HTPG

INSTALLATION & OPERATION MANUAL

A2L EQUIPMENT

INSTALLATION & OPERATION MANUAL

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OVERVIEW

General

HTPG's A2L-rated equipment follows similar installation procedures to standard systems, with key differences. This Installation & Operation Manual outlines the unique requirements for A2L refrigerants. For general installation practices, refer to HTPG's System IOM (HT-SYS-IOM).

Refrigerant Detection System

HTPG indoor equipment—including unit coolers and Water-Cooled Condensing Units—is furnished with an integral refrigerant detection system. Outdoor units do not require this feature.

The detection circuit includes a dry contact that can be used to:

- Trigger alarms
- Signal a building management system
- Activate a ventilation circuit

- These components must be furnished by the installer.

Leak Detector Locations

- Unit Coolers - Leak detectors located near drain pan on header end; longer units also on electrical end
- Water-Cooled Condensing Unit - Leak detectors located near the base of the unit

Leak Detector Power & System Response

- Powered by onboard 24V transformer
- One or more sealed relays are controlled by the leak detector.
- Response varies by system type:
  - Non-EcoNet units: purely electromechanical
  - EcoNet units: isolation valve is electromechanical; other features are controller-driven

Unique HTPG Features

- HTPG air and electric systems include several distinctive design elements:
- A single valve provides both liquid control and safety shutoff.
- The suction line uses a check valve instead of a solenoid.
- During a leak event, the compressor pumps down, reducing refrigerant release into the box.

Leak Response: Single Unit System

When a leak is detected:

- The liquid line solenoid valve closes
- The compressor pumps down until the system shuts off on low pressure
- Fans activate immediately, running at high or low speed depending on thermostat status
- If in defrost or drip mode, the system exits that mode and begins pump down
- Once refrigerant concentration drops below the alarm threshold and at least one hour has passed, the system automatically restarts

Leak Response: Multi-Unit System

When multiple unit coolers are connected to one condensing unit:

- Systems may be piped for individual isolation or group isolation
- Individual piping: each unit cooler has its own set of isolation valves
- Group piping: all unit coolers share one set of valves

⚠ SAFETY WARNING

To reduce the risk of fire, electric shock, or equipment damage, **do not use mechanical tools, heating devices**, or any unapproved methods to accelerate defrosting. Only use defrosting procedures and equipment explicitly recommended by the manufacturer.

- **Do not** use unapproved tools or methods to accelerate defrosting or cleaning. Only follow procedures recommended by the manufacturer.
- Store the appliance in a well-ventilated area, away from continuously operating ignition sources such as open flames, gas appliances, or electric heaters.
- **Do not** pierce or incinerate refrigerant-containing components.
- Be aware that some refrigerants may be odorless, making leaks difficult to detect without proper sensors.

Factory-installed refrigerant sensors or detectors **must not be disconnected** under any circumstances. Only HTPG-approved replacement parts may be used when replacing a refrigerant sensor.

GENERAL INFORMATION

Equipment shall be installed in accordance with the Safety Standard for Refrigeration Systems, ANSI/ASHRAE 15

- In order to reduce flammability hazards the installation of this appliance must only be carried out by a suitably qualified person.
- Keep clear of obstruction all ventilation openings in the appliance enclosure.
- Do not use electrical appliances inside the food/ice storage compartments unless they are of the type recommended by the manufacturer.
- Do not damage the refrigerating circuit.
- Component parts shall be replaced with like components so as to minimize the risk of possible ignition due to incorrect parts.
- This equipment shall not be installed in public corridors or lobbies.
- Outdoor equipment must be located a minimum of 20' from building opening(s)

FIELD PIPING & LABELING REQUIREMENTS

General Installation Guidelines

- Minimize the length and complexity of pipework wherever possible.
- Do not install pipework for flammable refrigerants in unventilated spaces smaller than A_{min}
- Systems charged on-site with A2L refrigerants that require brazing during installation must not be shipped with a flammable refrigerant charge.
- Quantify the effect of pipe length on refrigerant charge during system design.
- On A2L Water-Cooled Condensing Units, the receiver fusible plug or pressure relief valve, whichever is applicable, must be piped to vent outdoors.

Compliance & Safety Standards

All piping materials, routing, and installation must:

- Be protected from physical damage during operation and service.
- Comply with applicable national and local codes, such as:
  - ANSI/ASHRAE 15
  - IAPMO Uniform Mechanical Code
  - ICC International Mechanical Code
  - CSA B52
- All field joints must be accessible for inspection before being enclosed.
- Piping connections must be accessible for maintenance.
- On A2L Water-Cooled Condensing Units, the receiver fusible plug or pressure relief valve, whichever is applicable, must be piped to vent outdoors.

Thermal & Mechanical Considerations

- Provide allowances for expansion and contraction in long piping runs.
- Protect steel pipes and components from corrosion with rustproof coatings before applying insulation.
- Flexible piping elements must be:
  - Protected from mechanical damage and excessive torsional stress.
  - Inspected annually for signs of wear or damage.
  - Design piping to minimize vibration, pulsation, and hydraulic shock.

Labeling & Identification

- Mark exposed tubing or insulation with: "A2L WARNING—Risk of Fire. Flammable Refrigerant."
- Lettering must be at least ½ inch tall, placed every 20 feet.
- Install a label near or on exposed piping stating: "CAUTION – Risk of Fire or Explosion Due To Puncture of Refrigerant Tubing; Follow Handling Instructions Carefully. Flammable Refrigerant Used."

Leak Testing Requirements

Field-made refrigerant joints located indoors must be leak tested using a method with:

- Sensitivity of 5 grams/year or better.
- Test pressure of at least 0.25 × maximum allowable pressure.
- No leaks detected.

Continued on next page.

FIELD PIPING & LABELING REQUIREMENTS (CONTINUED)

Environmental Protection

Protect piping, fittings, and devices from adverse environmental effects, such as:

- Water accumulation and freezing in relief pipes.
- Dirt and debris buildup.
- Install equipment piping in occupied spaces to prevent accidental damage during operation or service.
- Securely mount an guard indoor equipment and piping to prevent rupture from activities like furniture movement or renovations.

FIELD LEAK TEST

After completing field piping for split systems, the system must undergo both pressure testing and vacuum testing prior to refrigerant charging. Follow these procedures:

1. Pressure Test with Inert Gas

- Use an inert gas (e.g., nitrogen) to pressure test the system.
- Minimum test pressures:
  - Low side: Test to the low side design pressure.
  - High side: Test to the high side design pressure, unless it cannot be isolated from the low side. In that case, test the entire system to the low side design pressure.
- After removing the pressure source:
  - Maintain test pressure for at least 1 hour.
  - No pressure drop should be observed.
  - Use a test gauge with resolution not exceeding 5% of the test pressure.

2. Vacuum Test

- Evacuate the system to 500 microns or lower (as required by applicable codes).
- Once the vacuum is achieved:
- Isolate the system from the vacuum pump.
- Monitor for 10 minutes.
- The pressure must not rise above 1500 microns during this period.

CHARGING

Please refer to HTPG's System IOM (HT-SYS-IOM) for general charging procedures and information. In addition to conventional charging procedures, the following requirements shall be followed:

1. Prevent Cross-Contamination

- Use dedicated charging equipment for each refrigerant type.
- Keep hoses and lines as short as possible to minimize refrigerant loss and contamination.

2. Cylinder Handling

- Position refrigerant cylinders upright or as specified by the manufacturer.
- Secure cylinders to prevent tipping or damage.`

3. System Grounding

- Ensure the refrigeration system is properly grounded before beginning the charging process to prevent static discharge.

4. Charging Process

- Use a refrigerant scale to measure the exact charge amount.
- Charge the system slowly and carefully to avoid overfilling.
- Follow manufacturer specifications for charge quantity and method (liquid or vapor).
- System Labeling
- Label the system with:
  - Refrigerant type
  - Charge amount
  - Date of charging
- Ensure labeling complies with applicable codes (e.g., ANSI/ASHRAE 15, UL 60335-2-40).

5. Post-Charging Leak Test

- Perform a final leak test using an electronic leak detector or soap solution.
- Verify no leaks before leaving the site.

GENERAL REPAIRS

Please refer to HTPG's System IOM (HT-SYS-IOM) for general repair & service guidelines. Service shall be performed only as recommended:

- 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.
- 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 shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially toxic or flammable atmospheres.
- Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e., non-sparking, adequately sealed, or intrinsically safe.
- If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available on hand. A dry chemical or CO2 fire extinguisher should be adjacent to the charging area.
- No person carrying out work in relation to a refrigeration system which involves exposing any pipe work shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion. All possible potential ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment shall be surveyed to make sure that there are no flammable hazards or ignition risks. “No Smoking" signs shall be displayed."
- 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.
- Where electrical components are being changed, they shall be fit for the purpose and of 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:
  a. The actual REFRIGERANT CHARGE is in accordance with the room size within which the refrigerant containing parts are installed.
  b. The ventilation machinery and outlets are operating adequately and are not obstructed.
  c. If an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant.
  d. Marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected.
  e. Refrigerating pipes 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.
- 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:

1. The capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking.
2. That no live electrical components and wiring are exposed while charging, recovering or purging the system.
3. That there is continuity of earth bonding.
4. During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc. If it is absolutely necessary to have an electrical supply to equipment during service, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.
5. Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected.

   This shall include:
   - damage to cables
   - excessive number of connections
   - terminals not made to original specification
   - damage to seals
   - incorrect fitting of strain relief devices, etc.
6. Ensure that the apparatus is mounted securely.
7. Ensure that seals or sealing materials have not degraded to the point that they no longer serve the purpose of preventing the ingress of flammable atmospheres.
8. Replacement parts shall be in accordance with the manufacturer's specifications.
   - Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.
   - Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere.
   - The test apparatus shall be at the correct rating.
   - Replace components only with parts specified by the manufacturer. Other parts can result in the ignition of refrigerant in the atmosphere from a leak.
   - NOTE: The use of silicon sealants can inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.
9. Check that cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges, or any other adverse environmental effects. The check shall also consider the effects of aging or continual vibration from sources such as compressors or fans.

LEAK REPAIRS

Please refer to HTPG's System IOM (HT-SYS-IOM) for general leak identification & repair.

Safety Precautions

- Under no circumstances shall potential sources of ignition be used in the search for or detection of refrigerant leaks.
- A halide torch (or any other detector using a naked flame) shall not be used.
- If a leak is suspected, all naked flames shall be removed/extinguished.

Acceptable Leak Detection Methods

Electronic leak detectors may be used, but for flammable refrigerants:

- Sensitivity might not be adequate, or might 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 the refrigerant used.
- Leak detection equipment shall be set at a percentage of the LFL of the refrigerant and shall be calibrated to the refrigerant employed, and the appropriate percentage of gas (25 % maximum) is confirmed.
- Leak detection fluids are also suitable for use with most refrigerants.
- Avoid detergents containing chlorine, which can react with refrigerants and corrode copper and joints.

  Examples of leak detection fluids are:
  - bubble method
  - fluorescent method agents

Leak Repair Procedure

- If a leak is suspected, all naked flames shall be removed/extinguished.
- If a leakage of refrigerant is found which requires brazing, all refrigerant shall be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the leak.
- 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:

  1. Safely remove refrigerant following local and national regulations
  2. Evacuate (optional for A2L)
  3. Purge with inert gas (optional for A2L)
  4. Open the circuit by cutting or brazing.

Purging & Safety for Flammable Refrigerants

- Recover refrigerant into correct recovery cylinders if venting is not allowed.
- Purge the system with oxygen-free nitrogen to render it safe.
- This may need to be repeated several times.
- Do not use compressed air or oxygen for purging.

Purging process:

1. Break vacuum with oxygen-free nitrogen.
2. Fill until working pressure is achieved.
3. Vent to atmosphere.
4. Pull down to vacuum (optional for A2L).
5. Repeat until no refrigerant remains (optional for A2L).

Final purge:

1. Vent down to atmospheric pressure before work begins.
2. Ensure vacuum pump outlet is not near ignition sources and that ventilation is available.

REFRIGERANT RECOVERY

Refrigerant Recovery & Cylinder Handling

All refrigerants must be removed safely during servicing or decommissioning.

- Use appropriate recovery cylinders
- Ensure enough cylinders are available for the total system charge.
- Cylinders must be:
  - Designated and labeled for the recovered refrigerant.
  - Equipped with pressure-relief valves and shut-off valves in good condition.
  - Evacuated and, if possible, cooled before recovery.
- Recovery equipment must:
  - Be in good working order.
  - Include instructions.
  - Be suitable for flammable refrigerants.
- Weighing scales must be:
  - Calibrated.
  - In good working order
- Hoses must:
  - Have leak-free disconnect couplings.
  - Be in good condition.
- Before using the recovery machine:
  - Verify it is properly maintained.
  - Ensure electrical components are sealed to prevent ignition.
  - Consult the manufacturer if in doubt.
- Recovered refrigerant shall be:
  - Returned to the supplier in the correct recovery cylinder.
  - Accompanied by the relevant waste transfer note.
  - Do not mix refrigerants in recovery units or cylinders

Compressor & Oil Removal

- Compressors or compressor oils must be evacuated to ensure flammable refrigerant does not remain in the lubricant.
- Evacuation must be completed before returning the compressor to the supplier.
- Use electric heating only to accelerate evacuation.
- Oil draining must be performed safely.

DECOMMISSIONING

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its details. 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 recovered refrigerant. It is essential that electrical power is available before the task commences.

a. Become familiar with the equipment and its operation.

b. Isolate the system electrically.

c. Before attempting the procedure, ensure that:

    a) mechanical handling equipment is available, if required, for handling refrigerant cylinders.
    b) All personal protective equipment is available and being used correctly.
    c) The recovery process is always supervised by a competent person.
    d) recovery equipment and cylinders conform to the appropriate standards.

d. Pump down refrigerant system, if possible.

e. If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.

f. Make sure that cylinder is situated on the scales before recovery takes place.

g. Start the recovery machine and operate in accordance with instructions.

h. Do not overfill cylinders (no more than 80 % volume liquid charge).

i. Do not exceed the maximum working pressure of the cylinder, even temporarily.

j. 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.

k. Recovered refrigerant shall not be charged into another REFRIGERATING SYSTEM unless it has been cleaned and checked.

Decommissioned equipment shall be labeled stating that it has been de-commissioned and emptied of refrigerant. The label shall be dated and signed.

LEAK MITIGATION REQUIREMENTS

Installations for field erected systems consisting of various partial units such as condensing units and unit coolers must provide the following mitigation actions. During a leak event in a cooler/freezer box, the unit cooler leak detector must close the safety shut off valve(s). Other actions are dependent on the refrigerant quantity that may be released.

The maximum releasable charge (m_{rel}) is the refrigerant mass which can be lost in a leak event. This quantity is used to determine if air circulation or ventilation is necessary and it also dictates the smallest room (A_{min}) in which the equipment may be installed. Unit cooler values for m_{rel} and A_{min} are listed in the Maximum Releasable Charge & Minimum Room Area tables. Alternatively, they may be calculated using the Maximum Releasable Charge Calculation section and A_{min} calculations shown below or you can get assistance from an HTPG associate. Water-Cooled Condensing Units use the complete system charge (m_c) rather than m_{rel}. This is the system charge applied during installation.

The value m_{rel} is compared to m_1, m_2, and m_3 (see table below) to determine the circulation and ventilation requirements.

Values for m_1, m_2, m_3

MASS	R454A		R454C		R455A	
	KG	LB	KG	LB	KG	LB
m1	3.614	7.97	3.783	8.34	4.121	9.09
m2	14.456	31.87	15.132	33.36	16.484	36.34
m3	72.280	159.35	75.660	166.80	82.420	181.70

If $m_{rel} < m_1$ there is no need to circulate air or ventilate the cooler/freezer box.
If $m_1 \leq m_{rel} \leq m_2$ the fans must be activated to provide constant air circulation within the cooler/freezer box. Also, there is no need for box ventilation.

If $m_2 \leq m_{rel} \leq m_3$ the fans must be activated to provide constant air circulation within the cooler/freezer box and box ventilation must be activated.
Unit cooler installations having $m_{rel} > m_3$ are not allowed. Condensing unit Installations that have $m_{rel} > m_3$ which are intended to be installed in a mechanical room or oudoors shall comply with the requirements of ASHRAE 15.

HTPG A2L unit coolers are equipped with a refrigerant detection system which will cause the fans to run immediately (continuous circulation) and to immediately close any isolation valves. They are also provided with a dry alarm contact which may be used to trigger an alarm, signal a building control system, or trigger a ventilation system. Any necessary ventilation equipment and ventilation controls are not furnished by HTPG.

The calculations for A_{min} and M_{max} are shown below. The A_{min} value is always used to ensure the room size is appropriate for the equipment. However, M_{max} is only used to determine the ventilation CFM requirement for installations requiring ventilation.

For installations **without** circulation or ventilation: *(This calculatation also applies to Water-Cooled Condensing Units when m_{rel} is substituted by mc.)*

$$A_{min} = \frac{m_{rel}}{(0.25 \times LFL \times H)}$$

For installations **with** circulation or ventilation: *(All HTPG unit coolers provide circulation.)*

$$m_{max} = 0.5 \times LFL \times H \times A$$

$$A_{min} = \frac{m_{rel}}{(0.5 \times LFL \times H)}$$

Where:

LFL, kg/m³ or lb/ft³ (Lower flammability limit. See table.)
H, m or ft (Height inside cooled space. For rooms taller than 2.2 m (7.22 ft) use 2.2m (7.22 ft).)
A, m² or ft² (Floor area of cooled space. For rooms greater than 250 m² (2691 ft²) use 250 m² (2691 ft²).)

m_{rel} , kg or lb
A_{min} , m² or ft²

If ventilation is required, it must be furnished by the installer and must comply with the following guidelines or those published in ASHRAE 15, the safety standard for refrigeration systems.

The required mechanical ventilation airflow is calculated as follows:

$$Q_{vent\ min} = \frac{30\ (m_{rel} - m_{max})}{LFL}$$; not to exceed -486 / LFL (SI Units) or -1071 / LFL (IP Units)

Where:

$Q_{vent\ min}$, m³/hr or lb/ft³
m_{rel} & m_{max}, kg or lb
LFL, kg/m³ or lb (See table.)

Lower Flammability Limits

REFRIGERANT	LFL	
	kg/m³	lb/ft³
R455A	0.278	0.01735
R454C	0.291	0.01817
R454A	0.317	0.01979

The room's ventilation exhaust opening shall be situated near the floor with bottom of the opening no higher than 100 mm (3.94 in) above the floor.

The ventilation exhaust shall be directed either outdoors or into a space of sufficient volume to ensure safe concentrations of the diluted refrigerant.

Installations requiring mechanical ventilation must provide circulation airflow to mix air in the room.

Si units

$Q_{circ\ min} = 135 \times CAP$
$V_{circ\ min} = 2$

Where:

$Q_{circ\ min}$, m^3/hr
$V_{circ\ min}$, m/s
CAP, kw (unit cooler cooling capacity)

Ip units

$Q_{circ\ min} = 1.397 \times CAP$
$V_{circ\ min} = 6.56$

Where:

$Q_{circ\ min}$, ft^3/hr
$V_{circ\ min}$, ft/s
$CAP, btu/h$ (unit cooler cooling capacity)

For determination of the air velocity ($v_{circ\ min}$) divide the airflow ($Q_{circ\ min}$) by the area of the outlet opening. The area of the grill shall not be deducted for this calculation.

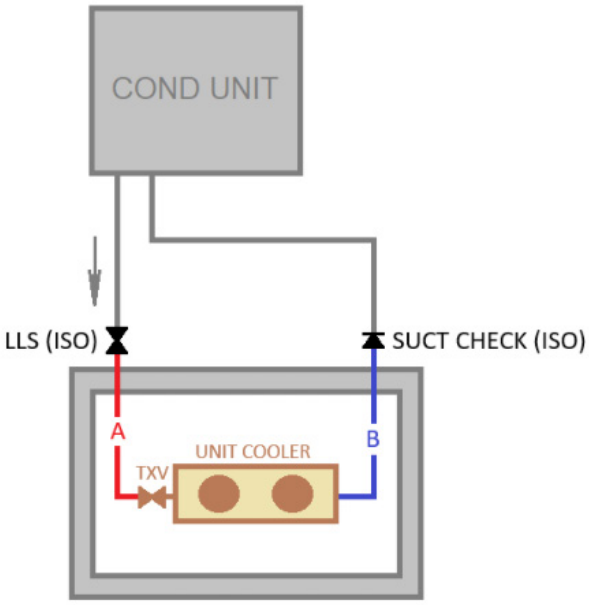
$V_{circ} = Q_{circ} / A_{vent}$

Ventilation must be controlled so that it will continue at least 5 minutes after the refrigerant leak detection system resets. HTPG does not include a timer relay in our equipment to support this function.

MAXIMUM RELEASABLE CHARGE & MINIMUM ROOM AREA TABLES

The unit cooler values for m_{rel} and A_{min} are shared in the following tables. These values are for cooled spaces having a height of 7.2 ft or taller. The values given are for unit coolers using isolated line lengths shown in the column headers. These line lengths represent the distance between the unit cooler inlet and the liquid solenoid valve. The suction line between the unit cooler outlet and check valve is assumed to be of the same length. Line sizes matched the unit cooler connections.

If your room height is less than 7.2 ft or if connection sizes don't match the unit cooler connections contact an HTPG representative for assistance determining m_{rel} and *A*min or use the formulas provided in the above section and in the Maximum Releasable Charge Calculation section.



LOW PROFILE UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

	Generic Model	R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AL6A050	1.1	1.4	1.8	2.1	1.1	1.4	1.8	2.2	1.1	1.4	1.8	2.2
	*AL6A062	1.2	1.6	1.9	2.3	1.2	1.6	1.9	2.3	1.2	1.6	1.9	2.3
	*AL6A081	1.3	1.7	2.1	2.4	1.4	1.7	2.1	2.4	1.3	1.7	2.1	2.4
	*AL6A088	1.3	1.7	2.0	2.4	1.3	1.7	2.1	2.4	1.3	1.7	2.0	2.4
	*AL6A113	1.6	1.9	2.3	2.7	1.6	2.0	2.3	2.7	1.6	2.0	2.3	2.7
	*AL6A141	1.7	2.1	2.4	2.8	1.7	2.1	2.5	2.9	1.7	2.1	2.5	2.8
	*AL6A159	1.8	2.2	2.6	2.9	1.8	2.2	2.6	3.0	1.8	2.2	2.6	3.0
	*AL6A170	1.8	2.2	2.6	2.9	1.8	2.2	2.6	3.0	1.8	2.2	2.6	2.9
	*AL6A196	2.2	2.9	3.6	4.3	2.3	3.0	3.7	4.4	2.3	3.0	3.7	4.4
	*AL6A220	2.6	3.3	4.0	4.7	2.7	3.4	4.1	4.8	2.6	3.3	4.0	4.7
	*AL6A234	2.5	3.2	3.8	4.5	2.5	3.2	3.9	4.6	2.5	3.2	3.9	4.6
	*AL6A289	2.6	3.4	4.1	4.8	2.7	3.4	4.1	4.9	2.7	3.4	4.1	4.8
	*AL6A316	3.1	3.8	4.6	5.3	3.1	3.9	4.6	5.3	3.1	3.9	4.6	5.3
	*AL6A375	3.6	4.3	5.0	5.8	3.6	4.4	5.1	5.8	3.6	4.3	5.1	5.8
	*AL6A404	3.7	4.4	5.1	5.9	3.7	4.5	5.2	5.9	3.7	4.5	5.2	5.9
	*AL6A477	4.1	4.8	5.5	6.2	4.1	4.8	5.6	6.3	4.1	4.8	5.5	6.3
ELECTRIC DEFROST													
6 FPI	*AL6E042	1.0	1.4	1.7	2.1	1.1	1.4	1.8	2.1	1.1	1.4	1.8	2.1
	*AL6E051	1.2	1.5	1.9	2.3	1.2	1.6	1.9	2.3	1.2	1.6	1.9	2.3
	*AL6E058	1.3	1.7	2.0	2.4	1.3	1.7	2.1	2.4	1.3	1.7	2.0	2.4
	*AL6E079	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4
	*AL6E092	1.5	1.9	2.2	2.6	1.6	1.9	2.3	2.6	1.5	1.9	2.3	2.6
	*AL6E110	1.6	2.0	2.4	2.7	1.7	2.0	2.4	2.8	1.6	2.0	2.4	2.8
	*AL6E129	1.8	2.2	2.5	2.9	1.8	2.2	2.6	2.9	1.8	2.2	2.5	2.9
	*AL6E148	1.9	2.3	2.7	3.0	1.9	2.3	2.7	3.1	1.9	2.3	2.7	3.0
	*AL6E173	2.6	3.3	3.9	4.6	2.6	3.3	4.0	4.7	2.6	3.3	4.0	4.7
	*AL6E194	2.6	3.2	3.9	4.6	2.6	3.3	4.0	4.7	2.6	3.3	4.0	4.7
	*AL6E218	3.0	3.7	4.4	5.1	3.1	3.8	4.5	5.2	3.0	3.8	4.5	5.2
	*AL6E237	2.9	3.6	4.3	5.0	2.9	3.7	4.4	5.1	2.9	3.6	4.3	5.1
	*AL6E290	3.2	3.9	4.6	5.3	3.3	4.0	4.7	5.4	3.3	4.0	4.7	5.4
	*AL6E343	3.9	4.6	5.3	6.0	4.0	4.7	5.4	6.1	3.9	4.6	5.4	6.1
4 FPI	*AL4E032	1.0	1.4	1.7	2.1	1.1	1.4	1.8	2.1	1.1	1.4	1.8	2.1
	*AL4E040	1.2	1.5	1.9	2.2	1.2	1.5	1.9	2.2	1.2	1.5	1.9	2.2
	*AL4E046	1.3	1.7	2.0	2.4	1.3	1.7	2.1	2.4	1.3	1.7	2.0	2.4
	*AL4E061	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4
	*AL4E076	1.5	1.9	2.2	2.6	1.6	1.9	2.3	2.6	1.5	1.9	2.3	2.6
	*AL4E099	1.8	2.1	2.5	2.8	1.8	2.2	2.5	2.9	1.8	2.2	2.5	2.9
	*AL4E114	1.9	2.3	2.7	3.0	1.9	2.3	2.7	3.1	1.9	2.3	2.7	3.0
	*AL4E133	2.3	2.6	3.0	3.4	2.3	2.7	3.0	3.4	2.3	2.6	3.0	3.4
	*AL4E150	2.2	2.6	3.0	3.3	2.3	2.6	3.0	3.4	2.3	2.6	3.0	3.4
	*AL4E170	2.7	3.1	3.4	3.8	2.7	3.1	3.5	3.9	2.7	3.1	3.5	3.8
	*AL4E184	2.9	3.6	4.3	4.9	2.9	3.6	4.3	5.0	2.9	3.6	4.3	5.0
	*AL4E232	3.2	3.9	4.6	5.3	3.3	4.0	4.7	5.4	3.3	4.0	4.7	5.4
	*AL4E281	3.9	4.6	5.3	6.0	4.0	4.7	5.4	6.1	3.9	4.6	5.4	6.1

LOW PROFILE UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

	Generic Model	R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AL6A050	17	23	28	34	16	22	28	33	15	20	25	30
	*AL6A062	19	25	31	36	18	24	30	35	17	22	27	32
	*AL6A081	21	27	33	38	21	26	32	37	19	24	29	34
	*AL6A088	21	27	32	38	20	26	31	37	18	23	29	34
	*AL6A113	25	31	37	43	24	30	36	42	22	27	33	38
	*AL6A141	27	33	39	45	26	32	38	44	24	29	34	40
	*AL6A159	29	35	41	47	28	34	40	45	26	31	36	41
	*AL6A170	29	35	41	47	28	34	39	45	25	31	36	41
	*AL6A196	36	47	58	69	35	45	56	67	32	41	51	61
	*AL6A220	42	53	64	75	40	51	62	73	37	47	57	66
	*AL6A234	39	50	61	72	38	49	59	70	35	44	54	64
	*AL6A289	42	54	65	77	41	52	63	74	37	47	58	68
	*AL6A316	50	61	73	84	48	59	70	81	44	54	64	74
	*AL6A375	57	69	81	92	56	67	78	89	51	61	71	81
	*AL6A404	59	71	82	94	57	68	79	91	52	62	73	83
	*AL6A477	65	76	88	99	63	74	85	96	57	67	77	88
ELECTRIC DEFROST													
6 FPI	*AL6E042	1.0	1.4	1.7	2.1	1.1	1.4	1.8	2.1	1.1	1.4	1.8	2.1
	*AL6E051	1.2	1.5	1.9	2.3	1.2	1.6	1.9	2.3	1.2	1.6	1.9	2.3
	*AL6E058	1.3	1.7	2.0	2.4	1.3	1.7	2.1	2.4	1.3	1.7	2.0	2.4
	*AL6E079	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4
	*AL6E092	1.5	1.9	2.2	2.6	1.6	1.9	2.3	2.6	1.5	1.9	2.3	2.6
	*AL6E110	1.6	2.0	2.4	2.7	1.7	2.0	2.4	2.8	1.6	2.0	2.4	2.8
	*AL6E129	1.8	2.2	2.5	2.9	1.8	2.2	2.6	2.9	1.8	2.2	2.5	2.9
	*AL6E148	1.9	2.3	2.7	3.0	1.9	2.3	2.7	3.1	1.9	2.3	2.7	3.0
	*AL6E173	2.6	3.3	3.9	4.6	2.6	3.3	4.0	4.7	2.6	3.3	4.0	4.7
	*AL6E194	2.6	3.2	3.9	4.6	2.6	3.3	4.0	4.7	2.6	3.3	4.0	4.7
	*AL6E218	3.0	3.7	4.4	5.1	3.1	3.8	4.5	5.2	3.0	3.8	4.5	5.2
	*AL6E237	2.9	3.6	4.3	5.0	2.9	3.7	4.4	5.1	2.9	3.6	4.3	5.1
	*AL6E290	3.2	3.9	4.6	5.3	3.3	4.0	4.7	5.4	3.3	4.0	4.7	5.4
	*AL6E343	3.9	4.6	5.3	6.0	4.0	4.7	5.4	6.1	3.9	4.6	5.4	6.1
4 FPI	*AL4E032	1.0	1.4	1.7	2.1	1.1	1.4	1.8	2.1	1.1	1.4	1.8	2.1
	*AL4E040	1.2	1.5	1.9	2.2	1.2	1.5	1.9	2.2	1.2	1.5	1.9	2.2
	*AL4E046	1.3	1.7	2.0	2.4	1.3	1.7	2.1	2.4	1.3	1.7	2.0	2.4
	*AL4E061	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4
	*AL4E076	1.5	1.9	2.2	2.6	1.6	1.9	2.3	2.6	1.5	1.9	2.3	2.6
	*AL4E099	1.8	2.1	2.5	2.8	1.8	2.2	2.5	2.9	1.8	2.2	2.5	2.9
	*AL4E114	1.9	2.3	2.7	3.0	1.9	2.3	2.7	3.1	1.9	2.3	2.7	3.0
	*AL4E133	2.3	2.6	3.0	3.4	2.3	2.7	3.0	3.4	2.3	2.6	3.0	3.4
	*AL4E150	2.2	2.6	3.0	3.3	2.3	2.6	3.0	3.4	2.3	2.6	3.0	3.4
	*AL4E170	2.7	3.1	3.4	3.8	2.7	3.1	3.5	3.9	2.7	3.1	3.5	3.8
	*AL4E184	2.9	3.6	4.3	4.9	2.9	3.6	4.3	5.0	2.9	3.6	4.3	5.0
	*AL4E232	3.2	3.9	4.6	5.3	3.3	4.0	4.7	5.4	3.3	4.0	4.7	5.4
	*AL4E281	3.9	4.6	5.3	6.0	4.0	4.7	5.4	6.1	3.9	4.6	5.4	6.1

CENTER MOUNT UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AE6A051	1.3	1.6	2.0	2.3	1.3	1.6	2.0	2.4	1.3	1.6	2.0	2.3
	*AE6A085	1.4	1.8	2.1	2.5	1.4	1.8	2.2	2.5	1.4	1.8	2.2	2.5
	*AE6A103	1.6	2.0	2.4	2.8	1.7	2.0	2.4	2.8	1.6	2.0	2.4	2.8
	*AE6A128	1.7	2.1	2.5	2.9	1.8	2.1	2.5	2.9	1.7	2.1	2.5	2.9
	*AE6A157	2.1	2.4	2.8	3.2	2.1	2.5	2.9	3.2	2.1	2.5	2.8	3.2
	*AE6A173	2.1	2.4	2.8	3.2	2.1	2.5	2.8	3.2	2.1	2.5	2.8	3.2
	*AE6A207	2.4	2.8	3.2	3.6	2.5	2.8	3.2	3.6	2.4	2.8	3.2	3.6
	*AE6A249	3.2	3.9	4.7	5.4	3.2	4.0	4.7	5.4	3.2	4.0	4.7	5.4
	*AE6A316	4.2	4.9	5.6	6.3	4.2	5.0	5.7	6.4	4.2	4.9	5.7	6.4
ELECTRIC DEFROST													
6 FPI	*AE6E045	1.1	1.5	1.8	2.2	1.1	1.5	1.9	2.2	1.1	1.5	1.9	2.2
	*AE6E054	1.2	1.6	1.9	2.3	1.2	1.6	2.0	2.3	1.2	1.6	2.0	2.3
	*AE6E090	1.5	1.8	2.2	2.5	1.5	1.8	2.2	2.6	1.5	1.8	2.2	2.5
	*AE6E107	1.6	2.0	2.4	2.8	1.7	2.0	2.4	2.8	1.7	2.0	2.4	2.8
	*AE6E129	1.7	2.1	2.5	2.8	1.8	2.1	2.5	2.9	1.7	2.1	2.5	2.9
	*AE6E149	2.0	2.4	2.7	3.1	2.0	2.4	2.8	3.1	2.0	2.4	2.8	3.1
	*AE6E160	2.0	2.4	2.7	3.1	2.0	2.4	2.8	3.1	2.0	2.4	2.7	3.1
	*AE6E217	2.7	3.4	4.1	4.8	2.7	3.5	4.2	4.9	2.7	3.4	4.1	4.8
	*AE6E265	3.1	3.8	4.5	5.2	3.2	3.9	4.6	5.3	3.1	3.8	4.6	5.3
	*AE6E337	4.0	4.7	5.4	6.1	4.1	4.8	5.5	6.2	4.1	4.8	5.5	6.2
4 FPI	*AE4E043	1.2	1.6	1.9	2.3	1.2	1.6	2.0	2.3	1.2	1.6	2.0	2.3
	*AE4E087	1.6	1.9	2.3	2.7	1.6	2.0	2.3	2.7	1.6	2.0	2.3	2.7
	*AE4E127	2.0	2.4	2.7	3.1	2.0	2.4	2.8	3.1	2.0	2.4	2.8	3.1
	*AE4E183	2.4	2.7	3.1	3.5	2.4	2.8	3.1	3.5	2.4	2.7	3.1	3.5
	*AE4E222	3.1	3.8	4.5	5.2	3.2	3.9	4.6	5.3	3.1	3.8	4.6	5.3
	*AE4E283	4.0	4.7	5.4	6.1	4.1	4.8	5.5	6.2	4.1	4.8	5.5	6.2

CENTER MOUNT UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AE6A051	20	26	31	37	19	25	30	36	18	23	28	33
	*AE6A085	23	29	34	40	22	28	33	39	20	25	30	35
	*AE6A103	26	32	38	44	25	31	37	43	23	28	34	39
	*AE6A128	28	34	40	46	27	33	38	44	24	30	35	40
	*AE6A157	33	39	45	51	32	38	43	49	29	34	40	45
	*AE6A173	33	39	45	51	32	38	43	49	29	34	40	45
	*AE6A207	39	45	51	57	38	43	49	55	34	40	45	50
	*AE6A249	51	63	74	86	50	61	72	83	45	55	66	76
	*AE6A316	67	78	90	101	64	76	87	98	59	69	79	89
ELECTRIC DEFROST													
6 FPI	*AE6E045	18	24	29	35	17	23	29	34	16	21	26	31
	*AE6E054	20	25	31	37	19	24	30	36	17	22	27	32
	*AE6E090	23	29	35	40	22	28	33	39	20	26	31	36
	*AE6E107	26	32	38	44	25	31	37	43	23	28	34	39
	*AE6E129	28	33	39	45	27	32	38	44	24	30	35	40
	*AE6E149	32	38	44	50	31	37	42	48	28	33	39	44
	*AE6E160	32	38	44	49	31	36	42	48	28	33	38	44
	*AE6E217	43	54	66	77	42	53	64	74	38	48	58	68
	*AE6E265	50	61	72	83	48	59	70	81	44	54	64	74
	*AE6E337	64	76	87	98	62	73	84	95	57	67	77	87
4 FPI	*AE4E043	20	25	31	37	19	24	30	36	17	22	27	32
	*AE4E087	25	31	37	42	25	30	36	41	22	27	33	38
	*AE4E127	32	38	44	50	31	37	42	48	28	33	39	44
	*AE4E183	38	44	49	55	36	42	48	54	33	38	44	49
	*AE4E222	50	61	72	83	48	59	70	81	44	54	64	74
	*AE4E283	64	76	87	98	62	73	84	95	57	67	77	87

LOW VELOCITY CENTER MOUNT UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AV6A053	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4	1.3	1.7	2.0	2.4
	*AV6A066	1.2	1.5	1.9	2.2	1.2	1.5	1.9	2.3	1.2	1.5	1.9	2.2
	*AV6A105	1.7	2.1	2.5	2.9	1.8	2.1	2.5	2.9	1.7	2.1	2.5	2.9
	*AV6A 13	2.0	2.4	2.8	3.2	2.1	2.4	2.8	3.2	2.1	2.4	2.8	3.2
	*AV6A159	2.2	2.6	3.0	3.4	2.3	2.6	3.0	3.4	2.2	2.6	3.0	3.4
	*AV6A196	2.7	3.0	3.4	3.8	2.7	3.1	3.4	3.8	2.7	3.0	3.4	3.8
	*AV6A216	2.6	3.0	3.4	3.8	2.7	3.1	3.4	3.8	2.7	3.0	3.4	3.8
	*AV6A270	3.6	4.3	5.0	5.7	3.6	4.3	5.1	5.8	3.6	4.3	5.0	5.8
	*AV6A338	4.2	4.9	5.6	6.4	4.3	5.0	5.7	6.5	4.2	5.0	5.7	6.4
ELECTRIC DEFROST													
6 FPI	*AV6E053	1.3	1.6	2.0	2.3	1.3	1.6	2.0	2.3	1.3	1.6	2.0	2.3
	*AV6E066	1.4	1.8	2.1	2.4	1.4	1.8	2.1	2.5	1.4	1.8	2.1	2.5
	*AV6E105	1.7	2.0	2.4	2.7	1.7	2.1	2.4	2.8	1.7	2.0	2.4	2.8
	*AV6E131	2.0	2.3	2.7	3.0	2.0	2.4	2.7	3.1	2.0	2.3	2.7	3.1
	*AV6E159	2.1	2.5	2.9	3.2	2.2	2.5	2.9	3.3	2.2	2.5	2.9	3.2
	*AV6E196	2.5	2.9	3.3	3.6	2.6	2.9	3.3	3.7	2.6	2.9	3.3	3.6
	*AV6E216	2.5	2.9	3.2	3.6	2.6	2.9	3.3	3.7	2.6	2.9	3.3	3.6
	*AV6E270	3.4	4.1	4.8	5.5	3.5	4.2	4.9	5.6	3.4	4.1	4.8	5.5
	*AV6E338	4.0	4.7	5.4	6.1	4.1	4.8	5.5	6.2	4.1	4.7	5.4	6.1

LOW VELOCITY CENTER MOUNT UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AV6A053	21	27	32	38	20	26	31	37	18	23	28	33
	*AV6A066	18	24	30	35	18	23	29	34	16	21	26	31
	*AV6A105	28	34	40	46	27	33	38	44	24	30	35	40
	*AV6A 13	33	39	45	51	31	37	43	49	29	34	39	45
	*AV6A159	36	42	48	54	34	40	46	52	31	37	42	47
	*AV6A196	42	48	54	60	41	47	53	58	37	43	48	53
	*AV6A216	42	48	54	60	41	47	52	58	37	43	48	53
	*AV6A270	57	68	80	91	55	66	77	88	50	60	70	81
	*AV6A338	67	79	90	102	65	76	87	98	59	69	80	90
ELECTRIC DEFROST													
6 FPI	*AV6E053	20	26	31	37	20	25	30	36	18	23	28	33
	*AV6E066	23	28	34	39	22	27	33	38	20	25	30	35
	*AV6E105	27	32	38	44	26	31	37	42	24	29	34	39
	*AV6E131	31	37	43	48	30	36	41	47	28	33	38	43
	*AV6E159	34	40	46	51	33	39	44	50	30	35	40	45
	*AV6E196	41	46	52	58	39	45	50	56	36	41	46	51
	*AV6E216	40	46	52	57	39	45	50	56	36	41	46	51
	*AV6E270	54	65	76	87	53	63	74	85	48	58	68	77
	*AV6E338	64	75	86	97	62	73	84	94	57	66	76	86

MEDIUM PROFILE UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AM6A219	2.7	3.4	4.1	4.8	2.7	3.4	4.1	4.9	2.7	3.4	4.1	4.9
	*AM6A268	2.9	3.6	4.4	5.1	2.9	3.7	4.4	5.1	2.9	3.7	4.4	5.1
	*AM6A336	2.9	3.7	4.4	5.1	3.0	3.7	4.4	5.2	3.0	3.7	4.4	5.1
	*AM6A448	3.5	4.2	5.0	5.7	3.5	4.3	5.0	5.8	3.5	4.2	5.0	5.8
	*AM6A540	4.3	5.5	6.6	7.8	4.4	5.6	6.7	7.9	4.4	5.5	6.7	7.8
	*AM6A668	4.6	5.8	6.9	8.1	4.7	5.8	7.0	8.2	4.7	5.8	7.0	8.1
	*AM6A800	5.4	6.6	7.8	9.0	5.4	6.7	7.9	9.1	5.4	6.6	7.8	9.0
	*AM6A888	6.1	7.4	8.7	10	6.2	7.5	8.8	10.1	6.1	7.4	8.7	10
	*AM6A990	6.5	7.8	9.1	10.4	6.6	7.9	9.2	10.5	6.5	7.8	9.1	10.4
MT ELECTRIC DEFROST													
6 FPI	*AM6D218	2.7	3.4	4.1	4.8	2.7	3.4	4.1	4.9	2.7	3.4	4.1	4.9
	*AM6D267	2.9	3.6	4.4	5.1	2.9	3.7	4.4	5.1	2.9	3.7	4.4	5.1
	*AM6D335	2.9	3.7	4.4	5.1	3.0	3.7	4.4	5.2	3.0	3.7	4.4	5.1
	*AM6D447	3.5	4.2	5.0	5.7	3.5	4.3	5.0	5.8	3.5	4.2	5.0	5.8
	*AM6D539	4.3	5.5	6.6	7.8	4.4	5.6	6.7	7.9	4.4	5.5	6.7	7.8
	*AM6D667	4.6	5.8	6.9	8.1	4.7	5.8	7.0	8.2	4.7	5.8	7.0	8.1
	*AM6D799	5.4	6.6	7.8	9.0	5.4	6.7	7.9	9.1	5.4	6.6	7.8	9.0
	*AM6D887	6.1	7.4	8.7	10	6.2	7.5	8.8	10.1	6.1	7.4	8.7	10
	*AM6D989	6.5	7.8	9.1	10.4	6.6	7.9	9.2	10.5	6.5	7.8	9.1	10.4
LT ELECTRIC DEFROST													
6 FPI	*AM6E181	2.7	3.4	4.1	4.8	2.7	3.4	4.1	4.8	2.7	3.4	4.1	4.8
	*AM6E217	2.9	3.6	4.3	5.0	2.9	3.7	4.4	5.1	2.9	3.6	4.3	5.1
	*AM6E371	3.5	4.2	5.0	5.7	3.6	4.3	5.0	5.8	3.5	4.3	5.0	5.7
	*AM6E446	4.4	5.6	6.8	7.9	4.5	5.7	6.9	8.0	4.5	5.6	6.8	8.0
	*AM6E557	4.9	6.1	7.2	8.4	5.0	6.1	7.3	8.5	4.9	6.1	7.3	8.5
	*AM6E669	5.6	6.7	7.9	9.1	5.7	6.8	8.0	9.2	5.6	6.8	8.0	9.2
	*AM6E741	5.8	7	8.2	9.4	5.9	7.1	8.3	9.5	5.8	7	8.2	9.4
	*AM6E890	6.3	7.4	8.6	9.8	6.4	7.5	8.7	9.9	6.3	7.4	8.6	9.8
4 FPI	*AM4E129	2.6	3.3	4.0	4.7	2.7	3.4	4.1	4.8	2.6	3.3	4.0	4.7
	*AM4E168	2.9	3.6	4.3	5.0	2.9	3.6	4.4	5.1	2.9	3.6	4.3	5.0
	*AM4E271	3.4	4.1	4.9	5.6	3.5	4.2	4.9	5.7	3.4	4.2	4.9	5.6
	*AM4E340	3.9	4.6	5.3	6.1	3.9	4.7	5.4	6.1	3.9	4.6	5.4	6.1
	*AM4E398	4.2	5.0	5.8	6.6	4.3	5.1	5.8	6.6	4.2	5.0	5.8	6.6
	*AM4E495	5.3	6.5	7.6	8.8	5.4	6.6	7.7	8.9	5.3	6.5	7.7	8.9
	*AM4E529	5.8	7	8.1	9.3	5.9	7.1	8.2	9.4	5.8	7	8.2	9.4
	*AM4E658	6.3	7.4	8.5	9.7	6.4	7.5	8.7	9.9	6.3	7.4	8.6	9.8

MEDIUM PROFILE UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AM6A219	42	54	66	77	41	52	63	74	37	48	58	68
	*AM6A268	47	58	70	81	45	56	67	78	41	51	61	72
	*AM6A336	47	58	70	82	45	56	68	79	41	52	62	72
	*AM6A448	55	67	79	92	53	65	77	88	49	59	70	81
	*AM6A540	69	88	106	124	67	85	102	120	61	77	94	110
	*AM6A668	74	92	111	129	71	89	107	125	65	81	98	114
	*AM6A800	86	105	124	143	83	101	120	138	76	93	109	126
	*AM6A888	112	148	183	219	108	143	177	212	99	130	162	193
	*AM6A990	119	155	190	226	115	150	184	219	105	137	168	200
MT ELECTRIC DEFROST													
6 FPI	*AM6D218	42	54	66	77	41	52	63	74	37	48	58	68
	*AM6D267	47	58	70	81	45	56	67	78	41	51	61	72
	*AM6D335	47	58	70	82	45	56	68	79	41	52	62	72
	*AM6D447	55	67	79	92	53	65	77	88	49	59	70	81
	*AM6D539	69	88	106	124	67	85	102	120	61	77	94	110
	*AM6D667	74	92	111	129	71	89	107	125	65	81	98	114
	*AM6D799	86	105	124	143	83	101	120	138	76	93	109	126
	*AM6D887	112	148	183	219	108	143	177	212	99	130	162	193
	*AM6D989	119	155	190	226	115	150	184	219	105	137	168	200
LT ELECTRIC DEFROST													
6 FPI	*AM6E181	42	54	65	76	41	52	63	74	37	47	57	67
	*AM6E217	46	58	69	80	45	56	67	78	41	51	61	71
	*AM6E371	56	68	79	91	54	65	77	88	50	60	70	80
	*AM6E446	71	89	108	127	68	87	105	123	62	79	95	112
	*AM6E557	78	97	115	134	75	94	112	130	69	85	102	118
	*AM6E669	89	108	126	145	86	104	122	140	79	95	112	128
	*AM6E741	92	111	130	148	89	107	125	144	81	98	114	131
	*AM6E890	116	153	189	225	113	148	183	218	103	135	167	199
4 FPI	*AM4E129	42	53	64	75	41	51	62	73	37	47	57	66
	*AM4E168	46	58	69	80	45	56	67	77	41	51	61	71
	*AM4E271	55	66	78	89	53	64	75	86	48	58	69	79
	*AM4E340	62	73	85	97	60	71	82	93	55	65	75	85
	*AM4E398	67	80	92	105	65	77	89	101	59	70	81	92
	*AM4E495	85	103	122	141	82	100	118	136	75	91	108	124
	*AM4E529	92	111	130	148	89	107	125	144	81	98	114	130
	*AM4E658	103	119	137	155	99	116	134	153	91	107	114	139

HEAVY DUTY UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AH6A038	5.5	6.2	7.0	7.8	5.5	6.3	7.1	7.8	5.5	6.3	7.0	7.8
	*AH6A053	7.7	8.8	10.0	11.1	7.8	8.9	10.1	11.3	7.7	8.9	10.1	11.2
	*AH6A064	9.5	10.7	11.9	13.1	9.6	10.8	12.0	13.2	9.5	10.7	11.9	13.1
	*AH6A076	9.4	10.6	11.8	13.0	9.5	10.7	12.0	13.2	9.5	10.7	11.9	13.1
	*AH6A108	14.3	16.6	19.0	21.3	14.5	16.9	19.2	21.6	14.4	16.7	19.1	21.4
	*AH6A130	17.6	20.0	22.3	24.6	17.8	20.2	22.6	24.9	17.7	20.1	22.4	24.8
	*AH6A162	19.1	21.5	23.8	26.1	19.4	21.8	24.1	26.5	19.3	21.6	24.0	26.3
	*AH6A193	24.2	26.7	29.2	31.6	24.5	27.0	29.5	32.0	24.4	26.9	29.3	31.8
	*AH6A215	24.2	26.6	29.1	31.6	24.5	27.0	29.4	31.9	24.3	26.8	29.3	31.7
	*AH6A263	32.2	36.1	40.0	44.0	32.6	36.6	40.6	44.6	32.4	36.4	40.3	44.3
MT ELECTRIC DEFROST													
6 FPI	*AH6D037	5.5	6.2	7.0	7.8	5.5	6.3	7.1	7.8	5.5	6.3	7.0	7.8
	*AH6D052	7.7	8.8	10.0	11.1	7.8	8.9	10.1	11.3	7.7	8.9	10.1	11.2
	*AH6D063	9.5	10.7	11.9	13.1	9.6	10.8	12.0	13.2	9.5	10.7	11.9	13.1
	*AH6D077	9.4	10.6	11.8	13.0	9.5	10.7	12.0	13.2	9.5	10.7	11.9	13.1
	*AH6D107	14.3	16.6	19.0	21.3	14.5	16.9	19.2	21.6	14.4	16.7	19.1	21.4
	*AH6D129	17.6	20.0	22.3	24.6	17.8	20.2	22.6	24.9	17.7	20.1	22.4	24.8
	*AH6D161	19.1	21.5	23.8	26.1	19.4	21.8	24.1	26.5	19.3	21.6	24.0	26.3
	*AH6D192	24.2	26.7	29.2	31.6	24.5	27.0	29.5	32.0	24.4	26.9	29.3	31.8
	*AH6D214	24.2	26.6	29.1	31.6	24.5	27.0	29.4	31.9	24.3	26.8	29.3	31.7
	*AH6D262	32.2	36.1	40.0	44.0	32.6	36.6	40.6	44.6	32.4	36.4	40.3	44.3
LT ELECTRIC DEFROST													
6 FPI	*AH6E040	5.9	6.7	7.5	8.3	6.0	6.8	7.6	8.4	6.0	6.8	7.6	8.3
	*AH6E053	8.0	9.1	10.3	11.5	8.1	9.3	10.5	11.6	8.0	9.2	10.4	11.6
	*AH6E065	9.6	10.7	11.9	13.1	9.7	10.9	12.1	13.3	9.7	10.8	12.0	13.2
	*AH6E080	9.5	10.8	12.0	13.2	9.7	10.9	12.2	13.4	9.6	10.8	12.1	13.3
	*AH6E106	14.7	16.9	19.2	21.5	14.9	17.2	19.5	21.8	14.8	17.1	19.4	21.7
	*AH6E131	17.9	20.2	22.6	24.9	18.2	20.6	22.9	25.3	18.0	20.4	22.8	25.1
	*AH6E160	19.4	21.8	24.1	26.5	19.8	22.1	24.5	26.9	19.6	22.0	24.3	26.7
	*AH6E188	24.2	26.7	29.1	31.6	24.7	27.1	29.6	32.0	24.5	26.9	29.4	31.8
	*AH6E237	30.4	32.8	35.2	37.7	30.9	33.3	35.8	38.3	30.6	33.1	35.5	38.0
4 FPI	*AH4E043	8.0	9.1	10.3	11.5	8.1	9.3	10.5	11.6	8.0	9.2	10.4	11.6
	*AH4E053	9.6	10.7	11.9	13.1	9.7	10.9	12.1	13.3	9.7	10.8	12.0	13.2
	*AH4E086	12.7	13.9	15.1	16.4	12.9	14.1	15.4	16.6	12.8	14.0	15.2	16.5
	*AH4E105	17.8	20.1	22.3	24.6	18.1	20.4	22.7	25.0	18.0	20.3	22.5	24.8
	*AH4E128	19.4	21.8	24.1	26.5	19.8	22.1	24.5	26.9	19.6	22.0	24.3	26.7
	*AH4E158	24.2	26.5	28.8	31.2	24.6	26.9	29.3	31.7	24.4	26.7	29.1	31.5
	*AH4E198	30.4	32.8	35.2	37.7	30.9	33.3	35.8	38.3	30.6	33.1	35.5	38.0

HEAVY DUTY UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AH6A038	87	100	112	124	84	96	108	119	77	88	98	109
	*AH6A053	123	141	159	178	119	136	154	172	108	124	141	157
	*AH6A064	151	170	189	208	146	165	183	201	133	150	167	184
	*AH6A076	151	170	189	208	145	164	182	201	133	150	166	183
	*AH6A108	228	266	303	340	221	257	293	329	202	234	267	300
	*AH6A130	281	319	356	393	272	308	344	380	248	281	314	347
	*AH6A162	306	343	380	417	296	332	368	404	270	303	335	368
	*AH6A193	387	426	466	505	374	412	450	488	341	376	411	445
	*AH6A215	386	425	465	504	373	411	449	487	340	375	410	444
	*AH6A263	514	577	639	702	498	558	619	679	454	509	564	620
MT ELECTRIC DEFROST													
6 FPI	*AH6D037	87	100	112	124	84	96	108	119	77	88	98	109
	*AH6D052	123	141	159	178	119	136	154	172	108	124	141	157
	*AH6D063	151	170	189	208	146	165	183	201	133	150	167	184
	*AH6D077	151	170	189	208	145	164	182	201	133	150	166	183
	*AH6D107	228	266	303	340	221	257	293	329	202	234	267	300
	*AH6D129	281	319	356	393	272	308	344	380	248	281	314	347
	*AH6D161	306	343	380	417	296	332	368	404	270	303	335	368
	*AH6D192	387	426	466	505	374	412	450	488	341	376	411	445
	*AH6D214	386	425	465	504	373	411	449	487	340	375	410	444
	*AH6D262	514	577	639	702	498	558	619	679	454	509	564	620
LT ELECTRIC DEFROST													
6 FPI	*AH6E040	95	107	120	132	92	104	116	128	84	95	106	117
	*AH6E053	127	146	164	183	123	141	159	177	112	129	145	162
	*AH6E065	153	172	190	209	148	166	184	203	135	152	168	185
	*AH6E080	152	172	192	211	148	167	186	205	135	152	169	187
	*AH6E106	234	271	307	343	228	263	298	333	207	239	271	303
	*AH6E131	286	323	361	398	277	313	350	386	253	286	319	352
	*AH6E160	310	348	385	423	301	337	374	410	275	308	341	374
	*AH6E188	387	426	465	504	376	413	451	488	342	377	411	445
	*AH6E237	485	524	563	602	471	508	546	583	429	463	498	532
4 FPI	*AH4E043	127	146	164	183	123	141	159	177	112	129	145	162
	*AH4E053	153	172	190	209	148	166	184	203	135	152	168	185
	*AH4E086	202	222	242	261	196	215	234	253	179	196	213	231
	*AH4E105	284	321	357	393	276	311	346	381	252	284	316	348
	*AH4E128	310	348	385	423	301	337	374	410	275	308	341	374
	*AH4E158	386	423	461	498	375	411	447	483	341	374	407	440
	*AH4E198	485	524	563	602	471	508	546	583	429	463	498	532

WAREHOUSE UNIT COOLERS - Maximum Releasable Charge (m_{rel}) - lb

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AW6A042	87	100	112	124	84	96	108	119	77	88	98	109
	*AW6A057	123	141	159	178	119	136	154	172	108	124	141	157
	*AW6A072	151	170	189	208	146	165	183	201	133	150	167	184
	*AW6A084	151	170	189	208	145	164	182	201	133	150	166	183
	*AW6A116	228	266	303	340	221	257	293	329	202	234	267	300
	*AW6A143	281	319	356	393	272	308	344	380	248	281	314	347
	*AW6A173	306	343	380	417	296	332	368	404	270	303	335	368
	*AW6A216	387	426	466	505	374	412	450	488	341	376	411	445
	*AW6A235	386	425	465	504	373	411	449	487	340	375	410	444
	*AW6A291	514	577	639	702	498	558	619	679	454	509	564	620
MT ELECTRIC DEFROST													
6 FPI	*AW6D042	87	100	112	124	84	96	108	119	77	88	98	109
	*AW6D057	123	141	159	178	119	136	154	172	108	124	141	157
	*AW6D072	151	170	189	208	146	165	183	201	133	150	167	184
	*AW6D084	151	170	189	208	145	164	182	201	133	150	166	183
	*AW6D116	228	266	303	340	221	257	293	329	202	234	267	300
	*AW6D144	281	319	356	393	272	308	344	380	248	281	314	347
	*AW6D174	306	343	380	417	296	332	368	404	270	303	335	368
	*AW6D216	387	426	466	505	374	412	450	488	341	376	411	445
	*AW6D235	386	425	465	504	373	411	449	487	340	375	410	444
	*AW6D292	514	577	639	702	498	558	619	679	454	509	564	620
4 FPI	*AW4D037	87	98	110	121	84	95	106	117	77	87	97	107
	*AW4D051	122	140	158	176	118	135	153	170	108	124	139	155
	*AW4D063	151	169	187	206	146	163	181	199	133	149	165	182
	*AW4D074	150	168	187	205	145	163	181	198	132	148	165	181
	*AW4D103	227	262	298	333	219	254	288	323	200	232	263	294
	*AW4D128	280	315	351	386	271	305	340	374	247	278	310	341
	*AW4D155	306	343	380	417	296	332	368	404	270	303	335	368
	*AW4D191	385	422	459	496	372	408	444	480	339	372	405	438
	*AW4D208	384	421	458	495	371	407	443	479	339	371	404	437
	*AW4D260	512	572	633	693	496	554	613	672	452	506	559	613
LT ELECTRIC DEFROST													
6 FPI	*AW6E044	95	107	120	132	92	104	116	128	84	95	106	117
	*AW6E057	127	146	164	183	123	141	159	177	112	129	145	162
	*AW6E071	153	172	190	209	148	166	184	203	135	152	168	185
	*AW6E087	152	172	192	211	148	167	186	205	135	152	169	187
	*AW6E114	234	271	307	343	228	263	298	333	207	239	271	303
	*AW6E142	286	323	361	398	277	313	350	386	253	286	319	352
	*AW6E170	310	348	385	423	301	337	374	410	275	308	341	374
	*AW6E215	387	426	465	504	376	413	451	488	342	377	411	445
	*AW6E256	485	524	563	602	471	508	546	583	429	463	498	532
4 FPI	*AW4E045	127	146	164	183	123	141	159	177	112	129	145	162
	*AW4E058	153	172	190	209	148	166	184	203	135	152	168	185
	*AW4E092	202	222	242	261	196	215	234	253	179	196	213	231
	*AW4E116	284	321	357	393	276	311	346	381	252	284	316	348
	*AW4E136	310	348	385	423	301	337	374	410	275	308	341	374
	*AW4E173	386	423	461	498	375	411	447	483	341	374	407	440
	*AW4E214	485	524	563	602	471	508	546	583	429	463	498	532

WAREHOUSE UNIT COOLERS - Minimum Room Area (A_{min}) - sq. ft

Generic Model		R-454A				R-454C				R-455A			
		10'	20'	30'	40'	10'	20'	30'	40'	10'	20'	30'	40'
AIR DEFROST													
6 FPI	*AW6A042	87	100	112	124	84	96	108	119	77	88	98	109
	*AW6A057	123	141	159	178	119	136	154	172	108	124	141	157
	*AW6A072	151	170	189	208	146	165	183	201	133	150	167	184
	*AW6A084	151	170	189	208	145	164	182	201	133	150	166	183
	*AW6A116	228	266	303	340	221	257	293	329	202	234	267	300
	*AW6A143	281	319	356	393	272	308	344	380	248	281	314	347
	*AW6A173	306	343	380	417	296	332	368	404	270	303	335	368
	*AW6A216	387	426	466	505	374	412	450	488	341	376	411	445
	*AW6A235	386	425	465	504	373	411	449	487	340	375	410	444
	*AW6A291	514	577	639	702	498	558	619	679	454	509	564	620
MT ELECTRIC DEFROST													
6 FPI	*AW6D042	87	100	112	124	84	96	108	119	77	88	98	109
	*AW6D057	123	141	159	178	119	136	154	172	108	124	141	157
	*AW6D072	151	170	189	208	146	165	183	201	133	150	167	184
	*AW6D084	151	170	189	208	145	164	182	201	133	150	166	183
	*AW6D116	228	266	303	340	221	257	293	329	202	234	267	300
	*AW6D144	281	319	356	393	272	308	344	380	248	281	314	347
	*AW6D174	306	343	380	417	296	332	368	404	270	303	335	368
	*AW6D216	387	426	466	505	374	412	450	488	341	376	411	445
	*AW6D235	386	425	465	504	373	411	449	487	340	375	410	444
	*AW6D292	514	577	639	702	498	558	619	679	454	509	564	620
4 FPI	*AW4D037	87	98	110	121	84	95	106	117	77	87	97	107
	*AW4D051	122	140	158	176	118	135	153	170	108	124	139	155
	*AW4D063	151	169	187	206	146	163	181	199	133	149	165	182
	*AW4D074	150	168	187	205	145	163	181	198	132	148	165	181
	*AW4D103	227	262	298	333	219	254	288	323	200	232	263	294
	*AW4D128	280	315	351	386	271	305	340	374	247	278	310	341
	*AW4D155	306	343	380	417	296	332	368	404	270	303	335	368
	*AW4D191	385	422	459	496	372	408	444	480	339	372	405	438
	*AW4D208	384	421	458	495	371	407	443	479	339	371	404	437
	*AW4D260	512	572	633	693	496	554	613	672	452	506	559	613
LT ELECTRIC DEFROST													
6 FPI	*AW6E044	95	107	120	132	92	104	116	128	84	95	106	117
	*AW6E057	127	146	164	183	123	141	159	177	112	129	145	162
	*AW6E071	153	172	190	209	148	166	184	203	135	152	168	185
	*AW6E087	152	172	192	211	148	167	186	205	135	152	169	187
	*AW6E114	234	271	307	343	228	263	298	333	207	239	271	303
	*AW6E142	286	323	361	398	277	313	350	386	253	286	319	352
	*AW6E170	310	348	385	423	301	337	374	410	275	308	341	374
	*AW6E215	387	426	465	504	376	413	451	488	342	377	411	445
	*AW6E256	485	524	563	602	471	508	546	583	429	463	498	532
4 FPI	*AW4E045	127	146	164	183	123	141	159	177	112	129	145	162
	*AW4E058	153	172	190	209	148	166	184	203	135	152	168	185
	*AW4E092	202	222	242	261	196	215	234	253	179	196	213	231
	*AW4E116	284	321	357	393	276	311	346	381	252	284	316	348
	*AW4E136	310	348	385	423	301	337	374	410	275	308	341	374
	*AW4E173	386	423	461	498	375	411	447	483	341	374	407	440
	*AW4E214	485	524	563	602	471	508	546	583	429	463	498	532

MAXIMUM RELEASABLE CHARGE CALCULATION

m_{rel} is the maximum refrigerant mass which may be released into an enclosed space during a leak event. It is based on standard cooling mode conditions. It is calculated as the sum of the refrigerant mass in the suction line (*vap*), liquid line (*liq*), unit cooler (*mix*), and the mass which may enter the isolated section during the time it takes for the system to respond to a leak (*resp*). System designers should attempt to limit refrigerant line dimensions downstream of the isolation valves to minimize m_{rel} as this affects the mitigation requirements. Matched systems which involve multiple unit coolers may use separate isolation valves for individual unit coolers to reduce m_{rel}.

m_{rel} is calculated as follows:

$$m_{rel} = m_{suct\ line} + m_{liq\ line} + m_{unit} + m_{resp}$$

SI units

$$m_{rel} = (L_{vap} \times TD_{vap} \times \rho_{vap}) + (L_{liq} \times TD_{liq} \times \rho_{liq}) + (IV_{unit} \times \rho_{mix}) + (0.0068, kg/s \times T_{resp})$$

Where:

L, m
$TD, m^3/m$
$\rho, kg/m^3$
IV/m^3
T, s

IP units

$$m_{rel} = (L_{vap} \times TD_{vap} \times \rho_{vap}) + (L_{liq} \times TD_{liq} \times \rho_{liq}) + (IV_{unit} \times \rho_{mix}) + (0.015, kg/s \times T_{resp})$$

Where:

L, ft
$TD, ft^3/ft$
$\rho, lb/ft^3$
IV/ft^3
T, s

L_{vap} is the total length of the suction tubing from the suction check valve to the unit cooler.
L_{liq} is the total length of the liquid tubing from the liquid isolation solenoid valve to unit cooler. Values for TD, ρ, and IV are given in the following tables.

MAXIMUM RELEASABLE CHARGE CALCULATION - TABLES

TUBE VOLUME PER LENGTH, TD

Tube OD		TD, Tube Internal Volume Per Unit Length	
mm	in	m^3 / m	ft^3 / ft
6.35	0.25	1.77E-05	2.05E-04
7.94	0.313	3.10E-05	3.59E-04
9.53	0.375	4.80E-05	5.55E-04
12.7	0.5	9.29E-05	1.08E-03
15.9	0.625	1.49E-04	1.73E-03
19.1	0.75	2.14E-04	2.48E-03
22.2	0.875	2.96E-04	3.43E-03
25.4	1	3.89E-04	4.50E-03
28.6	1.125	5.03E-04	5.82E-03
31.8	1.25	6.23E-04	7.21E-03
38.1	1.5	9.10E-04	1.05E-02
41.3	1.625	1.08E-03	1.25E-02
54	2.125	1.88E-03	2.18E-02
66.7	2.625	2.89E-03	3.35E-02

DENSITY TABLE, ρ

		Medium Temperature			Low Temperature		
		ρ_{vap}	ρ_{liq}	ρ_{mix}	ρ_{vap}	ρ_{liq}	ρ_{mix}
R454A	kg/m^3	18.42	970.72	161.31	7.05	970.72	151.69
	lb/ft^3	1.15	60.60	10.07	0.44	60.60	9.47
R454C	kg/m^3	16.98	994.75	163.71	6.41	994.75	154.74
	lb/ft^3	1.06	62.10	10.22	0.40	62.10	9.66
R455A	kg/m^3	17.46	984.17	162.59	6.57	984.17	153.30
	lb/ft^3	1.09	61.44	10.15	0.41	61.44	9.57

INTERNAL VOLUMES

LOW PROFILE UNIT COOLERS

	Generic Model	Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AL6A050	0.00074	0.0262
	*AL6A062	0.00110	0.0388
	*AL6A081	0.00149	0.0527
	*AL6A088	0.00142	0.0500
	*AL6A113	0.00208	0.0735
	*AL6A141	0.00245	0.0864
	*AL6A159	0.00279	0.0984
	*AL6A170	0.00275	0.0970
	*AL6A196	0.00307	0.1084
	*AL6A220	0.00414	0.1461
	*AL6A234	0.00368	0.1301
	*AL6A289	0.00412	0.1455
	*AL6A316	0.00544	0.1921
	*AL6A375	0.00681	0.2406
	*AL6A404	0.00711	0.2511
	*AL6A477	0.00809	0.2858
ELECTRIC DEFROST			
6 FPI	*AL6E042	0.00074	0.0262
	*AL6E051	0.00113	0.0400
	*AL6E058	0.00149	0.0527
	*AL6E079	0.00146	0.0516
	*AL6E092	0.00217	0.0765
	*AL6E110	0.00241	0.0851
	*AL6E129	0.00288	0.1017
	*AL6E148	0.00325	0.1147
	*AL6E173	0.00424	0.1499
	*AL6E194	0.00421	0.1485
	*AL6E218	0.00552	0.1951
	*AL6E237	0.00516	0.1824
	*AL6E290	0.00614	0.2169
	*AL6E343	0.00813	0.2872
4 FPI	*AL4E032	0.00074	0.0262
	*AL4E040	0.00110	0.0389
	*AL4E046	0.00149	0.0527
	*AL4E061	0.00146	0.0516
	*AL4E076	0.00217	0.0765
	*AL4E099	0.00288	0.1017
	*AL4E114	0.00325	0.1147
	*AL4E133	0.00424	0.1499
	*AL4E150	0.00421	0.1485
	*AL4E170	0.00552	0.1951
	*AL4E184	0.00516	0.1824
	*AL4E232	0.00614	0.2169
	*AL4E281	0.00813	0.2872

CENTER MOUNT UNIT COOLERS

	Generic Model	Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AE6A051	0.00125	0.0441
	*AE6A085	0.00175	0.0617
	*AE6A103	0.00229	0.0807
	*AE6A128	0.00256	0.0904
	*AE6A157	0.00349	0.1231
	*AE6A173	0.00347	0.1224
	*AE6A207	0.00452	0.1596
	*AE6A249	0.00573	0.2022
	*AE6A316	0.00844	0.2981
ELECTRIC DEFROST			
6 FPI	*AE6E045	0.00097	0.0343
	*AE6E054	0.00125	0.0441
	*AE6E090	0.00191	0.0676
	*AE6E107	0.00245	0.0864
	*AE6E129	0.00269	0.0950
	*AE6E149	0.00348	0.1230
	*AE6E160	0.00347	0.1224
	*AE6E217	0.00456	0.1609
	*AE6E265	0.00578	0.2040
	*AE6E337	0.00851	0.3005
4 FPI	*AE4E043	0.00125	0.0441
	*AE4E087	0.00233	0.0823
	*AE4E127	0.00348	0.1230
	*AE4E183	0.00456	0.1609
	*AE4E222	0.00578	0.2040
	*AE4E283	0.00851	0.3005

INTERNAL VOLUMES

LOW VELOCITY CENTER MOUNT UNIT COOLERS

Generic Model		Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AV6A053	0.00140	0.0493
	*AV6A066	0.00097	0.0343
	*AV6A105	0.00256	0.0904
	*AV6A 13	0.00342	0.1207
	*AV6A159	0.00394	0.1393
	*AV6A196	0.00514	0.1814
	*AV6A216	0.00511	0.1804
	*AV6A270	0.00670	0.2367
	*AV6A338	0.00851	0.3005
ELECTRIC DEFROST			
6 FPI	*AV6E053	0.00140	0.0493
	*AV6E066	0.00182	0.0642
	*AV6E105	0.00256	0.0904
	*AV6E131	0.00342	0.1207
	*AV6E159	0.00394	0.1393
	*AV6E196	0.00514	0.1814
	*AV6E216	0.00511	0.1804
	*AV6E270	0.00670	0.2367
	*AV6E338	0.00851	0.3005

MEDIUM PROFILE UNIT COOLERS

Generic Model		Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AM6A219	0.00249	0.0880
	*AM6A268	0.00322	0.1138
	*AM6A336	0.00328	0.1158
	*AM6A448	0.00465	0.1641
	*AM6A540	0.00600	0.2119
	*AM6A668	0.00681	0.2406
	*AM6A800	0.00883	0.3118
	*AM6A888	0.01051	0.3713
	*AM6A990	0.01177	0.4157
MT ELECTRIC DEFROST			
6 FPI	*AM6D218	0.00249	0.0880
	*AM6D267	0.00322	0.1138
	*AM6D335	0.00328	0.1158
	*AM6D447	0.00465	0.1641
	*AM6D539	0.00600	0.2119
	*AM6D667	0.00681	0.2406
	*AM6D799	0.00883	0.3118
	*AM6D887	0.01051	0.3713
	*AM6D989	0.01177	0.4157
LT ELECTRIC DEFROST			
6 FPI	*AM6E181	0.00267	0.0943
	*AM6E217	0.00341	0.1203
	*AM6E371	0.00516	0.1821
	*AM6E446	0.00655	0.2312
	*AM6E557	0.00789	0.2785
	*AM6E669	0.00992	0.3504
	*AM6E741	0.01051	0.3713
	*AM6E890	0.01177	0.4157
4 FPI	*AM4E129	0.00265	0.0935
	*AM4E168	0.00338	0.1195
	*AM4E271	0.00485	0.1714
	*AM4E340	0.00622	0.2197
	*AM4E398	0.00709	0.2503
	*AM4E495	0.00912	0.3222
	*AM4E529	0.01051	0.3713
	*AM4E658	0.01177	0.4157

INTERNAL VOLUMES

HEAVY DUTY UNIT COOLERS

Generic Model		Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AH6A038	0.01031	0.3641
	*AH6A053	0.01540	0.5438
	*AH6A064	0.02031	0.7173
	*AH6A076	0.02018	0.7127
	*AH6A108	0.03069	1.0837
	*AH6A130	0.04000	1.4125
	*AH6A162	0.04426	1.5631
	*AH6A193	0.05817	2.0541
	*AH6A215	0.05799	2.0478
	*AH6A263	0.07653	2.7027
MT ELECTRIC DEFROST			
6 FPI	*AH6D037	0.01031	0.3641
	*AH6D052	0.01540	0.5438
	*AH6D063	0.02031	0.7173
	*AH6D077	0.02018	0.7127
	*AH6D107	0.03069	1.0837
	*AH6D129	0.04000	1.4125
	*AH6D161	0.04426	1.5631
	*AH6D192	0.05817	2.0541
	*AH6D214	0.05799	2.0478
	*AH6D262	0.07653	2.7027
LT ELECTRIC DEFROST			
6 FPI	*AH6E040	0.01220	0.4307
	*AH6E053	0.01697	0.5993
	*AH6E065	0.02175	0.7681
	*AH6E080	0.02144	0.7570
	*AH6E106	0.03360	1.1867
	*AH6E131	0.04287	1.5138
	*AH6E160	0.04744	1.6754
	*AH6E188	0.06139	2.1681
	*AH6E237	0.07949	2.8073
4 FPI	*AH4E043	0.01697	0.5993
	*AH4E053	0.02175	0.7681
	*AH4E086	0.03069	1.0837
	*AH4E105	0.04287	1.5138
	*AH4E128	0.04744	1.6754
	*AH4E158	0.06139	2.1681
	*AH4E198	0.07949	2.8073

WAREHOUSE UNIT COOLERS

Generic Model		Vol, m^3	Vol, ft^3
AIR DEFROST			
6 FPI	*AW6A042	0.01031	0.3641
	*AW6A057	0.01540	0.5438
	*AW6A072	0.02031	0.7173
	*AW6A084	0.02018	0.7127
	*AW6A116	0.03069	1.0837
	*AW6A143	0.04000	1.4125
	*AW6A173	0.04426	1.5631
	*AW6A216	0.05817	2.0541
	*AW6A235	0.05799	2.0478
	*AW6A291	0.07653	2.7027
MT ELECTRIC DEFROST			
6 FPI	*AW6D042	0.04744	1.6754
	*AW6D057	0.06139	2.1681
	*AW6D072	0.07949	2.8073
	*AW6D084	0.01697	0.5993
	*AW6D116	0.02175	0.7681
	*AW6D144	0.03069	1.0837
	*AW6D174	0.04287	1.5138
	*AW6D216	0.04744	1.6754
	*AW6D235	0.06139	2.1681
	*AW6D292	0.07949	2.8073
LT ELECTRIC DEFROST			
6 FPI	*AW6E044	0.01031	0.3641
	*AW6E057	0.01540	0.5438
	*AW6E071	0.02031	0.7173
	*AW6E087	0.02018	0.7127
	*AW6E114	0.03069	1.0837
	*AW6E142	0.04000	1.4125
	*AW6E170	0.04426	1.5631
	*AW6E215	0.05817	2.0541
	*AW6E256	0.05799	2.0478
4 FPI	*AW4E045	0.07653	2.7027
	*AW4E058	0.01220	0.4307
	*AW4E092	0.01697	0.5993
	*AW4E116	0.02175	0.7681
	*AW4E136	0.02144	0.7570
	*AW4E173	0.03360	1.1867
	*AW4E214	0.04287	1.5138

LEAK DETECTOR SEQUENCE OF OPERATION

All HTPG A2L Unit Coolers are equipped with factory mounted leak detection sensors to be used in conjunction with field mounted safety shut off valve(s) and check valves to satisfy safety mitigation requirements. In case of a leak event, the alarm circuit will respond as detailed below.

Non-EcoNet Enabled Unit Coolers Sequence of Operation

1. Defrost is Terminated
2. Safety Shut-off Valve is Closed
3. Unit Cooler Pumps Down
4. Fan(s) Remain Active
5. Alarm Relay Closes

EcoNet Enabled Unit Coolers Sequence of Operation

1. Defrost is Terminated
2. Safety Shut-off Valve is Closed
3. Electronic Expansion Valve Opens
4. Unit Cooler Pumps Down
5. Fan(s) Remain Active
6. Alarm Relay Closes
7. Leak Event Logged

Water-Cooled condensing Unit Sequence of Operation

1. Compressor Shuts Off
2. Alarm Relay Closes

When the leak concentration falls below the alarm setpoint and an hour or longer has elapsed the system will restart automatically. If the power to the unit is cycled, the alarm will reset immediately.

The HTPG leak detectors perform a routine self-check to ensure that the sensor is operating correctly. The current sensor version does not have any indication to demonstrate this function or to show sensor health. Also, there are no buttons to force an alarm response for a field test. If the sensor fails the alarm circuit will behave as if a leak is detected.

If a leak detector becomes damaged, contact HTPG to order a replacement. Non-factory replacement sensors are not permissible and may cause damage or unsafe operation.

During installation and service protect the sensors from silicone sealant fumes as this may cause damage to the sensitivity. This may be done by temporarily removing the sensor or by covering the sensor with plastic film during caulking operations.

A2L PIPING SCHEMES

HTPG's matched systems should be piped to use one solenoid valve to serve as both the liquid line solenoid valve and the liquid isolation valve. For air and electric defrost equipped unit coolers the suction isolation valve should be a check valve rather than a solenoid. During a leak, the liquid valve and suction check valve isolate the unit cooler and piping inside the refrigerated space. The compressor will evacuate the isolated section of piping through the suction check valve. This scheme yields less parts for the installation, ensures that the liquid valve is exercised regularly, and allows for a pump down during a leak event. If these valves are to be provided.

The installer must position the isolation valves outside of the refrigerated space. We recommend mounting the valves close to the box exterior help keep m_{rel} as low as possible.

Figure 1: Simple Matched System

This configuration illustrates a basic matched system with one unit cooler and one condensing unit.

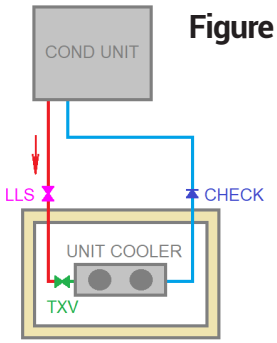


Figure 1

Figure 2: Multiple Unit Coolers with Shared Isolation Valves

This configuration shows a matched system with multiple unit coolers connected to a single condensing unit.

Shared isolation valves are used across all unit coolers.
In the event of a leak, the isolation solenoid closes, and the system initiates pump down.

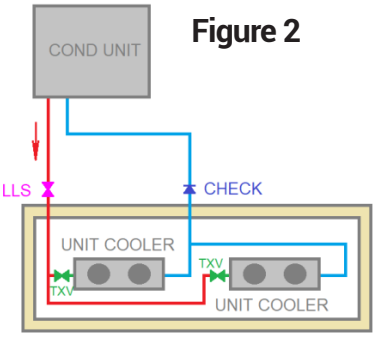


Figure 2

Figure 3: Multiple Unit Coolers with Individual Isolation Valves

This configuration features multiple unit coolers, each equipped with its own set of isolation valves.

The Maximum Refrigerant Emission Limit (m_{rel}) is calculated based on the largest isolated circuit, not the total system charge.

This approach may reduce the required room size (Amin) and potentially eliminate the need for mechanical ventilation.

The system is wired so that a leak triggers all isolation solenoids to close simultaneously, followed by a pump down sequence.

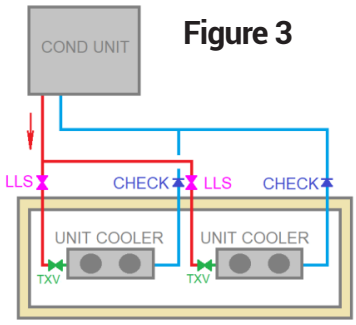
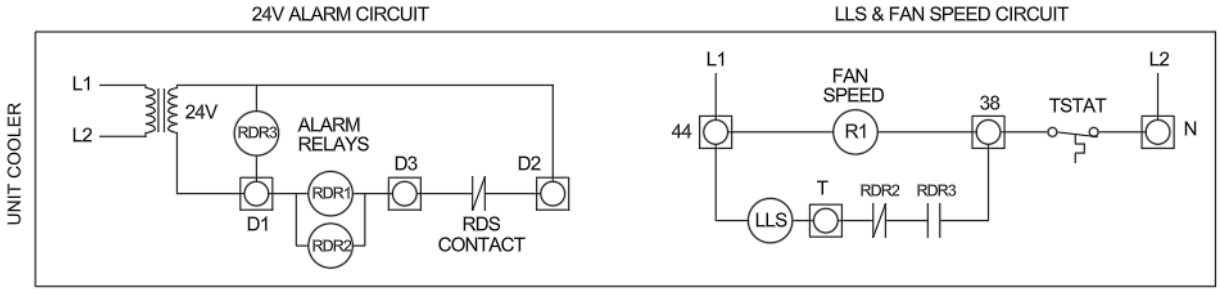


Figure 3

A2L WIRING

The following simplified diagram is presented here to explain how the alarm circuit closes the liquid solenoid. The 24V for the alarm circuit is supplied by a small transformer. The 230V solenoid circuit is supplied from terminals 44 and N and may connect back to a condensing unit.



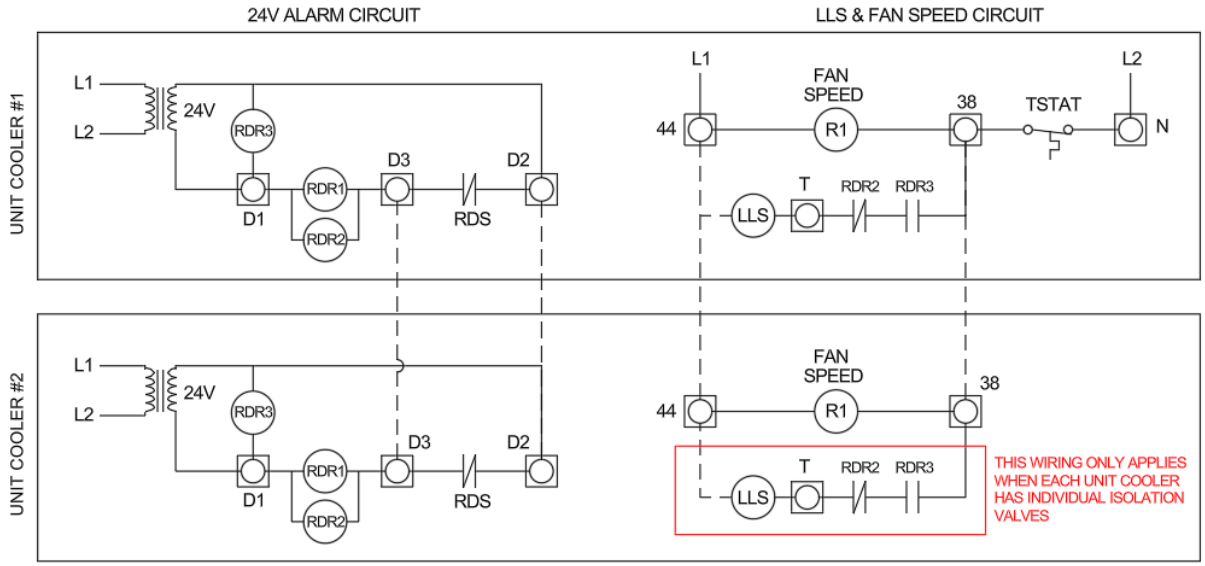
The liquid line solenoid is controlled in the following way:

- If 24V is not present the relay RDR3 will be inactive and its contact will be open. The liquid solenoid valve will be closed.
  - In case of Water-Cooled Condensing Units use the following note - If 24V is not present the relay RDR3 will be inactive and its contact will be open. The compressor will shut off.
- If 24V is present and the RDS does not sense a refrigerant leak it will hold the RDS alarm contact open. The relays RDR1 and RDR2 will be inactive. The RDR2 and RDR3 contacts will be closed and the liquid solenoid valve will be open.
- If 24V is present and the RDS senses a refrigerant leak it will release the RDS alarm contact to its normally closed state. The RDR1, RDR2, and RDR3 relays will be active. The RDR3 contact will be closed but the RDR2 contact will be open and the liquid solenoid valve will be closed.
- If 24V is present but the RDS has failed the RDS contact will be closed. The RDR1 and RDR2 relays will be active. The RDR3 contact will be closed but the RDR2 contact will be open and the liquid solenoid valve will be closed.

The RDR relays do numerous things. -Some of these are not shown in this simplified diagram.

- Closes the liquid solenoid in the event of a leak or sensor failure.
- Closes the liquid solenoid if the 24V transformer fails.
- Terminates an active defrost cycle in the event of a leak or sensor failure.
- Bypasses the drip delay period in the event of a leak or sensor failure.
- Causes unit cooler fans to run in the event of a leak or sensor failure. The fan speed is dependent upon room temperature.
- Closes the dry alarm contact provided for customer use in the event of a leak or sensor failure.
- Matched systems using multiple unit coolers on one condensing unit must have wired connections on the D2 and D3 terminals. These connections enable the unit coolers to act as a group during a leak. It is important to match polarities when connecting multiple unit coolers!

The following simplified diagram shows two unit cooler alarm and solenoid circuits connected together for use in a matched system. With this scheme only one RDS contact must close to cause all unit cooler RDR relays to trigger the required leak response. Another way of saying this is that only one sensor must detect a leak to cause all unit coolers to respond appropriately.

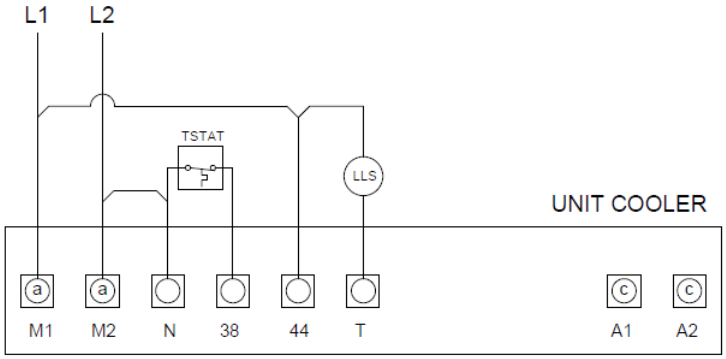


The following notes apply to the interconnection diagrams as indicated:

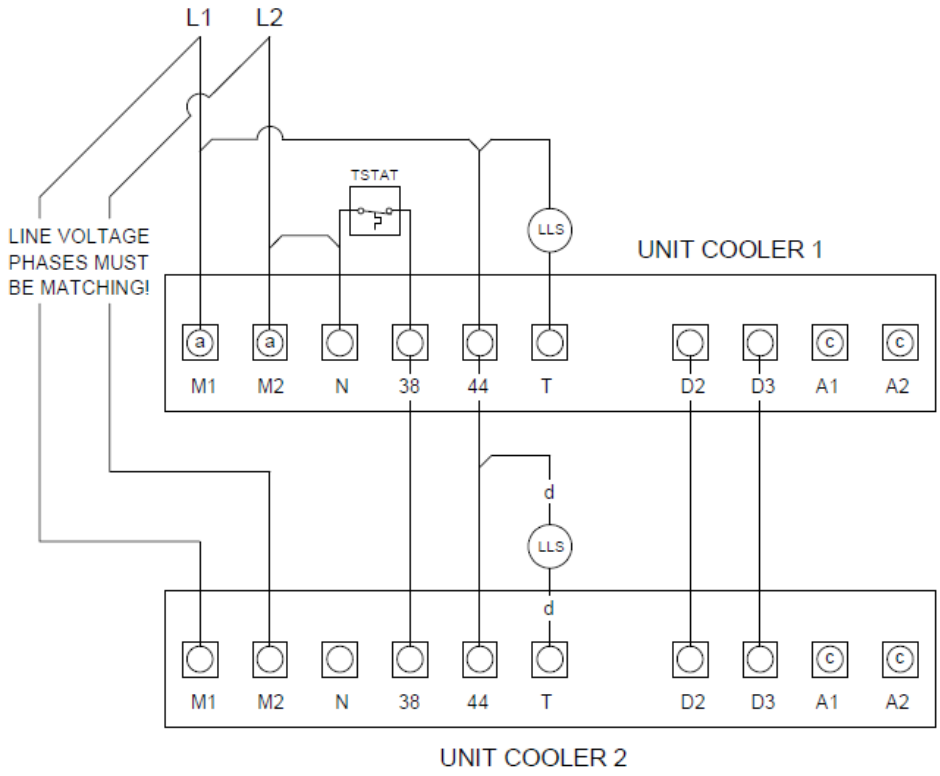
a. These terminals may be used to power an electronic thermostat.
b. Make this connection if the condensing unit has an unloader or hot gas bypass solenoid.
c. Alarm relay terminals for customer use: Normally Open, 240Vac, 40A
d. This solenoid circuit is only provided if each unit cooler has its own isolation valves.
e. This connection applies to 3 phase defrost kits.
f. For additional unit coolers, daisy chain these connections. Wire condensing unit TB3-2 to the last unit cooler terminal N and connect 1 to N for each unit cooler back to the condensing unit TB3-1 as shown.

The following interconnection diagrams show the field connections for common defrost configurations.

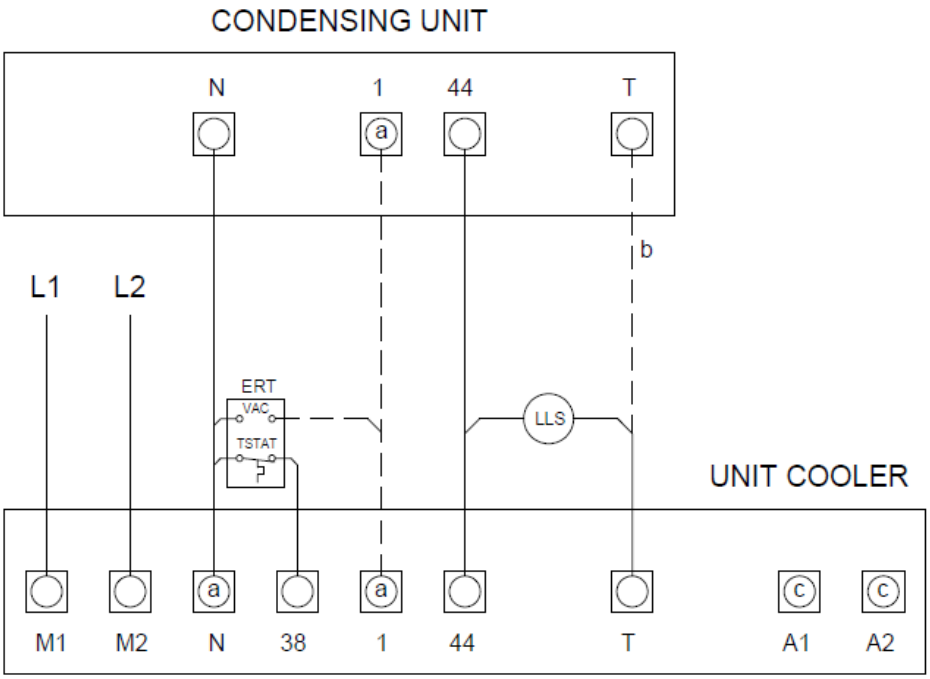
AIR DEFROST WITHOUT CONDENSING UNIT DEFROST TIMER



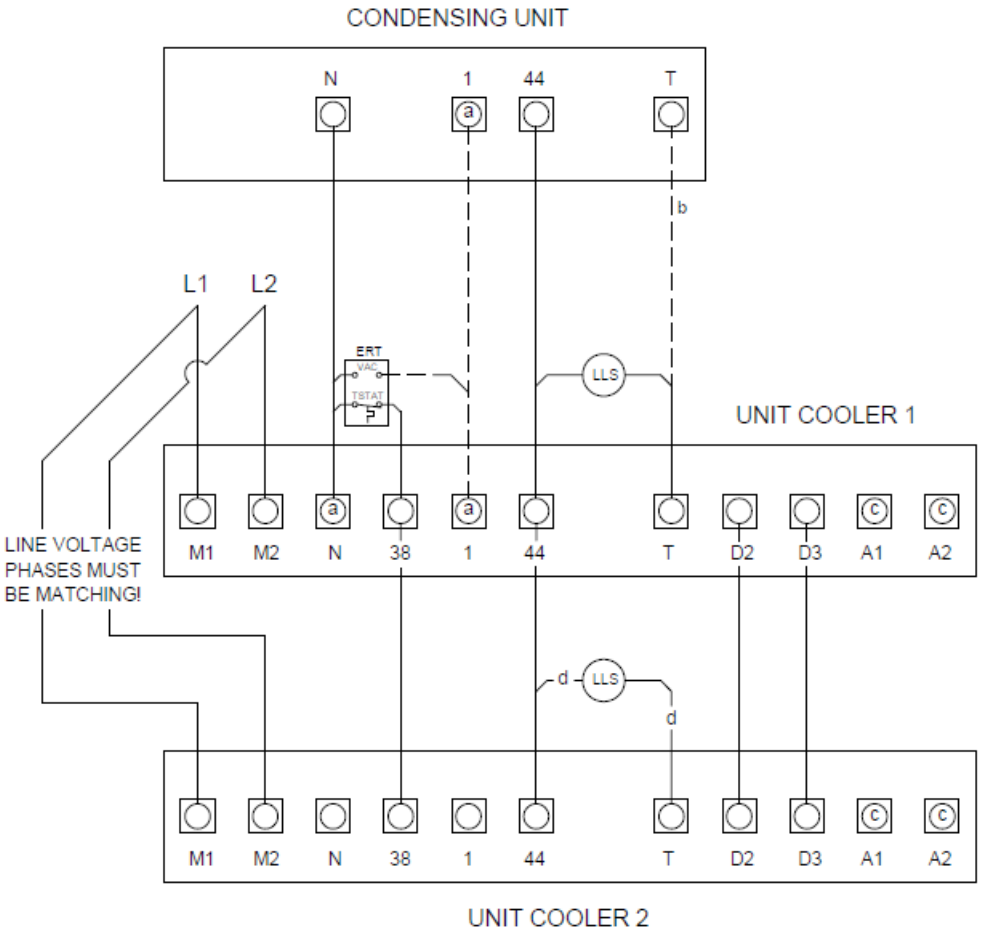
AIR DEFROST WITHOUT TIMER, MULTIPLE UNIT COOLERS



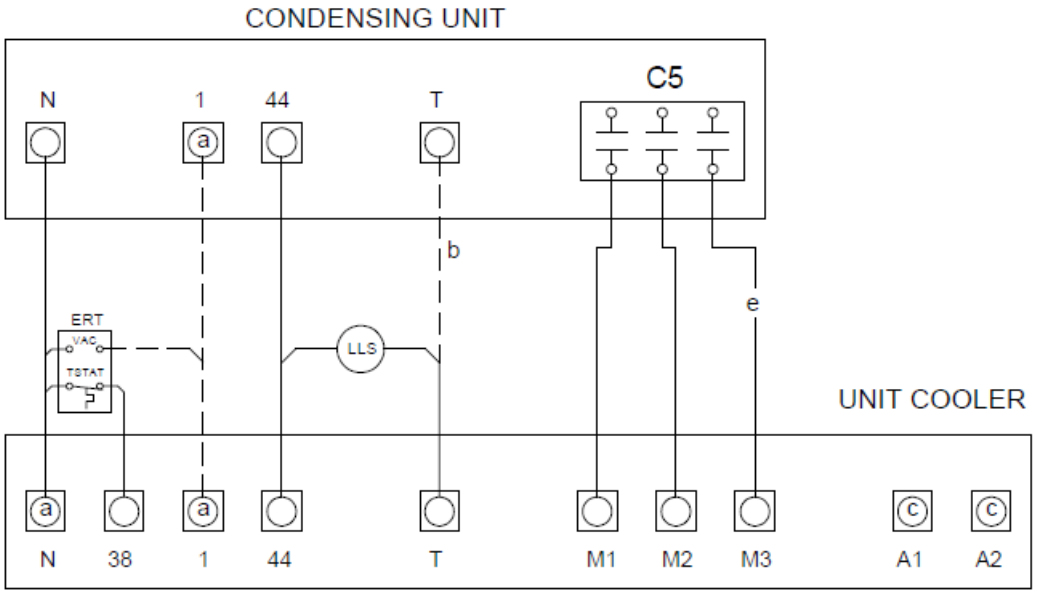
AIR DEFROST WITH CONDENSING UNIT DEFROST TIMER



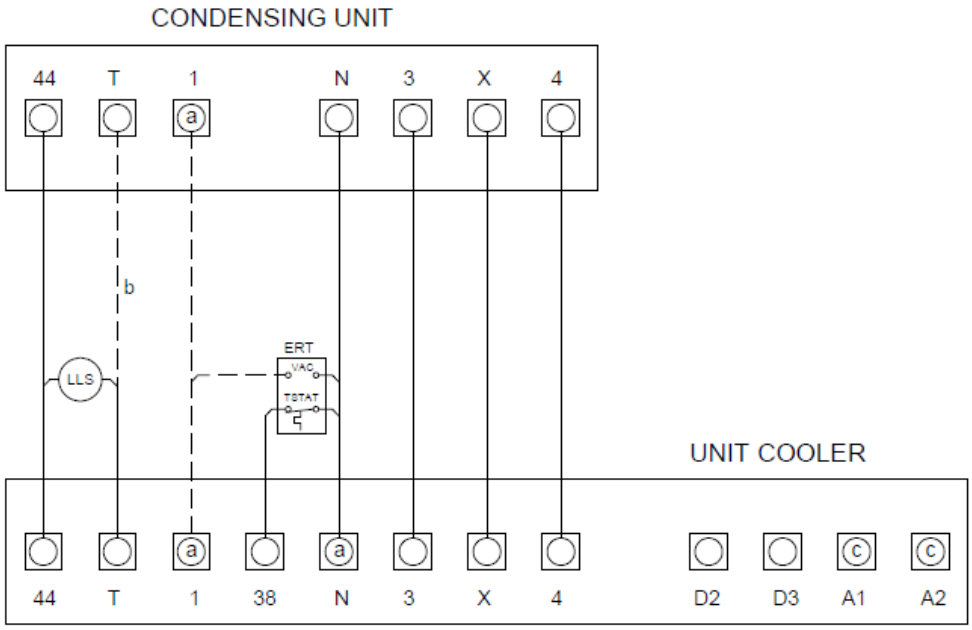
AIR DEFROST WITH CONDENSING UNIT DEFROST TIMER, MULTIPLE UNIT COOLERS



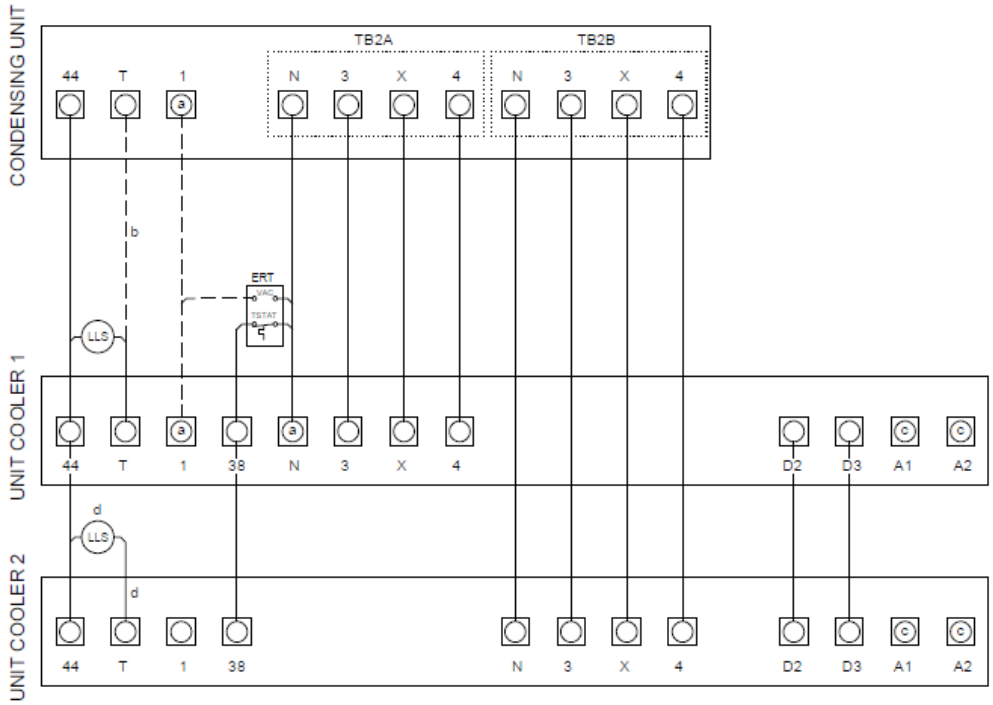
AIR DEFROST KITS: TRM-EF-15A, TMR-EF-30A



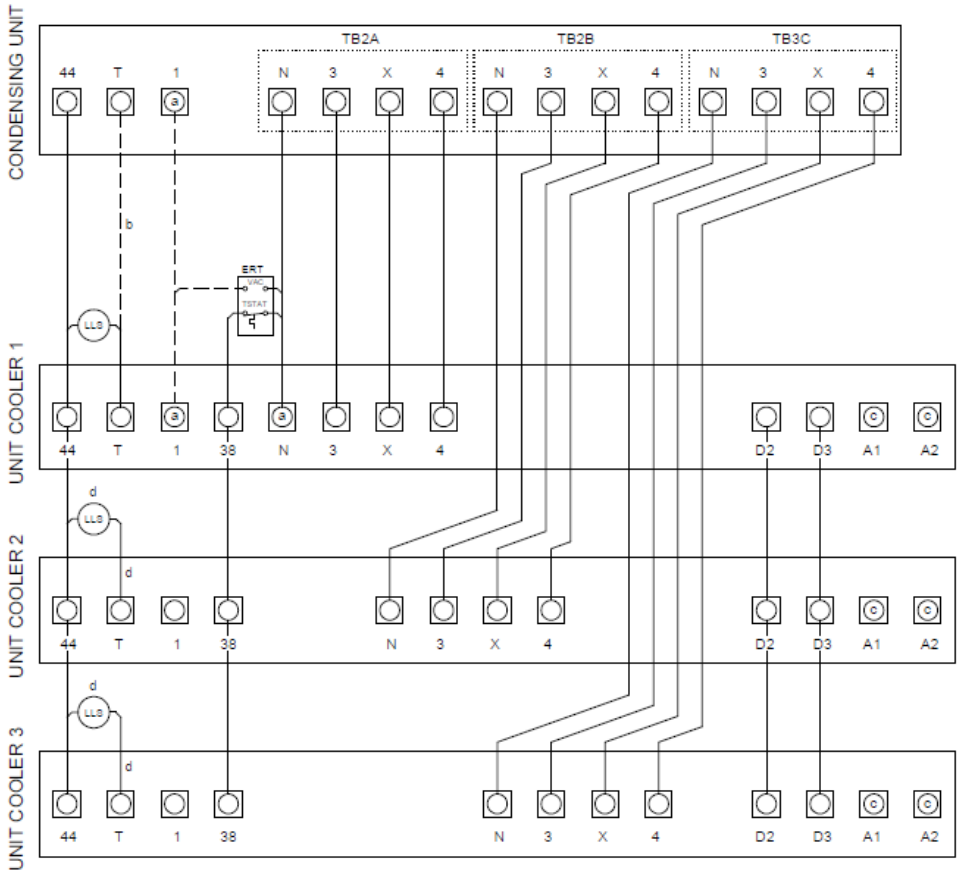
ELECTRIC DEFROST KITS: ED5-A2, ED6-A2, ED7-A2, ED10-A2



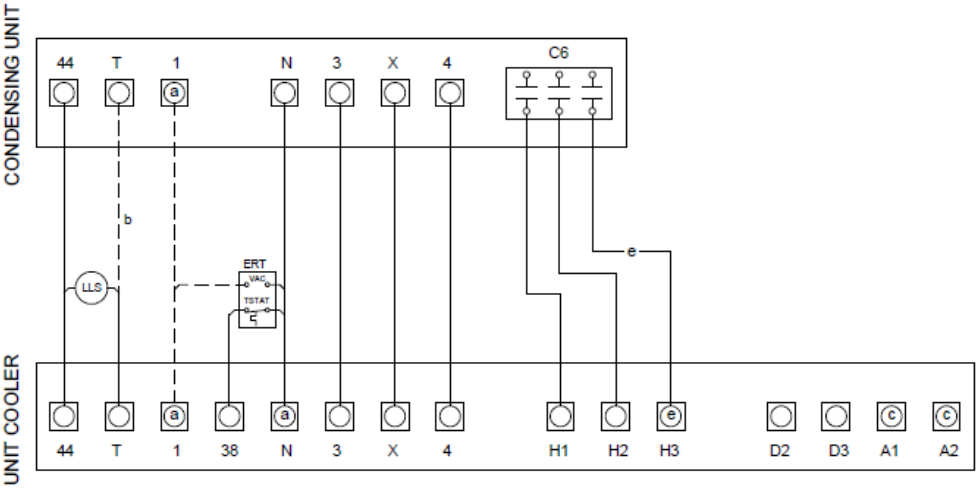
ELECTRIC DEFROST KIT: ED20-A2



ELECTRIC DEFROST KIT: ED30-A2

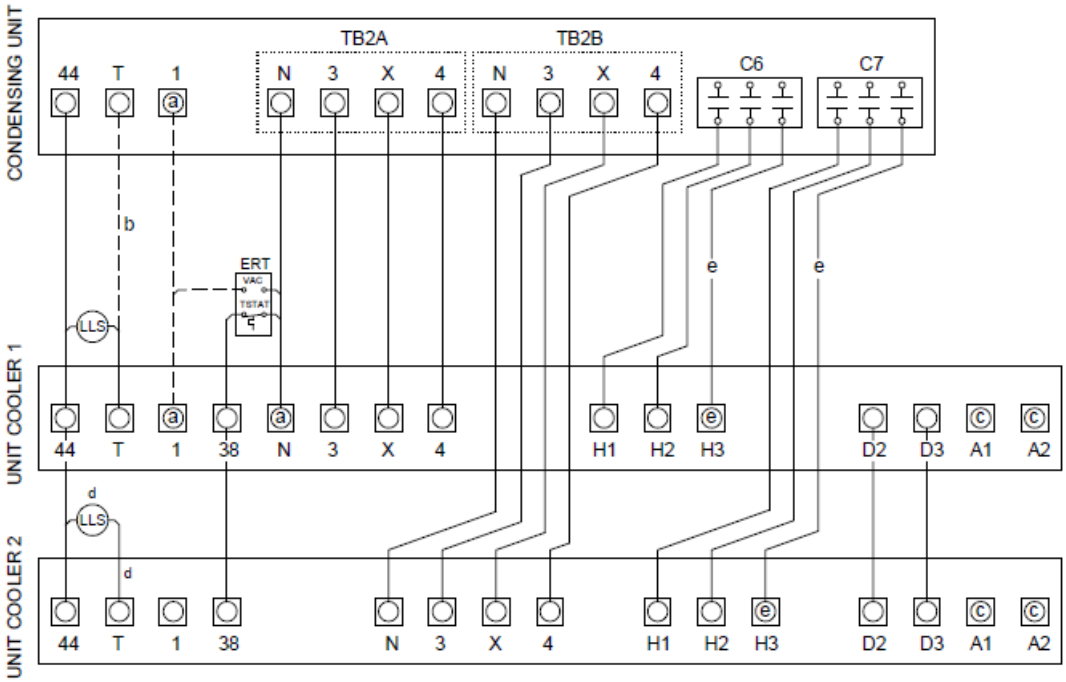


ELECTRIC DEFROST KITS: ED11-A2, ED11-B2



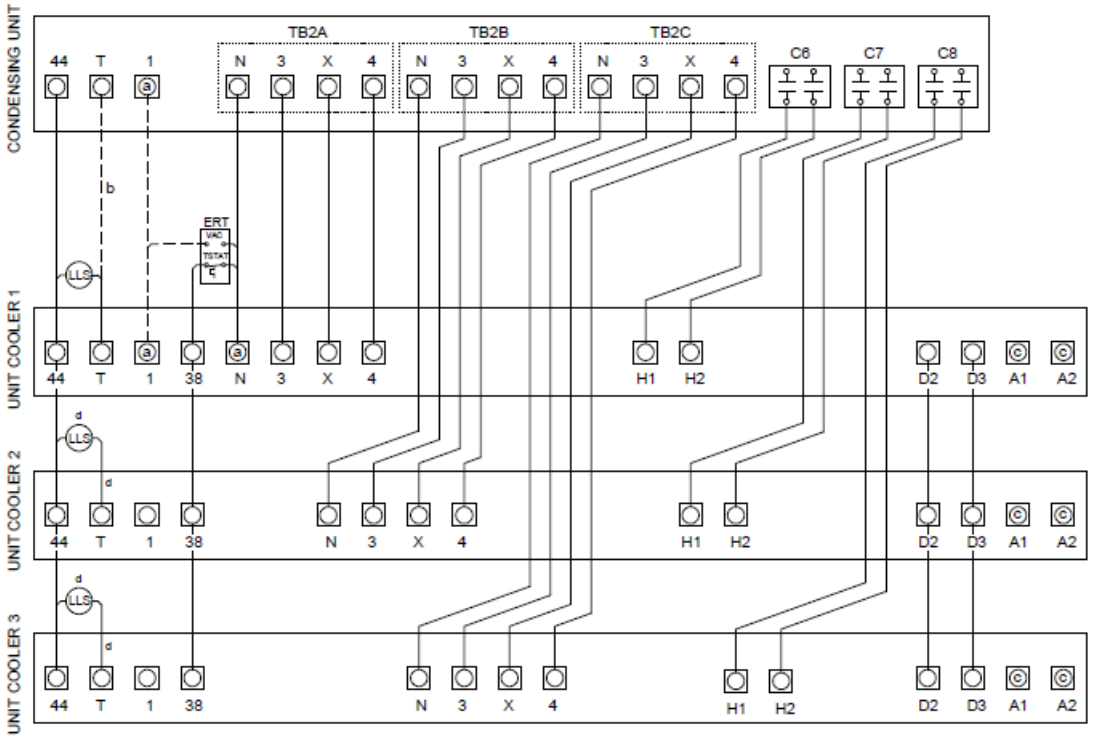
Note - A fuseblock option (not shown) is available for the contactor circuit (C6).

ELECTRIC DEFROST KIT: ED21-A2, ED21-B2, ED23-A2



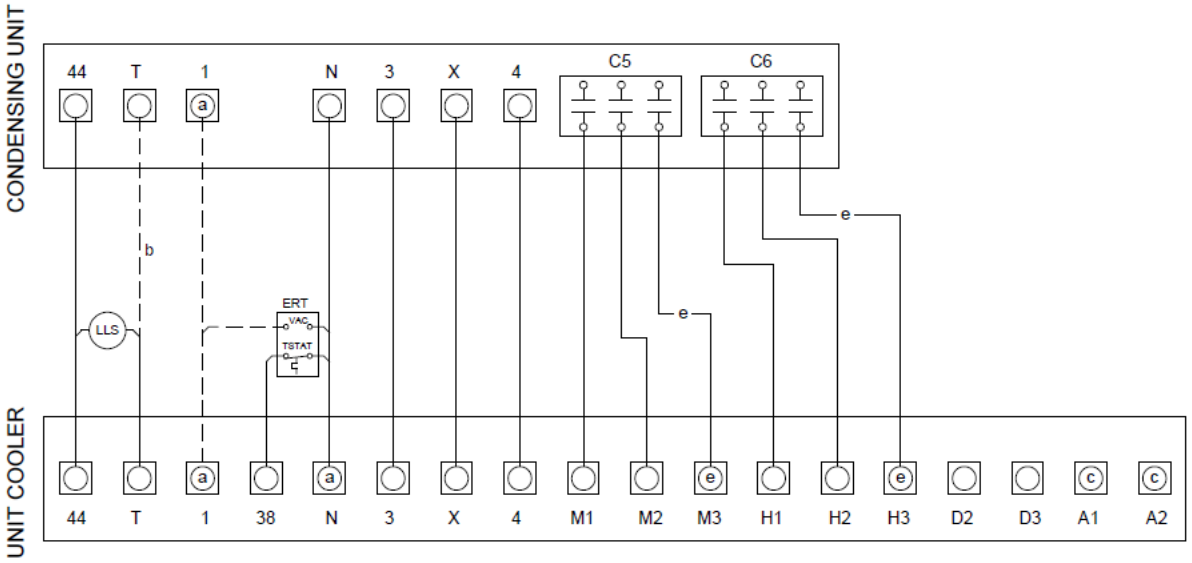
Note - A fuseblock option (not shown) is available for the contactor circuits (C6 & C7).

ELECTRIC DEFROST KIT: ED33-A2



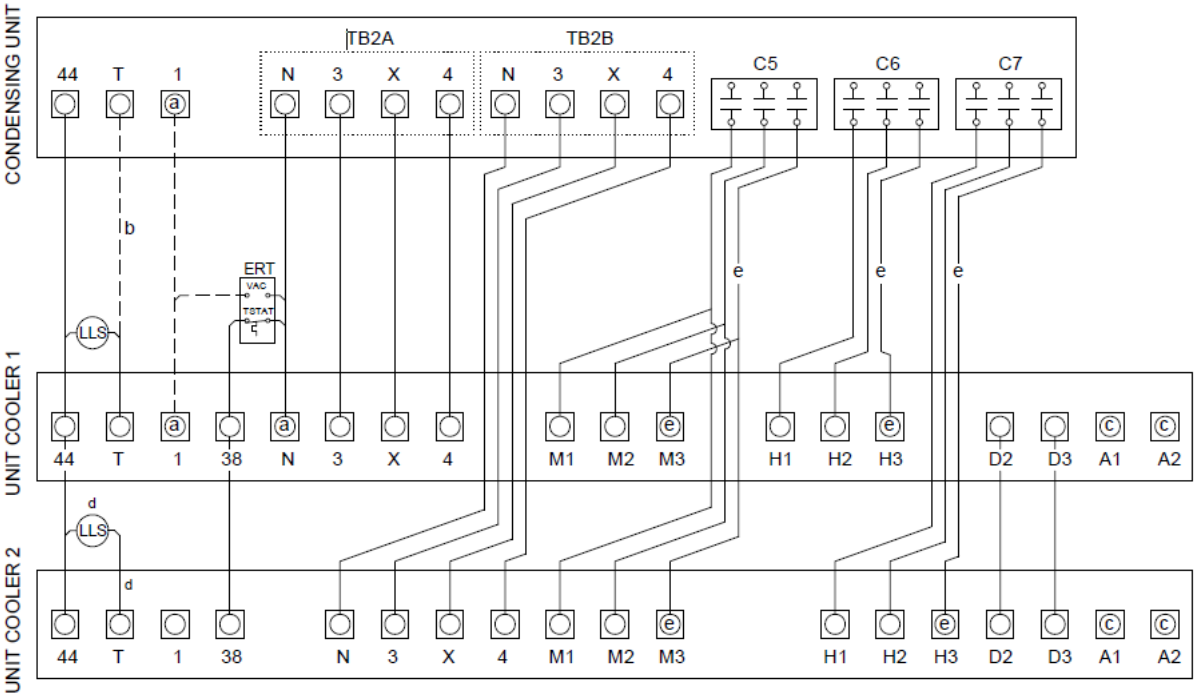
Note - A fuseblock option (not shown) is available for the contactor circuits (C6, C7, & C8).

ELECTRIC DEFROST KITS:
ED12-A2, -A4, -B2, -B4, -C2, -C4
ED17-A2, -A4, -B2, -B4, -C2, -C4
ED18-A2, -A4, -B2, -B4, -C2, -C4
DMA15, DMA20, DMA24, DMA30
DMA35, DMA40, DMA48



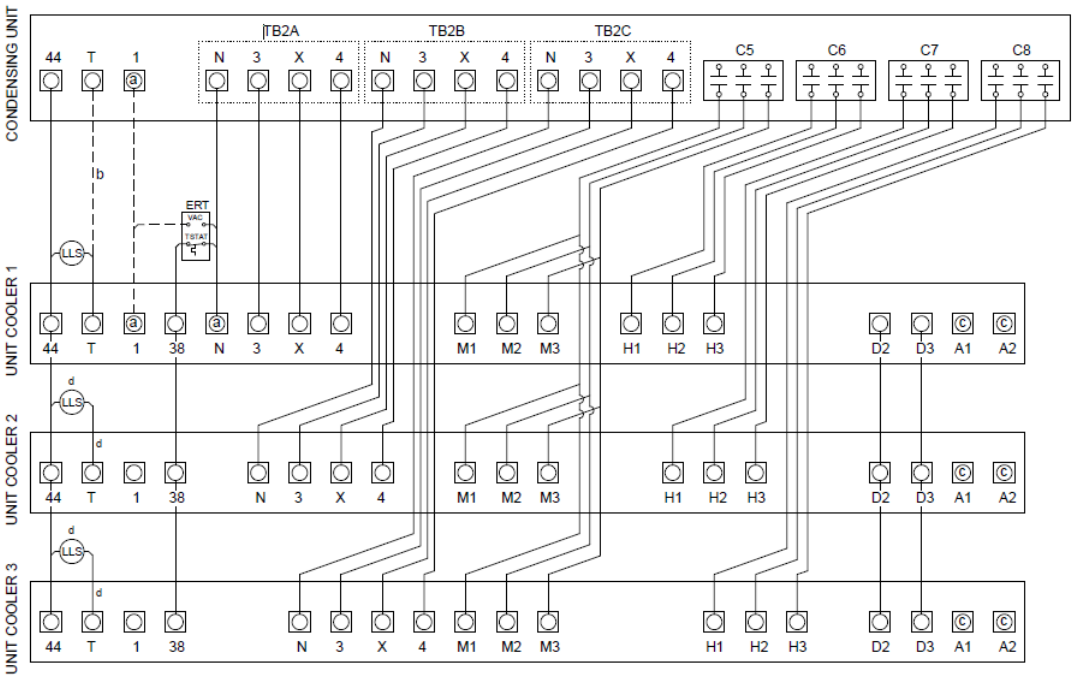
Note - A fuseblock option (not shown) is available for the contactor circuits (C5 & C6).

ELECTRIC DEFROST KIT:
ED22-A2, -A4, -B2, -B4, -C2, -C4
ED24-B2, -C2, -C4
DMB35, DMB40, DMB48, DMB60, DMB96



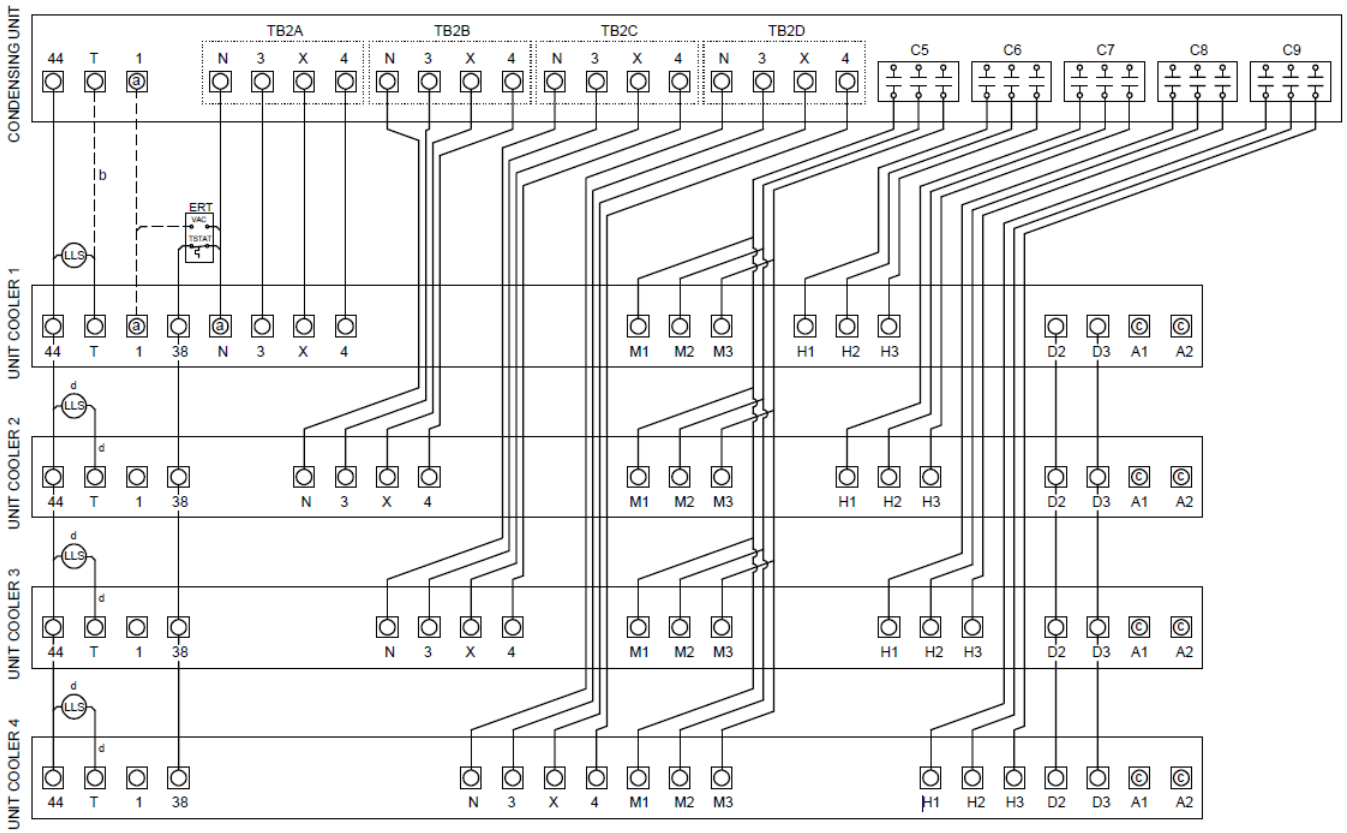
Note - A fuseblock option (not shown) is available for the contactor circuits (C5 through C7).

ELECTRIC DEFROST KITS: DMC35, DMC40, DMC48, DMC60, DMC96



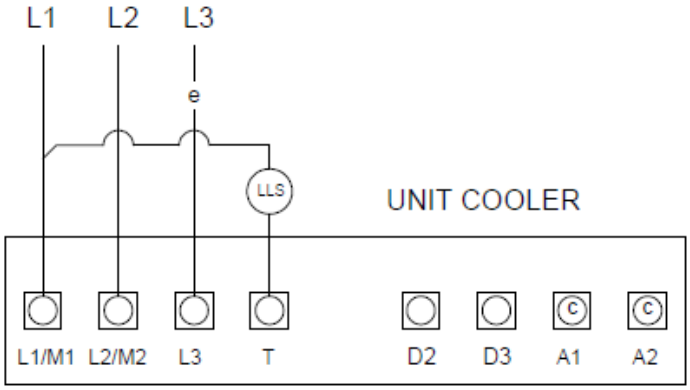
Note - A fuseblock option (not shown) is available for the contactor circuits (C5 through C8).

ELECTRIC DEFROST KITS: DMD35, DMD40, DMD48, DMD60, DMD96

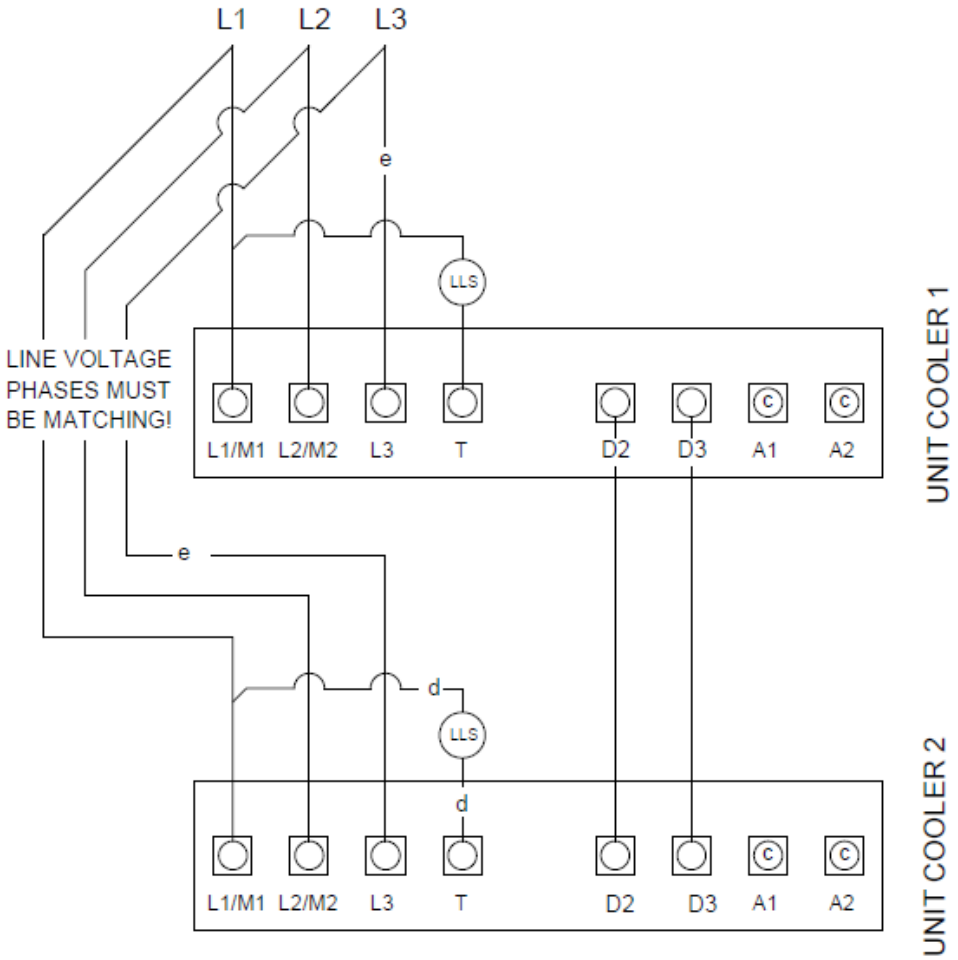


Note - A fuseblock option (not shown) is available for the contactor circuits (C5 through C9).

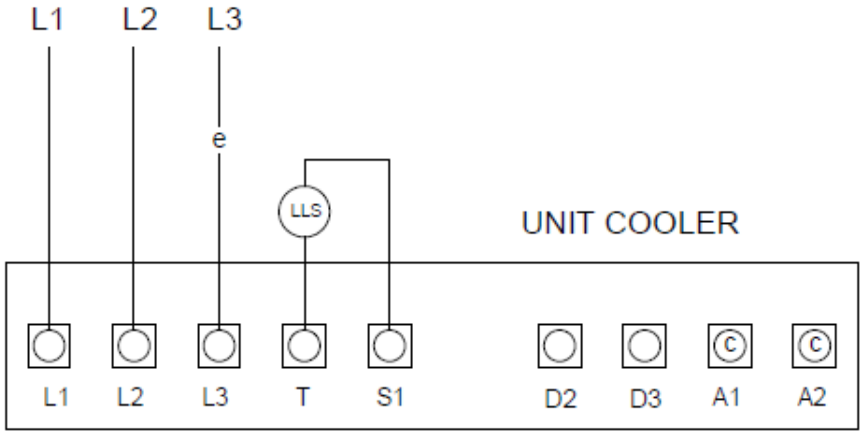
ECONET EQUIPPED UNIT COOLER, 115/230V, AIR OR ELECTRIC DEFROST, NO CONNECTION TO CONDENSING UNIT



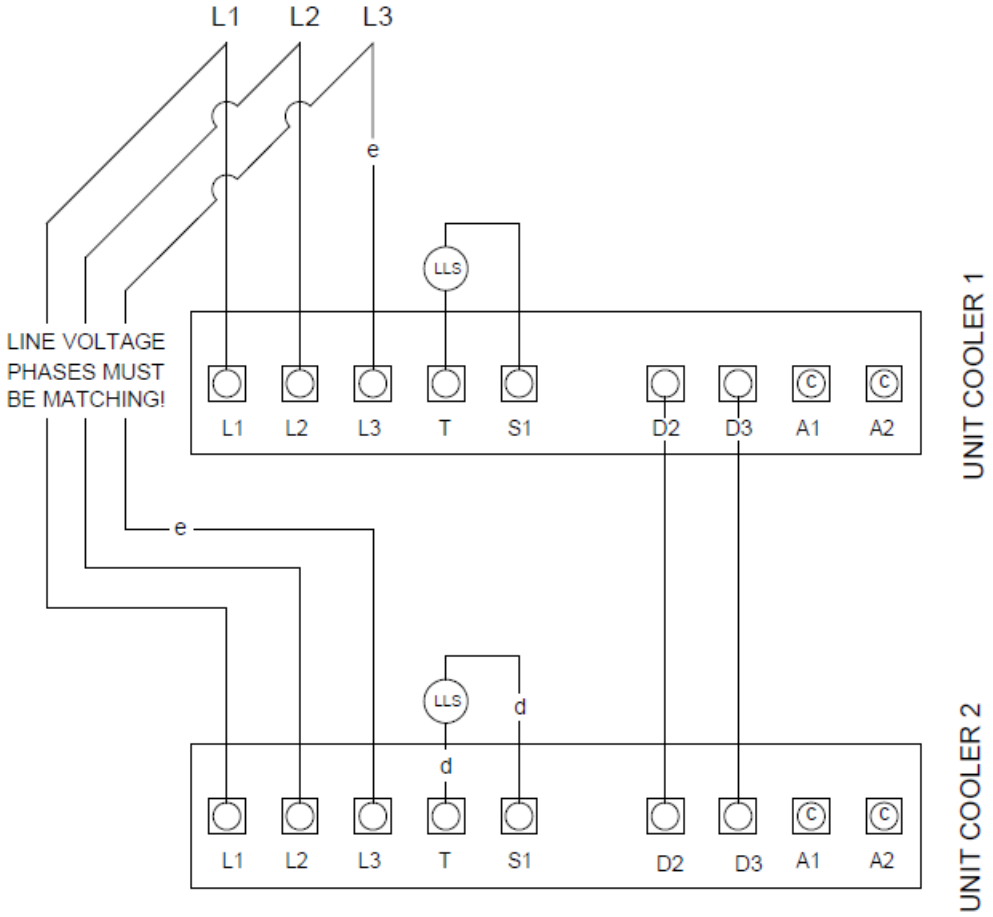
ECONET EQUIPPED UNIT COOLERS, 115/230V, AIR OR ELECTRIC DEFROST, NO CONNECTION TO CONDENSING UNIT, MULTIPLE UNIT COOLERS



ECONET EQUIPPED UNIT COOLER, 460V, AIR OR ELECTRIC DEFROST, NO CONNECTION TO CONDENSING UNIT

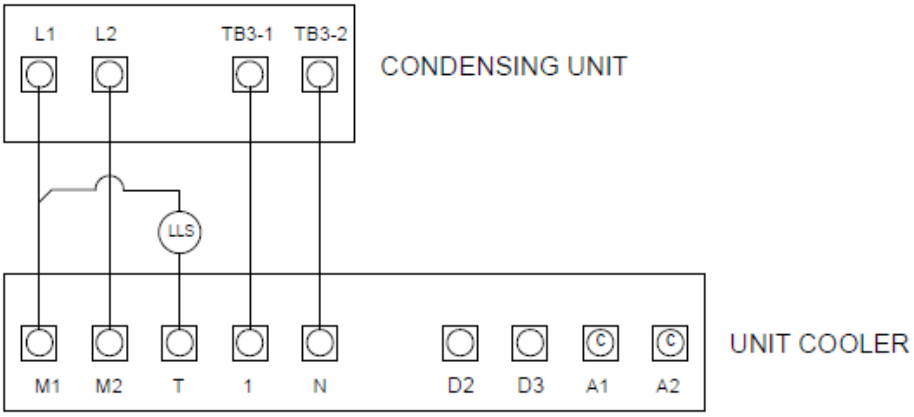


ECONET EQUIPPED UNIT COOLERS, 460V, AIR OR ELECTRIC DEFROST, NO CONNECTION TO CONDENSING UNIT, MULTIPLE UNIT COOLERS



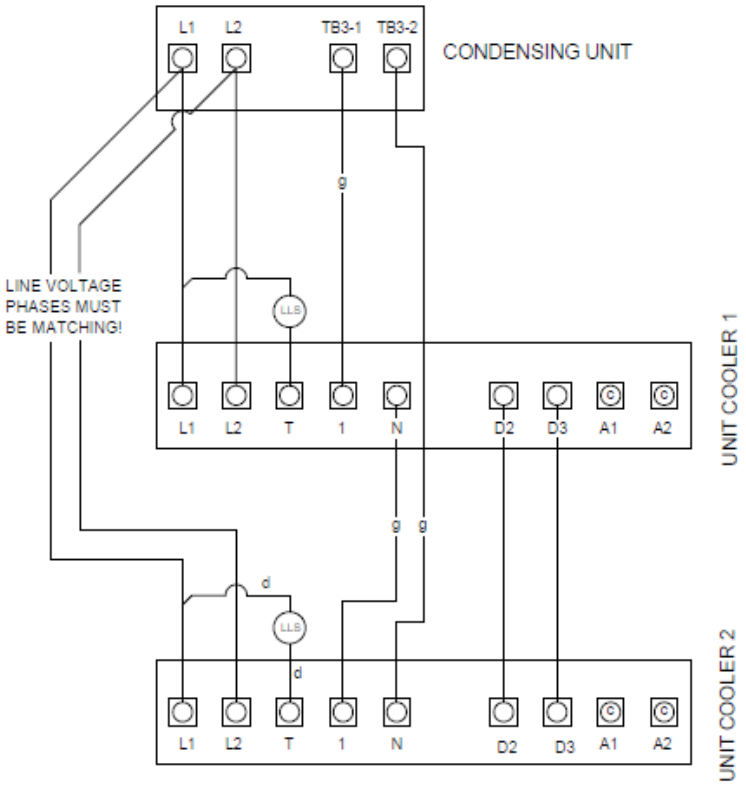
ECONET EQUIPPED, ELECTRIC DEFROST, CONDENSING UNIT CONNECTIONS, 230V

LOW PROFILE, CENTER MOUNT, OR LOW VELOCITY



ECONET EQUIPPED, ELECTRIC DEFROST, CONDENSING UNIT CONNECTIONS, 230V, MULTIPLE UNIT COOLERS

LOW PROFILE, CENTER MOUNT, OR LOW VELOCITY



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