Installation, Operation, and Maintenance Manual

**2026**

# CF Series (2-60 Tons)

## Condenser and Condensing Units

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R-454B

Conforms to UL STDs 60335-1 and 60335-2-40

Rev B Version 20251103

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# 1. SAFETY

Attention must be paid to the following statements:

Startup and service must be performed by a Factory-Trained Service Technician competent in working with flammable refrigerants.

This unit is for outdoor use only. See the General Information section for more information.

Every unit has a unique equipment nameplate with electrical, operational, and unit clearance specifications. Refer to the unit nameplate for specific ratings unique to the model purchased.

**Note**: Read the entire installation, operation, and maintenance manual. Other important safety precautions are provided throughout this manual.

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

This product is designed for the use of R-454B refrigerant only. The use of any other refrigerant in this product is not covered under ETL listing and voids the warranty.

# 2. NOTES, CAUTIONS, AND WARNINGS

**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, or serious personal injury.

**DANGER**

Danger statements are given to prevent actions that will result in equipment destruction, property damage, and severe personal injury or death.

**WARNING**

*Electric Shock, Fire, or Explosion Hazard*:
Failure to follow safety warnings could result in dangerous operation, serious injury, death, or property damage.

Improper servicing could result in dangerous operation, serious injury, death, or property damage.

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

**WARNING**

*Qualified Installer*:
Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury or loss of life. A Factory Trained Service Technician must perform startup and service. A copy of this IOM must be kept with the unit.

**WARNING**

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

**WARNING**

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

**WARNING**

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

**WARNING**

*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 an 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, must be followed.

**WARNING**

*Rotating Components*:
The unit contains fans with moving parts that can cause serious injury. Do not open the door containing the fans until the power to the unit has been disconnected and the fan wheel has stopped rotating.

**WARNING**

If any damage or fault to electrical equipment exists, do not provide power to the unit. If the issue cannot be resolved immediately, report the issue to the equipment owner to ensure power is not supplied before the issue is resolved.

**CAUTION**

*Variable Frequency Drives*:
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 motor's FLA rating as shown on the motor nameplate.

**CAUTION**

*Three-Phase Rotation*:
Rotation must be checked on all Motors and Compressors of three-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 must be checked for proper operation. Alterations must only be made at the unit power connection

**WARNING**

*Variable Frequency Drives*:
Do not leave VFDs unattended in hand mode or manual bypass. Damage to personnel or equipment can occur if left unattended. When in hand mode or manual bypass mode, the VFDs will not respond to controls or alarms.

**CAUTION**

*PVC Piping*:
PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-454B and other refrigerants, even in trace amounts, in a PVC or CPVC piping system, will result in stress cracking of the piping and fittings and complete piping system failure.

**WARNING**

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

**CAUTION**

*Door Latches*:
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 padlock, always reinstall the nut and bolt after closing the door to maintain tool access.

**WARNING**

Flammable refrigerant. Do not pierce or burn tubing or refrigerant-containing components.

**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.

**WARNING**

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

**CAUTION**

*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.

**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.

**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**

*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**

*Convenience Outlets*:
Factory-installed convenience outlets are not intended for use while the unit is operating.

**WARNING**

The appliance shall be stored in a room without continuously operating ignition sources (i.e., open flames, gas appliances, or electric heaters).

**CAUTION**

The unit supply wire must be only copper or aluminum.

**CAUTION**

To avoid a hazard due to inadvertent resetting of the Thermal Cut-out, this appliance must not be supplied through an external switching device, such as a timer, or connected to a circuit that is regularly switched on and off by the utility.

**WARNING**

This appliance is not intended for use by persons with reduced physical, sensory, or mental capabilities, or a lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children must be supervised to ensure they do not play with this appliance.

**WARNING**

Units with VFD driven motors/compressors have adjustable overload settings. These are set by the AAON factory for the protection of these motors/compressors and must not be adjusted over this factory setpoint or bypassed.

**WARNING**

*Compressor Cycling*:

*3 Minute Minimum Off Time*: To prevent motor overheating, compressors must cycle off for a minimum of 3 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 7 starts per hour.

**WARNING**

If a refrigerant leak is detected, remove or extinguish all sources of open flame. If repairing a refrigerant leak requires brazing, remove all refrigerant before beginning brazing.

**CAUTION**

*Refrigerant Piping*:

Field-installed pipework must be protected from physical damage in operation and service. All joints must be accessible for inspection prior to being covered. Install in accordance with applicable local codes. In the absence of local codes, install in accordance with ASHRAE 15, ASHRAE 15.2, IAPMO Uniform Mechanical Code, ICC International Mechanical Code, or CSA B52. Do not install any field made joints within the conditioned airstream.

**WARNING**

Do not use a torch or other potential ignition source to detect refrigerant leaks. Use only an electronic detector suitable for the refrigerant, or the bubble method with chlorine-free detergent.

**WARNING**

Minimum circulation airflow is required to prevent stagnation of refrigerant in the event of a refrigerant leak. Zone dampers and VAV boxes must be operated to allow for minimum circulation airflow in the event of a refrigerant leak.

**WARNING**

The Refrigerant Detection System activates the circulation airflow. In the event of a refrigerant leak within the airstream, the indoor blower is activated to provide circulation airflow. The mitigation board is provided with an alarm output. Wire all zone dampers and VAV boxes to the alarm output to open in the event of a refrigerant leak alarm.

**WARNING**

Flammable refrigerant. Be aware that refrigerant does not contain an odor.

**CAUTION**

If an electrical component requires changing, verify specifications and intended application match the component to be replaced, including sealed or intrinsically safe specifications. Damaged, sealed, or intrinsically safe components must be replaced. Electrical components must be free from producing arcs or sparks. The maintenance guidelines in this manual must always be followed. If there is any doubt, contact Factory Technical Support.

**WARNING**

Ensure that there are no live electrical components or wiring exposed when adjusting charge, recovering charge, or purging the system. Ensure that earthing continuity is unbroken.

**WARNING**

Do not use means to accelerate the defrosting process or to clean, other than those recommended in this manual.

# 3. AAON® CF SERIES FEATURES AND OPTIONS INTRODUCTION

**Energy Efficiency**

- Two-Stage, 10-100% Variable Capacity, or Tandem Scroll Compressors
- Air-Source Heat Pump
- VFD Controlled and ECM Driven 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
- 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), Single Zone Variable Air Volume (SZ VAV), and Dedicated Outdoor Air System (DX-DOAS)

**Environmentally Friendly**

- R-454B 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
- Condenser Coil Guards
- Custom Color Paint Options

# 4. CF SERIES FEATURE STRING NOMENCLATURE

The following is an example of the CF Series Feature String.

CFA-015-B-A-3-LA00N:0-00-E0-C0-AN0-D-DE0A-00A0C00-0A000DB

CF Series Feature String Description

## 4.1. CF Model Options Breakdown

| GEN | MJ REV | | SIZE | | SERIES | | MN REV | | VLT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CF | A | - | 015 | - | B | - | A | - | 3 | - | LA00N:0-00-E0-C0-AN0-D-DE0A-00A0C00-0A000DB |

**Series And Generation**

**CF**

**Major Revision**

**A**

**Unit Size**

**002** = 2-ton Capacity
**003** = 3-ton Capacity
**004** = 4-ton Capacity
**005** = 5-ton Capacity
**007** = 7-ton Capacity
**009** = 9-ton Capacity
**011** = 11-ton Capacity
**013** = 13-ton Capacity
**015** = 15-ton Capacity
**016** = 16-ton Capacity
**018** = 18-ton Capacity
**020** = 20-ton Capacity
**025** = 25-ton Capacity
**026** = 26-ton Capacity
**030** = 30-ton Capacity
**031** = 31-ton Capacity
**040** = 40-ton Capacity
**050** = 50-ton Capacity
**060** = 60-ton Capacity

**Series**

**A** = 2-7-ton units
**B** = 9-15-ton units
**C** = 16-25 and 30-ton units
**D** = 26 and 31-60-ton units

**Minor Revision**

**A**

**Voltage**

**1** = 230V/1Φ/60Hz
**2** = 230V/3Φ/60Hz
**3** = 460V/3Φ/60Hz
**4** = 575V/3Φ/60Hz
**8** = 208V/3Φ/60Hz
**9** = 208V/1Φ/60Hz

## 4.2. CF Model Options Breakdown

| | A1 | A2 | A3 | A4 | A5 | |
|---|---|---|---|---|---|---|
| CFA-015-B-A-3 - | **L** | **A** | **0** | **0** | **N** | : 0-00-E0-C0-AN0-D-DE0A-00A0C00-0A000DB |

**A1: Compressor Style**

**J** = R-454B Scroll two-step Capacity Compressor
**L** = R-454B Variable Capacity Scroll Compressor
**M** = R-454B Tandem Scroll Compressor
**N** = R-454B Tandem Variable Capacity Scroll Comp (Two Circuits)

**A2: Condenser Style**

**A** = Air-Cooled Microchannel Condenser
**J** = Air-Source Heat Pump (Fin and Tube)

**A3: Configuration**

**0** = Standard

**A4: Coating**

**0** = Standard
**E** = Polymer E-Coated Condenser Coil

**A5: Staging**

**G** = One Two-Step Refrigeration System
**H** = One Variable Capacity Refrigeration System
**J** = Two On/Off Refrigeration Systems
**K** = One Variable Capacity Refrigeration System + One On/Off Refrigeration System
**M** = Two Two-Step Refrig Systems
**N** = One Variable Refrig System + One Two-Step Refrig System

# 4.3. CF Model Options Breakdown

| | 1 | | 2A | 2B | | 3A | 3B | | 4 | 5 | | 6A | 6B | 6C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CFA-015-B-A-3-LA00N : | **0** | - | **0** | **0** | - | **E** | **0** | - | **C** | **0** | - | **A** | **N** | **0** | - | D-DE0A-00A0C000-0A000DB |

**Unit Feature Options**

**1: Unit Orientation**

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

**2A: Refrigeration Control**

**0** = Standard
**A** = Five 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
**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** = HGB Non-Variable Compressors [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** = One Circuit Flooded Condenser 0°F Low Ambient Controls
**E** = Options A + D
**F** = Options B + D
**G** = Options A + B + D
**H** = Two Circuit Flooded Condenser 0°F Low Ambient Controls
**J** = Options A + H
**K** = Options B + H
**L** = Options A + B + H

**5: Blank**

**0** = Standard

**6A: Unit Disconnect Type**

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

**6B: Disconnect Size**

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

**6C: Blank**

**0** = Standard

# 4.4. CF Model Options Breakdown

| | | 7 | | 8A | 8B | 8C | 8D | | 9 | 10 | | 11 | 12 | 13 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CFA-015-B-A-3-LA00N:0-00-E0-C0-ANO | - | D | - | D | E | 0 | A | - | 0 | 0 | - | A | 0 | C | 00-0A000DB |

## 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* - CAV Cool + CAV Heat
**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
**Q** = DX-DOAS Controls
**R** = DX-DOAS Controls Heat Pump

## 8B: Control Suppliers

**0** = Standard Terminal Block
**E** = VCC-X (Main Controller in Air Handling Unit)
**J** = AAON Refrigeration System Supervisory Controls

## 8C: Control Supplier Options

**0** = Standard

## 8D: BMS Connection & Diagnostics

**0** = Standard
**A** = BACnet IP
**J** = BACnet IP with Diagnostics

## 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** = Option C + Low Sound Condenser Fan
**S** = Options A + C + Low Sound Condenser Fan

## 4.5. CF Model Options Breakdown

| | 14 | 15 | | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|
| CFA-015-B-A-3-LA00N:0-00-E0-C0-AN0-D-DE0A-00A0C | 0 | 0 | - | 0 | A | 0 | 0 | 0 | D | B |

**14: Blank**

**0** = Standard

**15: Blank**

**0** = Standard

**16: Electrical Options**

**0** = Standard 5 KAIC
**C** = 10 KAIC

**17: Shipping Options**

**0** = Standard
**A** = Crating
**B** = Export Crating

**18: Blank**

**0** = Standard

**19: Blank**

**0** = Standard

**20: Cabinet Material**

**0** = Galvanized Steel Cabinet

**21: Warranty**

**0** = Standard
**D** = Extended Compressor Warranty (2-5 Years)

**22: Type**

**B** = Premium AAON Gray Paint Exterior
**E** = Premium AAON Gray Paint Exterior + Shrink Wrap
**X** = SPA + Premium AAON Gray Paint Exterior
**1** = SPA + Premium AAON Gray Paint Exterior + Shrink Wrap

# 5. 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. CF Series units are intended for installation up to 3,500 meters (11,500 ft).

**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.

## 5.1. Codes and Ordinances

CF Series units have been tested and certified by ETL, in accordance with UL Safety Standard 60335-2-40 4th Edition, ANSI Safety Standard Z21.47-2016.

System must 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.

**WARNING**

*Sharp Edges*:
Coils and sheet metal surfaces present sharp edges, and care must be taken when working with equipment.

**WARNING**

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

## 5.2. Receiving Unit

When received, check the unit for damage that might have occurred in transit. If damage is found it must be noted on the carrier's freight bill. A request for inspection by carrier's agent must be made in writing at once. Check the nameplate 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 must 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.

## 5.3. 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. Unit must be stored in accordance with ASHRAE 15 requirements for machine rooms.

**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.

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

**CAUTION**

*Crankcase Heater Operation*:
Units are equipped with compressor crankcase heaters, which must be energized at least 24 hours prior to cooling operation, to clear any liquid refrigerant from the compressors.

Never turn off the main power supply to the unit, except for a complete shutdown. When power is cut off from the unit, any compressors using crank-case 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.

**CAUTION**

*Three-Phase Rotation*:
Rotation must be checked on all Motors and Compressors of three-phase units. All motors, including and not limited to pump motors and condenser fan motors, must all be checked by a qualified service technician at startup, and any wiring alteration must only be made at the unit's power connection.

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 emergencies or for complete shutdown of the system).

**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 must be checked by a qualified service technician at startup using suction and discharge pressure gauges, and any wiring alteration must only be made at the unit's power connection.

The standard compressors must be on for a minimum of 5 minutes and off for a minimum of 3 minutes. The cycle rate must be no more than seven starts per hour.

**CAUTION**

*Compressor Cycling*:

*3 Minute Minimum Off Time*-To prevent motor overheating, compressors must cycle off for a minimum of 3 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  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.

## 5.4. Wiring Diagrams

Unit specific wiring diagrams are laminated and affixed inside the controls compartment door.

## 5.5. 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 sub-cooling and superheat.

# 6. INSTALLATION

## 6.1. 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 1.2 m (48") in length. 9-25- & 30-ton units must have forks 1.8 m (72") in length, or the forks must have 1.8 m (72") fork extensions. Standard units can be lifted from all sides except the condenser coil side. CF Series condensing unit sizes 26 & 31-60 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 15.25 cm (6") away from the edge of the unit.

**CAUTION**

_Forklifting (2-7 Ton Units)_:
Forks or Fork Extensions must be at least 1.2 m (48") in length.

**CAUTION**

_Forklifting (9-25- & 30-Ton Units)_:
Forks or Fork Extensions must be at least 1.8 m (72") in length.

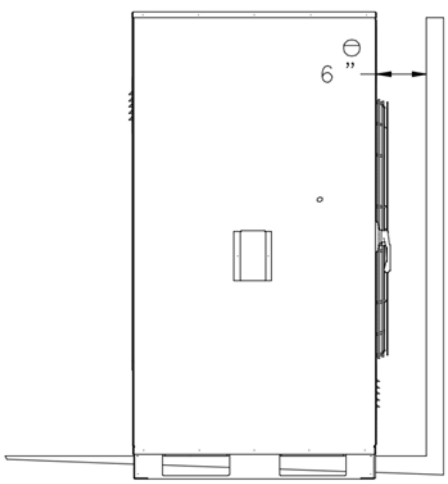



Figure 1: Forklifting a CF Series A Cabinet

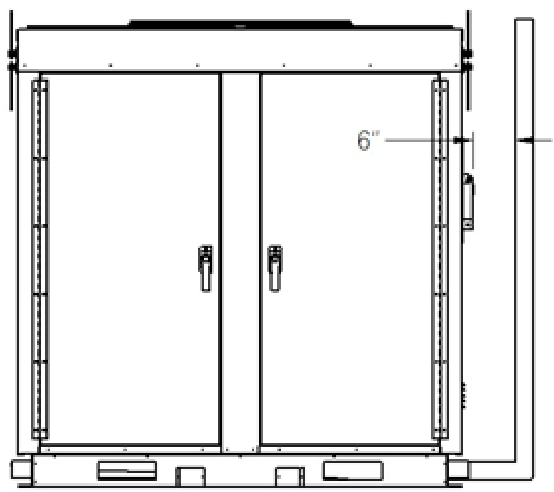



Figure 2: Forklifting a CF Series B and C Cabinet

## 6.2. Lifting the Cabinet

If cables or chains are used to hoist the unit, they must be the same length. Minimum cable length is 251.5 cm (99") for CF Series 9-60-ton units. CF Series 2-7-ton units do not include factory-installed lifting lugs and must be lifted by forklift only. Care must be taken to prevent damage to the cabinet, coils, and condenser fans.

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

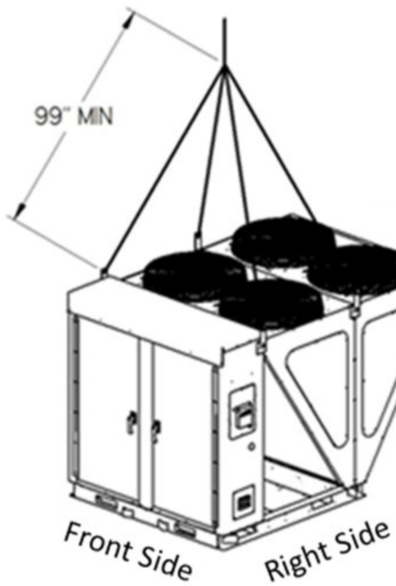



Figure 3: Lifting Details and Orientation of a CF Series 9-60-ton Condensing Unit

## 6.3. Locating the Unit

The CF Series condenser and condensing unit are 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 must 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.

Table 1 gives the clearance values for proper unit operation. Table 2 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 Table 2 clearances for the right-hand side of the unit.

Table 1: Clearances for Proper Operation

| Location | Unit Size | |
|---|---|---|
| | 2-7 tons cm (in.) | 9-60 tons cm (in.) |
| Front - (Controls Side) | Unobstructed | 91.4 (36) |
| Left Side | 15.25 (6) | 76.2 (30) |
| Right Side | 15.25 (6) | 91.4 (36) |
| Top | 7.6 (3) | Unobstructed |
| Back | 45.7 (18) | 15.25 (6) |

Table 2: Clearances for Coil Pull

| Unit Size | Right Hand Side cm (in.) |
|---|---|
| 2-7 tons | 106.7 (42) |
| 9-15 tons | 106.7 (42) |
| 16-25 & 30 tons | 137.2 (54) |
| 26 & 31-60 tons | 167.6 (66) |

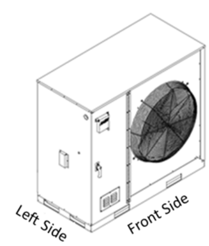



Figure 4: Orientation of Series 2-7-ton Condensing Unit

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 9-60-ton units must provide at least 76.2 cm (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 152.4 cm (60") or 1.5 meters (5 feet). Similarly, when 2-7-ton units are mounted adjacent to each other, the minimum clearance required between the back sides of the units is 91.4 cm (36") or 0.9 meters (3 feet).

Units must 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 1.5 meters (5 feet) (0.9 meters [3 feet] for 2-7-ton).

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 the condenser must remain free of debris that may be drawn in and obstruct airflow in the condensing section.

Consideration must be given to obstructions caused by snow accumulation when placing the unit. If the unit is to be installed indoors, or in areas without sufficient ventilation, provide venting from all pressure relief outlets to outdoors in accordance with ASHRAE 15 requirements.

## 6.4. Mounting Isolation

For roof-mounted applications or anytime vibration transmission is a factor, vibration isolators may be used. When vibration isolators are used, the CF Series unit must be directly mounted either on a flat platform or on support rails running front to back and at least 2.5 cm (1") wider than the unit base rail. If the CF is mounted on the support rails, the additional width of the support rail must be on the inside of the unit such that the support rail fully covers the corner connections of the unit base rail. Any isolation must be applied to the platform or support rails. DO NOT put spring isolation on the base of the CF Series Condensing Unit.

## 6.5. 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-454B 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.

## 6.6. 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 must be performed anytime a system is open to atmospheric pressure. The POE oils used with R-454B 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 2758 kPa (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 9.5 mm (3/8'') evacuation port. The larger diameter evacuation port will expedite system evacuation.
4. Connect the manifold set 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 must be connected to the manifold set using a 9.5 mm (3/8") vacuum-rated hose. Figure 5 shows two circuits. Both circuits must be evacuated separately.

Figure 5: CU Connections

5. An accurate micron gauge must be used and checked by pulling a vacuum on the gauge itself and verifying a rapid drop to less than 100 microns within a few minutes.
6. Do not attach the micron gauge to the system until the gauge manifold reads 71 cm (28") of vacuum to ensure the micron gauge does not see pressure and is thus damaged. Micron gauges will be damaged by pressure!!!
7. Replace the vacuum pump oil after one hour of the evacuation process. The oil cannot be broken down in the pump in the first hour, causing the 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 must then be isolated, and the pump turned off to check for vacuum rise due to leaks or moisture in the system. The micron gauge must not rise above 500 microns after 30 minutes of wait time.

## 6.7. Low Ambient and 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 a low ambient flooded condenser option require the following procedure to ensure the entire system is pulled into a good vacuum.

1. System evacuation must be performed anytime a system is open to atmospheric pressure. The POE oils used with R-454B 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 2758 kPa (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 9.5 mm (3/8") evacuation port. The larger diameter evacuation port will expedite system evacuation.
5. Connect the manifold set 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 must be connected to the manifold set using a 9.5 mm (3/8") vacuum rated hose. Figure 6 shows two circuits. The first circuit has a reheat line, and 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 verifying a rapid drop to less than 100 microns within a few minutes.

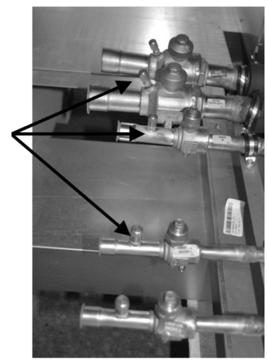


Figure 6: CU Connections

8. Do not attach the micron gauge to the system until the gauge manifold is reading 71 cm (28") of vacuum to ensure the micron gauge does not see pressure and is thus damaged. Micron gauges will be damaged by pressure!
9. Replace the vacuum pump oil after one hour of the evacuation process. The oil cannot be broken down in the pump in the first hour, causing the 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 must then be isolated, and the pump turned off to check for vacuum rise due to leaks or moisture in the system. The micron gauge must not rise above 500 microns after 30 minutes of wait time.

## 6.8. 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 the determination of liquid sub-cooling 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.

When the charge is adjusted in the field, the total system charge must be written on the decal near the nameplate, located on the inside of the control panel, using a permanent marker. See Figure 7. Ensure that the space served by the unit has a sufficient floor area in accordance with Table 6 & Table 7.

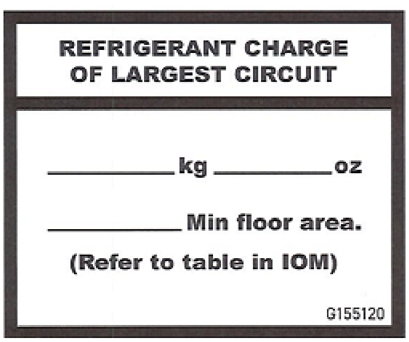



Figure 7: Refrigerant Charge of Largest Circuit

**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**

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

### 6.8.1. Before Charging

Refer to the Unit Nameplate to determine which refrigerant must be used to charge the system. The unit being charged must be at or near full load conditions before adjusting the charge.

Units equipped with a hot gas bypass must have the hot gas bypass valve closed to get the proper charge. Units equipped with hot gas reheat must be charged with the hot gas reheat valve closed while the unit is in cooling mode. After charging, operate the unit in reheat (dehumidification) mode to check for correct operation.

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

Table 3: Acceptable Fin & Tube (Heat Pump Unit) Refrigeration Circuit Values

| | Cooling Mode Liquid Sub-Cooling Values (°C) | Cooling Mode Liquid Sub-Cooling Values (°F) |
|---|---|---|

| | | |
|---|---|---|
| Heat Pump Unit | 1.1 - 2.2 | 2-4 |
| Heat Pump Unit with Hot Gas Reheat | 1.1 - 3.3 | 2-6 |

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 a unit with a fin & tube condensing coil (heat pump). Refer to Table 5 for a unit with a microchannel condensing coil (cooling only).

For units equipped with low ambient (-17.2°C [0°F]) option, see the special charging instructions at the end of this section.

*Checking Liquid Sub-cooling*

Measure the temperature of the liquid line as it leaves the condenser coil. Read the gauge pressure at the liquid line close to the point where the temperature was taken. Use the liquid line pressure, as it will vary from the discharge pressure due to the 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 the calculated sub-cooling to Table 3 or Table 5 for the appropriate unit type and options.

**Notes**:

- Close the hot gas valve before charging. After charging, operate the unit in reheat (dehumidification) mode to check for correct operation.
- The sub-cooling value in Table 3 shows the unit running in cooling mode of operation. After charging, operate the unit in heating mode to check for correct operation.
- The sub-cooling value in Table 3 shows the unit running in cooling mode of operation, with the hot gas valve closed. After charging, operate the unit in reheat (dehumidification) mode to check for correct operation and then in heating mode to check for correct operation.
- Sub-cooling must be increased by 0.6°C (1°F) per 3 meters (10 feet) of vertical liquid line rise for R-454BA (AHU above CU). For example, a heat pump unit with hot gas reheat and a vertical liquid drop can charge to a sub-cooling value of 1.1-3.3°C (2-6°F), but a heat pump unit with hot gas reheat and a vertical liquid rise of 9.1 m (30 ft) must charge to a sub-cooling value of at least 2.8 - 3.3°C (5-6°F). Do Not Overcharge. Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

Table 4: Acceptable Microchannel Air-Cooled Condenser Coil Liquid Sub-Cooling Values (Metric)

| Cooling Mode Liquid Sub-Cooling Values (°C) | | | | | |
|---|---|---|---|---|---|
| Ambient (°C) | Evaporator Coil Saturation Temperature (°C) | | | | |
| | 4.4 | 7.2 | 8.9 | 10.0 | 12.8 |
| 19.4 | 5.0 - 7.8 | 4.4 - 7.2 | 4.4 - 7.2 | 3.9 - 6.7 | 2.8 - 5.6 |
| 22.2 | 5.6 - 8.3 | 5.0 - 7.8 | 5.0 - 7.8 | 4.4 - 7.2 | 3.9 - 6.7 |
| 27.8 | 5.6 - 8.3 | 5.6 - 8.3 | 5.6 - 8.3 | 5.0 - 7.8 | 3.9 - 6.7 |
| 35.0 | 5.6 - 8.3 | 5.6 - 8.3 | 5.6 - 8.3 | 5.0 - 7.8 | 4.4 - 7.2 |
| 40.6 | 6.1 - 8.9 | 6.1 - 8.9 | 5.6 - 8.3 | 5.6 - 8.3 | 4.4 - 7.2 |
| 46.1 | 5.6 - 8.3 | 6.1 - 8.9 | 6.1 - 8.9 | 6.1 - 8.9 | 5.0 - 7.8 |

Table 5: Acceptable Microchannel Air-Cooled Condenser Coil Liquid Sub-Cooling Values (Imperial)

| Cooling Mode Liquid Sub-Cooling Values(°F) | | | | | |
|---|---|---|---|---|---|
| Ambient (°F) | Evaporator Coil Saturation Temperature (°F) | | | | |
| | 40 | 45 | 48 | 50 | 55 |
| 67 | 9 - 14 | 8 - 13 | 8 - 13 | 7 - 12 | 5 - 10 |
| 72 | 10 - 15 | 9 - 14 | 9 - 14 | 8 - 13 | 7 - 12 |
| 82 | 10 - 15 | 10 - 15 | 10 - 15 | 9 - 14 | 7 - 12 |
| 95 | 10 - 15 | 10 - 15 | 10 - 15 | 9 - 14 | 8 - 13 |
| 105 | 11 - 16 | 11 - 16 | 10 - 15 | 10 - 15 | 8 - 13 |
| 115 | 10 - 15 | 11 - 16 | 11 - 16 | 11 - 16 | 9 - 14 |

**Notes**:

- Microchannel condenser coils are more sensitive to charge. The system must be running in the cooling mode with the compressor, supply airflow, and condenser fan speed at full load. The sub-cooling value changes depending on the ambient temperature reading and the evaporator coil saturation temperature. To find the correct sub-cooling value, find the ambient temperature on the first column and follow that across to the SST (4.4-12.8°C [40-55°F]).
- Superheat for Microchannel condenser coils must be between 4.4 and 8.3°C (8 - 15°F)
- For units with hot gas reheat, close the hot gas valve before charging. After charging, operate the unit in reheat (dehumidification) mode to check for correct operation.
- The sub-cooling value in Table 5 shows the unit running in cooling mode of operation, with the hot gas valve closed. After charging, operate the unit in reheat (dehumidification) mode to check for correct operation.
- Sub-cooling must be increased by 0.6°C (1°F) per 3 meters (10 feet) of vertical liquid line rise for R-454BA (AHU above CU). For example, a cooling-only unit at 82°F ambient and 48°F SST and a vertical liquid drop can charge to a sub-cooling value of 5.6 - 8.3°C (10-15°F), but a cooling-only unit with hot gas reheat and a vertical liquid rise of 9.1 m (30 ft) must charge to a sub-cooling value of at least 7.2 - 8.3°C (13-15°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 evaporator.

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

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 must be 5.6-7.2°C (10-13°F) with one compressor running. The suction superheat will increase with both compressors running in tandem. 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 must be measured with both compressors in a refrigeration system running.

Compare calculated superheat to the acceptable cooling mode superheat values of 4.4-8.3°C (8-15°F) for all system types. Superheat will increase with long suction line runs.

**CAUTION**

Expansion Valve Adjustment:
Thermal expansion valves must be adjusted to approximately 4.4-8.3°C (8-15°F) of suction superheat. Failure to have sufficient superheat will damage the compressor and void the warranty.

*Adjusting Sub-cooling and Superheat Temperatures*

The system is overcharged if the sub-cooling temperature is too high compared to Table 3 or Table 5 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 4.4-8.3°C (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.

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

**CAUTION**

Do Not Overcharge!
Refrigerant overcharging leads to excess refrigerant in the condenser coils, resulting in elevated compressor discharge pressure. The maximum charge in any circuit is 25.5 kg (900 oz).

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 to be adjusted to correct the superheat.

Table 6: Minimum Circulation Airflow and Room Area for a Given Charge

| Charge of Largest Circuit in kg (oz) | | Min Circulation Airflow in $m^3$/hr. (CFM) | | Minimum Room Area in m2 (ft2) | | | | | | Floor area for unventilated storage | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.8 m (6 ft) ceiling/release height | | 3 m (10 ft) ceiling/release height | | 3.7 m (12 ft) ceiling/release height | | | |
| **2.1** | 75 | **215** | 127 | **8** | 86 | **5** | 52 | **4** | 42 | **3** | 34 |
| **2.5** | 88 | **253** | 149 | **9** | 101 | **6** | 60 | **5** | 49 | **4** | 46 |
| **2.9** | 104 | **299** | 176 | **11** | 119 | **7** | 71 | **5** | 58 | **6** | 65 |
| **3.4** | 120 | **345** | 203 | **13** | 137 | **8** | 82 | **6** | 67 | **8** | 86 |
| **3.9** | 136 | **391** | 230 | **14** | 156 | **9** | 93 | **7** | 76 | **10** | 111 |
| **4.3** | 152 | **437** | 257 | **16** | 174 | **10** | 104 | **8** | 85 | **13** | 139 |
| **4.8** | 168 | **483** | 284 | **18** | 192 | **11** | 115 | **9** | 94 | **16** | 169 |
| **5.2** | 184 | **529** | 311 | **20** | 211 | **12** | 126 | **10** | 103 | **19** | 203 |
| **5.7** | 200 | **575** | 338 | **21** | 229 | **13** | 137 | **10** | 111 | **22** | 240 |
| **6.1** | 216 | **621** | 365 | **23** | 247 | **14** | 148 | **11** | 120 | **26** | 280 |
| **6.6** | 232 | **667** | 392 | **25** | 266 | **15** | 159 | **12** | 129 | **30** | 323 |
| **7.0** | 248 | **713** | 419 | **26** | 284 | **16** | 170 | **13** | 138 | **34** | 369 |
| **7.5** | 264 | **759** | 446 | **28** | 302 | **17** | 181 | **14** | 147 | **39** | 418 |
| **7.9** | 280 | **805** | 474 | **30** | 321 | **18** | 192 | **14** | 156 | **44** | 470 |
| **8.4** | 296 | **850** | 501 | **31** | 339 | **19** | 203 | **15** | 165 | **49** | 526 |
| **8.8** | 312 | **896** | 528 | **33** | 357 | **20** | 214 | **16** | 174 | **54** | 584 |
| **9.3** | 328 | **942** | 555 | **35** | 376 | **21** | 225 | **17** | 183 | **60** | 645 |
| **9.8** | 344 | **988** | 582 | **37** | 394 | **22** | 236 | **18** | 192 | **66** | 710 |
| **10.2** | 360 | **1034** | 609 | **38** | 412 | **23** | 247 | **19** | 201 | **72** | 778 |
| **10.7** | 376 | **1080** | 636 | **40** | 431 | **24** | 258 | **19** | 210 | **79** | 848 |
| **11.1** | 392 | **1126** | 663 | **42** | 449 | **25** | 269 | **20** | 218 | **86** | 922 |
| **11.6** | 408 | **1172** | 690 | **43** | 467 | **26** | 280 | **21** | 227 | **93** | 999 |
| **12.0** | 424 | **1218** | 717 | **45** | 486 | **27** | 291 | **22** | 236 | **100** | 1079 |
| **12.5** | 440 | **1264** | 744 | **47** | 504 | **28** | 302 | **23** | 245 | **108** | 1161 |
| **12.9** | 456 | **1310** | 771 | **49** | 522 | **29** | 313 | **24** | 254 | **116** | 1247 |
| **13.4** | 472 | **1356** | 798 | **50** | 541 | **30** | 324 | **24** | 263 | **124** | 1337 |
| **13.8** | 488 | **1402** | 825 | **52** | 559 | **31** | 335 | **25** | 272 | **133** | 1429 |
| **14.3** | 504 | **1448** | 852 | **54** | 577 | **32** | 346 | **26** | 281 | **142** | 1524 |
| **14.7** | 520 | **1494** | 879 | **55** | 596 | **33** | 357 | **27** | 290 | **151** | 1622 |
| **15.2** | 536 | **1540** | 906 | **57** | 614 | **34** | 368 | **28** | 299 | **160** | 1724 |
| **15.6** | 552 | **1586** | 934 | **59** | 632 | **35** | 379 | **29** | 308 | **170** | 1828 |
| **16.1** | 568 | **1632** | 961 | **60** | 651 | **36** | 390 | **29** | 317 | **180** | 1936 |
| **16.6** | 584 | **1678** | 988 | **62** | 669 | **37** | 401 | **30** | 325 | **190** | 2046 |
| **17.0** | 600 | **1724** | 1015 | **64** | 687 | **38** | 412 | **31** | 334 | **201** | 2160 |
| **17.5** | 616 | **1770** | 1042 | **66** | 706 | **39** | 423 | **32** | 343 | **211** | 2276 |
| **17.9** | 632 | **1816** | 1069 | **67** | 724 | **40** | 434 | **33** | 352 | **223** | 2396 |

Table 7: Minimum Circulation Airflow and Room Area for a Given Charge (Continued)

| Charge of Largest Circuit in kg (oz) | | Min Circulation Airflow in m³/hr. (CFM) | | Minimum Room Area in m2 (ft2) | | | | | | Floor area for unventilated storage | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.8 m (6 ft) ceiling/release height | | 3 m (10 ft) ceiling/release height | | 3.7 m (12 ft) ceiling/release height | | | |
| **18.4** | 648 | **1862** | 1096 | **69** | 742 | **41** | 445 | **34** | 361 | **234** | 2519 |
| **18.8** | 664 | **1908** | 1123 | **71** | 761 | **42** | 456 | **34** | 370 | **246** | 2645 |
| **19.3** | 680 | **1954** | 1150 | **72** | 779 | **43** | 467 | **35** | 379 | **258** | 2774 |
| **19.7** | 696 | **2000** | 1177 | **74** | 797 | **44** | 478 | **36** | 388 | **270** | 2906 |
| **20.2** | 712 | **2046** | 1204 | **76** | 816 | **45** | 489 | **37** | 397 | **283** | 3041 |
| **20.6** | 728 | **2092** | 1231 | **77** | 834 | **46** | 500 | **38** | 406 | **295** | 3180 |
| **21.1** | 744 | **2138** | 1258 | **79** | 852 | **48** | 511 | **39** | 415 | **309** | 3321 |
| **21.5** | 760 | **2184** | 1285 | **81** | 871 | **49** | 522 | **39** | 424 | **322** | 3465 |
| **22.0** | 776 | **2230** | 1312 | **83** | 889 | **50** | 533 | **40** | 432 | **336** | 3613 |
| **22.5** | 792 | **2276** | 1339 | **84** | 907 | **51** | 544 | **41** | 441 | **350** | 3763 |
| **24.1** | 850 | **2442** | 1437 | **90** | 974 | **54** | 584 | **44** | 474 | **403** | 4335 |
| **24.6** | 866 | **2488** | 1465 | **92** | 992 | **55** | 595 | **45** | 483 | **418** | 4499 |
| **25.0** | 882 | **2534** | 1492 | **94** | 1010 | **56** | 606 | **46** | 491 | **434** | 4667 |
| **25.5** | 900 | **2586** | 1522 | **96** | 1031 | **57** | 619 | **47** | 502 | **451** | 4859 |

Table 8: R-454B Refrigerant Temperature-Pressure Chart (Metric)

| °C | KPA | °C | KPA | °C | KPA | °C | KPA | °C | KPA |
|---|---|---|---|---|---|---|---|---|---|
| **-6.7** | 484.5 | **8.3** | 843.3 | **23.3** | 1348.0 | **38.3** | 2034.6 | **53.3** | 2946.9 |
| **-6.1** | 495.6 | **8.9** | 859.3 | **23.9** | 1370.0 | **38.9** | 2064.1 | **53.9** | 2985.7 |
| **-5.6** | 506.9 | **9.4** | 875.3 | **24.4** | 1392.2 | **39.4** | 2093.9 | **54.4** | 3024.9 |
| **-5.0** | 518.2 | **10.0** | 891.6 | **25.0** | 1414.6 | **40.0** | 2123.9 | **55.0** | 3064.5 |
| **-4.4** | 529.7 | **10.6** | 908.1 | **25.6** | 1437.3 | **40.6** | 2154.3 | **55.6** | 3104.5 |
| **-3.9** | 541.5 | **11.1** | 924.8 | **26.1** | 1460.3 | **41.1** | 2185.0 | **56.1** | 3144.9 |
| **-3.3** | 553.3 | **11.7** | 941.7 | **26.7** | 1483.5 | **41.7** | 2216.1 | **56.7** | 3185.8 |
| **-2.8** | 565.4 | **12.2** | 958.8 | **27.2** | 1507.0 | **42.2** | 2247.4 | **57.2** | 3227.0 |
| **-2.2** | 577.6 | **12.8** | 976.2 | **27.8** | 1530.8 | **42.8** | 2279.1 | **57.8** | 3268.6 |
| **-1.7** | 589.9 | **13.3** | 993.7 | **28.3** | 1554.8 | **43.3** | 2311.1 | **58.3** | 3310.7 |
| **-1.1** | 602.5 | **13.9** | 1011.5 | **28.9** | 1579.0 | **43.9** | 2343.5 | **58.9** | 3353.2 |
| **-0.6** | 615.2 | **14.4** | 1029.4 | **29.4** | 1603.6 | **44.4** | 2376.2 | **59.4** | 3396.1 |
| **0.0** | 628.1 | **15.0** | 1047.6 | **30.0** | 1628.4 | **45.0** | 2409.2 | **60.0** | 3439.5 |
| **0.6** | 641.2 | **15.6** | 1066.0 | **30.6** | 1653.5 | **45.6** | 2442.6 | **60.6** | 3483.3 |
| **1.1** | 654.4 | **16.1** | 1084.7 | **31.1** | 1678.8 | **46.1** | 2476.2 | **61.1** | 3527.6 |
| **1.7** | 667.8 | **16.7** | 1103.5 | **31.7** | 1704.4 | **46.7** | 2510.3 | **61.7** | 3572.3 |
| **2.2** | 681.4 | **17.2** | 1122.6 | **32.2** | 1730.4 | **47.2** | 2544.7 | **62.2** | 3617.4 |
| **2.8** | 695.2 | **17.8** | 1141.9 | **32.8** | 1756.6 | **47.8** | 2579.4 | **62.8** | 3663.0 |
| **3.3** | 709.2 | **18.3** | 1161.5 | **33.3** | 1783.0 | **48.3** | 2614.5 | **63.3** | 3709.2 |
| **3.9** | 723.3 | **18.9** | 1181.3 | **33.9** | 1809.9 | **48.9** | 2650.0 | **63.9** | 3755.7 |
| **4.4** | 737.6 | **19.4** | 1201.3 | **34.4** | 1836.9 | **49.4** | 2685.7 | **64.4** | 3802.7 |
| **5.0** | 752.2 | **20.0** | 1221.5 | **35.0** | 1864.3 | **50.0** | 2721.9 | **65.0** | 3850.3 |
| **5.6** | 766.9 | **20.6** | 1242.0 | **35.6** | 1891.9 | **50.6** | 2758.5 | **65.6** | 3898.4 |
| **6.1** | 781.8 | **21.1** | 1262.8 | **36.1** | 1919.8 | **51.1** | 2795.4 | | |
| **6.7** | 796.9 | **21.7** | 1283.7 | **36.7** | 1948.1 | **51.7** | 2832.7 | | |
| **7.2** | 812.2 | **22.2** | 1304.9 | **37.2** | 1976.7 | **52.2** | 2870.4 | | |
| **7.8** | 827.7 | **22.8** | 1326.3 | **37.8** | 2005.5 | **52.8** | 2908.4 | | |

Table 9: R-454B Refrigerant Temperature-Pressure Chart (Imperial)

| °F | PSIG | °F | PSIG | °F | PSIG | °F | PSIG | °F | PSIG |
|---|---|---|---|---|---|---|---|---|---|
| **20** | 70.3 | **47** | 122.3 | **74** | 195.5 | **101** | 295.1 | **128** | 427.4 |
| **21** | 71.9 | **48** | 124.6 | **75** | 198.7 | **102** | 299.4 | **129** | 433.0 |
| **22** | 73.5 | **49** | 127.0 | **76** | 201.9 | **103** | 303.7 | **130** | 438.7 |
| **23** | 75.2 | **50** | 129.3 | **77** | 205.2 | **104** | 308.0 | **131** | 444.5 |
| **24** | 76.8 | **51** | 131.7 | **78** | 208.5 | **105** | 312.5 | **132** | 450.3 |
| **25** | 78.5 | **52** | 134.1 | **79** | 211.8 | **106** | 316.9 | **133** | 456.1 |
| **26** | 80.3 | **53** | 136.6 | **80** | 215.2 | **107** | 321.4 | **134** | 462.0 |
| **27** | 82.0 | **54** | 139.1 | **81** | 218.6 | **108** | 326.0 | **135** | 468.0 |
| **28** | 83.8 | **55** | 141.6 | **82** | 222.0 | **109** | 330.6 | **136** | 474.1 |
| **29** | 85.6 | **56** | 144.1 | **83** | 225.5 | **110** | 335.2 | **137** | 480.2 |
| **30** | 87.4 | **57** | 146.7 | **84** | 229.0 | **111** | 339.9 | **138** | 486.3 |
| **31** | 89.2 | **58** | 149.3 | **85** | 232.6 | **112** | 344.6 | **139** | 492.6 |
| **32** | 91.1 | **59** | 151.9 | **86** | 236.2 | **113** | 349.4 | **140** | 498.8 |
| **33** | 93.0 | **60** | 154.6 | **87** | 239.8 | **114** | 354.3 | **141** | 505.2 |
| **34** | 94.9 | **61** | 157.3 | **88** | 243.5 | **115** | 359.1 | **142** | 511.6 |
| **35** | 96.9 | **62** | 160.1 | **89** | 247.2 | **116** | 364.1 | **143** | 518.1 |
| **36** | 98.8 | **63** | 162.8 | **90** | 251.0 | **117** | 369.1 | **144** | 524.6 |
| **37** | 100.8 | **64** | 165.6 | **91** | 254.8 | **118** | 374.1 | **145** | 531.3 |
| **38** | 102.9 | **65** | 168.5 | **92** | 258.6 | **119** | 379.2 | **146** | 538.0 |
| **39** | 104.9 | **66** | 171.3 | **93** | 262.5 | **120** | 384.3 | **147** | 544.7 |
| **40** | 107.0 | **67** | 174.2 | **94** | 266.4 | **121** | 389.5 | **148** | 551.5 |
| **41** | 109.1 | **68** | 177.2 | **95** | 270.4 | **122** | 394.8 | **149** | 558.4 |
| **42** | 111.2 | **69** | 180.1 | **96** | 274.4 | **123** | 400.1 | **150** | 565.4 |
| **43** | 113.4 | **70** | 183.1 | **97** | 278.4 | **124** | 405.4 | | |
| **44** | 115.6 | **71** | 186.2 | **98** | 282.5 | **125** | 410.8 | | |
| **45** | 117.8 | **72** | 189.3 | **99** | 286.7 | **126** | 416.3 | | |
| **46** | 120.0 | **73** | 192.4 | **100** | 290.9 | **127** | 421.8 | | |

The following tables are available to help with estimating the initial charge to add based on refrigerant line lengths; however, the final refrigerant charge must be based on the sub-cooling and superheat values as discussed in the prior section.

Table 10: Estimated R-454B Refrigerant Charge per 1.5 meters

| Liquid Line (mm) od | Additional R454B charge per 1.5m of line (kg)* | Suction Line (mm) od | Additional R454B charge per 1.5m of line (kg)* | Reheat Line (mm) od | Additional R454B charge per 1.5m of line (kg)* | Hot Gas Bypass Line (mm) od | Additional R454B charge per 1.5m of line (kg)* |
|---|---|---|---|---|---|---|---|
| 9.5 | 0.073 | 9.5 | 0.003 | 9.5 | 0.007 | 9.5 | 0.005 |
| 12.7 | 0.144 | 12.7 | 0.005 | 12.7 | 0.014 | 12.7 | 0.010 |
| 15.9 | 0.233 | 15.9 | 0.009 | 15.9 | 0.022 | 15.9 | 0.016 |
| 19.1 | 0.336 | 19.1 | 0.012 | 19.1 | 0.032 | 19.1 | 0.023 |
| 22.2 | 0.467 | 22.2 | 0.018 | 22.2 | 0.044 | 22.2 | 0.031 |
| 28.6 | 0.795 | 28.6 | 0.030 | 28.6 | 0.075 | 28.6 | 0.053 |
| 34.9 | | 34.9 | 0.044 | 34.9 | 0.111 | 34.9 | 0.079 |

*at SCT = 35°C & Subcooling = 5.6°C, SST = 13.7°C & Superheat = 5.6°C

Table 11: Estimated R-454B Refrigerant Charge per 5 feet

| Liquid Line | Additional R454B charge per 5 ft of line (oz)* | Suction Line | Additional R454B charge per 5 ft of line (oz)* | Reheat Line | Additional R454B charge per 5 ft of line (oz)* | Hot Gas Bypass Line | Additional R454B charge per 5 ft of line (oz)* |
|---|---|---|---|---|---|---|---|
| 3/8od | 2.58 | 3/8od | 0.10 | 3/8od | 0.24 | 3/8od | 0.17 |
| 1/2od | 5.08 | 1/2od | 0.19 | 1/2od | 0.48 | 1/2od | 0.34 |
| 5/8od | 8.23 | 5/8od | 0.31 | 5/8od | 0.77 | 5/8od | 0.55 |
| 3/4od | 11.85 | 3/4od | 0.44 | 3/4od | 1.12 | 3/4od | 0.80 |
| 7/8od | 16.46 | 7/8od | 0.62 | 7/8od | 1.55 | 7/8od | 1.11 |
| 1-1/8od | 28.06 | 1-1/8od | 1.05 | 1-1/8od | 2.64 | 1-1/8od | 1.88 |
| 1-3/8od | | 1-3/8od | 1.56 | 1-3/8od | 3.90 | 1-3/8od | 2.78 |

*at SCT = 115°F & Subcooling = 10°F, SST = 45°F & Superheat = 10°F

*Special Low Ambient Option Charging Instructions*

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

If the ambient temperature is above 21°C (70°F), charge to approximately 0.6-1.1°C (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. For units with Microchannel Condenser coils, use Table 12to find the additional charge amount required for the system when running in cold ambient conditions.

Table 12: Charge to Flood Microchannel Condenser Coil for Ambient Above 21.3°C (70°F)

| CF Size | # of circuits | Per Circuit Charge kg (lbs.) |
|---|---|---|
| CF 2, 3, 4 | 1 | 2.5 (5.6) |
| CF 5, 6, 7 | 1 | 4.6 (10.2) |
| CF 9, 11 | 2 | 2.5 (5.6) |
| CF 13, 15 | 2 | 4.6 (10.2) |
| CF 16, 18 | 2 | 6 (13.3) |
| CF 20, 25, 30 | 2 | 6 (13.3) |
| CF 26, 31, 40 | 2 | 8.8 (19.5) |
| CF 50, 60 | 2 | 13.5 (29.8) |

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

1. If the ambient is below 21°C (70°F), charge to approximately 0.6-1.1°C (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 -17.8°C (0°F), no more charge is required. Ambient temperatures above -17.8°C (0°F) will require a percentage of the per circuit charge values from Table 12(for microchannel condenser coils). Using your ambient temperature, find the percentage value from Table 13, and multiply the Per Circuit Charge value from Table 12(for microchannel condenser coils) and the % value to determine the additional charge amount.

Table 13: % Charge to Flood Condenser Coil for Ambient Below 21.3°C (70°F)

| Condenser Ambient Temperature (°F) | % Per Circuit Charge from Table 12 |
|---|---|
| 15.6 (60) | 60% |
| 10.0 (50) | 37% |
| 4.4 (40) | 24% |
| -1.1 (30) | 15% |
| -6.7 (20) | 8% |
| -17.8 (0) | 0% |

2. Check the unit for proper operation once the ambient temperature is above 26.7°C (80°F).

Example: A CF size 50 with tandem compressors and Microchannel Condenser Coils where the ambient temperature is 4.4°C (40°F).

From Table 12- 29.8 lbs. refrigerant charge per circuit.

From Table 13 - 24% of Table 12 charge

Additional charge is needed for a unit with low ambient flooded condenser controls = 29.8 lbs. * 0.24 = 7.15 lbs. additional refrigerant charge per circuit.

## 6.9. Refrigerant Detection System

The unit is equipped with a Refrigerant Detection System (RDS) to detect leaked refrigerant within the conditioned airstream and in the cabinet. The RDS system consists of a mitigation board and refrigerant detection sensors in the conditioned airstream, and a cabinet with a corresponding mitigation board. In the event of a refrigerant leak that could leak into the occupied space, the RDS sensors will send an alarm to the mitigation board.

Applications using AAON VCC-X controls: In the event of an airstream RDS alarm in the air handler, compressor operation is disabled, and the indoor blower is enabled to provide circulation airflow in accordance with UL 60335-2-40. In the event of a Cabinet RDS alarm, compressor operation is disabled. The indoor blower and any form of heat will resume normal operation. In the event of a Gas Heat RDS alarm, compressor operation and gas heat operation are disabled. The indoor blower and any form of heat other than gas heat will resume normal operation. RDS alarm outputs are available via BACNet communication through the VCC-X controller.

For applications not using AAON VCC-X controls, mitigation board outputs will be wired to the respective unit's low-voltage terminal block. The CF has remote start/stop terminals to dictate compressor operation based on RDS alarm status from the corresponding Air Handler.

The previous statement is true for both Controls by Others and standalone CF units.

In all cases, the mitigation board will remain in alarm state for five minutes after the RDS sensor has cleared the alarm below the concentration setpoint. The mitigation board is equipped with an alarm output in the form of an NO/NC relay. For VAV applications and applications utilizing zone dampers, the VAV boxes and zone dampers must be wired to the mitigation board output to open all VAV boxes and zone dampers to allow for the required circulation airflow to prevent stagnation of leaked refrigerant. Other applications requiring additional refrigerant leak mitigation measures, as required by local code and ASHRAE 15, may be notified of detected refrigerant by this alarm output.

Verify functionality of RDS by removing the sensor connection at the mitigation board and ensuring that all sequences above take place, including the opening of VAV boxes and zone dampers, and additional mitigation procedures, if applicable.

Building fire and smoke systems may override the RDS alarm functions.

**CAUTION**

Refrigerant sensors may only be replaced with manufacturer-approved sensors.

**CAUTION**

*Expansion Valve Adjustment*:
Certain applications may allow the unit to bring in unconditioned air. Freeze protection needs to be considered in the final application.

**CAUTION**

Additional mitigation procedures or fault conditions initiated outside of AAON controls are the responsibility of the building Engineer and must give appropriate priority in accordance with local codes.

## 6.10. 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 12.8°C (55°F) ambient temperature.

AAON condenser fan head pressure control units can operate down to 1.7°C (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 -17.8°C (0°F) outside air temperature. See detailed information following.

### 6.10.1. 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 (689.5 - 3240.5 kPa [100-470 psi]) and pressure differential (241.3 - 1379 kPa [35-200 psi]) can be field adjusted using a flathead screwdriver. For example, if the head pressure is set to 2068.4 kPa (300psi), and the differential is set to 689.5 kPa (100psi), then fans will cut in at 2068.4 kPa (300psi) and cut out at 1379 kPa (200psi). Fan cycling and variable speed condenser fan head pressure control options allow mechanical cooling with ambient temperatures down to 1.7°C (35°F).


Figure 8: Adjustable Fan Cycling Switch

### 6.10.2. 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 the 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 10.6°C (35°F).

### 6.10.3. 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 pressure drop. 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 temperatures. 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.

## 6.11. LAC Valve

The Low Ambient Control (LAC) valve is a non-adjustable three-way valve that modulates in order to maintain the receiver pressure. As the receiver pressure drops below the valve setting (2034 kPa [295 psig] for R-454B), 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.

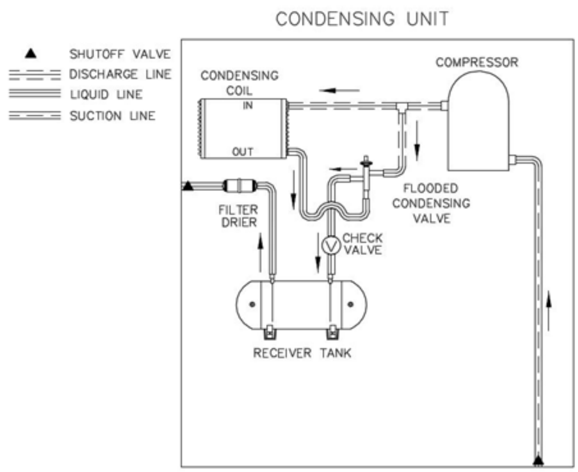



Figure 9: LAC Piping Example

**CAUTION**

*Refrigerant Piping*:
Line sizes must be selected to meet actual installation conditions, not simply based on the connection sizes at the condensing unit or air handling unit.

# 7. REFRIGERANT PIPING

(See the back of the manual for refrigerant piping diagrams)

**CAUTION**

*Refrigerant Piping*:
This section is for information only and is not intended to provide all details required by the designer or installer of the refrigerant piping between the condenser or condensing unit and the air handling unit. AAON, Inc. is not responsible for interconnecting refrigerant piping. Consult ASHRAE Handbook - Refrigeration and ASME Standards.

## 7.1. General

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

Use only clean type "ACR" rigid 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 must remain closed until the system is ready for start-up after installation.

Piping must conform to generally accepted practices and codes.

Care must be taken not to cross the circuits on multiple circuit systems.

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.

## 7.2. Determining Refrigerant Line Size

The piping between the condenser and low side must ensure:

1. Minimum pressure drop
2. Continuous oil return
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. To operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

### 7.2.1. 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. Do not run underground refrigerant lines.

## 7.3. 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 must 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.

### 7.3.1. Liquid Line Routing

Care must 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.

### 7.3.2. 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 the heating mode of operation.

### 7.3.3. 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 sub-cooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 0.56-1.1°C (1-2°F) change in saturation temperature. The sum of frictional losses (including valve losses, filter drier losses, other accessories, and line losses) and pressure loss due to vertical rise must not exceed 4.4°C (8°F) if the available sub-cooling is 6.7°C (12°F).

If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The maximum velocities for liquid lines are 100 fpm from the condenser to a receiver to discourage fluid backup, and 500 fpm from the receiver tank to the evaporator.

### 7.3.4. 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.

## 7.4. 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.

### 7.4.1. 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 position 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 the 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 must be sized to return oil at minimum load, while the larger diameter pipe must be sized so that flow through both pipes provides acceptable pressure drop at full load.

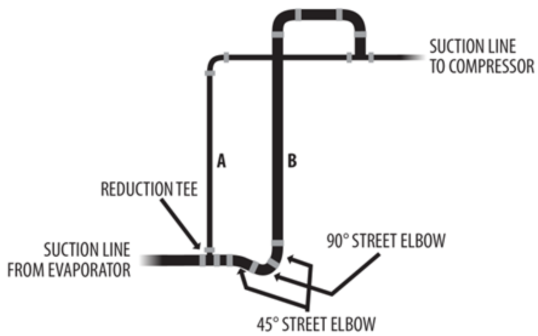



Figure 10: Double Suction Riser Construction

A double riser can also be used for heat pump operation. The specific volume ($ft^3$/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 11 & Figure 12), the cooling mode will use both lines, and the heating mode will use only one.

### 7.4.2. Suction Line Traps

Include traps every 6.1 meters (20 feet) in vertical suction riser sections for cooling only systems and every 3.7 meters (12 feet) for heat pump systems. Include a trap at the bottom of the vertical run.

### 7.4.3. Suction Line Insulation

The entire suction line must 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 must still be insulated in heat pump systems even though it acts as both a discharge and suction line.

### 7.4.4. Suction Line Guidelines

For proper performance, keep suction line velocities less than 4,000 fpm. 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.

A common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1.1°C (2°F) change in superheat temperature. Larger pressure losses in the suction line result in a greater loss of capacity.

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 pipe size 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 |
|---|
| *Suction Riser Traps*:<br>Circuits require suction riser traps every 20 feet. (every 12 feet for heat pumps) |

### 7.4.5. 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.

## 7.5. 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.

### 7.5.1. 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 must 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, the 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 the 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 must be sized to return oil at minimum load, while the larger diameter pipe must be sized so that flow through both pipes provides acceptable pressure drop at full load. (See the Double Suction Riser Construction Figure 10).

A double riser can also be used for heat pump operation. The specific volume ($ft^3$/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.

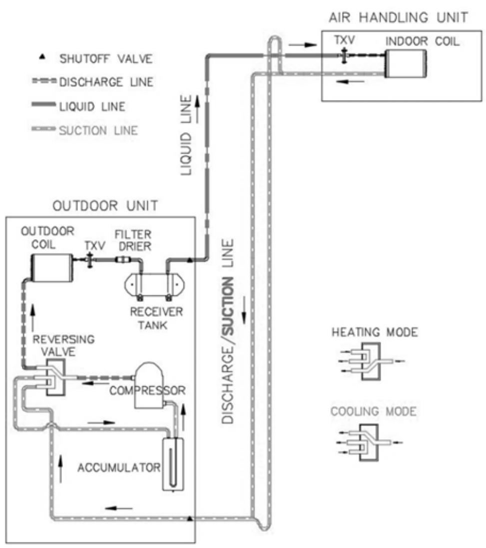



Figure 11: Heat Pump Piping Schematic of Cooling Mode in Double Riser

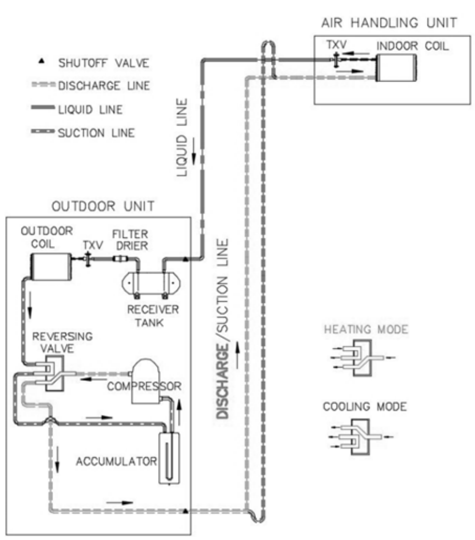



Figure 12: Heat Pump Piping Schematic of Heating Mode in Double Riser

### 7.5.2. Discharge Line Traps

Include traps every 3.7 meters (12 feet) in vertical discharge riser sections. Include a trap at the bottom of the vertical run.

### 7.5.3. 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.

### 7.5.4. Discharge Line Guidelines

For proper performance, keep discharge line velocities less than 17.8 m/s (3,500 fpm). The minimum velocity required to return oil is dependent on the pipe diameter; however, a general guideline of 4.6 m/s (900 fpm) minimum may be applied. When the discharge flow is up, variable capacity compressors require a minimum velocity of 4.6 m/s (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 the discharge flow is up, and the tandem has a variable capacity compressor, the velocity for only one compressor in operation must be greater than 4.6 m/s (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.

Another common guideline to consider is a system design with pressure losses due to friction through the line that does not exceed a corresponding 1.1°C (2°F) change in superheat 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 pipe size can be used on the horizontal runs and vertical drop sections. This helps with oil return, yet keeps the pressure drops to a minimum.

**CAUTION**

*Discharge Riser Traps*:
Circuits require discharge riser traps every 12 feet.

## 7.6. 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 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 falsely load the evaporator when reduced suction pressure is sensed. Field piping between the condensing unit and the evaporator is required.

### 7.6.1. 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 must be the same as the diameter of the riser, and a maximum of 25.4 cm (10”) long. Install a sight glass in the oil drip line for observation. Run an oil return line, using a 3.2 mm (1/8 inch) capillary tube, 3 meters (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.

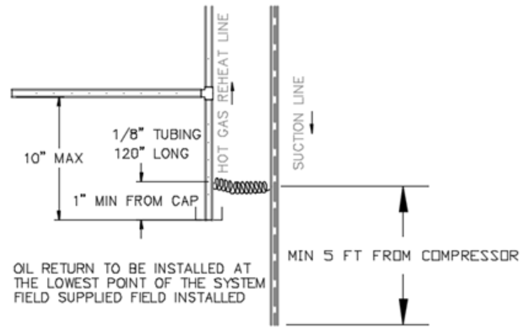



Figure 13: Oil Return Line

HGB valves are adjustable. Factory HGB valve settings will be sufficient for most applications, but may require slight adjustments for some applications, including some make up air applications.

Insulate the entire length of the HGB line with a minimum 2.5 cm (1 inch) thick Armaflex insulation.

### 7.6.2. Hot Gas Bypass Line Guidelines

Choose a small-sized line to ensure oil return and minimize refrigerant charge.

Maintain velocities below a maximum of 17.8 m/s (3,500 fpm). A general minimum velocity guideline to use is approximately 10.2 m/s (2,000 fpm).

## 7.7. 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 must be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and 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 must be the same as the diameter of the riser, and a maximum of

25.4 cm (10”) long. Install a sight glass in the oil drip line for observation. Run an oil return line, using 3.2 mm (1/8 inch) capillary tube, 3 meters (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 13)

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

### 7.7.1. Hot Gas Reheat Guidelines

Maintain velocities below a maximum of 17.8 m/s (3,500 fpm). A general minimum velocity guideline to use is approximately 10.2 m/s (2,000 fpm).

## 7.8. Electrical

The single-point electrical power connections are made in the electrical control compartment. For units not equipped with an incoming power disconnect, all pole disconnections must be provided in the fixed wiring in accordance with local or national codes.

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

Table 14: Nameplate Voltage Markings & Tolerances

| Hz | Nameplate Voltage | Nominal System Voltage | Operating Voltage Range[1] | | Acceptable Performance Range[2] | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max |
| 60 | 115 | 120 | 104 | 127 | 108 | 126 |
| | 208/230 | 208/240 | 187 | 254 | 187 | 252 |
| | 208 | 208 | 187 | 228 | 187 | 228 |
| | 230 | 240 | 208 | 254 | 216 | 252 |
| | 265 | 277 | 240 | 293 | 249 | 291 |
| | 460 | 480 | 416 | 508 | 432 | 504 |
| | 575 | 600 | 520 | 635 | 540 | 630 |
| 50 | 230 | 230 | 198 | 254 | 208 | 254 |
| | 400 | 400 | 344 | 440 | 360 | 440 |

**Notes**:

1. Operating voltage is the minimum and maximum voltage for which the unit can function. Never operate outside of the minimum and maximum voltages.
2. The Acceptable Performance Range is the minimum and maximum voltage for which the unit performance is designed and rated to give acceptable performance.

**WARNING**

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

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

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

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.

**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.

**CAUTION**

*Three-Phase Rotation*:
Rotation must be checked on all Motors and Compressors of three-phase units. Condenser fan motors must be checked by a qualified service technician at startup, and any wiring alterations must only be made at the unit's 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.

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.

All units require field-supplied electrical overcurrent and short circuit protection. The device must not be sized larger than the Maximum Overcurrent Protection (MOP) shown on the unit nameplate.

Supply voltage must be within the min/max range shown on the unit nameplate. Available short circuit current must not exceed the short circuit current rating (SCCR) shown on the unit nameplate.

Three phase voltage imbalances will cause motor overheating and premature failure. The maximum allowable imbalance is 2%. Voltage imbalance is defined as 100 times the maximum deviation from the average voltage divided by the average voltage.

Example:

(221V+230V+227V)/3 = 226V, then 100*(226V-221V)/226V = 2.2%, 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**

*Sealing Electrical Entries*:
The Installing Contractor is responsible for the proper sealing of the electrical entries into the unit. Failure to seal the entries may result in damage to the unit and property.

**Note**: A qualified 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 the 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 105°C (221°F) type AWM insulated conductors.

## 7.9. Fuses and Circuit Breakers

The interrupting rating of fuses and circuit breakers is to be determined based on the KAIC rating of the unit. Refer to the wiring diagram for fuse sizing.

Table 15: 35 KAIC Fuse Sizing

| 35 KAIC Construction | | |
|---|---|---|
| Component | Description | Interrupting Rating (kA) |
| Fuse | Class CC, 600V, 0.5A - 30A | 200 |
| Fuse | Class J, 600V, 35A - 600A | 200 |
| Disconnect | 3P, 600V, 15A - 600A | 35 |

Table 16: 65 KAIC Fuse Sizing

| 65 KAIC Construction | | |
|---|---|---|
| Component | Description | Interrupting Rating (kA) |
| Fuse | Class CC, 600V, 0.5A - 30A | 200 |
| Fuse | Class J, 600V, 35A - 600A | 200 |
| Disconnect | 3P, 600V, 15A - 600A | 65 |

**CAUTION**

Ensure that wires are protected from sharp edges, damage, wear caused by normal operation of the unit, and environmental factors.

# 8. OPERATION

## 8.1. Startup

(See back of the manual for startup form)

**WARNING**

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

**WARNING**

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.

Before the 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.

**CAUTION**

*Three-Phase Rotation*:
Rotation must be checked on all Motors and Compressors of three-phase units.
Condenser fan motors must all be checked by a qualified service technician at startup, and any wiring alteration must only be made at the unit's 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.

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

**CAUTION**

Before completing installation, a complete operating cycle must be observed to verify that all components are functioning properly.

## 8.2. Compressor Operation

The compressors must be off for a minimum of 3 minutes and on for a minimum of 5 minutes. Short cycling of the compressors can cause undue stress and wear.

**WARNING**

*Compressor Cycling*:
*3-Minute Minimum Off Time*-To prevent motor overheating, compressors must cycle off for a minimum of 3 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 seven starts per hour.

## 8.3. Microchannel Unit Restart Sequence

Units with microchannel condenser coils include a sequence of controls to allow additional compressor restarts without locking out the high-pressure switch on the compressors. This helps with the startup process when the microchannel coil is cold. The sequence allows four high-pressure trips with auto reset within the first 15 minutes after a compressor call, but will lock out the compressors on the fifth high-pressure trip. After the first 15 minutes of operation, one more restart is allowed, but the compressors will lockout if another fault occurs within 2 hours.

## 8.4. 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.


Figure 14: Variable Capacity Compressor Controller

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

## 8.5. 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 |

## 8.6. 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 Controller*:
To avoid damaging the compressor controller, do not connect wires to terminals C3, C4, T3, T4, T5, or T6.

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 18 for the relationship between thermistor temperature readings and resistance values.

Table 17: Demand Signal vs. Compressor Capacity Modulation

| Demand Signal (VDC) | Loaded % | Unloaded % | Time Loaded | Time Unloaded | % Compressor Capacity |
|---|---|---|---|---|---|
| 1.00 | Off | Off | Off | Off | 0% |
| 1.44 | 10% | 90% | 1.5 sec | 13.5 sec | 10% |
| 3.00 | 50% | 50% | 7.5 sec | 7.5 sec | 50% |
| 4.20 | 80% | 20% | 12 sec | 3 sec | 80% |
| 5.00 | 100% | 0% | 15 sec | 0 sec | 100% |

**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 1.0VDC.

Code 6 Discharge Thermistor Fault
Thermistor is not connected. Reset 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 rise above 19.5VAC.

Figure 15: Compressor Controller Flash Code Details

Table 18: Thermistor Temperature vs Resistance Values

| °C | °F | kΩ |
|---|---|---|
| -40 | -40 | 2889.60 |
| -35 | -31 | 2087.22 |
| -30 | -22 | 1522.20 |
| -25 | -13 | 1121.44 |
| -20 | -4 | 834.72 |
| -15 | 5 | 627.28 |
| -10 | 14 | 475.74 |
| -5 | 23 | 363.99 |
| 0 | 32 | 280.82 |
| 5 | 41 | 218.41 |
| 10 | 50 | 171.17 |
| 15 | 59 | 135.14 |
| 20 | 68 | 107.44 |
| 25 | 77 | 86.00 |
| 30 | 86 | 69.28 |
| 35 | 95 | 56.16 |
| 40 | 104 | 45.81 |
| 45 | 113 | 37.58 |
| 50 | 122 | 30.99 |
| 55 | 131 | 25.68 |
| 60 | 140 | 21.40 |
| 65 | 149 | 17.91 |
| 70 | 158 | 15.07 |
| 75 | 167 | 12.73 |
| 80 | 176 | 10.79 |
| 85 | 185 | 9.20 |
| 90 | 194 | 7.87 |
| 95 | 203 | 6.77 |
| 100 | 212 | 5.85 |
| 105 | 221 | 5.09 |
| 110 | 230 | 4.45 |
| 115 | 239 | 3.87 |
| 120 | 248 | 3.35 |
| 125 | 257 | 2.92 |
| 130 | 266 | 2.58 |
| 135 | 275 | 2.28 |
| 140 | 284 | 2.02 |
| 145 | 293 | 1.80 |
| 150 | 302 | 1.59 |
| 155 | 311 | 1.39 |
| 160 | 320 | 1.25 |
| 165 | 329 | 1.12 |
| 170 | 338 | 1.01 |
| 175 | 347 | 0.92 |
| 180 | 356 | 0.83 |

## 8.7. Compressor Lockouts

Some units include adjustable compressor lockouts. The compressor lockout in the picture below can be set to any temperature between -23.3°C and 21.1°C (-10°F and 70°F). The ambient temperature sensor hangs right outside the unit with a cover.

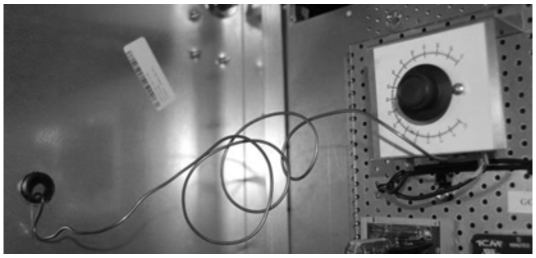


Figure 16: Adjustable Compressor Lockout

Heat pump units include a non-adjustable compressor lockout for the cooling mode set to 12.8°C (55°F), and an adjustable compressor lockout for the heating mode that can be set between -6.7°C (20°F) to 35°C (95°F). If a heat pump is selected with the compressor lockout feature, the adjustable compressor lockout will change to the -23.3°C and 21.1°C (-10°F and 70°F) range.

Figure 17: Ambient Sensor Cover

# 9. MAINTENANCE

## 9.1. 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.

## 9.2. Compressors

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

## 9.3. Refrigerant Filter Driers

Each refrigerant circuit contains a filter drier. Replace when there is excessive pressure drop across the assembly or moisture is indicated in a liquid line sight glass.

Table 19: Max Filter Drier Pressure Drops

| Circuit Loading | Max. Pressure Drop |
|---|---|
| 100% | 69 kPa (10 psig) |
| 50% | 34.5 kPa (5 psig) |

### 9.3.1. 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 10003396.

Proper oil levels must 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 must be a minimum of ⅜ from the bottom of the sight glass. With both compressors running, the level in the lead compressor will drop to the bottom of the sight glass, and the level in the second compressor must 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.

## 9.4. Lubrication

All original motors and bearings are furnished with an original factory charge of lubrication. Certain applications require bearings to be re-lubricated periodically. The schedule will vary depending on operating duty, temperature variations, or severe atmospheric conditions.

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

## 9.5. Condenser Coil Inspection

The coils are leak tested at 4482 kPa (650 psig) before shipment. AAON will not be responsible for the loss of refrigerant. It is the responsibility of the installer to verify that the system is sealed before charging with refrigerant.

## 9.6. Maintenance Requirements

### 9.6.1. Fan Motor Maintenance

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

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

### 9.6.2. Access Doors

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

### 9.6.3. Propeller Fans and Motors

The fans are directly mounted on the motor shafts, and the assemblies require minimal maintenance except to ensure they are clear of dirt or debris that would impede the airflow.

### 9.6.4. Required Annual Inspection

In addition to the above maintenance activities, a general inspection of the unit surface must be completed at least once a year.

### 9.6.5. Air-Cooled Condenser

The air-cooled condenser section rejects heat by passing outdoor air over the condenser coils used for cooling the hot refrigerant gas from the compressors.

Inspect the condenser coils annually to ensure unrestricted airflow. If the installation has a large amount of airborne dust or other material, clean the condenser coils with a water spray in a direction opposite to airflow. Care must be taken to prevent damage to the coils.

## 9.7. Microchannel Coil Cleaning

Cleaning microchannel coils is necessary in all locations. In some locations, it may be necessary to clean the coils more or less often than recommended. The condenser coil must be cleaned at a minimum of once a year. In locations where there is commonly debris or a condition that causes dirt/grease buildup, it may be necessary to clean the coils more often. Proper procedure must be followed at every cleaning interval. Using improper cleaning techniques or incorrect chemicals will result in coil damage, system performance, fall off, and potentially leaks requiring coil replacement.

Documented routine cleaning of microchannel coils with factory-provided e-coating is required to maintain coating warranty coverage. Use the E-Coated Coil Cleaning section for details on cleaning e-coated coils.

Field-applied coil coatings are not recommended with microchannel coils.

### 9.7.1. Allowed Chemical Cleaners and Procedures

AAON recommends certain chemicals that can be used to remove the buildup of grime and debris on the surface of microchannel coils. These chemicals have been tested for performance and safety and are the only chemicals that AAON will warrant as correct for cleaning microchannel coils.

There are two procedures that are outlined below that will clean the coils effectively without damage to the coils. Use of any other procedure or chemical may void the warranty on the unit where the coil is installed. With all procedures, make sure the unit is off before starting.

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

The water pressure used to clean must not exceed 689.5 kPa (100 psi), from no closer than 15.25 centimeters (6 inches) from the coils, and with the water aimed perpendicular to the coils.

#### 9.7.1.1. #1 Simple Green

Simple Green is available from AAON Parts and Supply (Part# T10701) and is biodegradable with a neutral 6.5 pH A 4 to 1 solution is recommended. Use the following procedure.

1. Rinse the coil completely with water. Use a hard spray but be careful not to bend or damage the fins. A spray that is too hard will bend the fins. Spray from the fan side of the coil.
2. With a pump sprayer filled with a mix of four parts water to one-part Simple Green spray the air inlet face of the coil. Be sure to cover all areas of the face of the coil.
3. Allow the coil to soak for 10-15 minutes.
4. Rinse the coil with water as in step one.
5. Repeat as necessary.

#### 9.7.1.2. #2 Water Flush

This procedure can be used when the only material to cause the coil to need cleaning is debris from plant material that has impinged the coil face.

1. Rinse the coil completely with water. Use a hard spray, but be careful not to bend or damage the fins. A spray that is too hard will bend the fins. Spray from the fan side of the coil.
2. Spray and rinse the coil from the face.

| CAUTION |
|---|
| Use pressurized clean water, with pressure not to exceed 689.5 kPa (100 psi). The nozzle must be 15.25 cm (6”) and perpendicular to the coil face. Failure to do so could result in coil bending/damage. |

#### 9.7.1.2.1. Application Examples

The two procedures can be used to clean microchannel coils. They will fit with the application depending on the area. In some areas where the spring/summer has a large cottonwood bloom, #2 might work fine if the unit is installed on an office building and no other environmental factors apply.

Generally, the best and broadest based procedure is #1. The grease-cutting effect of Simple Green is good for restaurant applications.

### 9.7.2. Other Coil Cleaners

There are many cleaners on the market for condenser coils. Before using any cleaner that is not covered in this section, you must get written approval from the AAON warranty and service department. The use of unapproved chemicals will void the warranty.

AAON testing has determined that unless a chemical has a neutral pH (6-8), it must not be used.

Beware of any product that claims to be a foaming cleaner. The foam that is generated is caused by a chemical reaction of the aluminum fin material on the tube and fin coils, and with the fin, tube, and coating material on microchannel coils.

Microchannel coils are robust in many ways, but like any component, they must be treated correctly. This includes cleaning the coils correctly to give optimal performance over many years.

## 9.8. E-Coated Coil Cleaning

Documented routine cleaning of e-coated coils is required to maintain coating warranty coverage for condenser coils. The E-Coated Coil Maintenance Record sheet is provided in this document.

**WARNING**

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

Remove surface-loaded fibers or dirt prior to water rinse to prevent restriction of airflow. If unable to backwash the side of the coil opposite the coil's entering air side, then remove any surface-loaded fibers or dirt 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 must 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 a low-velocity clean water rinse.

A monthly clean water rinse is recommended for coils that are applied in coastal or industrial environments to help remove chlorides, dirt, and debris. It is very important when rinsing that the water temperature is less than 39.5°C (130°F) and pressure is less than 689.5 kPa (100 psi) to avoid damaging the fin edges. An elevated water temperature (not to exceed 39.5°C [130°F]) will reduce surface tension, increasing the ability to remove chlorides and dirt.

**CAUTION**

High-velocity water from a pressure washer or compressed air must only be used at a very low pressure to prevent fin and/or coil damage. The force of the water or air jet may bend the fin edges and increase the airside pressure drop. Reduced unit performance or nuisance unit shutdowns may occur.

**Quarterly cleaning is essential to extend the life of an e-coated coil and is required to maintain coating warranty coverage**. Coil cleaning must be part of the unit's regularly scheduled maintenance procedures. Failure to clean an e-coated coil will void the warranty and may result in reduced efficiency and durability.

**CAUTION**

Harsh chemicals, household bleach, or acid cleaners must not be used to clean e-coated coils. These cleaners can be very difficult to rinse out of the coil and can accelerate corrosion and attack the e-coating. If there is dirt below the surface of the coil, use the recommended coil cleaners.

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.

### 9.8.1. Recommended Coil Cleaner

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

- Enviro-Coil Cleaner: AAON PN: V82540
- GulfClean ™ Coil Cleaner ; AAON PN: G074480

### 9.8.2. Recommended Chloride Remover

GulfClean Salt Reducer™ ; AAON PN: G074490

GulfClean Salt Reducer™ is used to remove soluble salts from the e-coated coil. Follow the manufacturer's instructions. This product is not intended for use as a degreaser. Any grease or oil film must first be removed with GulfClean ™ Coil Cleaner.

**Remove Barrier**: First, ensure the power to the unit is off and locked out. Clean the area around the unit if needed to ensure leaves, grass, or loose debris will not be blown into the coil. Soluble salts adhere to the substrate. For the effective use of this product, the product must be able to come in contact with the salts. These salts may be beneath any soils, grease, or dirt; therefore, these barriers must be removed prior to application of this product. As in all surface preparation, the best work yields the best results.

**Application**: Apply GulfClean ™ Coil Cleaner directly onto the substrate. Sufficient product must be applied uniformly across the substrate to thoroughly wet out the surface, with no areas missed. This may be accomplished by the use of a pump-up sprayer or a conventional spray gun. Apply the cleaner to the unit's interior air exiting side coil surfaces first. Work in sections/panels, moving side to side and from top to bottom. Allow the cleaning solution to soak for 5 to 10 minutes. Then move on to the exterior using the same method.

**Rinse**: Using pressurized potable water, such as a garden hose, (< 689.5 kPa [100 psi]), rinse the coils and continue to always work in sections/panels.

Continue until all coil areas on the inside of the unit have been rinsed.

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

Repeat these steps with GulfClean ™ Salt Reducer. When finished, replace all of the panels and tops that were removed.

### 9.8.3. Refrigerant Removal and Evacuation

If removal of refrigerant is required for any maintenance or service, conventional procedures must be used, and removal of refrigerant must be in accordance with local and national regulations.

Safety precautions must be taken prior to beginning work to ensure that the risk of fire due to flammable refrigerants is minimized. Work is to be undertaken under a controlled procedure to reduce the amount of refrigerant vapor present while work is being performed. All maintenance staff and others working in the area need to be instructed on the nature of work being performed. Care should be taken to ensure that working in a confined space is avoided.

**WARNING**

Prior to performing work that can result in the release of a flammable refrigerant, inspect the area to ensure it is free of any potential ignition sources. “No Smoking” signs are to be displayed while working.

Check area with a refrigerant detector suitable for use with the refrigerant prior to and during work in order to be aware of potential flammable environment. Keep a dry powder or $CO_2$ fire extinguisher nearby if any hot work is being performed.

Ensure that work area is sufficiently ventilated before breaking into the system. Ventilation must continue throughout all of the work. Ensure that ventilation safely removes flammable refrigerant to an area that will adequately disperse refrigerant to avoid concentration above flammable levels.

Refrigerant must be recovered into the correct recovery cylinders in accordance with local and national regulations. Recovery cylinders must be labeled properly. Ensure that the correct number of cylinders are available for holding the entire charge of the system. Cylinders must have pressure relief and shut-off valves that are in proper working order. Fully evacuate a recovery cylinder before use.

The recovery equipment must be in good working order with a set of instructions concerning the equipment that is at hand. Ensure that the equipment is suitable for the recovery of flammable refrigerant used. If there is any doubt, consult the manufacturer. Additionally, a set of calibrated weighing scales must be available and in good working order. Ensure that the hoses are complete with leak-free disconnect couplings and in good condition.

When removing refrigerant to open the system, evacuate the system and flush or purge the system continuously with an inert gas when using a flame to open the circuit. The system must be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerant. Compressed air or oxygen must not be used. When pulling a vacuum, ensure that the outlet of the vacuum pump is not near any potential ignition source and in a well-ventilated area.

The recovered refrigerant is to be processed according to local legislation in the correct recovery cylinder, and the relevant waste transfer note arranged. Do not mix refrigerants in recovery units and especially not in cylinders.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant. Do not heat the compressor body by using an open flame or other ignition sources to accelerate this process. Remove any drained oil safely.

## 9.9. 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 is permitted to service the systems to keep warranties in effect. If assistance is required, the service technician must contact AAON.

# 10. SPLIT SYSTEM REFRIGERANT PIPING DIAGRAMS

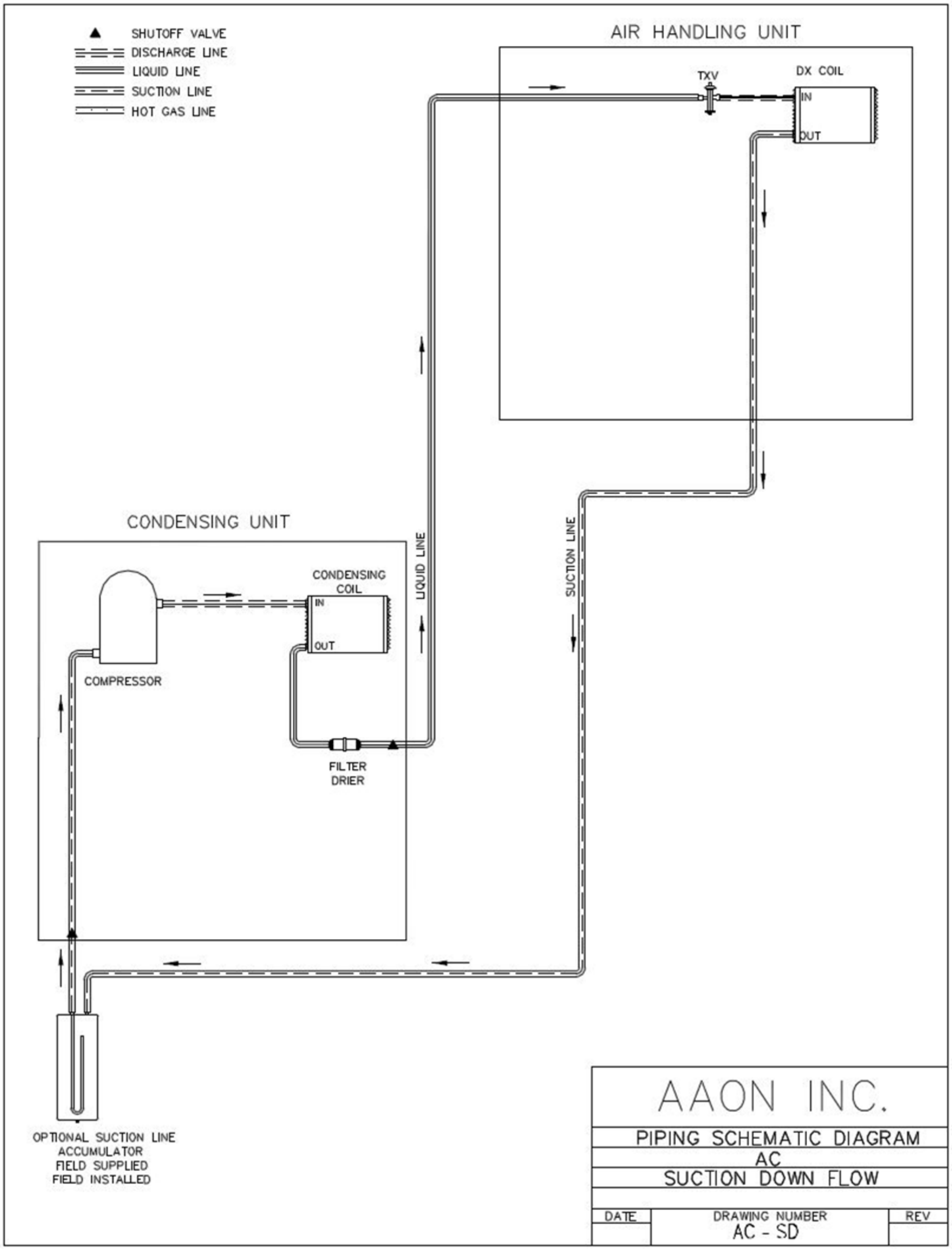



Figure 18: A/C Split System Piping, Suction Down

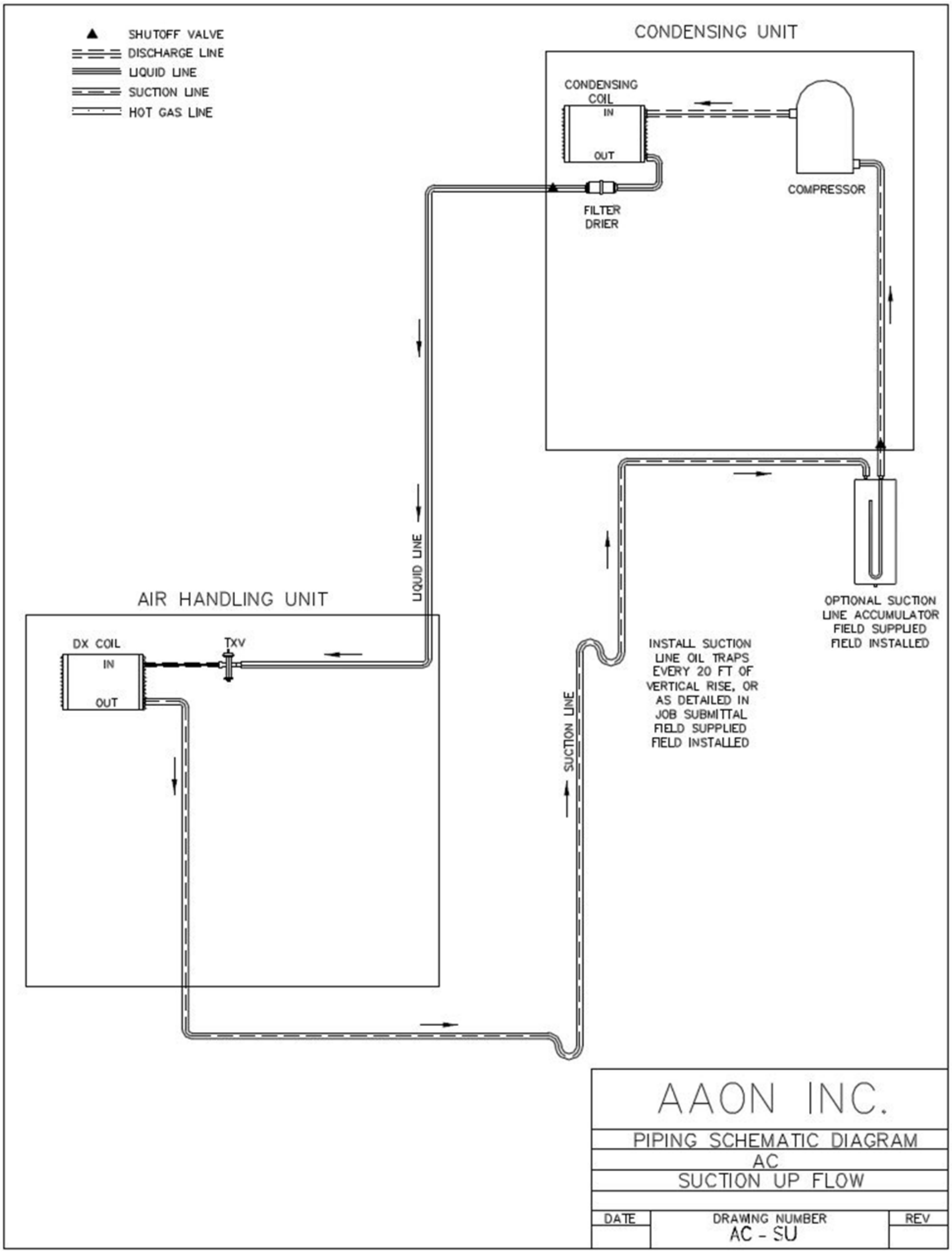



Figure 19: A/C Split System Piping, Suction Up

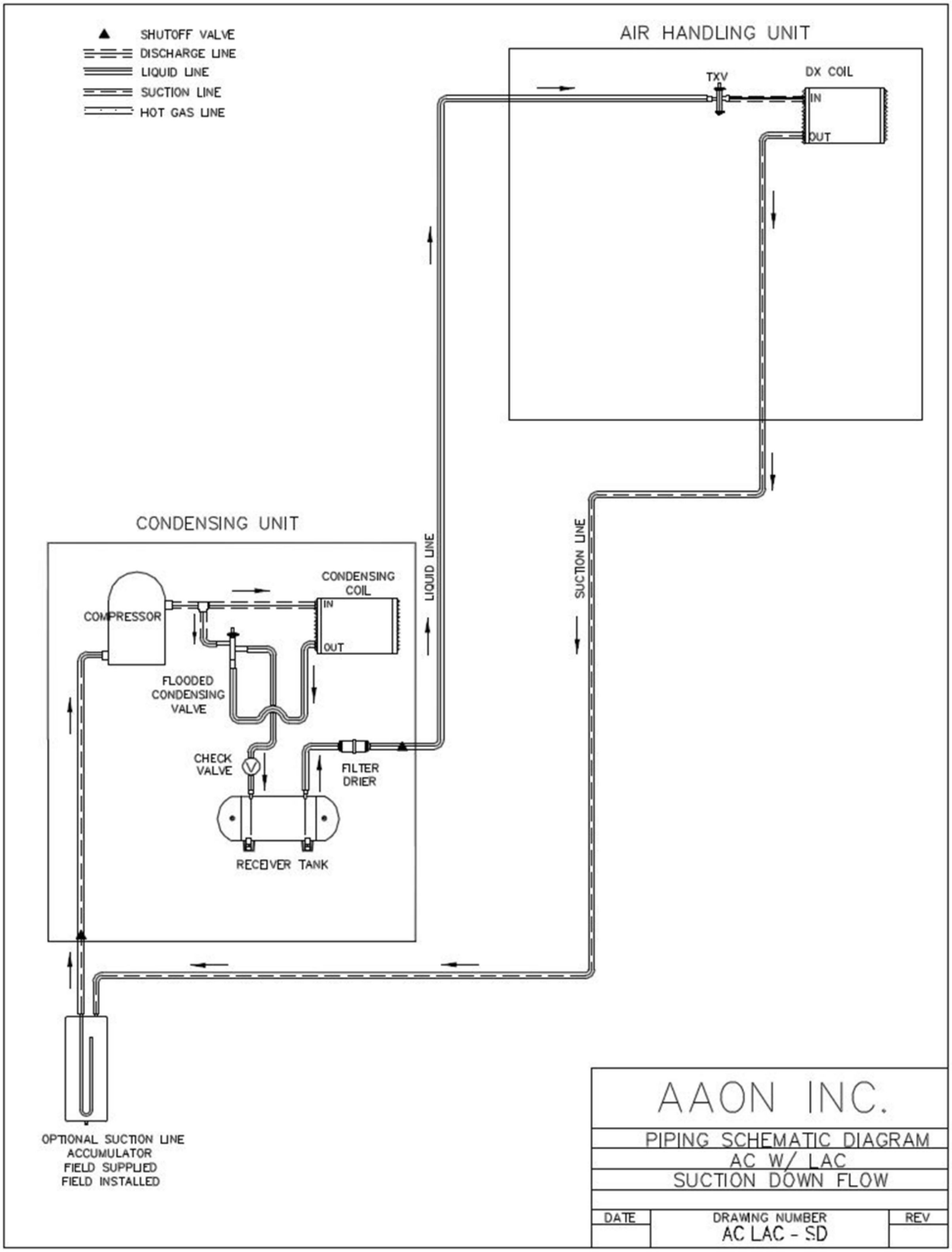



Figure 20: A/C with LAC Split System Piping, Suction Down

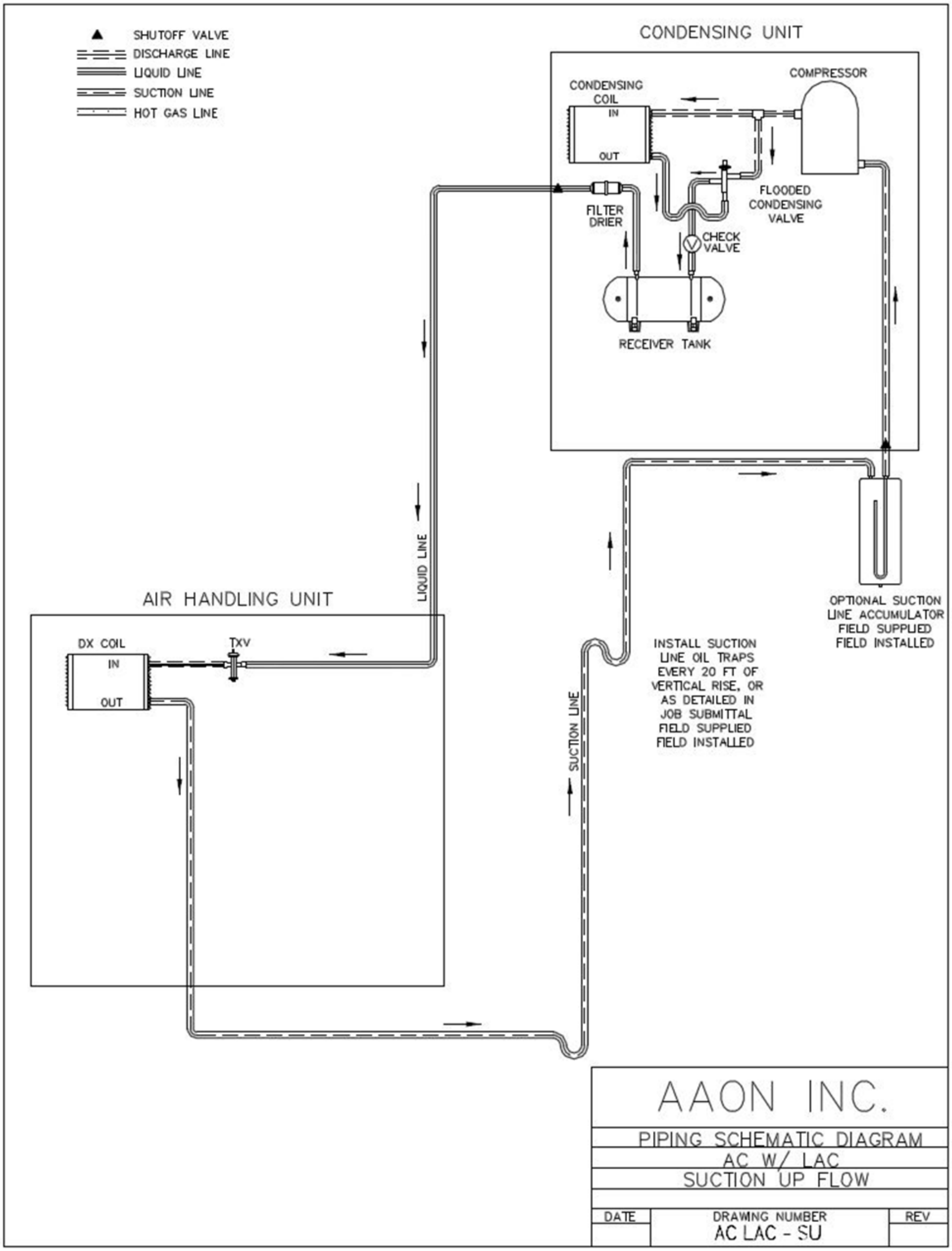



Figure 21: A/C with LAC Split System Piping, Suction Up

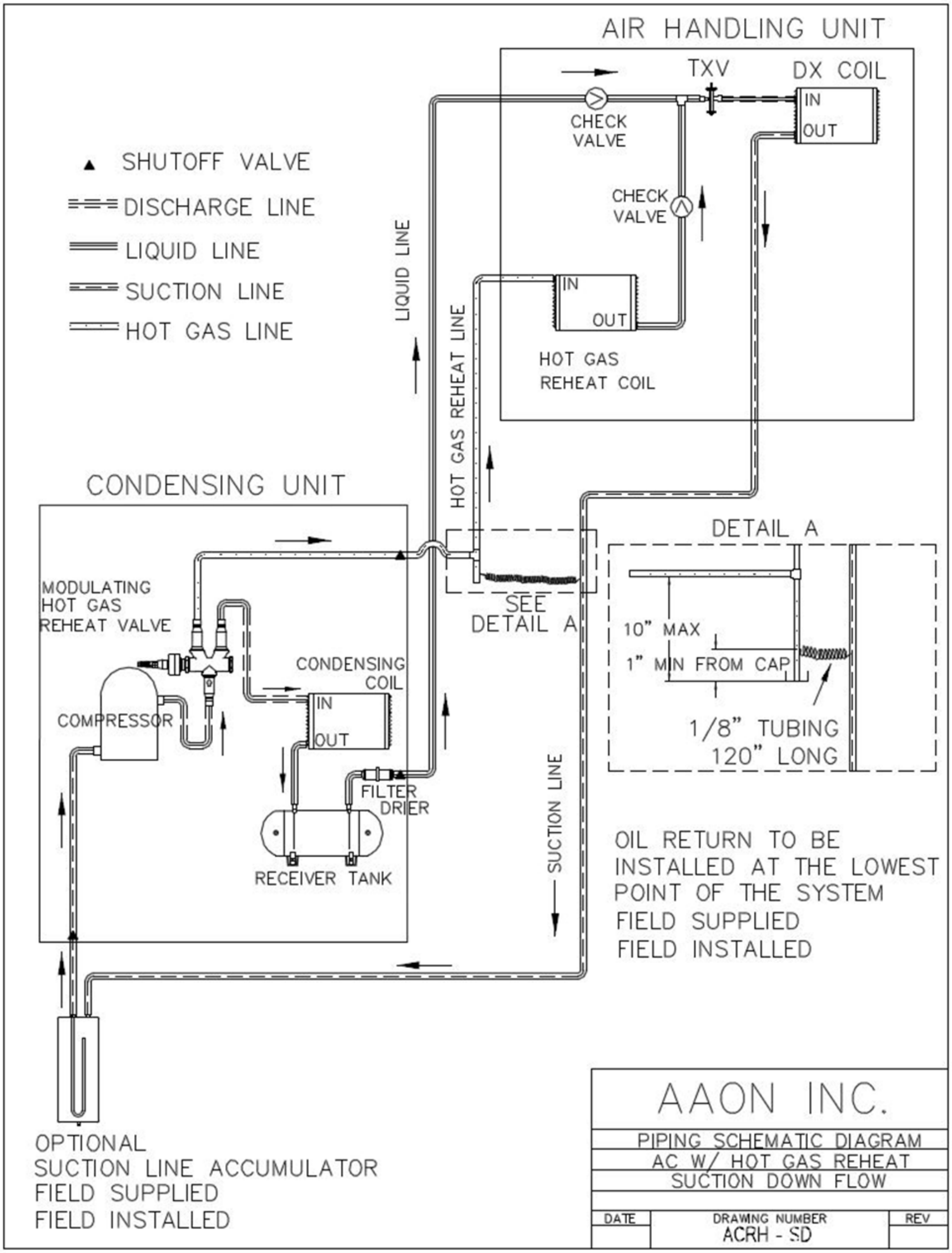



Figure 22: A/C with Modulating Hot Gas Reheat Split System Piping, Suction Down

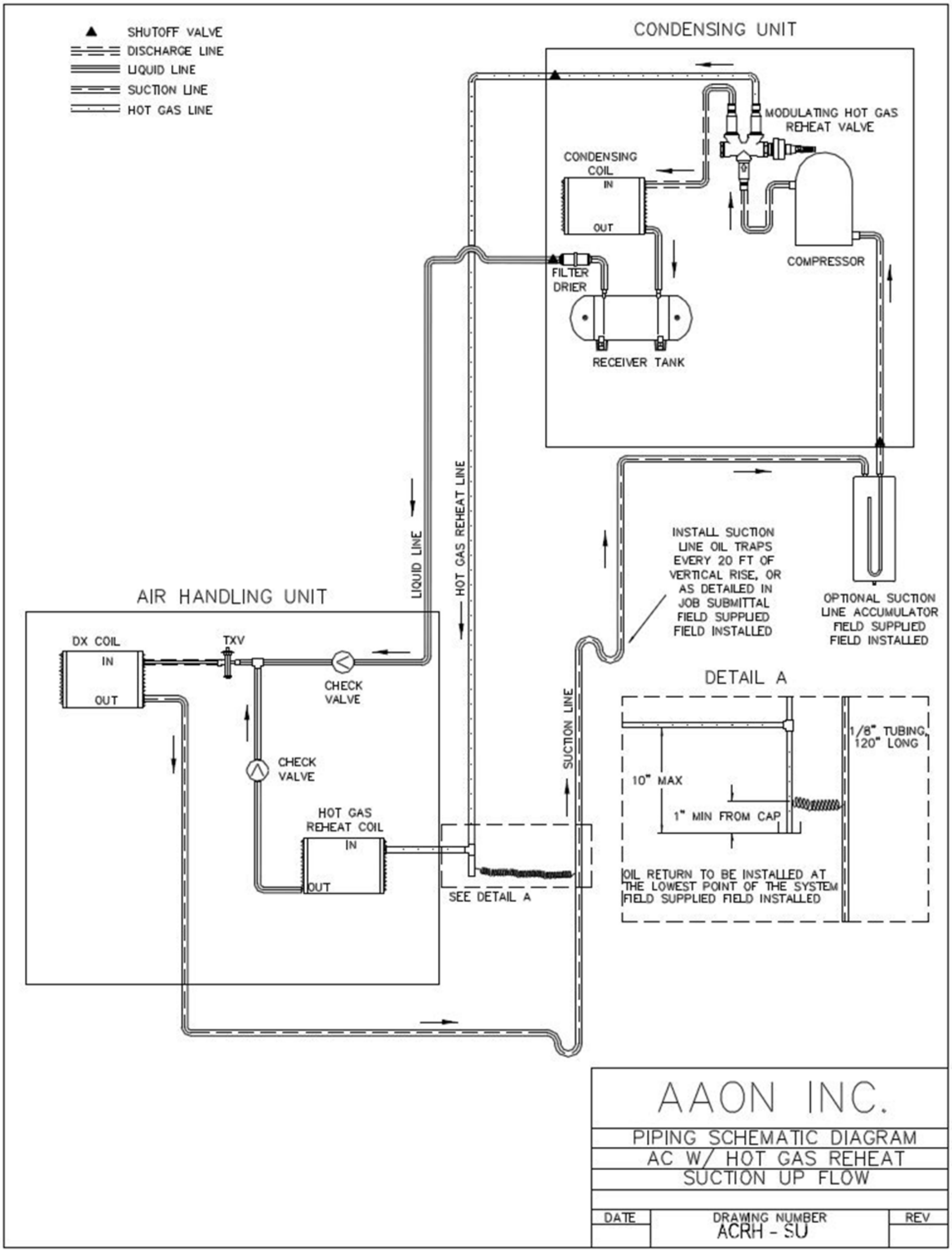



Figure 23: A/C with Modulating Hot Gas Reheat Split System Piping, Suction Up

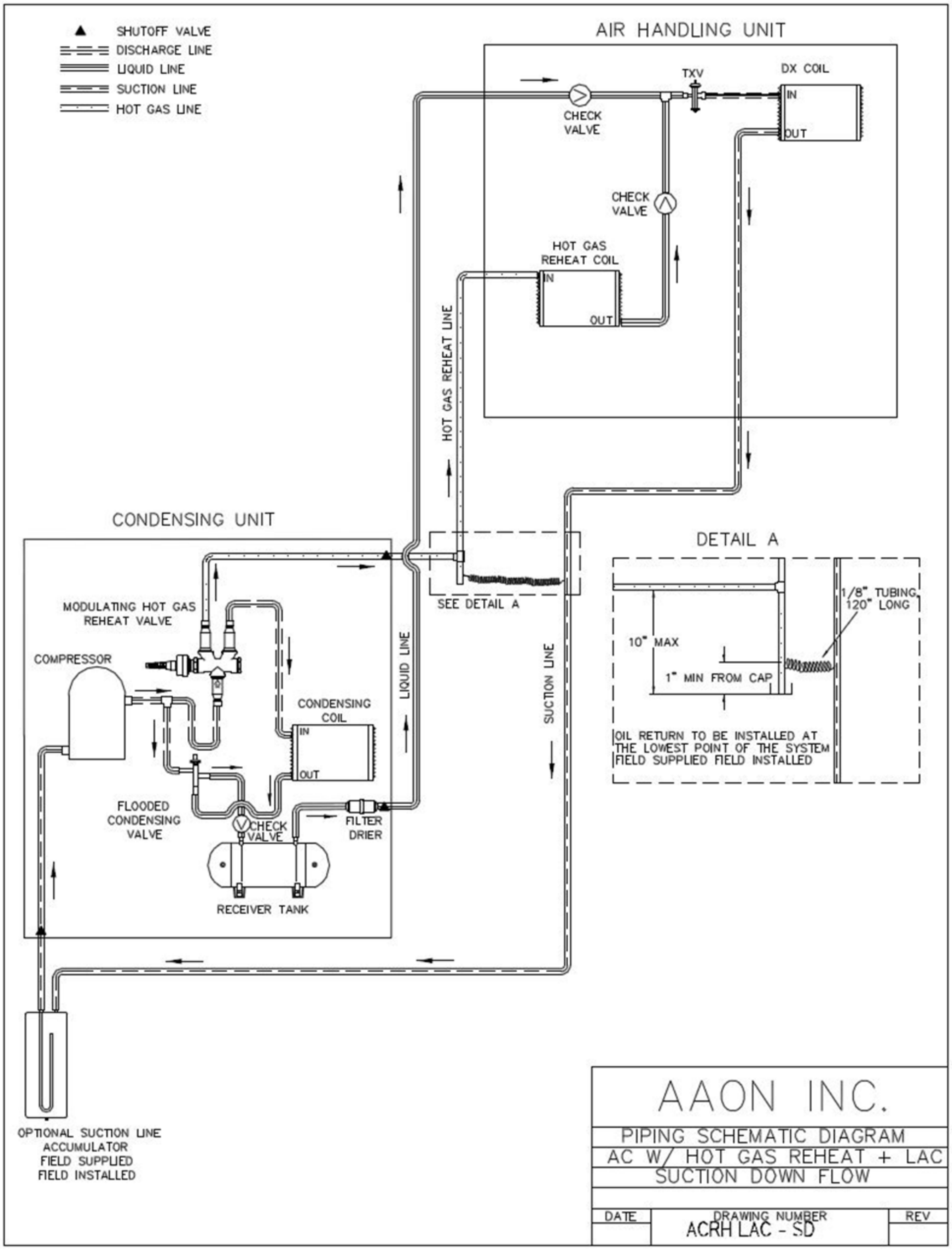



Figure 24: A/C with Modulating Hot Gas Reheat Split + LAC System Piping, Suction Down

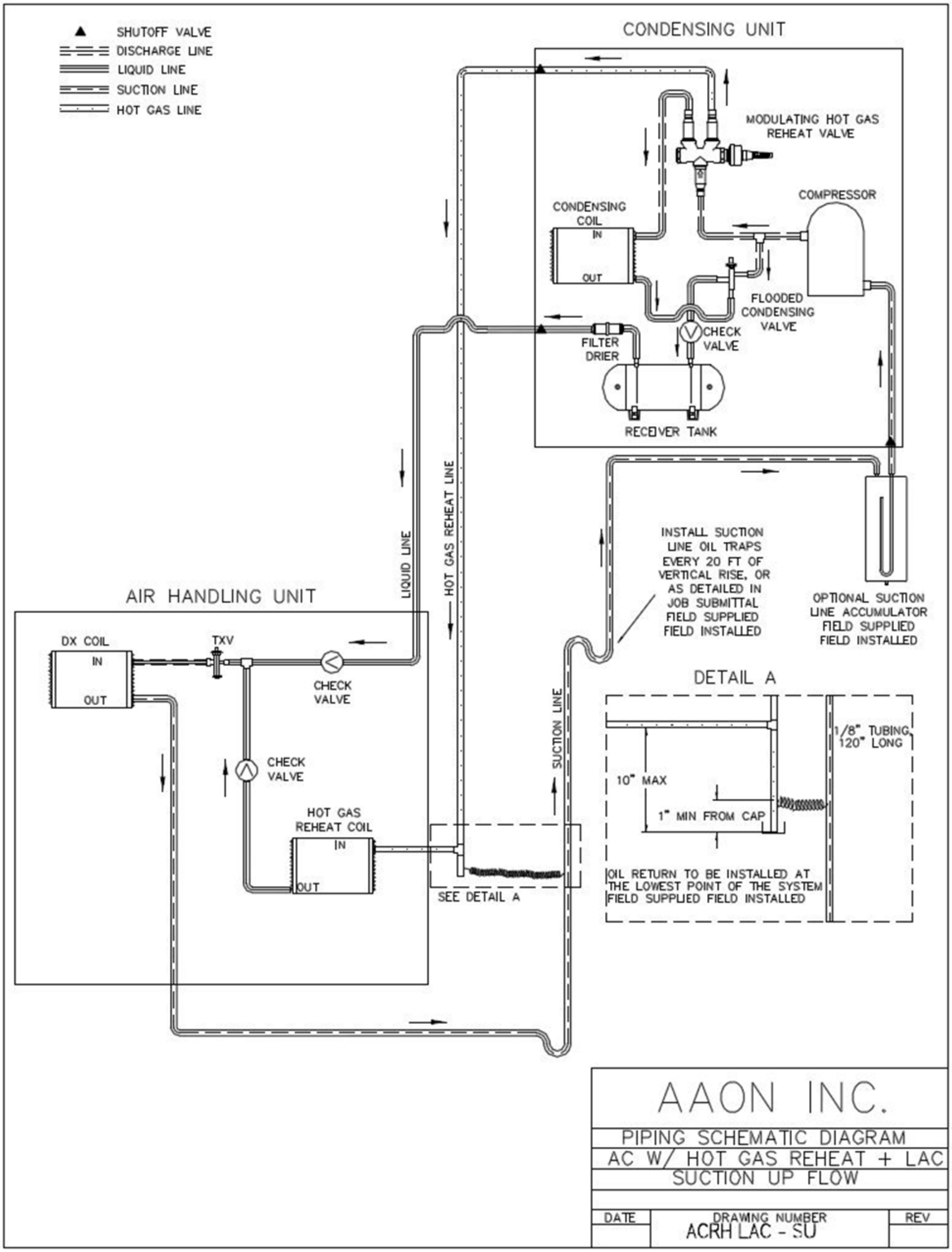



Figure 25: A/C with Modulating Hot Gas Reheat Split + LAC System Piping, Suction Up

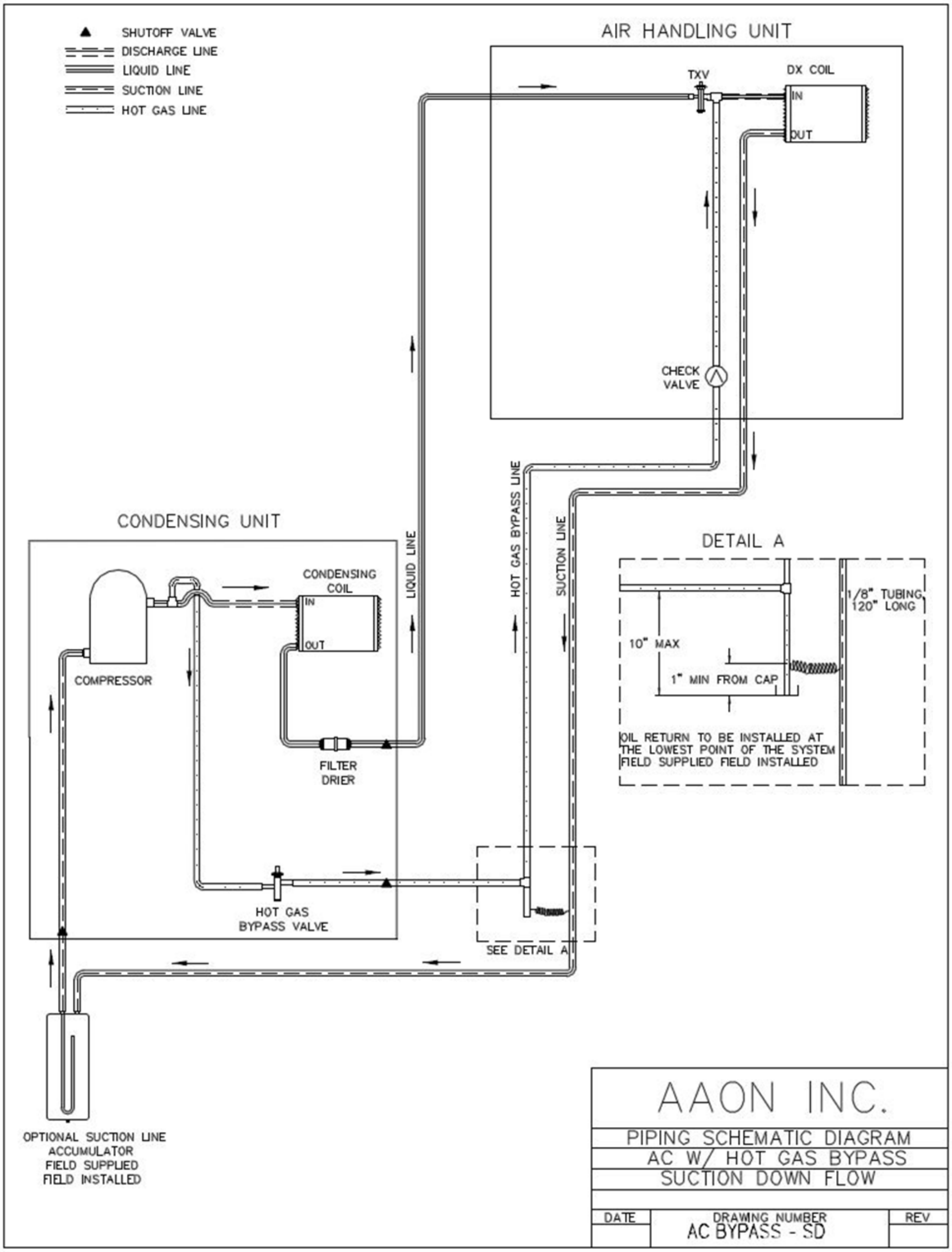



Figure 26: A/C with Hot Gas Bypass Split System Piping, Suction Down

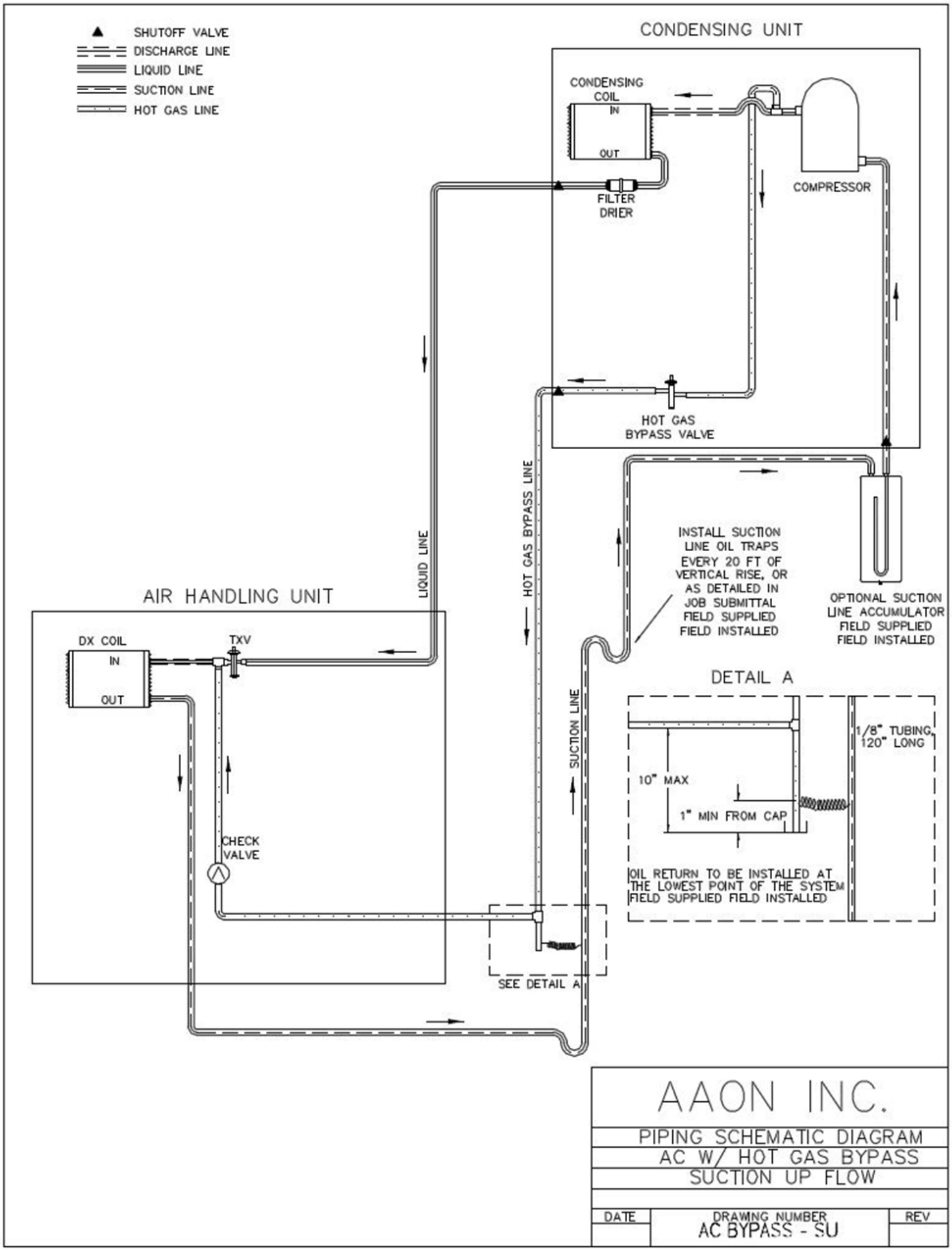



Figure 27: A/C with Hot Gas Bypass Split System Piping, Suction Up

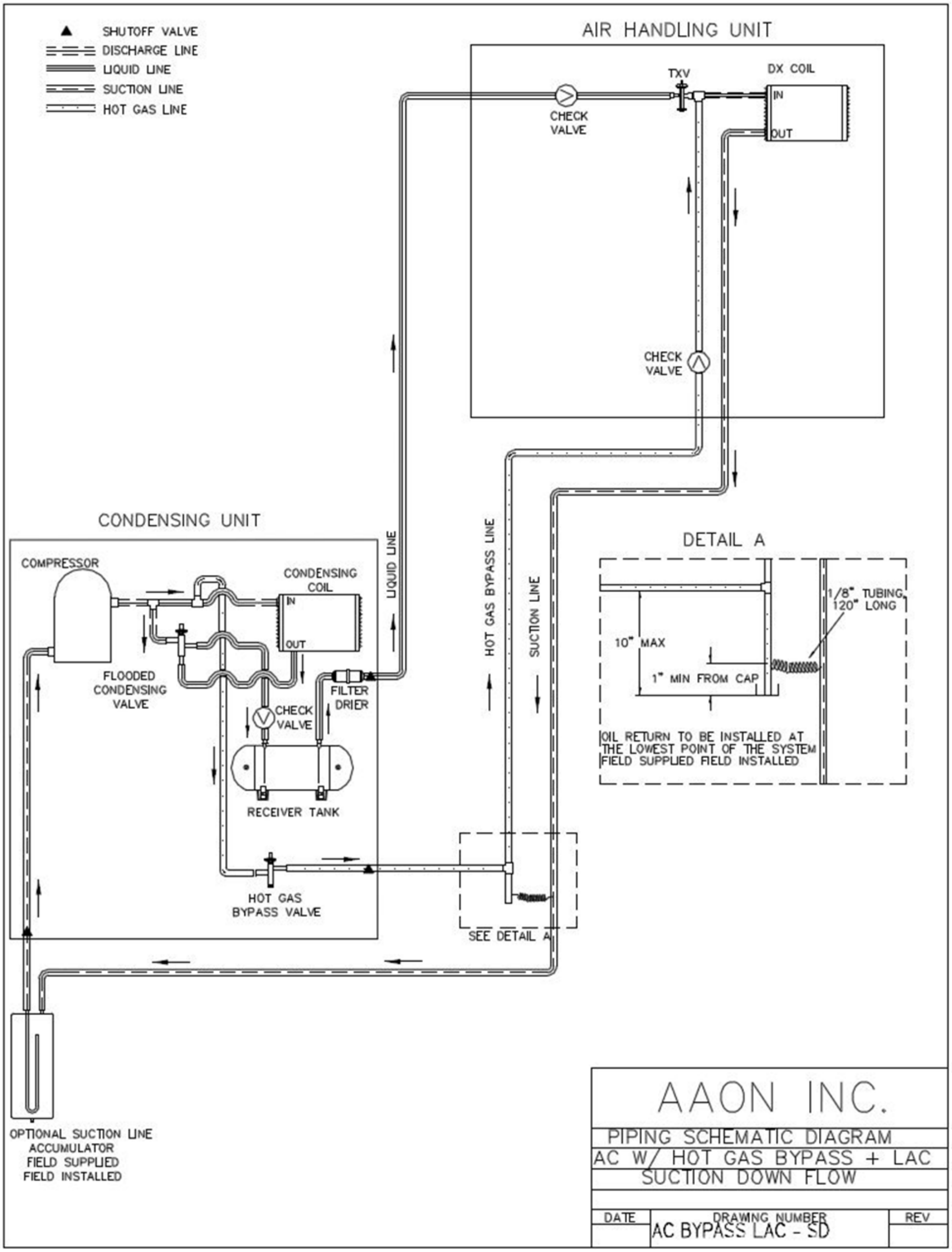



Figure 28: A/C with Hot Gas Bypass + LAC Split System Piping, Suction Down

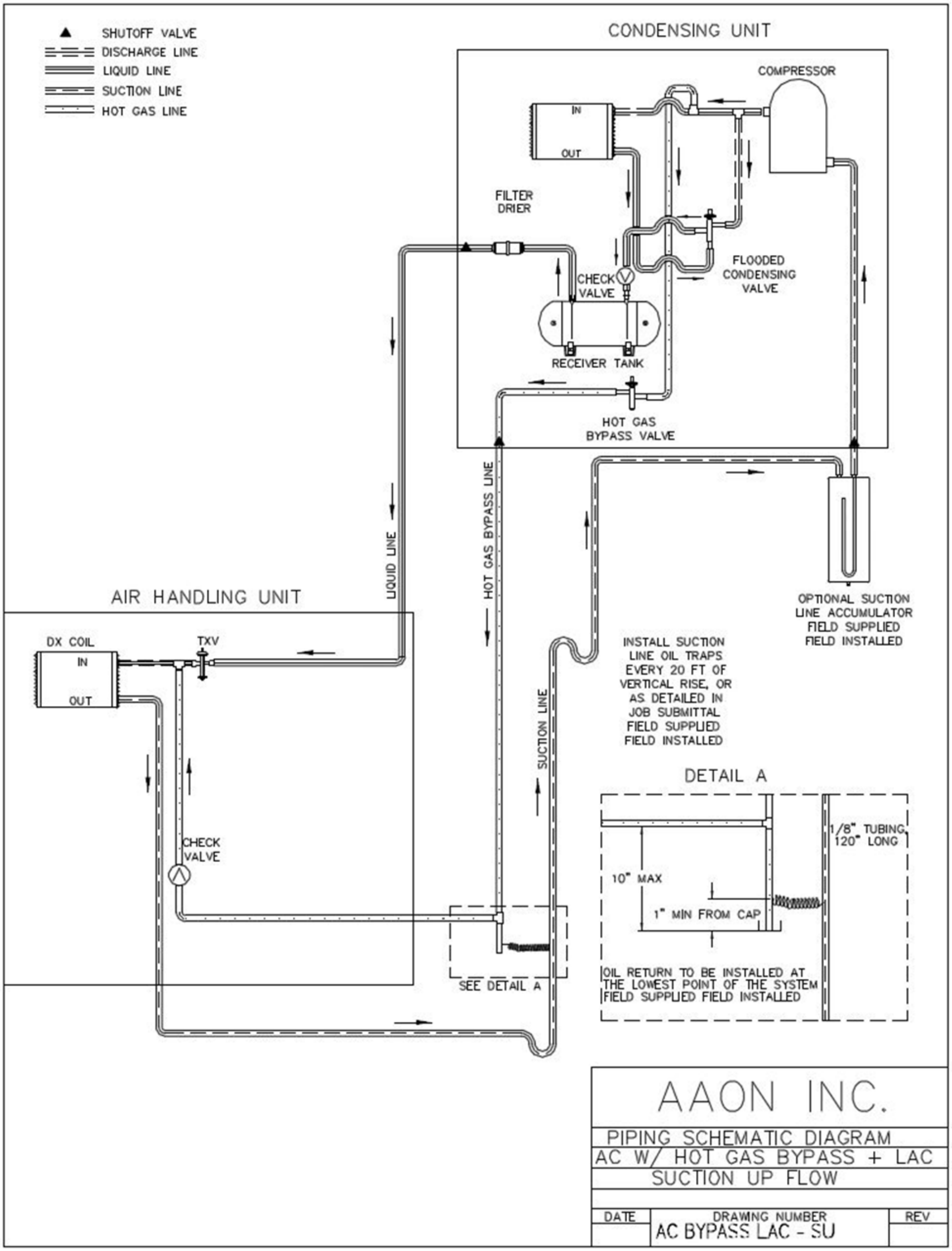



Figure 29: A/C with Hot Gas Bypass + LAC Split System Piping, Suction Up

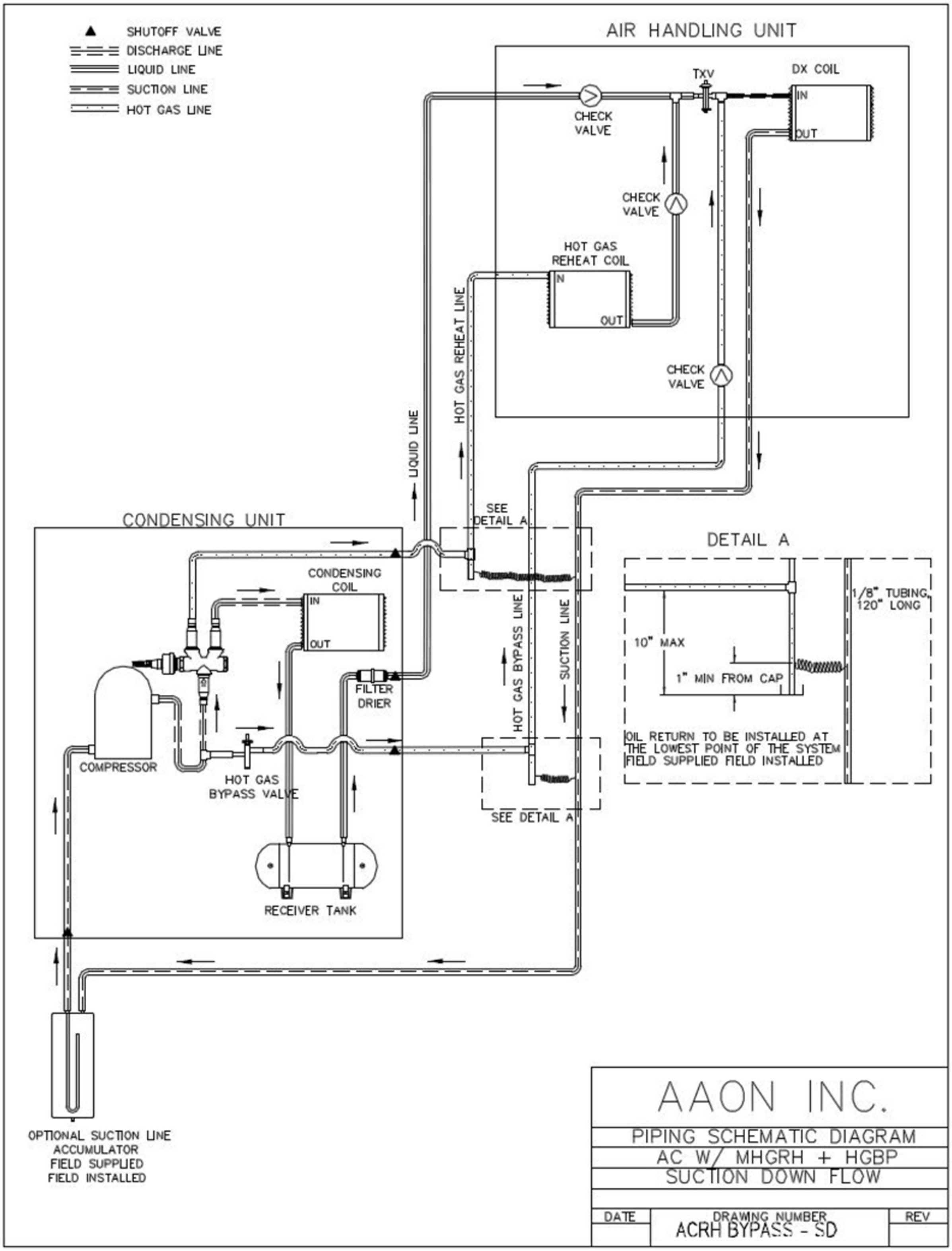



Figure 30: A/C with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Down

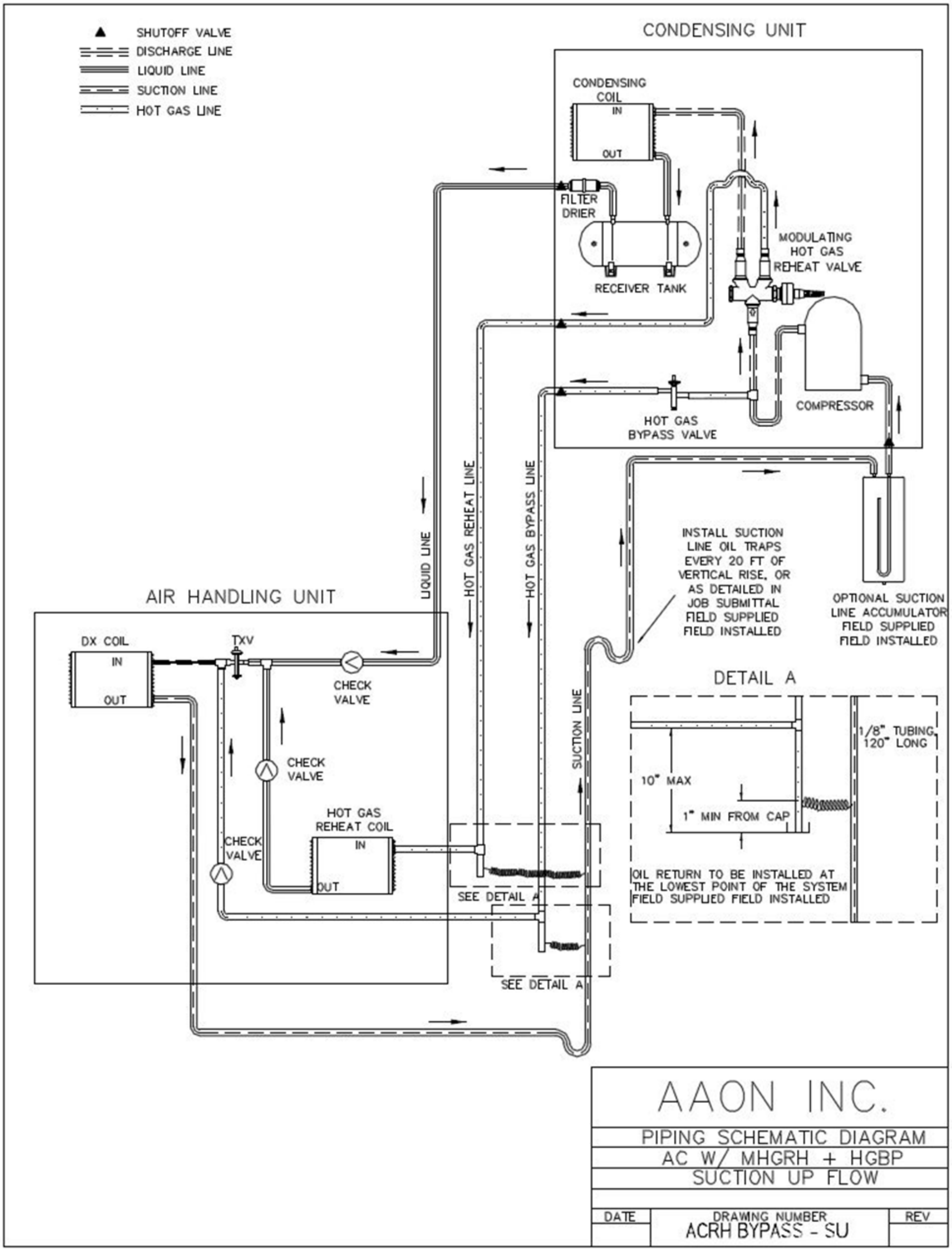



Figure 31: A/C with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Up

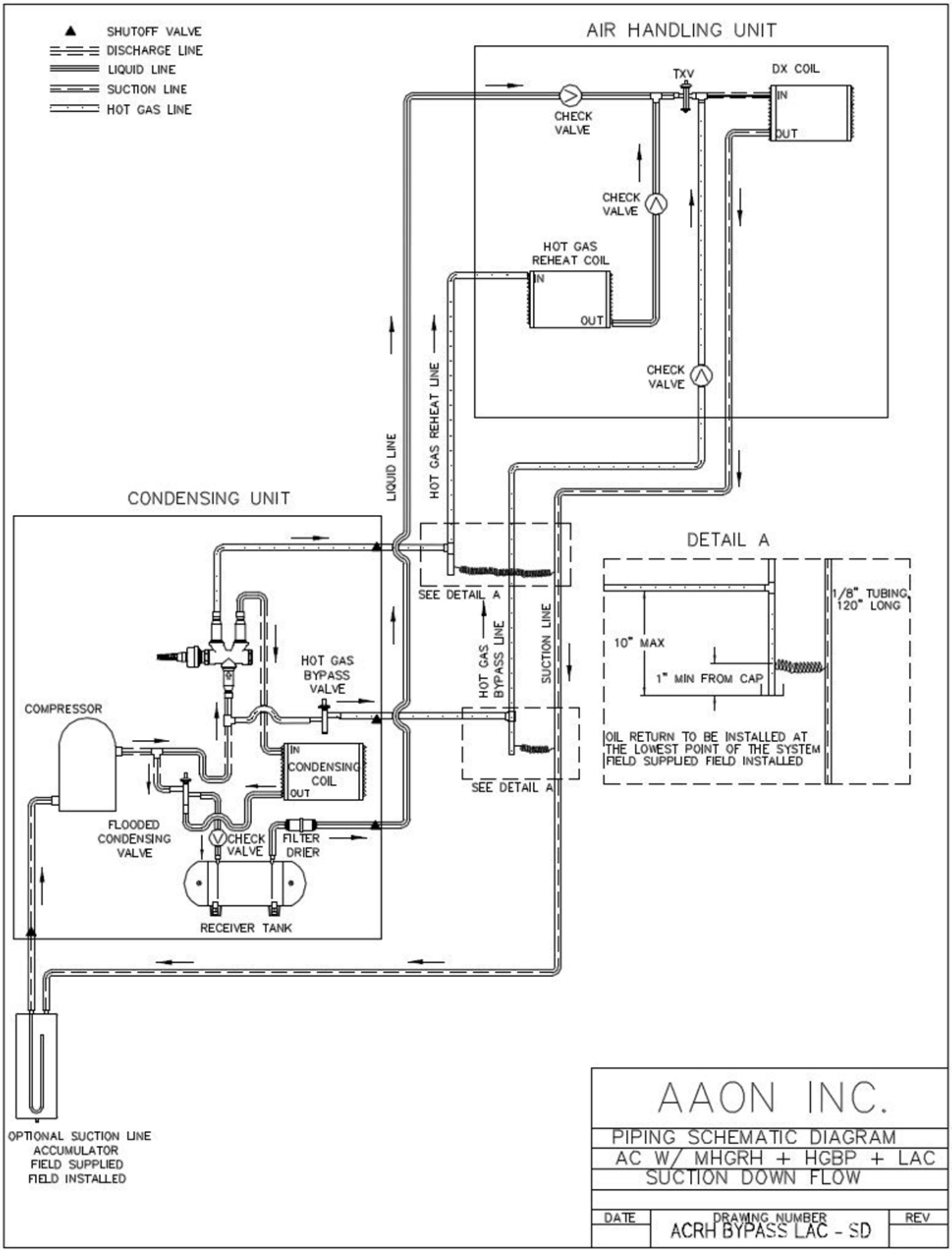



Figure 32: A/C with Modulating Hot Gas Reheat and Hot Gas Bypass + LAC Split System Piping, Suction Down

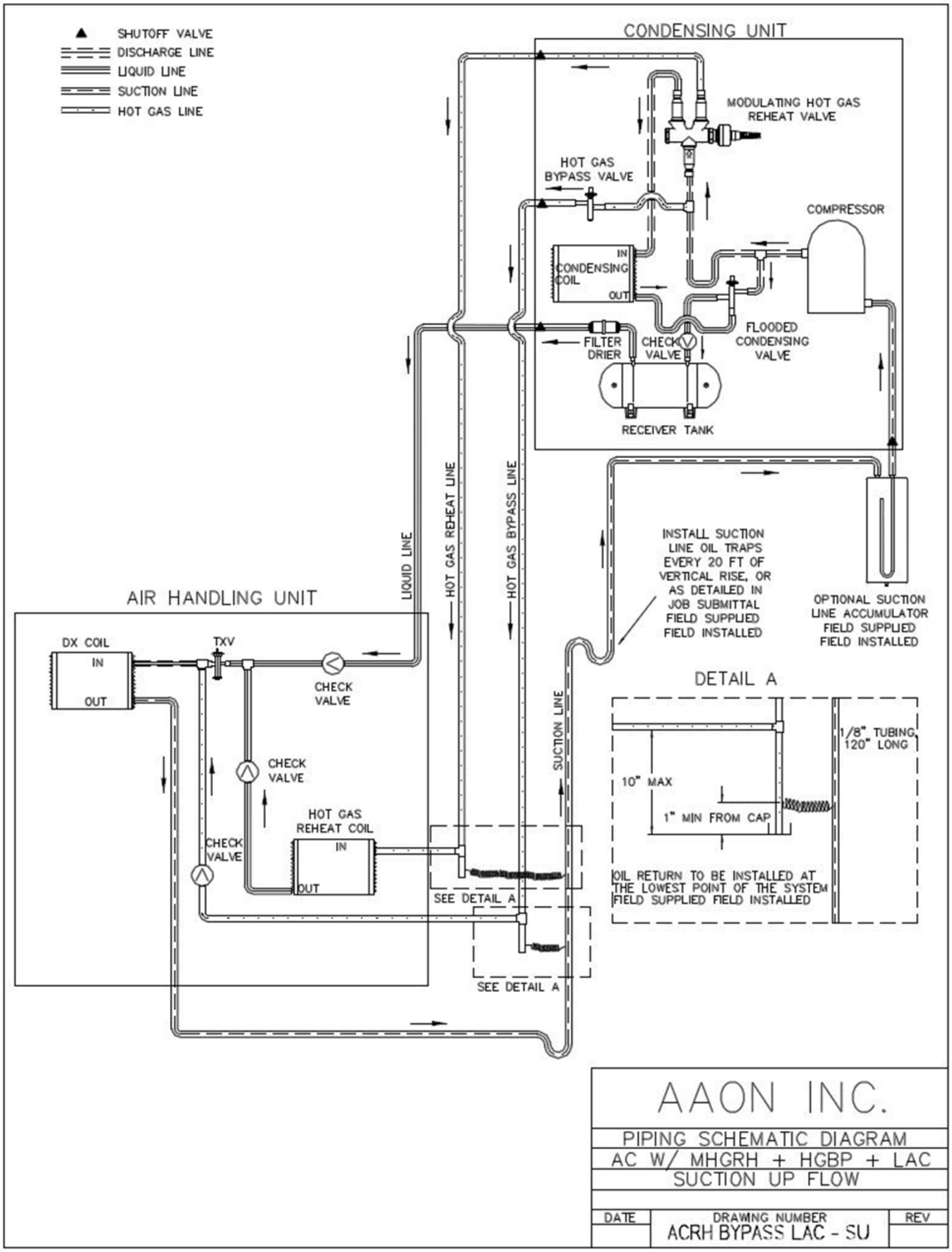



Figure 33: A/C with Modulating Hot Gas Reheat and Hot Gas Bypass + LAC Split System Piping, Suction Up

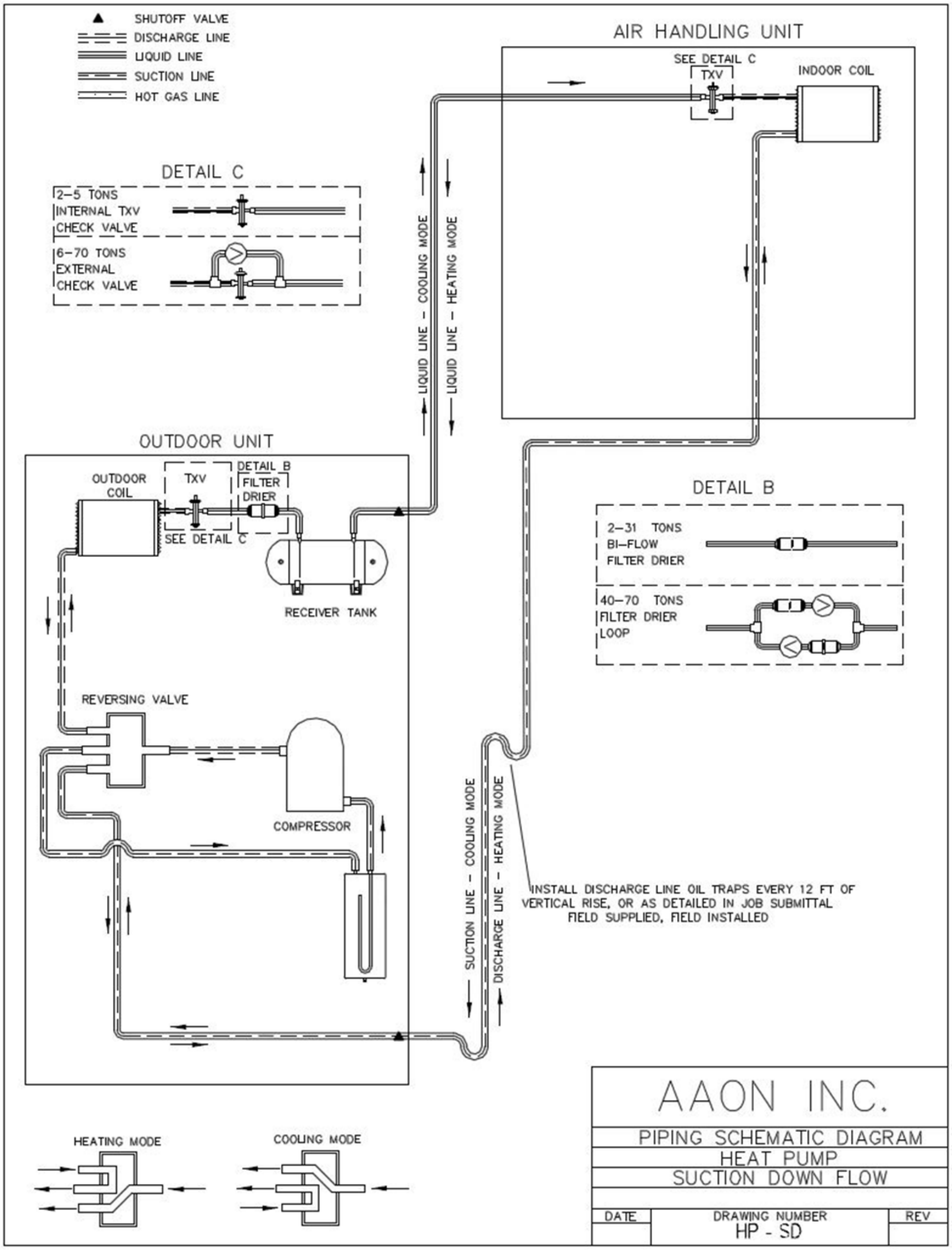



Figure 34: Heat Pump Split System Piping, Suction Down

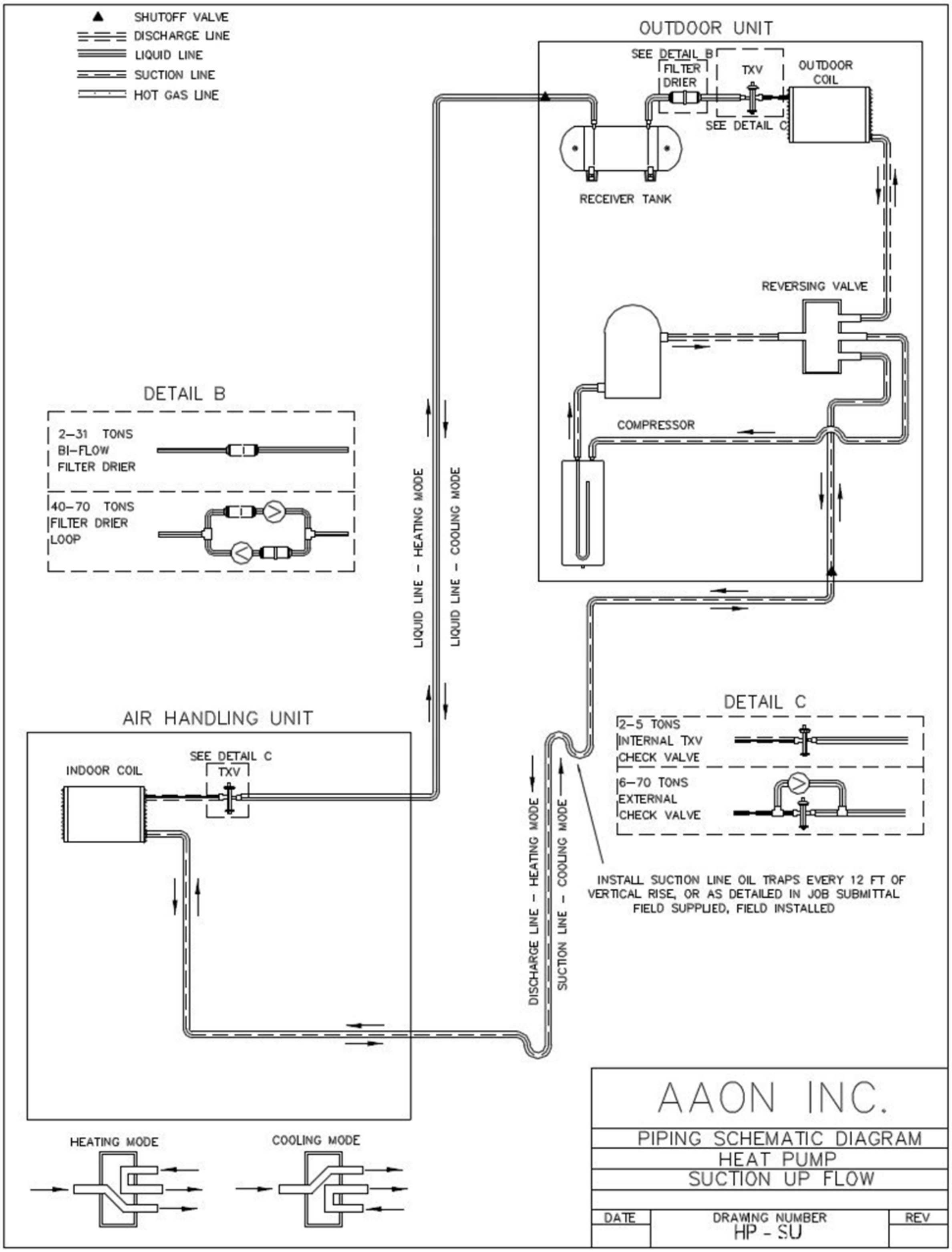



Figure 35: Heat Pump Split System Piping, Suction Up

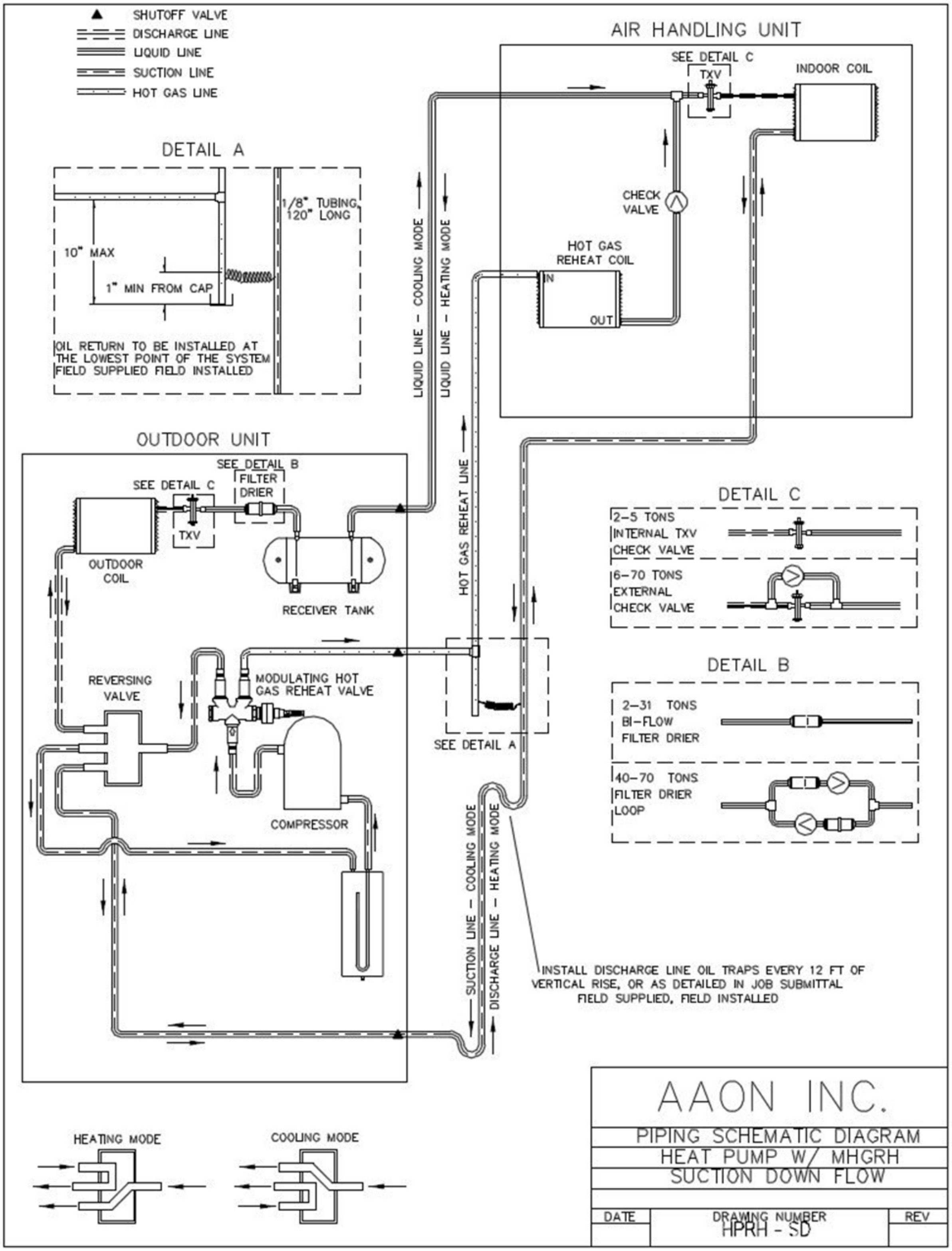



Figure 36: Heat Pump with Modulating Hot Gas Reheat Split System Piping, Suction Down

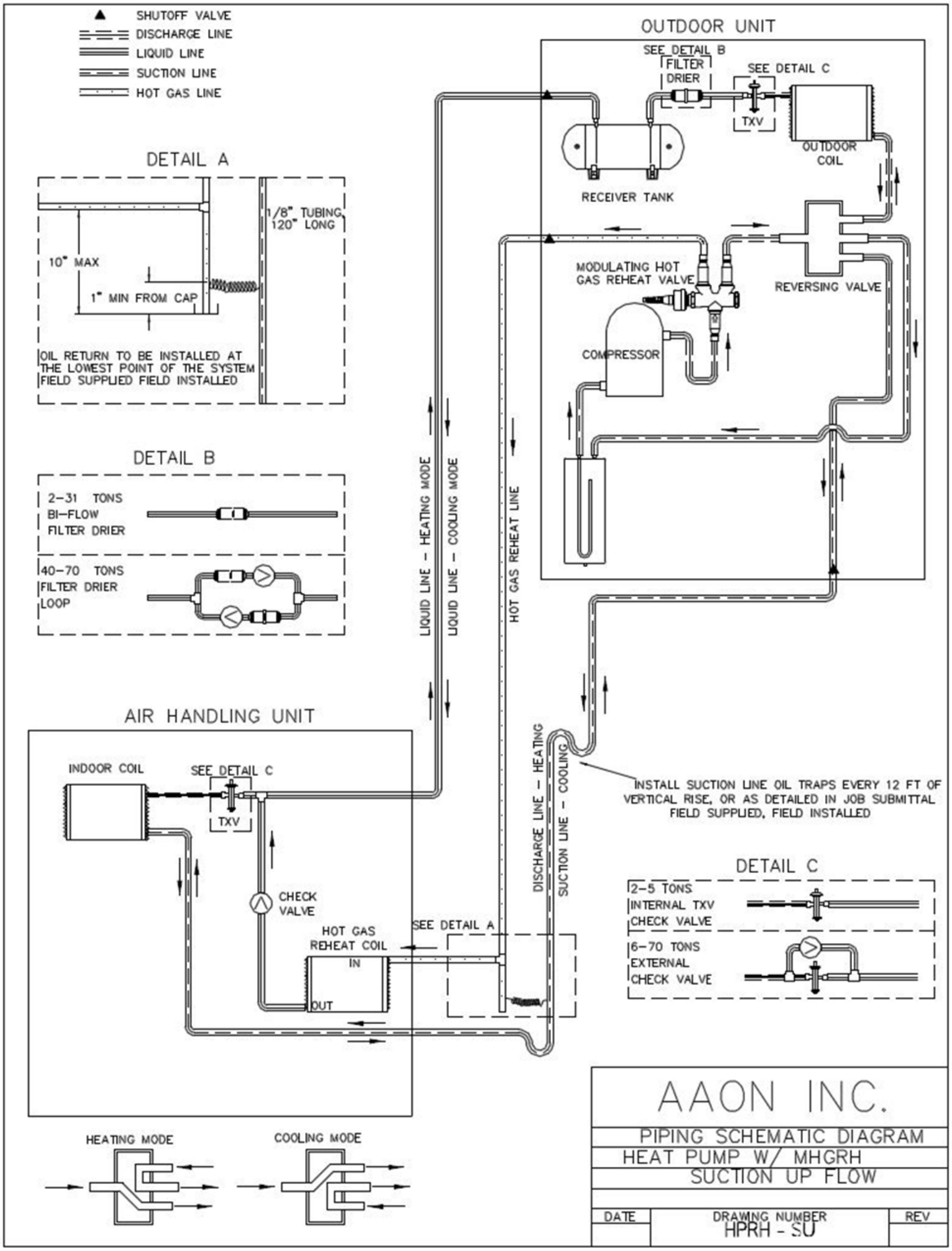



Figure 37: Heat Pump with Modulating Hot Gas Reheat Split System Piping, Suction Up

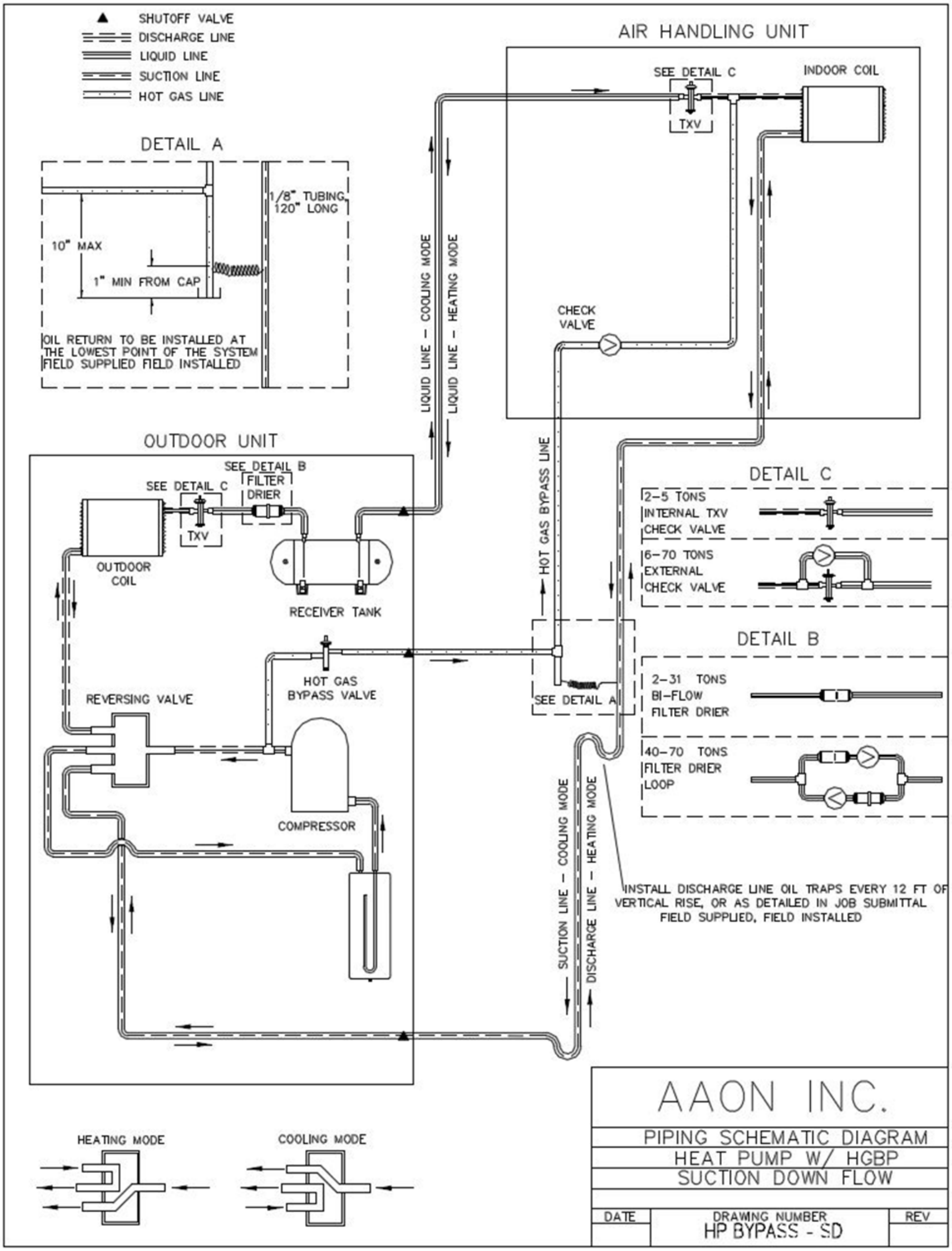



Figure 38: Heat Pump with Hot Gas Bypass Split System Piping, Suction Down

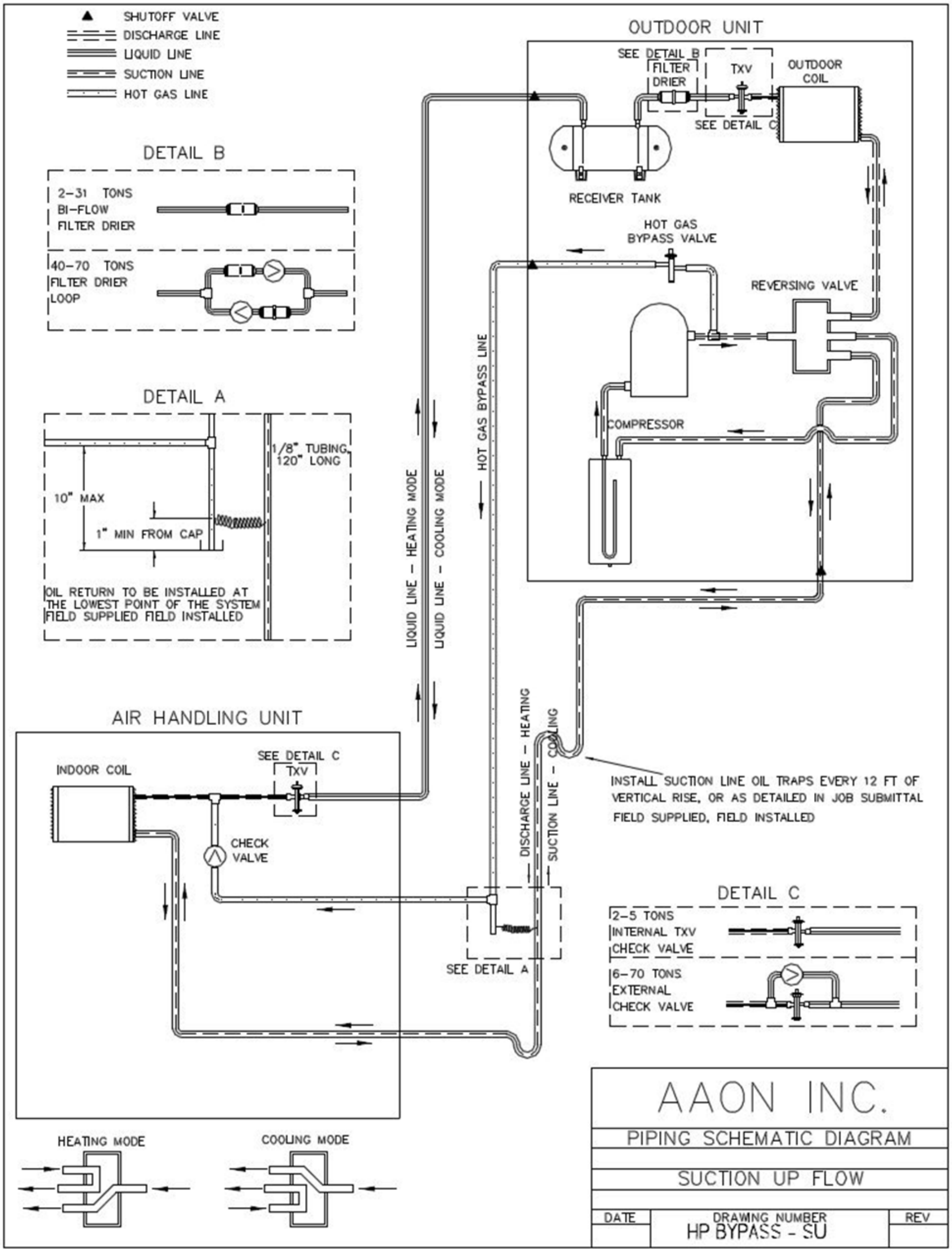



Figure 39: Heat Pump with Hot Gas Bypass Split System Piping, Suction Up

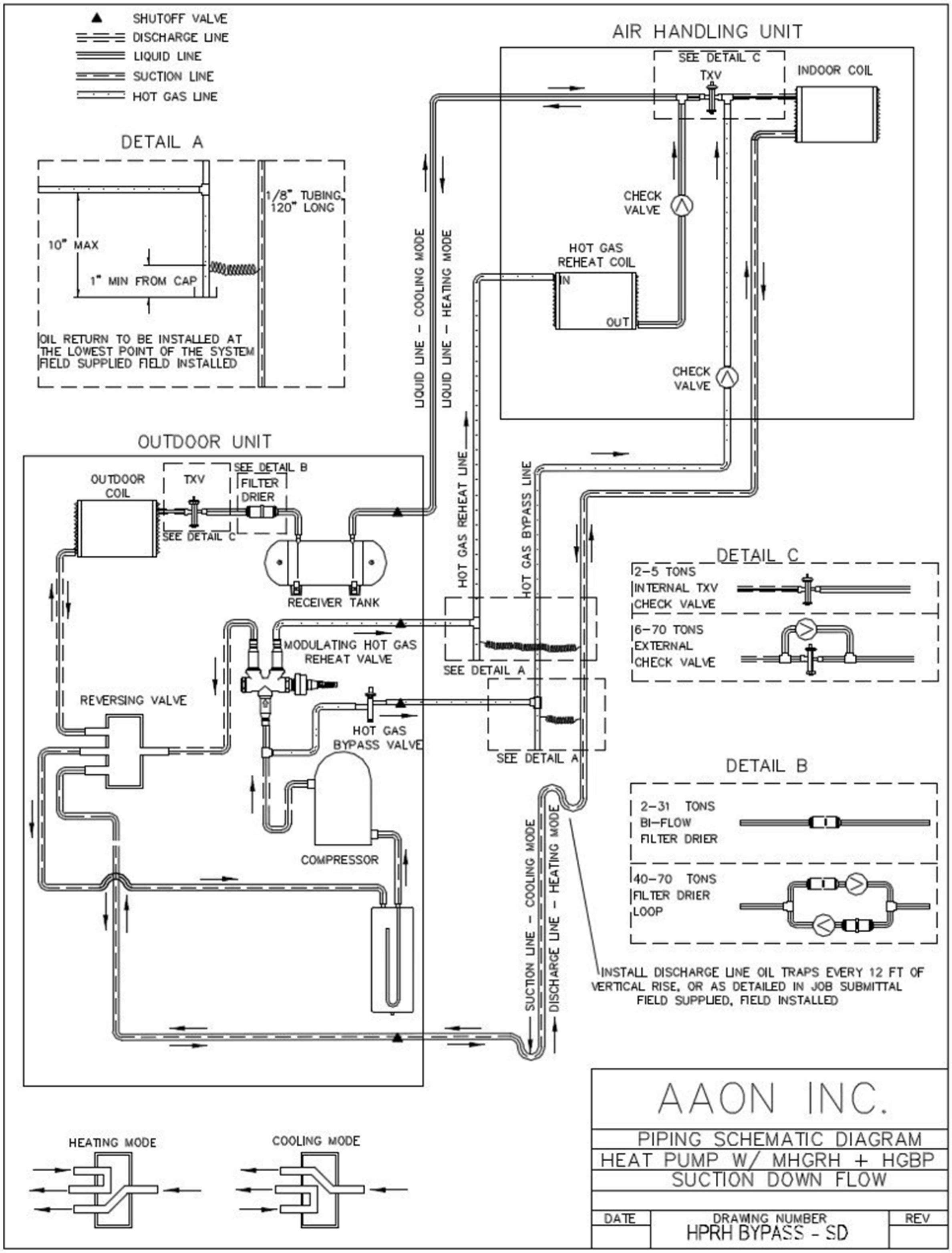



Figure 40: Heat Pump with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Down

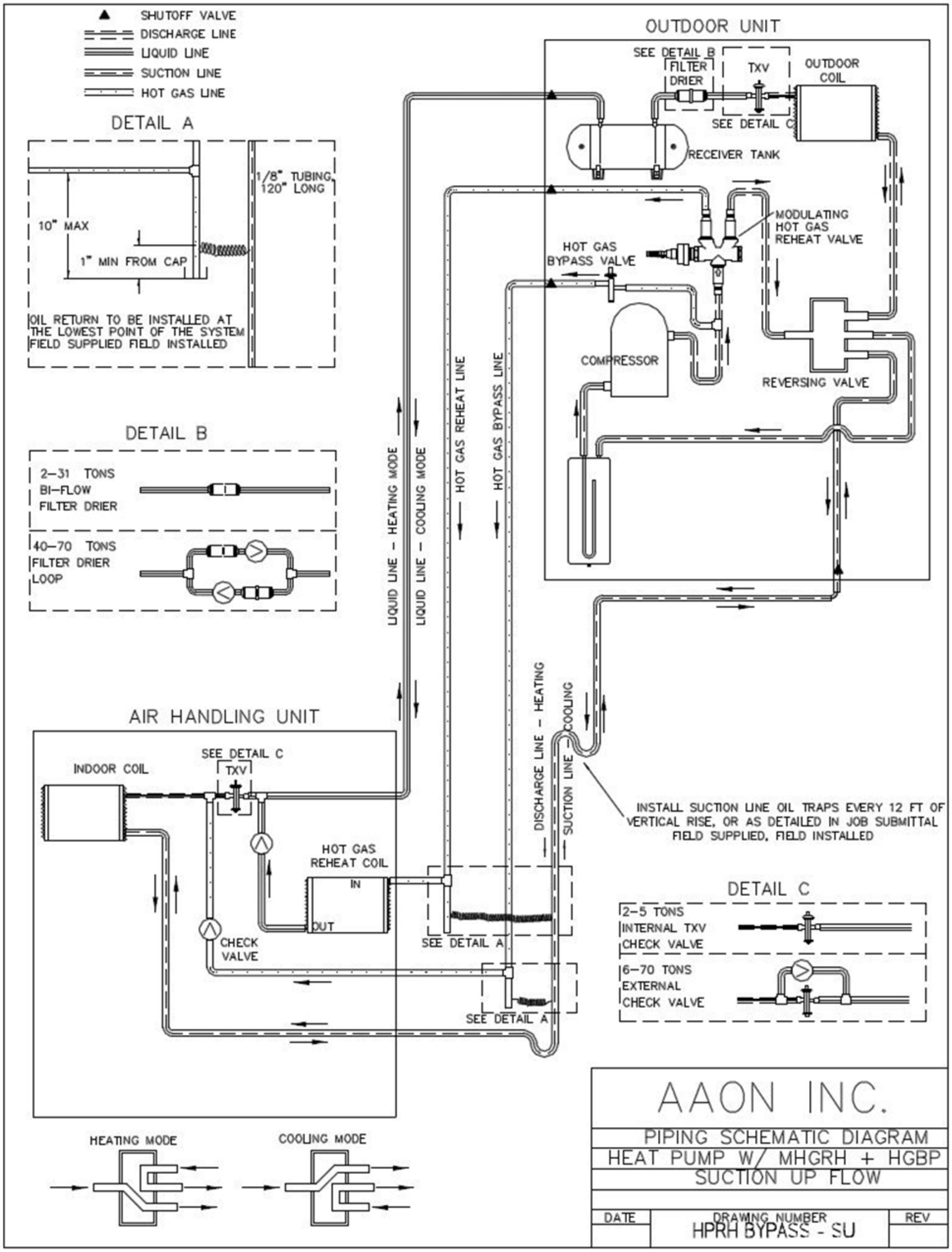



Figure 41: Heat Pump with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping, Suction Up

## 10.1. Warranties

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

## 10.2. 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
Warranty, Service, and Parts Department
203 Gum Springs Rd.
Longview, TX 75602
Ph: (918) 382-6450
techsupport@AAON.com
www.AAON.com

**Note**: Before calling, the technician must have the model and serial number of the unit available for the service department to help answer questions regarding the unit.

## 10.3. Decommissioning

Before decommissioning the unit, ensure you are familiar with the unit and its operation. Only individuals qualified to handle refrigerant may remove the charge from the unit. The unit must be isolated electrically before beginning any decommissioning work. Proper PPE is required.

Operate the recovery machine in accordance with the instructions. Remove refrigerant from all parts of the refrigeration system. On heat pumps, refrigerant must be recovered from discharge, suction, and common liquid lines.

Remove refrigerant from all parts of the refrigeration system. On heat pumps, refrigerant must be recovered from discharge, suction, and common liquid lines.

Weigh out refrigerant when removing to ensure that all refrigerant is removed and cylinders are not overfilled. Place the refrigerant cylinder on the scales before beginning the recovery process. Do not exceed the maximum pressure of the cylinder.

When recovery is completed, remove all cylinders containing recovered refrigerant from the site. Ensure all isolation valves on the equipment are closed, and all warning decals are still visible on the unit.

Label the unit as having been decommissioned, and date and sign the label.

**Warranty**: Refer to the Limited Warranty Certificate for the unit warranty details. Contact your AAON representative for a unit-specific copy of the certificate for your serial number.

# 11. WARRANTY

Refer to the Limited Warranty certificate for the unit's warranty details. Contact an AAON representative for a unit-specific copy of the certificate for the unit's serial number.

## Limited Warranty Certificate

**GENERAL CONDITIONS**
AAON Coil Products, Inc. (hereinafter referred to as "ACP") warrants this ACP equipment, as identified hereon, to be free of defects in material and workmanship under normal use, service, and maintenance. Our obligations under this warranty must be limited to repairing or replacing the defective part, or parts, which in our judgment show evidence of such defects. ACP is not liable for labor charges and other costs incurred for removing, shipping, handling or transporting defective part, or parts, or for shipping, handling, transporting, or installing repaired or replacement part, or parts.

The limited warranty is effective one (1) year from date of **original installation**, or eighteen (18) months from date of original shipment from the factory, whichever occurs first and covers all parts and components in this ACP equipment excluding air filters, belts, refrigerant moisture driers, and lost refrigerant, which are not included in any part of this limited warranty. The replacement part, or parts, assume only the unused portion of the original limited warranty and are shipped f.o.b. from the factory and freight prepaid by the factory.

The limited warranty is effective for products manufactured at the Tulsa, Oklahoma or Longview, Texas facility.

THIS LIMITED WARRANTY ONLY APPLIES WHEN THE **ORIGINAL MODEL NUMBER AND SERIAL NUMBER** OF THE ACP UNIT ARE GIVEN AT TIME OF REQUEST FOR REPLACEMENT PART, OR PARTS. DEFECTIVE PART, OR PARTS, MUST BE RETURNED **PREPAID**, WITH ITS ASSIGNED RETURN MATERIAL TAG, WITHIN FOURTEEN (14) DAYS OF RECEIPT OF THE REPLACEMENT PART, OR PARTS.

**EXTENDED LIMITED WARRANTY ON COMPRESSORS INCLUDED IN SINGLE PACKAGE EQUIPMENT (NOT INCLUDING CHILLERS); OPTIONAL ON OTHER EQUIPMENT**
For the second through the fifth year from date of **shipment**, we further agree to repair or replace the fully hermetic compressor, at our option, for the **original purchase-user only**. The repaired or replacement fully hermetic compressor will be supplied f.o.b. the factory, freight **prepaid and add**, providing the defective fully hermetic compressor is returned **prepaid by the customer**, and is proven to be inoperative due to defects in materials or workmanship. This extended limited warranty covers **only** the fully hermetic compressor and **does not include** any labor charges, or other additional costs incurred for removing, shipping, handling, transporting, or replacing the defective fully hermetic compressor. It also **does not include** additional costs incurred for shipping, handling, or transporting of electric controls such as relays, capacitors, pressure controls, or fan-motor assemblies, condensers, receivers, etc, which carry the standard **one-year limited warranty**.

**EXTENDED LIMITED WARRANTY OF M2/V3/H3 SERIES GAS FIRED HEAT EXCHANGERS**
For the second through the tenth year from date of original installation, we further warrant the steel heat exchanger against failure due to defects in materials and workmanship for the original purchaser-user only, in accordance with the following: For the first five (5) years from date of shipment, we agree to repair or replace the heat exchanger, at our option, for the original purchaser-user only; during the sixth year, we will charge 50% of the current trade price for repaired or replacement steel heat exchanger, as the case may be, during the seventh year, 60%, during the eighth year, 70% during the ninth year, 80% and during the tenth year, 90%.

In all cases, the repaired or replacement heat exchanger will be supplied f.o.b. our factory, freight prepaid, providing the defective heat exchanger is returned **prepaid**, and if it is proved to be inoperative due to defects in materials and workmanship. This extended limited warranty covers **only** the heat exchanger and **does not include** labor charges, or other costs incurred for removing, shipping, handling, transporting, or installing repaired replacement heat exchanger. This extend limited warranty **does not apply** where the furnace has been operated in an atmosphere contaminated by chlorine, fluorine, or any other damaging chemical compounds.

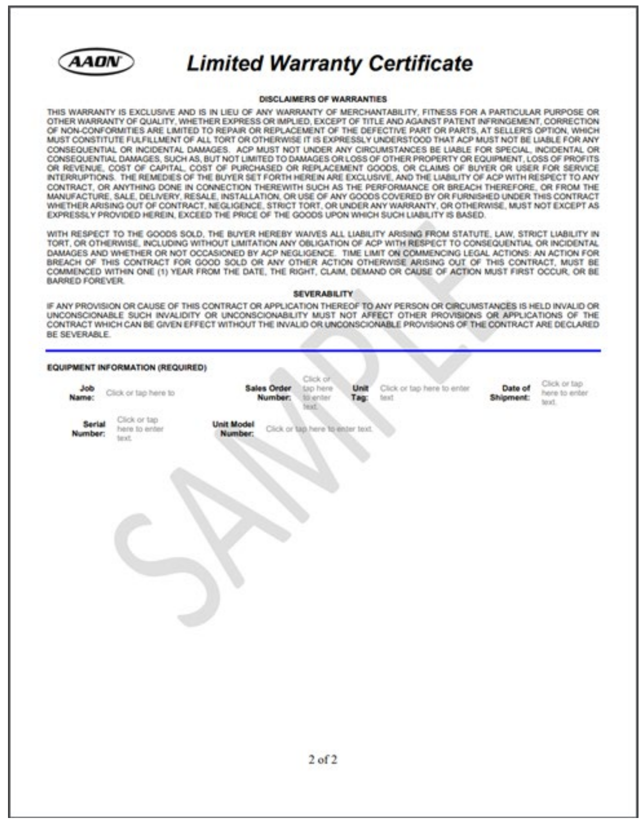
**FOR OPTIONAL FIVE YEAR EXTENDED LIMITED WARRANTY OF COIL COATING**
For the second through fifth year from date of shipment, we further warrant the coating of e-coated coils on the equipment against failure due to defects in materials and workmanship for the original purchaser-user only. Coil cleaning, maintenance, and record keeping must be followed according to the unit Installation, Operation and Maintenance Manual to maintain warranty.

**OTHER CONDITIONS**
This warranty **does not cover** any ACP unit or part thereof which has been subject to accident, negligence, damages in transit, misuse or abuse, **or which has been tampered with or altered in any way**, or which has **not** been installed operated serviced and maintained in accordance with our instructions, or which has been installed outside of the Continental United States or Canada, or on which the serial number or identification number has been altered defaced, or removed. ACP will not be responsible for failure of the unit to start due to voltage conditions, blown fuses, open circuit breakers, or other damages due to the inadequacy or interruption of electric service.

This warranty **does not cover** equipment containing a water-to-refrigerant heat exchanger for any damage resulting from freezing, fouling, corrosion or clogging.

ACP must not be liable for any default or delay in performance hereunder, caused by a contingency beyond its control, including governmental restrictions or restraint, strikes, short or reduced supply of raw materials or parts, floods, winds, fire, lightning strikes, or any other acts of God.

1 of 2



## Limited Warranty Certificate

**DISCLAIMERS OF WARRANTIES**

THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESS OR IMPLIED, EXCEPT OF TITLE AND AGAINST PATENT INFRINGEMENT, CORRECTION OF NON-CONFORMITIES ARE LIMITED TO REPAIR OR REPLACEMENT OF THE DEFECTIVE PART OR PARTS, AT SELLER'S OPTION, WHICH MUST CONSTITUTE FULFILLMENT OF ALL TORT OR OTHERWISE IT IS EXPRESSLY UNDERSTOOD THAT ACP MUST NOT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES. ACP MUST NOT UNDER ANY CIRCUMSTANCES BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, SUCH AS, BUT NOT LIMITED TO DAMAGES OR LOSS OF OTHER PROPERTY OR EQUIPMENT, LOSS OF PROFITS OR REVENUE, COST OF CAPITAL, COST OF PURCHASED OR REPLACEMENT GOODS, OR CLAIMS OF BUYER OR USER FOR SERVICE INTERRUPTIONS. THE REMEDIES OF THE BUYER SET FORTH HEREIN ARE EXCLUSIVE, AND THE LIABILITY OF ACP WITH RESPECT TO ANY CONTRACT, OR ANYTHING DONE IN CONNECTION THEREWITH SUCH AS THE PERFORMANCE OR BREACH THEREFORE, OR FROM THE MANUFACTURE, SALE, DELIVERY, RESALE, INSTALLATION, OR USE OF ANY GOODS COVERED BY OR FURNISHED UNDER THIS CONTRACT WHETHER ARISING OUT OF CONTRACT, NEGLIGENCE, STRICT TORT, OR UNDER ANY WARRANTY, OR OTHERWISE, MUST NOT EXCEPT AS EXPRESSLY PROVIDED HEREIN, EXCEED THE PRICE OF THE GOODS UPON WHICH SUCH LIABILITY IS BASED.

WITH RESPECT TO THE GOODS SOLD, THE BUYER HEREBY WAIVES ALL LIABILITY ARISING FROM STATUTE, LAW, STRICT LIABILITY IN TORT, OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY OBLIGATION OF ACP WITH RESPECT TO CONSEQUENTIAL OR INCIDENTAL DAMAGES AND WHETHER OR NOT OCCASIONED BY ACP NEGLIGENCE. TIME LIMIT ON COMMENCING LEGAL ACTIONS: AN ACTION FOR BREACH OF THIS CONTRACT FOR GOOD SOLD OR ANY OTHER ACTION OTHERWISE ARISING OUT OF THIS CONTRACT, MUST BE COMMENCED WITHIN ONE (1) YEAR FROM THE DATE, THE RIGHT, CLAIM, DEMAND OR CAUSE OF ACTION MUST FIRST OCCUR, OR BE BARRED FOREVER.

**SEVERABILITY**

IF ANY PROVISION OR CAUSE OF THIS CONTRACT OR APPLICATION THEREOF TO ANY PERSON OR CIRCUMSTANCES IS HELD INVALID OR UNCONSCIONABLE SUCH INVALIDITY OR UNCONSCIONABILITY MUST NOT AFFECT OTHER PROVISIONS OR APPLICATIONS OF THE CONTRACT WHICH CAN BE GIVEN EFFECT WITHOUT THE INVALID OR UNCONSCIONABLE PROVISIONS OF THE CONTRACT ARE DECLARED BE SEVERABLE.

**EQUIPMENT INFORMATION (REQUIRED)**

**Job Name:** Click or tap here to
**Sales Order Number:** Click or tap here to enter text.
**Unit Tag:** Click or tap here to enter text.
**Date of Shipment:** Click or tap here to enter text.
**Serial Number:** Click or tap here to enter text.
**Unit Model Number:** Click or tap here to enter text.

2 of 2

# 12. CF SERIES START-UP FORMS

**Job Name**:______________________________ **Date**: ______________

**Address**:______________________________

**Model Number**:______________________________

**Serial Number**:______________________________ **Tag**: ______________

**Startup Contractor**:______________________________

**Address**:______________________________

**Phone**:____________________

## 12.1. Pre-Startup Checklist

The installing contractor must verify the following items.

| | |
|---|---|
| 1. Is there any visible shipping damage? | ☐ Yes |
| 2. Is the unit level? | ☐ Yes |
| 3. Are the unit clearances adequate for service and operation? | ☐ Yes |
| 4. Do all access doors open freely, and are the handles operational? | ☐ Yes |
| 5. Have all of the shipping braces been removed? | ☐ Yes |
| 6. Have all of the electrical connections been tested for tightness? | ☐ Yes |
| 7. Has all gas heat piping been checked for leaks? | ☐ Yes |
| 8. Does the electrical service correspond to the unit nameplate? | ☐ Yes |
| 9. Has the transformer tap been checked for the 208/230V units? | ☐ Yes |
| 10. Has adequate overcurrent protection been installed to match the requirements listed on the unit nameplate? | ☐ Yes |
| 11. Have all set screws on the fans been tightened? | ☐ Yes |
| 12. Do all of the fans rotate freely? | ☐ Yes |
| 13. Does the field water piping to the unit appear to be correct per design parameters? | ☐ Yes |
| 14. Is all of the copper tubing isolated so it does not rub? | ☐ Yes |
| 15. Have the damper assemblies been inspected? | ☐ Yes |
| 16. Are the air filters installed with proper orientation? | ☐ Yes |
| 17. Have the condensate drain and p-trap been connected? | ☐ Yes |
| 18. Is the actual refrigerant charge of the largest circuit in accordance with the required conditioned floor area according to Table 6 and Table 7? | ☐ Yes |
| 19. Are the ventilation and exhaust openings unobstructed? | ☐ Yes |
| 20. Are the markings, decals, and warnings on the unit clearly visible? | ☐ Yes |
| 21. Have all of the damaged or illegible markings and warnings been replaced? | ☐ Yes |

## 12.2. A2L Refrigerant Detection System (RDS) Pre-Start Checklist

| | |
|---|---|
| 1. Does each port (sensors 1-3) have a male connector plugged into both the Cabinet and Airstream connections on the mitigation board? | ☐ Yes |
| 2. Do the compressor and gas heat operation shut off when the cabinet board sensor trips? | ☐ Yes |
| 3. Does normal unit operation commence, except for the compressor and gas heater, after the cabinet board sensor trips? | ☐ Yes |
| 4. Does the compressor shut off and the fan stay on when the Airstream board sensor trips? | ☐ Yes |
| 5. Does the non-compressor or gas heating/cooling stay on when both boards trip? (electric heater stays on) | ☐ Yes |
| 6. When the A2L airstream alarm is activated, do the supply fans start, VAV boxes open, and compressors stop? | ☐ Yes |

## 12.3. Ambient Temperature

| Ambient Temperature | |
|---|---|
| Ambient Dry Bulb Temperature _______°C/°F | Ambient Wet Bulb Temperature _______°C/°F |

## 12.4. Voltage

| L1-L2 | L2-L3 | L1-L3 |
|---|---|---|
| | | |

| L1-L2 | L2-L3 | L1-L3 |
|---|---|---|
| | | |

## 12.5. Refrigeration Systems Cooling Mode

| Refrigeration System 1 - Cooling Mode | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 2 - Cooling Mode | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 3 - Cooling Mode | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 4 - Cooling Mode | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

## 12.6. Refrigeration Systems Heating Mode

| Refrigeration System 1 - Heating Mode (Heat Pump Only) | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 2 - Heating Mode (Heat Pump Only) | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 3 - Heating Mode (Heat Pump Only) | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

| Refrigeration System 4 - Heating Mode (Heat Pump Only) | | | | | |
|---|---|---|---|---|---|
| | Pressure | Saturated Temperature | Line Temperature | Sub-cooling | Superheat |
| Discharge | | | | N/A | N/A |
| Suction | | | | N/A | |
| Liquid | | | | | N/A |

## 12.7. Condenser Fans

| Alignment ☐ | | Check Rotation ☐ | | Nameplate Amps ____________ |
|---|---|---|---|---|
| Number | Hp | L1 Volts/Amps | L2 Volts/Amps | L3 Volts/Amps |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

## 12.8. Compressors/DX Cooling

| Number | L1 Volts/Amps | L2 Volts/Amps | L3 Volts/Amps | Head Pressure PSIG | Suction Pressure PSIG |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |

## 12.9. Additional Findings

| |
|---|
| |
| |
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## 12.10. Signature

By signing this form, you verify that all of the information contained is correct and filled out to the best of your ability.

| | |
|---|---|
| **Name:** | |
| **Title:** | |
| **Rep/Contractor:** | |
| **Signature:**__________________________________________________ | **Date/Time:**__________________ |

# 13. APPENDIX A: UNIT SAFETY HIERARCHY

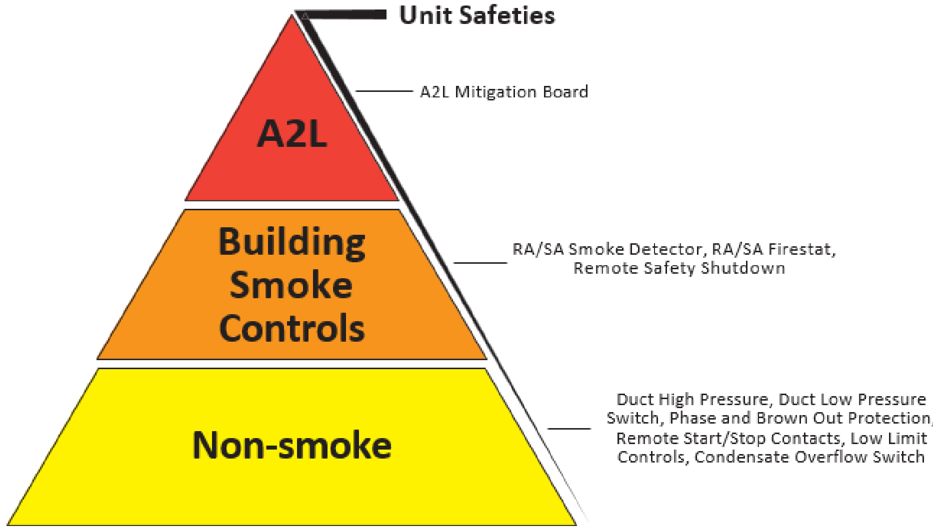


Figure 42: Unit Safety Hierarchy

**Default (A2L Priority)**

Units will ship with A2L sequences at the highest priority. This may activate the indoor blower in the event of an A2L leak, even if Building Smoke Controls or Non-smoke safeties interrupt the 24V/120V safety circuit. The terminal block labeled ‘Hierarchy Control’ will control the priority.

The jumper will connect ‘Com’ and ‘A2L’ for A2L priority.

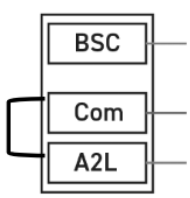


Figure 43: A2L Priority Jumper

**Building Smoke Control Priority**

Units will have the option to shift the Unit Safety Hierarchy in the field. To shift the priority, turn the power off to the unit and move the jumper to ‘Com’ and ‘BSC’ on the ‘Hierarchy Control’ terminals.

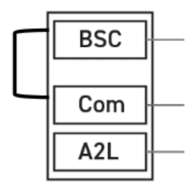


Figure 44: Building Smoke Control Priority Jumper

**Example Scenario**

If priority is given to Building Smoke Controls, and simultaneously both A2L and any of the Building Smoke Controls goes into alarm, the 24V/120V safety circuit will shut down the unit, and A2L mitigation will not take place.

*Locating the “Hierarchy Control” LVTB*

Locate the low voltage control section

Identify the ‘Hierarchy Control’ label by the (3) terminals labeled “BSC”, “COM”, and “A2L”

# 14. APPENDIX B: MAINTENANCE LOGS

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 a qualified licensed technician.

| Entry Date | Action Taken | Name/Tel. |
|---|---|---|
| | | |
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# 14.1. Maintenance Log (E-Coated Coil)

**AAON E-COATED COIL MAINTENANCE RECORD**

Installation Site ______________________ Installation Date ______________________
Unit Model # ______________________ Unit Location ______________________
Unit Serial # ______________________ Customer ______________________

| Year 20____ | Ambient Temp (°F) | Surface Debris Removed | Coil Cleaned | Approved Cleaner Used | Potable Water Backwash Rinse | Potable Water Frontwash Rinse | Chlorides Removed | Comments |
|---|---|---|---|---|---|---|---|---|
| Jan | | | | | | | | |
| Feb | | | | | | | | |
| Mar | | | | | | | | |
| Apr | | | | | | | | |
| May | | | | | | | | |
| Jun | | | | | | | | |
| Jul | | | | | | | | |
| Aug | | | | | | | | |
| Sep | | | | | | | | |
| Oct | | | | | | | | |
| Nov | | | | | | | | |
| Dec | | | | | | | | |

The following cleaning agents have been approved for use on AAON E-Coated Coils to remove mold, mildew, dust, soot, greasy residue, lint and similar particulate without harming the coated surfaces.

| CLEANING AGENT | RESELLER | PART NUMBER |
|---|---|---|
| GulfClean ™ Coil Cleaner<br>or<br>Enviro-Coil Cleaner | Rectorseal<br>2601 Spenwick Drive, Houston, Texas 77055<br>(P): 713-263-8001 | G074480 / 80406<br>or<br>V82540 |
| GulfClean Salt Reducer™ | " " | G074490 / 80408 |

| RECOMMENDED CHLORIDE REMOVER |
|---|
| Rectorseal<br>2601 Spenwick Drive, Houston, Texas 77055<br>(P): 713-263-8001 |

# 15. LITERATURE CHANGE HISTORY

**July 2022**

Added the clarification that "ACR" rigid copper tubing must be used for connecting copper.

**December 2022**

Added obsolete options in the feature string nomenclature for historical reference. Added Two-Stage Refrigeration system options M and N to Model Option A5.

**September 2023**

Added all information pertaining to UL-60335 standard. Included metric units with all imperial units. Added R-454b P.T. tables.

**July 2024**

Added text for Refrigerant Detection System

**August**

Added the process of decommissioning the unit. Added text to General Information stating the maximum installation elevation is 11,500 ft.

September 2024

Added detailed text to the RDS mitigation board section for A2L sensors.

**October 2024**

Updated part number.

**January 2025**

Updated decommissioning section. Updated RDS section, updated startup form. Updated the warnings and caution section.

**November 2025**

Updated and edited the document formatting.

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CF Series

Installation, Operation, & Maintenance

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