If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

**WARNING**

QUALIFIED INSTALLER

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Installation and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

**WARNING**

FOR YOUR SAFETY

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
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AAON CF Series Features and Options Introduction

Energy Efficiency
• Two-Stage, 10-100% Variable Capacity, or Tandem R-410A Scroll Compressors
• Air-Source Heat Pump
• VFD Controlled, ECM Driven, and ECM Low Sound Condenser Fans

Humidity Control
• Modulating Hot Gas Reheat
• Makeup Air Applications up to 100% Outside Air

Safety
• Phase and Brownout Protection
• Single Point Non-Fused Disconnect Power Switch
• Automatic Low Pressure and Manual Reset High Pressure Safety Cut-outs
• Adjustable Compressor Lockout

Installation and Maintenance
• Isolated Controls and Compressor Compartment
• Access Doors with Full Length Stainless Steel Piano Hinges
• Molded Lockable Handles
• Color-Coded Wiring Diagrams
• Run Test Report and Installation Manual Included in Controls Compartment
• Factory Installed Convenience Outlet
• Service Access Lights
• Remote Start/Stop Terminals
• Liquid Line Sight Glass
• Compressor Isolation Valves

System Integration
• Complete Split System with AAON DX Air Handling Units
• Remote Air-Cooled Condenser Option
• Labeled Split System Piping Stub Outs with Shut-Off Valves
• Flooded Condenser 0°F Low Ambient Controls
• Terminal Block for Thermostat with Isolation Relays
• Constant Air Volume (CAV), Makeup Air (MUA), Variable Air Volume (VAV), and Single Zone Variable Air Volume (SZ VAV)

Environmentally Friendly
• R-410A Refrigerant

Extended Life
• Optional 5 Year Compressor Warranty
• G90 Galvanized Steel Construction
• 2,500 Hour Salt Spray Tested Exterior Corrosion Protection
• 10,000 Hour Salt Spray Tested Polymer E-Coated Condenser Coils
• Copper Fin and Stainless Steel Casing Coils
• Condenser Coil Guards
• Custom Color Paint Options
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.

- 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

ELECTRIC SHOCK

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

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.
\section*{\textbf{WARNING}}
\textbf{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.

\section*{\textbf{WARNING}}
\textbf{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.

\section*{\textbf{WARNING}}
\textbf{LIVE ELECTRICAL}
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.

\section*{\textbf{WARNING}}
\textbf{ROTATING COMPONENTS}
Unit contains fans with moving parts that can cause serious injury. Do not remove grill containing fans until the power to the unit has been disconnected and fan has stopped rotating.

\section*{\textbf{WARNING}}
\textbf{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.
<table>
<thead>
<tr>
<th>CAUTION</th>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VARIABLE FREQUENCY DRIVES</strong></td>
<td><strong>DOOR LATCHES</strong></td>
</tr>
<tr>
<td>Electric motor over-current protection and overload protection may be a function of the Variable Frequency Drive to which the motors are wired. 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.</td>
<td>Door compartments containing hazardous voltage or rotating parts are equipped with door latches that allow locks. Door latches are shipped with a nut and bolt requiring tooled access. If the shipping hardware is not replaced with a pad lock, always re-install the nut and bolt after closing the door to maintain tooled access.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3-PHASE ROTATION</strong></td>
<td><strong>LEAK TESTING</strong></td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT HANDLING</strong></td>
<td><strong>PVC PIPING</strong></td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>
ENCLOSED AREA
Do not work in an enclosed area where refrigerant or nitrogen gases may be leaking. A sufficient quantity of vapors may be present and cause injury or death.

CAUTION
COMPRESSOR LUBRICANT
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
COIL CLEANERS
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.

CAUTION
COIL CLEANERS
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.

WARNING
COIL CLEANING
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
ENCLOSED AREA
Do not work in an enclosed area where refrigerant or nitrogen gases may be leaking. A sufficient quantity of vapors may be present and cause injury or death.

WARNING
CONVENIENCE OUTLETS
Factory installed convenience outlets are not intended for use while the unit is operating.
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. 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 purchased.

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

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

---

**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.
CF Series Feature String Nomenclature

Model Options

<table>
<thead>
<tr>
<th>GEN</th>
<th>NIREV</th>
<th>SIZE</th>
<th>SERIES</th>
<th>MNREV</th>
<th>VLT</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF</td>
<td>015</td>
<td>B</td>
<td>A</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>E</td>
<td>0</td>
<td>C</td>
<td>0</td>
</tr>
</tbody>
</table>

A1: Compressor Style
0 = Air-Cooled Condenser - No Compressors
A = R-410A Scroll Compressors
B = R-410A Two Step Capacity Scroll Compressors
D = R-410A Variable Capacity Scroll Compressors
G = R-410A Tandem Variable Capacity Scroll Compressors
P = Air-Cooled Condenser - No Compressors
Q = Air-Cooled Condenser - No Compressors

A2: Condenser Style
C = Air-Cooled Condenser
J = Air-Source Heat Pump

A3: Configuration
0 = Standard

A4: Coating
0 = Standard
E = Polymer E-Coated Condenser Coil
G = Copper Fin + Stainless Steel Casing - Condenser Coil

A5: Staging
0 = No Cooling
G = 1 On/Off Refrigeration System
H = 1 Variable Capacity Refrigeration System
J = 2 On/Off Refrigeration Systems
K = 1 Variable Capacity Refrigeration System + 1 On/Off Refrigeration System
L = 2 Variable Capacity Refrigeration System
R = 4 On/Off Refrigeration Systems
T = 2 Variable Capacity Refrigeration Systems + 2 On/Off Refrigeration Systems
U = 4 Variable Capacity Refrigeration Systems
## CF Series Feature String Nomenclature

### Model Options : Unit Feature Options

| CF | A | 015 | B | A | 3 | D | C | 0 | K | 0 | A | 0 | C0 | AN0 | B | DE | 0 | 0 | A | 0 | E | 0 | 0 | 0 | 0 | 0 | 0 | D | B |

### UNIT FEATURE OPTIONS

#### 1: Unit Orientation

- **0**: Vertical Condenser Discharge - Standard Access
- **A**: Horizontal Condenser Discharge - Standard Access

#### 2A: Refrigeration Control

- **0**: Standard
- **A**: 5 Minute Compressor Off Timer + 20 Second Compressor Stage Delay
- **C**: Adjustable Fan Cycling
- **D**: Adjustable Compressor Lockout
- **G**: Option A + Adjustable Fan Cycling
- **H**: Option A + Adjustable Compressor Lockout
- **M**: Adjustable Fan Cycling + Adjustable Compressor Lockout
- **W**: Option A + Adjustable Fan Cycling + Adjustable Compressor Lockout

#### 2B: Blank

- **0**: Standard

#### 3A: Refrigeration Options

- **0**: Standard
- **A**: Hot Gas Bypass Lead Stage [HGB]
- **B**: HGB Lead + HGB Lag
- **D**: Hot Gas Bypass Non-Variable Capacity Refrigeration Systems [HGBNV]
- **E**: Modulating Hot Gas Reheat [MHGR]
- **H**: HGB + MHGR
- **J**: HGB Lead + HGB Lag + MHGR
- **L**: HGBNV + MHGR

#### 3B: Blank

- **0**: Standard

#### 4: Refrigeration Accessories

- **0**: Standard
- **A**: Sight Glass
- **B**: Compressor Isolation Valves
- **C**: Options A + B
- **D**: Flooded Condenser 0°F Low Ambient Controls – One Circuit
- **E**: Options A + D
- **F**: Options B + D
- **G**: Options A + B + D
- **H**: Flooded Condenser 0°F Low Ambient Controls – Two Circuits
- **J**: Options A + H
- **K**: Options B + H
- **L**: Options A + B + H
- **R**: Flooded Condenser 0°F Low Ambient Controls – Four Circuits
- **S**: Options A + R
- **T**: Options B + R
- **U**: Options A + B + R

#### 5: Blank

- **0**: Standard

#### 6A: Unit Disconnect Type

- **0**: Single Point Power Block
- **A**: Single Point Power Non-Fused Disconnect

#### 6B: Disconnect 1 Size

- **0**: Standard
- **N**: 100 amps
- **R**: 150 amps
- **V**: 250 amps
- **Z**: 400 amps

#### 6C: Blank

- **0**: Standard
CF Series Feature String Nomenclature

Model Options: 

Unit Feature Options:

CF A - 015 - B - 0 - 3 - D C 0 0 K : 0 - A 0 - E 0 - C 0 - A N 0 - B - DC00 - 0 0A0E00

7: Accessories
0 = Standard
B = Phase & Brown Out Protection
D = Suction Pressure Transducer on Each Refrigeration Circuit
E = Compressor Sound Blanket
L = Options B + D
M = Options B + E
Q = Options D + E
1 = Options B + D + E

8A: Control Sequence
A = Terminal Block for Thermostat w/ Isolation Relays
D = VAV Unit Controller - VAV Cool + CAV Heat
E = CAV Unit Controller
F = Makeup Air Unit Controller - CAV Cool + CAV Heat
H = Constant Volume HP Unit Controller - CAV Cool + CAV Heat
J = Makeup Air HP Unit Controller - CAV Cool + CAV Heat
N = Field Installed DDC Controls by Others with Isolation Relays

8B: Control Suppliers
0 = Standard
E = Orion VCC-X (Main Controller in Air Handling Unit)
H = AAON Touchscreen Controller (Main Controller in Air Handling Unit)

8C: Control Supplier Options
0 = Standard

8D: BMS Connection & Diagnostics
0 = Standard

9: Blank
0 = Standard

10: Blank
0 = Standard

11: Maintenance Accessories
0 = Standard
A = Factory Wired 115VAC Convenience Outlet
B = Field Wired 115VAC Convenience Outlet
C = Service Lights
E = Remote Unit Start/Stop Terminals
F = Options A + C
H = Options A + E
J = Options B + C
L = Options B + E
N = Options C + E
R = Options A + C + E
U = Options B + C + E

12: Code Options
0 = Standard ETL USA Listing
B = ETL USA + Canada Listing

13: Air-Cooled Condenser Accessories
0 = Standard
A = Condenser Coil Guard
C = ECM Condenser Fan Head Pressure Control
E = VFD Condenser Fan Head Pressure Control
G = Options A + C
J = Options A + E
N = ECM Condenser Fan Head Pressure Control + Low Sound Condenser Fan
S = Options A + N

14: Blank
0 = Standard

15: Blank
0 = Standard

16: Electrical Options
0 = Standard

17: Shipping Options
0 = Standard
A = Crating
B = Export Crating
CF Series Feature String Nomenclature

Model Options : Unit Feature Options

| GEN | MREV | SIZE | SERIES | MREV | VLT | A1 | A2 | A3 | A4 | A5 | 1 | 2A | 2B | 3A | 3B | 4 | 5 | 6A | 6B | 6C | 7 | 8A | 8B | 8C | 8D | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| CF  | A    | -015 | -B     | -A     | -3  | -D | C  | 0  | 0  | K  | :  | 0  | -A | 0  | -E | 0  | -C | 0  | -A | N  | 0  | -B | -D | E | 0 | 0 | 0  | 0  | 0 | 0 | 0 | D | B |

**18: Blank**
0 = Standard

**19: Blank**
0 = Standard

**20: Cabinet Material**
0 = Galvanized Steel Cabinet

**21: Warranty**
0 = Standard
D = Compressor Warranty - Years 2-5

**22: Type**
B = Premium AAON Gray Paint Exterior
E = Premium AAON Gray Paint Ext + Shrink Wrap
X = SPA + Premium AAON Gray Paint Exterior
1 = SPA + Premium AAON Gray Paint Exterior + Shrink Wrap
General Information

AAON CF Series air-cooled condensers and condensing units have been designed for outdoor use only. They are factory assembled, wired, charged, and run-tested.

Codes and Ordinances

CF 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 CF Series units must conform to the ICC standards of the International Mechanical Code, the International Building Code, and local building, plumbing and electrical 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.

If repairs must be made to damaged goods, then the factory should be notified before any repair action is taken in order to protect the warranty. Certain equipment alteration, repair, and manipulation of equipment without the manufacturer’s consent may void the product warranty. Contact AAON Technical Support for assistance with handling damaged goods, repairs, and freight claims: (918) 382-6450.
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.

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

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 if liquid enters the compressor when power is restored.

Before unit operation, the main power switch must be turned on for at least twenty-four 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.

Always control the system from the control panel, never at the main power supply (except for emergency or for complete shutdown of the system).

CAUTION
3-PHASE ROTATION
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.

CAUTION
CLEAN AIR ACT
The Clean Air Act of 1990 bans the intentional venting of refrigerant as of July 1, 1992. Approved methods of recovery, recycling, or reclaiming must be followed.

CAUTION
CRANKCASE HEATER OPERATION
Units are 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.
The standard 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 variable capacity compressors must be on a minimum of 3 minutes and off for a minimum of 3 minutes. The cycle rate must be no more than 6 starts per hour.

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

Wiring Diagrams
A complete set of unit specific wiring diagram in point-to-point form is 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 condensing unit. This includes reading and recording suction pressures and checking for normal subcooling and superheat.

CAUTION
COMPRESSOR ROTATION
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.

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.
Installation

Forklifting the Unit
CF Series condensing unit sizes 2-25 & 30 tons can be lifted using a forklift. 2-7 ton units must have forks at least 48” in length. 9-25 & 30 ton units must have forks 72” in length, or the forks must have 72” fork extensions. Standard units can be lifted from all sides except the condenser coil side. CF Series condensing unit sizes 26 & 31-70 tons cannot be lifted using a forklift. They can be lifted as shown in Figure 3.

Forks must be perpendicular to the unit and they must be in far enough that the back of the forks are no more than 6” away from the edge of the unit.

Figure 1 - Forklifting a CF Series A Cabinet

Figure 2 - Forklifting a CF Series B and C Cabinet
Lifting the Unit
If cables or chains are used to hoist the unit they must be the same length. Minimum cable length is 99” for CF Series 9-70 ton units. CF Series 2-7 ton units do not include factory installed lifting lugs and should be lifted by forklift only. Care should be taken to prevent damage to the cabinet, coils, and condenser fans.

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. Care should be taken to protect the coil fins from damage due to vandalism or other causes.

The first clearance table below gives the clearance values for proper unit operation. The second clearance table gives the clearance necessary for removing the coil without disassembling a large part of the condensing unit. For ease of removing the condenser coil, use the second table clearances for the right hand side of the unit.

Table 1 – Clearances for Proper Operation

<table>
<thead>
<tr>
<th>Location</th>
<th>Unit Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front - (Controls Side)</td>
<td>2-7 tons</td>
</tr>
<tr>
<td></td>
<td>9-70 tons</td>
</tr>
<tr>
<td>Left Side</td>
<td>6”</td>
</tr>
<tr>
<td></td>
<td>30”</td>
</tr>
<tr>
<td>Right Side</td>
<td>6”</td>
</tr>
<tr>
<td></td>
<td>36”</td>
</tr>
<tr>
<td>Top</td>
<td>3”</td>
</tr>
<tr>
<td></td>
<td>Unobstructed</td>
</tr>
<tr>
<td>Back</td>
<td>18”</td>
</tr>
<tr>
<td></td>
<td>6”</td>
</tr>
</tbody>
</table>

Table 2 – Clearances for Coil Pull

<table>
<thead>
<tr>
<th>Unit Size</th>
<th>Right Hand Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-7 tons</td>
<td>42”</td>
</tr>
<tr>
<td>9-15 tons</td>
<td>42”</td>
</tr>
<tr>
<td>16-25 &amp; 30 tons</td>
<td>54”</td>
</tr>
<tr>
<td>26 &amp; 31-70 tons</td>
<td>66”</td>
</tr>
</tbody>
</table>

Locating the Unit
The CF Series condenser and condensing unit 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. When installed at ground level, a one-piece concrete slab should be used with footings that extend below the frost line. Also with ground level installation, care must be taken to protect the coil fins from damage due to vandalism or other causes.

Figure 3 – Lifting Details and Orientation of a CF Series 9-70 ton Condensing Unit

Figure 4 - Orientation of Series 2-7 ton Condensing Unit
The placement relative to the building air intakes and other structures must be carefully selected. Airflow to and from the condenser or condensing unit must not be restricted to prevent a decrease in performance and efficiency.

The installation position for 9-70 ton units must provide at least 30” of left and right side clearance for proper airflow to the condenser coils. When units are mounted adjacent to each other, the minimum right and left side clearance required between the units is 60” or 5 feet. Similarly, when 2-7 ton units are mounted adjacent to each other, the minimum clearance required between the back side of the units is 36” or 3 feet.

Units should not be installed in an enclosure or pit that is deeper than the height of the unit. When recessed installation is necessary, the clearance to maintain proper airflow is at least 5 feet (3 feet for 2-7 tons).

CF Series condensers and condensing units that have a vertical air discharge must have no obstruction above the equipment. Do not place the unit under an overhang. CF Series condensers and condensing units that have a horizontal discharge must have no obstruction in front of the unit.

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.

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

Access Doors
Access doors are provided to the compressor and electrical compartment.

CF Series condensers and condensing units that have a vertical air discharge must have no obstruction above the equipment. Do not place the unit under an overhang. CF Series condensers and condensing units that have a horizontal discharge must have no obstruction in front of the unit.

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.

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

Access Doors
Access doors are provided to the compressor and electrical compartment.

CAUTION

PVC PIPING
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.

Standard Evacuation Instructions:
Proper system evacuation is critical to remove moisture and non-condensables from the system before charging the system with refrigerant. A newly installed AAON condensing unit has already been evacuated and charged with some refrigerant at the factory. When evacuating a new system, keep the condensing unit service valves closed and evacuate the suction and liquid lines and the air handling unit. If the entire system must be evacuated, use the following procedure to ensure the entire system is pulled into a good vacuum.

1. System evacuation should be performed anytime a system is open to atmospheric pressure. The POE oils used with R-410A are extremely hydroscopic in nature and immediately begin pulling in moisture once the system is opened to the atmosphere.

2. Before starting to evacuate the system, you MUST ensure that there are no leaks by pressurizing the system with
400 psig of dry nitrogen and verifying no pressure loss after one hour.

3. Four valve manifold gauge sets are more effective than standard manifold gauge sets due to the extra hose port in combination with a 3/8” evacuation port. The larger diameter evacuation port will expedite system evacuation.

4. The manifold set should be connected to the condensing unit with one hose on the suction line service valve, one hose on the liquid line service valve and if an extra Schrader valve is field installed on the suction line, connect a third hose (not shown). The vacuum pump should be connected to the manifold set using a 3/8” vacuum rated hose. Figure 5 shows two circuits. Both circuits must be evacuated separately.

5. An accurate micron gauge must be used and checked by pulling a vacuum on the gauge by itself and verify a rapid drop to less than 100 microns within a few minutes.

6. The micron gauge should not be attached to the system until the gauge manifold is reading 28” of vacuum to ensure the micron gauge does not see pressure and is thus damaged. MICRON GAUGES WILL BE DAMAGED BY PRESSURE!!!

7. It is a good practice to replace the vacuum pump oil after one hour of the evacuation process. The oil can be broken down in the pump in the initial first hour causing system evacuation to take longer than it should.

8. The minimum micron level required by AAON is 350 microns for systems using POE oils.

9. The system should then be isolated and the pump turned off to check for vacuum rise due to leaks or moisture in the system. The micron gauge should not rise above 500 microns after 30 minutes of wait time.

Low Ambient & Modulating Reheat System Evacuation Instructions:
Proper system evacuation is critical to remove moisture and non-condensables from the system before charging the system with refrigerant. Systems with low ambient flooded condenser option require the following procedure to ensure the entire system is pulled into a good vacuum.

1. System evacuation should be performed anytime a system is open to atmospheric pressure. The POE oils used with R-410A are extremely hydroscopic in nature and immediately begin pulling in moisture once the system is opened to the atmosphere.

2. Open the reheat valve to 50% when evacuating.

3. Before starting to evacuate the system, you MUST ensure that there are no leaks by pressurizing the system with
400 psig of dry nitrogen and verifying no pressure loss after one hour.

4. Four valve manifold gauge sets are more effective than standard manifold gauge sets due to the extra hose port in combination with a 3/8” evacuation port. The larger diameter evacuation port will expedite system evacuation.

5. The manifold set should be connected to the condensing unit with one hose on the suction line service valve, one hose on the liquid line service valve and a third hose on the reheat line service valve. The vacuum pump should be connected to the manifold set using a 3/8” vacuum rated hose. Figure 6 shows two circuits. The first circuit has a reheat line, the second circuit is just the suction and liquid line. Both circuits must be evacuated separately.

6. FAILURE to connect to the liquid line service valve will result in the receiver tank not being fully evacuated and most likely lead to non-condensables in the system.

7. An accurate micron gauge must be used and checked by pulling a vacuum on the gauge by itself and verify a rapid drop to less than 100 microns within a few minutes.

8. The micron gauge should not be attached to the system until the gauge manifold is reading 28” of vacuum to ensure the micron gauge does not see pressure and is thus damaged. MICRON GAUGES WILL BE DAMAGED BY PRESSURE!!!

9. It is a good practice to replace the vacuum pump oil after one hour of the evacuation process. The oil can be broken down in the pump in the initial first hour causing system evacuation to take longer than it should.

10. The minimum micron level required by AAON is 350 microns for systems using POE oils.

11. The system should then be isolated and the pump turned off to check for vacuum rise due to leaks or moisture in the system. The micron gauge should not rise above 500 microns after 30 minutes of wait time.

**Adjusting Refrigerant Charge**

All AAON CF Series condensers and condensing units are shipped with a factory holding charge. The factory charge is different depending on the unit size and system (heat pump, modulating hot gas reheat, LAC). The factory charge per circuit is shown on the unit nameplate. Adjusting the charge of the system will be required during installation.
Adjusting the charge of a system in the field must be based on determination of liquid subcooling and evaporator superheat. On a system with a thermostatic expansion valve liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

Units equipped with hot gas reheat must be charged with the hot gas valve closed while the unit is in cooling mode. After charging, unit should be operated in reheat (dehumidification) mode to check for correct operation.

Units equipped with heat pump options should be charged in cooling mode to get the proper charge. After charging, unit should be operated in heating mode to check for correct charge. Charge may need to be adjusted for heating mode. If adjustments are made in the heating mode, cooling mode must be rerun to verify proper operation.

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 3 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.

**Check the Liquid Sub-cooling**

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 Table 3 for the appropriate unit type and options.

Table 3 - Acceptable Refrigeration Circuit Values

<table>
<thead>
<tr>
<th></th>
<th>Cooling Mode Liquid Sub-Cooling Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Only Unit</td>
<td>8-15°F</td>
</tr>
<tr>
<td>Cooling Only Unit with Hot Gas Reheat$^{1,4}$</td>
<td>5-15°F</td>
</tr>
<tr>
<td>Heat Pump Unit</td>
<td>2-4°F</td>
</tr>
<tr>
<td>Heat Pump Unit with Hot Gas Reheat$^{3,4}$</td>
<td>2-6°F</td>
</tr>
<tr>
<td>Cooling Only Unit with LAC$^{4}$</td>
<td>8-15°F</td>
</tr>
<tr>
<td>Cooling Only Unit with Hot Gas Reheat &amp; LAC$^{4}$</td>
<td>8-15°F</td>
</tr>
</tbody>
</table>

Notes:
1. Must be charged with the hot gas valve closed. After charging, unit should be operated in reheat (dehumidification) mode to check for correct operation.
2. The sub-cooling value in this table is for the unit running in cooling mode of operation. After charging, unit should be operated in heating mode to check for correct operation.
3. The sub-cooling value in this table is for the unit running in cooling mode of operation and the hot gas valve closed. After charging, unit should be operated in reheat (dehumidification) mode to check for correct operation and then in heating mode to check for correct operation.
4. Sub-cooling must be increased by 1°F per 10 feet of vertical liquid line rise for R-410A (AHU above CU). For example, a cooling only unit with hot gas reheat and a vertical liquid rise of 30 ft must charge to a sub-cooling value of at least 8-15°F. DO NOT OVERCHARGE. Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

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 compressors, it is critical that the suction superheat setpoint on the TXV 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 the acceptable cooling mode superheat values of 8-15°F for all system types. Superheat will increase with long suction line runs.
Adjusting Sub-cooling and Superheat Temperatures

The system is overcharged if the sub-cooling temperature is too high compared to Table 3 and the evaporator is fully loaded (low loads on the evaporator result in increased sub-cooling) and the evaporator superheat is within the temperature range of 8-15°F (high superheat results in increased sub-cooling).

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

---

**CAUTION**

EXPANSION VALVE ADJUSTMENT

Thermal expansion valves must be adjusted to approximately 8-15°F of suction superheat. Failure to have sufficient superheat will damage the compressor and void the warranty.

---

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 TXV 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:

If the ambient is **above** 70°F, charge to approximately 1-2°F of sub-cooling measured at the inlet to the expansion valve. Once enough charge has been added to get the evaporator superheat and sub-cooling values to the correct setting, more charge must be added. Use Table 4 to find the additional charge amount required for the system when running in cold ambient conditions.

**Table 4 – Charge to Flood Condenser Coil for Ambient Above 70°F**

<table>
<thead>
<tr>
<th>CF Size</th>
<th># of circuits</th>
<th>Per Circuit Charge (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF 2, 3</td>
<td>1</td>
<td>4.9</td>
</tr>
<tr>
<td>CF 4, 5, 6, 7</td>
<td>1</td>
<td>9.2</td>
</tr>
<tr>
<td>CF 9, 11</td>
<td>2</td>
<td>9.1</td>
</tr>
<tr>
<td>CF 13, 15</td>
<td>2</td>
<td>12.1</td>
</tr>
<tr>
<td>CF 16, 18</td>
<td>2</td>
<td>13.1</td>
</tr>
<tr>
<td>CF 20, 25, 30</td>
<td>2</td>
<td>17.5</td>
</tr>
<tr>
<td>CF 26, 31, 40</td>
<td>2, 4</td>
<td>18.0, 9.1</td>
</tr>
<tr>
<td>CF 50, 60, 70</td>
<td>2, 4</td>
<td>43.8, 22.1</td>
</tr>
</tbody>
</table>

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

1. If the ambient is **below** 70°F, charge to approximately 1-2°F of sub-cooling measured at the inlet to the expansion valve. 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. Ambient temperatures above 0°F will require a percentage of the per circuit charge values from Table 4. Using your ambient temperature, find the percentage value from Table 5, and multiply the Per Circuit Charge value from Table 4 and the % value to determine the additional charge amount.

**Table 5 – % Charge to Flood Condenser Coil for Ambient Below 70°F**

<table>
<thead>
<tr>
<th>Condenser Ambient Temperature °F</th>
<th>Percentage Per Circuit Charge from Table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>60%</td>
</tr>
<tr>
<td>50</td>
<td>37%</td>
</tr>
<tr>
<td>40</td>
<td>24%</td>
</tr>
<tr>
<td>30</td>
<td>15%</td>
</tr>
<tr>
<td>20</td>
<td>8%</td>
</tr>
<tr>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

2. The unit should be checked for proper operation once the ambient temperature is above 80°F.

Example: A CF size 31 with **tandem compressors** where the ambient temperature is 40°F

From Table 4 – 18 lbs refrigerant charge per circuit (tandem compressors would have 2 circuits in this size of CF).

From Table 5 – 24% of Table 4 charge Additional charge needed for a unit with low ambient flooded condenser controls = 18 lbs * 0.24 = 4.32 lbs additional refrigerant charge per circuit.
Low Ambient Operation
During low ambient temperatures, the vapor refrigerant will migrate to the cold part of the system and condense into liquid. All CF Series compressors are provided with factory installed crankcase heaters to help prevent liquid refrigerant from slugging the compressors during startup in low ambient conditions. The condenser or condensing unit must have continuous power 24 hours prior to startup. This ensures the compressor will receive sufficient refrigerant vapor at startup. Standard units can operate down to 55°F ambient temperature.

AAON condenser fan head pressure control units can operate down to 35°F ambient temperature. Three different condenser fan head pressure control options available are adjustable fan cycling, ECM condenser fan, or VFD controlled condenser fans. See detailed information following.

The AAON low ambient (condenser flood-back) system is used to operate a refrigerant system down to 0°F outside air temperature. See detailed information following.

Fan Cycling Low Ambient
Adjustable fan cycling is a low ambient head pressure control option that cycles the condenser fans to maintain refrigerant circuit head pressures at acceptable levels during cooling operation. The head pressure set point (100-470 psi) and pressure differential (35-200 psi) can be field adjusted using a flathead screwdriver. For example, if the head pressure is set to 300psi, and the differential is set to 100psi, then fans will cut in at 300psi and cut out at 200psi. Fan cycling and variable speed condenser fan head pressure control options allow mechanical cooling with ambient temperatures down to 35°F.

Figure 7 - Adjustable Fan Cycling Switch

Variable Speed Low Ambient
Variable speed condenser fan head pressure control is a low ambient head pressure control option that sends a variable signal in relation to the refrigerant circuit head pressure of the system to an electronically commutated motor (ECM) or VFD. The motor either speeds up or slows down air flow accordingly in order to maintain constant head pressure. Fan cycling and variable speed condenser fan head pressure control options allow mechanical cooling with ambient temperatures down to 35°F.

Flooded Condenser Low Ambient
Flooded condenser low ambient control maintains normal head pressure during periods of low ambient. When the ambient temperature drops, the condensing temperature and therefore pressure drops. Without ambient control, the system would shut down on low discharge pressure. The flooded condenser method of low ambient control fills the condenser coil with liquid refrigerant, decreasing the heat transfer capacity of the coil, which allows the coil to operate at an acceptable discharge pressure.
The condenser coil will not be flooded during summer ambient temperatures, so a receiver is included to store the additional liquid refrigerant required to flood the condenser coil in low ambient. The receiver is factory-sized to contain all of the flooded volume. Without a receiver there would be high head pressures during higher ambient conditions.

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 reduces liquid refrigerant flow from the condenser, reducing its effective surface area, which 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. CF Series condensers and condensing units use an LAC valve for low ambient operation.

**LAC Valve**

The Low Ambient Control (LAC) valve is a non-adjustable three way valve that modulates to maintain receiver pressure. As the receiver pressure drops below the valve setting (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 8 – LAC Piping Example
Refrigerant Piping
(See back of the manual for refrigerant piping diagrams.)

Upon completion of piping connection, the interconnecting piping and air handler MUST BE evacuated to 500 microns or less; leak checked and charged with refrigerant.

Determining Refrigerant Line Size

The piping between the condenser and low side must ensure:

1. Minimum pressure drop, and
2. Continuous oil return, and
3. Prevention of liquid refrigerant slugging, or carryover

Minimizing the refrigerant line size is favorable from an economic perspective, reducing installation costs, and reducing the potential for leakage. However, as pipe diameters decrease, pressure drop increases.

Excessive suction line pressure drop causes loss of compressor capacity and increased power usage resulting in reduced system efficiency. Excessive pressure drops in the liquid line can cause the liquid refrigerant to flash, resulting in faulty TXV operation and improper system performance. In order to operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

General
Piping from the condensing unit to the air handler is the responsibility of the installing contractor.

Use only clean type “ACR” copper tubing that has been joined with high temperature brazing alloy.

The pipe or line sizes must be selected to meet the actual installation conditions and NOT simply based on the connection sizes at the condensing unit or air handler.

All CF Series condensing units are provided with in-line shutoff valves on both the liquid and suction lines. These should remain closed until the system is ready for start-up after installation.

Piping should conform to generally accepted practices and codes.

Care must be taken not to cross the circuits on multiple circuit systems.
**Equivalent Line Length**
All line lengths discussed in this manual, unless specifically stated otherwise, are Equivalent Line Lengths. The frictional pressure drop through valves, fittings, and accessories is determined by establishing the equivalent length of straight pipe of the same diameter. **Always use equivalent line lengths when calculating pressure drop.** Special piping provisions must be taken when lines are up vertical risers or in excessively long line runs. **AAON does not recommend running underground refrigerant lines.**

**Liquid Line**
When sizing the liquid line, it is important to minimize the refrigerant charge to reduce installation costs and improve system reliability. This can be achieved by minimizing the liquid line diameter. However, reducing the pipe diameter will increase the velocity of the liquid refrigerant which increases the frictional pressure drop in the liquid line, and causes other undesirable effects such as noise.

Maintaining the pressure in the liquid line is critical to ensuring sufficient saturation temperature, avoiding flashing upstream of the TXV, and maintaining system efficiency. Pressure losses through the liquid line due to frictional contact, installed accessories, and vertical risers are inevitable. Maintaining adequate sub-cooling at the condenser to overcome these losses is the only method to ensure that liquid refrigerant reaches the TXV.

Liquid refrigerant traveling upwards in a riser loses head pressure. If the evaporator is below the condenser, with the liquid line flowing down, the gravitational force will increase the pressure of the liquid refrigerant. This will allow the refrigerant to withstand greater frictional losses without the occurrence of flashing prior to the TXV.

A moisture-indicating sight glass may be field installed in the liquid line to indicate the occurrence of premature flashing or moisture in the line. The sight glass should not be used to determine if the system is properly charged. **Use temperature and pressure measurements to determine liquid sub-cooling, not the sight glass.**

**Liquid Line Routing**
Care should be taken with vertical risers. When the system is shut down, gravity will pull liquid down the vertical column, and back to the condenser when it is below the evaporator. This could potentially result in compressor flooding. A check valve can be installed in the liquid line where the liquid column rises above the condenser to prevent this. The liquid line is typically pitched along with the suction line, or hot gas line, to minimize the complexity of the configuration.

**Liquid Line Insulation**
In cooling only systems, when the liquid line is routed through regions where temperature losses are expected, no insulation is required, as this may provide additional sub-cooling to the refrigerant. When routing the liquid line through high temperature areas, insulation of the line is appropriate to avoid loss of sub-cooling through heat gain.

In heat pump systems, when the liquid line is routed through regions where temperature losses are expected (all lines exposed to outside air conditions), insulate with a minimum 1 inch thick Armaflex insulation, as this will prevent capacity loss during heating mode of operation.
**Liquid Line Guidelines**

In order to ensure liquid at the TXV, the sum of frictional losses and pressure loss due to vertical rise must not exceed available subcooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature. An additional recommendation is that the sum of frictional losses (including valve losses, filter drier losses, other accessories, and line losses) and pressure loss due to vertical rise should not exceed 8°F if the available subcooling is 10°F.

If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The recommended maximum velocities for liquid lines are 100 fpm from the condenser to a receiver to discourage fluid backup, and 500 fpm from receiver tank to the evaporator (300 fpm if the line includes an electric valve to minimize valve induced liquid hammer).

**Liquid Line Accessories**

Liquid line shut off valves and filter driers are factory provided. The total length equivalent of pressure losses through valves, elbows and fittings must be considered when adding additional components in the field. It is a good practice to utilize the fewest elbows that will allow the mating units to be successfully joined.

A liquid line receiver is factory installed on units with modulating hot gas reheat, units with low ambient control flooded condenser, and units with heat pump.

**Suction Line**

The suction line is more critical than the liquid line from a design and construction standpoint. More care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load.

**Suction Line Routing**

For cooling only systems, pitch the suction line in the direction of flow (about 1 inch per 20 feet of length) to maintain oil flow towards the compressor, and keep it from flooding back into the evaporator.

For heat pump systems, do not pitch lines since they will be flowing in one direction in cooling mode and the opposite direction in heating mode.

Crankcase heaters are provided to keep any condensed refrigerant that collects in the compressor from causing damage or wear. Make sure to provide support to maintain suction line positioning, and insulate completely between the evaporator and condensing unit.

It is important to consider part load operation when sizing suction lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss.

For difficult line routing applications, a double suction riser can be applied to the situation of part load operation with a suction riser. A double suction riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. A double suction riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both
risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where velocity of the refrigerant is sufficient to maintain oil flow. At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load.

![Double Suction Riser Construction](image)

**Figure 9 - Double Suction Riser Construction**

A double riser can also be used for heat pump operation. The specific volume (ft³/lb) of refrigerant at the discharge temperature and pressure (heating mode line conditions) is significantly lower than the specific volume at the suction temperature and pressure (cooling mode line conditions). To compound the issue, the capacity in heating mode is lower than the capacity in cooling mode. The discharge velocity in the riser during heating mode is much lower than the suction velocity during cooling mode. Often, a double riser is necessary to get acceptable velocities for the discharge mode and acceptable velocities for the suction mode. In the example diagrams (See Figure 10 & Figure 11), the cooling mode will use both lines, and the heating mode will use only one.

**Suction Line Traps**

Include a trap immediately after the evaporator coil outlet to protect the TXV bulb from liquid refrigerant.

Include traps every 20 feet in vertical suction riser sections for cooling only systems and every 12 feet for heat pump systems.

**Suction Line Insulation**

The entire suction line should be insulated with a minimum 1 inch thick Armaflex insulation. This prevents condensation from forming on the line, and reduces any potential loss in capacity associated with heat gain placing additional load on the system. This line should still be insulated in heat pump systems even though it acts as both a discharge and suction line.

**Suction Line Guidelines**

For proper performance, suction line velocities less than a 4,000 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter, however, a general guideline of 1,000 fpm minimum may be applied.

When suction flow is up, variable capacity compressors require a minimum velocity of 1,500 fpm at full load.

Tandem compressors must be considered for full load operation (both compressors operating) and at partial load (only one compressor operating). When suction flow is up, and the tandem has a variable capacity compressor, the velocity for only one compressor in operation must be greater than 1,500 fpm. For on/off compressors, the velocity must be greater than the minimum velocity required to return oil.

Heat pump vapor lines must be checked for suction flow (cooling mode operation) and discharge flow (heating mode operation).
The same line must be used for both modes of operation.

In a fashion similar to the liquid line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

For split system piping with long horizontal runs and short vertical risers, a smaller pipe size can be used to provide sufficient velocity to return oil in vertical risers at part loads, and a larger size pipe can be used on the horizontal runs and vertical drop sections. This helps with oil return, yet keeps the pressure drop to a minimum.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUCTION RISER TRAPS</td>
</tr>
</tbody>
</table>
Circuits require suction riser traps every 20 feet. (every 12 feet for heat pumps)

*Suction Line Accessories*

If the job requirements specify suction accumulators, they must be separately purchased and field installed. Heat pump units will include a factory installed suction accumulator.

*Discharge Line*

The discharge line is similar to the suction line from a design and construction standpoint. Care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load.

Pressure loss in the discharge line has less of an impact on capacity than pressure loss in the suction line. Pressure loss in the discharge line causes the compressors to work harder and thus use more power.

*Discharge Line Routing*

For cooling only remote condenser systems, pitch the discharge line in the direction of flow (about 1 inch per 20 feet of length) to maintain oil flow towards the compressor.

In a heat pump system, the field installed suction line is also used as a discharge line in the heating mode of operation so the line must be sized to meet both the suction line conditions in cooling mode and the discharge line conditions in heating mode.

Because it is used in both directions for a heat pump unit, the line should be installed level, not pitched, to facilitate oil return in both modes of operation.

It is important to consider part load operation when sizing discharge lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss.

For difficult line routing applications, a double discharge riser can be applied to the situation of part load operation with a discharge riser. A double discharge riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. A double discharge riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where
velocity of the refrigerant is sufficient to maintain oil flow. At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load. (See the Double Suction Riser Construction Figure 9)

A double riser can also be used for heat pump operation. The specific volume (ft³/lb) of refrigerant at the discharge temperature and pressure (heating mode line conditions) is significantly lower than the specific volume at the suction temperature and pressure (cooling mode line conditions). To compound the issue, the capacity in heating mode is lower than the capacity in cooling mode. The discharge velocity in the riser during heating mode is much lower than the suction velocity during cooling mode. Often, a double riser is necessary to get acceptable velocities for the discharge mode and acceptable velocities for the suction mode. In the example diagrams, the cooling mode will use both lines, and the heating mode will use only one. See the following schematics that illustrate how the double discharge riser can work for heat pump applications.

Figure 10 – Heat Pump Piping Schematic of Cooling Mode in Double Riser

Figure 11 – Heat Pump Piping Schematic of Heating Mode in Double Riser
**Discharge Line Traps**
Include traps every 12 feet in vertical discharge riser sections.

**Discharge Line Insulation**
Although a typical discharge line does not need to be insulated, the suction line does. Since the same line is used for both, the line must be insulated as described in the *Suction Line Insulation* section.

**Discharge Line Guidelines**
For proper performance, discharge line velocities less than a 3,500 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter, however, a general guideline of 900 fpm minimum may be applied.

When discharge flow is up, variable capacity compressors require a minimum velocity of 900 fpm at full load.

Tandem compressors must be considered for full load operation (both compressors operating) and at partial load (only one compressor operating). When discharge flow is up, and the tandem has a variable capacity compressor, the velocity for only one compressor in operation must be greater than 900 fpm. For on/off compressors, the velocity must be greater than the minimum velocity required to return oil.

Heat pump vapor lines must be checked for suction flow (cooling mode operation) and discharge flow (heating mode operation). The same line must be used for both modes of operation.

In a fashion similar to the suction line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

For split system piping with long horizontal runs and short vertical risers, a smaller pipe size can be used to provide sufficient velocity to return oil in vertical risers at part loads, and a larger size pipe can be used on the horizontal runs and vertical drop sections. This helps with oil return, yet keeps the pressure drop to a minimum.

---

**CAUTION**

**DISCHARGE RISER TRAPS**
Circuits require discharge riser traps every 12 feet.

**Hot Gas Bypass Line**
Hot Gas Bypass is available for use with DX systems that may experience low suction pressure during the operating cycle. This may be due to varying load conditions associated with VAV applications or units supplying a large percentage of outside air. The system is designed to divert refrigerant from the compressor discharge to the low pressure side of the system in order to keep the evaporator from freezing and to maintain adequate refrigerant velocity for oil return at minimum load.

Hot discharge gas is redirected to the evaporator inlet via an auxiliary side connector (ASC) to false load the evaporator when reduced suction pressure is sensed. **Field piping between the condensing unit and the evaporator is required.**

**Hot Gas Bypass Piping Considerations**
Pitch the hot gas bypass (HGB) line downward in the direction of refrigerant flow, toward the evaporator.
When installing vertical hot gas bypass lines, an oil drip line must be provided at the lowest point in the system. The oil drip line must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Install a sight glass in the oil drip line for observation. Run an oil return line, using 1/8 inch capillary tube, 10 feet in length, from the hot gas bypass line oil drip line to the suction line. Connect the oil return line below the sight glass and 1 inch above the bottom of the oil drip line.

![Figure 12 – Oil Return Line](image)

**Hot Gas Reheat**
The AAON modulating hot gas reheat system diverts hot discharge gas from the condenser to the air handling unit through the hot gas line. **Field piping between the condensing unit and the air handler is required.**

The line delivers the hot discharge gas to the reheat coil and/or the hot gas bypass valve, so it is sized as a discharge line.

Discharge lines should be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and to minimize efficiency losses associated with friction.

Pitch the hot gas line in the direction of flow for oil return.

When installing vertical hot gas reheat lines, an oil drip line must be provided at the lowest point in the system. The oil drip line must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Run an oil return line, using 1/8 inch capillary tube, 10 feet in length, from the hot gas reheat line oil drip line to the suction line. Connect the oil return line below the sight glass and 1 inch above the bottom of the oil drip line. (See Oil Return Line Figure 12)

Insulate the entire length of the hot gas line with a minimum 1 inch thick Armaflex insulation.

**Hot Gas Bypass Line Guidelines**
Choose a small size line to ensure oil return, and minimize refrigerant charge.

Maintain velocities below a maximum of 3,500 fpm. A general minimum velocity guideline to use is approximately 2,000 fpm.

**Hot Gas Reheat Guidelines**
Maintain velocities below a maximum of 3,500 fpm. A general minimum velocity guideline is 2,000 fpm.
**Electrical**

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

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.

### Table 6 - Nameplate Voltage Markings

<table>
<thead>
<tr>
<th>Voltage Feature</th>
<th>Nameplate Voltage Marking</th>
<th>Min/Max VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 230V/1Φ/60Hz</td>
<td>230</td>
<td>197/252</td>
</tr>
<tr>
<td>2 230V/3Φ/60Hz</td>
<td>230</td>
<td>197/252</td>
</tr>
<tr>
<td>3 460V/3Φ/60Hz</td>
<td>460</td>
<td>456/504</td>
</tr>
<tr>
<td>4 575V/3Φ/60Hz</td>
<td>575</td>
<td>570/630</td>
</tr>
<tr>
<td>8 208V/3Φ/60Hz</td>
<td>208</td>
<td>197/228</td>
</tr>
<tr>
<td>9 208V/1Φ/60Hz</td>
<td>208</td>
<td>197/228</td>
</tr>
</tbody>
</table>

**NOTE:** Units are factory wired for 208V, 230V, 460V, or 575V. In some units, the 208V and 230V options may also be provided in single or three phase configurations. The transformer configuration must be checked by a qualified technician prior to startup.

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.

Three phase voltage imbalance will cause motor overheating and premature failure. The maximum allowable imbalance is 5%.

Voltage imbalance is defined as 100 times the maximum deviation from the average voltage divided by the average voltage.

Example:

\[
\frac{(218V+237V+235V)}{3} = 230V, \text{ then } 100\times\frac{(230V-218V)}{230V} = 5.2\%, \text{ which exceeds the allowable imbalance.}
\]

Check voltage imbalance at the unit disconnect switch and at the compressor terminal. Contact your local power company for line voltage corrections.

---

**CAUTION**

3-PHASE ROTATION

Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. Condenser fan motors should 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.
WARNING

ELECTRIC SHOCK

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

SEALING ELECTRICAL ENTRIES

Installing Contractor is responsible for proper sealing of the electrical entries into the unit. Failure to seal the entries may result in damage to the unit and property.

NOTE: 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.

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.
Startup
(See back of the manual for startup form.)

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTRIC SHOCK</td>
</tr>
<tr>
<td>Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUALIFIED INSTALLER</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

Before startup of the condenser or condensing unit, make 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 unit controller is requesting the unit to start.

Cycle through all the compressors to confirm that all are operating within tolerance.

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

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

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-PHASE ROTATION</td>
</tr>
<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>

Compressor Operation
The compressors must be off for a minimum of 5 minutes and on for a minimum of 5 minutes. Short cycling of the compressors can cause undue stress and wear.
Variable Capacity Compressor Controller

Units with variable capacity scroll compressors may include a variable capacity compressor controller. The following is an explanation of the terminals and troubleshooting of the alert flash codes on the controller. For more information on the compressor controller, see Emerson Climate Bulletin AE8-1328.

Variable Capacity Compressor Controller

The compressor controller modulates the compressor unloader solenoid in an on/off pattern according the capacity demand signal of the system. The following table shows the linear relationship between the demand signal and compressor capacity modulation. The compressor controller also protects the compressor against high discharge temperature. Refer to Table 8 for the relationship between thermistor temperature readings and resistance values.

**Low Voltage Terminals**
- **24COM** Module Common
- **24VAC** Module Power
- **C1** Demand Input -
- **C2** Demand Input +
- **P1** Pressure Common
- **P2** Pressure Input
- **P3** Pressure Power 5VDC
- **P4** Pressure Shield
- **P5** Pressure Output -
- **P6** Pressure Output +
- **T1 & T2** Discharge Temperature Sensor

**High Voltage Terminals**
- **A1 & A2** Alarm Relay Out
- **M1 & M2** Contactor
- **L1** Control Voltage N
- **L2** Control Voltage L
- **U1 & U2** Variable Capacity Unloader Solenoid
- **V1 & V2** Vapor Injection Solenoid

**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.

**Note:** When using field controls any variable capacity compressors should run at 100% for 1 minute when starting.

**WARNING**

**COMPRESSOR CONTROLLER**

To avoid damaging the compressor controller, DO NOT connect wires to terminals C3, C4, T3, T4, T5, or T6.

Figure 13 - Variable Capacity Compressor Controller
Table 7 - Demand Signal vs. Compressor Capacity Modulation

<table>
<thead>
<tr>
<th>Demand Signal (VDC)</th>
<th>Loaded %</th>
<th>Unloaded %</th>
<th>Time Loaded</th>
<th>Time Unloaded</th>
<th>% Compressor Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>0%</td>
</tr>
<tr>
<td>1.44</td>
<td>10%</td>
<td>90%</td>
<td>1.5 sec</td>
<td>13.5 sec</td>
<td>10%</td>
</tr>
<tr>
<td>3.00</td>
<td>50%</td>
<td>50%</td>
<td>7.5 sec</td>
<td>7.5 sec</td>
<td>50%</td>
</tr>
<tr>
<td>4.20</td>
<td>80%</td>
<td>20%</td>
<td>12 sec</td>
<td>3 sec</td>
<td>80%</td>
</tr>
<tr>
<td>5.00</td>
<td>100%</td>
<td>0%</td>
<td>15 sec</td>
<td>0 sec</td>
<td>100%</td>
</tr>
</tbody>
</table>

**LED Descriptions**
- Green LED - 24VAC Power
- Yellow LED - Unloader Solenoid On
- Red LED - ALERT Flash Code
- Flashing Green LED indicates anti-short cycle timer active
- All LEDs flashing at same rate indicates 24VAC supply too low for operation
- All LEDs solid at same time indicates controller failure
- Reset ALERT code or lockout by removing 24VAC supply to module
- All ALERTs close alarm relay contacts
- All ALERTs deenergize contactor and solenoids except Code 6
- Compressor always unloads for 0.1 second at startup
- Compressor only starts when Demand signal input is above 1.45 VDC and no ALERTs are present

**Troubleshooting ALERT Flash Codes**
- Code 1: Reserved for future use
- Code 2: High Discharge Temperature
  - Discharge thermistor above trip set point or thermistor short circuited.
  - Resets after 30 minutes and motor cools down.
  - If 5 events occur within 4 hours, the compressor is locked out.
- Code 3: Compressor Protector Trip
  - No compressor current is detected when compressor should be running.
  - Resets when compressor current is detected.
- Code 4: Locked Rotor
  - Locked rotor condition is detected. Compressor is locked out.
- Code 5: Demand Signal Loss
  - Demand input signal is below 0.5VDC.
  - Resets after demand input signal rises above 3.0VDC.
- Code 6: Discharge Thermistor Fault
  - Thermistor is not connected.
  - Resets by reconnecting thermistor.
- Code 7: Reserved for future use
- Code 8: Compressor Contactor Fault
  - Compressor current is detected when compressor should be off.
  - Resets when current is no longer detected.
- Code 9: Low 24VAC Supply
  - Supply voltage to module has dropped below 18.5VAC.
  - Resets after voltage rises above 19.5VAC.

Figure 14 - Compressor Controller Flash Code Details
### Table 8 - Thermistor Temperature vs. Resistance Values

<table>
<thead>
<tr>
<th>°C</th>
<th>°F</th>
<th>kΩ</th>
<th>°C</th>
<th>°F</th>
<th>kΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>-40</td>
<td>2889.60</td>
<td>75</td>
<td>167</td>
<td>12.73</td>
</tr>
<tr>
<td>-35</td>
<td>-31</td>
<td>2087.22</td>
<td>80</td>
<td>176</td>
<td>10.79</td>
</tr>
<tr>
<td>-30</td>
<td>-22</td>
<td>1522.20</td>
<td>85</td>
<td>185</td>
<td>9.20</td>
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<tr>
<td>-25</td>
<td>-13</td>
<td>1121.44</td>
<td>90</td>
<td>194</td>
<td>7.87</td>
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<td>-20</td>
<td>-4</td>
<td>834.72</td>
<td>95</td>
<td>203</td>
<td>6.77</td>
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<td>-15</td>
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<td>627.28</td>
<td>100</td>
<td>212</td>
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</tr>
<tr>
<td>-10</td>
<td>14</td>
<td>475.74</td>
<td>105</td>
<td>221</td>
<td>5.09</td>
</tr>
<tr>
<td>-5</td>
<td>23</td>
<td>363.99</td>
<td>110</td>
<td>230</td>
<td>4.45</td>
</tr>
<tr>
<td>0</td>
<td>32</td>
<td>280.82</td>
<td>115</td>
<td>239</td>
<td>3.87</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
<td>218.41</td>
<td>120</td>
<td>248</td>
<td>3.35</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>171.17</td>
<td>125</td>
<td>257</td>
<td>2.92</td>
</tr>
<tr>
<td>15</td>
<td>59</td>
<td>135.14</td>
<td>130</td>
<td>266</td>
<td>2.58</td>
</tr>
<tr>
<td>20</td>
<td>68</td>
<td>107.44</td>
<td>135</td>
<td>275</td>
<td>2.28</td>
</tr>
<tr>
<td>25</td>
<td>77</td>
<td>86.00</td>
<td>140</td>
<td>284</td>
<td>2.02</td>
</tr>
<tr>
<td>30</td>
<td>86</td>
<td>69.28</td>
<td>145</td>
<td>293</td>
<td>1.80</td>
</tr>
<tr>
<td>35</td>
<td>95</td>
<td>56.16</td>
<td>150</td>
<td>302</td>
<td>1.59</td>
</tr>
<tr>
<td>40</td>
<td>104</td>
<td>45.81</td>
<td>155</td>
<td>311</td>
<td>1.39</td>
</tr>
<tr>
<td>45</td>
<td>113</td>
<td>37.58</td>
<td>160</td>
<td>320</td>
<td>1.25</td>
</tr>
<tr>
<td>50</td>
<td>122</td>
<td>30.99</td>
<td>165</td>
<td>329</td>
<td>1.12</td>
</tr>
<tr>
<td>55</td>
<td>131</td>
<td>25.68</td>
<td>170</td>
<td>338</td>
<td>1.01</td>
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<tr>
<td>60</td>
<td>140</td>
<td>21.40</td>
<td>175</td>
<td>347</td>
<td>0.92</td>
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<tr>
<td>65</td>
<td>149</td>
<td>17.91</td>
<td>180</td>
<td>356</td>
<td>0.83</td>
</tr>
<tr>
<td>70</td>
<td>158</td>
<td>15.07</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Compressor Lockouts**

Some units include adjustable compressor lockouts. The compressor lockout in the picture below can be set to any temperature between -10°F and 70°F. The ambient temperature sensor hangs right outside the unit with a cover.

![Figure 15 - Adjustable compressor lockout](image15)

Heat pump units include a non-adjustable compressor lockout for the cooling mode set to 55°F, and an adjustable compressor lockout for the heating mode that can be set between 20°F to 95°F. If a heat pump is selected with the compressor lockout feature, the adjustable compressor lockout will change to the -10°F to 70°F range.

![Figure 16 - Ambient sensor cover](image16)
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.

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

Refrigerant Filter Driers
Each refrigerant circuit contains a 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>

Oil Level
It is critical that the refrigerant line piping is designed to maintain proper oil return to the compressors. Some systems may require oil to be added in addition to what is provided in the compressors. The oil is a POE type and is available from your AAON Representative under part number R63681.

Proper oil level should be observed under minimum load conditions. On units equipped with tandem compressors, all oil is returned to the lead compressor in each tandem pair. When only the lead compressor is running, the oil level should be a minimum of ⅜ from the bottom of the sight glass. With both compressors running, the level in the lead compressor should drop to the bottom of the sight glass and the level in the second compressor should be a minimum of ⅜, from the bottom of its sight glass. Do not allow the oil level in the sight glass to exceed ¾ full level.
Table 10 - R-410A Refrigerant Temperature-Pressure Chart

<table>
<thead>
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<th>°F</th>
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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.

Condenser Tube Inspection
The coils are leak tested at 650 psig, 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.

Maintenance Recommendations
Fan Motor Maintenance
Cleaning - Remove oil, dust, water, and chemicals from exterior of motor. 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.

**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.

**Propeller Fans and Motors**
The fans are directly mounted on the motor shafts and the assemblies require minimal maintenance except to assure 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.

**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 condenser coils should be inspected annually 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 quarterly cleaning of e-coated coils is required to maintain coating warranty coverage. E-Coated Coil Maintenance Record document is available on the AAON website.

![WARNING]

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

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, dirt and salts 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.

**Quarterly** cleaning is required to maintain warranty coverage and is essential to maintain the life of an E-coated coil. Coil cleaning shall be part of the unit's regularly scheduled maintenance procedures.
Failure to clean an E-coated coil on the prescribed quarterly cycle will void the warranty and may result in reduced efficiency and durability in the environment. A routine two-step quarterly coil cleaning is required to maintain warranty.

Step one is to clean the coil with the below approved coil cleaner (see approved products list under the "Recommended Coil Cleaners" section.

Step two is to use the approved salt/chloride remover under the "Recommended Chloride Remover" section to dissolve soluble salts and revitalize the unit. It is very important when cleaning and/or rinsing not to exceed 130°F and potable water pressure is less than 100 psig to avoid damaging the unit and coil fin edges.

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 – Step 1
GulfCoat™ Coil Cleaner, 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. Never use any cleaners that are not approved.

Recommended Chloride Remover – Step 2
CHLOR*RID® Concentrate, assuming it is used in accordance with the manufacturer's directions on the container for proper mixing, has been approved for use on E-coated coils to remove chlorides/salts & sulfates. Never use any chloride removers that are not approved.

Warranty Protection – Step 1
Complete the coil cleaning following these steps:

1. Ensure that the power to the unit is off and locked out.
2. Clean the area around the unit if needed to ensure leaves, grass or loose debris will not be blown into the coil.

3. Remove panels or tops as required gaining access to the coil(s) to be cleaned.

4. Using a pump up sprayer, fill to the appropriate level with potable water and add the correct amount of approved cleaner as per manufacture instructions leaving room for the pump plunger to be reinserted.

**NOTE:** Coils should always be cleaned / back flushed, opposite of airflow to prevent impacting the dirt into the coil.

5. If the coils have heavy dirt, fibers, grass, leaves etc. on the interior or exterior face areas, a vacuum and brush should be used to remove those surface contaminants prior to applying cleaner. The interior floor, drain tray or pan areas should also be vacuumed.

6. Apply the mixed cleaner to coil surfaces using a pressurized pump up sprayer maintaining a good rate of pressure and at a medium size nozzle spray, (not a solid stream and not a wide fan but somewhere in the middle). Work in sections/panels ensuring that all areas are covered and kept wetted.

7. Apply the cleaner to unit interior air exiting side coil surfaces first. Work in sections/panels moving side to side and from top to bottom.

8. Generously soak coils by spraying cleaner directly on and into the fin pack section to be cleaned and allow the cleaning solution to soak for 5 to 10 minutes.

9. Using pressurized potable water, (<100 psi), rinse the coils and continue to always work in sections/panels. Start at the top of the coil and slowly move vertically downward to the bottom. Then, staying in the same vertical area, slowly move back up to the top where you started. Now move over slightly overlapping the area just completed and repeat above. Continue until all coil areas on the inside of the unit have been rinsed.

10. Complete steps 5-9 for the exterior air entering side of the coils.

11. Final rinse – Now complete a quick rinse of both sides of the coil including the headers, piping, u-bends and hairpins.

12. If the coil has a drain pan or unit floor that is holding rinse water or cleaner, extra time and attention will need to be taken in those areas to ensure a proper rinse has been completed.

**Warranty Protection – Step 2**
Complete the coil chloride (salt) removal following these steps:

1. CHLOR*RID® is a concentrate to be used for both normal inland applications at a 100:1 mix ratio OR for severe coastal applications 50:1 mix ratio with potable water, (2.56 ounces of Chlor*rid to 1 gal of water). Using a pump up sprayer, fill to the appropriate level with potable water and add the correct amount of CHLOR*RID® salt remover leaving room for the pump plunger to be reinserted.
2. Apply CHLOR*RID® to all external coil surfaces using a pressurized pump up sprayer maintaining a good rate of pressure and at a medium size nozzle spray, (not a solid stream and not a wide fan but somewhere in the middle). Work in sections/panels ensuring that all areas are covered and kept wetted.

3. Generously soak coils by spraying CHLOR*RID® directly on and into the fin pack section. Let stand for 5 to 10 minutes keeping the area wetted. Do not allow to dry before rinsing.

4. Using pressurized potable water, (<100 psi), rinse the CHLOR*RID® and dissolved chlorides/salts off of the coils continuing to always work in sections/panels.

5. Starting at the top of the coil, begin rinsing the coil from side to side until you reach the bottom. Repeat as many times as is necessary to ensure all coil sections/panels have been completed and are thoroughly rinsed.

6. Reinstall all panels and tops that were removed.

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.

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

Replacement Parts
Parts for AAON equipment may be obtained by contacting your local AAON representative. When ordering parts, reference the serial number and part number located on the external or internal nameplate of the unit.

AAON Technical Support
203 Gum Springs Rd.
Longview, TX 75602
Ph: (918) 382-6450
techsupport@AAON.com
www.AAON.com

NOTE: Before calling, technician should have model and serial number of the unit available for the customer service department to help answer questions regarding the unit.
Figure 17 - A/C Split System Piping, Suction Down
Figure 18 - A/C Split System Piping, Suction Up
Figure 19 - A/C with LAC Split System Piping, Suction Down
Figure 20 - A/C with LAC Split System Piping, Suction Up
Figure 21 - A/C with Modulating Hot Gas Reheat Split System Piping, Suction Down
Figure 22 - A/C with Modulating Hot Gas Reheat Split System Piping, Suction Up
Figure 23 - A/C with Modulating Hot Gas Reheat Split + LAC System Piping. Suction Down
Figure 24 - A/C with Modulating Hot Gas Reheat Split + LAC System Piping, Suction Up
Figure 25 - A/C with Hot Gas Bypass Split System Piping, Suction Down
Figure 26 - A/C with Hot Gas Bypass Split System Piping, Suction Up
Figure 27 - A/C with Hot Gas Bypass + LAC Split System Piping, Suction Down
Figure 28 - A/C with Hot Gas Bypass + LAC Split System Piping, Suction Up
Figure 29 - A/C with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Down
Figure 30 - A/C with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Up
Figure 31 - A/C with Modulating Hot Gas Reheat and Hot Gas Bypass + LAC Split System Piping, Suction Down
Figure 32 - A/C with Modulating Hot Gas Reheat and Hot Gas Bypass + LAC Split System Piping, Suction Up
Figure 33 - Heat Pump Split System Piping, Suction Down
Figure 34 - Heat Pump Split System Piping, Suction Up
Figure 35 - Heat Pump with Modulating Hot Gas Reheat Split System Piping, Suction Down
Figure 36 - Heat Pump with Modulating Hot Gas Reheat Split System Piping, Suction Up
Figure 37 - Heat Pump with Hot Gas Bypass Split System Piping. Suction Down
Figure 38 - Heat Pump with Hot Gas Bypass Split System Piping, Suction Up
Figure 39 – Heat Pump with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Down
Figure 40 – Heat Pump with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Up
CF Series Startup Form

Job Name:_____________________________________________ Date:_____________
Address:____________________________________________________________________
____________________________________________________________________________
Model Number:_______________________________________________________________
Serial Number:___________________________________________ Tag:___________
Startup Contractor:____________________________________________________________________
Address:__________________________________________________________________________ Phone:________

Pre Startup Checklist
Installing contractor should verify the following items.

1. Is there any visible shipping damage? ☐Yes ☐No
2. Is the unit level? ☐Yes ☐No
3. Are the unit clearances adequate for service and operation? ☐Yes ☐No
4. Do all access doors open freely and are the handles operational? ☐Yes ☐No
5. Have all shipping braces been removed? ☐Yes ☐No
6. Have all electrical connections been tested for tightness? ☐Yes ☐No
7. Does the electrical service correspond to the unit nameplate? ☐Yes ☐No
8. On 208/230V units, has transformer tap been checked? ☐Yes ☐No
9. Has overcurrent protection been installed to match the unit nameplate requirement? ☐Yes ☐No
10. Have all set screws on the fans been tightened? ☐Yes ☐No
11. Do all fans rotate freely? ☐Yes ☐No

Ambient Temperature
Ambient Dry Bulb Temperature ________°F  Ambient Wet Bulb Temperature ________°F
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</table>

### Refrigeration System 4 - Heating Mode (Heat Pump Only)

<table>
<thead>
<tr>
<th></th>
<th>Pressure</th>
<th>Saturated Temperature</th>
<th>Line Temperature</th>
<th>Sub-cooling</th>
<th>Superheat</th>
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</thead>
<tbody>
<tr>
<td>Discharge</td>
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<tr>
<td>Suction</td>
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<td>Liquid</td>
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### Condenser Fans

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<th>Alignment</th>
<th>Check Rotation</th>
<th>Nameplate Amps</th>
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<tbody>
<tr>
<td>Number</td>
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</tr>
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</tr>
<tr>
<td>2</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
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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>
<tr>
<th>Entry Date</th>
<th>Action Taken</th>
<th>Name/Tel.</th>
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</table>
Literature Change History

July 2015
Initial version

March 2016
Clarified forklift instructions and removed wording about curb mounting.

June 2016
Updated CF Series Features and Options Introduction. Added Feature 17 Shipping Options in the Feature String Nomenclature. Added Storage information. Added Table for Service Clearances. Clarified Low Ambient section and added a picture of an adjustable fan cycle switch. Added guidelines for variable capacity compressors and tandem compressors in the line sizing section. Added double riser schematics and discussion for heat pump operation. Added a section on compressor lockouts. Included heat pump charging guidelines in the Acceptable Refrigeration Circuit Values Table. Added Special Low Ambient Option Charging Instructions. Added A/C with LAC Piping to show low ambient piping which is internal to the condensing unit.

March 2017
Updated Piping Diagrams because receivers are now factory installed in CF 2-7 tons.

April 2017
Updated service clearances tables and added a table for coil pull. Updated orientation of the CF 9-70 ton. Added a note that AAON does not recommend underground refrigerant lines. Added clarification to the liquid line solenoid valve recommendation. Added a double suction risers figure. Removed solenoid valve recommendation on the heat pump double risers and updated the figures. Added a suction line traps section. Changed the suction flow minimum velocity for variable compressors. Changed the caution note by removing the variable capacity compressor wording. Added discharge line sizing guidelines. Removed the hot gas bypass piping considerations for evaporator below condensing unit since they are the same as for evaporator above condensing unit. Added a figure for oil return line. Changed the maximum hot gas maximum velocity from 4,000 fpm to 3,500 fpm. Changed the sub-cooling values in the Acceptable Refrigeration Circuit Values table. Updated heat pump piping diagrams to include suction/discharge line traps in suction down diagrams. Added all the LAC piping diagrams.

October 2017
Updated digital compressor discharge up minimum velocity. Updated charge information. Updated phase imbalance example. Added Air Cooled Condenser Option in A1 Compressor Style. Added No Cooling Option in A5 Staging. Added Orion VCCX.

March 2018
Added AAON Touchscreen Controller feature 8B. Updated Refrigerant Piping section to match the DX Handbook. Added note about running variable capacity compressors at 100% for 1 minute when starting. Updated Acceptable Refrigeration Circuit Values Table and notes. Updated piping diagrams with 3-way reheat valve.
May 2018
Updated technical support contact information.

June 2018
Updated E-coated coil cleaning procedure. Added split system evacuation procedure for low ambient and modulating hot gas reheat.

November 2018
Added Feature Options N = ECM Condenser Fan Head Pressure Control + Low Sound Condenser Fan & S to Feature 13. Added Standard Evacuation Instructions & Low Ambient & Modulating Reheat System Evacuation Instructions to Installation section. Updated Special Low Ambient Option Charging Instructions and the LAC Valve Piping Schematic figure.

February 2019
Changed WattMaster to Orion. Added Do Not Overcharge note to Acceptable Refrigeration Circuit Values table.

May 2019
Added the minimum/maximum voltage range table in the Electrical section.

July 2019
Removed most references to PVE oils except in the caution boxes.
Note: Before calling Technical Support, please have the model and serial number of the unit available.

Parts: For replacement parts, please contact your local AAON Representative.

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