ApexAir
TECHNICAL MANUAL V3

⚠ WARNING:

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

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LIMITED WARRANTY

Cambridge Air Solutions Limited Warranty is included within the Terms and Conditions that are sent with every Order Acknowledgement. For questions regarding Limited Warranty, contact Cambridge Air Solutions Customer Service Group at 1-800-473-4569.

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ApexAir
TECHNICAL MANUAL

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1 Safety/Warning Labels

Hazard Identification

Throughout this manual are Warnings, Cautions and Notes to alert the installing contractors, service and maintenance personnel of potential hazards that could result in personal injury, death or serious damage to property or equipment.

Your personal safety and the proper operation of this machinery depend on the careful observance of all Warnings, Cautions and Notes:

⚠ WARNING: **Indicates a potentially hazardous situation which could result in death or serious injury.**

⚠ CAUTION: **Indicates a potentially hazardous situation which may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

NOTE: *Indicates a situation that could result in equipment or property damage, or provides important information on installation considerations.*

⚠ WARNING:

Personal Protective Equipment (PPE) Required! Installing/servicing this unit could result in exposure to electrical, mechanical and chemical hazards.

⚠ WARNING:

Proper Field Wiring and Grounding Required! All field wiring MUST be performed by qualified personnel. Ensure all field wiring and grounding is accomplished in full accordance with National Electrical Code (NEC) and local/state electrical codes. Failure to do so may pose FIRE or ELECTROCUTION hazards resulting in death or serious injury.

- Before installing/servicing this unit, technicians MUST wear all recommended Personal Protective Equipment (PPE) for the specific work being undertaken.
- ALWAYS refer to appropriate Safety Data Sheets (SDS) sheets and OSHA guidelines for proper PPE.
- When working with or around hazardous chemicals, ALWAYS review appropriate SDS and OSHA guidelines to ensure compliance with safety standards for personal exposure levels, proper respiratory protection and handling recommendations.
- If there is a risk of arc flash, technicians MUST put on all PPE in accordance with the National Electrical Code (NEC) for arc flash protection, PRIOR to servicing the unit.
- Failure to follow recommendations could result in death or serious injury.
- The appliance is not to be used by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction.

1.1 DX Unit Refrigerant Warnings

Refrigerant Safety Group A2L

⚠ WARNING:

Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.

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.)

Do not pierce or burn.

Be aware that refrigerants may not contain an odor.

Please see section 10 - A2L Information for additional information on requirements for units with A2L refrigerants.

All technicians who handle refrigerants must be certified according to local laws and regulations. In the United States, the Clean Air Act (Section 608) sets forth the requirements for the handling, installation, cleaning, recovering, and disposal of certain refrigerants and the equipment that is used in these service procedures. Comply with all national, state, or municipal requirements in the proper handling of refrigerants.

⚠ WARNING:

This unit is equipped with a refrigerant leak detector for safety. To be effective, the unit must be electrically powered at all times after installation, other than when servicing.

⚠ CAUTION:

Installation, maintenance, service, repair, and decommissioning operations (such as breaking into the refrigerating circuit, opening of sealed components, and opening of ventilated enclosures) shall be carried out by personnel trained to meet the relevant national competency standards, having completed training that includes flammable refrigerants, potential ignition sources, refrigerant detectors, ventilation requirements, and correct working procedures.

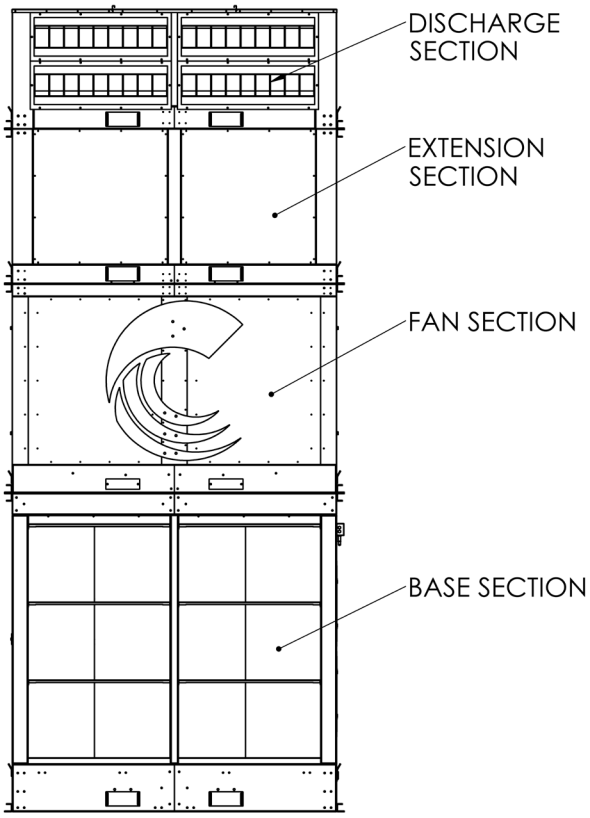
2 General Unit Information

Cambridge Air Solutions ApexAir units are air handlers that circulate air to distribute conditioned air to meet specific usage requirements. These models come in various configurations based on site requirements. Use this manual to install, start-up, operate, and maintain Cambridge Air Solutions ApexAir units. A careful review of this manual will help minimize installation, start-up, and maintenance difficulties.

Operating Environment

The unit is designed for indoor applications. When considering the placement of the air handler, it is important to consider the operating environment. The acceptable ambient temperature range for cooling operation is 60 °F to 104 °F (-15.5 °C to 40 °C). In fan-only or heating modes, the acceptable ambient temperature range is 20 °F to 104 °F (-6.7 °C to 40 °C). The maximum operating altitude of the air handler is 11,500 ft. above sea level.

NOTE: *Careful consideration is also required if the air handler(s) will be installed within a coastal temperate zone. Additional protective coatings may be necessary to prevent corrosion.*



2.1 Unit Construction

The ApexAir unit consists of four sections: Base, Fan, Extension, and Discharge.

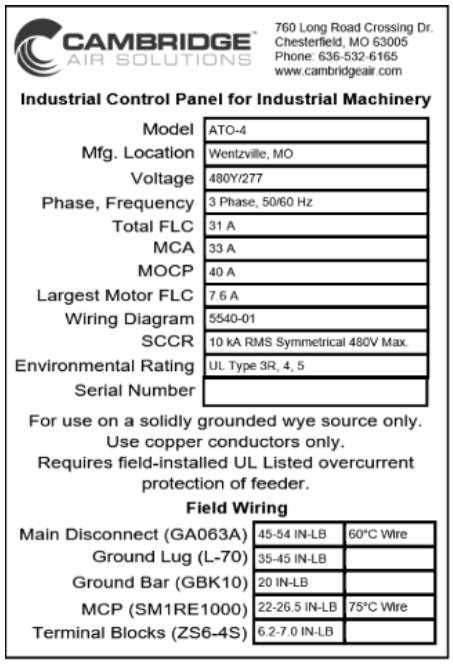
The unit ships in sections and requires field connection by the installation contractor.

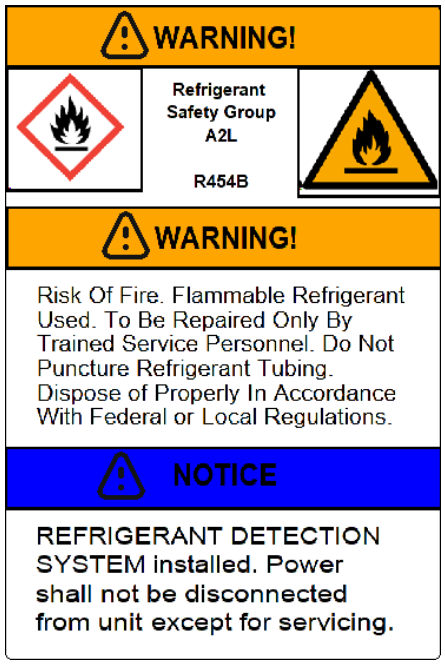
2 General Unit Information

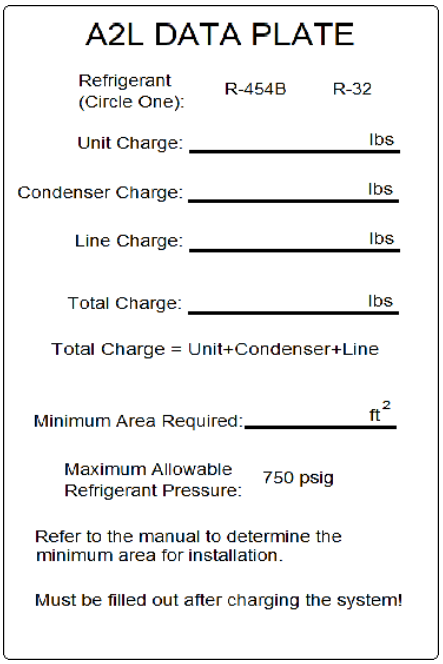
2.2 Nameplate & Labels

The ApexAir control panel will display a nameplate label displaying unit data.

Units with A2L refrigerants will display a label with refrigerant charge information. This data is to be populated by the installing contractor based on paired outdoor unit and installed line set. See section 10 - A2L Information for details.







3 Receiving/Storage/Packaging/Rigging

Upon receipt of the air handler(s), a thorough inspection should be performed to note any shipping damage that may have occurred and that the shipment is complete.

Factory shipping protection should be removed immediately to allow complete access for the inspection. The shipping protection provided by the factory is for transit protection only and should not be used as a jobsite storage cover.

3.1 Receiving Checklist

- Check all access doors to confirm that the latches and hinges are not damaged.
- Inspect the interior of each section for any internal damage.

NOTE: *Concealed damage must be reported within 5 days of receipt*.

- Inspect the coils for damage to the fin surface and/or coil connections.
- Check all control devices attached to the unit and confirm that they are not damaged.
- Manually rotate the fan impeller to ensure free movement.
- Inspect the fan housing and remove any foreign objects. Be careful not to step on the pressure nozzles or tubing.
- Locate all assembly hardware and any loose parts, typically packaged inside the Base section of the unit.

3.1.1 Resolving Shipping Damage

NOTE: *Cambridge Air Solutions is not responsible for shipping damage*.

Cambridge Air Solutions air handlers ship Free-On-Board (FOB).

Ownership of the units transfers to the customer the moment the delivery truck leaves the Cambridge Air Solutions factory. If damage has occurred to the unit during shipment, follow these instructions:

1. Make specific notation, describing the damage, on the freight bill. Take photos of the damaged material if possible.
2. Report all claims of shipping damage to the delivering carrier immediately and coordinate carrier inspection if necessary.
3. Contact Cambridge Air Solutions immediately for replacement of damaged parts or components.

NOTE: *Do not attempt to repair the unit without consulting the delivering carrier and Cambridge Air Solutions*.

3.2 Preparing the Site

Ensure the installation site can support the total operating weight and dimensions of the unit. Refer to the unit submittals for actual weights and dimensions. The area in front of the unit should be free of any obstructions or loose materials to allow air to flow properly into the unit.

It is recommended to maintain at least six feet of clearance (72") in front of the unit inlet to ensure uniform airflow and maximum unit performance. Three feet of clearance on the left and right of the unit is recommended for service access. Plan for possible replacement of the coil by leaving room to remove the coil through the side of the unit.

The airflow inlet at the base, the logo on the fan section, and the airflow discharge at the top of the unit should all face the same direction. Areas around the unit should be cleared to allow proper clearance for refrigerant lines, the units doors to open, and should allow access to the electrical panel.

General Notes:

- Allow room for all piping, ductwork, and electrical connections, and fan and coil removal.
- Allow easy access to the electrical panels and HMI without trip hazards.
- Ensure there is adequate height for condensate drain requirements (see section “Condensate Drain Connections”.)
- Confirm the foundation of the mounting platform is level and large enough to accommodate the unit. Refer to the unit submittals for specific dimensions.

- Provide adequate lighting for maintenance personnel to perform maintenance duties.
- Access to an electrical circuit meeting the electrical requirements specified on the unit submittals.
- Provide permanent power outlets in close proximity to the unit for installation and maintenance.
- Installation location should be chosen to avoid potential impacts with forklifts or other items. If in a high-traffic location, installation of bollards or similar is recommended to protect the unit and all piping.
- A unit with A2L refrigerant shall be installed in an area where the room size meets the minimum specified room area (see Section 10 - A2L Information). If installed in an unventilated area, the area shall be so constructed that should any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard.
- A unit with A2L refrigerant shall be installed in an area without continuously operating open flames or other potential ignition sources.

3.3 Lifting/Rigging Directions

All lifting and handling operations must be carried out in accordance with the standards and regulations applicable to the handling location and using standardized equipment.

Field rigging procedures will vary. Forklift pockets are located at the bottom of each section for lifting. Lifting brackets for use with a crane are located at the bottom corners of each section. Additional lifting brackets/clips may be provided with the unit when required. Use proper lifting procedures and rigging, including a spreader where necessary, to avoid equipment damage and personal injury.

3.3.1 General Lifting Considerations

The unit will arrive in sections and will need to be individually hoisted for assembly. Refer to unit submittals for section weights.

Before preparing the unit for lifting, estimate the approximate center of gravity for lifting safety. Because of placement of internal components, the unit weight may be unevenly distributed, with more weight in the coil and fan areas. Refer to the unit submittals for actual section weights. Test the unit for proper balance before lifting.

- Always rig sections as they ship from the factory.
- Do not bolt sections together before rigging unless otherwise approved. The Discharge and Extension sections may be bolted together before rigging.
- Use the lifting pockets or lugs provided. The air handler is not designed to be lifted or rigged from the top of the unit.
- All shipping supports and crating on the face of the sections must be removed to permit proper fit-up and sealing of the surfaces. Dispose of properly.
- Ensure that lids, covers, and doors are closed on sections, fans, junction boxes, and electrical panels

⚠ WARNING:
Refer to unit submittals for weight and forklift limitations before attempting to use a forklift for offloading.

Forklifting Considerations

All of the unit's sections are equipped with forklift pockets and lifting lugs. Fork pockets are through holes on the Base section, and are not through holes on the Fan, Extension, and Discharge sections. A forklift may be used to lift a single section using the fork pockets located near the bottom in each section.

NOTE: *Due to the weight of the coil, the center of the gravity for the Base section is shifted towards the front, and it is therefore recommended to lift the Base section from the front only.*

3.4 Storage Information

- Do not remove the protective caps on the coil prior to installation.
- The unit must be stored on a flat surface.
- Fit protection against shocks or that could damage the unit or its accessories.
- Store the sections in their packaging, in a dry area sheltered from the weather.
- Unit rated storage temperature range is -4 °F to 140 °F (-20 °C to 60 °C).

4 Installation

NOTE: *All work to conform to local, state, and national codes and ordinances and per approved submittals.*

4.1.1 Assembly Hardware

Locate all assembly hardware and any loose parts, typically packaged inside the Base section of the unit.

Check all sections thoroughly before contacting your Cambridge Air Solutions Sales Representative to report missing items.

NOTE: *Do not proceed with unit assembly until verification that all materials are present.*

4.2 Section-To-Section Mechanical Assembly

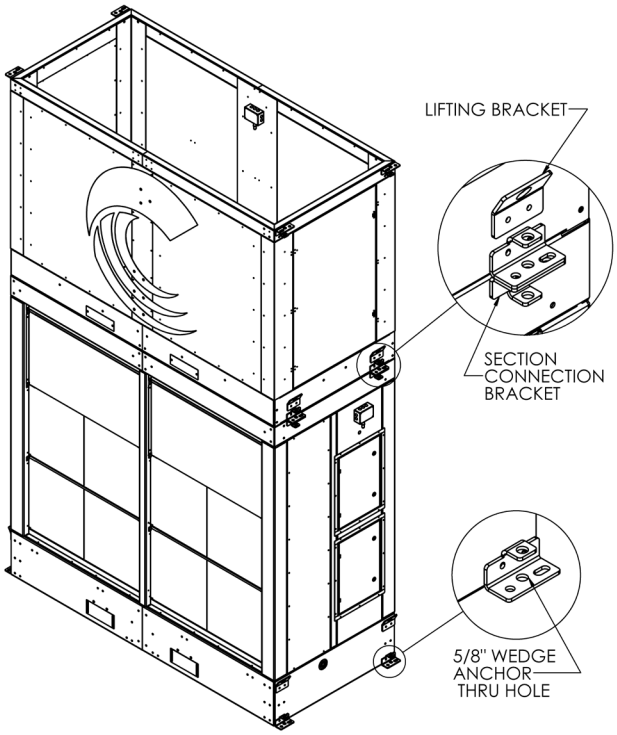
4.2.1 Base Section

Once the installation site has been selected and prepared, place the Base section into the desired location. The section must be supported by the Base channels around the entire perimeter of the unit. Check that the section is level to ensure proper operation of the unit. Anchor the Base section to the concrete floor with 5/8" wedge anchors or similar at each of the four corners.

NOTE: *Unit must be installed on a level foundation with variation of height not to exceed 1/8" (3.2 mm) over the length and width of the unit.*

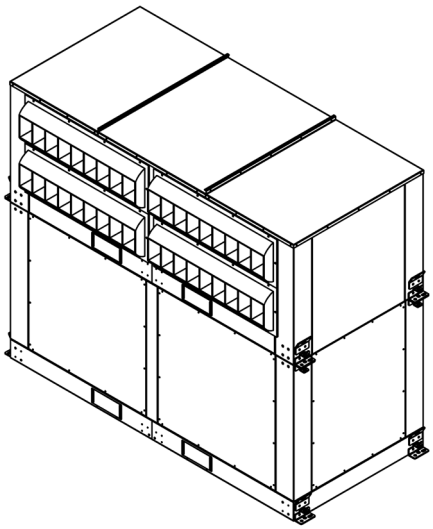
4.2.2 Fan Section

After securing the Base section to the floor, carefully place the Fan section on top of the Base section. Brackets should be present on the top side channels of the Base section and on the bottom side channels of the Fan section for alignment and fastening. It is recommended to use a ½"-13 X 1.5" hex head bolt with accompanying washers to loosely fasten one connection point and adjust the position of the fan section to align the rest of the connection points. Once aligned, tightly fasten together all four connection points. Only one bolt is necessary at each corner.



4.2.3 Discharge and Extension Section (if equipped)

While on the ground, orient the louvers on the Discharge section to the desired position. Use a forklift or crane to carefully place the Discharge section on top of the Extension section (if equipped) and align each corner. It is recommended to use a ½"-13 X 1.5" hex head bolt with accompanying washers to loosely fasten one connection point and adjust the position of the discharge section to align the rest of the connection points. Once aligned, tightly fasten together all four connection points. Only one bolt is necessary at each corner.



4.2.4 Final Stacking

Carefully place the assembled Discharge and Extension section on top of the Fan section using the same method previously described for stacking. Fasten seismic tiedowns on the Discharge or Extension section brackets. Close and fasten all fork pockets using the provided fork pocket covers. Apply caulk between every section.
Ensure all specified filters are installed.

> **⚠ WARNING:**
> Work on the electrical components must only be carried out by an electrician or technician with the relevant training in this field, under the supervision of an electrician and in accordance with industry practice.

> **⚠ WARNING:**
> All installations should be performed in accordance with local and state codes.

4.3 Section-To-Section Electrical

Consult the Field Wiring Connection Diagram provided with the unit for information specific to the unit.

Inside the stacked unit, cables can be located attached to the fan section. Locate the Fan section control cable and connect it to the corresponding receptacle on the upper (control circuit) panel in the base section.

Run the black motor cables to the correct motor circuit protectors in the lower (power circuit) panel.

Insulation Color	Terminal
Black	T1
White	T2
Red	T3
Green	Ground Bar

Secure the cables in the Base section with straps or ties to avoid pinch points and excessive movement.

Consult the table below for the color code. Tighten each cable gland on the enclosure to ensure strain relief.

NOTE:

- Wire the unit according to approved submittals and the wiring diagram.
- Electrical connection is only possible once mechanical assembly has been completed.
- Fans and sensors in the fan section are pre-wired.
- The Fan section control cable facilitates communication to and from the fans, sensors and PLC.
- Follow tightening torque requirements listed on the unit.

5 External Connections

When making external connections to the ApexAir unit, consider serviceability and accessibility before mounting and installing any permanent connections to the cabinet. The unit may include factory-provided casing penetration points (entry points) for field-provided piping and wiring.

Duct Connections

All duct connections to the air handlers should be installed in accordance with the standards of the National Fire Protection Association (NFPA) and all other local, state, and national codes and ordinances, including:

- NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems for installing air conditioning and ventilating systems other than residence type.
- NFPA 90B Standard for the Installation of Warm Air Heating & Air-Conditioning Systems.
- See unit submittal documentation & specifications for any additional duct mounting information.

To ensure the highest fan efficiency, duct turns and transitions must be made carefully, minimizing air friction losses and turbulence. Proper ductwork installation, as outlined by such organizations as Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), should be followed closely.

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 Cambridge Air Solutions or declared suitable with the refrigerant shall be installed in connecting ductwork.

5.1 Electrical Connections

5.1.1 Power and General Electrical Connections

NOTE: *All field installed wiring must comply with NEC and applicable codes. Properly ground the unit. The unit, when installed must be electrically grounded in accordance with the National Electrical Code, ANSI/ NFPA No. 70E.*

Refer to the Cambridge Air Solutions wiring diagrams furnished with the unit, regarding factory wired and field installed wiring requirements. Actual wiring diagrams will differ according to the options used. Any outdoor conduits leading into the unit should be installed to prevent rain from wetting any high voltage wire.

The air handler requires field-installed, UL-Listed overcurrent protection of the feeder circuit outside of the electrical panels.

Line Power should be brought into the unit and connected to the disconnect in the lower (power circuit) panel. Install all power wiring and controls per drawings, specifications, and applicable codes.

- Verify that power supply electrical characteristics comply with unit nameplate specifications.
- Inspect all electrical panel components and tighten any loose connections.
- Adhere to all tightening torques listed on the unit.

While working on electrical components, the electrical panel and unit casing shall not be altered in a way that the level of protection is affected. This includes damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc. Follow instructions listed on the specific wiring diagram to maintain the unit's environmental rating.

5 External Connections

5.1.2 Condensing Unit / Chiller Control Connections

Refer to the Field Wiring Connection Diagram provided with the unit for information specific to the unit.

Always use properly sized wire with the correct voltage insulation. For field-installed control wiring over 24V, follow instructions provided in the wiring diagram for spacing and separation of circuits.

Connect the condensing unit or chiller to the four dry-contact relays located in the control circuit panel. The air handler supports control of up to four stages of cooling. Always refer to the condensing unit or chiller manufacturer's literature for complete wiring information. For condensing units or chillers with more than four stages, consult the documentation from the manufacturer of the unit. Typically, this will involve jumping together stages of the same circuit.

5.1.3 Heat Pump Control Connections

The ApexAir unit is equipped with control terminals that allow direct integration with an external heat pump system. These terminals provide the necessary signals for on/off control, mode selection, and capacity modulation.

All field wiring between the ApexAir control panel and the heat pump shall be completed in accordance with the approved submittal documents and the field wiring connection diagram provided with the project. This diagram identifies all required terminal points and wire types for the specific configuration.
Control Terminals:

- Demand Output (0–10 VDC): Provides a proportional analog signal corresponding to the heating or cooling demand from the ApexAir control system.
- Enable Signal (Digital Output): Provides a dry-contact or 24 V signal to command the external heat pump to turn ON or OFF.
- Mode Selection (Digital Output): Provides a discrete signal to toggle the heat pump between Heating and Cooling modes.

All field wiring must conform to the National Electrical Code (NEC) and applicable local codes. Only qualified personnel familiar with heat-pump control interfaces should perform these connections. The installer shall verify that all control wiring is landed on the correct terminals and that polarity and voltage levels are correct prior to energizing the system. The ApexAir and external heat pump must remain de-energized until all wiring and safety checks are complete. The installer must also confirm that the control signals and reference voltages between devices are compatible and that wiring practices follow the standards outlined in the submittal documentation.

⚠ CAUTION:
Installation, maintenance, service, repair, and decommissioning operations (such as breaking into the refrigerating circuit, opening of sealed components, and opening of ventilated enclosures) shall be carried out by personnel trained to meet the relevant national competency standards, having completed training that includes flammable refrigerants, potential ignition sources, refrigerant detectors, ventilation requirements, and correct working procedures.

5.2 Refrigerant Connections

The installation of pipe-work shall be kept to a minimum, and pipe-work shall be protected from physical damage in operation and in service, and shall be in compliance with national and local codes and standards, such as ASHRAE 15, ASHRAE 15.2, IAPMO Uniform Mechanical Code, ICC International Mechanical Code, or CSA B52. All field joints shall be accessible for inspection prior to being covered or closed.

The ApexAir unit must only be connected to a condensing unit suitable for use with the same refrigerant. The ApexAir-Series or heat pump unit is a Partial Unit, complying with the Partial Unit requirements of UL 60335-2-40, and must only be connected to other units that have been confirmed as complying to corresponding Partial Unit requirements of this standard or of UL 1995/CSA C22.2 No 236. Refer to condensing unit manual for any additional refrigerant connection requirements.

5 External Connections

When installing or servicing a unit with an A2L refrigerant you must have all necessary equipment and adhere to the specified requirements. A2L refrigerants include R-454B and R-32. Only use the refrigerant specified for your unit. Necessary equipment includes:

- Gauge sets, hoses, refrigerant containers, and the recovery system must be designed to handle the Polyolester (POE) type oils and the pressures of the unit's refrigerant.
- Manifold sets must be high side and low side with low side retard.
- All hoses must have a 700 psig service pressure rating.
- Electronic leak detectors can be used for detecting refrigerant leaks. For flammable refrigerants, check the sensitivity and potentially recalibrate the detector.
- Leak detection fluids are also suitable for use with most refrigerants. Avoid using detergents containing chlorine, as they can react with refrigerants and corrode copper pipework. Examples of leak detection methods include the bubble method and fluorescent agents.
- Recovery equipment, including refrigerant recovery containers, must be specifically designed to handle the unit's A2L refrigerant..
- Only use a TXV that is specifically designed for this units refrigerant.
- If an indirect refrigerating circuit is used, inspect the secondary circuit for refrigerant presence.
- Maintain visible and legible markings on the equipment. Illegible markings or signs should be corrected.
- Install refrigerant pipes and components in locations where they are unlikely to be exposed to corrosive substances, unless the components are made from corrosion-resistant materials or adequately protected against corrosion.

5.2.1 Installing the Refrigerant Piping

Pipe-work shall not be installed in an unventilated space, if that space is smaller than the minimum floor area (A_{min}) specified in Tables 3 and 4, except for installations where the installed pipes comply with UL 60335-2-40 section 22.116. Mechanical connections shall be accessible for maintenance purposes, and all compliance with national gas regulations shall be observed in spaces containing refrigerant pipes.
To install the refrigerant piping correctly, you must do the following:

1. Install the vapor line and liquid line.
2. Install a liquid-line filter drier on the liquid line.
3. Braze the refrigerant lines and service valves
4. Install the thermostatic expansion valve (TXV).
5. Check the refrigerant system for leaks.
6. Evacuate the refrigerant lines and the indoor coil.
7. Release refrigerant into the system.

> **⚠ CAUTION:**
> When installing refrigerant piping through the wall, keep the piping capped to prevent debris from entering. Do not place pipe directly on the ground.

To install the vapor and liquid lines, do the following:

- Connect the outdoor unit to the indoor coil using field-supplied refrigerant grade (ACR) copper tubing that is internally clean and dry. You must install units with only the tubing sizes for approved system combinations.

- Install the refrigerant lines with as few bends as possible. Make sure not to damage the couplings or kink the tubing. Use clean hard-drawn copper tubing where no appreciable amount of bending around obstruction is necessary. If you must use soft copper, make sure to avoid sharp bends that may cause a restriction.
- Install the refrigerant lines so that they do not obstruct service access to the coil, indoor unit, or filter.
- Isolate the refrigerant lines to minimize noise transmission from the equipment to the structure.

5 External Connections

- Make sure that the vapor line is insulated with a minimum of 1/2 in. foam rubber insulation such as Armaflex or an equivalent. Make sure that the liquid line is insulated if it may be exposed to direct sunlight, high temperatures, or excessive humidity.
- Tape and suspend the refrigerant lines correctly. Do not allow tube metal-to-metal contact.
- Use PVC piping as a conduit for all underground installations. Keep buried lines as short as possible to minimize the build up of liquid refrigerant in the vapor line during long periods of shutdown.

Installing the Liquid Line Filter Drier:

You must install a bi-flow liquid-line filter drier external to the outdoor unit. The indoor unit must be in place before you install the field-supplied liquid-line filter drier designed for the specified refrigerant.

To install the liquid-line filter drier, do the following:

1. Find a suitable location on the liquid line near the indoor unit.
2. Install the liquid-line filter drier in accordance with the installation instructions for the liquid line filter drier.

Brazing the refrigerant lines and service valves:

It is important to take the necessary precautions for brazing the refrigerant lines and service valves. All outdoor unit and indoor coil connections are copper-to-copper, and must be braze them with phosphorous-copper alloy material such as Silfos-5 or equivalent. Do not use soft solder. Outdoor units should have reusable service valves on both the liquid and vapor connections. Please take adequate precautions to ensure an internally clean and dry system.

***NOTE**: Use a wet rag or heat blocking putty to prevent heat damage. Protect painted surfaces and any exposed insulation while brazing.*

To braze the refrigerant lines and service valves, do the following:

NOTE:

Using a line size larger than specified could result in oil return problems. Using too small a line results in loss of capacity and other problems caused by insufficient refrigerant flow. Horizontal refrigerant vapor lines between the indoor unit and the outdoor unit must slope towards the outdoor unit at approximately 1/8 in/ft to facilitate sufficient oil return.

1. Remove the cap and Schrader core from both the liquid and vapor service valve service ports at the outdoor unit.
2. Connect low pressure nitrogen to the liquid line service port.
3. Braze the liquid line to the liquid valve at the outdoor unit. Ensure to wrap the valve body with a wet rag. Allow the nitrogen to continue flowing.

⚠ CAUTION:

The indoor coil is under inert gas pressure. Relieve pressure from the coil by depressing the Schrader core at the end of the suction manifold stub out. Dry nitrogen must always be supplied through the tubing while it is being brazed because the temperature required is high enough to cause oxidation of the copper, unless an inert atmosphere is provided. The flow of dry nitrogen must continue until the joint cools. Always use a pressure regulator and safety valve to ensure that only low-pressure dry nitrogen is introduced into the tubing. Only a small flow is necessary to displace air and prevent oxidation.

⚠ WARNING:

Never attempt to repair any brazed connections while the system is under pressure. Personal injury could result.

4. Carefully remove the plugs from the liquid and vapor connections at the indoor coil.
5. Braze the liquid line to the indoor coil liquid connection. Nitrogen should be flowing through the indoor coil.

5 External Connections

6. Slide the grommet away from the vapor connection at the indoor coil. Braze the vapor line to the indoor coil vapor connection. After the connection has cooled, slide the grommet back into its original position.
7. Protect the vapor valve with a wet rag and braze the vapor line connection to the outdoor unit. The nitrogen flow should be exiting the system from the vapor service port connection. After this connection has cooled, remove the nitrogen source from the liquid fitting service port.
8. Replace the Schrader core in the liquid and vapor valves.

Installing the thermostatic expansion valve (TXV):

1. Relieve the holding charge in the system.
2. Connect the outlet of the TXV to the liquid line distributor. NOTE: Remove any plastic components such as an O-ring prior to brazing any connections. Use a wet rag during brazing. Keep the sensing bulb and capillary tubes away from the heat.
3. For an externally equalized TXV, the TXV equalization line should be installed past the suction line header. Install the equalizing line on top of the horizontal suction line, pointing up vertically. To avoid oil blockage, never install the equalizing line pointing down. For an internally equalized TXV, this step can be skipped.

NOTE:

To prevent moisture and contaminates from entering the system, the coil must not be open to atmosphere for extended periods of time. If the coil cannot be brazed into the refrigeration system during a routine installation period, the ends must be temporarily closed or plugged. For a short term delay, use masking tape over the ends of the copper tubing to close the tube from the air. For a longer term delay, use plugs or caps. There is no need to purge the coil if this procedure is followed.

4. Secure the sensing bulb on top of a horizontal section of the suction line. Wrap the entirety of the bulb and its securing bracket in insulation tape.

Checking for refrigerant leaks:

After completion of field piping, the field pipework shall be pressure tested with an inert gas and then vacuum tested prior to refrigerant charging, according to the following requirements:

- The minimum test pressure for the low side of the system shall be the low side design pressure and the minimum test pressure for the high side of the system shall be the high side design pressure, unless the high side of the system cannot be isolated from the low side of the system in which case the entire system shall be pressure tested to the low side design pressure.
- Field-made refrigerant joints indoors shall be tightness tested, with a test method having a sensitivity of 5 grams per year of refrigerant or better under a pressure of at least 0.25 times the maximum allowable pressure. No leak shall be detected.

Safety Considerations:

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

a. The following leak detection methods are deemed acceptable for all refrigerant systems:

b. 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 recalibration. Calibrate the detection equipment in a refrigerant-free area. Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used. Set leak detection equipment at a percentage of the LFL of the refrigerant and calibrate to the refrigerant employed. Ensure the appropriate percentage of gas with a maximum of 25% is confirmed.

2. Leak detection fluids are also suitable for use with most refrigerants. Avoid the use of detergents containing chlorine as the chlorine may react with the refrigerant and corrode the copper pipework. Examples of leak detection fluids are bubble method and fluorescent method agents.
3. If a leakage of refrigerant is found that requires brazing, recover all of the refrigerant from the system or isolate the leakage by means of shut-off valves in a part of the system remote from the leak. Remove refrigerant according to the outdoor unit's Installation Manual.

Conducting the Leak Test:

1. Pressurize the refrigerant piping and the indoor coil to 435 psig – 600 psig with dry nitrogen.
2. Leak test all refrigerant piping connections including the service port flare caps to be sure they are leak tight. Do not over-tighten the refrigerant piping connections.
3. Release the nitrogen charge.
4. If refrigerant leaks are present, repair the leaks and repeat Step 1 to Step 4 as needed until the testing indicates that no refrigerant leaks are present.

Evacuating the System:

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 is followed, since flammability is a consideration.

The following procedure shall be adhered to:
1. Evacuate.
2. Purge the circuit with inert gas, and evacuate (optional for A2L).
3. Continuously flush or purge with inert gas when using flame to open circuit.
4. Open the circuit.

The refrigerant charge shall be recovered into the correct recovery cylinders if venting is not allowed by local and national codes. Do not mix refrigerants in cylinders. If the circuit is purged, oxygen-free nitrogen should be used. Compressed air or oxygen shall not be used for purging refrigerant systems. 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.

5.2.2 Refrigerant Charging

When charging the system, in addition to conventional charging procedures, the following requirements shall be followed:

- 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 in an appropriate position according to the instructions.
- Ensure that the ApexAir and the condensing unit or heat pump are properly grounded prior to charging the system with refrigerant.

⚠ CAUTION:
It is unlawful to knowingly vent, release, or discharge refrigerant into the open air during repair, service maintenance, or the final disposal of this unit.

- Extreme care shall be taken not to overfill the refrigeration system.
- After charging the system, a follow-up leak test shall be carried out prior to leaving the site.

Refer to Section 10 - A2L Information for details on the calculation of system refrigerant charge and related requirements.

5 External Connections

5.3 Chilled Water Connections

5.3.1 Chilled Water Information

The entering water must meet the following requirements:
Minimum Temperature: 40 °F
Maximum Temperature: 250 °F
Minimum Pressure: 15 psig
Maximum Pressure: 300 psig at 200 °F

Glycol may be added to the system fluid supply, though use of glycol will change the performance characteristics of the system.

NOTE: *Hose sets are not to be used for appliances permanently connected to the water mains.*

Water Piping Recommendations

1. Proper installation, piping and trapping is necessary to ensure satisfactory coil operation and to prevent operational damage.
2. Support all piping independently of the coils.
3. Provide swing joints or flexible fittings in all connections that are adjacent to heating coils in order to absorb thermal expansion and contraction strains.

NOTE: *Use a "Back-Up Wrench" when attaching piping to coils with copper headers. Do not use brass fittings or brass pipe connectors. Brass distorts easily and causes connection leaks.*

4. When attaching the piping to the coil header, make the connection only tight enough to prevent leaks. Maximum recommended torque is 200 foot-pounds. Use pipe sealer on all threads.
5. Connect supply and return coil piping. Verify the coil's water lines are correctly installed for counter flow operation.
6. After completing the piping connections, seal around pipe from inner panel to outer panel.
7. Provisions must be made to drain coils that are not in use when subjected to freezing temperatures.

CAUTION: Failure to properly drain and vent coils when not in use during freezing temperatures may result in coil freeze-up damage. In all steam coil installations, the condensate return connections must be at the low point of the coil.

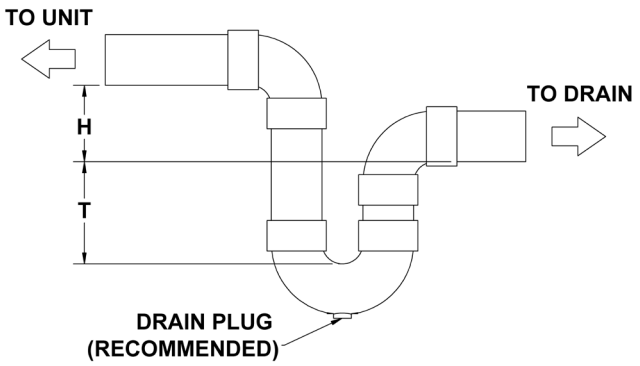
8. Install air vents for piping per plans, specifications and submittals and per local, state, and national codes and ordinances.
9. Check for coil fin damage and straighten if necessary.

CAUTION: Do not throttle or modulate the water flow for coils that are exposed to freezing air. Coil damage may result from freeze-up. NOTE: Cambridge Air Solutions recommends the following if not already included:

10. Install a strainer ahead of the control valve when used.
11. Install a drain line with a shutoff valve near the coil.

5.4 Condensate Connections

A condensate drain connection is provided on the electrical panel side of the Base section drain pan. Check the openings for obstruction to flow. Install drain and trap per local, state, national codes, and ordinances and approved submittals.



Dimension 'H' to be at least 1.75"

Dimension 'T' to be at least 1"

6 Start-Up

6.1 Start-Up Checklist

Mechanical Assembly

- ☐ Base section installed, positioned on level foundation and anchored per spec.
- ☐ Fan, extension and discharge sections installed: Stacked and bolted to base section.
- ☐ All joints between stacked sections are caulked.
- ☐ Fork pocket covers are installed and fastened.

General Physical Checks

- ☐ Seismix restraints in place (if required).
- ☐ Unit exterior and interior free of packing material or foreign objects.
- ☐ Confirm correct filters are installed and unobstructed.
- ☐ Check filter direction.
- ☐ Check fan rotation by hand to confirm no binding or obstructions.
- ☐ All duct connections sealed, aligned, and supported (if applicable)
- ☐ Condensate drain connected with P-trap and properly sloped. Install condensate pump, if required.
- ☐ Verify doors, panels, and HMI are accessible with adequate workspace.

Electrical Checks

- ☐ Supply voltage and phase match nameplate.
- ☐ All terminals tightened per unit spec.
- ☐ All wiring is secured; no pinched or loose wires.
- ☐ Unit grounded properly per the NEC and local code.
- ☐ Fan section control cable connected to control panel.
- ☐ Fan power wires are connected to base section terminals.
- ☐ Verify electrical circuit has proper overcurrent protection.

Refrigerant/Water System

- ☐ Refrigerant/Water lines connected and leak-free. Solenoid valves installed as required.
- ☐ DX system: Leak check completed with no leaks
- ☐ Line insulation complete, as required.

Control System / HMI Start-up

- ☐ Boot and login to HMI - Default PIN (1234).
- ☐ On HMI, turn PLC ON using the red power button on the dropdown menu.
- ☐ Enable cooling through the HMI to confirm operation.
- ☐ All fan, temperature, and pressure readings appear accurate.
- ☐ Check active faults for indications of errors.

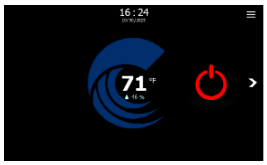
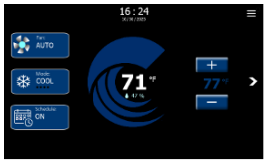
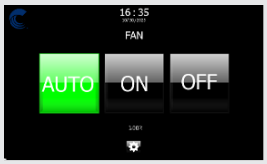
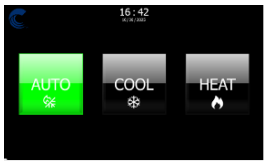
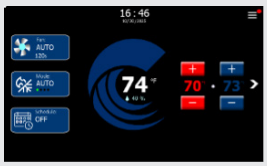
Final Checks Before Commissioning

- ☐ Ensure all doors and panels are closed and latched.
- ☐ Check visibility and readability of all labels and markings.
- ☐ Interior clean: No tools, packaging, or spare hardware left inside.
- ☐ Complete start-up form, including technician name, company, date, and site contact.

6 Start-Up

7 Operation

7.1 Basic HMI Walkthrough

Step	Instructions	Illustration
1	Login Page	
2	Touch Screen and touch the rectangle under ‘Enter Pin’ to access keyboard. Enter Password. Default password is 1234	
3	Select the red power button.	
4	Select ‘ON’ to enable PLC control. Return to the homepage by selecting the logo on the top left.	
5	Set unit to desired setpoint.	
6	Using the Fan button on the home screen, select fan mode. It is recommended to leave fans on AUTO.	
7	If using a heating and cooling enabled unit, select the appropriate mode using the Mode button on the home screen.	
8	If the unit is in ‘AUTO’ mode, set the desired Heating and Cooling setpoint on the home screen.	

7 Operation

7.2 Refrigerant Detection System

This system uses a refrigerant classified as A2L (lower flammability) in accordance with ANSI/ ASHRAE 34 and UL 60335-2-40. To ensure safety and compliance, a Refrigerant Detection System (RDS) is integrated to monitor potential refrigerant leaks and mitigate risks associated with accumulation in occupied spaces.

The primary function of the RDS is to detect refrigerant concentrations in the ambient air and initiate protective actions when levels approach safety thresholds. In compliance with **UL 60335-2-40** requirements, the system must detect A2L refrigerants before concentrations reach 25% of the Lower Flammability Limit (LFL).

The RDS performs the following safety functions:

- **Continuous Monitoring**: Real-time detection of air for the presence of refrigerant.
- **Alarm Activation:** Triggers an audible and visual alarm when refrigerant concentration exceeds 25% LFL.
- **System Response**: Initiates shutdown of cooling relays and ensures adequate ventilation to prevent flammable concentration buildup. Fans will run to ventilate the unit's interior space.
- **Fault Detection:** Monitors its own functionality and issues alerts in the event of sensor failure, wiring issues, or calibration errors.

Figure. Alert will display on the HMI, warning the user of a detected leak.

Refrigerant sensors are not limited-life sensors. Refrigerant sensors perform self-calibration and self-diagnostics and do not require service.

If a refrigerant sensor has a fault or is is no longer functioning, the unit will initiate mitigation actions. Mitigation actions may be verified by disconnecting the refrigerant sensor.

Refrigerant sensors that are part of the ApexAir-series Refrigerant Detection System shall only be replaced by sensors specified by Cambridge Air Solutions.

8 Maintenance

The following are general maintenance procedures and guidelines and should be used for reference purposes only. Refer to outdoor unit / chiller technical manuals for service of those items.

Every week

- Observe unit weekly for any change in running condition and unusual noise.

Every month

- Clean or replace air filters if clogged or dirty; replace filters more frequently in especially dirty environments, if necessary; Coat permanent filters with oil after cleaning; filters per manufacturer's recommendations.
- Ensure ventilation openings are clear of obstructions.

Every three to six months

- Inspect and clean drain pans, especially the trough along the center of the unit.
- Inspect the condensate piping for blockages. Verify function of condensate removal pump, if installed.
- Tighten electrical connections.
- Inspect coils for dirt build-up. Use a fin comb to straighten out any bent fins.

Every year

- Inspect the unit casing for corrosion. If damage is found, clean and repaint.
- Remove any dust or dirt from fan motors.
- Rotate the fan wheel and check for obstructions.
- Inspect and clean drain pans.
- Check door handles for proper fit and operation, adjust if necessary.
- Check condition of gasketing, seals, and caulk around unit, door and dampers. Repair or replace as necessary.
- Inspect electrical components and insulation.
- Inspect wiring for damage.
- Examine flex connections for cracks or leaks. Repair or replace damaged material.
- Check USB storage on HMI and back up / delete old data to free up space.

As required

- The fan and fan motor are maintenance-free due to the use of ball bearings with life-time lubrication. Once the grease service life (30,000-40,000 operating hours) has been reached, it may be necessary to change the bearing.
- If the unit is not in use for longer periods in a humid atmosphere, it is recommended to run the fans for at least two hours every month to remove any moisture that has entered the fan motors.
- Replace the A2L refrigerant sensor as necessary, subject to sensor service life. Sensors shall only be replaced with sensors specified by the equipment manufacturer.

8.1 Maintenance Guidelines

Sealed electrical components that are damaged shall be replaced. Intrinsically safe components that are damaged must be replaced.

8 Maintenance

9 Troubleshooting & Service

9.1 Controls & Electrical Troubleshooting

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.

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 take into account the effects of aging or continual vibration from sources such as compressors or fans.

Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures. Do not apply power to the circuit if a fault exists which compromises safety. If a fault exists that 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:
• Capacitors are discharged. This shall be done in a safe manner to avoid the possibility of sparking.
• No live electrical components or wiring are exposed while charging, recovering, or purging the system.
• Verify continuity of earth bonding.

⚠ CAUTION:
Installation, maintenance, service, repair, and decommissioning operations (such as breaking into the refrigerating circuit, opening of sealed components, and opening of ventilated enclosures) shall be carried out by personnel trained to meet the relevant national competency standards, having completed training that includes flammable refrigerants, potential ignition sources, refrigerant detectors, ventilation requirements, and correct working procedures.

9.2 Refrigerant System Troubleshooting

Be aware that malfunction of the equipment may be caused by refrigerant loss and a refrigerant leak is possible. 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 shall be completed prior to conducting work on the system:

- 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 to hand. Have a dry powder or CO2 fire extinguisher adjacent to the charging area.
- No person carrying out work in relation to a refrigerating 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 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 is to 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.

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. The following leak detection methods are acceptable:

- Electronic leak detectors may be used to detect refrigerant leaks, but the sensitivity may not be adequate or may need re-calibration. 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 Lower Flammability Limit (LFL) or the refrigerant in the system, and shall be calibrated to the refrigerant employed, 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. Examples of leak detection fluids include the bubble method and fluorescent method agents.

When brazing is required, the following procedures shall be carried out:

- Safely remove the refrigerant following local and national regulations. Take care that the drained refrigerant will not cause any danger. Take care that drained refrigerant will not float back into the building.
- Purge the refrigerant circuit with oxygen-free nitrogen.
- Evacuate the refrigerant circuit.
- Remove parts to be replaced by cutting or brazing
- Purge the braze point with nitrogen during the brazing procedure required for repair.
- Carry out a leak test before charging with refrigerant.

9 Troubleshooting & Service

9.3 System Troubleshooting Details

Problem	Possible Causes	Solution
Unit Does Not Power On	Disconnect is 'OFF' on Panel	Set switch to 'ON' position
	Incorrect line power connection	Check supply line connection per wiring diagram.
	High Voltage Panel has power, but low voltage panel does not	Verify power supply (PS1) in the high voltage panel is receiving power from breaker CB1, and that breakers CB2 and CB3 are switched on
	Panel wiring incorrect	Confirm connections to PLC and HMI per schematic
	Blown fuse or tripped breaker	Reset breaker or replace fuses as needed
Fans Not Running Correctly	Motor Circuit Protectors (MCPs) incorrectly set or inoperable.	Turn on all MCPs and ensure overloads are set to proper amperage. Replace if faulty
	Fan disabled in control panel	Place switch in 'AUTO' or ‘HAND’ position
	Fans have power, but do not receive a 24V D1 enable signal (LED on fan motor blinking red)	Check wiring and voltage from SS1 -> 171 -> PLC (NO6) -> 169 -> CR2 -> 157 -> D1
		Fans set to 'OFF' on HMI. Set to 'On' or 'AUTO'
	Impeller blocked or dirty	Check fan for obstructions
	Short circuit winding in motor	Replace fan and motor
	Incorrect software configuration	Check that the unit has been configured correctly, and not as a model with fewer fans
	Improper / loose wiring	Check fan wiring and contacts, including junction box, fan power wires, Modbus connections, D1, E1, and ID1 wires per electrical schematic. Verify 24V supply stability Inspect continuity of ground and control wires
Low Airflow	Obstructed air passage	Inspect and replace filters Check ducting and discharge for free air passage
	Fan turns too slowly	Motor may be overheated. Check for free air passage and remove dirt from motor housing
	Incorrect fan rotation	Verify rotation matches arrow direction on housing Correct the connection of the motor leads on the supply
Temperature Sensors Reading Incorrectly	Sensor not wired properly	Check wiring and wiring terminations per the schematic
	Sensor damaged	Install replacement sensor

9 Troubleshooting & Service

Problem	Possible Causes	Solution
Outdoor and indoor units not communicating	Mis-wired communication line	Check control wiring per schematic and submittals
	Polarity reversed	Check U1/U2 wiring polarity, confirm shielded twisted-pair cable used
	Comm kit not powered	Verify comm kit LED status and 12V supply
No Cooling	Control panel switch(es) set to ‘OFF’ (fans must be enabled for cooling)	Enable Cooling Switch SS1 with 'AUTO' or ‘HAND’ Enable Fan Switch SS2 with ‘AUTO’ or ‘HAND’
	A2L sensor not wired properly	Confirm connections per schematic
Sweating or Freezing Piping	Improper insulation	Insulate all refrigerant lines
	Overcharged or undercharged system	Have technician check system charge
Coil Icing or Sweating Excessively	Low refrigerant charge	Check refrigerant levels via service technician
	Restricted airflow	Inspect filters and airflow path
	Improper TXV operation	Verify coil sensors and TXV function
Drain Pan Overflowing	Blocked drain line	Clear drain line with compressed air
	Missing trap	Ensure trap is properly installed and not clogged
	Improper unit leveling	Confirm drain line slope toward drain outlet
Vibration or Rattling	Loose fasteners	Tighten all screws and latches
	Missing gasket	Replace worn gaskets
	Unbalanced fan	Check fan for damage or soiling, rebalance if required

9 Troubleshooting & Service

9.4 Controls Troubleshooting Details

Problem	Possible Causes	Solution
HMI Not Responding (Off, Frozen, or Blank Screen)	No 24V supply	Verify HMI is receiving 24Vdc
	Screen lock-up	Power cycle HMI using breaker CB2
	Loose HMI communication cable	Reseat HMI communication cable to COM 1 and power cycle the HMI
PLC Emitting Beeping Sound	Active alarm	View and clear active alarms on the HMI. Pressing the red alarm button on the PLC also silences alarm beeps
Unit Remains in Passive Mode	ODU_RunStatus (U1) input active	Verify outdoor unit (ODU) status signal is off. Trigger Clear_Passive_Mode on the drop-down menu page
	Improper wiring to U1	Make sure U1 is properly wired in on the PLC
Cooling or Heating Not Activating in Auto Mode	Improper deadband configuration	Review Cooling/Heating setpoints and ensure proper deadband spacing
	NO1 incorrectly wired	Verify that NO1 is wired properly to the PLC
	(Heat Pump Units) - Comm kit not receiving a signal from NO1	Verify wiring from control panel to Comm Kit
System Not Responding to HMI	Control panel switches set to 'HAND'	Set switches SS1 and SS2 to AUTO
Schedule Not Activating Events	Incorrect time/date	Reset time on HMI under 'Date and Time' in system settings. Verify that time on the PLC is also the same.
	Misconfigured event	Verify schedule event enable is enabled (green circle under 'EVENT')
	Schedule disabled	Enable Schedule
Setpoint Not Changing	Schedule is enabled	Disable Schedule or add event to change setpoint
Fan Not Turning Off	Schedule is enabled	Disable Schedule or add event to disable circulation

9 Troubleshooting & Service

10 A2L Information

10.1 Application Guidelines

- Non-duct connected appliances containing A2L refrigerants with the supply and return air openings in the conditioned space may have the body of the appliance 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.
- For duct connected appliances, 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.

System Refrigerant Charge

Refrigerant charge in the system (m_c) is the sum of the ApexAir-series unit's charge, the line charge, and the outdoor unit's charge. The ApexAir-series outdoor unit's charge can be found on the submittal and is unit-specific. Refer to Table 1 for the calculation of the line charge. The condensing unit charge can be found in the manufacturer's literature or submittals. Verify that the total charge matches the added charge after charging the system. The unit A2L data plate (shown in Section 2.2 – Nameplate & Labels) must be filled out with complete charge information.

Minimum Room Area

Equipment with A2L refrigerants are required to be installed in rooms meeting specified minimum room area (A_{min}) requirements. Minimum room area requirements are calculated from system refrigerant charge (m_c) and room height, per the requirements of UL 60335-2-40. Refer to Table 3 and Table 4 for minimum floor area requirements for refrigerants R-454B and R-32.

The value from Table 3 or Table 4 will be multiplied by an altitude adjustment factor (AF) as necessary, based on the building site ground level altitude (H_{alt}). The altitude adjustment factor can be found in Table 2. The unit A2L data plate (shown in Section 2.2 – Nameplate & Labels) must be filled out with minimum room area from Tables 3 or 4, adjusted for altitude if necessary.

10.2 Refrigerant System Checks

The following checks shall be applied to installations using flammable refrigerant

- The actual refrigerant charge is in accordance with the room size within which the refrigerant containing parts are installed.
- Ventilation machinery and outlets are operating adequately and are not obstructed.
- Marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected.
- Refrigerant 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.

10.3 Decommissioning

Before carrying out the decommissioning procedure, it is essential that the technician is completely familiar with the equipment and all of 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 is begun.

1. Become familiar with the equipment and its operation.
2. Isolate the system electrically.
3. 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 supervised at all times by a competent person.
   d. Recovery equipment and cylinders conform to the appropriate standards.
4. Pump down refrigerant system, if possible.

10 A2L Information

5. If a vacuum is not possible, make a manifold sothat refrigerant can be removed from various parts of the system.
6. Make sure that cylinder is situated on the scales before recovery takes place.
7. Start the recovery machine and operate in accordance with instructions.
8. Do not overfill cylinders (no more than 80% volume liquid charge).
9. Do not exceed the maximum working pressure of the cylinder, even temporarily.
10. 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.
11. Recovered refrigerant shall not be charged into another refrigerating system unless it has been cleaned and checked.

Equipment shall be labelled stating that it has been de-commissioned and emptied of refrigerant. The label shall be signed and dated. For appliances containing flammable refrigerants, there shall be a label on the equipment stating the equipment contains flammable refrigerant.

Continued on next page.

10 A2L Information

Table 1. Line Charge (lb) by Line Set Length

	Line Size (O.D., in.)	10 ft.	20 ft.	30 ft.	40 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.
R-454B	1/4	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	5/16	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
	3/8	0.4	0.9	1.3	1.7	2.1	2.6	3.0	3.4	3.9	4.3
	1/2	0.8	1.5	2.3	3.0	3.8	4.6	5.3	6.1	6.9	7.6
	5/8	1.2	2.4	3.6	4.8	6.0	7.1	8.3	9.5	10.7	11.9
	7/8	2.3	4.7	7.0	9.3	11.7	14.0	16.3	18.7	21.0	23.3
	1-1/8	3.9	7.7	11.6	15.4	19.3	23.1	27.0	30.9	34.7	38.6
	1-3/8	5.8	11.5	17.3	23.0	28.8	34.6	40.3	46.1	51.8	57.6
R-32	1/4	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
	5/16	0.3	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.6	2.9
	3/8	0.4	0.8	1.3	5.0	2.1	2.5	2.9	3.4	3.8	4.2
	1/2	0.7	1.5	2.2	3.0	3.7	4.5	5.2	6.0	6.7	7.5
	5/8	1.2	2.3	3.5	4.7	5.8	7.0	8.2	9.3	10.5	11.6
	7/8	2.3	4.6	6.8	9.1	11.4	13.7	16.0	18.3	20.5	22.8
	1-1/8	3.8	7.5	11.3	15.1	18.9	22.6	26.4	30.2	34.0	37.7
	1-3/8	5.6	11.3	16.9	22.6	28.2	33.8	39.5	45.1	50.7	56.4

Table 2. Altitude Adjustment Factor (AF)

Altitude (ft)	0 - 2000	2,001 - 4,000	4,001 - 6,000	6,001 - 8,000	8,001 - 10,000	10,001 - 12,000	Over 12,000
Adjustment Factor (AF)	1	1.05	1.11	1.18	1.25	1.33	1.42

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Table 3. Minimum Room Area from Total System Charge (m_c) – R-454B

m_c - Refrigerant Charge (lbs)	m_c - Refrigerant Charge (kg)	Minimum Area (ft^2) Room Height 30 ft (9.1 m)	Minimum Area (m^2) Room Height 30 ft (9.1 m)	Minimum Area (ft^2) Room Height 40 ft (12.2 m)	Minimum Area (m^2) Room Height 40 ft (12.2 m)
60	27.2	216.5	20.1	162.3	15.1
65	29.5	234.5	21.8	175.9	16.3
70	31.8	252.5	23.5	189.4	17.6
75	34.0	270.6	25.1	202.9	18.9
80	36.3	288.6	26.8	216.5	20.1
85	38.6	306.7	28.5	230.0	21.4
90	40.8	324.7	30.2	243.5	22.6
95	43.1	342.7	31.8	257.1	23.9
100	45.4	360.8	33.5	270.6	25.1
105	47.6	378.8	35.2	284.1	26.4
110	49.9	396.9	36.9	297.6	27.7
115	52.2	414.9	38.5	311.2	28.9
120	54.4	432.9	40.2	324.7	30.2
125	56.7	451.0	41.9	338.2	31.4
130	59.0	469.0	43.6	351.8	32.7
135	61.2	487.0	45.2	365.3	33.9
140	63.5	505.1	46.9	378.8	35.2
145	65.8	523.1	48.6	392.3	36.4
150	68.0	541.2	50.3	405.9	37.7
155	70.3	559.2	52.0	419.4	39.0
160	72.6	577.2	53.6	432.9	40.2
165	74.8	595.3	55.3	446.5	41.5
170	77.1	613.3	57.0	460.0	42.7
175	79.4	631.4	58.7	473.5	44.0
180	81.6	649.4	60.3	487.0	45.2

Continued on next page.

10 A2L Information

Table 4. Minimum Room Area from Total System Charge (m_c) – R-32

m_c - Refrigerant Charge (lbs)	m_c - Refrigerant Charge (kg)	Minimum Area (ft^2) Room Height 30 ft (9.1 m)	Minimum Area (m^2) Room Height 30 ft (9.1 m)	Minimum Area (ft^2) Room Height 40 ft (12.2 m)	Minimum Area (m^2) Room Height 40 ft (12.2 m)
60	27.2	209.4	19.5	157.0	14.6
65	29.5	226.8	21.1	170.1	15.8
70	31.8	244.3	22.7	183.2	17.0
75	34.0	261.7	24.3	196.3	18.2
80	36.3	279.2	25.9	209.4	19.5
85	38.6	296.6	27.6	222.5	20.7
90	40.8	314.1	29.2	235.6	21.9
95	43.1	331.5	30.8	248.7	23.1
100	45.4	349.0	32.4	261.7	24.3
105	47.6	366.4	34.0	274.8	25.5
110	49.9	383.9	35.7	287.9	26.7
115	52.2	401.3	37.3	301.0	28.0
120	54.4	418.8	38.9	314.1	29.2
125	56.7	436.2	40.5	327.2	30.4
130	59.0	453.7	42.1	340.3	31.6
135	61.2	471.1	43.8	353.3	32.8
140	63.5	488.6	45.4	366.4	34.0
145	65.8	506.0	47.0	379.5	35.3
150	68.0	523.5	48.6	392.6	36.5
155	70.3	540.9	50.3	405.7	37.7
160	72.6	558.4	51.9	418.8	38.9
165	74.8	575.8	53.5	431.9	40.1
170	77.1	593.3	55.1	445.0	41.3
175	79.4	610.7	56.7	458.0	42.6
180	81.6	628.2	58.4	471.1	43.8

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REVISION HISTORY LOG

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