INSTALLATION, OPERATION

AND MAINTENANCE MANUAL

FOR

AF / DCU SERIES

AIR COOLED CONDENSERS and FLUID COOLERS

UNIT MODEL NO. _____
UNIT SERIAL NO. _____
SERVICED BY: _____
TEL. NO: _____

CANADIAN HEAD OFFICE AND FACTORY

1401 HASTINGS CRES. SE
CALGARY, ALBERTA
T2G 4C8
Ph: (403) 287-4774
Fx: 888-364-2727

USA HEAD OFFICE AND FACTORY

32050 W. 83rd STREET
DESOTO, KANSAS
66018
Ph: (913) 583-3181
Fx: (913) 583-1406

CANADIAN EASTERN FACTORY

1175 TWINNEY DRIVE
NEWMARKET, ONTARIO
L3Y 5V7
Ph: (905) 898-1114
Fx: (905) 898-7244

SALES OFFICES ACROSS CANADA AND USA

Retain instructions with unit and maintain in a legible condition.
Please give model number and serial number when contacting factory for information and/or parts.

www.engineeredair.com

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SAFETY PRECAUTIONS

Read, understand and follow the complete manual before beginning the installation, including all safety precautions and warnings.

Warning: 	**Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.**

Warning:  	**This unit is connected to high voltages. Electrical shock or death could occur if instructions are not followed. This equipment contains moving parts that can start unexpectedly. Injury or death could occur if instructions are not followed. All work should be performed by a qualified technician. Always disconnect and lock out power before servicing. DO NOT bypass any interlock or safety switches under any circumstances.**

YOU HAVE RESPONSIBILITIES TOO

This installation, operation and maintenance manual cannot cover every possibility, situation or eventuality. Regular service, cleaning and maintaining the equipment is necessary. If you are not capable of performing these tasks, hire a qualified service specialist. **Failure to perform these duties can cause property damage and/or harm to the building occupants and will void the manufacturers' warranty.**

INTRODUCTION

Engineered Air units are high quality products designed and manufactured to provide many years of trouble-free operation. We recommend that this manual be read thoroughly to ensure proper installation, efficient operation and proper maintenance of this equipment. The submittal record is considered to be part of the Installation, Operation and Maintenance Manual. Please report any omissions to the national service manager.

WARRANTY

LIMITED WARRANTY ENGINEERED AIR will furnish without charge, F.O.B. factory, freight collect, replacement parts for, or repairs to products covered herein which prove defective in material or workmanship under normal and proper use for a period of twelve (12) months from the initial start-up or eighteen (18) months from the date of shipment, whichever expires sooner, provided the customer gives ENGINEERED AIR written notice of such defects within such time periods and provided that inspection by ENGINEERED AIR establishes the validity of the claim and all pertinent invoices have been paid in full. The repairs or replacements will be made only when the complete product(s) or part(s) claimed to be defective are returned to ENGINEERED AIR or a depot designated by ENGINEERED AIR, transportation charges prepaid. Repairs or replacements as provided for by this paragraph shall constitute fulfillment of all ENGINEERED AIR's obligations with respect to this warranty. The refrigerant charge is not included in any part of this warranty. This warranty does not apply to any products or parts thereof that have been subject to accident, misuse or unauthorized alterations, or where ENGINEERED AIR's installation and service requirements have not been met.

The foregoing warranty is in lieu of all other warranties, express or implied. ENGINEERED AIR specifically disclaims any implied warranty of merchantability and/or fitness for purpose. Under no circumstances shall ENGINEERED AIR be liable to, nor be required to indemnify, Buyer or any third parties for any claims, losses, labor, expenses or damages (including special, indirect, incidental, or consequential damages) of any kind, resulting from the performance (or lack thereof) of this Agreement or the use of, or inability to use the goods sold hereunder, including, but not limited to, damages for delay, temporary heating/cooling costs, loss of goodwill, loss of profits or loss of use. Furthermore, the parties agree that the Buyer's sole remedy under this agreement shall be limited to the limited warranty set forth in the preceding paragraph relating to the repair or replacement of any defective goods. Under no circumstances shall any claim or award against ENGINEERED AIR exceed the original contract price whether awarded through arbitration, litigation or otherwise.

ENGINEERED AIR Warranty is void if:

1. The unit is not installed in accordance with this manual.
2. The start-up and operation of the unit is not performed in accordance with this manual.
3. The unit is operated in an atmosphere containing corrosive substances.
4. The unit is allowed to operate during building construction.

PARTS

Warning: **Any replacement part must be of equivalent listing or certification and be functionally equivalent. The replacement part must meet the original's specification in terms of functionality including certifications, timing, input and output range, accuracy and operation.**
Failure to replace parts or components with equivalent parts can cause property damage, injury or death.

1. Motors:
   Motor manufacturers have service centers that will repair or replace motors as required.

2. Parts Other Than Motors:
   Contact the nearest Engineered Air sales office or factory. Be sure to include Model Number, Serial Number, date of installation and nature of failure along with the description of the parts required. Some parts may not be stocked items that must be made or ordered.

RECEIVING

Refer to the back of the packing slip for receiving unit instructions.

On receipt of the unit, check for damage. Inspect protective covers for punctures or other signs that there may be internal damage. Remove protective covers and check for internal damage. Replace covers if the unit is not being assembled or installed at this time. Open access doors and check for internal damage. Close access doors when the inspection is complete. If damage is found follow the instructions on the packing slip.

On receipt of the unit, check electrical characteristics (see rating plate) to make sure the unit voltage is compatible with that available for the unit. All parts for field installation are listed on the shipping order form.

TEMPORARY STORAGE

If a unit is to be stored prior to installation the following precautions are required:

- Store in a well drained area that will not accumulate surface water.
- Store in an area where the unit will not get damaged.
- The entire perimeter and any full height cross members of the unit must be supported by a level surface and the supporting surface must be adequate for supporting the entire weight of the unit.
- All protective coverings that were provided for shipping must be in place.

INSTALLATION

Warning:

This unit is not rated for hazardous locations and cannot be installed in areas requiring any hazardous location rating.

Caution:

All wiring and piping installation must be completed by qualified persons in accordance with all federal, state, provincial and/or local codes.

Note:

Installation shall be in accordance with this manual and all other associated component and control Installation, Operation and Maintenance Manuals.

CODES

In Canada:

1. The installation of this unit shall be in accordance with the latest edition of the Canadian Electrical Code, Part 1 – C.S.A. Standard C22.1, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.
2. This unit shall be electrically grounded in accordance with the latest edition of the Canadian Electrical Code, Part 1 – C.S.A. Standard C22.1, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.
3. The installation of this unit shall be in accordance with the latest edition of the Canadian Natural Gas and Propane Installation Code, C.S.A. Standard B149.1, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.
4. The installation of this unit shall be in accordance with the latest edition of the National Plumbing Code of Canada, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.
5. The installation of this unit shall be in accordance with all other National, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.

In USA:

1. The installation of this unit shall be in accordance with the latest edition of the National Electrical Code (ANSI/NFPA 70), State and Local Codes and in accordance with the local authorities having jurisdiction.
2. This unit shall be electrically grounded in accordance with the latest edition of the National Electrical Code (ANSI/NFPA 70), State and Local Codes and in accordance with the local authorities having jurisdiction.
3. If the unit has not been provided with an electric disconnect switch, one of adequate ampacity shall be installed in accordance with Article 430 of the National Electrical Code (ANSI/NFPA 70).
4. The installation of this unit shall be in accordance with the latest edition of the National Fuel Gas

Code ANSI/Z223.1/NFPA 54, State and Local Codes and in accordance with the local authorities having jurisdiction.

5. The installation of this unit shall be in accordance with the latest edition of the National Standard Plumbing Code (NSPC), State and Local Codes and in accordance with the local authorities having jurisdiction.
6. The installation of this unit shall be in accordance with all other National, State and Local Codes, and in accordance with the local authorities having jurisdiction.

CLEARANCE FOR AIR FLOW

Proper air flow is essential for the operation of this equipment. Maintain at least 60" (1500 mm) clearance between the coil and any obstruction. Maintain at least 96" (2400mm) between adjacent sections. Do not place in a well. Wells create a situation where air re-circulates from the fan back to the coil. Enclosures must be designed for proper air flow and to prevent blockage or re-circulated air.

QUALIFIED INSTALLER

To complete the installation, a refrigeration contractor experienced and qualified in system piping is required. The contractor is responsible for the design, selection and installation of the refrigeration specialties and refrigerant piping for this equipment. The following information is intended to provide general information and guidelines for the successful installation of this equipment.

For detailed information about installation practices consult ASHRAE handbooks, ANSI/ASME Codes, ANSI/ASHRAE Safety Code for Mechanical Refrigeration, CAN/CSA B52 Mechanical Refrigeration Code and any local authorities having jurisdiction.

Note: ⚠ **Component selection, piping design and installation of the air conditioning system are the responsibility of the installing contractor. This manual is designed to provide general guidelines and recommendations only. It is not intended to be a complete manual for air conditioning design.**

REFRIGERATION PIPING RECOMMENDATIONS

UNDERGROUND REFRIGERANT PIPING

Caution: ⚠ **Underground condenser refrigerant piping is not recommended.**
Improper installation of a condensing unit with underground piping will result in equipment failure.
Consult Factory on all systems with underground refrigerant piping.
Underground piping will void compressor warranty unless specifically authorized by Engineered Air.

In the off cycle, the refrigerant charge will migrate to the coldest location. Typically, ground temperatures are cooler than air temperatures, and the underground piping becomes the coolest location. In this case the refrigerant charge will migrate to underground piping. When the compressor starts, any liquid refrigerant in the discharge line could cause nuisance tripping on high head pressure.

PIPING CONNECTION SIZES

Refrigerant piping must be selected to meet the conditions required for your specific installation. The tubing connection sizes on the equipment may or may not be the correct size for your specific application.

Note: DO NOT select tubing sizes based on the size of the connection stubs.
The correct tubing size for your installation must be checked and selected for each and every job.

TRAPS

It is recommended that traps be installed on all suction or discharge gas risers.

LIQUID LINE

Select the line size using piping tables.

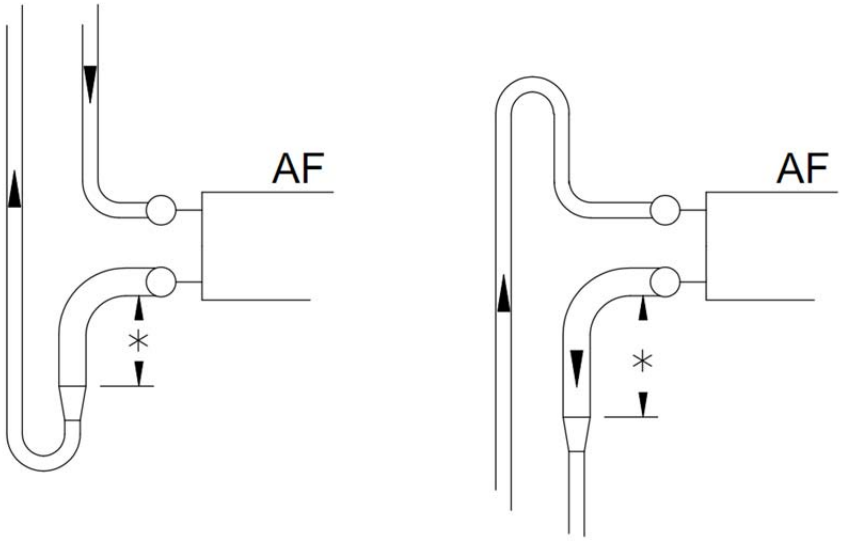
Liquid lines should have a maximum refrigerant velocity of 350 feet per minute (1.78 m/s) to avoid liquid hammer. Select pressure drop for a temperature penalty of less than 2°F (1°C). If a liquid line travels through a warm area, such as a boiler room, insulate the line to prevent heat gain.

Ensure the temperature penalty does not exceed the subcooling provided by the condensing unit.
A sight glass should be installed at the TX valve to ensure the valve is receiving a solid column of liquid if adequate subcooling is a concern. An EngA Intercooler may be ordered and installed to help reduce the effects of inadequate subcooling.

DISCHARGE LINE

Discharge lines must be selected to balance two requirements; minimize pressure drop and ensure adequate line velocity to allow for oil return. Horizontal discharge lines should be sloped down in the direction of flow. Use sizing tables to select tubing sizes based on capacity, equivalent length and maximum size for oil return.

The sketch below describes above and below piping connections and trap requirements. Only install reducers on the vertical line, at least 12” (300mm) below the header connection.



* 12” (300mm) minimum height before reducing size.

REFRIGERATION SPECIALTIES (BY OTHERS)

Note: ⚠	**Refrigerant specialties are selected, supplied and installed by the installing contractor. Most of these devices have specified directions of flow and may be permanently damaged if not installed correctly. Always follow the installation instructions provided with the components.**

SERVICE VALVES (Recommended)

Service valves should be installed to allow servicing of the equipment. A liquid line service valve at the condensing unit is considered a minimum requirement.

SIGHT GLASS/MOISTURE INDICATOR (Required)

Sight glasses are installed in the liquid line to give a visual indication of the refrigerant charge. The moisture indicator gives an indication of the moisture content of the refrigerant.

LIQUID LINE FILTER-DRIER (Required)

The filter-drier is installed in the liquid line to filter particulate and foreign matter from the refrigerant. Filter-driers also absorb small amounts of moisture and acid.

LIQUID LINE SOLENOID VALVE (Required)

The liquid line solenoid valve is installed to control liquid refrigerant in the off cycle. The solenoid valve must be installed close to the TX valve at the evaporator coil. Several different control methods are used to control liquid line solenoid valves. See wiring diagram and unit function for details.

Note:

⚠ **Liquid line solenoid valves must be installed at the evaporator coil, close to the TX valve.**

THERMOSTATIC EXPANSION VALVE (Required)

The thermostatic expansion valve is sized to match the capacity of the system. The TX valve should be balanced or dual ported and must be externally equalized. One valve is required per distributor. The equalization tube connects to the suction line at the outlet of the evaporator downstream of the bulb. The TX valve sensing bulb is installed at the same location tightly strapped to the suction line. Suggested positioning is at the side of the pipe, at the 4:00 o'clock or 8:00 o'clock position. Insulate the TX bulb after installation.

DISCHARGE CHECK VALVES (Required)

Provide discharge check valve(s) to the inlet of the AF. This controls liquid migration to the compressor in the off cycle.

Refrigeration Table 1 Equivalent Length.

ACR (OD)	Approximate pressure loss of fittings (equivalent feet of tubing)									
Tubing Size	90° Std	90° Long Radius	90° Street	45° Std	Return Bend	Tee Branch Flow	Tee Straight Through	Ball Valve	Globe Valve	Angle Valve
1/2" OD	1.4	0.9	2.3	0.7	2.3	2.7	0.9	0.9	17	6
5/8" OD	1.6	1.0	2.5	0.8	2.5	3.0	1.0	1.0	18	7
7/8" OD	2.0	1.4	3.2	0.9	3.2	4.0	1.4	1.4	22	9
1 1/8" OD	2.6	1.7	4.1	1.3	4.1	5.0	1.7	1.7	29	12
1 3/8" OD	3.3	2.3	5.6	1.7	5.6	7.0	2.3	2.3	38	15
1 5/8" OD	4.0	2.6	6.3	2.1	6.3	8.0	2.6	2.6	43	18
2 1/8" OD	5.0	3.3	8.2	2.6	8.2	10.0	3.3	3.3	55	24
2 5/8" OD	6.0	4.1	10.0	3.2	10.0	12.0	4.1	4.1	69	29

Refrigeration Table 2 (**R410A**) Piping Guidelines for Normal Air Conditioning Duty.

R410A						
Net Evaporator Capacity		Equivalent Length (Actual length plus fittings and valves)				Maximum Riser Size
Tons	Line	30 feet	50 feet	100 feet	150 feet	
3 tons	Suction	3/4" (7/8")	3/4" (7/8")	7/8"	7/8"	7/8"
	Discharge	1/2"	1/2"	5/8"	5/8"	5/8"
	Liquid	3/8"	3/8"	1/2"	1/2"	
	Condensate	5/8"	5/8"			
4 tons	Suction	3/4" (7/8")	7/8"	7/8"	1 1/8"	7/8"
	Discharge	1/2"	5/8"	5/8"	3/4" (7/8")	5/8"
	Liquid	3/8"	1/2"	1/2"	1/2"	
	Condensate	5/8"	5/8"			
5 tons	Suction	7/8"	7/8"	1 1/8"	1 1/8"	1 1/8"
	Discharge	5/8"	5/8"	3/4" (7/8")	3/4" (7/8")	5/8"
	Liquid	1/2"	1/2"	1/2"	1/2"	
	Condensate	3/4" (7/8")	3/4" (7/8")			
7.5 tons	Suction	7/8"	1 1/8"	1 1/8"	1 3/8"	1 3/8"
	Discharge	5/8"	3/4" (7/8")	7/8"	7/8"	3/4" (7/8")
	Liquid	1/2"	1/2"	1/2"	5/8"	
	Condensate	7/8"	7/8"			
10 tons	Suction	1 1/8"	1 1/8"	1 3/8"	1 3/8"	1 3/8"
	Discharge	3/4" (7/8")	3/4" (7/8")	7/8"	7/8"	7/8"
	Liquid	5/8"	5/8"	5/8"	5/8"	
	Condensate	1 1/8"	1 1/8"			
12.5 tons	Suction	1 1/8"	1 3/8"	1 3/8"	1 5/8"	1 5/8"
	Discharge	7/8"	7/8"	7/8"	1 1/8"	7/8"
	Liquid	5/8"	5/8"	5/8"	5/8"	
	Condensate	1 1/8"	1 1/8"			
15 tons	Suction	1 3/8"	1 3/8"	1 5/8"	1 5/8"	1 5/8"
	Discharge	7/8"	7/8"	1 1/8"	1 1/8"	1 1/8"
	Liquid	3/4" (7/8")	3/4" (7/8")	3/4" (7/8")	7/8"	
	Condensate	1 3/8"	1 3/8"			
20 tons	Suction	1 3/8"	1 3/8"	1 5/8"	2 1/8"	1 5/8"
	Discharge	7/8"	1 1/8"	1 1/8"	1 1/8"	1 1/8"
	Liquid	7/8"	7/8"	7/8"	7/8"	
	Condensate	1 3/8"	1 3/8"			

Refrigeration Table 2 (**R407C**) Piping Guidelines for Normal Air Conditioning Duty.

R407C						
Net Evaporator Capacity		Equivalent Length (Actual length plus fittings and valves)				Maximum Riser Size
Tons	Line	30 feet	50 feet	100 feet	150 feet	
3 tons	Suction	3/4" (7/8")	7/8"	1 1/8"	1 1/8"	1 1/8"
	Discharge	1/2"	5/8"	5/8"	3/4"	7/8"
	Liquid	3/8"	3/8"	1/2"	1/2"	
	Condensate	5/8"	5/8"			
4 tons	Suction	7/8"	7/8"	1 1/8"	1 1/8"	1 3/8"
	Discharge	5/8"	5/8"	3/4" (7/8")	7/8"	1 1/8"
	Liquid	1/2"	1/2"	1/2"	1/2"	
	Condensate	5/8"	5/8"			
5 tons	Suction	7/8"	1 1/8"	1 1/8"	1 3/8"	1 3/8"
	Discharge	5/8"	3/4" (7/8")	7/8"	7/8"	1 1/8"
	Liquid	1/2"	1/2"	1/2"	5/8"	
	Condensate	3/4" (7/8")	3/4" (7/8")			
7.5 tons	Suction	1 1/8"	1 1/8"	1 3/8"	1 3/8"	1 5/8"
	Discharge	3/4" (7/8")	7/8"	7/8"	1 1/8"	1 3/8"
	Liquid	1/2"	5/8"	5/8"	5/8"	
	Condensate	7/8"	7/8"			
10 tons	Suction	1 1/8"	1 3/8"	1 5/8"	1 5/8"	1 5/8"
	Discharge	7/8"	7/8"	1 1/8"	1 1/8"	1 5/8"
	Liquid	5/8"	5/8"	5/8"	3/4" (7/8")	
	Condensate	1 1/8"	1 1/8"			
12.5 tons	Suction	1 3/8"	1 3/8"	1 5/8"	2 1/8"	2 1/8"
	Discharge	7/8"	7/8"	1 1/8"	1 1/8"	1 5/8"
	Liquid	5/8"	5/8"	3/4" (7/8")	3/4" (7/8")	
	Condensate	1 1/8"	1 1/8"			
15 tons	Suction	1 3/8"	1 5/8"	1 5/8"	2 1/8"	2 1/8"
	Discharge	7/8"	1 1/8"	1 1/8"	1 3/8"	1 5/8"
	Liquid	3/4" (7/8")	3/4" (7/8")	3/4" (7/8")	7/8"	
	Condensate	1 1/8"	1 1/8"			
20 tons	Suction	1 5/8"	1 5/8"	2 1/8"	2 1/8"	2 5/8"
	Discharge	1 1/8"	1 1/8"	1 3/8"	1 3/8"	2 1/8"
	Liquid	7/8"	7/8"	7/8"	1 1/8"	
	Condensate	1 3/8"	1 3/8"			

Refrigeration Table 2 (**R134a**) Piping Guidelines for Normal Air Conditioning Duty.

R134a						
Net Evaporator Capacity		Equivalent Length (Actual length plus fittings and valves)				Maximum Riser Size
Tons	Line	30 feet	50 feet	100 feet	150 feet	
3 tons	Suction	7/8″	1 1/8"	1 1/8″	1 3/8″	1 3/8"
	Discharge	5/8"	3/4″ (7/8″)	3/4″ (7/8″)	7/8"	7/8"
	Liquid	3/8"	3/8″	1/2"	1/2"	
	Condensate	5/8"	5/8"			
4 tons	Suction	1 1/8″	1 1/8"	1 3/8″	1 3/8″	1 3/8"
	Discharge	3/4″ (7/8″)	3/4″ (7/8″)	7/8″	7/8"	7/8"
	Liquid	1/2"	1/2″	1/2"	1/2"	
	Condensate	7/8"	7/8"			
5 tons	Suction	1 1/8"	1 3/8"	1 3/8"	1 5/8"	1 5/8"
	Discharge	3/4″ (7/8″)	7/8″	7/8"	1 1/8"	1 1/8"
	Liquid	1/2"	1/2"	5/8"	5/8″	
	Condensate	7/8″	7/8″			
7.5 tons	Suction	1 3/8"	1 3/8"	1 5/8"	1 5/8"	1 5/8"
	Discharge	7/8"	7/8"	1 1/8"	1 1/8"	1 1/8"
	Liquid	1/2"	1/2"	5/8"	7/8"	
	Condensate	7/8″	7/8″			
10 tons	Suction	1 3/8"	1 5/8"	2 1/8"	2 5/8"	2 1/8"
	Discharge	7/8″	1 1/8"	1 1/8"	1 1/8"	1 1/8"
	Liquid	5/8"	5/8"	5/8"	3/4″ (7/8″)	
	Condensate	1 1/8″	1 1/8″			
12.5 tons	Suction	1 5/8"	1 5/8"	2 1/8"	2 1/8"	2 1/8"
	Discharge	1 1/8"	1 1/8"	1 1/8"	1 3/8"	1 3/8"
	Liquid	5/8″	5/8"	7/8″	3/4″ (7/8″)	
	Condensate	1 1/8"	1 1/8"			
15 tons	Suction	1 5/8"	2 1/8"	2 1/8"	2 1/8"	2 1/8"
	Discharge	1 1/8"	1 1/8"	1 3/8"	1 3/8"	1 3/8"
	Liquid	3/4″ (7/8″)	3/4″ (7/8″)	7/8″	7/8"	
	Condensate	1 3/8"	1 3/8"			
20 tons	Suction	2 1/8"	2 1/8"	2 5/8"	2 5/8"	2 5/8"
	Discharge	1 1/8"	1 3/8"	1 5/8"	1 5/8"	1 5/8"
	Liquid	7/8″	7/8″	7/8″	7/8″	
	Condensate	1 3/8″	1 3/8″			

NOTES:

1. Sizes are OD dimensions, Type L, ACR refrigeration tubing.
2. 3/4” (7/8”) noted above: 7/8” ACR tubing may replace 3/4" as required.
3. Selections are based on equivalent length. Equivalent length is the actual length plus the additional losses in feet due to fittings. See Table 1 for pressure losses due to fittings.
   (If number of fittings is unknown an equivalent length estimate can be made by multiplying the actual piping run by a complexity factor of 1.5 to 2 times the actual length. 1.5 times for a simple system or long runs and 2 times for a close coupled system or one with a lot of fittings.)
4. For compressors or circuits with unloading (tandem compressors included). Always check tubing sizes for oil return at the unloaded conditions. Determine the unloaded capacity in tons and verify that the selected tubing is not larger than maximum riser size at the unloaded capacity.
5. Selection Criteria to develop table.
   Suction line - PD less than 2°F temperature penalty.
   Discharge line - PD less than 2.5°F temperature penalty.
   Liquid line - PD less than 2°F temperature penalty, with velocity less than 350fpm to avoid liquid hammer.
   Condensate line (condenser to receiver if equipped - velocity less than 115 fpm. (two phase flow) with no traps.
   Maximum riser sizes are the largest recommended tubing sizes for oil return. Sizes are based on 75% capacity to allow for low load conditions.

For detailed evaluation of piping systems, guidelines and pressure losses consult ASHRAE handbooks.

Refrigeration Table 3

Approximate effect of gas line pressure drop on compressor capacity and power (ASHRAE REFRGERATION 2.3)		
Line Loss	Capacity	Required Power
Suction	%	%
0°F	100	100
2°F	96.4	104.8
4°F	92.9	108.1
Discharge	%	%
0°F	100	100
2°F	99.1	103.0
4°F	98.2	106.3

Refrigeration Table 4

Weight of refrigerant in liquid lines per 100ft of tubing (100°F)			
Liquid Line	R134a Lbs (kg)	R407C Lbs (kg)	R410A Lbs (kg)
3/8”	3.9 (1.8)	3.6 (1.6)	3.4 (1.5)
1/2”	7.3 (3.3)	6.8 (3.0)	6.2 (2.8)
5/8”	12 (5)	11 (2.3)	10 (4.5)
7/8”	24 (11)	23 (10.4)	21 (9.5)
1 1/8”	41 (19)	39 (18)	36 (16)
1 3/8”	63 (29)	59 (27)	54 (24)

REFRIGERATION PIPING MATERIALS AND PROCEDURES

Note:	**A qualified refrigeration contractor experienced in refrigerant piping must complete the installation. The installation must be completed using industry-accepted methods and materials.**

WARNING:	**The AF unit is shipped with a holding charge of dry nitrogen. This pressure shall be released safely before opening system or connecting tubing.**

TUBING

Use Nitrogenized ACR grade, 'Type L' or 'Type K' copper tubing only. All refrigerant tubing shall be clean and dry. The tubing shall be nitrogen purged during the brazing process. This prevents harmful copper oxides from forming in the tubing.

WARNING:	**Nitrogen cylinders shall be equipped with a high-pressure regulator and flow meter. Do not connect high-pressure cylinders to the refrigerant circuit without a regulator. Failure to do so may result in property damage, injury or death.**

Refrigerant tubing must be cut with a tube cutter and the ends deburred before installation. Never use a hacksaw or abrasive cutter to cut refrigeration tubing.

Long radius elbows should be used to reduce pressure drop.

Copper to copper connections should be made with SILFOS, or similar silver bearing low temperature brazing material.

Copper to brass or copper to steel joints should be made with 45% silver solder and the appropriate flux. Flux must be cleaned from tubing after installation.

WARNING:	**Soft solders (50/50, 95/5, etc) are not suitable for use with air conditioning systems.**

All accessories shall be properly protected from heat during installation. Refer to the installation guidelines supplied with the components. It is preferred to install the filter/drier last to avoid extended exposure to atmosphere (moisture).

Piping shall be properly supported and allowances shall be made for thermal expansion or contraction of tubing.

LEAK CHECKING

After installation, all joints, both factory and field installed, shall be pressure checked and leak tested using approved industry methods.

WARNING:

Test pressures must not exceed the maximum pressure ratings specified on the unit rating plate.

WARNING:

Oxygen must NEVER be used to pressurize a system.

Ensure all service valves and manual valves are open. If leaks are located, remove pressure and repair leaks. Recheck as necessary.

If brazing is necessary to repair leaks, a dry nitrogen purge through tubing while brazing is required to prevent the formation of copper oxides.

EVACUATION AND DEHYDRATION

The system must be evacuated prior to charging. Proper evacuation will remove non-condensable gasses and water vapor from the system. Water vapor in the system will combine with the oil and refrigerant to form acids and other undesirable by-products. Non-condensable gasses such as air or nitrogen will increase the head pressure and operating temperature and degrade system performance.

Sketch a piping schematic showing all valves and components. Check the diagram to ensure that all portions of the system will be evacuated. Add additional hoses or service fittings as required.

Note:

A high vacuum cannot be pulled through a solenoid valve whether or not it is energized.
A high vacuum cannot be pulled through a check valve regardless of direction of flow.

Evacuation Procedure:

1. Remove leak-testing gasses from the system. If refrigerant was used to leak test, the refrigerant shall be recovered.
2. Connect a high vacuum pump to the system. Use the shortest and largest diameter hose available.
3. Use as many connections as the system will allow.
4. If evacuating through 'Schraeder valves', remove the Schraeder valve core before evacuation.
5. Open all service valves.
6. Use a micron gauge to measure the vacuum.

Note:

A standard refrigeration gauge with "inches of mercury" is not suitable to measure the high vacuums. A high vacuum gauge capable of measuring Microns is required.

7. Triple evacuation or high evacuation methods are both acceptable.
8. Evacuate the system to an ultimate vacuum of 500 microns (0.5mm of mercury).
9. Check unit rating-plate for correct refrigerant type. Break the vacuum with virgin refrigerant from a sealed container.
10. Pressurize the system to a slight positive pressure, (one or two psig). Replace all Schraeder valve cores. Do not allow air into the system.
11. Reinstall gauges, proceed to the start-up section for charging instructions.

CAUTION: 	**NEVER use system compressors to evacuate a system. Operating a compressor while the system is under a high vacuum may cause internal arcing of the windings and compressor failure. Compressor damage caused by high vacuum operation is not covered by system warranty.**

REFRIGERANT CHARGING

System charge will depend on the length and orientation of the installed system.
An initial estimate for an AC system charge is 1 lb. (0.5kg). per ton plus the weight of liquid in the liquid line (see Table 4 Weight of refrigerant in copper lines). Ideally charging should be done in warm weather.

If the ambient temperature is less than design, restrict the airflow across the condenser to increase head pressure to 130°F (55°C) saturated discharge temperature for charging.

1. Check that all manual shut off valves in the refrigeration circuit are in the normal operating position.
2. Weigh in an initial charge of approximately 75% of the estimated charge.
3. Check to ensure evaporator section has proper airflow. Check static pressure drop and compare with design static. Check inlet air temperature to evaporator. Ensure that there is sufficient load to operate the air conditioning.
4. Check the supply voltage and ensure that is within 10% of design voltage on unit rating plate.
5. Check control voltage at refrigerant solenoid valves and ensure that it is within 10% of rated voltage.
6. Set controls to call for cooling.
7. Close the system service switch.
8. With the saturated discharge temperature approximately equal to 130°F (55°C), [475 psig (R-410a), 325 psig (R-407C)] This step may require blocking condenser airflow to increase head pressure. Charge system slowly until the sight glass is clear. DO NOT OVERCHARGE.
9. Check evaporator superheat.
   Attach an accurate temperature sensor tightly to the suction line at the TX bulb. Measure the suction pressure at the condensing unit. Add 2 psig to this pressure and convert it to the saturated suction temperature using the appropriate pressure temperature table. Subtract the saturated temperature from the temperature measured at the TX bulb. This is the suction superheat. Superheat should be between 8°F to 14°F (5° to 8°C) when the system is operating at full load with a clear sight-glass.

10. Set up the hot gas bypass valve (optional). Using a pressure-temperature chart find the refrigerant pressure that corresponds to a temperature of 34°F (1°C).
    Create a low load condition on the evaporator by restricting the airflow across the evaporator. Adjust the hot gas bypass regulator so that it will start to open at the pressure corresponding to 34°F (1°C). If the hot gas system is equipped with a desuperheating TX valve, measure the superheat at the compressor and ensure the valve is working.
11. Check the settings of the Condenser Fan Cycling Controls (CFC's), adjust as required.

FLUSHING AND DEGREASING OF WATER AND GLYCOL COILS

Coil tubing may contain material or residue from manufacturing, transportation or storage. To prevent possible damage to other components in the system, the coils must be flushed and degreased. Consult a qualified water treatment specialist.

HEAT TRANSFER FLUIDS

The coil(s) provided have been selected for use with a specific heat transfer fluid as shown on the Submittal Record. Use of other fluids will result in different performance and can damage the coil(s).

It is imperative to properly select and apply heat transfer fluids used in heating and cooling systems. Untreated, improperly treated or improper use of fluids or use of fluids not approved for use in commercial heating and cooling systems can damage coils and system components. For selection and application of heat transfer fluids, always follow the manufacturers' recommendations including treatment, mixing and filling. Warranty will be void if coil damage results from misapplication or improper treatment of the heat transfer fluid.

SHUTDOWN PROCEDURE

Warning: **Electrical shock or death can occur if instructions are not followed. This equipment contains moving parts that can start unexpectedly. Injury or death could occur if instructions are not followed. All work should be performed by a qualified technician. Always disconnect power before servicing. DO NOT bypass any interlock or safety switches under any circumstances.**

1. Shutdown
   To shut the unit down for a short time (such as for inspection or service). Shut of the service switch in the main control panel then turn off the main disconnect.
2. Re-Start after Shutdown
   Turn on main disconnect for the unit. Turn on the service switch in the main electrical control panel.

MAINTENANCE

Warning: **This unit is connected to high voltages. Electrical shock or death could occur if instructions are not followed. This equipment contains moving parts that can start unexpectedly. Injury or death could occur if instructions are not followed. All work should be performed by a qualified technician. Always disconnect and lock out power before servicing. DO NOT bypass any interlock or safety switches under any circumstances.**

To provide a maintenance history, It is recommended that the owner have a maintenance file for each unit. **The following maintenance instructions are to be carried out each spring and fall or as otherwise indicated by qualified service personnel.**

Caution:

Label all wires prior to removal when servicing controls or critical components. Wiring errors can cause improper and dangerous operation.

Verify proper operation after servicing.

HERESITE® MAINTENANCE

Heresite® is a baked on phenolic coating used to protect metals from some forms of chemical corrosion. At the time of purchase new coils can, as an option, have Heresite® applied at the factory.

If you have a Heresite® coated coil:

- Inspect once per year or more often as required.
- Clean with low pressure air and vacuum with a soft brush.
- Low pressure, chemical free water may be used.

Repair Instructions (using air-dried Heresite® touch-up spray):

1) Ensure surfaces are completely dry.
2) Use a nylon brush to remove any loose scale.
3) Roughen up areas to be repaired with a wire brush.
4) Vacuum fins or the affected area to ensure any loose residue is gone.
5) Spray or brush S-440 solvent* (or any equivalent cleaner) to dissolve any oils or grease.
6) Again, vacuum the affected area.
7) Allow one hour for the solvent to dissolve completely.
8) Cover areas not requiring repair with plastic (or equivalent) and masking tape.
9) Using Heresite® VR-554-T* coating spray all affected areas from different angles to ensure complete coverage. Apply 2-3 full coats. Let dry 3 to 4 hours between coats.
10) Allow Heresite® to cure 24 hours before putting equipment back into service.

* Review the MSDS documentation included with the solvent and coating spray.

ELECTRICAL

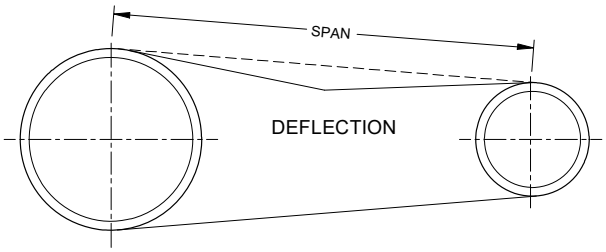
- Check all wiring for loose connections.
- Check voltage at unit (while in operation).
- Check amperage draw against unit rating plate.
- Where possible, all contactors should be inspected to ensure that contacts are clean and are making good contact. If contacts are abnormally pitted or burned badly, replace contactor. Single phasing and motor burnouts can result from bad contacts.

BELT ADJUSTMENT

For maximum belt and bearing life, pulley alignment and belt tension must be properly maintained. Only replace with belts of the proper type and size.

NOTE: If belts are too tight or improperly aligned, the life expectancy of the motor(s), fan bearings and belt(s) are reduced.

Alignment: Pulleys must be aligned to within 1/16” per foot (1mm per 760mm) of span.



Belt Deflection: Allow 1/64” (0.4mm) of deflection for each 1” (25.4 mm) of span length.

CAUTION:

Excessive belt tension is the most frequent cause of belt wear, bearing wear and noise.

SET SCREWS

Check set screws on fan wheel, fan bearings, fan and motor pulleys for looseness on the shaft. Tighten where required. It is important to perform this check before initial start-up, after a run-in period of 2 weeks and then on 4 month intervals.

CAUTION:

Overtightening set screws can damage bearings.

Shaft diameter	NTN	KOYO	NTN	KOYO	DODGE
Type	UC SERIES (set screw)		UK SERIES (adapter sleeve locknut)		SC 203-215 SERIES
3/4" (19mm)	35 in-lb (3.9 Nm)	35 in-lb (4.0 Nm)	Install the washer and lock nut; tighten the nut fully by hand. Apply a punch or screw driver into the notch of the nut and tap it with a hammer. Stop tapping after the nut has turned 60° to 90°. Do not strike the seal. Bend the tab on the rim of the washer, which is in line with the notch of the nut. If a tab does no line up with a notch, tighten the nut further. DO NOT BACK THE NUT OFF.		66 - 80 in-lb (7.5 - 9 Nm)
1" (25mm)	35 in-lb (3.9 Nm)	35 in-lb (4.0 Nm)			126 -156 in-lb (14 - 18 Nm)
1 3/16" (30mm)	43 in-lb (4.9 Nm)	35 in-lb (4.0 Nm)			126 -156 in-lb (14 - 18 Nm)
1 7/16" (37mm)	51 in-lb (5.8 Nm)	75 in-lb (8.5 Nm)			126 -156 in-lb (14 - 18 Nm)
1 11/16" (43mm)	69 in-lb (7.8 Nm)	75 in-lb (8.5 Nm)			228 -272 in-lb (26 - 31 Nm)
1 15/16" (49mm)	69 in-lb (7.8 Nm)	155 in-lb (17.5 Nm)			228 -272 in-lb (26 - 31 Nm)
2 3/16" (56mm)	87 in-lb (9.8 Nm)	155 in-lb (17.5 Nm)			228 -272 in-lb (26 - 31 Nm)
2 7/16" (62mm)	147 in-lb (16.6 Nm)	155 in-lb (17.5 Nm)			228 -272 in-lb (26 - 31 Nm)
2 11/16" (68mm)	173 in-lb (19.6 Nm)	248 in-lb (28.0 Nm)			228 -272 in-lb (26 - 31 Nm)
2 15/16" (75mm)	173 in-lb (19.6 Nm)	248 in-lb (28.0 Nm)			228 -272 in-lb (26 - 31 Nm)

Refer to bearing manufacturers' literature for all other types of bearings.

MOTOR LUBRICATION

Refer to motor manufacturer for lubrication recommendations. On motors having grease drain plugs, remove the plugs and operate the motor for 15 minutes before replacing plugs. **DO NOT OVER GREASE.**

RECOMMENDED MOTOR LUBRICATION INTERVALS

Service Per Day	Up to 7.5 HP Up to 5.6 kW	10 to 40 HP 7.5 to 29.8 kW	Over 40 HP Over 29.8 kW
Less than 12	5 Years	3 Years	1.5 Years
More than 12	2 Years	1 Year	9 Months

NOTE: Motors that run in severe conditions should be greased as specified by the motor manufacturer.

DAMPERS

If supplied, check semi-annually for cleanliness, integrity and proper operation. Adjust dampers where required.

CONTROLS

Annually clean and recalibrate all controls, check for proper operation, and repair or replace any faulty controls. Check all damper hardware settings every three months. Replace blown fuses with equivalent size and type fuse. Failure to do so can result in damage to the unit.

REFRIGERATION

Seasonal Maintenance

- Check operating temperature and pressures.
- The external surface of finned coils can be cleaned using a low pressure water spray and a brush. Coil fins are easily damaged. Do not use high pressure steam or water to clean coils; it will permanently damage the coil. When using cleaning additives or solutions they must be compatible with the coil materials or coatings. Use a fin comb to straighten any damaged or bent fins.
- Inspect refrigerant lines for evidence of oil leaks.
- Check condenser fans and tighten set screws.

NOTE: Air flow is restricted by dirty coils, slipping fan belts etc. This will reduce capacity.

Pressure Controls

Encapsulated pressure controls have fixed settings and are not adjustable. Most pressure controls have the setpoint marked directly on the control. The following table shows typical cut in and cut out setpoint using saturated temperature; refer to refrigerant specific saturated temperature/pressure tables to convert to pressure.

TYPICAL SETTINGS (Saturated Temperature)

Pressure Controls	Cut In	Cut Out
Low Pressure	35°F (1.7°C)	15°F (-9.4°C)
High Pressure	Manual	150°F (65.6°C)
High Pressure (Water Cooled)	105°F (40.6°C)	125°F (51.7°C)
Condenser Fan	Various settings to maintain saturated condensing temperature between 85°F to 125°F (29.4°C to 51.7°C)	

Note: Specialized applications or different refrigerants may have pressure control settings outside typical settings. Refer directly to mounted pressure controls, wiring diagram and/or unit function for specific details.

Note: Equipment with a receiver can use high pressure controls with the lower setting of than that noted above, the maximum rated working pressure of the receiver, 90% of the pressure relief valve rating.

TROUBLESHOOTING CHART

Symptoms	Problem	Cure
High head pressure	Dirty Condenser	Clean or wash
	Flattened or hail damaged fins	Comb fins
	Condenser fan motors not running	Check and correct problem
	Broken condenser fan blade	Replace blade
	Defective or incorrectly set condenser fan cycling control	Adjust or replace as required
	Condenser air, short circuiting	Check temperature of inlet air and correct as required. Ensure proper airflow clearances.
	System overcharged with refrigerant	Reclaim excess refrigerant
	Non condensable in system	Reclaim refrigerant, evacuate system, recharge with new refrigerant
Control relays chatter or solenoid valves not energized	Voltage drop in field wiring to solenoids or thermostat. (greater than 10%)	Check voltage at solenoid or relay when it is energized, If it is less than 10% of rated voltage, check wire size, or determine cause and repair as required.
	Primary voltage not within 10% of unit rating plate.	Have electrician check and repair as required.