

EngA®

ENGINEERED AIR®

**INSTALLATION, OPERATION
AND MAINTENANCE MANUAL
FOR
CU SERIES**

CONDENSING UNITS

INDOOR AND OUTDOOR MODELS



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

**CANADIAN
HEAD OFFICE
AND FACTORY**

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CALGARY, ALBERTA
T2G 4C8
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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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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.

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.

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, labour, 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.
- Protect indoor units from rain and snow.

INSTALLATION

Warning:



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

Caution:



All wiring, piping and fuel line 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 Mechanical Refrigeration Code, C.S.A. Standard B52, Provincial and Local Codes, and in accordance with the local authorities having jurisdiction.
4. 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 ANSI/ASHRAE Standard 15 - Safety Code for Mechanical Refrigeration, ANSI/ASME SEC VIII - Boiler and Pressure Vessel Code, ANSI/ASME B31.S ASME Code for Pressure Piping and Refrigeration Piping, State 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, State and Local Codes, and in accordance with the local authorities having jurisdiction.

MINIMUM CLEARANCE FOR SERVICE AND TO COMBUSTIBLES IN INCHES (mm)

MODEL	COMBUSTIBLE CLEARANCE					SERVICE CLEARANCE	
	TOP	FRONT	BACK	SIDE	BOTTOM	SERVICE SIDE	CONTROL PANEL †
CU	1" (25)	1" (25)	1" (25)	1" (25)	0	36" (915)	42" (1067)

† - As required by the Canadian Electrical Code or the National Electrical Code.
For Safety and Service, the minimum clearances must be observed.

Note: The minimum clearance for proper air flow is 60" (1500 mm) to obstructions and 96" (2400 mm) to an adjacent condensing unit or air conditioning unit.

QUALIFIED INSTALLER

To complete the installation, an air-conditioning 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.

COMPONENT LOCATIONS

Consider the issues related to your installation and the relative location of the components.

Locate the condensing unit as close as practical to the evaporator section. Shorter refrigerant piping will always result in a lower refrigerant charge, greater reliability and longer system life.

Considerations for different arrangements.

Three arrangements are possible:

1. Condensing unit above evaporator
2. Condensing unit is on the same level as evaporator.
3. Condensing unit below evaporator.

1. Condensing Unit Above The Evaporator

In this orientation, the suction gas must travel up a riser to get to the condensing unit. The suction riser must be correctly sized to ensure proper oil return. Traps are required at the bottom of all risers. Double risers may be required on systems with tandem compressors or unloaders. Refer to ASHRAE Refrigeration Handbook for information on double risers.

The liquid line will have a vertical drop in this orientation and gravity will aid in taking the liquid to the evaporator section. The liquid refrigerant will GAIN pressure at the rate of one half a psig per foot of vertical drop. If the drop is considerable, this pressure gain may affect the sizing of the TX valve.

2. Condensing Unit At The Same Elevation As The Evaporator.

Select suction and liquid lines from the appropriate tables. Horizontal suction lines should slope down in the direction of flow with a 1:200 slope.

3. Condensing Unit Located Below The Evaporator.

This arrangement should only be considered when other options are not available.

With the compressor below the evaporator, oil return in the suction line is helped by gravity. Horizontal runs are sloped down in the direction of flow with a 1:200 slope.

The liquid must travel upwards, and there are several issues that must be addressed. As the liquid travels upward, it must fight gravity and it will LOSE pressure at the rate of 0.5 psig per vertical foot. Adequate subcooling is required to counteract the pressure losses due to vertical rise, plus the pressure drop due to friction losses and accessories. Standard subcooling for most condensing units is 10°F, (5°C).

In the off cycle, all liquid refrigerant in the line will drain down to the condenser by gravity. When the system restarts, time is required for the liquid refrigerant to fill the liquid line and travel to the TX valve. A low-pressure control bypass timer may be required, to allow time for liquid to reach the TX valve, and prevent the system from short-cycling during startup.

An EngA Intercooler (optional) may be installed at the TX valve to improve performance and reduce flash gas during fluctuating load conditions.

Consider installing an additional liquid line sight glass at the TX valve to ensure that a solid column of liquid reaches the TX valve. This simple step at installation time can save many hours of troubleshooting if there is a flash gas issue.

PIPING RECOMMENDATIONS

Underground Piping

Caution:**Underground 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 the factory.


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 suction line will enter the compressor causing both diluted oil and slugging. Either condition will reduce the life of the compressor.

Suction line accumulators and crankcase heaters are required on all systems with underground piping. Consult factory for guidance.

PIPING CONNECTION SIZES

Refrigerant piping must be selected to meet the conditions required for your specific installation. The tubing connection sizes on the condensing unit and/or evaporator 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.

Suction Line

The temperature penalty is a measure of capacity loss due to pressure drop in the tubing. Select the suction line to have a maximum temperature penalty of 2°F (1°C). Higher temperature penalties will reduce both system capacity and efficiency. See Refrigeration Table 3.

Use Refrigeration Table 2 Piping Guidelines to select the suction line size. Suction lines are selected at design load conditions, and must be rechecked at minimum load conditions to ensure oil return. Tandem compressor systems and systems with unloaders must be re-checked at the unloaded condition to ensure oil return.

Should a compromise be required between oil return and pressure drop, oil return must always have priority.

- Slope the suction line down with a 1:200 grade in the direction of flow to help oil return.
- Suction lines should be insulated to prevent unnecessary heat gain.
- Install oil traps at the bottoms of all 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.

Condensate Line (Systems with Receivers Only)

The condensate line connects the condenser to the liquid receiver. This is perhaps one of the most critical and misunderstood lines in a system. Condensate lines contain liquid and gas together, and are sized and installed to provide sewer flow to the receiver.

Size condensate lines for a maximum liquid velocity of 100 FPM (0.4 m/s). This is often the same size as the discharge line. The condensate must “free drain” to the receiver with no intervening traps. Recommended slope is 1:50.

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 suction and 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.



Suction Line Filter (Optional)

A suction line filter is designed to catch any debris from the installation before it enters the compressor. Suction filters are recommended on all systems with long refrigerant piping runs.

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.



Hot Gas Solenoid Valves (Required When Equipped With A Hot Gas Bypass Valve)

Whenever a system is equipped with hot gas bypass valve, a hot gas solenoid valve is required. The valve will open and close with the liquid line solenoid valve. The hot gas bypass solenoid valve must be installed at the condensing unit, close to the discharge line tee.

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

NOTE: Hot gas solenoid valves must be installed at the condensing unit, close to the discharge line tee.

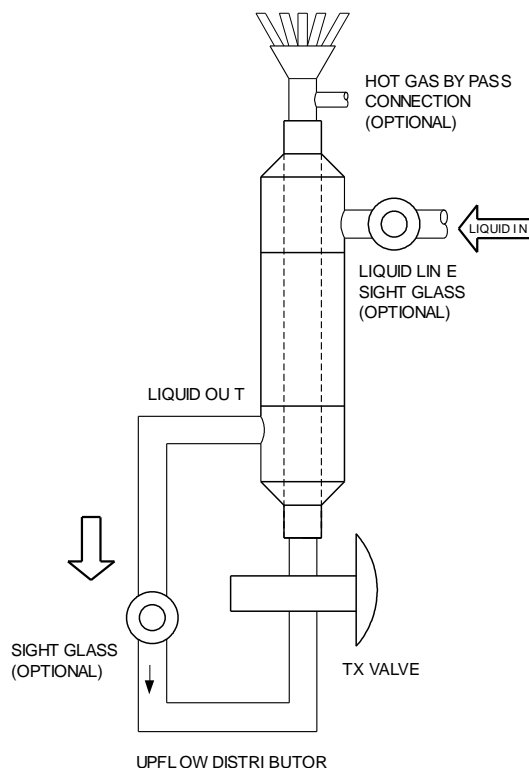
Thermostatic Expansion Valve (TX Valve) (Required)

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 4:00 o'clock or 8:00 o'clock position. It is good practice to insulate the TX bulb after installation.



EngA Intercooler (Optional)

The EngA Intercooler is a small liquid heat exchanger installed between the TX valve and the distributor. The heat exchanger provides, “just in time”, subcooling to liquid refrigerant entering the TX valve. This adds stability to systems that experience occasional flashing in the liquid line.



Suction Accumulators

Suction accumulators are installed in the suction line close to the compressor. These devices are designed to trap slugs of liquid before they can cause damage to the compressor.

Accumulators are **REQUIRED** on:

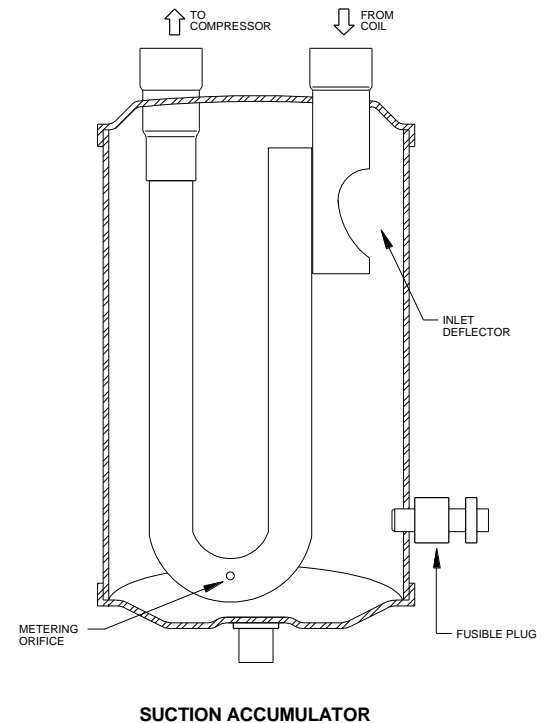
1. Systems with multiple DX coils in series. All compressors on the downstream DX coils require accumulators.
2. Systems with over 75 feet (20m) of piping.
3. All systems that operate below 50°F (10°C) ambient temperature.
4. All systems with underground piping. (Underground piping is not recommended, and may void warranty)

Caution:



Consult Factory on all systems with underground refrigerant piping.

Underground piping will void compressor warranty unless specifically authorized by Engineered Air.



Accumulators are **STRONGLY RECOMMENDED** on:

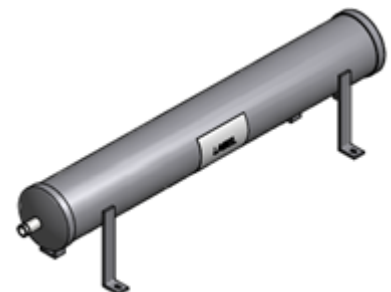
1. 100% Outside air systems.
2. VAV systems.
3. Process cooling systems that experience rapid load changes.

Condensing units may be ordered with suction accumulators installed at the factory (optional) or they may be field supplied and installed.

Discharge Holding Tank (Optional)

The Discharge Holding Tank (DHT) is designed to provide additional volume to the system. The DHT is used when the entire system charge cannot be held by the condenser. This occurs on split systems with long piping runs where the pump down charge will not fit into the condenser.

It is installed between the compressor and the condenser to prevent the liquid refrigerant from filling the discharge line and/or compressor during the idle state. The DHT is not a receiver.



Liquid Receivers (Optional)

NOTE: Liquid receivers **MUST NOT** be field installed unless the air-cooled condenser has been specifically designed for use with a receiver.

If receivers are required the condenser coil must be ordered with a “receiver ready” condenser coil (optional) or a factory installed receiver (optional).

Receivers are designed to hold excess refrigerant on systems that have variable refrigerant charges.

Typical applications are:

1. Systems with reheat coils.
2. Low ambient systems.
3. Systems with long piping runs where the pump down charge will not fit into the condenser.

The refrigerant entering a receiver must be saturated. If subcooled liquid is introduced into a receiver, the system will experience pressure fluctuations, and will generally operate poorly.

The refrigerant leaving a receiver is saturated; however, subcooling is required to prevent flashing in the liquid line due to pressure drop or static losses in liquid risers. All required subcooling must be added **after** the receiver. Custom condenser coils must be ordered with separate subcooling circuits to allow subcooling after the receiver.

Hot Gas Bypass (Optional)

NOTE: Hot gas valves and hot gas solenoid valves must be installed close to the discharge line at the condensing unit. Valves installed in the wrong location will cause compressor failure and void warranty.

Hot gas bypass is a method of preventing evaporator frosting under low load conditions. The hot gas bypass valve allows discharge gas into the low side of the system during low load conditions.

Correctly applied, a hot gas bypass system can reduce compressor cycling and prevent coil frosting during low load conditions.

Caution: Hot Gas bypass will cause system problems if it is not designed and piped correctly. If hot gas bypass piping is oversized, or incorrectly installed, it can trap oil causing compressor failures.



If the hot gas bypass valves are installed in the wrong location, the hot gas line can fill with liquid refrigerant. Hot gas bypass piping should be insulated to reduce heat loss.

Two piping methods are acceptable.

1. For systems with short piping runs and operation above 50°F (10°C) ambient. Hot gas is piped to the suction header at the evaporator coil. The hot gas bypass valve (located at the condensing unit) can be sized for up to 80% of the unloaded circuit capacity.
2. For low ambient systems, less than 50°F (10°C), or systems with long piping runs, the hot



gas line is piped into the suction line at the compressor. This configuration requires the following components.

- a. Hot gas bypass valve.
- b. Hot gas solenoid valve.
- c. Desuperheating TX valve.
- d. Desuperheating liquid solenoid.
- e. Suction accumulator.

Internal hot gas bypass may be ordered as a factory option (recommended) or is field installed as required.

A suction accumulator is recommended to ensure good mixing of the desuperheating liquid and hot gas. Internal hot gas bypass is limited to a maximum of 50% of the minimum compressor capacity due to oil return issues in the suction line. Hot gas bypass piping may be sized for a relatively high-pressure drop to encourage oil return at lower levels of bypass. **Suction line velocities must be checked for proper oil return at low loads with allowances made for the hot gas bypass capacity.**

Example: With a 10 ton operating capacity per circuit, if the internal hot gas is bypassing 3 tons, the capacity flowing through the suction line is:

10 tons – 3 tons internal hot gas bypass = 7 tons suction gas line flow.

The suction line must be checked for oil return at 7 tons. If the compressor is equipped with unloaders or has a tandem compressor set, the unloaded capacity minus the hot gas is checked.

LOW-AMBIENT OPERATION (optional)

Several low-ambient packages are available for cold weather operation. Standard condensing units are designed for operation above 50°F (10°C) ambient.

Above 20°F (-7°C) Package

This package will have condenser fan motors operating at extended pressures. An Engineered Air Intercooler is included, and is installed between the TX valve and the distributor to allow 'just in time' subcooling at the evaporator.

All Ambient -40°F (-40°C) Package

The minus forty system is equipped with a flooded condenser style of head pressure control. The package will include head pressure valves, receivers and all required controls.

Piping For Low Ambient Systems

There are several concerns that must be addressed when piping low ambient systems.

- Hot gas bypass is not recommended. If hot gas bypass is used, it must be piped internal to the condensing unit with an accumulator and desuperheating valve.
- The maximum amount of hot gas to be bypassed is 50% of the compressor unloaded capacity.
- Keep the overall length of outdoor suction piping to a minimum. When the ambient temperature is colder than the saturated suction temperature (most of the winter), gas in the suction line may be cooled and condense to a liquid before entering the compressor. Suction accumulators are required.
- All exposed refrigerant piping must be insulated.

PIPE SELECTION PROCEDURE

Distances shown on piping selection tables are for EQUIVALENT LENGTH. Equivalent length is the actual distance PLUS allowance for fittings. Typically fittings will increase the “actual length” by 50% to 100%.

1. Record the actual distance the piping must be run to connect the components. Refer to Submittal Record for maximum allowed line length. If exceeded, please contact an Engineered Air office.
2. Determine the number of fittings required. Include all fittings required for traps etc.
3. Estimate an equivalent length by doubling the actual length of tubing.
4. Select a preliminary tubing size from Table 2.
5. Lookup the equivalent length of the fittings for this tubing size from Table 1.
6. Add the equivalent length of the fittings to the actual length of tubing to calculate the total equivalent length of the tubing.
7. If the calculated length is substantially different from the estimated length (item 3) Reselect the tubing size from Table 2. Use this value and repeat steps 5, 6 and 7.

Example:

A CU-212 with two 10.5-ton circuits is to be installed on a mall. Each circuit has 25 feet of horizontal run, 10-feet of vertical rise, 15 elbows and an angle service valve. Select a suction line and a liquid line for each circuit.

Solution:

The capacity of each circuit is 10.5 tons.

Suction line selection

1. The system has 35 feet of actual piping run.
2. An initial estimate would be 70 feet of equivalent length (2 x 35ft.).
3. From Table 2 (R407c), select the closest length for the selection. (50 feet). Choose 1 3/8" tubing (10 ton 50 feet Equivalent length).
4. Number of fittings is given at 15 elbows, 1 angle valve
5. From Table 1 determine equivalent length (EL) of fittings.
 - + (15) long radius elbows at EL = 2.3 ft. each
 - + (1) angle valve EL = 15 ft. each
6. Calculate equivalent length.
35 feet actual + (15 x 2.3 = 34.5 feet elbows) + (15 ft angle valve) = 84.5 feet.
7. This length is closer to 100 feet than the original 50 feet used for the first estimate. RESELECT from table 2 (R407c). Using 100 Feet equivalent length.
8. Reselect at 100 feet. Choose 1 5/8 ...new EL = (35 + (15 x 2.6) + 18) = 92 feet. (This is closer to the 100 feet the table used.)
9. Use: **1 5/8" tubing for the suction line.**

Liquid line selection

1. Estimate 70 feet of EL; Select 5/8" from table 1. (the closest length is 50') Calculate actual EL = 35 ft + (15 x 1.0) + 7 ft. = 57 feet actual equivalent length. This is close to the length initially estimated.
2. Check the 100-foot column, the tube size is the same.
3. Use: **5/8" for liquid.**

The piping selections for this CUB-212 example would be:

Suction line 1 5/8"

Liquid line 5/8"

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 (R407c) Piping Guidelines for Normal Air Conditioning Duty.

R-22 / 407C						
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"	7/8"	
	Condensate	1 3/8"	1 3/8"			

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 (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:

- Sizes are OD dimensions, Type L, ACR refrigeration tubing.
- 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, + (velocity less than 350fpm for liquid hammer).
Condensate line (condenser to receiver if equipped) ... velocity less than 115 fpm. (two phase flow)
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)

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 condensing 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.

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. Ensure all service valves and manual valves are open.

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.

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 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.

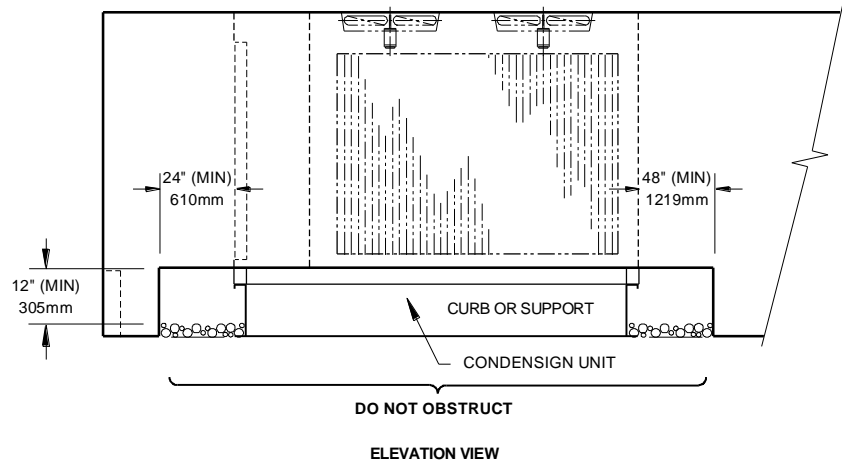
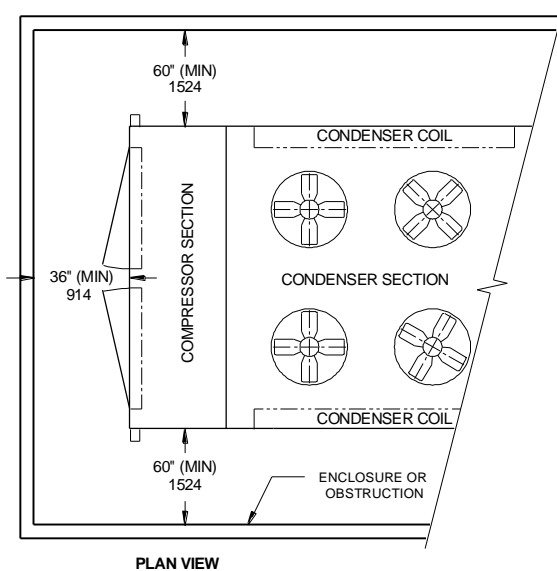
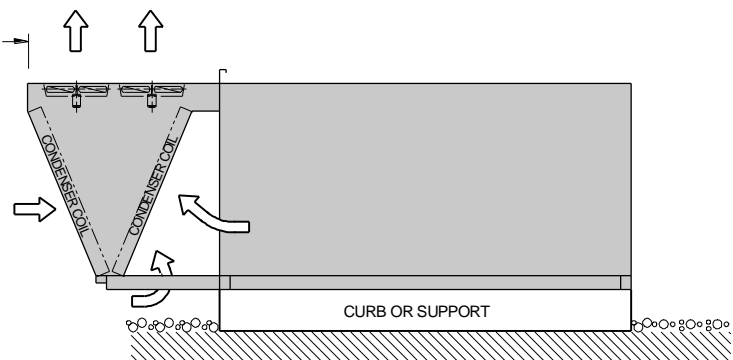
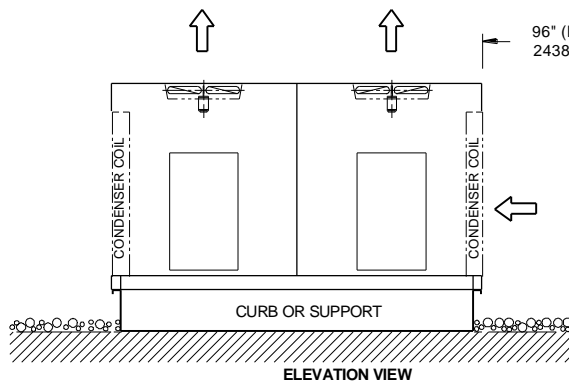
10. Pressurize the system to a slight positive pressure, (one or two psig). Replace all Schraeder valve cores. Do not allow air into the system.
11. Reinstall gauges, proceed to the start-up section for charging instructions.

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.

CLEARANCE FOR CONDENSER AIR FLOW

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



LIFTING

Engineered Air units are constructed on a structural steel base frame. The unit base frame is equipped with lifting lugs specifically located to facilitate proper lifting of the unit. Spreader bars must be used to keep rigging away from the unit cabinetry. All lifting lugs must be used. If using a lift truck, **ONLY** lift using the perimeter structural frame. **DO NOT** allow forks to lift on cabinet or unit floor.

Note: There may be bottom mounted components, such as drain piping, that can be easily damaged.

Warning:

Injury or death can result from improper rigging and lifting. Rigging and lifting of equipment must be performed by qualified personnel with proper equipment using appropriate and approved safety precautions.

MOUNTING

Units must be mounted level.

Equipment must be installed so that sufficient working clearance and component access is provided. Some units are designed for cantilevered installation. Consult the Submittal Record for specific unit mounting.

Consult the Submittal Record for specific unit mounting. Engineered Air condensing units are constructed for two types of mounting:

1. Base mounting – Consult the Submittal Record for type of mounting. Unless the unit is specifically designed for point or other mounting, the base of the unit must be supported continuously by a mounting support system that is directly below the unit structural base frame and runs the entire length and width of the unit. Refer to the Submittal Record for mounting information. Units 100” (2500mm) wide and under can be supported on each side continuously along the length of the unit. As a minimum, sleepers that are installed perpendicular to the length of the unit must be continuous across the width of the unit and shall be installed at the end lifting point base rails and the lesser of 80” (2000mm) on center or at all lifting points.
2. Roof curb mounting – The curbs are constructed of heavy gauge load bearing, galvanized steel, and must be fully insulated after installation. Wood nailer strips are provided for easy attachment of roof flashing. Gasket material is supplied with the unit and must be field mounted on the curb to seal the joint between the curb and the unit frame. The curb must be supported along its entire perimeter and any full height cross members as shown on the shop drawings. Point loading of curbs is not permissible.

The gasket material provided for the curb is closed cell foam. Closed cell foam is dense and does not compress easily. If the unit is split and shipped in sections there will also be gasket material for sealing between sections. The gasket material for splits is open cell foam. It is less dense than the closed cell foam and compresses easily.

ONLY USE THE CLOSED CELL FOAM GASKET PROVIDED FOR SEALING THE CURB.

Curbs may be broken down for shipping. Field assembly is required by the installing contractor. Bolt all sections together at split joints using hardware provided. The installing contractor must caulk and seal all joint and corner flashings. All flashings and braces that are provided must be installed. DO NOT screw/penetrate joint, corner or adaptor flashings. Refer to assembly instructions sent with roof curb.

SHIPPING MATERIALS

Remove shipping materials. Shipping materials may include, but are not limited to:

- Protective covers over openings, inlets, condenser coils etc.
- Protective covers over split sections if provided.
- Tie-down bolts, straps and blocks on fan and compressor vibration isolators.

ASSEMBLY

Warning:



Assembly of split units requires bolting together the base frame of adjacent sections. This may require personnel to work under the unit during assembly. Injury or death can result from improper support or improper loading of the curb. Additional temporary support shall be provided by the installer for the safety of personnel.

If the unit is split and shipped in sections, the sections must be field assembled. All sections are pre-drilled for assembly. The hardware and gaskets are packed in one of the sections. Apply the gasket, align the sections. The base frame must be bolted together first. Access below the unit for bolting of the base frame must be provided. Once the base frame has been tightly fastened, loosely assemble all the bolts and nuts, and then tighten. Caulk all split lines. Install split joint caps. The inlet hood is designed for field installation. On outdoor units connect the hood to the support flange and attach with appropriate fasteners. Connect all wiring on units that had been split for shipment.

The gasket material provided for the split is open cell foam. Open cell foam is light and compresses easily. If the unit is mounted on a curb provided by Engineered Air there will also be gasket material for sealing the curb. The gasket material for curbs is closed cell foam. It is more dense than open cell foam and does not compress as easily.

ONLY USE THE OPEN CELL FOAM GASKET PROVIDED FOR SEALING THE SPLIT(S).

PIPING, ELECTRICAL OR CONTROL SERVICE CONNECTIONS

DO NOT install anything that will interfere with equipment access or the rating plate.

Curb mounted equipment is constructed with cabinet and floors designed to prevent water from entering the building through the installed unit. When ordered, factory installed pipe chases and/or electrical chases are built into the unit floor. Factory chases are provided with covers that need to be replaced and sealed after piping and electrical connections are made.

IF UNIT IS CURB MOUNTED, THE FLOOR OF HAS BEEN MADE WATER-RESISTANT. DO NOT CUT OR DRILL HOLES IN THE FLOOR OR USE PENETRATING FASTENERS.

All penetrations through the unit walls must be caulked and sealed to prevent air and/or water from entering the unit.

ELECTRICAL INSTALLATION

DO NOT install anything that will interfere with equipment access or the rating plate.

The unit must be electrically grounded and all wiring must be installed in accordance with the National Electrical Code, ANSI/NFPA 70, and/or the Canadian Electric Code CSA 22-1 and to the approval of the authorities having jurisdiction. **THE FLOOR OF THE UNIT HAS BEEN MADE WATER-RESISTANT. DO NOT CUT OR DRILL HOLES IN THE FLOOR OR USE PENETRATING FASTENERS.** Field wiring diagrams, internal wiring diagrams and operating functions are included in the control cabinet. The power requirements are indicated on the rating plate. Where field wiring of control circuits is required, take care to size the field wiring for a maximum 10% voltage drop. The control circuit ampacity is noted on the field wiring diagram. See the field wiring diagram for requirements for shielded or twisted pair wire for solid state devices.

Warning:



No unspecified external load shall be added to the control transformer circuit(s) or to the main power circuit(s).

Recommended 24V Field Wiring Size:

Copper conductors only

Circuit Load (Amps) (1)	Maximum Total Length of Run									
	< 50 Ft (~ 15 m)	< 100 Ft (~ 30 m)	< 150 Ft (~ 45 m)	< 200 Ft (~ 60 m)	< 250 Ft (~ 75 m)	< 300 Ft (~ 90 m)	< 350 Ft (~ 105 m)	< 400 Ft (~ 120 m)	< 450 Ft (~ 135 m)	< 500 Ft (~ 150 m)
1	16 AWG	16 AWG	16 AWG	16 AWG	16 AWG	16 AWG	14 AWG	14 AWG	14 AWG	12 AWG
2	16 AWG	16 AWG	16 AWG	14 AWG	12 AWG	12 AWG	12 AWG	10 AWG	10 AWG	10 AWG
3	16 AWG	16 AWG	14 AWG	12 AWG	12 AWG	10 AWG	10 AWG	10 AWG		
4	16 AWG	14 AWG	12 AWG	10 AWG	10 AWG	10 AWG				
5	16 AWG	12 AWG	12 AWG	10 AWG						
6	16 AWG	12 AWG	10 AWG	10 AWG						
7	14 AWG	12 AWG	10 AWG							
8	14 AWG	10 AWG	10 AWG							
9	14 AWG	10 AWG								
10	12 AWG	10 AWG								
11	12 AWG	10 AWG								
12	12 AWG	10 AWG								
13	12 AWG									
14	12 AWG									
15	12 AWG									

Notes:

- 1) The field wiring load depends on the actual load on a particular control circuit the field wiring is connected to. Refer to the internal wiring diagram of the unit.
- 2) The table above is based on a maximum 10% voltage drop on a 24V control circuit. Wire size was calculated using the following formula:

$$CM = (25 \times I \times L) / V$$

Where **CM** is circular mils of conductor for a constant load of **I** amps, wire length **L** in feet from the unit to the field device and back, and voltage drop **V**.

When connecting to a three phase power supply, check for the correct rotation of all motors and fans. All electrical conduit outlets in the control panel must be sealed to prevent moist building air from migrating to the control panel.

BEFORE START-UP

Remove tie-down bolts, straps and blocks on fan and compressor vibration isolators, tilt equipped heat pipes and enthalpy/desiccant wheels if supplied.

START-UP CHECK LIST

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.

The start-up and operation must be in accordance with safe practices. Start-up must be performed by qualified personnel. Complete attached start-up record.

1. Set all associated electrical switches, controls, thermostats and main disconnect switch to "OFF" position.
2. Close all manual valves and field piping valves.
3. Before startup, review the Unit Function (mounted on the control panel door) and all control manuals supplied with this equipment. On units with heating sections, please follow the start-up procedure in the heating manuals. (Pack, DJ, DG, RT, HE, LM-K etc.)
4. Confirm all shipping materials has been removed. On units with semi-hermetic compressors, remove four spring isolator spacers and back off the top nut so that there is 1/32" (0.8mm) to 1/16" (1.6mm) space between the nut and neoprene spacer.
5. Check all bearings, drive and fan set screws for tightness.

6. Check drive alignment and belt tension. Refer to Maintenance, page 36.
7. Ensure that refrigerant lines and control capillary lines do not rub against cabinet or other lines.
8. Inspect all electrical wiring, both field and factory installed, for loose connections. Ensure fire alarm contact is installed, or jumpered if not required.
9. Turn disconnect switch ON (control switch is still off) and check the supply voltage. Voltage must be within 10% of rating plate. If not, contact the installing electrical contractor and have the voltage condition corrected before continuing start-up.
10. Crankcase heaters must be energized for at least twenty-four hours prior to starting the compressors. Check to see if heaters are working.
11. Attach service gauges. Some units are equipped with optional service valves at various locations. Ensure all service valves and post valves are back seated (fully open).
12. Rotation check.

Check rotation of all 3 phase motors. Motors were checked for correct rotation at the factory, if rotation is incorrect, turn off disconnect switch and reverse any two power leads leaving the disconnect. Re-check rotation.

Caution:

Screw and Scroll compressors MUST be checked for proper rotation at startup. Permanent damage can occur if rotation is not correct.

Scroll compressors running backwards will typically have low head pressure, high suction pressure and are usually noisy. Screw compressors MUST be checked with a phase meter before starting. If rotation is incorrect, instantaneous permanent damage can occur.

Reciprocating and Turbocor centrifugal compressors do not require rotational checks.

13. At all times of the year units equipped with water cooled condensers are shipped with a glycol solution in the condenser to prevent freeze damage during shipping. Depending on the application, the condensers may have to be flushed prior to use. Dispose of the glycol as required by local authorities having jurisdiction. Turn on the water supply and fill the condenser. Check for water leaks.
14. Turn on the service switch. Set controls to call for cooling. The supply fan will start as described in the unit function. The compressors should now be ready to start. Condenser fans will start as required when compressors are operating. If the compressor is equipped with an oil level sight glass, check the oil level.
15. Check the amperage draw of each motor and compressor. Refer to unit or motor rating plate for full load amps. At the unit, check and record the voltage while it is running. For 3 phase power the

phase to phase voltage imbalance should be less than 2%. A 2% voltage imbalance can cause up to a 10% current imbalance that will overheat motor windings.

To calculate voltage imbalance (NEMA method) refer to the following example:

Phase to phase voltage readings: 235V 236V 230V

The average Voltage between legs is 233.7V $(235+236+230)/3$

Highest voltage deviation from average is: $233.7V - 230V = 3.7V$

Voltage imbalance percentage = Highest deviation divided by average X 100

$3.7 / 233.7 \times 100 = 1.6\%$ This imbalance is less than 2% and therefore is OK

If voltage imbalance is greater than two percent (2%), turn off main disconnect and contact the installing electrical contractor to have the voltage condition corrected.

16. Confirm field wiring voltage drop is less than 10% when equipment is operating.
17. For the unit to operate properly a system air balance must be performed to ensure correct air flow. Failure to do so can damage the equipment and/or building and can be a cause of poor indoor air quality.
18. Damper sections:
 - a) Flat mixing dampers:
Both the fresh air and return air dampers are fully open when the dampers are at a 45° angle when fully stroked. This provides optimum mixing of the air streams for this damper arrangement.
 - b) Angle mixing damper:
Angle mixing section dampers open to an angle of 90° when fully stroked. This provides optimum mixing of the air streams for this damper arrangement.
19. Some units are equipped with an adjustable coil air bypass. This must be field adjusted during the system air balance to ensure proper air flow across the coil. Adjust the bypass to achieve coil pressure drop as stated on the submittal and/or the unit function sheet.
20. Allow system to operate until stable running conditions have been established.
21. Check and record amperage draw of each motor and compressor. Refer to unit label for running full load amps of motors and compressors.
22. Measure and record the suction and discharge pressures. On compressors equipped with an oil pump, measure and record net oil pressure. (net oil pressure is oil pressure minus suction pressure.).

Check and record the oil level on compressors that are equipped with oil level sight glasses.

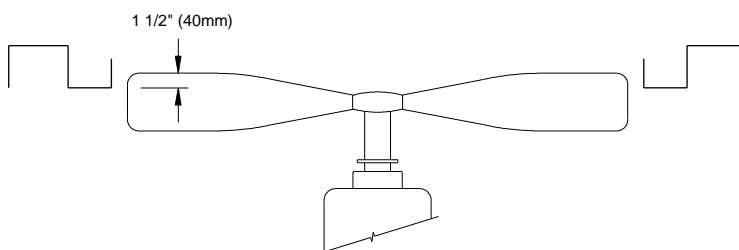
23. Check system charge:

When thermostatic expansion valves (TX valves) are provided, the charge can be checked with the liquid line sight glass. Under normal operating conditions the sight glass is clear of bubbles. Refer to Charging Instructions.

NOTE: It is possible for conditions other than low refrigerant charge to cause the sight glass to bubble. Bubbling may occur when condenser fans cycles on, superheat setting is too low or filter-drier is plugged etc.

The TX valve superheat was checked and adjusted at the factory to maintain a superheat of 18°F (10°C) plus or minus 3°F (2°C) measured on the suction line 10 inches (250mm) from the compressor. This setting rarely requires readjustment. Should adjustment be necessary, refer to the TX valve manufacturers recommendations.

24. Condenser fan blades: Fan blades must be correctly positioned within the orifice for proper air flow.



25. **Set all controls to the settings indicated on the wiring diagram.**

26. Re-install all access panels.

27. Remove any packing material or debris and dispose appropriately.

INITIAL START-UP

WARNING:

To prevent possible injury to personal or equipment damage, the start-up shall be performed by a Qualified Personal.

1. Check all packing material has been removed.
2. Check that shipping blocks and fasteners have been removed.
3. Check condenser fans to ensure they spin freely.
4. Check all electrical connections for tightness.
5. Check that power supply voltage matches the rating plate.

CHARGING

System charge will depend on the length and orientation of the installed system.

An initial estimate for an R-22 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.

Caution:

Screw and Scroll compressors MUST be checked for proper rotation at startup. Permanent damage can occur if rotation is not correct.

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), [300 psig (R-22) 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.

OPERATION

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.



Warning: Proper commissioning and start-up of the air handling system is the responsibility of the installing contractor. It is recommended that an air balance be completed by a certified air balancing contractor to insure the air volume being delivered matches the unit rating plate. Failure to perform a proper air balance can cause injury or death, damage to the equipment, property damage, system operational problems, or be a cause of poor air quality. Moisture carry over can result from improper air flow.



This unit may incorporate one or more functions and a variety of controls and options to suit individual requirements. A description of the unit functions and options is shown on the Electrical Data Sheet and unit wiring diagram. Carefully check your wiring diagram to verify that all remote controls are properly located and correctly field wired.

Some equipment may contain programmable unitary controllers or programmable logic controllers (PLC). Additional information can be obtained from the specific programmable control manufacturer. Often this information is available from the control manufacturer's website.

Caution: When recovering refrigerant from a system equipped with a water cooled condenser, the water valve must be manually opened so water flows continuously through the condenser while the refrigerant is being recovered. Failure to do so can cause the condenser to freeze, which will permanently damage the condenser.



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. Temporary 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-Startup after Temporary Shutdown
 - a) Turn on main disconnect for the unit.
 - b) After the crankcase oil is warm again, turn on service switch.
3. Extended Shutdown
Note: Leaving the main power on will keep the crankcase heaters energized and will not harm the system.
4. Re-Start After Extended Shutdown
 - a) If the main power was off, re-connect main power and allow 24 hours for crankcase heaters to work prior to start-up of compressors.
 - b) If main power was left on, check to ensure the crankcase heaters are still operating. If not, replace them and allow at least 24 hours before starting the compressor.
 - c) Follow the steps in the initial start-up procedure.

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.

Warning:

Follow the cleaning instructions and recommended inspection schedule to reduce the risk of mold or other bacterial growth. Property damage or personal injury claims may result from mold or biological growth arising from improper installation, inadequate maintenance, or failure to inspect. Engineered Air has no responsibility for and makes no express or implied warranties regarding mold or bacterial growth or any other indoor air quality issues. If mold or biological growth is present, determine and fix the cause. Properly remove and dispose of the contamination. Properly clean and sanitize the affected area using only approved sanitizers suitable for HVAC equipment.

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.

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.

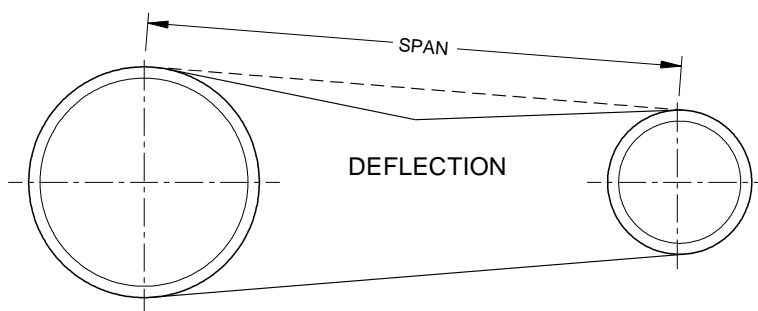
FOR FANS EQUIPPED WITH SPIDER BRACKETS:

A properly adjusted V-belt rides the inside of the pulley faces. Because the sides of the belt wedge in the pulleys, the V-belt does not have to be extremely tight. It should be as loose as possible without slipping in the pulley grooves.

Belt deflection: 3/4 " (19mm) for each foot (300mm) of span between the pulleys.

FOR FANS EQUIPPED WITH PILLOW BLOCK BEARINGS:

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.

BEARING SETSCREW TORQUES

TABLE I

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.		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)	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°.		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)	Bend the tab on the rim of the washer, which is in line with the notch of the nut.		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)	If a tab does no line up with a notch, tighten the nut further. DO NOT BACK THE NUT OFF.		228 -272 in-lb (26 - 31 Nm)

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

CONDERSER FANS

It is recommended that all condenser fan set screws be inspected at least once a year. Check set screws to ensure tightness according to recommended torque values below.

Condenser Fan Type	Torque Setting (in.lbs)
LAU	150-165
REVCOR	120-150
HESSAIRE	100-120

LUBRICATION OF FAN BEARINGS

Some fans have permanently lubricated sealed ball bearings which should not require lubrication. These bearings are factory packed 30 to 50% full. **Bearings that require lubrication should be greased while the bearing is rotating slowly, with the following quantities of a lithium base lubricant. DO NOT OVERGREASE. DO NOT USE NON-LITHIUM BASED GREASE.**

Extended lubrication lines may be provided. Tubing is not factory filled.

RECOMMENDATIONS FOR BALL BEARINGS

Bearing Temperature ° F (°C)	Re-Greasing Interval		
	Clean	Dusty	Dusty & Wet
Under 120 (50)	2 ½ Years	Yearly	4 Months
Under 158 (70)	Yearly	4 Months	1 Month

Shaft Dia.	3/4" (19mm)	1" (25mm)	1 3/16" (30mm)	1 7/16" (37mm)	1 11/16" (43mm)	1 15/16" (49mm)	2 7/16" (62mm)	2 15/16" (75mm)
Grease	0.06 oz. (1.8g)	0.12 oz. (3.3g)	0.20 oz. (5.6g)	0.23 oz. (6.5g)	0.27 oz. (7.7g)	0.36 oz. (10.3g)	0.53 oz. (14.9g)	1.00 oz. (31.0g)

For additional information refer to the fan and/or bearing manufacturers' literature.

LUBRICATION OF DODGE FAN BEARINGS

Suggested Re-lubrication Schedule (Months)* for Dodge Ball Bearing Pillow Block

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA.									
½" - 1 1/16"	6	6	5	3	3	2	2	2	1
1 15/16" - 2 7/16"	6	5	4	2	2	1	1	1	1
2 11/16" - 2 5/16"	5	4	3	2	1	1	1		
3 7/16" - 3 15/16"	4	3	2	1	1				

* Suggested initial greasing interval. . If safety permits, re-lubricate while running until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature and surrounding conditions will affect the re-lubrication frequency required. For 24 hour operation double the lubrication frequency.

Lubricate with a multipurpose NLGI No. 2 or No. 3 ball bearing grease having rust inhibitors, antioxidant additives and a minimum viscosity of 500 SSU at 100°F (38°C). Some examples of grease having these properties are:

Shell Alvania RL 2
Mobil Mobilith SHC220
Exxon Ronex MP

Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Suggested Re-lubrication Schedule (Months)* for Dodge Spherical Roller Bearing - Solid Pillow Block

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA.									
1 ³ / ₁₆ " – 1 ⁷ / ₁₆ "	6	4	4	2	1	1	1	1	¹ / ₂
1 ¹¹ / ₁₆ " – 2 ³ / ₁₆ "	4	2	1 ¹ / ₂	1	¹ / ₂	¹ / ₂	¹ / ₂	¹ / ₂	¹ / ₂
2 ⁷ / ₁₆ " – 3 ⁷ / ₁₆ "	3	1 ¹ / ₂	1	¹ / ₂	¹ / ₂	¹ / ₄	¹ / ₄		
3 ¹⁵ / ₁₆ " – 4 ¹⁵ / ₁₆ "	2 ¹ / ₂	1	¹ / ₂	¹ / ₄					

* Suggested initial greasing interval. If safety permits, re-lubricate while running until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature and surrounding conditions will affect the re-lubrication frequency required. For 24 hour operation double the lubrication frequency.

Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100°F. Some examples of grease having these properties are:

Shell	Alvania No. 2
Mobil	Mobilith AW2
	Mobilith SHC100
Texaco	Premium RB2
American	Rykon Premium 2

Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Suggested Re-lubrication Schedule (Months)* for Dodge Spherical Roller Bearing – Split Pillow Blocks

Speed ^(RPM)	500	750	1000	1500	2000	2500	3000	3500	4000	** oz.
Shaft ^{DIA.}										
1 ⁷ / ₁₆ " – 1 ¹⁵ / ₁₆ "	6	4 ¹ / ₂	4	4	3 ¹ / ₂	2 ¹ / ₂	2 ¹ / ₂	1	1	0.05
2 ³ / ₁₆ " – 2 ¹¹ / ₁₆ "	5	4 ¹ / ₂	4	2 ¹ / ₂	2 ¹ / ₂	1 ¹ / ₂	¹ / ₂	¹ / ₄	¹ / ₄	0.75
2 ¹⁵ / ₁₆ " – 3 ¹⁵ / ₁₆ "	4 ¹ / ₂	4	3 ¹ / ₂	2 ¹ / ₂	1 ¹ / ₂	1	¹ / ₂			2.00
4 ⁷ / ₁₆ " – 4 ¹⁵ / ₁₆ "	4	4	2 ¹ / ₂	1	¹ / ₂					4.00
5 ⁷ / ₁₆ " – 5 ¹⁵ / ₁₆ "	4	2 ¹ / ₂	1 ¹ / ₂	1						7.00

* Suggested initial greasing interval. Remove bearing cap and observe condition of used grease. Adjust lubrication frequency as needed. Hours of operation, temperature and surrounding conditions will affect the re-lubrication frequency required. Clean and repack bearing annually. Remove old grease, pack bearing full and fill housing reservoirs on both sides of bearing to bottom of shaft. For 24 hour operation double the lubrication frequency.

** Grease to be added at each interval.

Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100°F. Some examples of grease having these properties are:

Shell	Alvania No. 2
Mobil	Mobilith AW2
	Mobilith SHC100
Texaco	Premium RB2
American	Rykon Premium 2

Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Static Oil Lubrication

Use only highest quality mineral oil with a minimum viscosity of 100 SSU at the oil's operating temperature. The oil's operating temperature is approximately 10°F greater than the bearing's housing. SAE values having this viscosity at the following operating temperature are:

150° - SAE 20 160° - SAE 30 180° - SAE 40

Static oil level should be at the center of the lower-most roller (do not overfill).

Complete lubrication change should be made annually.

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

Hours 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.

FILTERS

Filter-changing intervals can be based on the pressure drop across the filter or by calendar scheduling or visual inspection. Scheduled intervals should be between one and six months, depending on the pollutant loading from indoor and outdoor air. More-frequent changes may be required during the economizer season.

Units that operate with high levels of outside air should have filters removed (or moved to winter filter location if available) during the winter months in areas that have heavy frost or snow.

Plugged or excessively dirty filters can cause damage to the equipment. See submittal record for filter quantities, sizes and types. Use same size and type for replacement.

A. High Velocity Permanent:

It is important that the filters be checked and cleaned regularly during the period immediately following installation, in order to determine the best service interval. To clean, rinse with water. Shake off excess water and re-install. These filters do not require an oil adhesive.

B. Pleated Throwaway and/or Replaceable Media (Cartridge, Bag):

Replacement filters can be obtained from any Engineered Air representative.

In some applications the used filters/media may contain chemical or biological hazards. All local, regional and national regulations for safety and disposal should always be followed.

VFD ENCLOSURE

Filters may be located on the air inlet of VFD enclosures. Filter-changing intervals can be based on calendar scheduling or visual inspection. Scheduled intervals should be between one and six months, depending on the pollutant loading in the enclosure area.

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.

CONTROL ENCLOSURE VENTILATION

Control enclosures are often ventilated in summer to provide component cooling. A manually adjustable slide damper is provided for adjustment and seasonal shut off. The slide damper should be closed for winter operation and opened for summer operation.

OUTDOOR AIR INTAKES, MIXING SECTIONS AND DAMPERS

Outdoor air intakes, screens, and adjacent areas shall be checked semi-annually for cleanliness, integrity and proper operation. Adjust dampers where required.

REFRIGERATION

Seasonal Maintenance

- On semi-hermetic and screw compressors, check compressor oil level and add refrigerant oil if necessary.
- Check operating temperature and pressures.

- On units with sight glasses, check for bubbles. There should be no foaming under steady state operation.
- Water Cooled Condensers - With time, condensers can foul with mineral deposits from the water, resulting in a reduced heat transfer capacity and increased refrigerant head pressure. Should this condition occur, the condenser coil should be chemically cleaned or replaced.

Air Cooled Condensers – 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, dirty filters, slipping fan belts etc. This will reduce cooling capacity and coil frosting can occur.

ROTOLOCK FITTINGS

It is recommended that systems with compressor Rotolock fittings be checked for tightness according to compressor manufacturers recommended torque at the start of every cooling season. If the fittings are found to be loose, they may need to be re-torqued at increased intervals.

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
Compressors not running	No power	Restore power to unit.
	Blown Fuse or breaker	Replace fuse or reset breaker
	Low voltage	Find and correct reason for low voltage
	Faulty control system	Check and repair as required
	Open safety contacts	Check safety controls and identify and correct problems
	Ambient temperature below design	Check low ambient control and adjust as necessary
	Open control sensor	Check and replace as necessary
Compressor cycles	Low refrigerant charge. Unit cycling on low-pressure control.	Find and repair leak, evacuate and recharge
	Low voltage to compressor contactor.	Check voltage at contactor. Repair as required.
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.
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 condensables in system	Reclaim refrigerant, evacuate system, recharge with new refrigerant
Low Suction pressure	Dirty evaporator	Clean or wash coil
	Low refrigerant charge	Find and repair leak, evacuate, and recharge
	Low load or supply air flow	Check air-conditioning loads and supply air volume. Check for dirty filters, closed fire dampers, defective VAV boxes etc.
	Plugged liquid line drier	Check temperature drop across drier. Replace drier as required.

	TX valve not opening	Check for high superheat and correct problem as required.
High Suction pressure	System load higher than design	Determine reason for high load and correct as necessary.
	Too much air flow	Check airflow, balance system air. Check blower speed. Repair as required.
	Inefficient compressor	Check and replace as required.
Noisy Compressor	Scroll compressor running backwards	Check rotation with gauges Reverse direction of scroll compressor as required
	Compressor damaged	Check and replace as required