A2L REFRIGERANT SAFETY, SERVICE AND DECOMMISSIONING MANUAL

Models:

All Bard Models Using R-454B Refrigerant

IMPORTANT NOTE:

Read this manual carefully before installing, operating or servicing the new air conditioning unit. Make sure to save this manual for future reference.

CAUTION:
Risk of Fire

Refrigerant
Safety Group
A2L

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The design and specifications are subject to change without prior notice for product improvement. Consult with the sales agency or manufacturer for details. Any updates to the manual will be uploaded to the Bard website, please check for the latest version.

⚠ WARNING

Read safety precautions before operation and installation.

Incorrect installation due to ignoring instructions can cause serious damage or injury.

The section below provides requirements, warnings, and information regarding best practices for safe and proper installation, service and storage of Bard R-454B equipment. Please adhere to all requirements and recommendations.

1. Installation
   - Bard wall mount air conditioners are classified as SPVUs (single package vertical units). All refrigerant piping is contained within the unit and all units are shipped with a factory refrigerant charge. No field joints are required for installation. However, care should be taken not to damage pipe work during installation.
   - In cases where the installation space requires mechanical ventilation, ensure that ventilation openings are kept clear of obstructions.
2. Servicing
   - Any person who is involved with working on a unit or breaking into a refrigerant circuit should hold a current valid certificate from an industry-accredited assessment authority, which authorizes their competence to handle refrigerants safely in accordance with an industry recognized assessment specification. Certification examples include: EPA 608 Certification and/or ACCA A2L Training and Certification classes.
   - Examples for such working procedures are:
     - Breaking into the refrigerating circuit
     - Opening of sealed components
     - Opening of ventilated enclosures
3. Maintenance and repair requiring the assistance of other skilled personnel shall be carried out under the supervision of the person competent in the use of flammable refrigerants.
4. Do not use means to accelerate the defrosting process or to clean, other than those recommended by Bard. See most recent version of User's Guide 2100-034 for more information.
5. The appliance shall be stored in a room without continuously operating ignition sources (for example: Open flames, an operating gas appliance or an operating electric heater).
6. Be careful that foreign matter (oil, water, etc) does not enter the piping. Also, when storing piping or components for service replacement, securely seal all openings by pinching, taping, etc.
7. Do not pierce or burn copper or refrigerant-containing components.
8. Be aware that refrigerants may not contain an odor.
9. Work procedures shall only be carried out by competent persons.
10. Appliance shall be stored in well-ventilated area where room size corresponds to the room area as specified for operation. Appliances stored in unventilated areas shall comply with the information found on page 9.
11. The appliance shall be stored so as to prevent mechanical damage from occurring.
12. All field joints shall be tested with detection equipment with a capability of 5 g/year of refrigerant or better, with the equipment in standstill and under operation or under a pressure of at least these standstill or operation conditions after installation. Detachable joints shall NOT be used in the indoor side of the unit (brazed, welded joint could be used).
13. When a FLAMMABLE REFRIGERANT is used, the requirements for installation space of appliance and/or ventilation requirements are determined according to:
    - The mass charge amount (M_c) used in the appliance
    - The installation location
    - The type of ventilation of the location or of the appliance

    The maximum charge in a room shall be in accordance with the following:

    - $M_{max} = 0.5 \times LFL \times h_0 \times A$

    or the required minimum floor area A_{min} to install an appliance with refrigerant charge M_c (kg) shall be in accordance with:

    - $A_{min} = M_c/(0.5 \times LFL \times h_0)$

    Where

    M_{max} is the allowable maximum charge in a room, in kg

M_c is the refrigerant change amount in appliance, in kg

A_{min} is the required minimum room area, in m^2

A is the room area, in m^2

LFL is the lower flammable limit, in kg/m^3. For R-454B at worst case formulation, this value is 0.296 kg/m^3.

h_0 is the release height, the vertical distance in meters from the floor to the lowest point of release when the appliance is installed.

$h_0 = (h_{inst} + h_{rel})$ or 0.6m, whichever is higher

h_{rel} is the release offset in meters from the bottom of the appliance to the point of the release

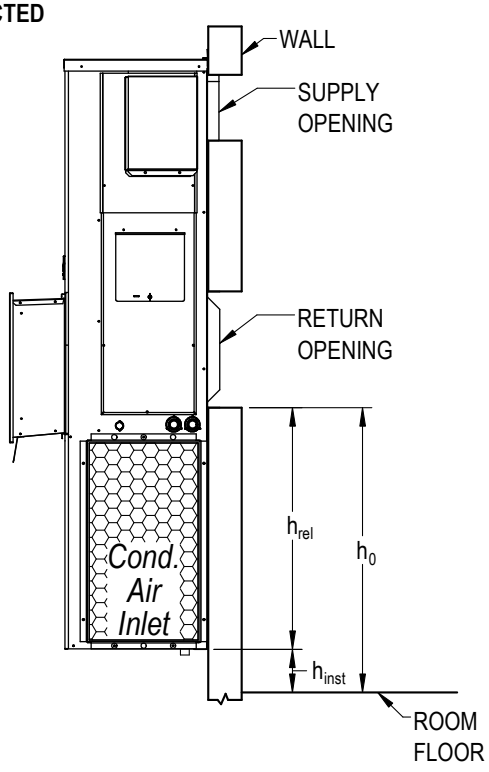
h_{inst} is the installed height in meters of the unit

For appliances serving one or more rooms with an air duct system, the lowest opening of the duct connection to each conditioned space or any opening of the indoor unit greater than 5 cm^2, at the lowest position to the space, shall be used for h_0. However, h_0 shall not be less than 0.6 m. A_{min} shall be calculated as a function of the opening. See Figure 1 for examples of h_0, h_{rel} and h_{inst} as applied to common installations of Bard units.

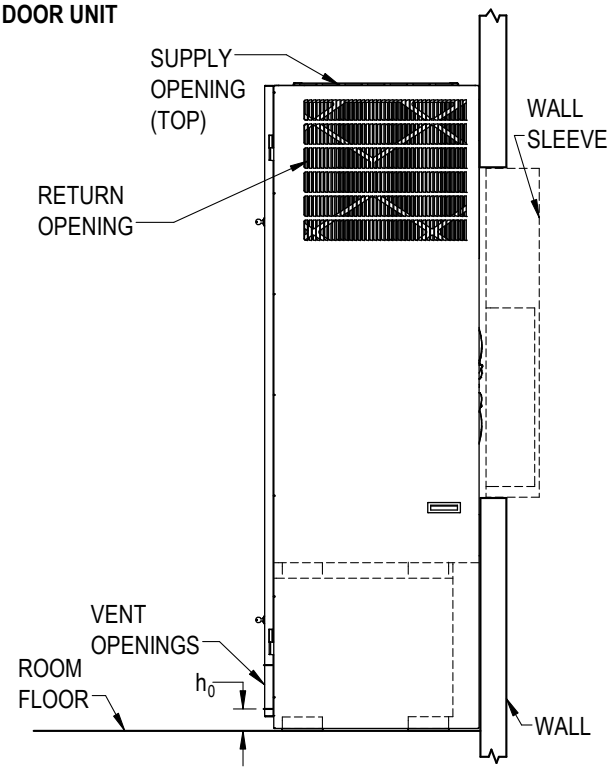
NOTE: *The unit charge (Mc) is listed on the unit serial plate. This can be used to calculate A_{min}.*

FIGURE 1
Release Height, Release Offset and Installed Height in Common Installations of Bard Units

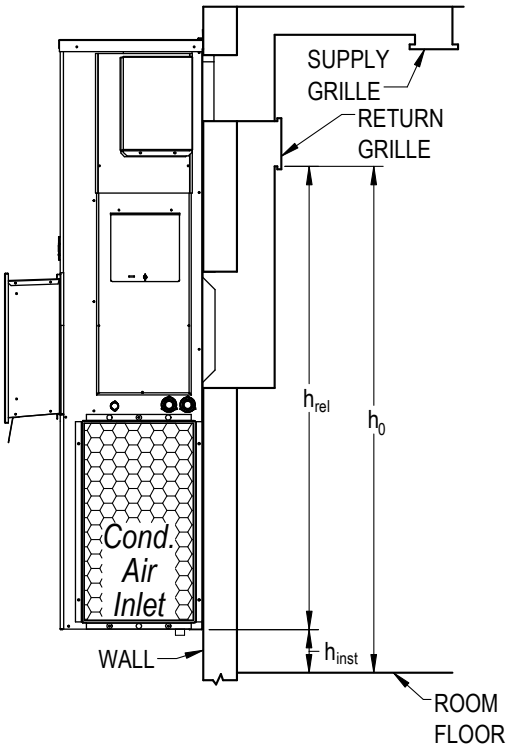
BARD WALL MOUNT OUTDOOR UNIT- NON-DUCTED



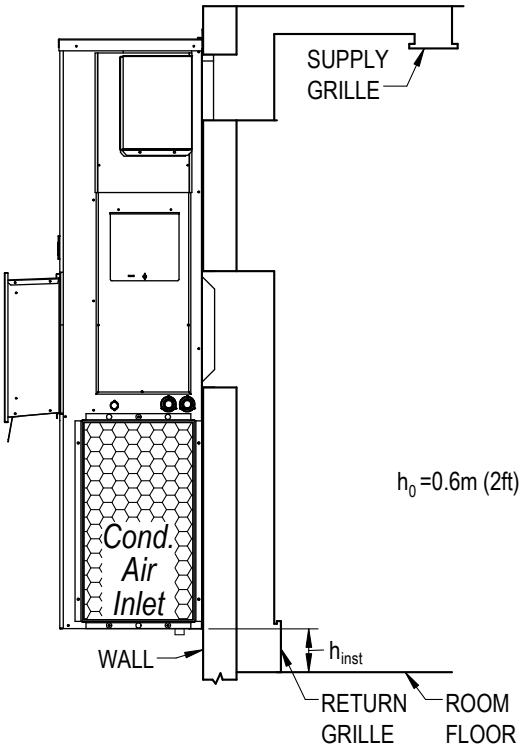
BARD I-TEC INDOOR UNIT



BARD WALL MOUNT OUTDOOR UNIT- DUCTED



BARD WALL MOUNT OUTDOOR UNIT- DUCTED



MIS-4523

TABLE 1A
Maximum Allowable Charge (M_{max}) in Kilograms

Release Height h_0 (m)	Room Area (m^2)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0.6	1	2	3	4	4	5	6	7	8	9
1.0	1	3	4	6	7	9	10	12	13	15
1.5	2	4	7	9	11	13	16	18	20	22
2.0	3	6	9	12	15	18	21	24	27	30
2.5	4	7	11	15	19	22	26	30	33	37
3.0	4	9	13	18	22	27	31	36	40	44

NOTE: *Values are based on a non-ventilated room at sea level.*

TABLE 1B
Maximum Allowable Charge (M_{max}) in Ounces

Release Height h_0 (ft)	Room Area (ft^2)									
	100	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**
2	30	59	89	118	148	177	207	237	266	296
3	44	89	133	177	222	266	310	355	399	443
4	59	118	177	237	296	355	414	473	532	591
5	74	148	222	296	370	443	517	591	665	739
6	89	177	266	355	443	532	621	710	798	887
7	103	207	310	414	517	621	724	828	931	1035
8	118	237	355	473	591	710	828	946	1064	1183
9	133	266	399	532	665	798	931	1064	1197	1330
10	148	296	443	591	739	887	1035	1183	1330	1478

NOTE: *Values are based on a non-ventilated room at sea level.*

TABLE 2A
Minimum Room Area (A_{min}) in m^2

Release Height h_0 (m)	Mc (kg)										
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
0.6	6	11	17	23	28	34	39	45	51	56	62
1.0	3	7	10	14	17	20	24	27	30	34	37
1.5	2	5	7	9	11	14	16	18	20	23	25
2.0	2	3	5	7	8	10	12	14	15	17	19
2.5	1	3	4	5	7	8	9	11	12	14	15
3.0	1	2	3	5	6	7	8	9	10	11	12

NOTE: *Values are based on a non-ventilated room at sea level.*

TABLE 2B
Minimum Room Area (A_{min}) in ft^2

Release Height h_0 (ft)	Mc (oz)								
	40	60	80	100	120	140	160	180	200
2	135	203	271	338	406	474	541	609	676
3	90	135	180	225	271	316	361	406	451
4	68	101	135	169	203	237	271	304	338
5	54	81	108	135	162	189	216	244	271
6	45	68	90	113	135	158	180	203	225
7	39	58	77	97	116	135	155	174	193
8	34	51	68	85	101	118	135	152	169
9	30	45	60	75	90	105	120	135	150
10	27	41	54	68	81	95	108	122	135

NOTE: *Values are based on a non-ventilated room at sea level.*

In cases where appliances are connected to one or more rooms via an air duct system and directly ducted to the space, M_{max} may be reduced or A_{min} may be increased. In these cases, M_{max} shall be determined based on the total area of the conditioned space (TA) connected by ducts, taking into consideration that the circulation airflow distributed to all the rooms by the appliance's integral indoor fan will mix and dilute the leaking refrigerant before entering any room. Note that in spaces where the airflow may be limited by zoning dampers, the Refrigerant Leak Detection System (RDS) shall open the zoning dampers when in alarm state (see unit installation manual for RDS alarm output connection information).

For appliances connected to one or more rooms via an air duct system, the minimum airflow for compliance may be determined using the equation below. See Tables 3A and 3B for reference values.

$Q_{min} = 30 \times M_c/LFL$

Where Q_{min} is the minimum circulation airflow circulated to the total conditioned space in m^3/h.

TABLE 3A
Minimum Airflow (Q_{min}) in m^3/h

Mc (kg)	Q_{min} (m^3/h)										
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
	51	101	152	203	253	304	355	405	456	507	557

TABLE 3B
Minimum Airflow (Q_{min}) in CFM

Mc (oz)	Q_{min} (cfm)								
	40	60	80	100	120	140	160	180	200
	68	101	135	169	203	237	271	304	338

The maximum refrigerant charge for compliance based on the room area for the total conditioned space can be calculated using the equation below. See Tables 4A and 4B for reference values.

$M_{max} = CF \times LFL \times H \times TA$

Where

M_{max} is the maximum allowable refrigerant charge in the system in kg

CF is the concentration factor with a value of 0.50

H is the height of the room = 2.2 m.

TABLE 4A
Maximum Charge (M_{max}) in Kilograms

TA (m^2)	M_{max} (kg)									
	20	40	60	80	100	120	140	160	180	200
	6.5	13.0	19.5	26.0	32.6	39.1	45.6	52.1	58.6	65.1

TABLE 4B
Maximum Charge (M_{max}) in Ounces

TA (ft^2)	M_{max} (oz)									
	100	200	300	400	500	600	700	800	900	1000
	3.0	65.1	97.7	130.2	162.8	195.4	227.9	260.5	293.0	325.6

The minimum total conditioned room area for compliance based on the refrigerant charge may be calculated using the following equation. See Tables 5A and 5B for reference values.

$TA_{min} = M_c/(CF \times LFL \times H)$

Where TA_{min} is the required minimum area of the total conditioned space in m^2.

TABLE 5A
Minimum Total Room Area (TA_{min}) in m^2

Mc (kg)	TA_{min} (m^2)										
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
	2	3	5	6	8	9	11	12	14	15	17

TABLE 5B
Minimum Total Room Area (TA_{min}) in ft^2

Mc (oz)	TA_{min} (ft^2)								
	40	60	80	100	120	140	160	180	200
	37	56	75	94	112	131	150	169	187

Altitude Adjustment

Once A_{min}, TA_{min} or M_c has been determined using the methods above, it must be corrected for the final installation site altitude using an Altitude Adjustment Factor (AF). To correct A_{min}, TA_{min} or M_c based on a building site's altitude, multiply the calculated area or refrigerant charge by the AF. The AF accounts for reduced air density at higher altitudes. The formula for adjusting the minimum room area is:

Adjusted Area = Original Area x AF

In the same way, the formula for adjusting the maximum charge is:

Adjusted Maximum Charge = Original Maximum Charge x AF

The AF depends on the specific appliance type and the altitude (H_{alt}) where it will be installed. The formula for calculating AF is:

$$AF = \frac{P_{sea}}{P_{site}}$$

where:

P_{site} is the atmospheric pressure at the installation site

P_{sea} level is the standard atmospheric pressure at sea level (usually around 101325 Pa/14.7 psi)

Air pressure above sea level can be calculated as:

$P_{site} = 101325\ (1 - 2.25577\ 10^{-5}\ h)^{5.25588}$

where

101325 = normal temperature and pressure at sea level (Pa)

P_{site} = air pressure (Pa)

h = altitude above sea level (m)

NOTE: *P_{site} calculation must be done using SI units as shown. The calculated AF can then be applied to any area units.*

See Tables 6A and 6B on page 10 for reference values.

Ventilation of the Conditioned Space

For installations where $M_c > M_{max}$ for the area of the room, compliance can be achieved with the addition of either natural or mechanical ventilation of the conditioned space. See UL60335-2-40, Annex GG for additional paths to compliance.

14. Unventilated Areas

For units containing more than 62.6 oz (1.775 kg) of R454B refrigerant for any refrigerating circuit, an unventilated area where the appliance is installed shall be so constructed that should any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard.

For units installed in a room with an area less than A_{min} (see tables 2A and 2B on page 7), but connected via an air duct system to one or more rooms, that room shall be without continuously

TABLE 6A
Example Altitude Adjustment Factors (AF) and Use Example (m)

Site Altitude Above Sea Level (m)	Site Pressure (Pa/PSI)	AF	A_{min} (m^2)					
			50	100	150	200	250	300
0	101325.0/14.7	1.000	50	100	150	200	250	300
1000	89874.6/13.0	0.887	44.3	88.7	133.0	177.4	221.7	266.1
2000	79495.2/11.5	0.785	39.2	78.5	117.7	156.9	196.1	235.4
3000	70108.5/10.2	0.692	34.6	69.2	103.8	138.4	173.0	207.6
4000	61640.2/8.9	0.608	30.4	60.8	91.3	121.7	152.1	182.5
5000	54019.9/7.8	0.533	26.7	53.3	80.0	106.6	133.3	159.9
6000	47181.0/6.8	0.466	23.3	46.6	69.8	93.1	116.4	139.7

TABLE 6B
Example Altitude Adjustment Factors (AF) and Use Example (ft)

Site Altitude Above Sea Level (ft)	Site Pressure (Pa/PSI)	AF	A_{min} (ft^2)					
			50	100	150	200	250	300
0	101325.0/14.7	1.000	50	100	150	200	250	300
1000	97716.7/14.2	0.964	48.2	96.4	144.7	192.9	241.1	289.3
2000	94213.2/13.7	0.930	46.5	93.0	139.5	186.0	232.5	278.9
3000	90812.1/13.2	0.896	44.8	89.6	134.4	179.2	224.1	268.9
4000	87511.2/12.7	0.864	43.2	86.4	129.6	172.7	215.9	259.1
5000	84308.0/12.2	0.832	41.6	83.2	124.8	166.4	208.0	249.6
6000	81200.5/11.8	0.801	40.1	80.1	120.2	160.3	200.3	240.4

operating open flames (i.e., an operating gas appliance) or other potential ignition sources (e.g., an operating electric heater, hot surfaces). A flame-producing device may be installed in the same space if the device is provided with an effective flame arrest.

For units connected via an air duct system to one or more rooms, auxiliary devices which may be a potential ignition source shall not be installed in the duct work. Examples of such potential ignition sources are hot surfaces with a temperature exceeding 700°C and electric switching devices. Only auxiliary devices approved by Bard or declared suitable with R-454B refrigerant shall be installed in connecting ductwork.

For duct connected units, false ceilings or drop ceilings may be used as a return air plenum if a refrigerant detection system (RDS) is provided in the appliance and any external connections are also provided with a sensor immediately below the return air plenum duct joint. All Bard products containing R-454B refrigerant come with a factory-installed RDS in the appliance. However, any external sensors required for compliance such as those in this example must be field supplied.

For non-duct connected units with the supply and return air openings in the conditioned space, the body of the appliance may be installed in open areas such as false ceilings not being used as return air plenums, as long as the conditioned air does not directly communicate with the air of the false ceiling.

1. Checks to the Area

   Prior to beginning work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimized. For repair to the refrigerating system, the following precautions (items 2-9) shall be complied with prior to conducting work on the system.

2. Work Procedure

   Work shall be undertaken under a controlled procedure so as to minimize the risk of a flammable gas or vapor being present while the work is being performed.

   Technical personnel in charge of operation, supervision, maintenance of air-conditioning systems shall be adequately instructed and competent with respect to their tasks.

   Works shall be undertaken with appropriate tools only. (In case of uncertainty, please consult the manufacturer of the tools for use with flammable refrigerants.)

3. General Work Area

   All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided. The area around the work space shall be sectioned off. Ensure that the conditions within the area have been made safe by control of flammable material.

4. Checking for Presence of Refrigerant

   The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially flammable atmospheres. Ensure that the leak detection equipment being used is suitable for use with flammable refrigerants, e.g., no sparking, adequately sealed or intrinsically safe.

5. Presence of Fire Extinguisher

   If any hot work is to be conducted on the refrigeration equipment or any associated parts, appropriate fire extinguishing equipment shall be available on hand. Have a dry power or CO_2 fire extinguisher adjacent to the charging area.

6. No Ignition Sources

   No person carrying out work in relation to a refrigerating system which involves exposing any pipe work that contains or has contained flammable refrigerant shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion. All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which flammable refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment is to be surveyed to make sure that there are no flammable hazards or ignition risks. NO SMOKING signs shall be displayed.

7. Ventilated Area

   Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

8. Checks to the Refrigeration Equipment

   Where electrical components are being changed, they shall be fit for the purpose and to the correct specification. At all times, the manufacturer's maintenance and service guidelines shall be followed. If in doubt, consult the manufacturer's technical department for assistance. The following checks shall be applied to installations using flammable refrigerants:

   - The refrigerant charge size is in accordance with the room size within which the refrigerant containing parts are installed.
   - The ventilation machinery and outlets are operating adequately and are not obstructed;
   - If an indirect refrigerating circuit is being used, the secondary circuits shall be checked for the presence of refrigerant.
   - Marking to the equipment continues to be visible and legible marking and signs that are illegible shall be corrected.
   - Refrigeration pipe or components are installed in a position where they are unlikely to be exposed to any substance which may corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.

9. Checks to Electrical Devices

   Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures. If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with. If the fault cannot be corrected

immediately but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment so all parties are advised.

Initial safety checks shall include:

- That capacitors are discharged: This shall be done in a safe manner to avoid possibility of sparking.
- That no live electrical components and wiring are exposed while charging, recovering or purging the system.
- That there is continuity of earth bonding.

10. Repairs to Sealed Components

    Sealed electrical components shall be replaced.

11. Repair to Intrinsically Safe Components

    Intrinsically safe components must be replaced.

12. Cabling

    During installation, check that field wiring and cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges or any other adverse environmental effects. The check shall also take into account the effects of aging or continual vibration from sources such as compressors or fans.

13. Detection of Flammable Refrigerants

    Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks. A halide torch (or any other detector using a naked flame) shall not be used.

14. Leak Detection Methods

    The following leak detection methods are deemed acceptable for systems containing flammable refrigerants. Electronic leak detectors may be used to detect refrigerant leaks but, in the case of flammable refrigerants, the sensitivity may not be adequate, or may need re-calibration.(Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for R-454B refrigerant. Leak detection equipment shall be set at a percentage of the lower flammable limit (LFL) of the refrigerant and shall be calibrated for R-454B and the appropriate percentage of gas (25% maximum) is confirmed. Leak detection fluids are suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine may react with the refrigerant and corrode the copper pipe-work.

    NOTE: *Examples of leak detection fluids are:*

    - *Bubble method*
    - *Fluorescent method agents*

    If a leak is suspected, all naked flames shall be removed or extinguished.

    If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system. In accordance with industry-standard practice, oxygen-free nitrogen (OFN) shall then be purged through the system both before and during the brazing process.

15. Removal and Evacuation

    When breaking into the refrigerant circuit to make repairs—or for any other purpose—conventional procedures shall be used. However, for flammable refrigerants it is important that best practice be followed, since flammability is a consideration. The following procedure shall be adhered to:

    - Safely remove refrigerant following local and national regulations
    - Evacuate
    - Purge the circuit with oxygen-free nitrogen
    - Evacuate
    - Continuously flush or purge with oxygen-free nitrogen when using flame to open circuit
    - Open the circuit

    The refrigerant charge shall be recovered into the correct recovery cylinders if venting is not allowed by local and national codes. For appliances containing flammable refrigerants, the system shall be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerants. This process might need to be repeated several times. Compressed air or oxygen shall not be used for purging refrigerant systems.

    For appliances containing flammable refrigerants, refrigerants purging shall be achieved by breaking the vacuum in the system with oxygen-free nitrogen and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum. This process shall be repeated until no refrigerant is within the system. When the final oxygen-free nitrogen charge is used, the system shall be vented down to atmospheric pressure to enable work to take place.

    The outlet for the vacuum pump shall not be close to any potential ignition sources, and ventilation shall be available.

16. Charging Procedures

    In addition to conventional charging procedures, the following requirements shall be followed:

    - Work shall be undertaken with appropriate tools only. (In case of uncertainty, please consult the manufacturer of the tools for use with flammable refrigerants.)

- Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines shall be as short as possible to minimize the amount of refrigerant contained in them.
- Cylinders shall be kept upright.
- Ensure that the refrigeration system is earthed prior to charging the system with refrigerant
- Extreme care shall be taken not to overfill the refrigeration system.
- Prior to recharging the system, it shall be pressure tested with oxygen-free nitrogen.

The system shall be leak tested on completion of charging but prior to commissioning. A follow-up leak test shall be carried out prior to leaving the site.

17. Decommissioning

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its detail. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of reclaimed refrigerant. It is essential that electrical power is available before the task is commenced.

- Become familiar with the equipment and its operation.
- Isolate system electrically.
- Before attempting the procedure, ensure that:
  - Mechanical handling equipment is available, if required, for handling refrigerant cylinders.
  - All personal protective equipment is available and being used correctly.
  - The recovery process is supervised at all times by a competent person.
  - Recovery equipment and cylinders conform to the appropriate standards.
- Pump down refrigerant system, if possible.
- In order to pull a complete vacuum, fully reclaim the system or charge the unit, connections to all service ports—suction, liquid and discharge—need to be utilized.
- Make sure that cylinder is situated on the scales before recovery takes place in order to ensure refrigerant charge is weighed in properly.
- Start the recovery machine and operate in accordance with manufacturer's instructions.
- Do not overfill cylinders (no more than 80% volume liquid charge).
- Do not exceed the maximum working pressure of the cylinder, even temporarily.
- When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
- Recovered refrigerant shall not be charged into another refrigeration system unless it has been cleaned and checked.

18. Labeling

Equipment shall be labeled stating that it has been de-commissioned and emptied of refrigerant. The label shall be dated and signed. Ensure that there are labels on the equipment stating the equipment contains flammable refrigerant.

19. Recovery

When removing refrigerant from a system, either for service or decommissioning, be sure that all refrigerants are removed safely.

When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct numbers of cylinders for holding the total system charge are available. All cylinders to be used are designated for the recovered refrigerant and labeled for that refrigerant (i.e., special cylinders for the recovery of refrigerant). Cylinders shall be complete with pressure relief valve and associated shut-off valves in good working order.

The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of the flammable refrigerant. If in doubt, the manufacturer should be consulted. In addition, a set of calibrated weighing scales shall be available and in good working order. Hoses shall be complete with leak-free disconnect couplings and in good condition.

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

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant. The compressor body shall not be heated by an open flame or other ignition sources to accelerate this process. When oil is drained from a system, it shall be carried out safely.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant. The compressor body shall not be heated by an open flame or other ignition source to accelerate this process. When oil is drained from a system, it shall be carried out safely.

20. Transport of Equipment Containing Flammable Refrigerants

    Additional transportation regulations may exist with respect to equipment containing flammable gas. The maximum number of pieces of equipment or the configuration of the equipment permitted to be transported together will be determined by the applicable transport regulations.

21. Marking of Equipment Using Signs

    Signs for similar appliances used in a work area are generally addressed by local regulations and give the minimum requirements for the provision of safety and/or health signs for a work location. All required signs are to be maintained and employers should ensure that employees receive suitable and sufficient instruction and training on the meaning of appropriate safety signs and the actions that need to be taken in connection with these signs. The effectiveness of signs should not be diminished by too many signs being placed together. Any pictograms used should be as simple as possible and contain only essential details.

22. Disposal of Equipment Using Flammable Refrigerants

    See national regulations.

23. Storage of Equipment/Appliances

    The storage of the appliance should be in accordance with the applicable regulations or instructions provided by Bard, whichever is more stringent.

24. Storage of Packed (Unsold) Equipment

    Storage package protection should be constructed in such a way that mechanical damage to the equipment inside the package will not cause a leak of the refrigerant charge. The maximum number of pieces of equipment permitted to be stored together will be determined by local regulations.

Explanation of Symbols Displayed on the Unit

This symbol indicates that the unit contains a mildly flammable refrigerant.

Refrigerant Safety Group A2L

This symbol indicates that the refrigerant used is classified as an A2L, or mildly flammable refrigerant.

This symbol indicates that the Operation Manual should be read carefully.

This symbol indicates that a service personnel should be handling this equipment with reference to the Installation Manual.

This symbol indicates that information is available such as the Operation Manual or Installation Manual.

REFRIGERANT LEAK DETECTION SYSTEM (RDS)

For information about the Refrigerant Leak Detection System (RDS), see unit installation manual.

⚠ WARNING

The oils used with R-454B refrigerant are hydroscopic and absorb water from the atmosphere readily. Do not leave systems open to the atmosphere for more than 5 minutes. If the system has been open for more than 5 minutes, change the filter dryer immediately before evacuation. Then recharge the system to the factory-specified charge.

Recovery Equipment Rated for R-454B Refrigerant

R-454B has an ozone depletion potential of zero, but must be reclaimed due to its global warming potential.

R-454B refrigerant operates at pressures similar to R-410A. The gauge manifold set must be designed to withstand the higher pressure associated with R-454B. Manifold sets are required to range up to 800 psig on the high side and 250 psig on the low side with a 250 psig low side retard.

All hoses must have a service rating of 800 psig. (This information will be indicated on the hoses.)

Vacuum pump and micron gauge must be used when evacuating a system to 500 microns.

Leak Detectors

An electronic leak detector rated for use with flammable refrigerants can be used with R-454B refrigerant.

Gauge Manifold

⚠ WARNING

Gauge manifold must be suitable for use with R-454B refrigerant and POE oils.

A necessary instrument in checking and serving air conditioning and heat pump equipment is the gauge manifold. Its purpose is to determine the operating refrigerant pressures in order for the service technician to analyze the condition of the system.

The valving on the manifold is so arranged that when the valves are closed (front-seated) the center port on the manifold is closed to the gauges and gauge ports. With the valves in the closed position, the gauge ports are still open to the gauges, permitting the gauges to register system pressures. Opening either valve opens the center port to that side of the manifold and system.

Attaching Gauge Manifold

For leak testing, purging, checking charge, charging liquid or evacuating, connect high pressure side of gauge manifold to Schrader valve on liquid or discharge line. Connect suction side of gauge manifold to Schrader valve on suction line. On heat pumps the suction line is between compressor and reversing valve.

⚠ WARNING

As a safety measure, it is wise to attach refrigerant hoses at the points of lowest pressure in the system. To do this:

A. Put high pressure hose "B" on first. (Unit should not be running.)

B. Put low pressure hose "A" on second. (Unit should be running.)

Attaching manifold hose to Schrader valve:

1. Remove cap from valve.
2. Make sure gauge manifold valves are closed.
3. If hose does not have an unseating pin, a number 395 Superior or equivalent unseating coupler must be used.
4. Make sure coupler is lined up straight with Schrader valve. Screw coupler onto valve.
5. Open gauge manifold valve slightly and purge air from hose with refrigerant.
6. Read the suction pressure on compound gauge and heat pressure on pressure gauge.
7. To remove, push end of hose tight against end of Schrader valve and hold in place while quickly unscrewing coupler nut from Schrader valve.
8. Remove coupler from Schrader valve. Replace caps on valve.

Leak Test

1. If the system still contains refrigerant when a leak is suspected, check all soldered joints and areas of suspicion with an electronic leak detector suitable for use with R-454B refrigerant.

   NOTE: *Older R-22 leak detectors will not detect leaks in R-454B systems.*

2. If no leak is found in Step 1, or the total refrigerant charge has leaked out, recover remaining refrigerant from the system and evacuate. (See **Evacuation** section below and unit installation manual for more information.)

   NOTE: *When working on an R-454B system, recovery pumps, vacuum pumps and charging cylinders should be connected to an earth ground at all times during use.*

3. Remove gauge port cap from suction and liquid service valve ports and attach manifold gauge hoses. Connect an upright cylinder of oxygen-free dry nitrogen (OFN) to center port of gauge manifold. Open nitrogen cylinder valve and manifold high pressure gauge valve to pressurize system to a positive pressure with OFN vapor. Pressurize the complete system until the pressure reaches 200 psig. Do not exceed 250 psig.
4. Close manifold high pressure gauge valve. Check all soldered joints, including those on the evaporator coil, by spraying with a soap and water solution and looking for bubbles. If a leak is found which requires soldering, pressure in the system must be bled off since it is impossible to solder with unit pressurized. Be sure all leaks are located and marked before bleeding pressure from system.
5. Close OFN tank valve and disconnect from center port. Release nitrogen into the atmosphere through suction line of gauge manifold.
6. Correct any leaks and recheck.
7. Replace filter drier. The liquid line filter dryer (R-454B compatible) must be replaced any time the system is open. When removing a filter dryer from a system, do not use a torch; use a tubing cutter to avoid releasing moisture back into the system.
8. Once filter drier has been replaced, recheck for leaks. When leaks, if any, have been repaired, system is ready to be evacuated and charged. Relieve all pressure from the system down to 0 psig.

   REMEMBER: *Always use a pressure regulator with nitrogen and a safety valve down stream.*

Evacuation

An evacuation to 500 microns is usually sufficient to remove moisture from a system using R-22 and mineral oil lubricant. A 500 micron evacuation, however, will not separate moisture from Polyol Ester oil (POE) in R-454B systems.

1. Evacuate system to less than 500 microns, using a good vacuum pump designed for use with flammable refrigerants and an accurate high vacuum gauge. Operate the pump below 500 microns for 60 minutes and then close valve to the vacuum pump. Allow the system to stand for 30 additional minutes to be sure a 500 micron vacuum or less is maintained.

⚠ WARNING

Do not use the compressor to evacuate the system or any part of it.

2. Disconnect charging line at vacuum pump and connect to refrigerant supply. Crack the cylinder valve and purge charging line at center on manifold. Then close cylinder valve.
3. The system is now ready for the correct operating charge of refrigerant R-454B.

R-454B System Charging

Even though R-454B has a low fractionation potential, it cannot be ignored when charging. For this reason, R-454B systems should never be "topped off". The remaining system charge should always be recovered, the system evacuated, and then charged to the amount shown on the unit serial plate. To avoid fractionation, charging of an air conditioner or heat pump system incorporating R-454B shall be done with “liquid” to maintain optimum system performance. To ensure that the proper blend composition is charged into the system, it is important that liquid only be removed from the charging cylinder.

Some cylinders supplied by manufacturers have dip tubes which allow liquid refrigerant to be removed from the cylinder when it is in the upright position. Cylinders without dip tubes have to be tipped upside down in order for liquid to be removed. The service technician must differentiate between which type of charging cylinder they are using to avoid removing vapor refrigerant instead of liquid refrigerant to avoid fractionation and for safety concerns.

Allow liquid to enter the high side only. The high side will hold 80-100% of the total charge. When liquid stops flowing, close high-side port. The remainder of the charge will be added to the low side. Keep in mind two issues: First, never start the compressor with less than 55 psig of suction pressure. Secondly, make sure the liquid is throttled, thus vaporized into the low side of the system to avoid compressor damage. A throttling valve can be used to ensure that liquid is converted to vapor prior to entering the system. Proper manipulation (restricting) of the manifold gauge set can also act as a throttling device to ensure liquid is not entering the compressor.

For single package units, refer to the unit serial plate for the full operating charge.

Preliminary Charging Steps

If the system has been open to the atmosphere, the filter dryer should be replaced and then evacuated. Then proceed as follows:

1. Attach a cylinder of proper, clean refrigerant to the center port of the charging manifold with one of the charging hoses.
2. Attach a second charging hose to the suction gauge (low pressure) side of the gauge manifold.
3. Remove the cap from the suction line valve.
4. Loosely attach the suction gauge hose to the line valve. Open the valve on the refrigerant cylinder and the suction valve on the charging manifold slightly to purge the air from the manifold and hoses before tightening the fitting.
5. Attach the third hose to the high pressure side of the manifold and the liquid line valve. Repeat Steps 3 and 4 above.

Charging the System by Weight

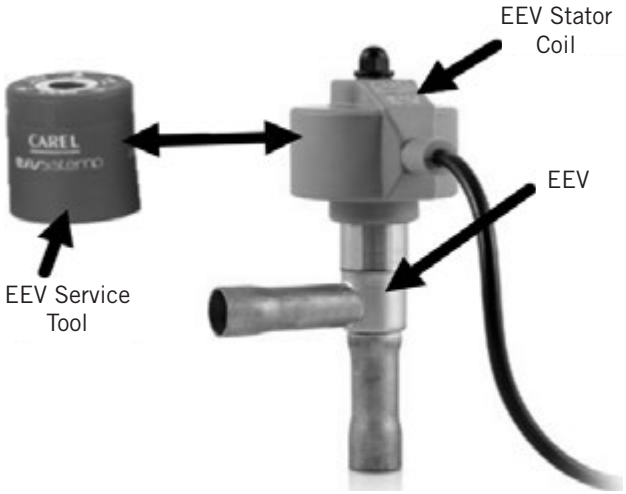
1. Connect manifold as instructed.
2. Place refrigerant cylinder on scale and determine exact weight of the refrigerant and cylinder.
3. With manifold suction valve closed and manifold discharge valve open, open refrigerant cylinder liquid valve and allow pressure in system to balance with pressure of cylinder or 80% of charge is in the unit—whichever comes first.
4. When there is approximately an 80% charge, front seat (close) the discharge manifold valve and let the system stabilize for about five minutes.
5. Start compressor by setting thermostat.
6. Finish charging with liquid by cracking the suction valve. Open the manifold low pressure valve to allow refrigerant to flow into the system. Throttle the manifold valve to keep pressure about 100 psig for R-454B.
7. When the correct weight of refrigerant has been added to the unit, close refrigerant cylinder valve and allow unit to run for 30 minutes. Refer to Start-Up Procedure and Check List for further start-up details.
8. Front seat gauge manifold valves, disconnect charging and gauge hoses and replace all valve caps.

EEV Instructions for Recovering, Evacuating and Charging the Unit

Some Bard units use an electronic expansion device to meter refrigerant, In these units, the electronic expansion valve moves to a closed position when there is no call to control. In order to pull a complete vacuum, fully recover the system or charge the unit, connections to all service ports—suction, liquid and discharge—need to be utilized or the valve needs to be manually opened first. The valve can be opened manually using the magnetic EEV service tool (Bard Part # 2151-021) shown in Figure 2. To do this, remove the EEV stator coil (red color with retaining nut on top), slide the magnetic tool over the shaft where the stator was removed and turn in a clockwise direction to open the valve to the full open position (directional arrows are provided on the tool).

Reapply the EEV stator coil and retaining nut once complete. Upon powering the unit back up, the control board will automatically drive the EEV back to the fully shut position. Once the compressor starts, the control board will again modulate the EEV position to control the system superheat.

FIGURE 2
Electronic Expansion Valve (EEV) and Service Tool



⚠ WARNING

To speed refrigerant flow, it may be necessary to place refrigerant cylinder in a pan of warm water (not greater than 130°F). Remember to either consider the total weight of the pan of water or remove the cylinder for weighing frequently to keep track of the charging process.

FIGURE 3
Typical Air Conditioning System Cooling Cycle

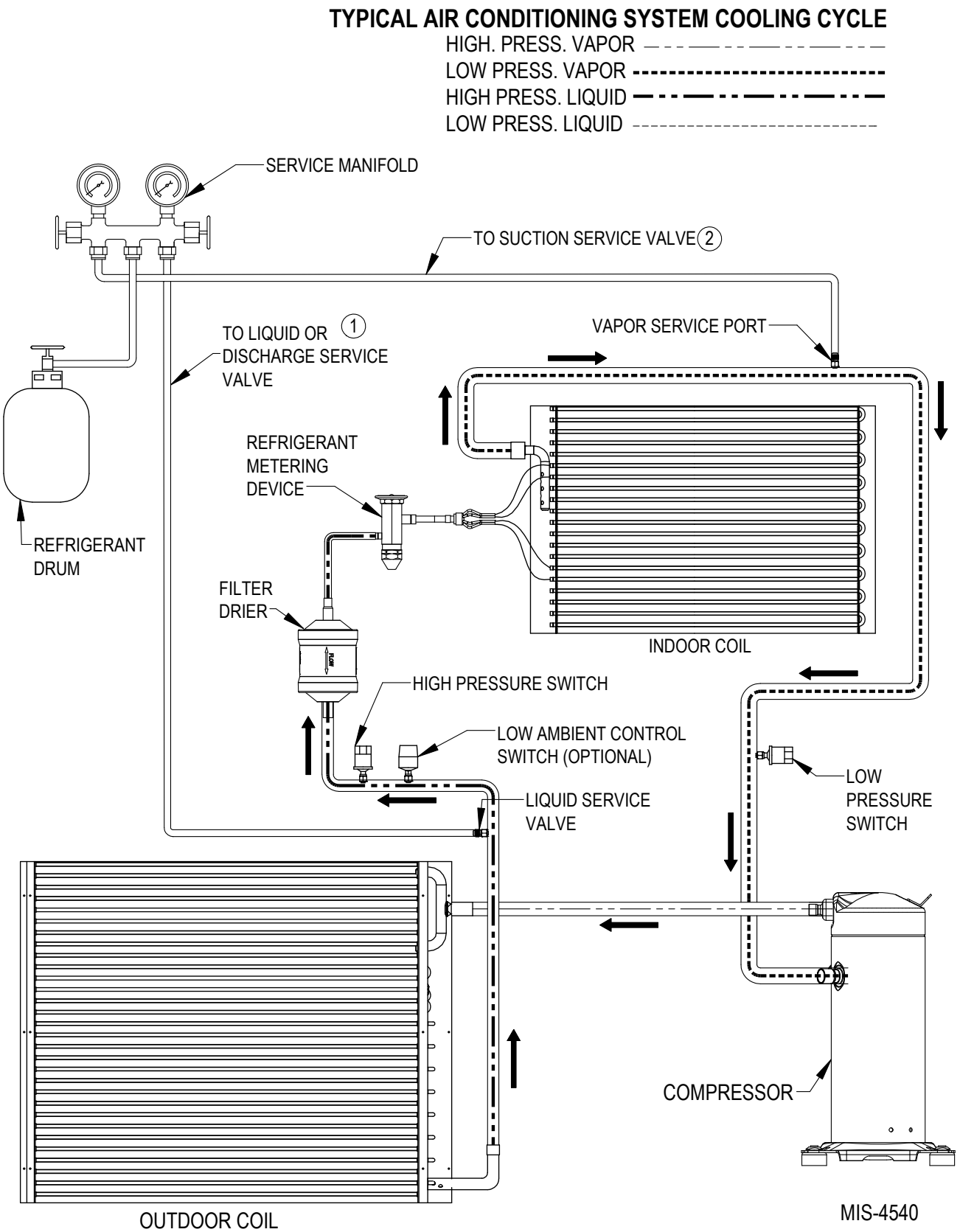


FIGURE 4
Typical Heat Pump System Cooling Cycle

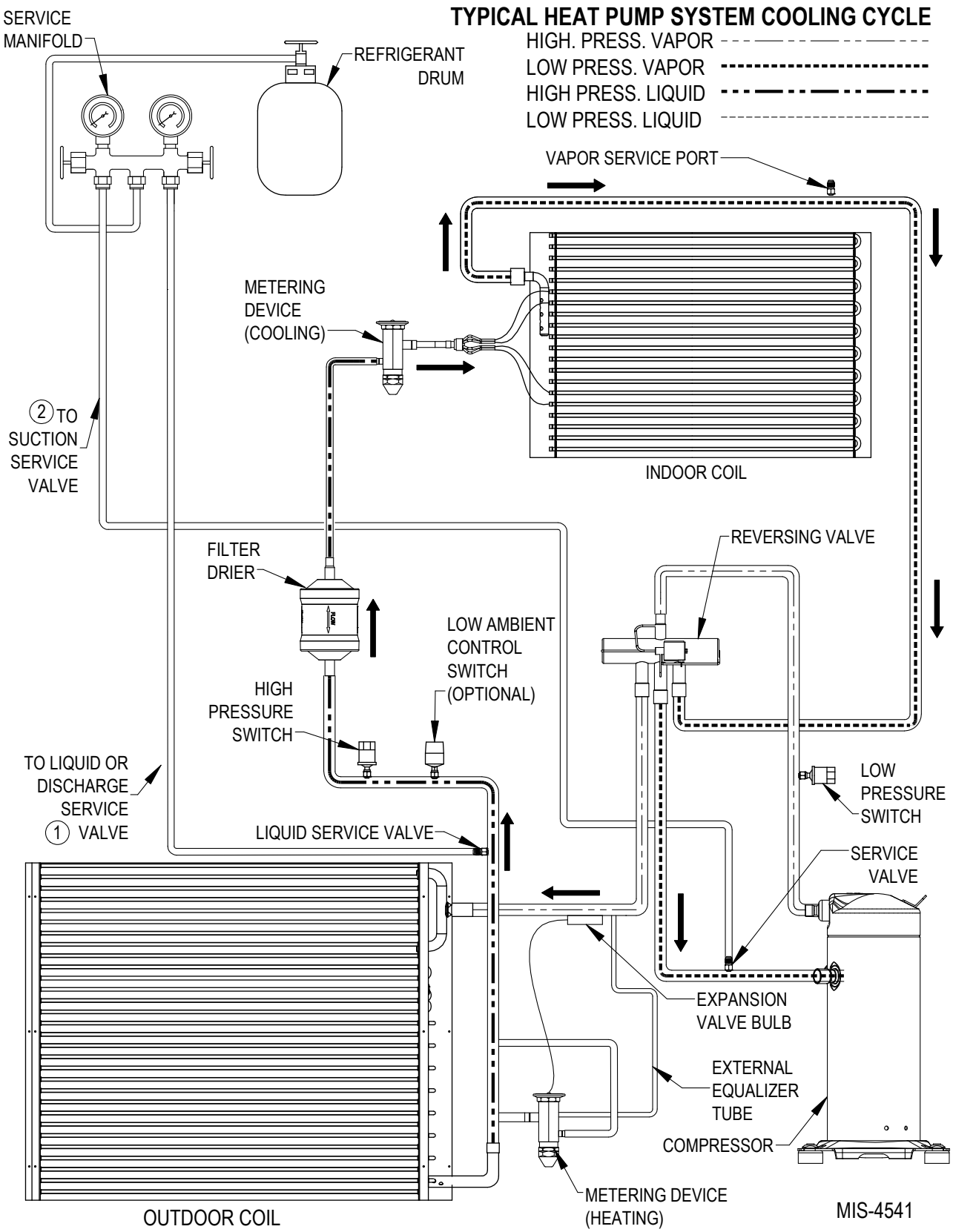


FIGURE 5
Heating Cycle

TYPICAL HEAT PUMP SYSTEM HEATING CYCLE

HIGH. PRESS. VAPOR
LOW PRESS. VAPOR
HIGH PRESS. LIQUID
LOW PRESS. LIQUID

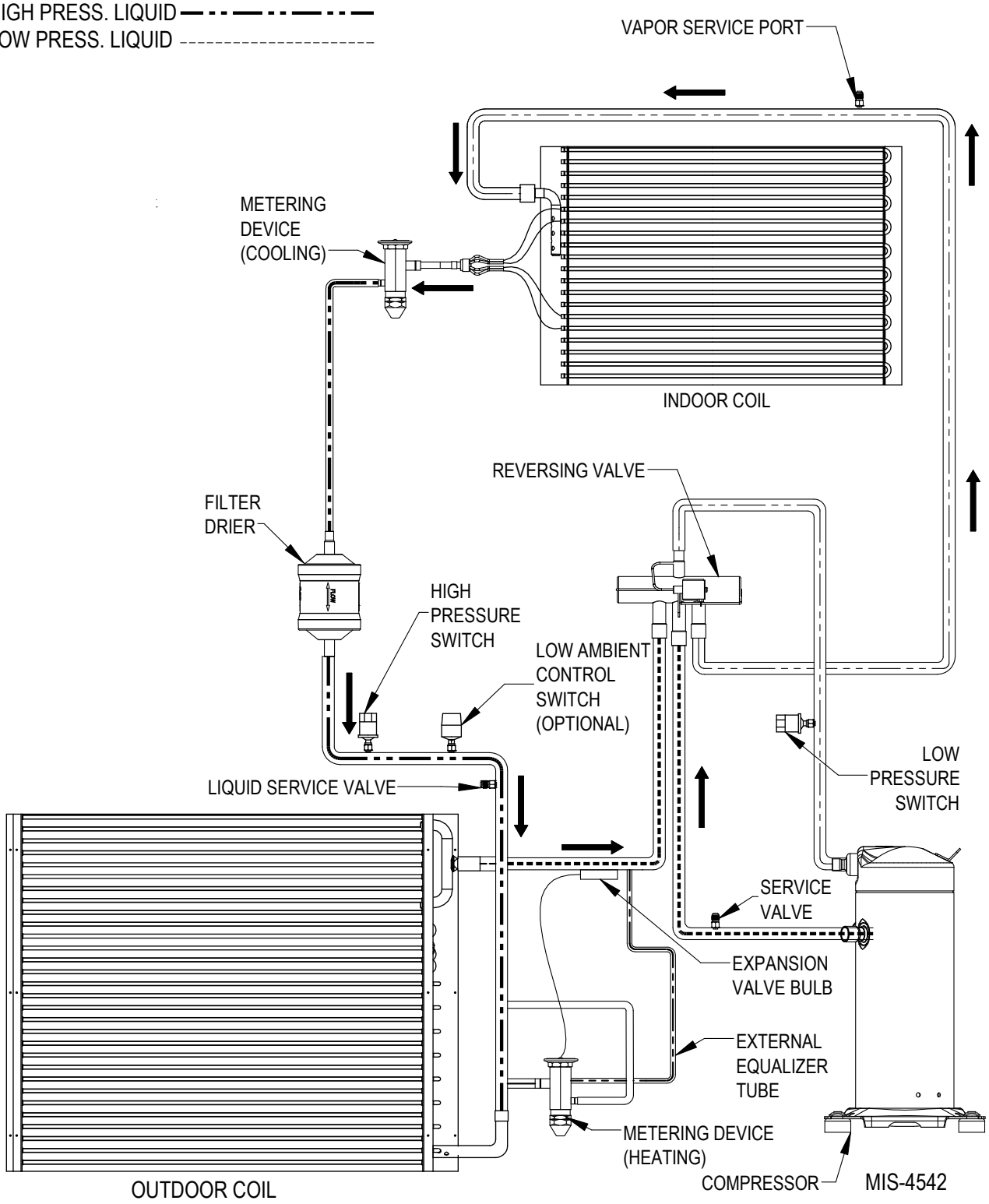


FIGURE 6
Air Conditioning Mode Circuit Diagram

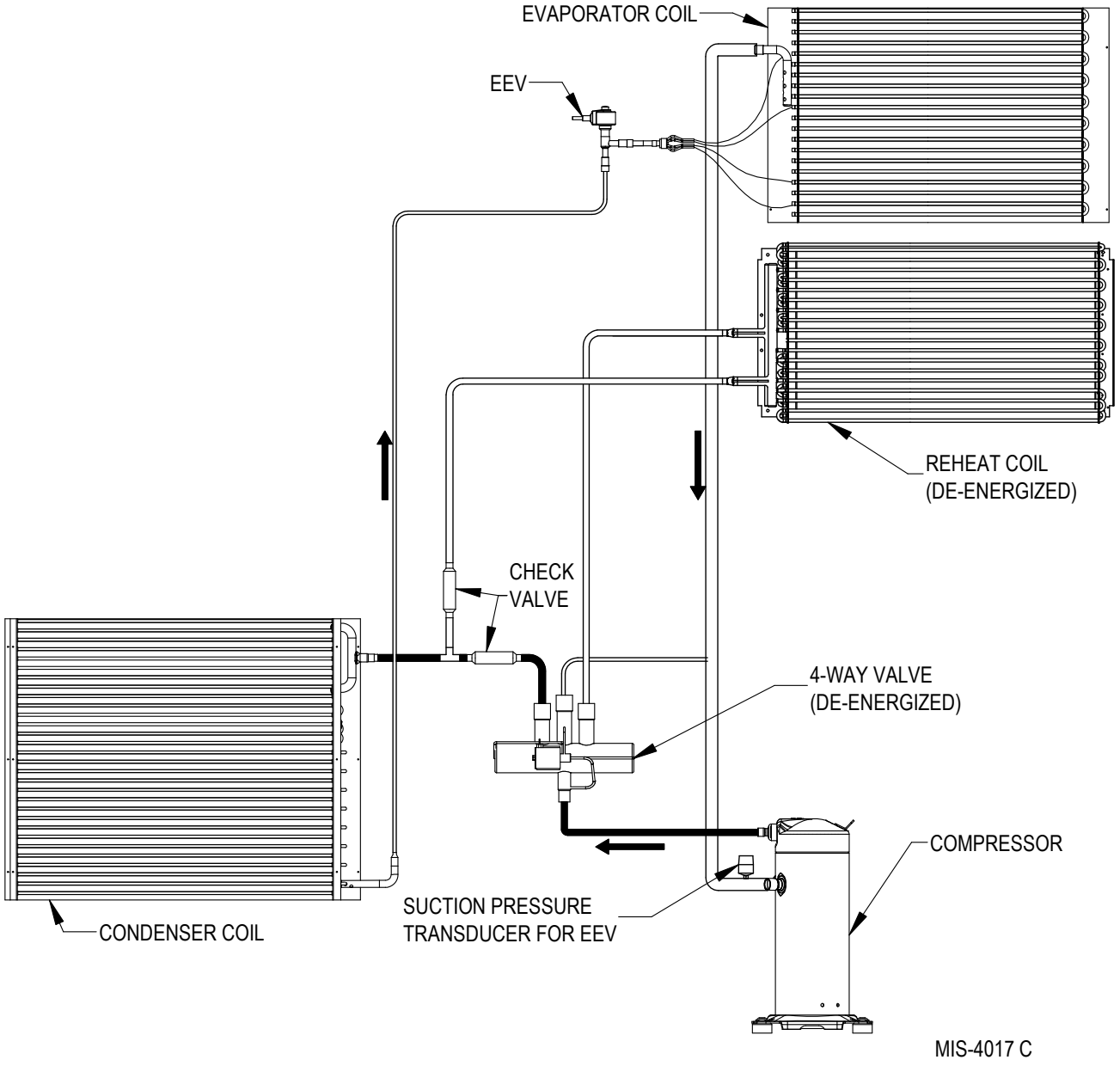
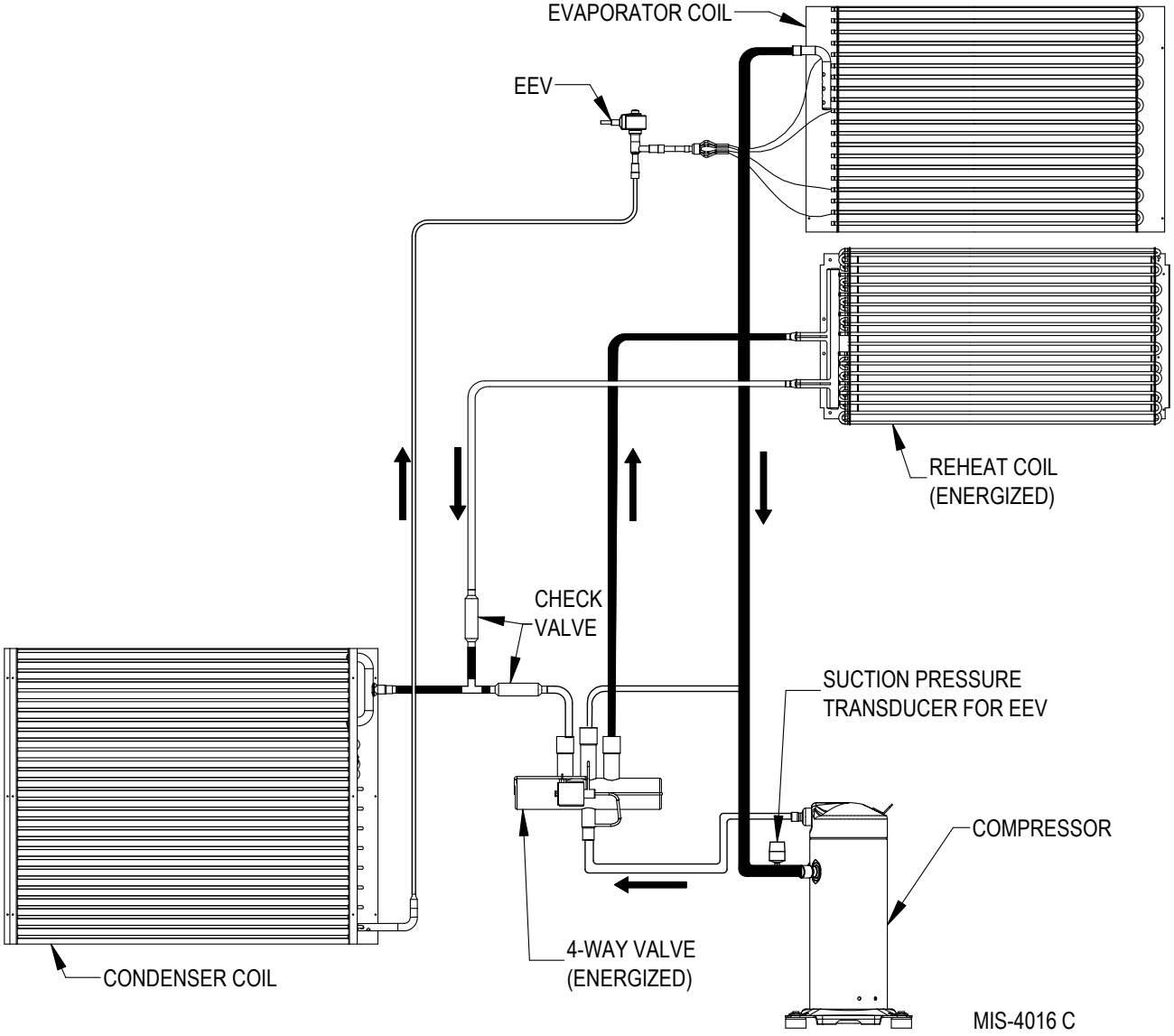


FIGURE 7
Dehumidification Mode Circuit Diagram



Air Conditioning and Heat Pump – Cooling

Low Suction – Low Head Pressure

1. Restricted airflow over indoor coil
2. Defective indoor fan motor
3. Low indoor temperature
4. Iced indoor coil
5. Restricted liquid line, dryer, metering device, etc.
6. Low charge
7. Low ambient entering air temperature. (Low entering water temperature to water coil.[1])

High Suction – Low Head Pressure

1. Defective or broken valves
2. IPRV valve open
3. Defective reversing valve

Low Suction – High Head Pressure

1. Partial restriction and then overcharged

High Suction – High Head Pressure

1. High entering outdoor air temperature. (High entering water temperature.[1])
2. Low airflow outdoor coil. (Low water flow.[1])
3. Overcharged
4. Air in system
5. Restricted outdoor coil. (Restricted water coil.[1])
6. High indoor air temperature

Heat Pump – Heating

Low Suction – Low Head Pressure

1. Restricted airflow through outdoor coil. (Restricted water flow through water coil.[1])
2. Defective outdoor motor. (Defective water pump.[1])
3. Low outdoor air temperature. (Low water temperature.[1])
4. Frozen outdoor coil. (Frozen water coil.[1])
5. Restricted liquid line, dryer, metering device, etc.
6. Low charge
7. Low indoor air temperature

High Suction – Low Head Pressure

1. Defective or broken valves
2. IPR valve open
3. Defective reversing valve

Low Suction – High Head Pressure

1. Partial restriction and then overcharged

High Suction – High Head Pressure

1. High entering outdoor air temperature. (High entering water temperature.[1])
2. Low indoor airflow
3. Overcharged
4. Air in system
5. Restricted air coil
6. High indoor air temperature

[1] Water source heat pump

TROUBLESHOOTING CHART FOR AIR CONDITIONERS

● Generally the cause. Always make these checks first.

◆ Occasionally the cause. Make these checks only if first checks fail to locate trouble.

■ Rarely the cause. Make this check only if previous checks fail to locate trouble.

	Power Supply																										
	Meter to Line Side of Contactor								Load Side of Contactor to Motor Terminal										Control Circuit								
	Power Failure	Blown Fuses or Tripped Circuit Breakers	Faulty Wiring	Loose Terminals	Low Voltage	Single 1PH Failure of 3PH	Unbalanced Power Supply 3PH	Voltage Too High	Open Disconnect Switch	Faulty Wiring	Loose Terminal	Low Voltage	Defective Contacts in Contactor	Compressor Overload	Potential Relay Fails to Open	Potential Relay Fails to Close	Run Capacitor	Start Capacitor	Faulty Wiring	Loose Terminals	Control Transformer	Low Voltage	Thermostat	Contactor Coil	Pressure Control	Condenser Fan Relay	Evaporator Fan Relay
Compressor and condenser fan motor will not start	●	●	●	●	◆	■	■		●	●	●	◆	◆	●					●	●	●	◆	◆	●	●		
Compressor will not start but condenser fan will run				◆	◆	◆	◆			●	●	◆	◆	●		◆	●	●									
Condenser fan motor will not start										●	●															●	
Compressor "hums" but will not start			●	●	◆	◆	◆			●	●	◆	◆	●	●			●									
Compressor cycles on overload			●	●	●	■	●			●	●	●	●	◆	●		●										
Compressor short cycles on low pressure																											
Compressor runs continuously—no cooling																											
Compressor runs continuously —cooling																			●				●				
Compressor noisy																	◆										
Compressor loses oil																											
Head pressure too high																											
Head pressure too low																											
Liquid line frosting or sweating																											
Suction pressure too high																											
Suction pressure too low																											
Evaporator frosting																											
Suction line frosting or sweating																											
Evaporator blower will not start	●	●	●	●	■	■				●	●	■							●	●	●	■	■				●
Condenser fan motor runs contactor not pulled in																											
Liquid refrigerant flooding back to compressor—cap tube system																											
Space temperature too high																							●				

	Motors				High Pressure Side of System														
					Compressor						System Operation								
	Compressor Motor	Condenser Motor	Evaporator Motor	Compressor Off on Internal Overload	Hold Down Bolts	Defective Compressor Bearings	Seized Compressor	Defective Compressor Valves	Compressor Oil Level	Open or Short Motor Windings	Refrigerant Charge Low	Overcharge of Refrigerant	High Head Pressure	High Suction Pressure	Low Suction Pressure	Temperatures	Non-Condensables (Air, etc.)	Excessive Load in Space	Liquid Valve Partially Closed
Compressor and condenser fan motor will not start		■	■								●	■	●		●		●		
Compressor will not start but condenser fan will run	●					●	●			●									
Condenser fan motor will not start		●																	
Compressor "hums" but will not start	◆					●	◆			◆		■	■		■	■			
Compressor cycles on overload	◆							■	■	◆	◆	◆	◆	◆			◆	◆	
Compressor short cycles on low pressure											●				●				
Compressor runs continuously—no cooling								●			●			◆			◆		
Compressor runs continuously —cooling																		●	
Compressor noisy					●	●		●	●										
Compressor loses oil											●				●				
Head pressure too high									■			●				●	●	◆	
Head pressure too low								◆			●				●				
Liquid line frosting or sweating																			●
Suction pressure too high								●				◆	●			◆		●	
Suction pressure too low											●					◆			
Evaporator frosting			◆								◆				●	◆			
Suction line frosting or sweating												●							
Evaporator blower will not start			●																
Condenser fan motor runs contactor not pulled in				●															
Liquid refrigerant flooding back to compressor—cap tube system												●				■			
Space temperature too high								◆			●				●				

	High Pressure Side of System					Low Side						General					
	Condenser Air					Evaporator Air											
	Condenser Fins Dirty or Plugged	Condenser Fan Belt Slipping	Condenser Air Short Circuiting	Low Condenser Air Volume	Condenser Air Temperature Low	Plugged or Restricted Metering Device	Evaporator Fins Dirty or Plugged	Evaporator Belt Slipping	Low Evaporator Air Volume	Dirty Filters	Ductwork Small or Restricted	Restrictions	Thermostat Setting	Thermostat Location	Stratified Air in Space	Incorrect Refrigerant Piping	System Too Small
Compressor and condenser fan motor will not start	■	■	■	■									■				
Compressor will not start but condenser fan will run																	
Condenser fan motor will not start																	
Compressor "hums" but will not start																	
Compressor cycles on overload	■	■	■	■	■							■					
Compressor short cycles on low pressure						●	●	●	●	●	●	●			■		
Compressor runs continuously—no cooling	■	■	■	■	■	◆	●	●	●	●	●	◆	■	◆	◆		
Compressor runs continuously —cooling														●			◆
Compressor noisy																◆	
Compressor loses oil							■	■	■	■	■	◆				●	
Head pressure too high	●	●	◆	●		◆						■					
Head pressure too low					●												
Liquid line frosting or sweating						◆						●					
Suction pressure too high																	
Suction pressure too low						◆	◆	●	●	●	●	◆			◆	■	
Evaporator frosting						◆	◆	●	●	●	●	◆			◆	■	
Suction line frosting or sweating						◆●	●	●	◆●	■							
Evaporator blower will not start																	
Condenser fan motor runs contactor not pulled in																	
Liquid refrigerant flooding back to compressor—cap tube system							◆	◆	◆	◆	◆				■		
Space temperature too high						◆	●	●	●	●	●		●	◆	◆	■	●

TROUBLESHOOTING CHART FOR AIR TO AIR HEAT PUMPS

● Denotes common cause.

◆ Denotes occasional cause.

		Power Supply																			
		Line Voltage												Control Circuit							
		Power Failure	Blown Fuse or Tripped Breaker	Faulty Wiring	Loose Terminals	Low Voltage	Single 1PH Failure of 3PH	Unbalanced 3PH	Defective Contacts in Contactor	Compressor Overload	Potential Relay	Run Capacitor	Start Capacitor	Faulty Wiring	Loose Terminals	Control Transformer	Low Voltage	Thermostat	Contactor Coil	Pressure Control or Impedance Relay	Indoor Fan Relay
Heating or Cooling Cycles	Compressor and O.D. fan motor do not operate	●	●	●	●		◆	◆	◆	◆				●	●	●	◆	◆	●	●	
	Compressor will not run O.D. fan motor runs			●	●	●	◆	◆		●	●	●	●								
	Compressor "hums" but will not start			●	●	●	●	◆	◆		●	●	●								
	Compressor cycles on overload			●	●	●	◆	◆	◆	●	●	●	●								
	Compressor off on high pressure control																			◆	●
	Compressor noisy																				
	Head pressure too high																				
	Head pressure too low																				
	Suction pressure too high																				
	Suction pressure too low																				
	I.D. blower will not start	●	●	●	●									●	●	●	◆	◆			●
	I.D. coil frosting or icing-																				
	High compressor amps					●															
Cooling Cycle	Compressor runs continuously—no cooling																				
	Liquid refrigerant flooding back to compressor																				
Heating Cycle	Compressor runs continuously—no heating																				
	Defrost cycle initiates no ice on coil																				
	Reversing valve does not shift			●	●																
	Ice build up on lower part of O.D. coil																				
	Liquid refrigerant flooding back to compressor																				
	Auxiliary heat on I.D. blower off			●	●									●	●			◆			●
	Excessive operating costs			◆	◆													◆			
	Excessive ice on O.D. coil			◆	◆																

		Outdoor Section																			
		Compressor					Refrigerant System								Defrost Control			Rev. Valve		Check Valve	
		Discharge Line Hitting Inside of Shell	Bearings Defective	Seized	Valve Defective	Motor Windings Defective	Refrigerant Charge Low	Refrigerant Overcharge	High Head Pressure	Low Head Pressure	High Suction Pressure	Low Suction Pressure	Non-Condensables	Unequalized Pressures	Sensing Bulb Loose-Poorly Located	Cycle Too Long (Clock timer)	Defective Control, Timer or Relay	Leaking	Defective Valve or Coil	Sticking Closed	Leaking or Defective
Heating or Cooling Cycles	Compressor and O.D. fan motor do not operate																				
	Compressor will not run O.D. fan motor runs		◆	●		●								●							
	Compressor "hums" but will not start		●	●		●								●							
	Compressor cycles on overload		◆		◆	◆	●	●	◆		◆		●					◆			
	Compressor off on high pressure control							●					●		◆	●	●			●	
	Compressor noisy	◆	◆		●																
	Head pressure too high							●					●		◆	◆			◆	◆	
	Head pressure too low				●		●					●						●			◆
	Suction pressure too high				●			●	●									●			◆
	Suction pressure too low						●			◆										◆	
	I.D. blower will not start																				
	I.D. coil frosting or icing-						●					●								◆	
	High compressor amps		●	●				●	●		●		●							◆	
Cooling Cycle	Compressor runs continuously—no cooling				●		●														
	Liquid refrigerant flooding back to compressor							●	●												
Heating Cycle	Compressor runs continuously—no heating				●		●									◆	◆	●			
	Defrost cycle initiates no ice on coil						◆										●				
	Reversing valve does not shift						◆			◆									●		
	Ice build up on lower part of O.D. coil						●					◆			●	●	●				
	Liquid refrigerant flooding back to compressor							●	●												
	Auxiliary heat on I.D. blower off																				
	Excessive operating costs						●	●									●	●	●		
	Excessive ice on O.D. coil						●								●	●	●		●		

		Outdoor Section						Indoor Section								Aux. Heat
		Outdoor Fan Motor and Coil						Indoor Blower Motor and Coil						Check		
		Plugged or Restricted Meter Device (Htg)	Fins Dirty or Plugged	Motor Winding Defective	Recirculation of Air	Air Volume Low (Cooling)	Low Temperature Coil Air (Cooling)	Plugged or Restricted Metering Device (Clg)	Fins Dirty or Plugged	Motor Winding Defective	Air Volume Low	Air Filters Dirty	Undersized or Restricted Ductwork	Sticking Closed	Leaking or Defective	Auxiliary Heat Upstream of Coil
Heating or Cooling Cycles	Compressor and O.D. fan motor do not operate															
	Compressor will not run O.D. fan motor runs															
	Compressor "hums" but will not start															
	Compressor cycles on overload		◆	◆	◆	◆			◆	◆	◆	●	◆			
	Compressor off on high pressure control	◆	●	●	●	●		◆	●	●	●	●	●	●		●
	Compressor noisy															
	Head pressure too high	◆	●	●	◆	●		◆	◆	◆	●	●	◆	◆		●
	Head pressure too low						●								◆	
	Suction pressure too high														◆	
	Suction pressure too low	◆	●	●	◆		◆	◆	●	◆	●	●	◆	◆		
	I.D. blower will not start															
	I.D. coil frosting or icing-							◆	●	●	●	●	◆			
	High compressor amps								●	●	●	●	◆	◆		
Cooling Cycle	Compressor runs continuously—no cooling		◆	◆	◆	◆	◆		●	●	●	●	◆			
	Liquid refrigerant flooding back to compressor								●	●	●	●	◆	◆		
Heating Cycle	Compressor runs continuously—no heating															
	Defrost cycle initiates no ice on coil															
	Reversing valve does not shift															
	Ice build up on lower part of O.D. coil															
	Liquid refrigerant flooding back to compressor															
	Auxiliary heat on I.D. blower off									●						
	Excessive operating costs		◆	◆	◆				◆	◆	◆					
	Excessive ice on O.D. coil															