



BY JOHNSON CONTROLS

# SPLIT SYSTEMS INSTALLATION GUIDE/CHECKLIST

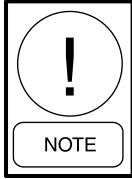
## CHECKLIST

Supersedes: 50.40-CL1 (804)

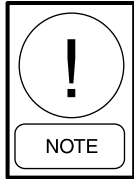
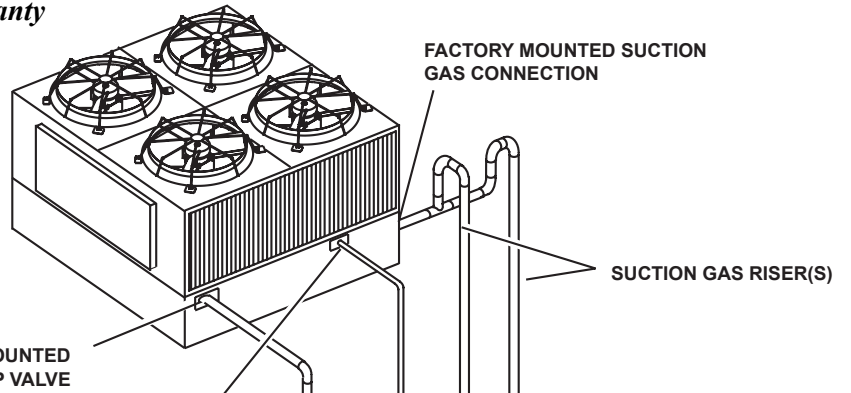
Form 50.40-CL1 (409)

035-20894-000

### GUIDELINE/CHECKLIST FOR FIELD INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING UNITS (R-22, 407C AND 410A)



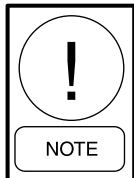
*To protect your warranty coverage, please review Page 2, "Warranty Requirements"*



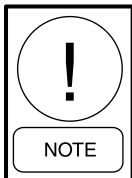
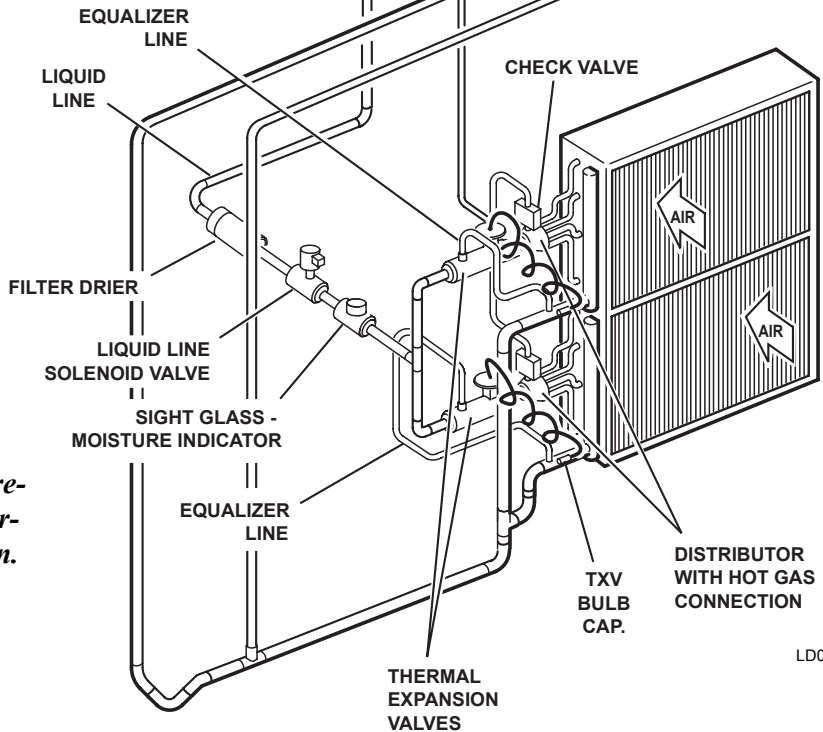
*Only one refrigerant circuit is illustrated. This will be similar for the second circuit.*

OPTIONAL FACTORY MOUNTED HOT GAS BYPASS VALVE

HOT GAS BYPASS



*Double suction risers are shown for illustration only. Most applications will need only single risers.*



*This illustration is for reference only and requirements may vary considerably for your installation.*

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FIG. 1 - CONDENSING UNIT ABOVE AHU

# IMPORTANT!

## READ BEFORE AND REVIEW FOLLOWING INSTALLATION AND FIELD PIPING OF YORK "SPLIT-SYSTEM" EQUIPMENT

Project: \_\_\_\_\_ Date Installed: \_\_\_\_\_

Condensing Unit Model No: \_\_\_\_\_ Serial No: \_\_\_\_\_

Air Handling unit Model No: \_\_\_\_\_ Serial No: \_\_\_\_\_

### WARRANTY REQUIREMENTS

To ensure warranty coverage, the installer must follow the general guidelines outlined in this publication. Startup supervision by Johnson Controls service personnel is recommended to include a review of the field piping installation to verify compliance. Failure to meet these guidelines could void certain warranty coverage. It is not the intent of this publication to detail all aspects of receiving, installation, piping practices, or codes, but to provide an overview and checklist for those items, components and piping, field installed, that can affect reliable system operation. It is the installing contractors responsibility to follow proper field piping design and installation practices (*For additional information on applying refrigeration piping and specialties in the field, please contact your local Johnson Controls Service office for the Installation Guidelines, Form 050.40-ES3, or refer to ASHRAE Refrigeration Handbook on "System Practices for Halocarbon Refrigerants"*).

***Johnson Controls assumes no warranty responsibility for failures due to improper field piping, its design or application.***

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## INSTALLATION OVERVIEW & CHECKLIST

### 1. Compressor vs.. Evaporator Location

It is essential to account for the equivalent feet of piping associated with Split-Systems. Exceeding general guidelines can affect design performance and system reliability. The general rule is to not exceed 150 equivalent feet of piping on split-systems (*Contact Johnson Controls Service if greater than 150 equivalent feet*). On systems where the evaporator is "above" the compressor, always include the pumping pressure, or static head loss, required for liquid line vertical risers (*i.e. 0.5 psi per foot of riser*). This also applies to static "gain" where vertical drops are encountered (*i.e. - 0.5 psi per foot of drop*).

***Reviewed By:*** \_\_\_\_\_ ***Date:*** \_\_\_\_\_

## 2. Piping General

It is essential that all piping be sized and piped for the correct system velocities associated with reasonable pressure drops and good oil management. This includes proper trapping of all suction line risers (and drops) as well as evaluating the need for double suction risers. Also note that refrigeration lines must not come in contact with each other due to heat transfer effects and wear points. Where piping is strapped together, always include a minimum of 3/4" insulation between pipes. Use long radius elbows on piping mains and short radius at traps. This will minimize pressure loss and promote good oil return. Include provisions for expansion and contraction of piping on straight runs over 100 feet with the use of flexible swing points or braided flexible connections. Always choose the shortest route for split-system piping, providing it doesn't violate good piping practices.

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## 3. Piping Insulation Requirements

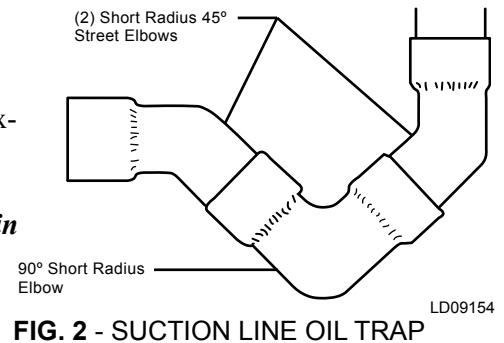
All suction line and hot gas bypass lines **MUST** be insulated. Additionally, any liquid line that passes through a compartment or segment of the building that is projected to be warmer than the liquid refrigerant (a general rule here is 95° F) **MUST** be insulated. Also any outside liquid line exposed to direct sunlight or temperatures above 95° F **MUST** be insulated. **Pressure test all piping and repair leaks "before" insulating joints and fittings.**

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## 4. Suction Line Piping & Specialties

It is essential that suction line piping be sized and designed for acceptable line loss and oil return to the compressor. Suction line loss should not exceed 2° F (Nominal 3 PSI for R-22 & R407c / 4.5 PSI for R410a). It is **not recommended** to oversize suction lines. Oversized lines only add cost as well as surface area that can harbor oil and prevent oil return.

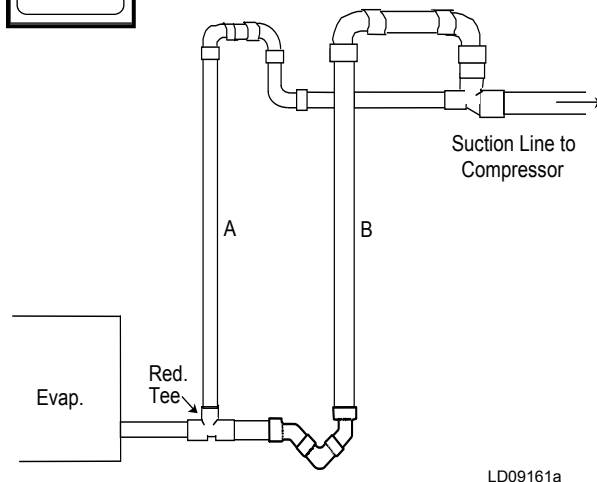
Traps must utilize short radius elbows (Fig. 2) in order to promote good oil return. Use traps on any vertical riser over 3 feet. Any riser in excess of 20 feet must include an intermediate trap (mid point). If risers exceed 40 feet please contact Johnson Controls Service for further review.



**FIG. 2 - SUCTION LINE OIL TRAP**



**DO NOT locate the Thermostatic Expansion Bulb either in the trap area or "after" the trap. Oil in the trap area or after the trap WILL influence bulb accuracy and TXV control.**



**FIG. 3 - DOUBLE SUCTION RISER SHOWING "INVERTED" TOP TRAPS**

**control.**

Review the need for double suction risers (Fig. 3). Double suction risers may be necessary for entraining oil up the riser and promoting good oil return. (Reference ASHRAE Refrigeration Handbook or YORK Form 050.40-ES3 for selection practices.)

Where traps and vertical risers tie into other overhead suction lines, "inverted" traps must be utilized at the top of the vertical riser to prevent oil "logging" of the bottom suction line (Fig. 3). This is also important when multiple suction line circuits are teed together.

Slope all horizontal suction lines ½” per 10 linear feet of run, in direction of refrigerant flow to promote oil return to the compressor. Provide proper support and/or bracing to eliminate any line deflection (*Installer supplied suction piping, brackets and insulation*).

As a rule, it is not recommended to run suction lines underground. **Always consult Johnson Controls Service if the need arises** (*Alternate routing should always be considered vs. underground*). Special piping chases, expansion joints and insulation needs must be met in **addition to using suction line accumulators** if lines are underground.

Accumulator Notes:

1. Do not exceed maximum tonnage rating of accumulator
2. Size for 50% of line charge or greater
3. Accumulators can be in series with each other to achieve required volume
4. Always provide a **heat band or heat trace** at bottom of accumulator
5. Follow accumulator manufacturer's recommendations

**DO NOT allow field suction line piping to trap refrigerant and/or oil between the Evaporator and the Compressor (either during operation or in the off-cycle).**

**Reviewed By:** \_\_\_\_\_ **Date:** \_\_\_\_\_

## 5. Liquid Line Piping & Specialties

It is essential that liquid line piping be sized and designed for acceptable line loss to prevent “flashing” at the thermostatic expansion valve. Design requirements are such that the PD must not exceed a 1 or 2° F change in Saturated Suction Temperatures (SST). Flashing is caused by excessive line loss design exceeding normal sub-cooling allowances (*Typical sub-cooling allowance is 15° F*).

Line slope is not as critical as suction line routing, since oil dissolves in the liquid refrigerant, enabling it to pass readily through the liquid line to the evaporator during compressor operation.

The following components are typically supplied with the condensing unit. Review the Johnson Controls submittal to confirm this provision (*Refer to Fig. 1 for component locations*):

- Liquid Line Filter-Drier – one per system
- Sight Glass – one per system

The following items are typically furnished and installed by the field installing contractor. Review the Johnson Controls submittal to confirm provision (*Refer to Fig. 1 for component locations*):

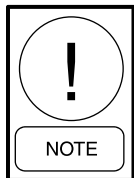
- \*Thermostatic Expansion Valves – one/distributor circuit (verify circuit load)
  - ◆ Furnish TXV with a balanced port design having an external equalizer line
  - ◆ Generally bulb charge is VGA, but it is the installers responsibility to review charge requirements with system design and TXV location (*i.e. non-migration type charges may be required*)
  - ◆ Locate TXV in the vertical "up or down" position if possible, close coupled to the distributor (2 Ft max) with “no” elbows between TXV and ASC/Distributor
- \*Liquid Line Solenoid Valve – one per compressor(s) “system” located near the evaporator coil to allow for holding refrigerant charge during pumpdown
- \*Type “L” Refrigeration grade copper piping (if needed, consult your Johnson Controls Service Office for a copy of Form 050.40-ES3 Section 7 – Brazing)

- **\*\***(Optional) Accumulators, Heater and Control
- **\*\***(Optional) Discharge Line Oil Separators

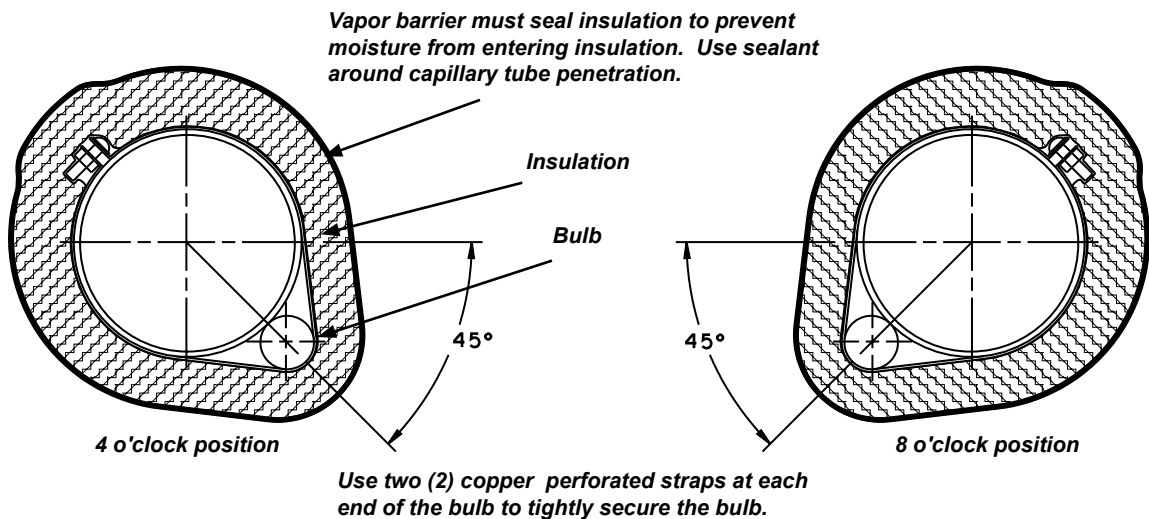
\*Selection by installing contractor

\*\*1<sup>st</sup> – Review if required by Contract. 2<sup>nd</sup> – The installing contractor is to review and determine if options are needed based on his design and final piping arrangement.

**Johnson Controls assumes no warranty responsibility for failures due to improper field piping, its design or application.**



**Pipe must be clean at bulb contact and fit flat against pipe surface.**



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**FIG. 4 - TXV BULB INSTALLATION**

**Bulb installation is extremely critical** (refer to Fig. 4). Oil leaving the evaporator or its trap must not influence the bulb. The ideal location is horizontal, approx 6” from the suction header, but before the trap. The **TXV Equalizer line** must also be located just after the bulb and enter from the top, but again, before the trap (Contact Johnson Controls Service if in question). Bulb position must be 6” minimum away from elbows and pipe transitions.

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**6. Hot Gas Bypass Line & Specialties (Optional)**

Hot Gas Bypass (HGBP) lines are utilized to prevent coil frost and compressor short cycling that contributes to poor building temperature, humidity and mold control. (Review Contract requirements to see if this item is required). Care must be taken in the installation to assure proper performance, operation, and oil management with the rest of the system.

Refer to Fig 1 for HGBP line details. This item consists of the following factory furnished part(s):

- Discharge Bypass Valve equal to Sporlan SHGB (with integral solenoid valve)

Parts required by the installing contractor include:

- Auxiliary Side Connector (ASC) if not integral to the distributor (*See below*)
- Check valves to isolate HGBP circuits and prevent multiple TXV short circuiting and pressure influence. (**Compressor(s) Systems with multiple circuit Distributors only**)
- **Refrigerant piping and insulation**

Installation of the HGBP Valve is to bypass hot gas to the distributor /ASC. Generally the distributor comes with a Sporlan Auxiliary Side Connector (ASC) integral with the distributor (*This can be verified through Johnson Controls Service*). If not included, the installing contractor is required to provide a separate ASC tee (Sporlan) for installation just ahead of the distributor inlet.

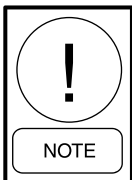


**The installation of the ASC tee requires relocation of the distributor orifice to the ASC tee inlet that connects to the thermostatic expansion valve. Installation of the ASC side connector MUST be located in the vertical plane (positioned "UP"). The use of a dead head Tee as the ASC is not acceptable.**

The HGBP line sizing requires sizing the HGBP line to the minimum evaporator load “per system” & “per circuit” maintaining acceptable pressure drops and oil management control. The following line size vs. tons, is based on ASHRAE Refrigeration 2002, Tables 3, 5 & 9 at 40° F SST/80° F CT/2° F Line loss (R-407c is close to R-22). *Reference ASHRAE “Note 2” formula for other variables:*

Line Size (Type "L" Refrig Grade)	R-22 & (R407c) - Max Tons, Capacity @ Equivalent Ft. (EF)		R-410a - Max Tons, Capacity @ Equivalent Ft. (EF)	
	150 EF	50 EF	150 EF	50 EF
3/4"	2.6	4.7	4.0	7.4
7/8"	3.9	7.1	6.2	11.4
1-1/8"	7.9	14.4	12.6	23.0
1-3/8"	13.7	25.1	21.8	40.0
1-5/8"	21.7	39.6	34.5	63.1
2-1/8"	44.9	82.1	71.1	130.2

**HGBP Line Size Example:** YCUL-0040 using R-22 with System #1 having 150 Equivalent Feet of pipe handling 39 Nominal Tons, using (3) scroll compressors & (2) Distributor circuits requires a common discharge line size of  $(39/3 = 13 \text{ tons})$  1-3/8" Copper Pipe with two branch sizes of  $(13/2 = 6.5 \text{ tons})$  1-1/8" Copper. *The same would be applied to recip compressors with cylinder unloading (using the lowest stage of unloading for the HGBP selection).*



**Line size is also typically determined by Johnson Controls and should be identified in the contract Johnson Controls submittal (Contact Johnson Controls Service if needed).**

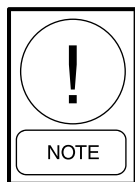
The HGBP Line(s) must always slope toward the evaporator (1/2" per 10 ft rule) to mitigate the possibility of liquid slugging when the HGBP is energized (*It is critical to eliminate any "traps" between the HGBP Valve and the Evaporator*).

Generally, locate the HGBP valve as close as possible to the condensing unit discharge line. The HGBP valve size is pre-selected by YORK and furnished with the condensing unit. Most HGBP valves come factory installed. Those that aren't will be shipped loose for field installation by the installing contractor.

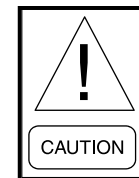
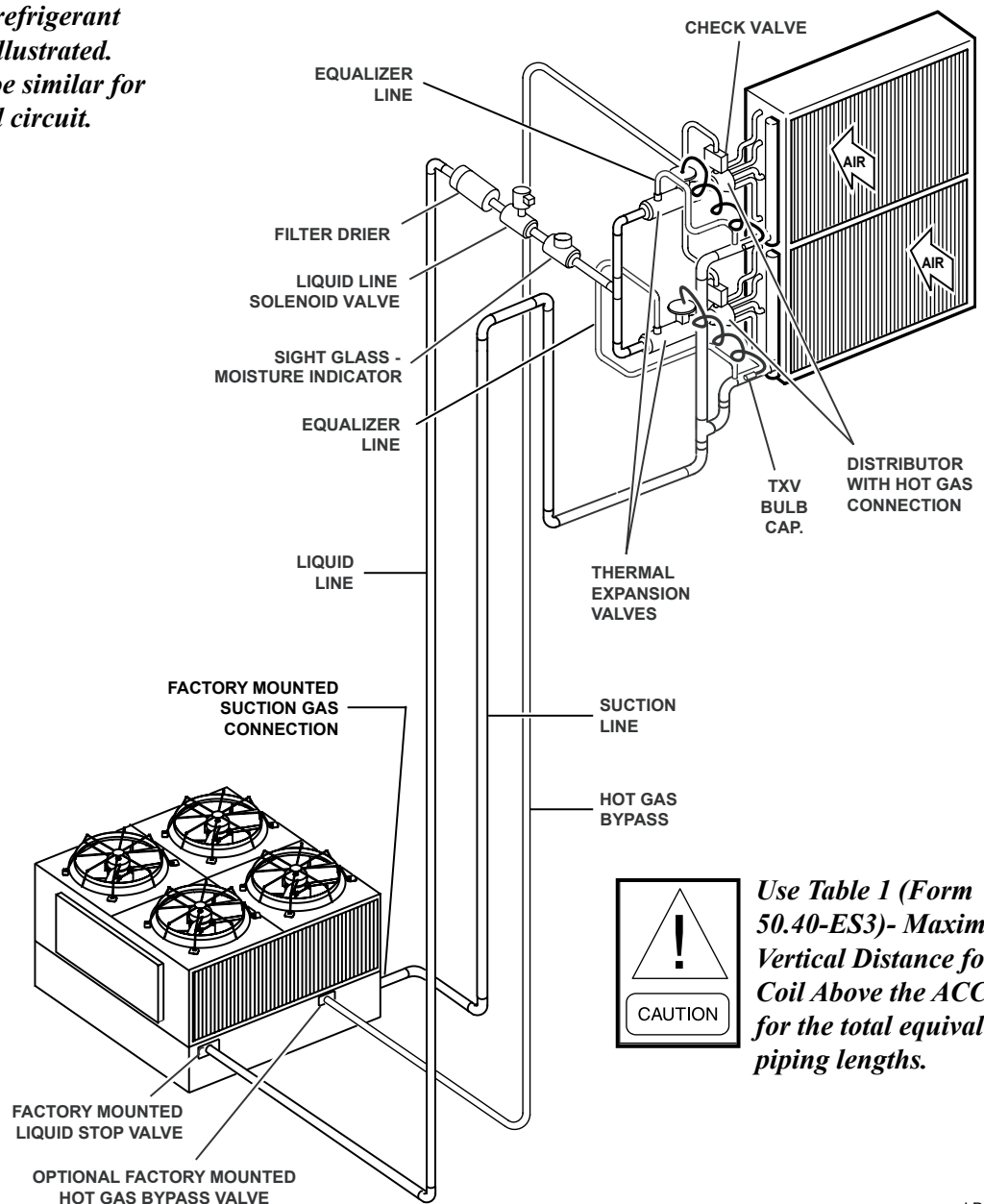
**Design Cautions:**

1. Where air cooled condensing units are “below” the AHU (refer to Fig. 5), you should route the HGBP line to minimize the horizontal line length as much as possible (Contact Johnson Controls Service if you have any questions).
2. Always include HGBP with check valves on “each” distributor circuit where multiple circuits are provided.
3. Design for equal line losses where the main is teed to the numerous ASC’s (i.e. line length, elbows, etc.)
4. To utilize lead-lag provisions generally available with condensing units, you **MUST** furnish HGBP on “all” systems. This also holds true where multiple Air Cooled Condensing Units (ACCU’s) are provided to a single AHU Evaporator (This is pending the coil circuiting is designed for HGBP use – consult with Johnson Controls Service if in question).

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*Only one refrigerant circuit is illustrated. This will be similar for the second circuit.*



*Use Table 1 (Form 50.40-ES3)- Maximum Vertical Distance for DX Coil Above the ACCU for the total equivalent piping lengths.*

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**FIG. 5 - CONDENSING UNIT BELOW THE AHU**

## 7. Piping Specials and Options for Split-Systems

On occasion, project or application needs dictate additional piping requirements from those previously outlined. The following are items that may be a contract requirement (*Review Johnson Controls Submittals, Contract Plans, and Specifications to verify if applicable*):

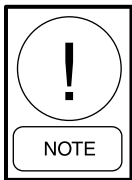
1. Filter driers on each distributor “circuit” vs. system
2. Sight glass on each distributor “circuit” vs. system
3. Ball type isolation valves with relief valve for isolating the suction and discharge side of the compressor(s) to facilitate servicing
4. Special component tagging
5. Vibration isolation (spring, seismic or neoprene where specified is shipped loose for field installation by the Installer). **Contractor “must” furnish and install necessary vibration eliminator flex lines as well as vibra-sorbers (or coiled capillary tubes) on all lines leaving the Condensing unit.**

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## 8. Field Piping Interface (Air Cooler Condensing Unit to AHU Evaporator)

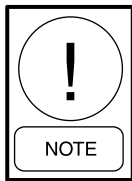
The condensing unit (ACCU) interfaces with three basic evaporator coil arrangements (*Refer to Fig. 6*):

1. Face Split (Where coils are stacked 2 or more high, all face split distributors must be circuited to one system to provide an active full face)



**Two-system ACCU's require 4 distributor circuits (minimum), row split or interlaced where two coils are stacked**

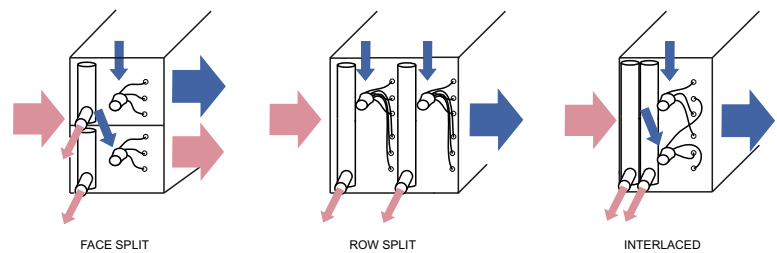
2. Row Split (Generally split 66/33% nominal with leaving row 1<sup>st</sup> on, entering row last on). Where coils are stacked 2 or more high, each respective row split (33% to 33% and 66% to 66%) distributor must be circuited to one system to provide an active full face
3. Interlaced (Most desirable ensuring the full face of the coil is active). Where coils are stacked 2 or more high, each respective interlaced distributor must be circuited to one system to provide an active full face



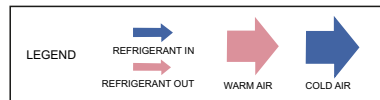
**Special care must be taken to properly pipe interconnecting piping between the compressor system(s) and the correct evaporator coil circuits. Contact Johnson Controls Service if in question.**

An active full face is essential in providing:

- Space Humidity Control
- TEV Superheat Control
- Non-stratified Air Temp.
- Compressor Reliability



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**FIG. 6 - EVAPORATOR CIRCUITING TYPES**

Consult your local Johnson Controls Service Office if additional information on this interface is required.

**Johnson Controls assumes no warranty responsibility for failures due to improper field piping, its design or application.**

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## 9. General Pipe Brazing Overview

Form 050.40-ES3 Sect. 7 offers in-depth brazing techniques covering safety, tools, materials and practices necessary. Contact Johnson Controls Service for information. An excerpt from Form 050.40-ES3 is shown below.



FIG. 7 - PIPE BRAZING WITH NITROGEN



FIG. 9 - CLEAN PIPE AFTER CUTTING AND BEFORE FITTING



FIG. 8 - PIPE BRAZING WITHOUT NITROGEN

It is very important to mask off openings in the piping to ensure that all air has been completely purged from the assembly and that a small gentle flow of nitrogen is flowing through and past each piping joint while it is being brazed and during the cooling process. If there are branch fittings, be sure you have purged the branch piping section and that there is flow through the branch before brazing. See Fig. 7 for results of brazing with nitrogen purge and Fig. 8 for results when nitrogen is not used.

**Failure to adequately purge the piping or promote flow past branch fittings will have nearly the same effect as no nitrogen at all.**

### PROCEDURES

#### 1. Cutting tubing

Pipe or tube ends should be cut off square and burrs removed by reaming or filing, taking care that any metal debris or chips fall out of the piping. Reaming and filing should be held to the absolute minimum necessary to remove the burrs. Care should be taken not to taper the pipe or tube end. If the end of the tubing is deformed during cutting so that it is no longer round, a tubing resizing tool should be used to restore the shape of the tubing otherwise the braze joint may be weakened.

#### 2. Cleaning

Brazing surfaces and filler metal must be cleaned to bright metal before brazing (Fig. 9).

Prior to brazing, oil, grease, etc., should be removed using an approved commercial safety solvent.

Oxides must be removed by wire brushing or crocus cloth.

*Do not use steel wool, emery cloth or sandpaper!*

#### 3. Fit-up

Braze joint strength is directly related to fit up clearances. A general rule of thumb is that the joint internal clearance should be 0.002 to 0.005 inch (Fig. 10). This clearance range is necessary for capillary flow of the filler metal into the joint and it is the optimal clearance for joint strength.

#### Brazing Materials

Copper to Copper Joints  
BCuP-3

- 5% silver
- 89% copper
- 6% phosphorous

Copper to Brass Joints  
BAG-20

- 30% silver
- 38% copper
- 32% zinc

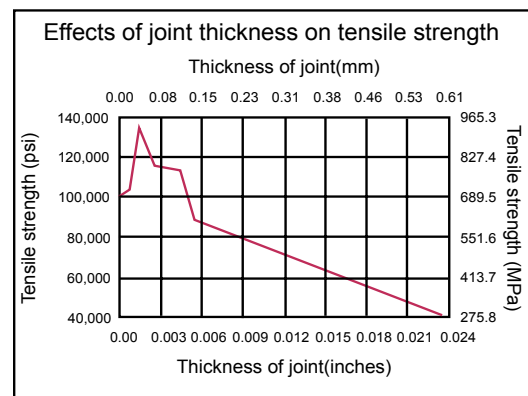


FIG. 10 - JOINT THICKNESS vs. TENSILE STRENGTH

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## 10. Testing the System for Leaks

On completion of the piping, the refrigeration system must be evacuated and checked for leaks following ASHRAE guidelines. Evacuate the system down to 500 microns and hold for 10 minutes. An acceptable leak rate is a max rise of 100 microns in 10 minutes.

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## 11. Charging the System

It is essential to charge the system with the correct amount of refrigerant charge to ensure proper system operation and compressor reliability.

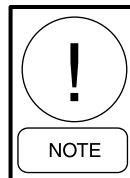
The condensing unit is generally factory charged with 6 pounds of dry nitrogen as a holding charge. The beginning operating charge must be weighed in after all the refrigerant piping is installed, leak tested and evacuated.

The weigh-in charge\* amount is determined by the catalogued operating charge in pounds of refrigerant for the Air Cooled Condensing Unit (ACCU), plus the calculated refrigerant line charge for the liquid and suction line, plus the evaporator charge estimate. Keep in mind each "dual" system carries its own charge amount and that systems can vary in tonnage. *Reference the tables below for refrigerant line charge estimates. Reference Installation, Operating & Maintenance (IOM) manual for the charge of the ACCU.* The evaporator charge can only be an estimate (a rough rule of thumb estimate would be to use 20% of the coil volume from YorkWorks in cubic feet x 78 lbs).

R-22 Charge in Pounds per 100 Ft of Refrigerant Line							R-407 Charge in Pounds per 100 Ft of Refrigerant Line						
Line Size, OD	Liquid Line Sat Disch Temp, °F			Suction Line Sat Suction Temp, °F			Line Size, OD	Liquid Line Sat Disch Temp, °F			Suction Line Sat Suction Temp, °F		
	R-22							R-407C					
	80	110	140	35	45	55		80	110	140	35	45	55
5/8"	12.01	11.29	10.44	0.23	0.27	0.32	5/8"	11.42	10.67	9.81	0.20	0.24	0.29
3/4"	17.93	16.86	15.59	0.34	0.40	0.47	3/4"	17.05	15.93	14.65	0.30	0.36	0.43
7/8"	24.91	23.42	21.66	0.47	0.56	0.66	7/8"	23.69	22.14	20.35	0.42	0.50	0.60
1-1/8"	42.47	39.93	36.93	0.80	0.95	1.12	1-1/8"	40.39	37.74	34.70	0.72	0.86	1.03
1-3/8"	64.69	60.82	56.24	1.22	1.44	1.70	1-3/8"	61.52	57.49	52.85	1.09	1.31	1.56
1-5/8"	91.56	86.09	79.61	1.72	2.04	2.41	1-5/8"	87.08	81.37	74.81	1.55	1.86	2.21
2-1/8"	159.30	149.80	138.50	3.00	3.56	4.19	2-1/8"	151.50	141.60	130.10	2.69	3.23	3.84
2-5/8"	245.60	231.00	213.60	4.62	5.48	6.47	2-5/8"	233.60	218.30	200.70	4.15	4.98	5.93
3-1/8"	350.60	329.70	304.80	6.60	7.83	9.23	3-1/8"	333.40	311.60	286.40	5.93	7.10	8.46

**\*Never rely on the weigh-in charges to determine the correct final charge. Final adjustment of refrigerant charge should be verified by subcooling values at design with a final clear site glass.**

R-410a Charge in Pounds per 100 Ft of Refrigerant Line						
Line Size, OD	Liquid Line Sat Disch Temp, °F			Suction Line Sat Suction Temp, °F		
	R-410a					
	80	110	140	35	45	55
5/8"	10.66	9.68	8.34	0.34	0.40	0.46
3/4"	15.91	14.46	12.45	0.50	0.60	0.73
7/8"	22.11	20.09	17.30	0.70	0.80	1.00
1-1/8"	37.69	34.26	29.49	1.20	1.40	1.66
1-3/8"	57.41	52.17	44.92	1.76	2.16	2.56
1-5/8"	81.26	73.85	63.58	2.48	3.00	3.60
2-1/8"	141.40	128.50	110.60	4.33	5.20	6.30
2-5/8"	218.00	198.10	120.60	6.65	8.00	9.25
3-1/8"	311.10	282.80	243.50	9.50	11.45	13.75

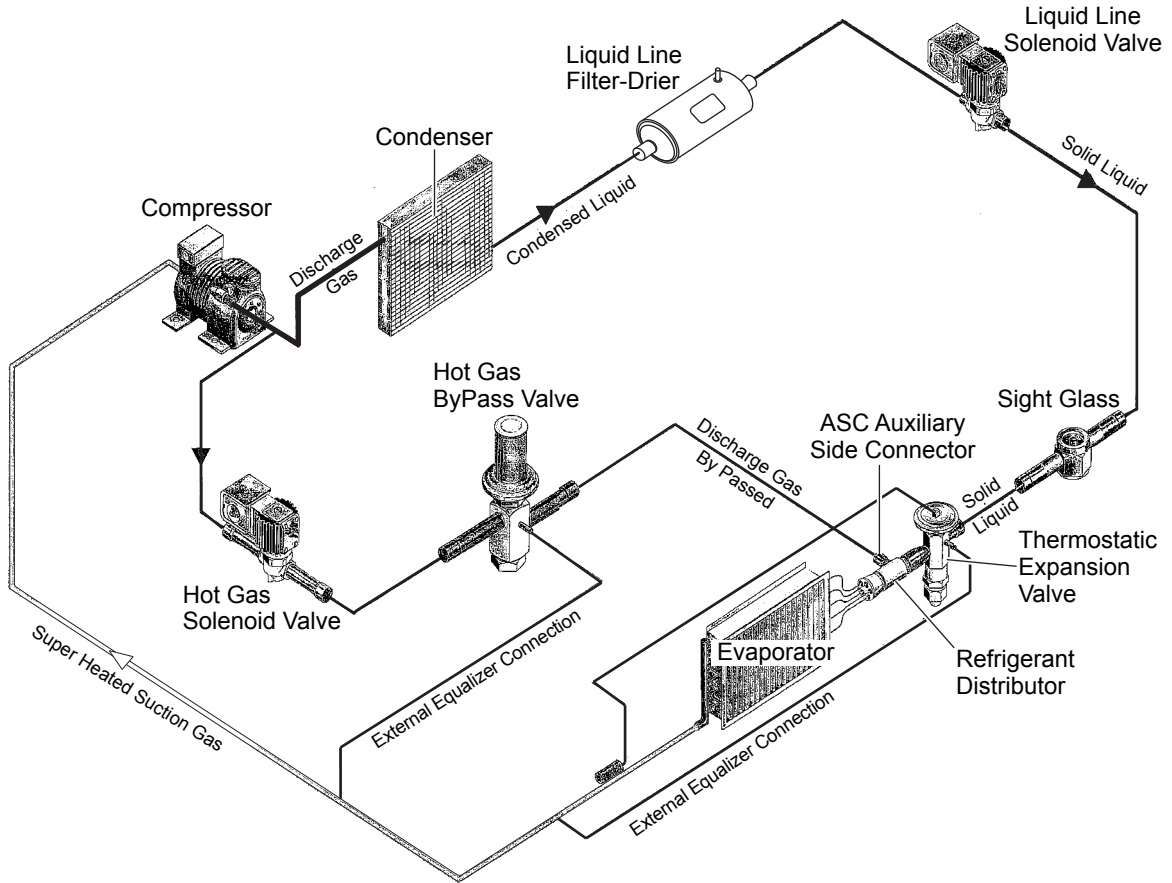


***Overcharging or undercharging the system will affect performance and compromise system reliability. Always validate the correct charge.***

**Reviewed By:** \_\_\_\_\_ **Date:** \_\_\_\_\_

### Summary System Piping Diagram

**Figure 7** – General Piping System Diagram for Illustration purposes only depicting a single “system” with single circuit layout (no HGBP check valve required on single circuit). Note the HGBP solenoid and bypass valve are typically one component.



LIQUID LINE SOLENOID VALVE



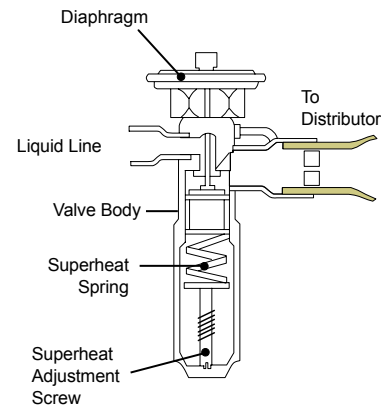
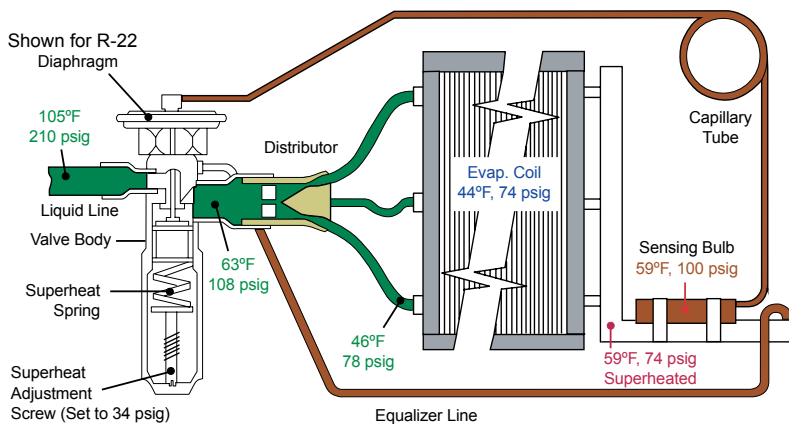
REPLACEABLE CORE FILTER DRIER



SEALED FILTER DRIER



SIGHT GLASS



THERMOSTATIC EXPANSION VALVE (TXV) (RIGHT), BULB AND EXTERNAL EQUALIZER INSTALLATION SHOWN (LEFT) .(Conditions will vary)

