alkaline chemical coil cleaners with a pH value greater than 8.5, after mixing, without first using an aluminum corrosion inhibitor in the cleaning solution.
1. Startup and service must be performed by a Factory Trained Service Technician.

2. The unit is for outdoor use only. See General Information section for more information.

3. Use only with type of the gas approved for the boiler. Refer to the boiler rating plate.

4. Provide adequate combustion ventilation air to the boiler.

5. 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.

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

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

---

**WARNING**

Some chemical coil cleaning compounds are caustic or toxic. Use these substances only in accordance with the manufacturer’s usage instructions. Failure to follow instructions may result in equipment damage, injury or death.

**CAUTION**

Do not clean DX refrigerant coils with hot water or steam. The use of hot water or steam on refrigerant coils will cause high pressure inside the coil tubing and damage to the coil.

**WARNING**

COMPRESSOR CYCLING

**5 MINUTE MINIMUM OFF TIME**
To prevent motor overheating compressors must cycle off for a minimum of 5 minutes.

**5 MINUTE MINIMUM ON TIME**
To maintain the proper oil level compressors must cycle on for a minimum of 5 minutes.

The cycle rate must not exceed 6 starts per hour.

**CAUTION**

Polyolester (POE) and Polyvinylether (PVE) oils are two types of lubricants used in hydrofluorocarbon (HFC) refrigeration systems. Refer to the compressor label for the proper compressor lubricant type.

**CAUTION**

Door compartments containing hazardous voltage or rotating parts are equipped with door latches to allow locks. Door latch are shipped with nut and bolts requiring tooled access. If you do not replace the shipping hardware with a padlock always re-install the nut & bolt after closing the door.
LL Series Feature String Nomenclature

<table>
<thead>
<tr>
<th>GEN</th>
<th>SIZE</th>
<th>VLT</th>
<th>CONFIG</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
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<tr>
<td>LL</td>
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<td>3</td>
<td>0 – DB 0A – A2 C : CR JG – 0 FB – K 5 E – K JG – A0 C0 CBA – EC – 0 FAA 0 0 B0 B</td>
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**BASE MODEL**

**SERIES AND GENERATION**

LL

**UNIT SIZE**

- 035 = 35 ton Capacity
- 050 = 50 ton Capacity
- 055 = 55 ton Capacity
- 060 = 60 ton Capacity
- 067 = 67 ton Capacity
- 075 = 75 ton Capacity
- 085 = 85 ton Capacity
- 090 = 90 ton Capacity
- 092 = 92 ton Capacity
- 104 = 104 ton Capacity
- 105 = 105 ton Capacity
- 115 = 115 ton Capacity
- 118 = 118 ton Capacity
- 120 = 120 ton Capacity
- 125 = 125 ton Capacity
- 140 = 140 ton Capacity
- 150 = 150 ton Capacity
- 170 = 170 ton Capacity
- 180 = 180 ton Capacity
- 181 = 181 ton Capacity
- 185 = 185 ton Capacity
- 210 = 210 ton Capacity
- 230 = 230 ton Capacity
- 240 = 240 ton Capacity
- 245 = 245 ton Capacity
- 275 = 275 ton Capacity
- 300 = 300 ton Capacity
- 335 = 335 ton Capacity
- 360 = 360 ton Capacity
- 365 = 365 ton Capacity
- 450 = 450 ton Capacity
- 540 = 540 ton Capacity

**VOLTAGE**

- 2 = 230V/3Φ/60Hz
- 3 = 460V/3Φ/60Hz
- 4 = 575V/3Φ/60Hz
- 8 = 208V/3Φ/60Hz

**BLANK**

- 0 = Standard

**MODEL OPTION A: COOLING**

**A1: COOLING STYLE**

- B = R-134a Variable Capacity Oil-Free Magnetic Bearing Centrifugal Compressors
- D = R-410A Dual Circuited Scroll Compressors
- E = R-410A Independently Circuited Scroll Compressors
- M = R-410A VFD Compatible Scroll Compressors

**A2: COOLING CONFIGURATION**

- 0 = Air-Cooled Condenser, Low Water Flow
- A = Air-Cooled Condenser, High Water Flow
- B = Evap-Cooled Condenser, Low Water Flow
- C = Evap-Cooled Condenser, High Water Flow

**A3: COOLING COATING**

- 0 = Standard
- 1 = Polymer E-Coated Condenser Coil
- 2 = Stainless Steel Condenser Coil Casing

**A4: COOLING STAGING**

- A = Shell and Tube Heat Exchanger
- C = Oversized Shell and Tube Heat Exchanger (Glycol)
- V = Shell and Tube Heat Exchanger + All Variable Speed Compressors
- W = Oversized Shell and Tube Heat Exchanger (Glycol) + All Variable Speed Compressors
LL Series Feature String Nomenclature

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<tr>
<th>GEN</th>
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<th>B1: HEATING TYPE</th>
<th>B2: BOILER QUANTITY</th>
<th>B3: BOILER HEATING CAPACITY</th>
<th>1A: PUMP OPTIONS</th>
<th>1B: PUMP CONFIGURATION</th>
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<tr>
<td>L L</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>0 = No Boiler</td>
<td>0 = No Boiler</td>
<td>0 = No Boiler</td>
<td>0 = Standard - No Building Pump</td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>0</td>
<td>A = Natural Gas Fired Boiler</td>
<td>1 = 1 Boiler</td>
<td>A = 500 MBH Modulating High Flow</td>
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<td></td>
<td></td>
<td>B = Propane Fired Boiler</td>
<td>2 = 2 Boilers</td>
<td>B = 750 MBH Modulating High Flow</td>
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<td>3 = 3 Boilers</td>
<td>C = 1,000 MBH Modulating High Flow</td>
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<td></td>
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<td>D = 1,500 MBH Modulating High Flow</td>
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<td>E = 500 MBH Modulating Low Flow</td>
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<td>F = 750 MBH Modulating Low Flow</td>
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<td>G = 1,000 MBH Modulating Low Flow</td>
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<td>H = 1,500 MBH Modulating Low Flow</td>
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</table>

1A: PUMP OPTIONS

0 = Standard - No Building Pump
A = Common Water Connections
B = Primary Pumping System
C = Primary/Secondary Pumping System

1B: PUMP CONFIGURATION

0 = Standard - No Building Pump
D = 1 Pump - Prem Eff, 1170 RPM
E = 2 Single Pumps - Prem Eff, 1170 RPM
F = dualArm Pump - Prem Eff, 1170 RPM
G = 1 Pump w/ VFD - Prem Eff, 1170 RPM
H = 2 Single Pumps w/ 2 VFDs - Prem Eff, 1170 RPM
J = dualArm Pump w/ 2 VFDs - Prem Eff, 1170 RPM
N = 1 Pump - Prem Eff, 1760 RPM
P = 2 Single Pumps - Prem Eff, 1760 RPM
Q = dualArm Pump - Prem Eff, 1760 RPM
R = 1 Pump w/ VFD - Prem Eff, 1760 RPM
S = 2 Single Pumps w/ 2 VFDs - Prem Eff, 1760 RPM
T = dualArm Pump w/ 2 VFDs - Prem Eff, 1760 RPM
Y = 1 Pump - Prem Eff, 3520 RPM
Z = 2 Single Pumps - Prem Eff, 3520 RPM
1 = dualArm Pump - Prem Eff, 3520 RPM
2 = 1 Pump w/ VFD - Prem Eff, 3520 RPM
3 = 2 Single Pumps w/ 2 VFDs - Prem Eff, 3520 RPM
4 = dualArm Pump w/ 2 VFDs - Prem Eff, 3520 RPM
**LL Series Feature String Nomenclature**

<table>
<thead>
<tr>
<th>GEN</th>
<th>SIZE</th>
<th>VLT</th>
<th>CONFIG</th>
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<td>J</td>
<td>G</td>
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<tr>
<td>0</td>
<td>A</td>
<td>0</td>
<td>B</td>
</tr>
</tbody>
</table>

**1C: PUMP SIZE**

0 = Standard - No Building Pump
A = Pump 4360 1.5B
B = Pump 4360 2B
C = Pump 4360 2D
D = Pump 4380 1.5x1.5x6
E = Pump 4380 2x2x6
F = Pump 4380/4382 3x3x6
G = Pump 4380/4382 4x4x6
H = Pump 4380 1.5x1.5x8
J = Pump 4380 2x2x8
K = Pump 4380/4382 3x3x8
L = Pump 4380/4382 4x4x8
M = Pump 4380 5x5x8
N = Pump 4380/4382 6x6x8
P = Pump 4380 2x2x10
Q = Pump 4380/4382 3x3x10
R = Pump 4380/4382 4x4x10
S = Pump 4380/4382 6x6x10
T = Pump 4380/4382 8x8x10
U = Pump 4380 4x4x11.5
V = Pump 4380 5x5x11.5
W = Pump 4380 6x6x11.5
Y = Pump 4380 8x8x11.5
Z = Pump 4380 4x4x13
1 = Pump 4380 6x6x13
2 = Pump 4380 8x8x13
3 = Pump 4382 6x6x6
4 = Pump 4382 8x8x8
5 = Pump 4360 3D

**1D: PUMP MOTOR**

0 = Standard - No Building Pump
A = 0.5 hp
B = 0.75 hp
C = 1 hp
D = 1.5 hp
E = 2 hp
F = 3 hp
G = 5 hp
H = 7.5 hp
J = 10 hp
K = 15 hp
L = 20 hp
M = 25 hp
N = 30 hp
P = 40 hp
Q = 50 hp
R = 60 hp
S = 75 hp

**FEATURE 2: WATER CONNECTION LOCATION**

0 = Back Water Connections
A = Front Water Connections
B = Bottom Water Connection

**FEATURE 3: CHILLER ACCESSORIES**

0 = Standard
A = Glycol System
D = Air Separator
E = Options A + D
F = Thermometers & Pressure Gauges + Option D
G = Thermometers & Pressure Gauges + Option E
### LL Series Feature String Nomenclature

**Model Options**

<table>
<thead>
<tr>
<th>GEN</th>
<th>SIZE</th>
<th>VLT</th>
<th>CONFIG</th>
</tr>
</thead>
</table>

**Feature Options**

- **FEATURE 4: LOW AMBIENT**
  - 0 = Standard - None
  - A = One Refrigerant Circuit
  - B = Two Refrigerant Circuits
  - C = Three Refrigerant Circuits
  - D = Four Refrigerant Circuits
  - E = Five Refrigerant Circuits
  - F = Six Refrigerant Circuits
  - G = Seven Refrigerant Circuits
  - H = Eight Refrigerant Circuits

- **FEATURE 5: RECIRCULATING PUMP**

  **5A: PUMP CONFIGURATION**
  - 0 = Standard - No Recirculating Pump
  - D = 1 Pump/Barrel - Prem Eff, 1170 RPM
  - E = 2 Single Pumps/Barrel - Prem Eff, 1170 RPM
  - F = dualArm Pump/Barrel - Prem Eff, 1170 RPM
  - G = 1 Pump/Barrel w/ VFD - Prem Eff, 1170 RPM
  - H = 2 Single Pumps/Barrel w/ 2 VFDs - Prem Eff, 1170 RPM
  - J = dualArm Pump/Barrel w/ 2 VFDs - Prem Eff, 1170 RPM
  - N = 1 Pump/Barrel - Prem Eff, 1760 RPM
  - P = 2 Single Pumps/Barrel - Prem Eff, 1760 RPM
  - Q = dualArm Pump/Barrel - Prem Eff, 1760 RPM
  - R = 1 Pump/Barrel w/ VFD, Prem Eff, 1760 RPM
  - S = 2 Single Pumps/Barrel w/ 2 VFDs, Prem Eff, 1760 RPM
  - T = dualArm Pump/Barrel w/ 2 VFDs, Prem Eff, 1760 RPM
  - Y = 1 Pump/Barrel - Prem Eff, 3520 RPM
  - Z = 2 Single Pumps/Barrel - Prem Eff, 3520 RPM
  - 1 = dualArm Pump/Barrel - Prem Eff, 3520 RPM
  - 2 = 1 Pump/Barrel w/ VFD - Prem Eff, 3520 RPM
  - 3 = 2 Single Pumps/Barrel w/ 2 VFDs - Prem Eff, 3520 RPM
  - 4 = dualArm Pump/Barrel w/ 2 VFDs - 3520 RPM

  **5B: PUMP SIZE**
  - 0 = Standard - No Recirculating Pump
  - A = Pump 4360 1.5B
  - B = Pump 4360 2B
  - C = Pump 4360 2D
  - D = Pump 4380 1.5x1.5x6
  - E = Pump 4380 2x2x6
  - F = Pump 4380/4382 3x3x6
  - G = Pump 4380/4382 4x4x6
  - H = Pump 4380 1.5x1.5x8
  - J = Pump 4380 2x2x8
  - K = Pump 4380/4382 3x3x8
  - L = Pump 4380/4382 4x4x8
  - M = Pump 4380 5x5x8
  - N = Pump 4380/4382 6x6x8
  - P = Pump 4380 2x2x10
  - Q = Pump 4380/4382 6x6x10
  - R = Pump 4380/4382 4x4x10
  - S = Pump 4380/4382 6x6x10
  - T = Pump 4380/4382 8x8x10
  - U = Pump 4380 4x4x11.5
  - V = Pump 4380 5x5x11.5
  - W = Pump 4380 6x6x11.5
  - Y = Pump 4380 8x8x11.5
  - Z = Pump 4380 4x4x13
  - 1 = Pump 4380 6x6x13
  - 2 = Pump 4380 8x8x13
  - 3 = Pump 4380 6x6x6
  - 4 = Pump 4382 8x8x8
  - 5 = Pump 4360 3D

  **5C: PUMP MOTOR**
  - 0 = Standard - No Recirculating Pump
  - A = 0.50 hp
  - B = 0.75 hp
  - C = 1 hp
  - D = 1.5 hp
  - E = 2 hp
  - F = 3 hp
  - G = 5 hp
  - H = 7.5 hp
  - J = 10 hp
  - K = 15 hp
  - L = 20 hp
  - M = 25 hp
  - N = 30 hp
  - P = 40 hp
  - Q = 50 hp
  - R = 60 hp
  - S = 75 hp
LL Series Feature String Nomenclature

Model Options : Unit Feature Options

| GEN | SIZE | VLT | CONFIG | 6A | 6B | 6C | 7A | 7B | 7C | 7D | 7E | 7F | 7G | 7H | 7I | 7J | 7K | 7L | 7M | 7N | 7O | 7P | 7Q | 7R | 7S | 7T | 7U | 7V | 7W | 7X | 7Y | 7Z | 1A | 1B | 1C | 1D |
|-----|------|-----|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0   | 75   | 0   | DB     | 0A | B  | C  | CR | J  | G  | 0  | F  | B  | K  | 5  | E  | A  | 0  | C  | 0  | CBA | E  | C  | 0  | FA  | A  | 0  | B  | 0  | B  |

**FEATURE 6: BOILER BUILDING**

**PUMP**

**6A: PUMP CONFIGURATION**
0 = Standard - No Boiler
D = 1 Pump - Prem Eff, 1170 RPM
E = 2 Single Pumps - Prem Eff, 1170 RPM
F = dualArm Pump - Prem Eff, 1170 RPM
G = 1 Pump w/ VFD - Prem Eff, 1170 RPM
H = 2 Single Pumps w/ 2 VFDs - Prem Eff, 1170 RPM
J = dualArm Pump w/ 2 VFDs - Prem Eff, 1170 RPM
N = 1 Pump - Prem Eff, 1760 RPM
P = 2 Single Pumps - Prem Eff, 1760 RPM
Q = dualArm Pump - Prem Eff, 1760 RPM
R = 1 Pump w/ VFD - Prem Eff, 1760 RPM
S = 2 Single Pumps w/ 2 VFDs - Prem Eff, 1760 RPM
T = dualArm Pump w/ 2 VFDs - Prem Eff, 1760 RPM
Y = 1 Pump - Prem Eff - 3520 RPM
Z = 2 Single Pumps - Prem Eff, 3520 RPM
1 = dualArm Pump - Prem Eff, 3520 RPM
2 = 1 Pump w/ VFD - Prem Eff, 3520 RPM
3 = 2 Single Pumps w/ 2 VFDs - Prem Eff, 3520 RPM
4 = dualArm Pump w/ 2 VFDs - Prem Eff, 3520 RPM

**6B: PUMP SIZE**
0 = Standard - No Boiler
A = Pump 4360 1.5B
B = Pump 4360 2B
C = Pump 4360 2D
D = Pump 4380 1.5x1.5x6
E = Pump 4380 2x2x6
F = Pump 4380/4382 3x3x6
G = Pump 4380/4382 4x4x6
H = Pump 4380 1.5x1.5x8
J = Pump 4380 2x2x8
K = Pump 4380/4382 3x3x8
L = Pump 4380/4382 4x4x8
M = Pump 4380 5x5x8
N = Pump 4380/4382 6x6x8
P = Pump 4380 2x2x10
Q = Pump 4380/4382 3x3x10
R = Pump 4380/4382 4x4x10
S = Pump 4380/4382 6x6x10
T = Pump 4380/4382 8x8x10
U = Pump 4380 4x4x11.5
V = Pump 4380 5x5x11.5
W = Pump 4380 6x6x11.5
Y = Pump 4380 8x8x11.5
Z = Pump 4380 4x4x13
1 = Pump 4380 6x6x13
2 = Pump 4380 8x8x13
3 = Pump 4382 6x6x6
4 = Pump 4382 8x8x8
5 = Pump 4360 3D
6 = Pump 4382 8x8x10
7 = Pump 4382 4x4x11.5
8 = Pump 4382 5x5x11.5
9 = Pump 4382 6x6x11.5
A = Pump 4382 8x8x13
B = Pump 4382 4x4x13
C = Pump 4382 6x6x13
D = Pump 4382 8x8x13
E = Pump 4382 4x4x13
F = Pump 4382 6x6x13
G = Pump 4382 8x8x13
H = Pump 4382 4x4x13
I = Pump 4382 6x6x13
J = Pump 4382 8x8x13
K = Pump 4382 4x4x13
L = Pump 4382 6x6x13
M = Pump 4382 8x8x13
N = Pump 4382 4x4x13
O = Pump 4382 6x6x13
P = Pump 4382 8x8x13
Q = Pump 4382 4x4x13
R = Pump 4382 6x6x13
S = Pump 4382 8x8x13
T = Pump 4382 4x4x13
U = Pump 4382 6x6x13
V = Pump 4382 8x8x13
W = Pump 4382 4x4x13
X = Pump 4382 6x6x13
Y = Pump 4382 8x8x13
Z = Pump 4382 4x4x13

**FEATURE 7: SERVICE OPTIONS**
0 = Standard
A = 115V Outlet, Factory Wired
B = 115V Outlet, Field Wired
### LL Series Feature String Nomenclature

<table>
<thead>
<tr>
<th>Model Options</th>
<th>Unit Feature Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN</td>
<td>SIZE</td>
</tr>
</tbody>
</table>

#### FEATURE 8: REFRIGERATION OPTIONS
- 0 = Standard
- B = VFD Controlled Condenser Fans (Air-Cooled)
- D = Hot Gas Bypass - All Circuits
- E = Options B + D

#### FEATURE 9: REFRIGERATION ACCESSORIES
- 0 = Standard
- A = Sight Glass
- B = Compressor Isolation Valves
- C = Options A + B

#### FEATURE 10: POWER OPTIONS
- 0 = Standard Power Block
- A = Power Switch (225 Amps)
- B = Power Switch (400 Amps)
- C = Power Switch (600 Amps)
- D = Power Switch (800 Amps)
- E = Power Switch (1200 Amps)
- F = Dual Point Power Block (2)
- G = Dual Point Power Switch (2 x 225 Amps)
- H = Dual Point Power Switch (2 x 400 Amps)
- J = Dual Point Power Switch (2 x 600 Amps)
- K = Dual Point Power Switch (2 x 800 Amps)
- L = Dual Point Power Switch (2 x 1200 Amps)

#### FEATURE 11: SAFETY OPTIONS
- 0 = No Boiler
- A = Standard, Boiler w/ UL/FM/CSD-1 Certification
- B = Boiler w/ IRI Gas Train
- C = Boiler w/ IRI Gas Train and Proof of Closure
- D = Boiler w/ Low Water Cutoff
- E = Options B + D
- F = Options C + D

#### FEATURE 12: CONTROLS
- 0 = Standard
- A = Touchscreen Unit Controls Interface
- B = Phase and Brown Out Protection
- F = Options A + B

#### FEATURE 13: SPECIAL CONTROLS
- 0 = MCS Magnum Controller
- A = w/ Diagnostics
- C = w/ Diagnostics and Modbus Connection
- D = w/ Diagnostics and N2 Connection
- E = w/ Diagnostics and LonTalk Connection
- G = w/ Modem
- H = w/ Diagnostics and Modem
- K = w/ Diagnostics, Modbus Connection and Modem
- L = w/ Diagnostics, N2 Connection and Modem
- M = w/ Diagnostics, LonTalk Connection and Modem
- Q = w/ Modbus Connection
- R = w/ N2 Connection
- S = w/ LonTalk Connection
- V = w/ Modbus Connection and Modem
- W = w/ N2 Connection and Modem
- Y = w/ LonTalk Connection and Modem
- 1 = w/ BACnet IP Connection
- 2 = w/ Diagnostics and BACnet IP Connections
- 3 = w/ Diagnostics, BACnet IP Connection and Modem
- 4 = w/ BACnet IP Connection and Modem
- 5 = w/ BACnet MS/TP Connection
- 6 = w/ Diagnostics and BACnet MS/TP Connection
- 7 = w/ Diagnostics, BACnet MS/TP Connection and Modem
- 8 = w/ BACnet MS/TP Connection and Modem
### LL Series Feature String Nomenclature

**Model Options**

<table>
<thead>
<tr>
<th>GEN</th>
<th>SIZE</th>
<th>VLT</th>
<th>CONFIG</th>
<th>Feature String</th>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>LL-075-3-0</td>
</tr>
</tbody>
</table>

**Unit Feature Options**

### FEATURE 14: COMPRESSION TANK

14A: CHILLER COMPRESSION TANK
- 0 = No Chiller Compression Tank
- A = AX-15V
- B = AX-20V
- C = AX-40V
- D = AX-60V
- E = AX-80V
- F = AX-100V
- G = AX-120V
- H = AX-180V
- J = AX-200V
- K = AX-240V
- L = AX-260V
- M = AX-280V
- N = 1000-L
- P = 1200-L
- Q = 1600-L
- R = 2000-L

14B: BOILER COMPRESSION TANK
- 0 = No Boiler Compression Tank
- A = AX-15V
- B = AX-20V
- C = AX-40V
- D = AX-60V
- E = AX-80V
- F = AX-100V
- G = AX-120V
- H = AX-180V
- J = AX-200V
- K = AX-240V
- L = AX-260V
- M = AX-280V
- N = 1000-L
- P = 1200-L
- Q = 1600-L
- R = 2000-L

### FEATURE 15: OPTION BOXES

- 0 = Standard
- A = 2ft Option Box
- B = 4ft Option Box
- C = 6ft Option Box
- D = 8ft Option Box
- E = 10ft Option Box
- F = 12ft Option Box

### FEATURE 16: CABINET OPTIONS

- 0 = Standard
- A = Electrical Vestibule Heating
- B = Fan/Coil Vestibule Cooling
- F = Options A + B

### FEATURE 17: CABINET OPTIONS

- 0 = Standard
- A = Access Door Windows

### FEATURE 18: CUSTOMER CODE

- 0 = Standard
- A = Second to Fifth Year Extended Compressor Warranty
LL Series Feature String Nomenclature

<table>
<thead>
<tr>
<th>Model Options</th>
<th>Unit Feature Options</th>
</tr>
</thead>
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<td>0</td>
<td>C</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>0</td>
<td>B</td>
</tr>
</tbody>
</table>

**FEATURE 19: CODE OPTIONS**
0 = Standard - ETL U.S.A. Listing
A = M.E.A. (New York)
B = Chicago - Cool + Gas
H = ETL U.S.A. + Canada Listing

**FEATURE 20: UNIT CONFIGURATION**
0 = Standard (One Piece Unit)
A = Two Piece Unit

**FEATURE 21: EVAPORATIVE-COOLED CONDENSER**
0 = Standard - No Evaporative-Cooled Condenser
A = No Sump Heater
B = Sump Heater

**FEATURE 22: BLANK**
0 = Standard

**FEATURE 23: TYPE**
B = Standard Paint
U = Special Price Authorization and Special Paint
X = Special Price Authorization and Standard Paint
General Information

AAON LL Series chiller outdoor mechanical rooms are complete self-contained liquid chilling units. They are assembled, wired, charged, and run-tested. Models are available for air-cooled and evaporative-cooled applications. Chiller primary and primary/secondary pumping packages and boilers with pumping package are available as optional features.

Codes and Ordinances
LL Series units have been tested and certified, by ETL, in accordance with UL Safety Standard 1995/CSA C22.2 No. 236.

System should be sized in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers Handbook.

Installation of LL Series units must conform to the ICC standards of the International Mechanical Code, the International Building Code, and local building, plumbing and waste water codes. All appliances must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

Receiving Unit
When received, the unit should be checked for damage that might have occurred in transit. If damage is found it should be noted on the carrier’s Freight Bill. A request for inspection by carrier’s agent should be made in writing at once. Nameplate should be checked to ensure the correct model sizes and voltages have been received to match the job requirements.

Storage
If installation will not occur immediately following delivery, store equipment in a dry protected area away from construction traffic and in the proper orientation as marked on the packaging with all internal packaging in place. Secure all loose-shipped items.
Outdoor Mechanical Room

**WARNING**

**COMPRESSOR CYCLING**

5 MINUTE MINIMUM OFF TIME
To prevent motor overheating compressors must cycle off for a minimum of 5 minutes.

5 MINUTE MINIMUM ON TIME
To maintain the proper oil level compressors must cycle on for a minimum of 5 minutes.

The cycle rate must not exceed 6 starts per hour.

Failure to observe the following instructions will result in premature failure of your system, and possible voiding of the warranty.

**CAUTION**

**CRANKCASE HEATER OPERATION**

Units may be equipped with compressor crankcase heaters, which should be energized at least 24 hours prior to cooling operation, to clear any liquid refrigerant from the compressors.

Never turn off the main power supply to the unit, except for complete shutdown. When power is cut off from the unit, any compressors using crankcase heaters cannot prevent refrigerant migration. This means the compressor will cool down, and liquid refrigerant may accumulate in the compressor. The compressor is designed to pump refrigerant gas and damage may occur when power is restored if liquid enters the compressor.

**CAUTION**

Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. All motors, to include and not be limited to pump motors and condenser fan motors, should all be checked by a qualified service technician at startup and any wiring alteration should only be made at the unit power connection.

Before unit operation, the main power switch must be turned on for at least 24 hours for units with compressor crankcase heaters. This will give the crankcase heater time to clear any liquid accumulation out of the compressor before it is required to run.

**CAUTION**

Scroll compressors are directional and will be damaged by operation in the wrong direction. Low pressure switches on compressors have been disconnected after factory testing. Rotation should be checked by a qualified service technician at startup using suction and discharge pressure gauges and any wiring alteration should only be made at the unit power connection.

Never cut off the main power supply to the unit, except for complete shutdown. Always control the system from the building management system, or control panel, never at the main power supply (except for emergency or for complete shutdown of the system).
Scroll compressors must be on a minimum of 5 minutes and off for a minimum of 5 minutes. The cycle rate must be no more than 6 starts per hour.

The chiller is furnished with a pressure differential switch that is factory installed between the chilled water supply and return connections. This sensor must not be bypassed since it provides a signal to the unit controller that water flow is present in the heat exchanger and the unit can operate without the danger of freezing the liquid.

Compressor life will be seriously shortened by reduced lubrication, and the pumping of excessive amounts of liquid oil and refrigerant.

**Wiring Diagrams**
A complete set of unit specific wiring diagrams in both ladder and point-to-point form are laminated in plastic and located inside the control compartment door.

**General Maintenance**
When the initial startup is made and on a periodic schedule during operation, it is necessary to perform routine service checks on the performance of the chiller and boiler. This includes reading and recording suction pressures and checking for normal subcooling and superheat. See the evaporative-cooled condenser and air-cooled condenser sections in this manual for specific details.

**Chiller Primary Pumping**
Primary pumping uses a single pump to move water (or glycol) through the chiller barrel and back to the building. This pumping package provides a constant flow of water to the system. The pump is activated whenever the chiller is given a run signal.

Water enters the unit through the return water piping, and then travels through an air separator to remove any air that is entrapped in the water. Following this, the water flows through a suction guide with strainer. The end of the suction guide is removable for strainer access. The strainer assembly is composed of two parts, the operational strainer and the startup strainer, (located inside the operational strainer) which is to be removed 24 hours after startup.

The pump is installed after the suction guide, and before a combination valve (Flo-Trex). This combination valve acts as isolation valve, check valve, and flow balancing valve. The evaporator barrel is placed after the combination valve in the water circuit, with a differential pressure switch installed across its inlet and outlet. This pressure switch closes when the differential pressure increases above the setpoint, which should be set 1-2 psig below the pressure drop across the heat exchanger at design flow rate. The closing differential pressure switch signals the control system to indicate flow through the heat exchanger and allow cooling to activate as required to maintain the setpoint. The water exiting the chiller barrel leaves the unit through the water out connection.

**Chiller Primary/Secondary Pumping**
Primary/secondary pumping option provides variable flow to the system. It consists of a constant flow pump for the chiller heat exchanger and a variable flow pump for the building. The controls package senses differential pressure across the pump with pressure transducers installed at the suction and discharge, and varies the speed of the pump using a VFD in order to maintain a given differential pressure across the pump.

The primary/secondary pumping package is essentially composed of two piping loops.
coupled together. The primary loop has a constant flow rate in order to keep the chiller heat exchanger from freezing, and the secondary, variable flow loop, provides water to the building. The two loops are coupled via a water line that compensates for excess flow in either loop. As the flow in the secondary loop decreases below the flow in the primary loop, excess flow bypasses the building loop and circulates through the bypass water line. On the other hand, as the flow in the secondary loop increases above the flow in the primary loop, excess flow bypasses the chiller and circulates through the bypass water line.

The secondary pump has its own suction guide, combination valve, and isolation valve, similar to the primary pump, with the addition of an air separator to remove any air that is entrapped in the water.

**Boiler System**

Optional boilers and pumping packages are factory installed. The boiler system uses a primary/secondary pumping package. There can be 1-4 boilers in parallel and each boiler has its own primary pump. The heating loop must be designed to return at least 120°F water to the boiler during normal operation. Failure to return 120°F water to the boiler will create condensation, which will reduce the life of the heat exchanger and void the boiler warranty. See unit submittal for unit specific piping schematics. See the Thermal Solutions Boiler “Installation, Operating, and Service Instructions” that are included with the unit for additional information about the boiler.

Once the boiler is given a run signal, the boiler secondary pump will be activated and the controls package will stage boilers as necessary to maintain the leaving water temperature setpoint.

The controls package will also control the speed of the secondary pump in the boiler system to maintain differential pressure across the pump similar to the chiller secondary pump.

**Boiler Primary/Secondary Pumping**

Water enters the unit through the return water piping, and then travels through a suction guide with strainer. The end of the suction guide is removable for strainer access. The strainer assembly is composed of two parts, the operational strainer, and the startup strainer, (located inside the operational strainer) which is to be removed 24 hours after startup.

The pump is installed after the suction guide, and before a combination valve (Flo-Trex). This combination valve acts as isolation valve, check valve, and flow balancing valve. The boiler is placed after the combination valve in the water circuit.

The primary/secondary pumping package provides variable flow to the system. It consists of a constant flow pump for the boiler, and a variable flow pump for the building. The controls package senses differential pressure across the pump with pressure transducers installed at the suction and discharge, and varies the speed of the pump using a VFD in order to maintain a given differential pressure across the pump.

The primary/secondary pumping package is essentially composed of two piping loops coupled together. The primary loop has a constant flow rate in order to maintain water temperature through the boiler, and the secondary, variable flow loop, provides water to the building. The two loops are coupled via a water line that compensates for excess flow in either loop. As the flow in the secondary loop decreases below the flow in the primary loop, excess flow bypasses
the building loop and circulates through the bypass water line. On the other hand, as the flow in the secondary loop increases above the flow in the primary loop, excess flow bypasses the boiler and circulates through the bypass water line.

The secondary pump includes suction guide, combination valve, and isolation valve with the addition of an air separator to remove any air that is entrapped in the water.

See appendix for additional information on the installation, operation and maintenance of pumps.

**Make Up Water**
A city make up water connection is provided to replace water that is lost from the system.

Glycol units require a glycol feeder (optional factory installed or field installed) to replace fluid that is lost in the system. Water should not be directly added to glycol applications as this would dilute the glycol concentration and thereby increase the freezing temperature of the fluid.

The makeup water connection is provided with a backflow preventer that has isolation valves on the inlet and outlet for service. Figure 1 shows the pressure drop versus flow rate for the backflow preventer.

![Figure 1 - Backflow Preventer](image)

There is a pressure-reducing valve after the backflow preventer. This valve reduces the city water pressure to maintain the operating pressure of the system. This valve is adjustable from 10-35 psig with a factory setting of 30 psig. The system pressure varies with the height of the system. The pressure-reducing valve setting should be set so that the pressure at the high point in the system is high enough to vent air from the system (usually 4 psig). There should be air vents at all parts in the system where air could be trapped. If the pressure is not high enough throughout the system, flashing could occur in the piping or the pump could cavitate. There is an isolation valve on the inlet and outlet of the pressure-reducing valve for service.

The pressure reducing valve fills the system at a reduced rate. There is a bypass around the pressure reducing valve for the initial fill of the system to increase the initial fill speed. After the initial system fill, this valve should be closed.

**Compression/Expansion Tank**
As the water temperature in the system increases, the volume that water displaces increases. In order to compensate for these expansion forces, a compression or expansion tank must be used. The factory installed tank option includes a pre-pressurized diaphragm compression tank that is preset for 12 psig.

The factory pre-charge pressure may need to be field adjusted. The tank must be pre-charged to system design fill pressure before placing into operation. Remove the pipe plug covering the valve enclosure. Check and adjust the charge pressure by adding or releasing air.

If the system has been filled, the tank must be isolated from the system and the tank emptied before charging. This ensures that
all fluid has exited the diaphragm area and proper charging will occur.

If the pre-charge adjustment is necessary, oil and water free compressed air or nitrogen gas may be used. Check the pre-charge using an accurate pressure gauge at the charging valve and adjust as required. Check air valve for leakage. If evident, replace the Schrader valve core. Do not depend on the valve cap to seal the leak. After making sure the air charge is correct, replace the pipe plug over the charging valve for protection.

Purge air from system before placing tank into operation. All models have system water contained behind the diaphragm.

It is recommended that the pre-charge be checked annually to ensure proper system protection and long life for the vessel.

**Pressure Relief Valve**

Required pressure relief valve is installed in the unit. This valve is set at 125 psig. Figure 2 shows inlet pressure versus capacity for this pressure relief valve. See appendix for additional information.

![Figure 2 - Pressure Relief Valve](image)

**Automatic Air Vent**

There is an automatic air vent installed at the high point of the system inside the pumping package compartment. The air vent valve must be in the proper position for operation. Ensure that the small vent cap is loosened two turns from the closed position, allowing air to be vented from the system. It is advisable to leave the cap on to prevent impurities from entering the valve. See appendix for additional information.

**Dual Pumps**

When redundant pumping is required, factory installed dual pumps or two single pumps can be ordered. A dual pump is a pump with two independent motors and pumps in a single casing. This dual pump has a swing split-flapper valve in the discharge port to prevent liquid recirculation when only one pump is operating. Isolation valves in the casing allow one pump to be isolated and removed for service while the other pump is still operating.

When redundant pumping is required with high flow rates, two independent pumps may be installed in parallel. Each pump will have its own suction guide/strainer, combination valve, and isolation valves.

The controls package will activate the pump when the unit is given a run command. If the controls do not recognize flow in 60 seconds, the second pump will be activated and an alarm signal will be generated. If the second pump does not activate, the cooling will be locked out. See appendix for additional information.

**Pressure Gauges and Thermometers**

Pressure gauges and thermometers are available as a factory installed option. Thermometers are installed on the inlet and outlet of the unit. One pressure gauge is installed at each pump. This pressure gauge is connected in three places to the water piping before the suction guide/strainer, after the suction guide and before the pump,
and after the pump. There is also a needle valve at each of these points to isolate the pressure. To measure the pressure at any given point, open the needle valve at that point and close the other two needle valves. One gauge is used so that the calibration of the pressure gauge is irrelevant in the calculation of the differential pressure.

**Pipe Insulation**
The water piping and components on units with pumping packages are not insulated at the factory. Insulation should be installed on the water piping after the system has been checked for leaks.
Installation

Outdoor Mechanical Room Placement
The AAON LL Series is designed for outdoor applications and mounting at ground level or on a rooftop. It must be placed on a level and solid foundation that has been prepared to support its weight.

The placement relative to the building air intakes and other structures must be carefully selected. Be sure to observe the dimensions that are on the rating plate of the chiller for operational and service clearances.

Table 1 - Service Clearances

<table>
<thead>
<tr>
<th>Location</th>
<th>Unit Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front - (Controls Side)</td>
<td>100”</td>
</tr>
<tr>
<td>Back</td>
<td>100”</td>
</tr>
<tr>
<td>Ends</td>
<td>100”</td>
</tr>
<tr>
<td>Top</td>
<td>Unobstructed</td>
</tr>
</tbody>
</table>

Condenser coils and fans must be free of any obstructions in order to start and operate properly with a correct amount of airflow. For proper unit operation, the immediate area around condenser must remain free of debris that may be drawn in and obstruct airflow in the condensing section.

Consideration must be given to obstruction caused by snow accumulation when placing the unit.

Curb and Steel Mount Installation
Make openings in the roof decking large enough to allow for water piping, electrical, and gas penetrations and workspace only. Do not make openings larger than necessary. Set the curb to coincide with the openings. Make sure curb is level.

Units require rail support along all four sides of the unit base.

When installed at ground level, a one-piece concrete slab should be used with footings that extend below the frost line. Care must also be taken to protect the coil and fins from damage due to vandalism or other causes.

If unit is elevated a field supplied catwalk is recommended to allow access to unit service doors.

This unit ships with a curb gasket that is 1¼” wide and 1½” tall. It is recommended that this or another similar gasket be used between the curb and the unit to reduce vibration from the unit to the building.

Figure 3 - Curb Mounting with Dimensions
Table 2 - Mounting Dimensions

<table>
<thead>
<tr>
<th>Tons</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-115 (Scroll)</td>
<td>100&quot;</td>
<td>96&quot;</td>
<td>92&quot;</td>
<td>97&quot;</td>
</tr>
<tr>
<td>125-365 (Scroll)</td>
<td>142&quot;</td>
<td>138&quot;</td>
<td>134&quot;</td>
<td>139&quot;</td>
</tr>
<tr>
<td>90-540 (Centrifugal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lifting and Handling**

If cables or chains are used to hoist the unit they must be the same length and care should be taken to prevent damage to the cabinet. See Figure 6 for additional information.

Before lifting unit, be sure that all shipping material has been removed from unit. Secure hooks and cables at all lifting points/lugs provided on the unit.

Hoist unit to a point directly above the curb or mounting rail. Be sure that the gasket material has been applied to the curb or mounting rail.

Carefully lower and align unit with utility and duct openings. Lower the unit until the unit skirt fits around the curb. Make sure the unit is properly seated on the curb and is level.

Do not push, pull or lift the unit from anything other than its base.

Figure 4 - Steel Mounting Rail with Dimensions

Figure 5 - Marked Lifting Points
Lifting slot locations are unit specific. Unit must be rigged at all marked lifting points.

Water Connection
Connect the supply and return water lines. The connection size is listed on the unit rating sheet, along with the designed volumetric flow rate. The maximum operating pressure for AAON LL Series units is 125 psi.

⚠️ 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
The chiller must be operated only with liquid flowing through the evaporators.
Gas Connection
For LL Series outdoor mechanical units with boiler systems, size gas piping to supply the unit with proper pressure when all gas consuming devices in the building connected to the same gas system are operating. The maximum gas train inlet pressure for all boiler sizes is 5 psig. The minimum gas train inlet pressure for the 500 MBH boiler is 5 inches of water column, and for all other boilers, 7 inches of water column.

Carefully consider all current and future gas usage. Table 3 details the input rate for each boiler unit.

Gas connection sizes are listed on the unit rating sheet.

<table>
<thead>
<tr>
<th>Boiler Size</th>
<th>Rated Capacity (CFH)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural</td>
</tr>
<tr>
<td>500 MBH</td>
<td>500</td>
</tr>
<tr>
<td>750 MBH</td>
<td>750</td>
</tr>
<tr>
<td>1000 MBH</td>
<td>1000</td>
</tr>
<tr>
<td>1500 MBH</td>
<td>1500</td>
</tr>
</tbody>
</table>

*Note: Rating is for sea level conditions.

For additional information regarding the gas piping connection, see the Thermal Solutions Boiler “Installation, Operating, and Service Instructions” that are included with the unit.

Boiler Exhaust Connection
In addition to gas connection installation, each boiler requires installation of the exhaust vent piping and inlet vent hood. The exhaust panel with chimney cutout is removed for shipping, and replaced with a shipping cover.

![Exhaust Shipping Cover]

Remove the shipping cover and attach the exhaust panel shipped with the unit. When the exhaust panel is securely fastened with
sheet metal screws, locate the exhaust piping that is also shipped along with the unit. The exhaust piping that must be attached to the internal exhaust vent piping includes the vent length, 90 degree elbow and rain cap.

Examine all components prior to installation. The female end of each vent pipe component incorporates a sealing gasket and a mechanical locking band.

Intake and exhaust covers are in place for shipping. These must be removed and external intake/exhaust components must be installed prior to boiler operation.

Gasket must be in proper position or flue gases could leak.

**WARNING**

Failure to follow proper joint connection procedure may result in carbon monoxide gas poisoning due to flue gas leakage.

Securely fasten the vent pipe joints according to the following procedure.

1. Insert the male end into the female section. Push the units together and turn them until the bead of the male end is seated against the flared end of the female section. This creates the necessary airtight seal. Align the seams on the vent lengths and orient them upward in all horizontal applications.

2. Tighten the locking band with a nut driver until snug plus 1/4 turn.

Before proceeding, recheck all joints and ensure that all male sections extend to the top of the flared female end and all clamps are tightened.
Boiler Intake Connection
Remove the intake shipping cover. The round collar on the back of the intake vent passes through the cabinet wall and slides over the crimped end of the air intake pipe inside the unit. This joint should be secured with aluminum foil tape. The outer flange of the wall vent is fastened to the outer wall of the cabinet using sheet metal screws.

Mounting Isolation
For roof mounted applications or anytime vibration transmission is a factor, vibration isolators may be used.

Access Doors
Lockable access door is provided to the compressor and control compartment. A separate access door is also provided to the evaporator and pumping package compartment.

A light switch is provided on the wall of the compressor and control compartment.

Low Ambient Operation
If the chiller is ordered with the Low Ambient feature, the liquid system must use a glycol solution and the piping must be insulated to be prepared for freezing conditions. Care must be taken in the source of electrical power for the heating tape and thermostat.

The AAON low ambient (condenser flood-back) system is used to operate a refrigerant system below 25°F outside air temperature. As the ambient temperature drops, the condenser becomes more effective therefore lowering the head pressure. When the head pressure gets too low, there will be insufficient pressure to operate the expansion valve properly. During low ambient temperatures, it is difficult to start a system because the refrigerant will migrate to the cold part of the system (condenser) and make it difficult for refrigerant to flow.

The low ambient system maintains normal head pressure during periods of low ambient by restricting liquid flow from the condenser to the receiver, and at the same time bypassing hot gas around the condenser to the inlet of the receiver. This backs liquid refrigerant up into the condenser reducing its capacity that in turn increases the condensing pressure. At the same time the bypassed hot gas raises liquid pressure in the receiver, allowing the system to operate properly.

There are different types of low ambient control used. The following describe the different systems. Inspect the unit to determine the system used.

LAC Valve
The LAC valve is a non-adjustable three way valve that modulates to maintain receiver pressure. As the receiver pressure drops below the valve setting (180 psig for R-22 and 295 psig for R-410A), the valve
modulates to bypass discharge gas around the condenser. The discharge gas warms the liquid in the receiver and raises the pressure to the valve setting. The following schematic shows an example system using the LAC valve.

**Figure 11 - Piping Schematic of Example System using the LAC Valve.**

**OROA Valve**

This system uses a non-adjustable head pressure control valve that performs the function of limiting the flow of liquid refrigerant from the condenser and at the same time regulates the flow of the hot gas around the condenser to the receiver. The valve setpoint is 180 psig. This valve is called an OROA valve (Open on Rise of Outlet pressure). The following schematic shows an example system using the OROA valve.
**ORI/ORD Valves**

This system uses a two valve arrangement. The head pressure control valve is an inlet pressure regulating valve and responds to changes in condensing pressure. This valve is located in the discharge of the condenser and is called an ORI valve (Open on Rise of Inlet pressure). As the ambient temperature drops, the condenser capacity increases and the condensing pressure falls, causing the ORI to modulate toward the closed position. The condenser bypass valve is a pressure differential valve that responds to changes in the pressure differential across the valve. This valve is called an ORD valve (Open on Rise of Differential pressure). As the ORI starts to restrict liquid flow from the condenser, a pressure differential is created across the ORD. When the differential reaches the setpoint, the ORD starts to open and bypass hot gas to the liquid line. The ORI valve is adjustable from 65 to 225 psig (factory setting of 180 psig). The ORD is not adjustable. On refrigeration systems that are too large for a single ORI and ORD valve, there will be two ORI and two ORD valves in parallel. The following schematic shows an example system using the ORI/ORD valves.

---

Figure 12 - Piping Schematic of Example System using the OROA Valve.
The pressure setting of the ORI valve determines how well the system will operate. The proper setting is a function of the specific system in which it is installed. Generally, the setting should be equivalent to a condensing temperature of 90°F to 100°F or a receiver pressure equivalent to a temperature of 80°F to 90°F. This means that as the ambient temperature falls below 70°F, the head pressure control valve will begin to throttle. To adjust the ORI valve, remove the cap and turn the adjustment screw with the proper size hex wrench (1/4” for ORI-6 and 5/16” for ORI-10). A clockwise rotation increases the valve setting while a counter-clockwise rotation decreases the setting. To obtain the desired setting, a pressure gauge should be used at the compressor discharge service valve so the effects of any adjustment can be observed. Small adjustments are recommended in order to allow the system adequate time to stabilize after each adjustment.

**Condenser Flooding**

In order to maintain head pressure in the refrigeration system, liquid refrigerant is backed up in the condenser to reduce condenser surface. The following chart shows the percentage that a condenser must be flooded in order to function properly at the given ambient temperature.
Table 4 - Condenser Flooding

<table>
<thead>
<tr>
<th>Ambient Temperature (°F)</th>
<th>Evaporating Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>0° 10° 20° 30° 35° 40° 45° 50°</td>
</tr>
<tr>
<td>70°</td>
<td>40 24 0 0 0 0 0 0</td>
</tr>
<tr>
<td>60°</td>
<td>60 47 33 17 26 20 10 4</td>
</tr>
<tr>
<td>50°</td>
<td>70 60 50 38 45 40 33 28</td>
</tr>
<tr>
<td>40°</td>
<td>76 68 60 50 56 52 46 42</td>
</tr>
<tr>
<td>30°</td>
<td>80 73 66 59 64 60 55 51</td>
</tr>
<tr>
<td>20°</td>
<td>86 77 72 65 69 66 62 59</td>
</tr>
<tr>
<td>0°</td>
<td>87 83 78 73 76 73 70 68</td>
</tr>
<tr>
<td>-20°</td>
<td>91 87 82 77 80 79 76 73</td>
</tr>
</tbody>
</table>

During higher ambient temperatures the entire condenser is required to condense refrigerant. During these higher ambient temperatures, a receiver tank is used to contain the refrigerant that was required to flood the condenser during low ambient operation. The receiver must be sized to contain all of the flooded volume otherwise there will be high head pressures during higher ambient conditions.

Electrical
The single point electrical power connections are made in the electrical control compartment.

The microprocessor control furnished with the unit is supplied with its own power supply factory wired to the main power of the outdoor mechanical room.

Verify the unit nameplate voltage agrees with the power supply. Connect power and control field wiring as shown on the unit specific wiring diagram provided with the unit.

Size supply conductors based on the unit MCA rating. Supply conductors must be rated a minimum of 167°F (75°C).

Route power and control wiring, separately, through the utility entry. Do not run power and signal wires in the same conduit.

Protect the branch circuit in accordance with code requirements. The unit must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

Power wiring is to the unit terminal block or main disconnect. All wiring beyond this point has been done by the manufacturer and cannot be modified without affecting the unit's agency/safety certification.

⚠️ **WARNING**

Electric shock hazard. Before attempting to perform any installation, service, or maintenance, shut off all electrical power to the unit at the disconnect switches. Unit may have multiple power supplies. Failure to disconnect power could result in dangerous operation, serious injury, death or property damage.

⚠️ **CAUTION**

Installing Contractor is responsible for proper sealing of the electrical and gas entries into the unit. Failure to seal the entries may result in damage to the unit and property.
Figure 14 - Terminal Block

Startup technician must check for proper motor rotation and check fan motor amperage listed on the motor nameplate is not exceeded. Motor overload protection may be a function of the variable frequency drive and must not be bypassed.

Note: All units are factory wired for 208/230V, 460V, or 575V. If unit is to be connected to a 208V supply, the transformer must be rewired to 208V service. For 208V service interchange the yellow and red conductor on the low voltage control transformer.
Red-Black for 208V
Yellow-Black for 230V

Wire control signals to the unit’s low voltage terminal block located in the controls compartment.

If any factory installed wiring must be replaced, use a minimum 221°F (105°C) type AWM insulated conductors.

Evaporative-Cooled Condenser Field Piping Connections

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. Condenser fan motors should all be checked by a qualified service technician at startup and any wiring alteration should only be made at the unit power connection. Variable frequency drives are programmed to automatically rotate the fan in the correct rotation. Do not rely on fans with variable frequency drives for compressor rotation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scroll compressors are directional and will be damaged by operation in the wrong direction. Low pressure switches on compressors have been disconnected after factory testing. Rotation should be checked by a qualified service technician at startup using suction and discharge pressure gauges and any wiring alteration should only be made at the unit power connection.</td>
</tr>
</tbody>
</table>

There are at least two field water connections that must be made for the evaporative-cooled condenser. There is a 3/4” PVC socket city make up water connection and a 2” PVC socket drain connection, as shown in Figure 15. This drain should connect to a sanitary sewer or other code permitted drain. These connections can go through the base or the wall of the unit. There is a cutout in the base with a cap that is 1” tall and the cap is sealed to the unit base to prevent any leaks in the unit from
penetrating into the building. Any piping through the base should go through a field cutout in this cap. The pipes must be sealed to the cap once the piping is complete to prevent any leaks in the unit from penetrating into the building.

A field cutout must be made in the wall if the evaporative-cooled condenser piping is to go through the unit wall. This cutout must be sealed once the piping is installed to prevent water from leaking into the unit.

Figure 15 - Evaporative-Cooled Condenser Section Layout Including Field Water Connections and Base Cutout
Before the startup of the chiller and boilers be sure that the following items have been checked.

1. Verify that electrical power is available to the unit.

2. Verify that any remote stop/start device connected to the chiller (and boiler) controller is requesting the chiller (and boiler) to start.

3. Verify that liquid flow is present through the chiller (and boiler) from the building.

4. There should be a building load of at least 25% of the chiller (and boiler) capacity in order to properly check operation.

5. With the main power switch off, review the MCS Controller Manual provided with the chiller. Understand the keypad functions, how to set the leaving water temperature setpoint and how to initiate the Run State.

Use the general check list at the top of the startup form to make a last check that all the components are in place, water flow is present, and the power supply is energized.

Using the controller keypad, individually set the outputs in “Manual On” to confirm relay closure and compressor operation.

Cycle through all the compressors (and boilers) to confirm that all are operating within tolerance.

While performing the check, use the startup form to record observations of compressor amps, refrigerant pressures and boiler amps.

When all is running properly, place the controller in the Run mode and observe the system until it reaches a steady state of operation.

**Note:** For more information on programming the controller refer to the MCS Controller manual provided with the chiller.
Axial Flow Condenser Fans

Multi-Wing Z Series Aluminum Fan Blade Pitch Angle Setting Instructions

1. Maintain the balance of fan
Mark the hub castings across a joint, so the fan hub can be reassembled in the same orientation.

Mark the location of any balancing weight. Balancing weight will be on the outer bolt circle, in the form of washers, and/or longer bolts, or an additional balancing nut.

Number the blades and blade sockets, so that they are replaced into their original position.

2. Determine the direction of rotation
Right, R, is clockwise when facing the discharge side of the fan and Left, L, is counterclockwise when facing the discharge side of the fan.

3. Determine the bushing mount location
The bushing mount is the center section of the hub through which the fan is mounted to the shaft, and typically contains either setscrews or a center-tapered hole where the bushing inserts.

Location A is with the bushing mount on air inlet side of the fan.
Location B is with the bushing mount on air discharge side of the fan.

4. Determine the pin location groove
Disassemble fan on a flat surface and note in which groove the pin is located.
5. Determine whether the pin is in the HUB or RET

Figure 19 - Fan HUB and RET Castings

6. Determine the current blade pitch and the pin location for the new blades

<table>
<thead>
<tr>
<th>Type</th>
<th>Bushing Mount</th>
<th>Blade Pitch Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>5Z</td>
<td></td>
<td>20° 25° 28° 30° 33° 35° 38° 40° 45° 50°</td>
</tr>
<tr>
<td>A</td>
<td>- RET RET RET HUB HUB HUB HUB</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>- HUB HUB HUB RET RET RET RET</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 - Return/Exhaust Fan Pin Location

<table>
<thead>
<tr>
<th>Type</th>
<th>Rot.</th>
<th>Blade Pitch Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>5Z</td>
<td></td>
<td>20° 25° 28° 30° 33° 35° 38° 40° 45° 50°</td>
</tr>
<tr>
<td>R</td>
<td>4</td>
<td>3 2 1 4 3 2 1</td>
</tr>
<tr>
<td>L</td>
<td>1</td>
<td>2 3 4 1 2 3 4</td>
</tr>
</tbody>
</table>
7. Replace fan blades in the new pin location and reassemble the fan

Replace the blades with the pin in the 1, 2, 3, or 4 groove position of either the HUB or RET. Assemble the fan making sure to place the blades in their previous blade sockets, to match up the previous orientation of HUB and RET and to replace any balancing weights in their previous locations. Tighten bolts in a cross pattern to 5-6 ft-lbs. of torque.

**Multi-Wing W Series Black Glass Reinforced Polypropylene Fan Blade Pitch Angle Setting Instructions**

Contact the AAON parts department to acquire the new pitch pins for the fan blades.

Note original position of retaining plates, center boss and all hardware including additional hardware used for balancing.

1. Remove all the bolts and nuts.

2. Determine blade rotation – on the concave side of the blade is a blade marking showing 6WR, 6WL, 7WL, 7WR, or 9WR. The “L” and “R” denote the rotation of the blade.

3. Replace the pitch insert in the blade root with an insert of the desired pitch.

4. Replace blades to their original location.

5. Replace all nuts, bolts, and washers on the fan hub.

6. Replace retaining plates and center boss to original location.

7. Tighten nuts and bolts to 14 ft-lbs of torque.

**Fan Assembly Bushings**

The fan assembly bushings should be tightened to the specifications listed in the following table.

<table>
<thead>
<tr>
<th>Bushing</th>
<th>Tightening Torque (in-lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H X 1.125&quot;</td>
<td>95</td>
</tr>
<tr>
<td>H X 1.375&quot;</td>
<td>95</td>
</tr>
<tr>
<td>SH X 1.125&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SH X 1.375&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SD X 1.125&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SD X 1.375&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SD X 1.625&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SD X 1.875&quot;</td>
<td>108</td>
</tr>
<tr>
<td>SK X 2.125&quot;</td>
<td>180</td>
</tr>
</tbody>
</table>
Maintenance

General
Qualified technicians must perform routine service checks and maintenance. This includes reading and recording the condensing and suction pressures and checking for normal sub-cooling and superheat.

Air-cooled and evaporative-cooled condenser units require different maintenance schedules/procedures. Unit specific instructions for both types are included in this manual.

Compressors
The scroll compressors are fully hermetic and require no maintenance except keeping the shell clean.

Refrigerant Filter Driers
Each refrigerant circuit contains a replaceable core filter drier. Replacement is recommended when there is excessive pressure drop across the assembly or moisture is indicated in a liquid line sight glass.

<table>
<thead>
<tr>
<th>Circuit Loading</th>
<th>Max. Pressure Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>10 psig</td>
</tr>
<tr>
<td>50%</td>
<td>5 psig</td>
</tr>
</tbody>
</table>

The filter driers are provided with pressure taps and shutoff valves for isolation when changing the core. For safety purposes a service manifold must be attached prior to filter maintenance.

Evaporator/Heat Exchangers
Evaporators are direct expansion type with an electronic expansion valve or thermal expansion valve to regulate refrigerant. Normally no maintenance or service work will be required.

Adjusting Refrigerant Charge
All AAON chillers are shipped with a full factory charge. Periodically adjusting the charge of a system may be required.

Adjusting the charge of a system in the field must be based on determination of liquid sub-cooling and evaporator superheat. On a
system with an expansion valve liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

**CAUTION**

Polyolester (POE) and Polyvinylether (PVE) oils are two types of lubricants used in hydrofluorocarbon (HFC) refrigeration systems. Refer to the compressor label for the proper compressor lubricant type.

**CAUTION**

The Clean Air Act of 1990 bans the intentional venting of refrigerant (CFC’s and HCFC’s) as of July 1, 1992. Approved methods of recovery, recycling or reclaiming must be followed. Fines and/or incarceration may be levied for non-compliance.

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**Before Charging**

Refer to the unit nameplate as a reference when determining the proper refrigerant charge.

Unit being charged must be at or near full load conditions before adjusting the charge.

Units equipped with hot gas bypass must have the hot gas bypass valve closed to get the proper charge.

After adding or removing charge the system must be allowed to stabilize, typically 10-15 minutes, before making any other adjustments.

The type of unit and options determine the ranges for liquid sub-cooling and evaporator superheat. Refer to Table 9 when determining the proper sub-cooling.

For units equipped with low ambient (0°F) option see the special charging instructions at the end of this section.

**Checking Liquid Sub-cooling**

Measure the temperature of the liquid line as it leaves the condenser coil.

Read the gauge pressure at the liquid line close to the point where the temperature was taken. You must use liquid line pressure as it will vary from discharge pressure due to condenser coil pressure drop.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the measured liquid line temperature from the saturated temperature to determine the liquid sub-cooling.

Compare calculated sub-cooling to the table below for the appropriate unit type and options.

**Checking Evaporator Superheat**

Measure the temperature of the suction line close to the compressor.

Read gauge pressure at the suction line close to the compressor.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the saturated temperature from the measured suction line temperature to determine the evaporator superheat.

For refrigeration systems with tandem scroll compressors, it is critical that the suction superheat setpoint on the expansion valve is
set with one compressor running. The suction superheat should be 10-13°F with one compressor running. The suction superheat will increase with both compressors in a tandem running. Inadequate suction superheat can allow liquid refrigerant to return to the compressors which will wash the oil out of the compressor. Lack of oil lubrication will destroy a compressor. Liquid sub-cooling should be measured with both compressors in a refrigeration system running.

Compare calculated superheat to Table 9 for the appropriate unit type and options.

Table 9 - Acceptable Refrigeration Circuit Values

<table>
<thead>
<tr>
<th>Air-Cooled Condenser with Scroll Compressors</th>
<th>Sub-Cooling</th>
<th>Superheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12-18°F</td>
<td>10-15°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaporative-Cooled Condenser with Scroll Compressors</th>
<th>Sub-Cooling</th>
<th>Superheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6-10°F</td>
<td>10-15°F</td>
</tr>
</tbody>
</table>

1 One compressor running in tandem
2 Two compressors running in tandem

Correct an overcharged system by reducing the amount of refrigerant in the system to lower the sub-cooling.

**DO NOT OVERCHARGE!**
Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

The system is undercharged if the superheat is too high and the sub-cooling is too low.

Correct an undercharged system by adding refrigerant to the system to reduce superheat and raise sub-cooling.

If the sub-cooling is correct and the superheat is too high, the expansion valve may need adjustment to correct the superheat.

**Special Low Ambient Option Charging Instructions**
For units equipped with low ambient refrigerant flood back option being charged in the summer when the ambient temperature is warm:

Once enough charge has been added to get the evaporator superheat and sub-cooling values to the correct setting more charge must be added. Add approximately 80% of the receiver tank volume to the charge to help fill the receiver tank. The additional charge is required for the system when running in cold ambient conditions.

For units equipped with low ambient refrigerant flood back option being charged
in the summer when the ambient temperature is cold:

Once enough charge has been added to get the evaporator superheat and sub-cooling values to the correct setting more charge may need to be added. If the ambient temperature is 0°F no more charge is required. If the ambient temperature is around 40°F add approximately 40% of the receiver tank volume.

The unit will have to be checked for proper operation once the ambient temperature is above 80°F.

Table 10 - R-134a Refrigerant Temperature-Pressure Chart

<table>
<thead>
<tr>
<th>°F</th>
<th>PSIG</th>
<th>°F</th>
<th>PSIG</th>
<th>°F</th>
<th>PSIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>15</td>
<td>63</td>
<td>61</td>
<td>111</td>
<td>149</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>64</td>
<td>63</td>
<td>113</td>
<td>154</td>
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<td>18</td>
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<td>66</td>
<td>115</td>
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<td>30</td>
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Lubrication
All original motors and bearings are furnished with an original factory charge of lubrication. Certain applications require bearings be re-lubricated periodically. The schedule will vary depending on operating duty, temperature variations, or severe atmospheric conditions.

Bearings should be re-lubricated at normal operating temperatures, but not when running.

Rotate the fan shaft by hand and add only enough grease to purge the seals. DO NOT OVERLUBRICATE.

Air-Cooled Condenser
The air-cooled condenser section rejects heat by passing outdoor air over the fin tube coils for cooling of the hot refrigerant gas from the compressors. The heated air will discharge from the top of the section through the axial flow fans.

The condenser coils should be inspected yearly to ensure unrestricted airflow. If the installation has a large amount of airborne dust or other material, the condenser coils should be cleaned with a water spray in a direction opposite to airflow. Care must be taken to prevent bending of the aluminum fins on the copper tubes.

E-Coated Coil Cleaning
Documented routine cleaning of e-coated coils is required to maintain coating warranty coverage.

Surface loaded fibers or dirt should be removed prior to water rinse to prevent restriction of airflow. If unable to back wash the side of the coil opposite of the coils entering air side, then surface loaded fibers or dirt should be removed with a vacuum cleaner. If a vacuum cleaner is not available, a soft non-metallic bristle brush may be used. In either case, the tool should be applied in the direction of the fins. Coil surfaces can be easily damaged (fin edges bent over) if the tool is applied across the fins.

Use of a water stream, such as a garden hose, against a surface loaded coil will drive the fibers and dirt into the coil. This will make cleaning efforts more difficult. Surface loaded fibers must be completely removed prior to using low velocity clean water rinse.

A monthly clean water rinse is recommended for coils that are applied in coastal or industrial environments to help to remove chlorides, dirt, and debris. It is very important when rinsing, that water temperature is less than 130°F and pressure is than 900 psig to avoid damaging the fin edges. An elevated water temperature (not to exceed 130°F) will reduce surface tension, increasing the ability to remove chlorides and dirt.

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**WARNING**

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

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**CAUTION**

High velocity water from a pressure washer or compressed air should only be used at a very low pressure to prevent fin and/or coil damages. The force of the water or air jet may bend the fin edges and increase airside pressure drop. Reduced unit performance or nuisance unit shutdowns may occur.
Quarterly cleaning is essential to extend the life of an e-coated coil and is required to maintain coating warranty coverage. Coil cleaning shall be part of the unit’s regularly scheduled maintenance procedures. Failure to clean an e-coated coil will void the warranty and may result in reduced efficiency and durability.

For routine quarterly cleaning, first clean the coil with the below approved coil cleaner. After cleaning the coils with the approved cleaning agent, use the approved chloride remover to remove soluble salts and revitalize the unit.

Recommended Coil Cleaner
The following cleaning agent, assuming it is used in accordance with the manufacturer’s directions on the container for proper mixing and cleaning, has been approved for use on e-coated coils to remove mold, mildew, dust, soot, greasy residue, lint, and other particulate:

Enviro-Coil Concentrate, Part Number H-EC01.

Recommended Chloride Remover
CHLOR*RID DTS™ should be used to remove soluble salts from the e-coated coil, but the directions must be followed closely. This product is not intended for use as a degreaser. Any grease or oil film should first be removed with the approved cleaning agent.

Remove Barrier - Soluble salts adhere themselves to the substrate. For the effective use of this product, the product must be able to come in contact with the salts. These salts may be beneath any soils, grease or dirt; therefore, these barriers must be removed prior to application of this product. As in all surface preparation, the best work yields the best results.

Apply CHLOR*RID DTS - Apply directly onto the substrate. Sufficient product must be applied uniformly across the substrate to thoroughly wet out surface, with no areas missed. This may be accomplished by use of a pump-up sprayer or conventional spray gun. The method does not matter, as long as the entire area to be cleaned is wetted. After the substrate has been thoroughly wetted, the salts will be soluble and is now only necessary to rinse them off.

Rinse - It is highly recommended that a hose be used, as a pressure washer will damage the fins. The water to be used for the rinse is recommended to be of potable quality, though a lesser quality of water may be used if a small amount of CHLOR*RID DTS is added. Check with CHLOR*RID International, Inc. for recommendations on lesser quality rinse water.

Evaporative-Cooled Condenser
Evaporative cooling equipment rejects heat by evaporating a portion of the recirculated water spray and discharging it from the unit with the hot, saturated air. As the spray water evaporates, it leaves behind the mineral content and impurities of the supply water. If these residuals are not purged from the water distribution system, they will become concentrated and lead to scaling,
corrosion, sludge build-up and biological fouling.

A water treatment monitoring and control system has been furnished with this unit. Be sure to read the complete manual that has been furnished. All water treatment is a combination of bleed water and chemical treatment for proper control of the residuals and to prevent any biological contamination.

**WARNING**

Batch-loading chemicals into the unit is NOT PERMITTED. The control system must regulate the chemical feed.

**Severe Service**
The following recommended maintenance procedures are basic requirements for normal operating environments. For severe operating conditions, the frequency of inspection and service should be increased. Air containing industrial and chemical fumes, salt, dust, or other airborne contaminates and particulates will be absorbed by the recirculating water system and may form solutions and deposits harmful to the products and personnel.

**Safety**
The recirculating water system contains chemical additives for water quality control and biological contaminants removed from the air by the washing action of the water. Personnel exposed to the saturated effluent, drift, or direct contact should use proper precaution. Proper location of the evaporative-cooled condenser requires good judgment to prevent the air discharge from entering fresh air intakes or to avoid allowing contaminated building exhaust from entering the condenser.

Follow local and national codes in locating the evaporative-cooled condenser but as minimum the evaporative-cooled condenser sump must be 15 feet from the nearest intake.

**WARNING**
The evaporative-cooled condenser must be thoroughly cleaned on a regular basis to minimize the growth of bacteria, including Legionella Pneumophila, to avoid the risk of sickness or death. Service personnel must wear proper personal protective equipment. Do not attempt any service unless the fan motor is locked out.
Improper location of the evaporative-cooled condenser may seriously degrade the capacity of the equipment. Make sure the equipment is located such that discharge air from the condenser does not enter the condenser air inlet.

**Warranties**
Please refer to the limitation of warranties in effect at the time of purchase.

**Condenser Tube Inspection**
The coil is leak tested at 450 P.S.I.G. before shipment. AAON will not be responsible for loss of refrigerant. It is the responsibility of the installer to verify that the system is sealed before charging with refrigerant. If the unit is operated during low ambient temperature conditions, freeze protection for the recirculating water system must be provided.

**Freeze Protection**
In order to prevent water temperatures from dropping below 50°F, this unit is equipped with a VFD on the fan motors when the refrigeration system is operating.

**Recirculating Water System**
Electric sump heaters are available to keep the sump water from freezing when the refrigeration system is not operating. An electric resistance heater is supplied in the vestibule when sump heaters are selected.

**Note:** The condenser should not be operated with the fan on and the pump cycled on and off to maintain head pressure control under any conditions. The unit is equipped with a water temperature controller which varies fan speed to maintain sump water temperature. This unit is not equipped with a compressor discharge pressure controller for fan speed modulation and therefore cannot be operated without water flow.

**Startup**
Do not start the evaporative-cooled condenser or compressors without installation of proper water treatment chemicals. Contact your local water treatment expert for correct selection of water treatment chemical, adjustment of chemical feed and bleed rates.

**Cleanliness**
Dirt and debris may accumulate in the sump during shipping and storage. The sump should be cleaned prior to startup to prevent clogging the water distribution system. Any surfaces that show contamination should be cleaned ONLY with a commercial stainless steel cleaner to restore the initial appearance. The inlet screens should be inspected for foreign material.

**Storage**
Pumps removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is
ready to connect to the piping. Rotate the shaft periodically (At least monthly) to keep rotating element free and bearings fully functional.

For long term storage, the pump must be placed in a vertical position in a dry environment. Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rust-proofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

**Pump Operation**
Before initial start of the pump, check as follows:

1. Be sure that pump operates in the direction indicated by the arrow on the pump casing. Check rotation each time motor leads have been disconnected.
2. Check all connections of motor and starting device with wiring diagram. Check voltage, phase and frequency of line circuit with motor name plate.
3. Check suction and discharge piping and pressure gauges for proper operation.
4. Turn rotating element by hand to assure that it rotates freely.

**Running**
Periodically inspect pump while running, but especially after initial start-up and after repairs.

1. Check pump and piping for leaks. Repair immediately.
2. Record pressure gauge readings for future reference.
3. Record voltage, amperage per phase, and kW.

**Condenser Fan Motors**
The direct drive condenser motors on AAON evaporative-cooled condensers are 1200 rpm premium efficiency motors controlled by a VFD. These motors are totally enclosed air over motors with weep holes in the bottom end bell so that any condensation can drain out of the motor.

The motors have a small electric resistance heater installed inside the casing to keep the motors warm when they are deactivated. The heaters are designed to keep the interior of the motor 10°F warmer than the surrounding ambient temperature. This prevents condensation from forming inside the motor.

Ensure that fan is tightly mounted to the motor shaft and the motor mounting bolts are aligned and secure.

**Water Make Up Valve**
The sump water level is controlled by a set of conductivity probes at different levels in the sump. This water level controller is located in the vestibule behind the condenser pump. There are four conductivity probes in this controller. There is a reference probe (shown as “ref” on the wiring diagram). This probe is one of the two longest probes. The other long probe is the low water level probe (shown as “lo” on the wiring diagram). The medium length probe is for the medium water level (shown as “med” on the wiring diagram). The short probe is for the high water level (shown as “hi” on the wiring diagram). There is a solenoid valve in the makeup water line that is activated by the water level controller. The water level controller determines the level of water in the sump based on conductivity between two probes. If the controller sees conductivity between two probes, it knows that water is at least at the level of that probe.
If the water in the sump is below the low probe, it will not allow the condenser pump or the sump heater to operate. It will activate the make-up water solenoid to try to fill the sump assuming water is flowing to the unit. Once water is above the low probe, it will allow the condenser pump and sump heater (if ordered and the ambient temperature is below 40°F) to operate. The make-up water solenoid will remain activated until water gets to the high water level. The make-up water solenoid will deactivate until water gets to the medium water level. In normal operation, the water level should swing between the medium and high water levels. The maximum high water level should be 1” below the overflow drain which occurs after the make-up water valve shuts off when the water level reaches the high level probe.

**Figure 24 - Water Makeup Valve**

Make up water supply pressure should be maintained between 15 and 60 psig for proper operation of the valve. The make-up water valve assembly should be inspected monthly and adjusted as required. Replace the valve seat if leakage occurs when the valve is in the closed position.

**Water Treatment System**

All AAON evaporative-cooled condensers come equipped with a water treatment system that should be maintained by a local water treatment professional trained in the water treatment of evaporative-cooled condensers. This system consists of a controller, three chemical pumps and storage tanks, a conductivity sensor, a motorized ball valve for water bleed and a water meter.

One chemical pump and tank is typically used for a de-scaling chemical to prevent scale from forming in the condenser. The other two pumps and tanks are typically used for two different biocides (to kill any microorganisms that could grow in the condenser). Two biocides are used to prevent organisms from becoming resistant to one chemical.

The mineral content of the water must be controlled. All make up water has minerals in it. As water is evaporated from the condenser, these minerals remain. As the mineral content of the water increases, the conductivity of the water increases. The water treatment controller monitors this conductivity. As the water conductivity rises above set point, the controller will open a motorized ball valve on the discharge side of the condenser pump and dumps water into the condenser drain until conductivity is lowered. While the motorized ball valve is opened, the controller will not disperse chemicals.

The chemicals are dispersed by the water treatment controller based on the scheduled input by the water treatment professional.

The water meter measures the quantity of makeup water used by the condenser.

Any water treatment program must be compatible with stainless steel, copper,
aluminum, ABS plastic and PVC. Batch feed processes should never be used as concentrated chemicals can cause corrosion. Never use hydrochloric acid (muriatic acid) as it will corrode stainless steel.

**Sequence of Operation for LL Series units without Diagnostics**

On a call for cooling, the condenser pump is activated. A pressure switch in the pump discharge is bypassed for six seconds by a time delay relay in order for the pump to establish recirculating water flow. If flow is not proven within the six seconds, the pressure switch opens, breaking the safety circuit, thereby shutting down the entire system. This pressure switch is set to close at 3 psi and open at 1 psi.

A Johnson Controls S350C measures the water temperature in the pump discharge line. If the sump water temperature exceeds 105°F, the cooling system will be shut down thereby preventing damage to the evaporative-cooled condenser.

If a fault occurs in the evaporative-cooled condenser fan motor VFD, normally closed fault terminals on the VFD will interrupt the safety circuit, thereby shutting down the system.

If the VFD does fault and cannot be reset, there is a VFD bypass switch mounted near the VFD. This switch has four positions—line, off, drive, and test. The “line” position will bypass the VFD, sending power to the motor. In this position, the condenser fans will run at full speed. The “off” position will not allow power to pass through the switch. This functions as a disconnect switch. The “drive” position runs power through the VFD. This is the normal operation for the switch. The “test” position routes power to the VFD but not to the motor. This is useful for running tests on the VFD without sending power to the motor.

A Johnson Controls A350P controls the VFD speed. This device sends a 0-10 VDC signal to the VFD. This controller is set to maintain a sump temperature of 70°F. On a rise in sump temperature, the controller increases the voltage to the VFD, increasing the speed of the condenser fans. Conversely, on a drop in sump temperature, the controller will decrease the voltage to the VFD, decreasing the speed of the condenser fans.

An outside air thermostat does not allow the condenser to operate when the ambient temperature is below 35°F.

**Sequence of Operation for LL Series units with Diagnostics**

These units operate the same way as described in the previous section, except the unit controller operates the evaporative-cooled condenser. These units can also operate down to 0°F when equipped with the flooded condenser option as described in the low ambient section.

On units with diagnostics, each refrigerant system has suction and discharge pressure transducers and suction and discharge temperature sensors. Each compressor has a current transformer. The condenser pump is the first stage of condenser control and the condenser fans are the second stage of condenser control. The unit controller brings on the condenser stages based on the discharge pressures of each system. The system with the highest pressure will control the condenser staging. The first stage of condensing will activate at 180 psig (R-22) and deactivate at 160 psig. The second stage of condensing will activate at 195 psig and deactivate at 185 psig. The unit controller
will change the speed of the VFD to maintain 195 psig.

The unit controller will monitor the sump temperature and if it exceeds 105°F, it will reduce the number of compressors that are running. The unit controller monitors the condenser pump pressure switch. If this switch opens, it will not allow the compressors to operate. The unit controller also monitors the VFD fault status. If it receives a VFD fault, it will activate the alarm contacts on the unit controller. The VFD will no longer run, but the compressors will run until the pressures or temperatures get too high. The controller will reduce the number of compressors to try to keep as much of the unit running as possible. The VFD bypass switch can be set to “line” to operate the condenser fans at full speed.

Units with diagnostics can operate below 35°F down to 0°F. This is possible because of the finned de-superheat coil. When the ambient temperature is below 32°F, the condenser pump will not operate. As the ambient temperature increases, the condenser pump will activate at 35°F. As the ambient temperature decreases, the condenser pump will deactivate at 32°F. This dead band prevents the condenser pump from cycling too much. Below 32°F, the unit operates as an air-cooled condenser. An optional sump heater operates when the ambient temperature is below 32°F to prevent the sump from freezing and offers freeze protection to 0°F.

Pump Maintenance
Cleaning - Remove oil, dust, water, and chemicals from exterior of motor and pump. Keep motor air inlet and outlet open. Blow out interior of open motors with clean compressed air at low pressure.

Labeled Motors - It is imperative for repair of a motor with Underwriters’ Laboratories label that original clearances be held; that all plugs, screws, other hardware be fastened securely, and that parts replacements be exact duplicates or approved equals. Violation of any of the above invalidates Underwriters’ Label.

Fan Motor Maintenance
Same as pump maintenance.

Access Doors
If scale deposits or water is found around the access doors, adjust door for tightness. Adjust as necessary until leaking stops when door is closed.

Bearings - Lubrication
Every 6 months or after a prolonged shut down. Use waterproof, lithium based grease. Below 32°F - Esso Exxon or Beacon 325. Above 32°F - Mobil Mobilox EP2, Shell Alvania EP2, or Texaco RB2.

Recommended Monthly Inspection
1. Clean sump section interior. Dirt and other impurities which have accumulated in the sump should be removed from the sump area. Shut off make-up water ball valve and open the drain connection for flushing of the sump.
2. Clean dirt out of sump using a water hose (not a pressure washer).
3. Clean sump suction strainer.
4. Check water operating level. Adjust float as required.
5. Inspect fan motor(s) and water circulation pump(s) and lubricate per the lubrication nameplate or manufacture’s recommendations.
6. Inspect axial fans and eliminators removing any debris which may have accumulated during operation.
7. Inspect the water distribution system to insure that nozzles and spray orifices are functioning correctly. The inspection
should be made with the circulation pump on and fans off.

**Mist Eliminators**
The mist eliminators must be correctly positioned when they are replaced during cleaning or service.

**Air Inlet**
Inspect the air inlet louvers and mist eliminators into the condenser section on a monthly basis to remove any paper, leaves or other debris that may block the airflow.

**Stainless Steel Base Pan**
The base pan under the tube bundles is stainless steel and may sometimes become tarnished due to contamination. These surfaces should be inspected yearly to ensure they remain clean of any contamination that may result in damage. Any surfaces that show contamination should be cleaned ONLY with a commercial stainless steel cleaner to restore the initial appearance.

**Propeller Fans and Motors**
The fans are directly mounted on the motor shafts and the assemblies require minimal maintenance except to assurance they are clear of dirt or debris that would impede the airflow.

**Recommended Annual Inspection**
In addition to the above maintenance activities, a general inspection of the unit surface should be completed at least once a year. Remove spray header and flush out.

**Cleaning**
Mechanical cleaning, including pressure washing, should never be performed as surfaces and seals could be damaged. Chemical cleaning that is safe for stainless steel, copper, aluminum, ABS plastic and PVC is the only acceptable means of cleaning the evaporative condenser. A proper water treatment program should reduce cleaning needs.

**Water Quality**

<table>
<thead>
<tr>
<th>Table 12 - Recirculating Water Quality Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PH</strong></td>
</tr>
<tr>
<td>Hardness as CaCO₃</td>
</tr>
<tr>
<td>Alkalinity as CaCO₃</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>Chlorides as NaCl</td>
</tr>
<tr>
<td>Sulfates</td>
</tr>
</tbody>
</table>

Cycles of concentration (the ratio of dissolved solids in recirculated water to dissolved solids in makeup water), should be determined and monitored frequently by a competent water treatment expert. To limit cycles of concentration to maintain the above guideline, it is necessary to “bleed” a certain portion of the recirculated water. This is achieved automatically with a solenoid valve actuated by a conductivity meter set at the desired conductivity corresponding to the desired cycles of concentration. It should be noted that these are guidelines and even though these individual values are met, under certain conditions the water quality can be aggressive. For example, water with very low alkalinity and levels of chlorides and sulfates approaching maximum recommended levels can be corrosive.

All AAON evaporative-cooled condensers are furnished with a bleed system fitting and valve to continuously remove a small portion of the recirculated water to keep the water quality within the above listed parameters. This device is located on the discharge side of the pump. It is important to note that since “bleed” rate is a function of evaporation rate (i.e., amount of heat
rejected), if the bleed setting is manual based on design heat load, too much water will be removed when the heat load is less that design.

The AAON evaporative-cooled condenser is equipped with a de-superheater. The de-superheater coil is located above the mist eliminators. Approximately 22% of the total heat of rejection is accomplished with the de-superheater. Water usage of the AAON evaporative-cooled condenser is approximately 22% less than evaporative-cooled condensers not equipped with a de-superheater.

One method of calculating evaporation and bleed in gallons per minute (gpm) is shown as follows:

**Evaporation Rate**

\[
\text{Evaporation Rate} = \frac{\text{Total Heat of Rejection via Evaporation}}{\frac{h_f g \text{ btu/} \text{lb} \times \rho \text{ lb/gal} \times 60 \text{ min/hr}}{525,000 \text{ (Btu/hr/gpm)}}}
\]

**Bleed Rate**

\[
\text{Bleed Rate} = \frac{\text{Evaporation Rate}}{\text{Cycles of Concentration} - 1}
\]

**Example:**
A unit has 100 ton cooling capacity with a compressor EER = 15

**Total Heat of Rejection**

\[
= \text{Unit Capacity in Tons} \times 12000 \times (1 + \frac{3.413 \text{ EER}}{15})
\]

\[
= 100 \times 12000 \times (1 + \frac{3.413}{15})
\]

\[
= 1,473,040 \text{ Btu/hr}
\]

**Total Full Load Heat of Rejection via Evaporation**

\[
= \text{Total Heat of Rejection} \times (1 - \text{fraction of heat rejected by de-superheater})
\]

\[
= 1,473,040 \text{ Btu/hr} \times (1 - 0.22)
\]

\[
= 1,148,971 \text{ Btu/hr}
\]

Note that approximately 22% of the total heat of rejection is accomplished with the de-superheater at full load. So, the fraction of heat rejected by the de-superheater (in the equation above) is approximately 0.22 at full load and increases as the ambient dry bulb decreases.

**Evaporation Rate**

\[
= \frac{1,148,971 \text{ (Btu/hr)}}{525,000 \text{ (Btu/hr/gpm)}}
\]

\[
= 2.19 \text{ gpm}
\]

Assuming 4 cycles of concentration:

**Bleed Rate**

\[
= \frac{2.19}{4-1}
\]

\[
= 0.73 \text{ gpm}
\]

**Mechanical Cleaning**
Do not attempt to mechanically clean the copper tubing in the evaporative-cooled condenser. Do not use wire brushes or any other mechanical device on the copper tubing. Severe damage may result. Contact your water treatment expert for recommendations on chemical cleaning procedures.

**Service**
If the unit will not operate correctly and a service company is required, only a company with service technicians qualified and experienced in both refrigerant chillers and air conditioning are permitted to service the systems to keep warranties in effect. If assistance is required, the service technician must contact AAON.
Replacement Parts
Parts for AAON equipment may be obtained from your local AAON representative. Reference the unit serial number and part number when ordering parts.

AAON Warranty, Service and Parts Department
2424 S. Yukon Ave.
Tulsa, OK 74107
Ph: 918-583-2266
Fax: 918-382-6364
www.aaon.com

Note: Before calling, technician should have model and serial number of the unit available for the service department to help answer questions regarding the unit.
Appendix - Water Piping Component Information

Water Pressure Reducing Valve

Water Pressure Reducing Valves are designed to reduce incoming water pressure to protect plumbing system components and reduce water consumption.

Overview
Standard construction includes Z3 sealed spring cage and corrosion resistant adjusting cage screws for outdoor/waterworks pit installations
- Integral stainless steel strainer
- Replaceable seat module
- Bronze body construction
- Serviceable in line
- High temperature resistant reinforced diaphragm for hot water
- Low pressure range 10 – 35psi (69 – 241 kPa)

Materials
Body: Bronze
Seat: Replaceable stainless steel
Integral Strainer: Stainless steel
Diaphragm: Reinforced EPDM
Valve Disc: EPDM

Standards
Meets requirements of ASSE Standard 1003; (ANSI A112.26.2); CSA Standard B356; Southern Standard Plumbing Code and listed by IAPMO.
Teflon® is a registered trademark of E.I. Dupont de Nemours & Company.

CALIFORNIA PROPOSITION 65 WARNING
**WARNING:** This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. (California law requires this warning to be given to customers in the State of California.)
For more information: www.wallets.com/prop65
Capacity

Note: Use a pressure gauge downstream to adjust and verify the pressure setting.

Troubleshooting
High System Pressure
If the downstream system pressure is higher than the set pressure under no flow conditions, the cause could be thermal expansion, pressure creep or dirt/debris on the seat. Thermal expansion occurs whenever water is heated in a closed system. The system is closed when supply pressure exceeds 150 psi, or a check valve or backflow preventer is installed in the supply piping. To determine if this is the result of thermal expansion, try briefly opening the cold water tap. If the increased pressure is caused by thermal expansion, the pressure will immediately be relieved and the system will return to the set pressure.

Maintenance Instructions
To clean strainer remove the bottom plug and pull out strainer.

Adjustment
To adjust pressure setting, loosen the lock nut and turn the adjusting bolt clockwise to increase pressure, counter clockwise to decrease pressure.

Dimensions-Weights:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>SIZE (IN)</th>
<th>DIMENSIONS</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>in.</td>
<td>mm</td>
</tr>
<tr>
<td>U5-Z3</td>
<td>⅜</td>
<td>20</td>
<td>55</td>
</tr>
</tbody>
</table>
Water Pressure Relief Valve

Overview
ASME Rated, Design Certified and Listed by C.S.A.

Used for protection against excessive pressure on domestic storage tanks or tankless water heaters, the pressure relief valve has no temperature relieving element.

Standard setting, 125 psi Size $\frac{3}{4}'' \times \frac{3}{4}''$ (20mm x 20mm).

ASME construction and is tested, listed and certified by the National Board of Boiler and Pressure Vessel Inspectors.

ANSI Z21.22 “Relief Valves for Hot Water Supply Systems.” DESIGN CERTIFIED and listed by C.S.A.

Automatic Air Vent Valves

Automatic Air Vent Valves provide automatic air venting for hot or cold water distribution systems. These vents purge air that may be in the water system.

The vent valve utilizes a float to actuate the valve plug which is located at the top of the valve. Once the air is displaced and the system pressure is sustained, the valve plug seals and prevents any water from escaping from the system.

The float vent can also operate as an anti-vacuum device since it will permit air to enter the system when it must be drained. It can also be installed to permit the separation and dispersal of air while fluid is actually circulating in the system.

Overview
- Body and cover are brass construction.
- Air vent with silicone rubber seal.
- Impurities do not usually affect function as maximum float line of water is always lower than the valve seal.
- Float is high temperature resistant polyethylene.
- Suitable for use with glycol systems.
- Can be disassembled for inspection and cleaning.
Operating Range:
Minimum working pressure: 1.45psi (10 kPa)
Maximum working pressure: 150psi (10 bars)
Temperature Range: 33°F – 240°F (5°C – 116°C)

Performance

Performance curve details the quantity of air vented by the “Float Vent” according to the pressure in the system.

Note: In order to get the best results in venting air from risers, use connecting pipes of at least £2” diameter between the “Float Vent” valves and installation.

Installation
When the air vent valve is installed as shown, the air will not be vented while the fluid is circulating in the system, but it can vent when the system is shut off.

The figure below shows the installation of the vent valve for the venting of air while the fluid is circulating in the system and the required increase in pipe size in order to obtain proper separation of air from water.

The valve should be mounted only in a vertical position as its operation is based on the vertical movement of the float.

While the air vent valve is in operation, back off the small vent cap two turns. This is the proper operating setting which will allow air to be vented from the system. It is advisable to leave the cap on to prevent impurities from entering the valve.
Maintenance
No maintenance is normally necessary. However, if the FV-4M1 is disassembled for inspection or cleaning it is important that when re-assembling to ensure that the spring loaded lever properly engages under the float collar.

Dimensions – Weights:

<table>
<thead>
<tr>
<th>SIZE (CM)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>75</td>
<td>67</td>
<td>41</td>
<td>31</td>
<td>7.9</td>
<td>0.40</td>
</tr>
<tr>
<td>1/4</td>
<td>79</td>
<td>67</td>
<td>41</td>
<td>31</td>
<td>7.9</td>
<td>0.43</td>
</tr>
<tr>
<td>1/2</td>
<td>85</td>
<td>69</td>
<td>32</td>
<td>18</td>
<td>16</td>
<td>0.44</td>
</tr>
<tr>
<td>5/4</td>
<td>85</td>
<td>69</td>
<td>32</td>
<td>18</td>
<td>16</td>
<td>0.45</td>
</tr>
<tr>
<td>1</td>
<td>89</td>
<td>69</td>
<td>35</td>
<td>18</td>
<td>20</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Pumps - Installation and Operating Instructions

Introduction
This document contains specific information regarding the safe installation, operating and maintenance of Vertical In-Line pumps and should be read and understood by installing, operating and maintenance personnel. The equipment supplied has been designed and constructed to be safe and without risk to health and safety when properly installed, operated and maintained. The instructions following must be strictly adhered to. If clarification is needed on any point please contact Armstrong quoting the equipment serial number.
Where under normal operating conditions the limit of 68°C/155°F (Restricted Zone) for normal touch, or 80°C/176°F (Unrestricted Zone) for unintentional touch, may be experienced, steps should be taken to minimize contact or warn operators/users that normal operating conditions will be exceeded. In certain cases where the temperature of the pumped liquid exceeds the above stated temperature levels, pump casing temperatures may exceed 100°C/212°F and not withstanding pump insulation techniques appropriate measures must be taken to minimize risk for operating personnel.

Storage
Pumps removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is ready to connect to the piping. Rotate the shaft periodically (At least monthly) to keep rotating element free and bearings fully functional.

For long term storage, the pump must be placed in a vertical position in a dry environment. Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rust-proofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

Handling Large VIL Units
One effective way of lifting a large pumping unit is to place lifting hooks through the motor lifting rings or straps around the upper part of the motor. The pump and motor unit will free-stand on the casing ribs.

Remove the coupling guard and place (2) lifting straps through the pump/motor pedestal, one on each side of the motor shaft and secure to the lifting device.

With the straps in place, using a spacer bar if necessary to protect the motor fan cover, the whole assembly can now be lifted securely.

Note: Handling, transportation and installation of this equipment should only be undertaken by trained personnel with proper use of lifting equipment.

Remove coupling guard and place lifting straps on each side of coupling, use spacer bar if necessary to protect motor fan cover.

Vertical Inline Pump Lifting Strap Positioning:

Note: All split-coupled pumps contain a tapped hole in the motor bracket above the discharge flange for draining the well. Pipe this drain hole to a floor drain to avoid overflow of the cavity caused by collecting chilled water condensate or from seal failure.
Pump Piping - General

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Caution. Piping may carry high temperature fluid.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge valve only is to be used to throttle pump flow.</td>
</tr>
</tbody>
</table>

The discharge valve only is to be used to throttle pump flow, not the suction valve. Care must be taken in the suction line layout and installation, as it is usually the major source of concern in centrifugal pump applications.

Alignment
Alignment is unnecessary on close-coupled pumps as there is no shaft coupling.

Split-coupled units are accurately aligned at the factory prior to being shipped and do not need re-aligning when installed.

Pump Operation

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not run pumps with discharge valve closed or under very low flow conditions.</td>
</tr>
</tbody>
</table>

Starting Pump
Ensure that the pump turns freely by hand, or with some mechanical help such as a strap and lever on larger pumps. Ensure that all protective guarding is securely fixed in position.

The pump must be fully primed on start up. Fill the pump casing with liquid and rotate the shaft by hand to remove any air trapped in the impeller. On split coupled units, any air trapped in the casing as the system is filled must be removed by the manual air vent in the seal flush line. Close-coupled units are fitted with seal flush/vent lines piped to the pump suction area. When these units operate residual air is drawn out of the pump towards the suction piping.

“Bump” or energize the motor momentarily and check that the rotation corresponds with the directional arrow on the pump casing. To reverse rotation of a three phase motor, interchange any two power leads.

Start the pump with the discharge valve closed and the suction valve open, and then gradually open the discharge valve when the motor is at operating speed. The discharge valve may be cracked” or open slightly at start up to help eliminate trapped air.

When stopping the pump: Close the discharge valve and de-energize the motor.

DO NOT run the pump against a closed discharge valve for an extended period of time. (A few minutes maximum)

Star-Delta motor starters should be fitted with electronic/mechanical interlocks that have a timed period of no more than 40 milliseconds before switching from star (Starting) to delta (Run) connection yet allow the motor to reach full star (Starting) speed before switching to delta (Run).

Should the pump be noisy or vibrate on start-up a common reason is overstated system head. Check this by calculating the pump operating head by deducting the suction pressure gauge value from the discharge gauge reading. Convert the result
into the units of the pump head as stated on the pump nameplate and compare the values. Should the actual pump operating head be significantly less than the nameplate head value it is typically permissible to throttle the discharge isolation valve until the actual operating head is equal to the nameplate value.

Any noise or vibration usually disappears. The system designer or operator should be made aware of this soon as some adjustment may be required to the pump impeller diameter or drive settings, if applicable, to make the pump suitable for the system as installed.

### CAUTION

Check rotation arrow prior to operating the unit.

Check rotation arrow prior to operating the unit. The rotation of all Vertical In-Line units is “clockwise” when viewed from the drive end. (Looking from on top of / behind the motor)

**General Care**

Vertical In-Line pumps are built to operate without periodic maintenance, other than motor lubrication on larger units. A systematic inspection made at regular intervals, will ensure years of trouble-free operation, giving special attention to the following:

- Keep unit clean
- Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
- Avoid operating the unit in overheated surroundings (Above 100°F/40°C).

### WARNING

Electric shock hazard. Before attempting to perform any service or maintenance on pumping unit, disconnect power source to the driver, LOCK IT OFF and tag with the reason.

Any possibility of the unit starting while being serviced must be eliminated.

If mechanical seal environmental accessories are installed, ensure water is flowing through the sight flow indicator and that filter cartridges are replaced as recommended.

**Lubrication**

**Pump**

Lubrication is not required. There are no bearings in the pump that need external lubrication service.

Large Series split-coupled units are installed with a shaft bushing located beneath the impeller that is lubricated from the pump discharge. This bearing is field removable for service on the 20x20x19 size without disturbing the motor or other major pump components.

**Motor**

Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated and need no added lubrication. Generally if there are grease fittings evident the motor needs periodic lubrication, and if there are no grease fittings evident, no periodic lubrication is required.

Check the lubrication instructions supplied with the motor for the particular frame size indicated on the motor nameplate.
**Mechanical Seal**
Mechanical seals require no special attention. The mechanical seal is fitted with a flush line. The seal is flushed from discharge of the pump casing on split-coupled pumps and is flushed/vented to the suction on close coupled pumps.

The split-coupled pump is flushed from the pump discharge because the mechanical seal chamber is isolated from the liquid in the pump by a throttle bushing. Because the seal chamber is isolated, seal environmental controls such as filters and separators, when installed in the split-coupled flush line are very effective, as only the seal chamber needs cleansing, and will prolong seal life in HVAC systems.

Do not run the pump unless properly filled with water as the mechanical seals need a film of liquid between the faces for proper operation.

Mechanical seals may ‘weep’ slightly at start-up. Allow the pump to continue operating for several hours and the mechanical seal to ‘seat’ properly prior to calling for service personnel.

**System Cleanliness**
Before starting the pump the system must be thoroughly cleaned, flushed and drained and replenished with clean liquid.

Welding slag and other foreign materials, “Stop Leak” and cleaning compounds and improper or excessive water treatment are all detrimental to the pump internals and sealing arrangement.

Proper operation cannot be guaranteed if the above conditions are not adhered to.

---

**CAUTION**

**Double Check Prior to Startup**

**Note**
Particular care must be taken to check the following before the pump is put into operation:
1. Pump primed?
2. Rotation OK?
3. Lubrication OK?
4. Pipe work properly supported?
5. Voltage supply OK?
6. Overload protection OK?
7. Is the system clean?
8. Is the area around the pump clean?

**Warranty**
Does not cover any damages to the equipment resulting from failure to observe the above precautions.
Noise Levels
Estimated Pumping Unit Sound Power Level, Decibels, A-Weighted, at 1 m (3 ft.) from unit.

<table>
<thead>
<tr>
<th>Frame Designation</th>
<th>1200 rpm</th>
<th>1800 rpm</th>
<th>3000 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ODP</td>
<td>TEFC</td>
<td>ODP</td>
</tr>
<tr>
<td></td>
<td>hp</td>
<td>dB-A</td>
<td>hp</td>
</tr>
<tr>
<td>140</td>
<td>0.75 - 1</td>
<td>65</td>
<td>0.75 - 1</td>
</tr>
<tr>
<td>180</td>
<td>1.5 - 2</td>
<td>67</td>
<td>1.5 - 2</td>
</tr>
<tr>
<td>210</td>
<td>3 - 5</td>
<td>72</td>
<td>3 - 5</td>
</tr>
<tr>
<td>250</td>
<td>7.5 - 10</td>
<td>76</td>
<td>7.5 - 10</td>
</tr>
<tr>
<td>320</td>
<td>25 - 30</td>
<td>88</td>
<td>25 - 30</td>
</tr>
<tr>
<td>360</td>
<td>40 - 50</td>
<td>86</td>
<td>40 - 50</td>
</tr>
<tr>
<td>400</td>
<td>60 - 75</td>
<td>88</td>
<td>60 - 75</td>
</tr>
<tr>
<td>440</td>
<td>100 - 125</td>
<td>91</td>
<td>100 - 125</td>
</tr>
</tbody>
</table>

Vibration Levels
Vertical In-Line pumps are designed to meet vibration levels set by Hydraulic Institute Standard HI Pump Vibration 9.6.4. Standard levels are as detailed below:

Dual Pump Specific Information

Dual Pump Flapper Valve Operating Instructions
This unit is fitted with internal valves to allow isolation of one pump for service and to automatically prevent recirculation of the flow when only one pump is running.

Procedure for Parallel or Stand-By Pumping
Discharge and suction valve stems should be locked in the center position. This is indicated by both locking handles in the vertical position and the center pin of the locking arms (4) locked by the handles. This procedure allows the discharge flapper valves to pivot freely and locks the suction valve firmly in the center position.

Procedure for Isolation of One Side
1. Stop the pump to be serviced.
2. Close and lock the suction and discharge valves: as per instructions below.
3. Ensure seal flush line interconnection valve is closed and drain the isolated casing.
4. Service isolated pump as required.

Procedure for Starting the Pump after Servicing
1. Ensure serviced pump is fully re-assembled including all seal flush lines and drain plugs.
2. Fill the dry casing with system fluid by opening the seal flush line interconnecting valve and the air vent fitting.
3. Allow the pressure to equalize in the two casings, if necessary, by opening seal flush line interconnected valve.
4. Unlock the discharge valve as per instructions below.
5. Unlock the suction valve as per instructions below.

**NOTE:** Keep hands and tools away from locked suction valve arm, as the differential pressure may cause the arm to rotate quickly with force when unlocked.

6. Close the seal flush line interconnect valve and restart pump.

**Valve Operation** - Refer to following 3”, 4” & 6” valve illustration and the 8” valve illustration.

**Discharge Valve**
This valve performs the dual function of automatically sealing the discharge of the inactive pump when one pump is running and can manually be closed and locked to isolate one pump for service.

**Automatic Flapper Operation**
In the flapper mode the two halves of the discharge valve are free to pivot independently under normal operating conditions. The locking handle (3) should be secured with the set screw (11) in the vertical position with the center pin of the locking arm (4) trapped by the locking handle (3).

**Manual Valve Locking**
The locking feature of this valve is to ensure a positive seal (leak proof) of the discharge port on the pump to be serviced.

**Note:** Ensure the pump to be isolated is not operating before attempting to release the locking mechanism. Failure to do so may result in injury to the operator and/or damage to the pump.

**Locking**
1. Loosen discharge side set screw (11) to release the locking handle (3).
2. Rotate the discharge side locking handle (3) so that the handle points toward the pump to be serviced and secure in the horizontal position, using set screw (11). This releases the discharge locking arm (4).
3. Rotate discharge valve shaft (16) towards the pump to be isolated. The orientation of the shaft is indicated by the center pin on the locking arm (4).
4. Raise the locking handle (3) so that the cam on the base of the handle forces the pin of the locking arm (4) towards the pump to be isolated. The locking handle (3) should be raised to between 45 degrees and the vertical position.
5. Tighten set screw (11) to lock the locking handle (3) in position.

**Unlocking**
1. Open the interconnecting valve on the seal flush line to pressurize the serviced pump and vent air through bleeder valve on series 4302
2. Close these valves once the pressure is equalized and air removed.
3. Loosen set screw (11) and lower locking handle (3) to the horizontal position, secure with set screw (11).
4. Rotate valve to center position so that the center pin of the locking arm (4)
locates in the recess on the locking handle (3).

5. Loosen set screw (11) and raise locking arm (3) to the vertical position, locking the center pin in the locking arm recess, secure with set screw (11).

**Suction Valve Manual Operation**

The suction side valve is designed for use as a manually operated isolation valve. This valve is not designed to automatically pivot as the discharge flappers do.

1. Loosen suction side set screw (11) to release the locking handle (3).
2. Rotate the suction side locking handle (3) so that the handle points towards the pump to be serviced and secure in the horizontal position, using set screw (11). This releases the suction locking arm (4).

**Note:** The locking handle (3) should only be rotated towards the pump stopped for service. The suction valve is designed to prevent the locking handle (1) from rotating towards the running pump, as the suction of the running pump could cause the valve to slam shut with sufficient force to injure the operator and/or cause damage to the pump. Do not attempt to circumvent this safety feature.

3. Rotate the suction valve towards the pump to be isolated. The orientation of the shaft is indicated by the center pin on the locking arm (4).
4. Loosen set screw (11) and raise the locking handle (3) so that the cam on the base on the handle forces the pin of the locking arm (4) towards the pump to be isolated. The locking handle (3) should be raised to between 45 degrees and the vertical position.

**This handle should not be rotated past the vertical position.**

5. Tighten set screw (11) to secure the locking handle (3) in position.

**WARNING**

Care should be taken when performing procedures 3 and 4. Read instructions carefully.

**Unlocking**

1. Open the interconnecting valve on the seal flush line to pressurize the serviced pump and vent air through bleeder valve on series 4302. Close these valves once the pressure is equalized and air removed.
2. Loosen set screw (11) and lower locking handle (3) to the horizontal position, secure with set screw (11).

**NOTE:** Keep hands and tools away from suction valve locking arm when freed by locking handle as differential pressure may cause arm to rotate quickly with force when unlocked.

3. Rotate valve to center position so that the center pin of the locking arm (4) is located in the recess on the locking handle (3).
4. Loosen set screw (11) and raise locking arm (3) to the vertical position, locking the center pin in the locking arm recess, secure with set screw.
Valve Illustration (3", 4" and 6")

This pump suction is now closed. (Locked when handle is elevated and secured).

This pump discharge is now closed. (Locked when handle is elevated and secured).

Suction Valve  

Discharge Valve  

Normal Operation  

Normal Operation
Valve Illustration (8"")

This pump suction is now closed. (Locked when handle is elevated and secured).

This pump discharge is now closed. (Locked when handle is elevated and secured).

Suction Valve

Discharge Valve

Normal Operation

Normal Operation
Horizontal and Vertical Expansion Tanks

ASME PRE-PRESSURIZED
DIAPHRAGM EXPANSION TANKS
FOR HEATING & COOLING SYSTEMS

Vessel Description
Tanks are ASME constructed and pre-charged. They are designed to absorb the expansion forces and control the pressure in heating/cooling systems.

The system’s expanded water is contained behind a heavy-duty diaphragm fully compatible with water/glycol mixtures preventing tank corrosion and water logging problems.

The factory set pre-charge for these tanks is **12 psig (83 kPa)**.

Materials
Shell – Carbon Steel  
Diaphragm – Heavy Duty Butyl

Operating Conditions
Maximum Working Temperature - 240°F (115°C)  
Maximum Working Pressure – 125 psi (862 kPa)

Maintenance Steps & Procedure
Visually inspect tank for damage, which may occur during transit.

Factory pre-charge pressure may not be correct for the installation. Tank MUST be pre-charged to system design fill pressure BEFORE placing into operation. Remove pipe plug covering the valve enclosure. Check and adjust the charge pressure by adding or releasing air for each application.

**Note:** If the system has been filled, the tank must be isolated from the system and the tank emptied before charging. This ensures all fluid has exited the diaphragm area and proper charging will occur.

If the pre-charge adjustment is necessary, oil and water free compressed air or nitrogen gas may be used. Check the pre-charge using an accurate pressure gauge at the charging valve and adjust as required. Check air valve for leakage. If evident, replace the Schrader-type tire valve core.

Do not depend on the valve cap to seal the leak.

After making sure air charge is correct, replace pipe plug over the charging valve for protection.

Set tank in place and pipe system connection to system. Be sure to include isolation valve(s) and drain.

Purge air from system BEFORE placing tank into operation. All models have system water contained behind diaphragm.

When filling the system with water, open valves to tank to ensure that any residual air in the tank is displaced by water.

It is recommended that the pre-charge be checked annually to ensure proper system protection and long life for the vessel.
**Suction Guides**

**Introduction**
Suction Guides are designed for bolting directly onto the suction flange of horizontal or vertical shaft centrifugal pumps.

**Operating Limits**
The suction guide is designed to be a *four-function* fitting. Each Suction Guide is a 90° elbow, a Pipe Strainer and a Flow Stabilizer. It may also be used as a Reducing Elbow, should the suction piping be larger than the pump inlet.

**Installation**
The Suction Guides may be installed in any arrangement feasible the arrangement of the pump flange bolt-holes.

**Inspection**
Suction Guides are thoroughly tested and inspected before shipment to assure they meet with your order requirements. All units must be carefully examined upon arrival for possible damage during transit. Any evidence of mishandling should be reported immediately to the carrier and noted on the freight bill.

**Operation**
No special attention need be paid to the Suction Guide at start-up. The fitting is stationary and will strain the pumped fluid and stabilize the flow into the pump automatically.
Temporary strainer must be removed following system clean up.

After all debris has been removed from the system, or a maximum of 24 running hours, stop the pump and close the pump isolation valves. Drain the Suction Guide by removing the drain plug or opening the blowdown valve, if installed.

Remove the Suction Guide cover and remove the strainer assembly from the valve body.

A temporary fine-mesh start-up strainer is tack-welded to the permanent stainless steel strainer. This temporary strainer should now be removed from the permanent strainer. The fine-mesh strainer is designed to remove small particulate from new piping systems and could easily clog with debris if left in place. This will be detrimental to the operation of the pump.

Inspect the cover O-ring and replace if necessary.

Replace the permanent strainer into the fitting body, once the temporary strainer is removed.

Replace the cover into the body. Ensuring that the strainer is properly seated, tighten the cover bolts diagonally, evenly and firmly.

Glycol Auto Fill Unit

The glycol auto fill unit (GLA) is designed to maintain the HVAC system pressure by adding the appropriate mix of glycol and water to the system. During the normal operation of the HVAC system, fluid is lost causing a drop in the system pressure.

Standard Unit

When the system pressure drops below the set point on the pressure switch, the GLA pump is started adding fluid from the GLA tank into the HVAC system. When the system pressure returns to normal operating conditions, the pump stops. As the tank empties, a level switch is actuated preventing the pump from running dry.

Ultra Unit

When the system pressure drops below the set point on the pressure switch, the GLA pump is started adding fluid from the GLA tank into the HVAC system. When the system pressure returns to normal operating conditions, the pump stops. As the tank empties, a level switch is actuated lighting the low level pilot light. If the system is not filled, a second level switch stops the pump(s) preventing the pump(s) from running dry. Should the system be overfilled, a high level alarm is actuated by level switch. Dry contacts can be provided for remote indication of the above conditions.

A manual “push to mix” switch is provided for agitation of the contents of the GLA unit. The switch starts the pump and opens the return line solenoid valve circulating the fluid.

Duplex units are equipped with a manual alternator to equalize wear on the pumps.

Essential Safety Requirements

Glycol is toxic and the glycol supplier’s safety instructions must be adhered to. In critical areas a retaining wall should be used to contain any spillage or leakage. Overflows should be arranged not to contaminate drainage systems.

It is recommended that initial commissioning be carried out with water.
The flow rates from the unit are designed for make-up rates. It is therefore suggested that the system is back-filled with due precautions taken to avoid contamination.

Glycol is sometimes subject to bacterial attack and can become slimy as a result. AAON recommend the addition of a suitable biocide. The dosage should be calculated on the amount of water glycol mixture added and not the total tank contents. If bacterial attack occurs on untreated mixtures the unit should be drained, flushed and refilled with fresh mixture and dosed with biocide.

Check that the supply voltage and overload protection is correct.

Guards and covers must not be removed during operation.

The pipework from the system to the expansion vessels should not be insulated.

For systems operating above 200°F (93°C), an anti-gravity loop with a minimum height of 6 feet, (or an intermediate vessel) should be installed to provide thermal protection to the expansion tanks.

The ball float valve is fitted with a low-pressure seat; a high-pressure seat is attached to the float valve and should be fitted if required.

**Pressure Switch Adjustment**

Low system pressure – PS1
High system pressure – PS2
Duty pump control switch – PS3
Standby pump control switch (where fitted) – PS4

For each switch, set the delivery to the required pressure. Then very slowly turn the adjusting screw on the switch until the contacts change.

The high system pressure switch should first be set higher than the required pressure by turning the screw clockwise and the setting then made by turning the screw counter-clockwise until the switch contacts changeover.

The other switches should first be set lower than the required pressure by turning the screw counter-clockwise and the setting then made by turning the screw clockwise until the switch contacts changeover.

A pipe plug is provided on the outlet to allow connection of a test pump to simulate differing system pressures to check switch settings.

The Ultra versions of the GLA have the capability of controlling duty and standby pumps from a single pressure switch.

**GLA Ultra Settings**

The extra functionality of Ultra units is integral. The only selectable option is Manual or Automatic reset of alarm conditions. DIP switch 1, on the display board should be set to OFF for auto reset (Factory setting), and ON for manual reset. On alarm conditions, the MUTE switch will mute the buzzer. In manual reset mode this MUTEx switch will reset the alarms after the fault condition has been cleared. Other switches change the mode of the printed circuit board for use with other products. For GLA application, all switches except 1 and 7 must be set to OFF.

**Priming the makeup pumps:**

1. Close suction isolating valve.
2. Fill the glycol-mixing tank.
3. Remove the upper vent plug from the makeup pump.
4. Open suction isolation valve until water flows out of this tapping.
5. Close valve and replace plug.
6. Repeat for standby pump (where fitted).
7. Close the system-isolating valve.
8. Open suction isolating valve.
9. Switch on unit, initially both pumps will run. As the pressure reaches the pump control switch threshold, the pumps will switch off.
10. Check all piping for leaks following shipping.
11. Crack open system valve. The pressure will fall and the pump will start and maintain pressure.

**Powered agitation (Ultra model only):**
A solenoid valve is fitted to provide powered agitation of the mixture. Automatically this valve is periodically opened and the duty pump starts creating circulation through the pump and mixing tank. Automatic mixing is inhibited when there is a system demand for make-up.
A switch is provided for manual agitation when adding glycol to the mixing tank.

**Topping up with glycol:**
The mixing tank is calibrated in liters and US gallons. The normal top up level is 53 US gallons (200 liters).
1. Calculate the amount of water needed and add or drain to the correct level.
2. Add the required amount of glycol.
3. Operate the manual-agitating switch.
4. Check the mixture percentage.
The unit is now ready for service.

**Flo-Trex Combination Valve**

**Introduction**
The Flo-Trex combination valves are designed for installation on the discharge side of centrifugal pumps, and incorporate three functions in one valve:

1. Drip-tight shut-off valve
2. Spring closure design, Non-slam check valve
3. Flow throttling valve

**Armgrp Flange Adapter Installation**
1. Position the two halves of the Armgrp flange adapter on the valve body ensuring that the lugs on each half of the flange adapters are located between the anti-rotation lugs on the valve body (as shown).

[Image of flange adapter installation]

Insert two bolts of specified size (Table A1) to secure the halves of the flange adapter to the valve body (as shown).
Table A1. Armgrip Flange Adapter Details

<table>
<thead>
<tr>
<th>Valve Size</th>
<th>125 psi/150 psi</th>
<th>250 psi/300 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ductile Iron Bolt</td>
<td>Ductile Iron Bolt</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>Size</td>
</tr>
<tr>
<td>2-1/2</td>
<td>4</td>
<td>5/8</td>
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<tr>
<td>3</td>
<td>4</td>
<td>5/8</td>
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<tr>
<td>4</td>
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<td>8</td>
<td>3/4</td>
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<tr>
<td>10</td>
<td>12</td>
<td>7/8</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>7/8</td>
</tr>
</tbody>
</table>

The gasket cavity should face out to the adjoining flange.

2. Lubricate the inner and outer diameter of the gasket with the lubricant provided or a similar non-petroleum based water soluble grease.

3. Press the gasket firmly into the flange cavity ensuring that the sealing lip is pointed outward. When in place, the gasket should not extend beyond the end of the pipe (as shown).

4. Position the adjoining flange or the pipe to the Armgrip flange adapter and install the remaining bolts. The two locking bolts should be tightened first in order to position the flange correctly.

Note: Care should be taken to ensure that the gasket is not pinched or bent between flanges.

5. Tighten remaining nuts evenly by following bolting instructions, so that the flange faces remain parallel (as shown in the figure labeled Recommended Bolt Tightening Procedure). Flange bolts should be tightened to 70 ft-lbs torque minimum to assure firm metal to metal contact. When raised face flanges are sued, there will be a gap between the faces of the outer diameter.

6. Flange gaskets are not interchangeable with other mechanical pipe couplings or flange gaskets.

---

**Recommended Bolt Tightening Procedure**

**Field Conversion (Straight to Angle Pattern Valve):**

1. Open valve at least one complete turn.
2. Remove the body bolts from valve body using Allen Key
3. Rotate one half of the valve body 180° making sure the lower valve seat and O ring stay in position. Inspect the O ring for any cuts or nicks and replace if necessary.
4. Replace body bolts and torque evenly to 70 ft-lbs.

**Flow Measurement with the valve in the Wide Open position**

Where approximate indication of flow is acceptable the Flo-Trex valve can be used.
Step 1. Measure and record the differential pressure across the valve.

Step 2. With valve in fully open position, locate the differential pressure on the Performance curve, and for the given valve size in use, read the corresponding flow rate.

Flow Measurement with the valve in the throttled position

Step 1. The valve stem with its grooved rings and positioning sleeve is the flow indicator scale for the throttled position of the valve.

The quarter turn graduations on the sleeve, with the scribed line on the stem provide an approximate flow measurement.

Note: The valve is shipped in closed position. The indicator on the plastic sleeve is aligned with the vertical scribed line on the stem.

Step 2. Record the size of the valve and stem position using the flow indicator scale. Calculate the percentage of valve opening based on the number of rings at the fully open position.

<table>
<thead>
<tr>
<th>Valve Size</th>
<th>2-1/2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Rings (valve fully open)</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>18</td>
<td>28</td>
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</tbody>
</table>

Step 3. Measure and record the differential pressure across the valve in the throttled position.

Step 4. Locate percentage of valve opening on the flow characteristic curve. For the given valve, record the percentage of maximum flow rate.

Step 5. Locate the differential pressure determined for the valve in the throttled position on the Flo-Trex Performance Curve. Determine the flow rate for the given valve size at this differential pressure.

Step 6. Calculate the flow rate of the valve in the throttled position by multiplying the flow rate (Step 5) by the percentage of maximum flow rate (Step 4).

Example:
Valve size: 4 in.
Differential pressure is 5.4 ft
Number of open rings is 3.

From the table, the number of rings for the 4 in valve fully open is 6.

Divide open rings by total, $\frac{3}{6} = 50\%$ throttled.

From the Flo-Trex performance curve, a 4 in. valve with 5.4 ft of pressure drop represents a flow of 400 USgpm.
From the flow characteristic curve, a 4 inch valve at 50% open represents 34% of maximum flow.

The approximate flow of a 4 inch valve with a 5.4 ft pressure drop when 50% throttled is:

\[
\frac{(400 \times 34)}{100} = 136 \text{ USgpm}
\]

\[
\frac{(25.2 \times 34)}{100} = 8.57 \text{ L/s}
\]

Note: To prevent premature valve failure it is not recommended that the valve operate in the throttled position with more than 25 ft pressure differential. Instead the pump impeller should be trimmed or valves located elsewhere in the system to partially throttle the flow.

Operation
To assure tight shut-off, the valve must be closed using a wrench with 25 to 30 ft-lbs of torque.

To assure trouble free check valve operation and shut-off operation, the valve should be periodically opened and closed to keep valve seat and valve disc guide stem free of buildup of system contaminants.

Repacking of Flo-Trex valve under full system pressure
If it is necessary, the stem O ring can be changed under full system pressure.

Step 2. Turn the valve stem counterclockwise until the valve is fully open and will not turn any further. Torque to a maximum of 45 ft-lbs. This will ensure good metal to metal contact and minimal leakage.

Step 3. The valve bonnet may now be removed. There may be a slight leakage, as the metal to metal backseating does not provide a drip-tight seal.

Step 4. Clean exposed portion of valve stem being careful not to leave scratches.

Step 5. Remove and replace the O ring gasket.

Step 6. Install the valve bonnet.

Step 7. Tightening the valve bonnet is necessary to stop any leaks.

Step 8. Open valve to balance set point as recorded in Step 1.

Note: On valve sizes of 2-1/2 inch and 3 inch, the full open position is 5 turns, though the valve will open to 5-1/2 turns which is just back of seating of valve.

Seat Replacement
Step 1. Drain the system and remove valve from piping.

Step 2. Remove the body bolts from the body using an Allen Key.

Step 3. Remove seat and O Ring. O rings are not used on valves of 8 inches or larger.

Step 4. Inspect and clean O ring cavity and install new O ring and seat. Valve disc stem should be inspected and replaced if worn. Valve stem O ring should be replaced at this time as discussed under Repacking of Flo-Trex section.
Pressure-Temperature Limits

Flo-Trex Cross Section

1. Body Main
2. Eye Bolt
3. Shaft
4. Spring
5. Spacer
6. Disc
7. Seat
8. O ring body
9. Body Suction
10. Capscrew
12. O ring
13. Bonnet
14. Sleeve
# LL Series Startup Form

<table>
<thead>
<tr>
<th>Job Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
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<table>
<thead>
<tr>
<th>Model Number:</th>
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<th>Serial Number:</th>
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<th>Startup Contractor:</th>
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<tr>
<th>Phone:</th>
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## Pre Startup Checklist

Installing contractor should verify the following items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there any visible shipping damage?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is the unit level?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are the unit clearances adequate for service and operation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Do all access doors open freely and are the handles operational?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Have all shipping braces been removed?</td>
<td></td>
<td></td>
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<tr>
<td>6. Have all electrical connections been tested for tightness?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Does the electrical service correspond to the unit nameplate?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. On 208/230V units, has transformer tap been checked?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Has overcurrent protection been installed to match the unit nameplate requirement?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>10. Have all set screws on the fans been tightened?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>11. Do all fans rotate freely?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>12. Does the field water piping to the unit appear to be correct per design parameters?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

## Ambient Temperature

<table>
<thead>
<tr>
<th>Ambient Dry Bulb Temperature</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Ambient Wet Bulb Temperature</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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### Water/Glycol System

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<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the entire system been flushed and pressure checked?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have isolation valves to the chiller been installed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have isolation valves to the boiler been installed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the entire system been filled with fluid?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has air been bled from the heat exchangers and piping?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there a minimum load of 50% of the design load?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the water piping been insulated?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the glycol the proper type and concentration (N/A if water)?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the freeze point of the glycol (N/A if water)?</td>
<td></td>
</tr>
</tbody>
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### Chiller Configuration

<table>
<thead>
<tr>
<th>Feature</th>
<th>Status</th>
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<tbody>
<tr>
<td>Air-Cooled Condenser</td>
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<td>Low Ambient Control</td>
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<tr>
<td>No Water Leaks</td>
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<tr>
<td>Chilled Water In Temperature</td>
<td>______ °F</td>
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<tr>
<td>Chilled Water Out Temperature</td>
<td>______ °F</td>
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<tr>
<td>Evaporative-Cooled Condenser</td>
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<tr>
<td>Condenser Safety Check</td>
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<tr>
<td>Water Flow</td>
<td>______ gpm</td>
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### Boiler Configuration

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<tbody>
<tr>
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<td>______ gpm</td>
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<td>Boiler Safety Check</td>
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<tr>
<td>Boiler Building Water Flow</td>
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## Compressors/DX Cooling

**Check Rotation**

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<tr>
<th>Number</th>
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<th>L2</th>
<th>L3</th>
<th>Head Pressure PSIG</th>
<th>Suction Pressure PSIG</th>
<th>Crankcase Heater Amps</th>
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### Refrigeration System 1 - Cooling Mode

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### Condenser Pumps

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### Pumping Package

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### Boilers

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</table>
**Maintenance Log**
This log must be kept with the unit. It is the responsibility of the owner and/or maintenance/service contractor to document any service, repair or adjustments. AAON Service and Warranty Departments are available to advise and provide phone help for proper operation and replacement parts. The responsibility for proper start-up, maintenance and servicing of the equipment falls to the owner and qualified licensed technician.

<table>
<thead>
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Literature Change History

**June 2010**
Revision of the IOM adding PVC and CPVC piping Caution.

**November 2010**
Revision of the IOM changing the recommended superheat values to 10-15°F and adding a note that superheat on tandem compressors should be measured with only one compressor in the tandem running.

**August 2011**
Revision of the IOM adding information about the variable capacity oil-free magnetic bearing centrifugal compressor option, specifying that electronic expansion valves are available, and adding the electronic startup form.

**November 2011**
Revision of the IOM adding information about the variable capacity VFD controlled scroll compressor options.

**March 2012**
Revision of the IOM correcting the minimum inlet gas pressure for the 500 MBH boiler to 5” w.c and the 750, 1000, and 1500 MBH boiler to 7” w.c.

**April 2012**
Revision of the IOM adding the index of tables and figures and updating the table of contents.

**June 2012**
Revision of the IOM adding the caution about POE and PVE refrigeration system lubricants.

**November 2012**
Update of the IOM adding information about compressor cycling.

**July 2013**
Update of the format of the Feature String Nomenclature and revision of the left warning on cover.

**October 2013**
Added cautions calling for the need to seal water, electrical, and gas entries into the unit.
LL Series
Installation, Operation & Maintenance
R10100 · Rev. B · 140226

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