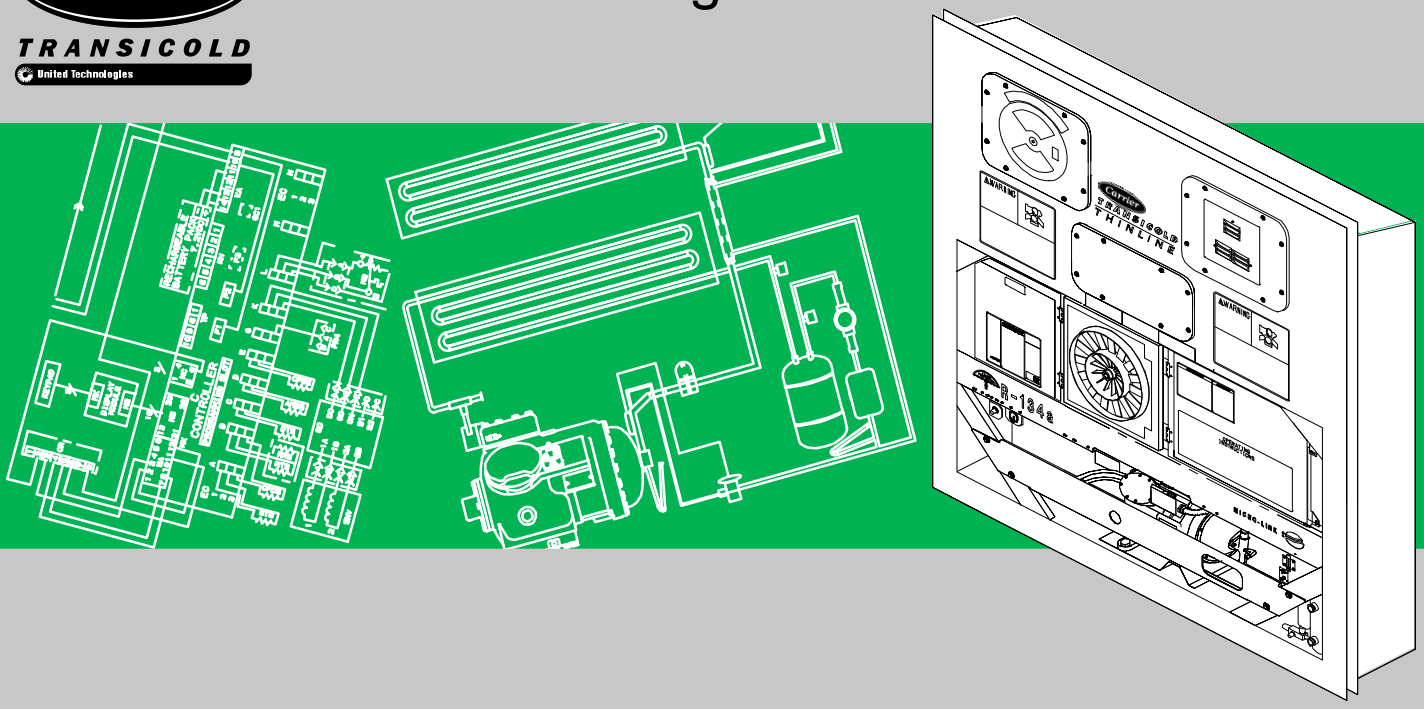
Carrier TRANSICOLD United Technologies

Container Refrigeration



OPERATION AND SERVICE

for

EverFresh Controlled Atmosphere

69NT40-489-100 Series

Container Refrigeration Units

T–305 Rev C

OPERATION & SERVICE MANUAL
CONTAINER REFRIGERATION UNIT

EVERFRESH
CONTROLLED ATMOSPHERE
MODEL
69NT40-489-100 Series

SAFETY SUMMARY

CONTROLLED ATMOSPHERE (CA) SAFETY CONSIDERATIONS

Air contains nitrogen and oxygen, and only oxygen supports life. Oxygen is normally present at a concentration of about 21% in the atmosphere. The balance is nitrogen, with traces of other gases.

Controlled atmosphere (CA) systems reduce the oxygen content in the container to 2 – 5%. These levels will not support life. The low-oxygen atmosphere is colorless, odorless and tasteless. Indications of a potentially hazardous situation are generally absent.

One or two breaths in a low-oxygen atmosphere will cause unconsciousness within 10 seconds and death within a few minutes.

Before entering containers which are equipped with CA systems, the oxygen content must be increased to normal (21%) by ventilation.

Carrier Transicold containers using the CA option are equipped with:

1. Hazard labels on the front of the unit.
2. Hazard labels near the evaporator access panels. Hazard labels on the evaporator motor mounting bracket.
3. Hazard labels on rear doors of the container.
4. Door interlock system on rear doors of the container to prevent access of personnel when low-oxygen levels are present.

   In addition, a hazard label is provided with the poly sheet curtain, which is used to help stop gas leakage at the rear doors of the container.

IMMEDIATE EFFECTS OF BREATHING OXYGEN DEFICIENT ATMOSPHERES

As blood passes through the lungs it gives up carbon dioxide and accepts oxygen through the thin walls of tiny air sacs.

- Blood from the lungs takes less than 10 seconds to reach the brain.
- Breathing oxygen deficient air flushes the blood of oxygen.
- The brain is quickly depleted of oxygen resulting in swift unconsciousness.
- Within 5 seconds of breathing oxygen-free gas, there is a rapid drop of oxygen in the blood. As the oxygen concentration is progressively lowered the physiological effects are:
  - Giddiness
  - Mental confusion
  - Loss of judgement
  - Incoordination
  - Weakness
  - Nausea
  - Fainting
  - Death
- Symptoms or warnings are generally absent.

HUMAN RESPONSE TO OXYGEN DEFICIENT ATMOSPHERES

OXYGEN CONTENT OF AIR	SIGNS/SYMPTOMS OF PERSON AT REST
15% – 19%	Decreased ability to work strenuously. May impair coordination and may induce early symptoms in persons with coronary, pulmonary or circulatory problems.
12% – 14%	Respiration deeper, increased pulse rate and impaired coordination, perception and judgement.
10% – 12%	Further increase in rate and depth of respiration, further increase in pulse rate, performance failure, giddiness, poor judgement, blue lips.
8% – 10%	Mental failure, nausea, vomiting, fainting, unconsciousness, ashen face, blue face.
6% – 8%	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4-5 minutes, recovery with treatment for all exposures.
4%	Coma in 40 seconds, convulsions, respiration ceases, death.

CONTROLLED ATMOSPHERE (CA) SAFE CONTAINER ENTRY

Entry into a CA equipped container must be performed by a (minimum) two person team. The operator will be the person performing the required procedures and that person is to be supervised by someone who is familiar with the required procedures. The person supervising entry must ensure that all venting procedures outlined in section 10.7 page 113 have been performed and all waiting periods have expired. The following steps must be adhered to:

1. Both persons are to read and understand the preceding Safety Considerations and all hazard labels on the unit.
2. The supervising person is responsible for keeping all persons away from open doors and access panels until the venting procedure is completed.
3. Avoid opening doors of a low-oxygen level container while at a loading platform. Never open doors if rain or refrigeration barriers are near the door. Low-oxygen content gas will exit the container and can asphyxiate nearby personnel who are working an adjacent container or are in the warehouse. Instead, follow the venting procedure before backing up to the loading platform.
4. Avoid venting in a confined space.
5. A hazardous low-oxygen atmosphere exists within the evaporator section. **Before** opening the evaporator access panel(s) the container must first be ventilated per section 10.5, page 114. Then the access panel(s) must be open for 10 minutes before working inside the evaporator section.
6. The supervising person will declare it safe to enter the container. Prior to entry the supervisor or a **second** person must be present. Every time the doors or panels are to be opened, the supervising person must ensure the venting procedures are performed and the waiting times have expired prior to declaring the container safe to enter and allowing any person to enter. **Every time.**

ALWAYS:

- Look for **Danger, Warning** and **Caution** hazard labels on containers. Use a flashlight if necessary!
- Assume there is a low-oxygen atmosphere present when the doors are closed.
- Assume low-oxygen content even if there was air yesterday.
- Assume low-oxygen content even if the CA start-stop switch (CAS) is OFF.
- Assume low-oxygen content even if no generator set is attached.
- Assume low-oxygen content even if the container has no load in it.
- Assume low-oxygen content even if the door is not locked.
- Assume low-oxygen content even if the container is in for maintenance.
- Assume low-oxygen content even if the container is to be washed out.
- Use your watch and write times down when ventilating a container.
- Warn others of the hazard. Tell them from a distance if necessary.
- Ask qualified personnel if you are not sure or forgot some of this training.

RESUSCITATION

Personnel working with or near hazardous atmosphere or materials shall be familiar with approved resuscitation methods. If someone is injured and stops breathing, initiate resuscitation immediately. A delay could cost the victim's life.

RESCUE

– All rescue personnel shall have adequate supplies of oxygen or air from self-contained breathing apparatuses or fresh air lines

– Only those who are properly trained in the use of self-contained breathing apparatus will attempt to rescue the victim. All other personnel will stay clear of the area until the oxygen level stabilizes.

– The victim shall be removed to the open air without delay and shall be kept warm. Oxygen shall be administered or artificial respiration shall be applied by an approved method.

– Resuscitation procedures shall be continued until the patient revives or until a doctor gives instructions.

FIRST AID

– Persons suffering from lack of oxygen should be quickly moved to areas with normal atmosphere.

– If the person is not breathing, assisted ventilation should be the first step.

– Give supplemental oxygen with ventilation if oxygen is available.

ENTERING CONTAINER IN AN EMERGENCY

In case of a power failure to the unit, there is no emergency provision to unlock the automatic door interlock system:

⚠ DANGER

WHEN OVERRIDING THE CA CONTROLLER, THE OPERATOR MUST BE AWARE OF THE IMMEDIATE DANGER OF UNCONSCIOUSNESS AND DEATH. THE OPERATOR MUST READ AND UNDERSTAND ALL WARNING LABELS AND SAFETY INSTRUCTIONS BEFORE PROCEEDING WITH THE EMERGENCY BY-PASS PROCEDURE.

To enter the container in a true emergency situation, do the following:

1. Ensure at least two persons are present. One person is to act in a supervisory manner, and that person is charged with the responsibility to ensure all procedures are performed correctly and all waiting times have expired before allowing entry.
2. Open the fresh air makeup vent 100% (fully open). Avoid any direct breathing of venting gases from the air makeup vent.
3. To enter the container, the interlock system must be removed. To remove the system, remove the center bolt from the catch or remove the four screws holding the interlock system to the container door. Refer to Figure A.

⚠ WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

4. Fully open container doors.
5. Pull back the curtain (poly sheet) to accelerate the time of a complete ambient air exchange.
6. Step away from the container rear doors. Do not close doors. Wait 30 minutes prior to entry or unloading of the container. Wait 45 minutes before climbing on contents inside of the container.
7. If access to the container is necessary (i.e., life and death situations) prior to the safety venting procedures being performed, then: only rescue personnel trained in safety procedures in removing victims from hazardous atmospheres are to be allowed entry into the container at this point.
8. All other personnel are to stay well clear of the doors.

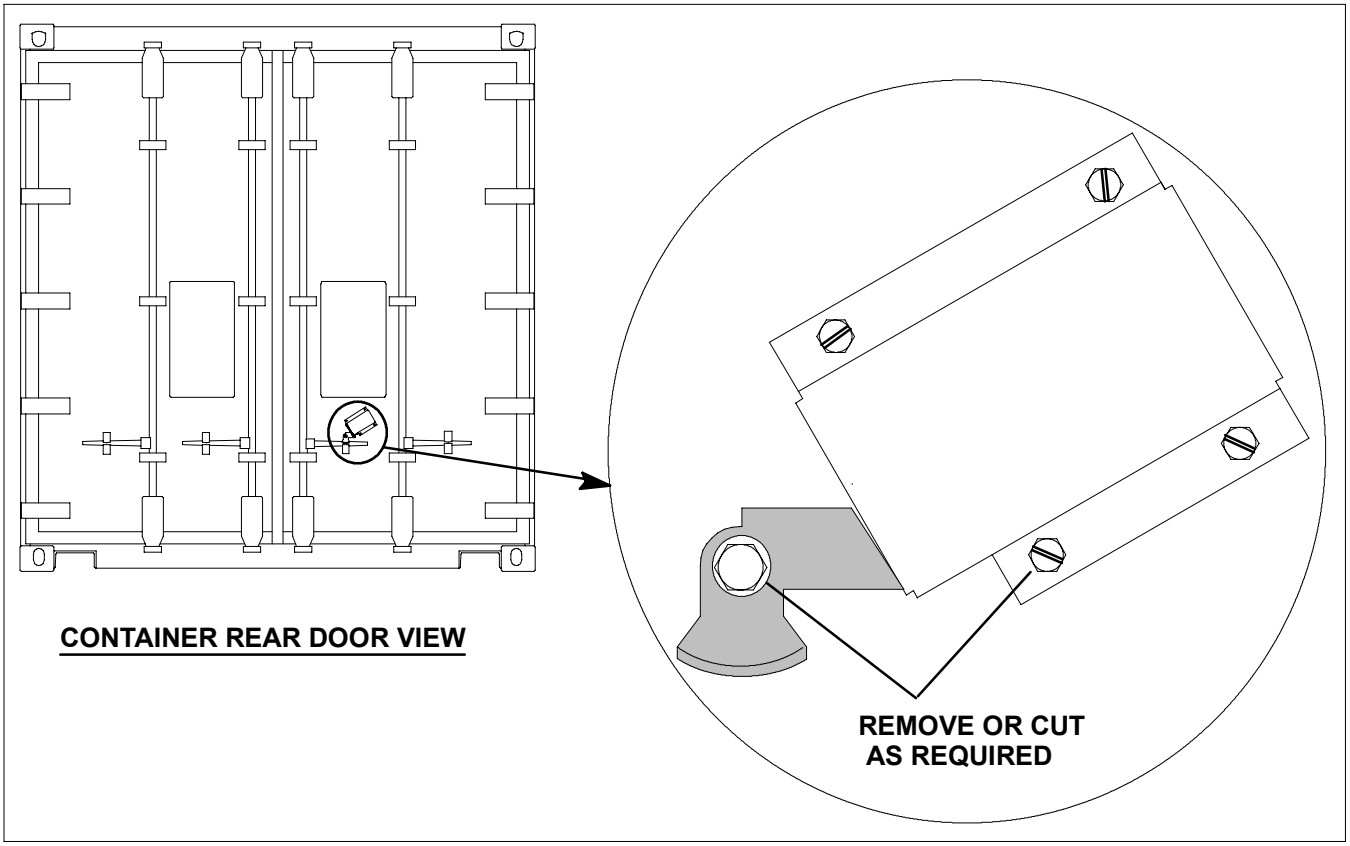


Figure A. Emergency Bypass for the Door Interlock System

PRECAUTIONS FOR HANDLING COMPRESSED GAS

Chemical safety goggles or a full face shield shall be used while handling cylinders of compressed gas.

If the unit is being supplied with nitrogen or carbon dioxide, all nonessential persons shall be prohibited from being in or entering the container space while this procedure is taking place.

Emergency self-contained breathing apparatuses shall be located within the immediate area to permit safe evacuation in the event of an accident. A high concentration of nitrogen gas will dilute the air (oxygen) in the space. Breathing this diluted, contaminated air can result in rapid (5 to 10 seconds) loss of consciousness. Therefore, it is necessary to stop breathing until the self-contained breathing apparatus has been put on and is supplying air.

Emergency rescue procedures shall be established to ensure all personnel can be safely removed from potentially hazardous exposures.

⚠ DANGER

HAZARDOUS ATMOSPHERE INSIDE. LOW OXYGEN INSIDE CONTAINER CAN CAUSE DEATH.

Performing service on, or entering a CA equipped unit can be extremely dangerous. Refer to the Safety section of this manual before servicing or entering the container.

⚠ DANGER

HAZARDOUS ATMOSPHERE INSIDE OF THE CONTAINER. LOW OXYGEN LEVEL INSIDE CONTAINER CAN CAUSE DEATH. THE CONTAINER MUST BE VENTED PRIOR TO ENTERING.

1. **On keypad press VENT and then press ENTER.**
2. **Fully open fresh air port, and then press ENTER on keypad. Avoid direct breathing of venting gases.**
3. **Allow refrigeration unit to run. Door lock will open.**
4. **Open both rear doors and pull curtain back. Step away from rear doors. Continue refrigeration operation for ten minutes prior to entry or unloading. Do not close doors. (Wait 45 minutes before climbing on contents inside container.)**

⚠ DANGER

LOW OXYGEN LEVELS INSIDE CONTAINER. VENTILATE CONTAINER BEFORE ENTERING. STAY AWAY FROM DOORS WHILE VENTING.

⚠ DANGER

HAZARDOUS ATMOSPHERE INSIDE. VENTILATE CONTAINER BEFORE ACCESS.

⚠ DANGER

WHEN OVERRIDING THE CA CONTROLLER, THE OPERATOR MUST BE AWARE OF THE IMMEDIATE DANGER OF UNCONSCIOUSNESS AND DEATH. THE OPERATOR MUST READ AND UNDERSTAND ALL WARNING LABELS AND SAFETY INSTRUCTIONS BEFORE PROCEEDING WITH THE EMERGENCY BYPASS PROCEDURE.

⚠ WARNING

When servicing the unit, use caution when handling R-134a. The refrigerant when in contact with high temperatures (about 1000°F) will decompose into highly corrosive and toxic compounds.

⚠ WARNING

Be sure ventilation in the workspace is adequate to keep the concentration of refrigerant below 1000 parts per million. If necessary, use portable blowers.

⚠ WARNING

Beware of rotating fan blades and unannounced starting of fans.

⚠ WARNING

Do not use a nitrogen cylinder without a pressure regulator. Never mix refrigerants with air for leak testing. It has been determined that pressurized, air-rich mixtures of refrigerants and air can undergo combustion when exposed to an ignition source.

⚠ WARNING

Never fill a refrigerant cylinder beyond its rated capacity. Cylinder may rupture due to excessive pressure when exposed to high temperatures.

⚠ WARNING

When starting the unit, be sure that all manual refrigerant valves in the discharge line are open. Severe damage could occur from extremely high refrigerant pressures.

GENERAL SAFETY NOTICES

The following general safety notices supplement the specific danger, warning and caution hazard labels appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein. The general safety notices are presented in the following three sections labeled: First Aid, Operating Precautions and Maintenance Precautions. A listing of the specific warnings and cautions appearing elsewhere in the manual follows the general safety notices.

FIRST AID

An injury, no matter how slight, should never go unattended. Always obtain first aid or medical attention immediately.

OPERATING PRECAUTIONS

Always wear safety glasses.

Keep hands, clothing and tools clear of the evaporator and condenser fans.

No work should be performed on the unit until all circuit breakers, start-stop switches are turned off, and power supply is disconnected.

Always work in pairs. Never work on the equipment alone.

In case of severe vibration or unusual noise, stop the unit and investigate.

MAINTENANCE PRECAUTIONS

Beware of unannounced starting of the evaporator and condenser fans. Do not open the condenser fan grille or evaporator access panels before turning power off, disconnecting and securing the power plug.

Be sure power is turned off before working on motors, controllers, solenoid valves and electrical control switches. Tag circuit breaker and power supply to prevent accidental energizing of circuit.

Do not bypass any electrical safety devices, e.g. bridging an overload, or using any sort of jumper wires. Problems with the system should be diagnosed, and any necessary repairs performed, by qualified service personnel.

When performing any arc welding on the unit or container, disconnect all wire harness connectors from the modules in both control boxes. Do not remove wire harness from the modules unless you are grounded to the unit frame with a static safe wrist strap.

In case of electrical fire, open circuit switch and extinguish with CO_2 (never use water).

UNIT LABEL IDENTIFICATION

To help identify the hazard labels on the unit and explain the level of awareness each one carries, an explanation is given with the appropriate consequences:

DANGER – means an immediate hazard which WILL result in severe personal injury or death.

WARNING – means to warn against hazards or unsafe conditions which COULD result in severe personal injury or death.

CAUTION – means to warn against potential hazard or unsafe practice which could result in minor personal injury, or damage to product or property.

SPECIFIC DANGER, WARNING AND CAUTION STATEMENTS

The statements listed below are applicable to the refrigeration unit and appear elsewhere in this manual. These recommended precautions must be understood and applied during operation and maintenance of the equipment covered herein.

⚠ WARNING

Beware of unannounced starting of the evaporator and condenser fans. The unit may cycle the fans and compressor unexpectedly as control requirements dictate.

⚠ WARNING

Do not attempt to remove power plug(s) before turning OFF start-stop switch (ST), unit circuit breaker(s) and external power source.

⚠ WARNING

Make sure the power plugs are clean and dry before connecting to any power receptacle.

⚠ WARNING

Make sure that the unit circuit breaker(s) (CB-1 & CB-2) and the START-STOP switch (ST) are in the "O" (OFF) position before connecting to any electrical power source.

⚠ WARNING

Never use air for leak testing. It has been determined that pressurized, mixtures of refrigerant and air can undergo combustion when exposed to an ignition source.

⚠ WARNING

Make sure power to the unit is OFF and power plug disconnected before replacing the compressor.

⚠ WARNING

Before disassembly of any external compressor component make sure to relieve possible internal pressure by loosening the bolts and tapping the component with a soft hammer to break the seal.

⚠ WARNING

Do not use a nitrogen cylinder without a pressure regulator. Do not use oxygen in or near a refrigeration system as an explosion may occur.

⚠ WARNING

Do not open the condenser fan grille before turning power OFF and disconnecting power plug.

⚠ WARNING

Oakite No. 32 is an acid. Be sure that the acid is slowly added to the water. DO NOT PUT WATER INTO THE ACID – this will cause spattering and excessive heat.

⚠ WARNING

Wear rubber gloves and wash the solution from the skin immediately if accidental contact occurs. Do not allow the solution to splash onto concrete.

⚠ WARNING

Always turn OFF the unit circuit breakers (CB-1 & CB-2) and disconnect main power supply before working on moving parts.

⚠ WARNING

Make sure power to the unit is OFF and power plug disconnected before removing capacitor(s).

⚠ WARNING

With power OFF discharge the capacitor before disconnecting the circuit wiring.

⚠ WARNING

The unit power plug must be disconnected to remove power from circuit breaker CB1

⚠ CAUTION

Do not remove wire harnesses from controller unless you are grounded to the unit frame with a static safe wrist strap.

⚠ CAUTION

Unplug all controller wire harness connectors before performing arc welding on any part of the container.

⚠ CAUTION

Pre-trip inspection should not be performed with critical temperature cargoes in the container.

⚠ CAUTION

When Pre-Trip key is pressed, dehumidification and bulb mode will be deactivated. At the completion of Pre-Trip activity, dehumidification and bulb mode must be reactivated.

⚠ CAUTION

When condenser water flow is below 11 lpm (3 gpm) or when water-cooled operation is not in use, the CFS switch MUST be set to position ”1” or the unit will not operate properly.

⚠ CAUTION

When a failure occurs during automatic testing the unit will suspend operation awaiting operator intervention.

⚠ CAUTION

When Pre–Trip test Auto 2 runs to completion without being interrupted, the unit will terminate pre-trip and display “Auto 2” “end.” The unit will suspend operation until the user depresses the ENTER key!

⚠ CAUTION

The unit will remain in the full cooling mode as long as the emergency bypass switch is in the BYPASS position. If the cargo may be damaged by low temperatures, the operator must monitor container temperature and manually cycle operation as required to maintain temperature within required limits.

⚠ CAUTION

The unit will remain in the DEFROST mode as long as the emergency defrost switch is in the DEFROST position. To prevent cargo damage, the operator must monitor container temperature and manually cycle operation as required to maintain temperature within required limits.

⚠ CAUTION

To prevent trapping liquid refrigerant in the manifold gauge set be sure set is brought to suction pressure before disconnecting.

⚠ CAUTION

Removing the compressor motor press-fit stator in the field is not recommended. The rotor and stator are a matched pair and should not be separated.

⚠ CAUTION

The copper tube which connects to the oil suction strainer extends out the bottom with the bottom plate removed. Take precautions to avoid bending or breaking it while changing crankcase positions.

⚠ CAUTION

Ensure that thrust washer does not fall off dowel pins while installing oil pump.

⚠ CAUTION

The set screw on the crankshaft must be removed for this type of oil pump.

⚠ CAUTION

Use only Carrier Transicold approved Polyol Ester Oil (POE) – Castrol-Icematic SW20 compressor oil with R-134a. Buy in quantities of one quart or smaller. When using this hygroscopic oil, immediately reseal. Do not leave container of oil open or contamination will occur.

⚠ CAUTION

Take necessary steps (place plywood over coil or use sling on motor) to prevent motor from falling into condenser coil.

⚠ CAUTION

If the thermostatic expansion valve is found to be in need of replacement, then the power head and cage assembly are to replaced as a pair. They are a matched pair and replacing one without the other will affect the superheat setting.

⚠ CAUTION

DO NOT disassemble piston from NEW suction modulating valve powerhead assembly. Doing so may result in damage to piston.

⚠ CAUTION

The unit must be OFF whenever a programming card is inserted or removed from the controller programming port.

⚠ CAUTION

All 69NT40-511-3XX units must use software revision 5108 or higher to enable stepper motor. Optional features may require higher software revision levels to enable functionality.

⚠ CAUTION

Do not allow moisture to enter wire splice area as this may affect the sensor resistance.

FOREWORD

The Model 69NT40–489–100 Series (100 through 199) units are basic Carrier Transicold ThinLine container refrigeration units which are equipped with the Carrier Transicold EverFresh controlled atmosphere system. The EverFresh system provides continuous, precise management of the gases surrounding the cargo. Coverage of the equipment is provided in this manual as follows:

PART ONE

PART ONE of this manual contains Operating Data, Electrical Data and Service Instructions for the refrigeration unit. Part One is divided into six sections. These sections are: One, Introduction; Two, Description; Three, Microprocessor; Four, Operation; Five, Troubleshooting and Six, Service.

PART TWO

PART TWO of this manual covers the Controlled Atmosphere system. The units are equipped with a separate controller module and support equipment dedicated to the Controlled Atmosphere system. PART TWO is also divided into sections in the same manner as Part One, that is Seven, Introduction; Eight, Description; Nine, Microprocessor; Ten, Operation; Eleven, Troubleshooting and Twelve, Service.

PART THREE

PART THREE of this manual contains the Electrical Schematics for both the refrigeration unit and the Controlled Atmosphere system. PART THREE has been divided into two sections; Thirteen contains the schematics for the refrigeration controls, and Fourteen contains the schematics for the Controlled Atmosphere system.

ABOUT REFERENCES IN THIS MANUAL

When references are made in the manual, the reference will include a page number unless the referenced item is on the same page. For example, when reading the following reference text: **(Refer to section 3.2)**, the reader will not need to turn to another page to find section 3.2. The other example is: **(Refer to section 4.2, page45)**, this would indicate the reader must turn to page 45 to find the referenced item.

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PART ONE - REFRIGERATION UNIT

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

The Carrier Transicold model 69NT40-489-100 series units are of lightweight aluminum frame construction, designed to fit in the front of a container and serve as the container's front wall.

They are one piece, self-contained, all electric units which are fitted with cooling, heating and atmosphere control systems. The cooling and heating systems provide precise temperature control while the Carrier Transicold EverFresh controlled atmosphere system continuously provides a supply of high purity nitrogen to reduce the interior oxygen and carbon dioxide levels.

The units are suppled with a complete charge of refrigerant R-134a and compressor lubricating oil and are ready for operation upon installation. Forklift pockets are provided for unit installation and removal.

The base unit operates on nominal 380/460 volt, 3 phase, 50/60 hertz power. An optional autotransformer may be fitted to allow operation on nominal 190/230 , 3 phase, 50/60 hertz power. Power for the control system is provided by a transformer which steps the supply power down to 18 and 24 volts, single phase.

The controller is a Carrier Transicold Micro-Link 2i microprocessor. The controller will operate automatically to select cooling, holding or heating as required to maintain the desired set point temperature within very close limits.

The controller is fitted with a keypad and display for viewing or changing operating parameters. The display is also equipped with lights to indicate various modes of operation.

1.2 CONFIGURATION IDENTIFICATION

Unit identification information is provided on a plate located near the compressor. The plate provides the unit model number, the unit serial number and the unit parts identification number (PID). The model number identifies the overall unit configuration while the PID provides information on specific optional equipment, factory provision to allow for field installation of optional equipment and differences in detailed parts.

Configuration identification for the models covered herein may be obtained on the Container Products Group Information Center by authorized Carrier Transicold Service Centers.

1.3 OPTION DESCRIPTION

Various options may be factory or field fitted to the base unit. These options are listed in the tables and described in the following subparagraphs.

1.3.1 Battery

The refrigeration controller may be fitted with standard replaceable batteries or rechargeable battery pack. The unit is fitted with the EverFresh controlled atmosphere option, the CA controller may be fitted with the same battery option.

1.3.2 Dehumidification

The unit may be fitted with a humidity sensor. This sensor allows setting of a humidity set point in the controller. In the dehumidification mode the controller will operate to reduce internal container moisture level.

1.3.3 Control Box

The control box may be of aluminum or composite material and each type box may be fitted with a lockable door.

1.3.4 Temperature Readout

The unit may be fitted with suction and discharge temperature sensors. The sensor readings may be viewed on the controller display.

1.3.5 Pressure Readout

The unit may be fitted with suction and discharge pressure gauges or suction and discharge transducers or no pressure readout. The transducer readings may be viewed on the controller display.

1.3.6 USDA

The unit may be supplied with fittings for additional temperature probes which allow recording of USDA Cold Treatment data by the integral DataCORDER function of the Micro-Link refrigeration controller.

1.3.7 Interrogator

Units that use the DataCORDER function are fitted with interrogator receptacles for connection of equipment to download the recorded data. Two receptacles may be fitted, one accessible from the front of the container and the other mounted inside the container (with the USDA receptacles).

1.3.8 Remote Monitoring

The unit may be fitted with a remote monitoring receptacle. This item allows connection of remote indicators for COOL, DEFROST and IN RANGE. Unless otherwise indicated, the receptacle is mounted at the control box location

1.3.9 Communications

The unit may be fitted with a communications interface module. The communications interface module is a slave module which allows communication with a master central monitoring station. The module will respond to communication and return information over the main power line. Refer to the ship master system technical manual for further information.

1.3.10 Compressor, Refrigeration

The unit is fitted with a single speed reciprocating compressor.

1.3.11 Condenser Coil

The unit may be fitted with a 2 row or 4 row coil using nominal 3/8 inch tubing, or the unit may be fitted with a 3 row coil using 7mm tubing. The required refrigerant charge is different for each coil.

1.3.12 Autotransformer

An autotransformer may be provided to allow operation on 190/230, 3phase, 50/60 hertz power. The autotransformer raises the supply voltage to the nominal 380/460 volt power required by the base unit. The autotransformer may also be fitted with an individual circuit breaker for the 230 volt power.

If the unit is fitted with an autotransformer and communications module, the autotransformer will be fitted with a transformer bridge unit (TBU) to assist in communications.

1.3.13 Gutters

Rain gutters may be fitted over the control box and EverFresh control box to divert rain away from the controls.

1.3.14 Handles

The unit may be fitted with handles to facilitate access to stacked containers. These handles may include fixed handles (located at the sides of the unit) and/or a hinged handle at the center (attached to the condenser coil cover).

1.3.15 Water Cooling

The refrigeration system may be fitted with a water cooled condenser. The condenser is constructed using copper–nickel tube for sea water applications. The water cooled condenser is in series with the air cooled condenser and replaces the standard unit receiver. When operating on the water cooled condenser, the condenser fan is deactivated by either a water pressure switch or condenser fan switch.

1.3.16 Back Panels

Back panel designs that may be fitted include panels of aluminum and stainless steel. Panels may be fitted with access doors and/or hinge mounting.

1.3.17 460 Volt Cable

Various power cable and plug designs are available for the main 460 volt supply. The plug options tailor the cables to each customers requirements.

1.3.18 230 Volt Cable

Units equipped with an autotransformer require an additional power cable for connection to the 230 volt source. Various power cable and plug designs are available. The plug options tailor the cables to each customers requirements.

1.3.19 Cable Restraint

Various designs are available for storage of the power cables. These options are variations of the compressor section front cover.

1.3.20 Upper Air (Fresh Air Make Up)

The unit is fitted with an upper fresh air makeup assembly. The openings may also be fitted with screens.

1.3.21 Controlled Atmosphere

All units covered in this manual are fitted with the Carrier Transicold EverFresh controlled atmosphere system. This system includes an air compressor, membrane separator, valves, sensors and a dedicated controller to generate nitrogen and control the level of oxygen and carbon dioxide in the container. Details of this system are found in Part Two of this manual, beginning on page 87.

1.3.22 Arctic Mode

To improve operation in cold ambients, the unit may be fitted with a crankcase heater and/or a condensate drain line heater. The crankcase heater is operated, before start–up, to warm the compressor oil and boil off any liquid refrigerant that may be present in the crankcase. The drain line heater is operated to prevent freezing of the evaporator condensate drain system.

1.3.23 Humidification

The unit may be equipped with the Carrier Transicold NatureFresh humidity management system. The system includes a water tank, water pump, water heater and atomizer along with various control and monitoring devices. It is designed to add additional moisture into the supply air for control of cargo moisture level. A separately bound manual covering operation and parts for the CTD NatureFresh System is available, see the following chart.

Manual Number	Equipment Covered	Type of Manual
T-297	Humidity Management System Option	Technical Supplement

1.3.24 Power Correction

The unit may be fitted with a set of power factor correction capacitors to assist in correction of imbalance in current draw by the compressor.

1.3.25 Evaporator

Evaporator section options include a semi–hermetic thermal expansion valve, a hermetic thermal expansion valve and two sizes of heat exchangers.

1.3.26 Evaporator Fan Operation

The units are fitted with Normal Evaporator Fan Operation, opening of an evaporator fan internal protector will shut down the unit.

1.3.27 Labels

Operating Instruction and Function Code listing labels will differ depending on the options installed. For example, additional operating instructions are required to describe start-up of a unit equipped with an autotransformer. Where the labels are available with additional languages, they are listed in the parts list.

1.3.28 Plate Set

Each unit is equipped with a tethered set of wiring schematic and wiring diagram plates. The plate sets are ordered using a seven digit base part number and a two digit dash number. EverFresh controlled atmosphere units have a second set of plates for the controlled atmosphere system. These plate sets are numbered and ordered in the same manner. **(See Identification Matrix)**

1.3.29 Controller

There are two controllers in the unit, the refrigeration controller controls the temperature and the EverFresh controller controls the Controlled Atmosphere components. Replacement controllers may be ordered as a universal un-configured controller (without configuration software) or configured.

1.3.30 Stepper Drive

All the units covered by this manual have suction modulating valves which act to control system capacity. Units indicated as being fitted with “stepper drive” have digital control motors fitted to the suction modulating valve to open and close the valve in steps as required.

1.3.31 Condenser Grille

Two styles of condenser grilles are available, direct bolted grilles and hinged grilles.

SECTION 2

DESCRIPTION

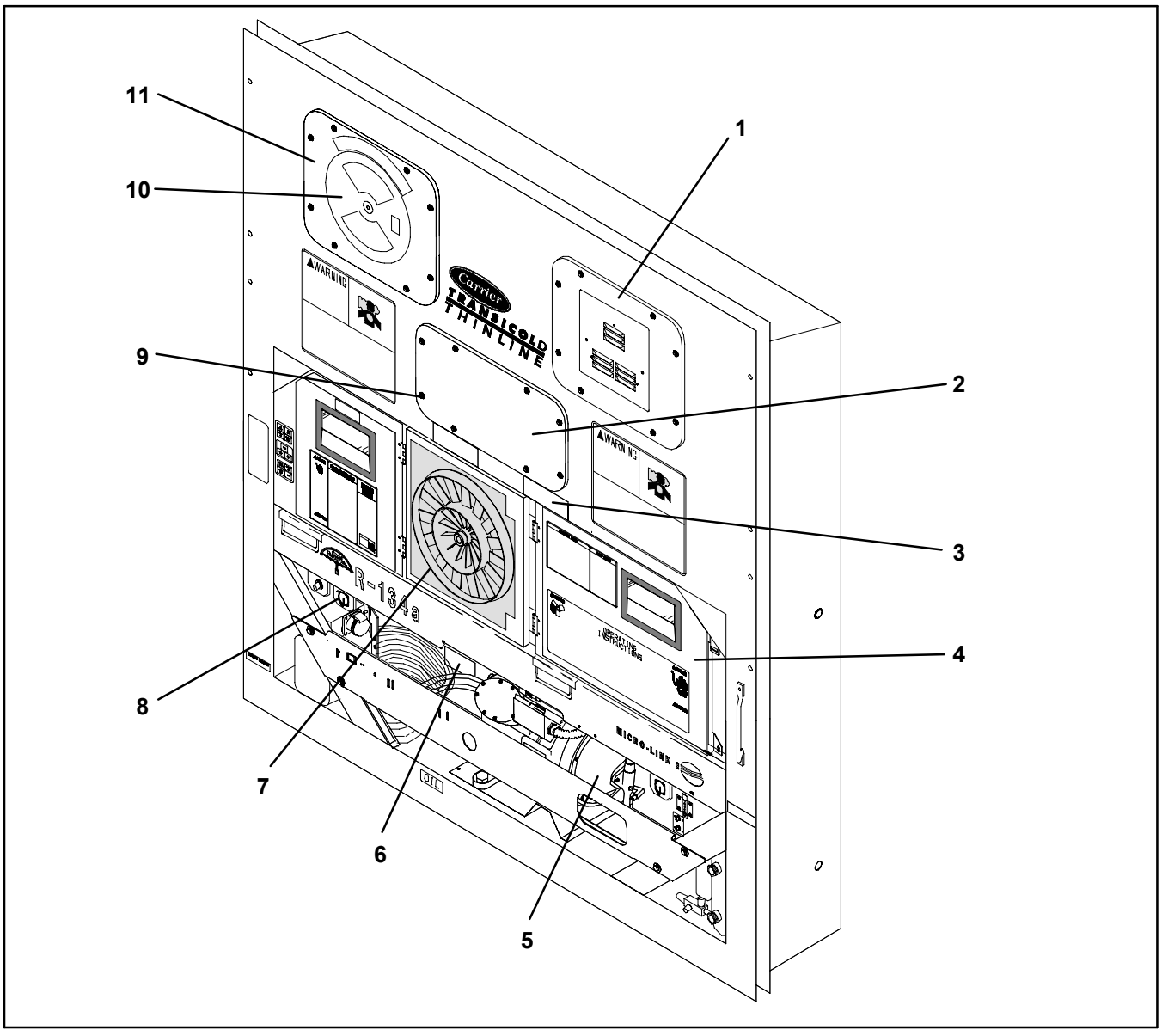
2.1 GENERAL DESCRIPTION

2.1.1 Refrigeration Unit – Front Section

The unit is designed so that the majority of the components are accessible from the front, see Figure 1. The upper access panels allow entry into the evaporator section, and the center access panel allows access to the thermostatic expansion valve and evaporator coil heaters. The unit model number, serial number and parts identification number can be found on the serial plate to the left of the compressor.

2.1.2 Upper Fresh Air Makeup Vent

The function of the upper makeup air vent is to provide ventilation for commodities that require fresh air circulation.



1. Access Panel (Evap. Fan #1)
2. Access Panel (Heater & Thermostatic Expansion Valve)
3. Fork Lift Pockets
4. Control Box
5. Compressor
6. Unit Serial Number, Model Number and Parts Identification Number (PID) Plate
7. Condenser Fan
8. Interrogator Connector (Front)
9. TIR (Transports Internationaux Routiers) Sealing Provisions - Typical All Panels
10. Upper Fresh Air Makeup Vent
11. Access Panel (Evap. Fan #2)

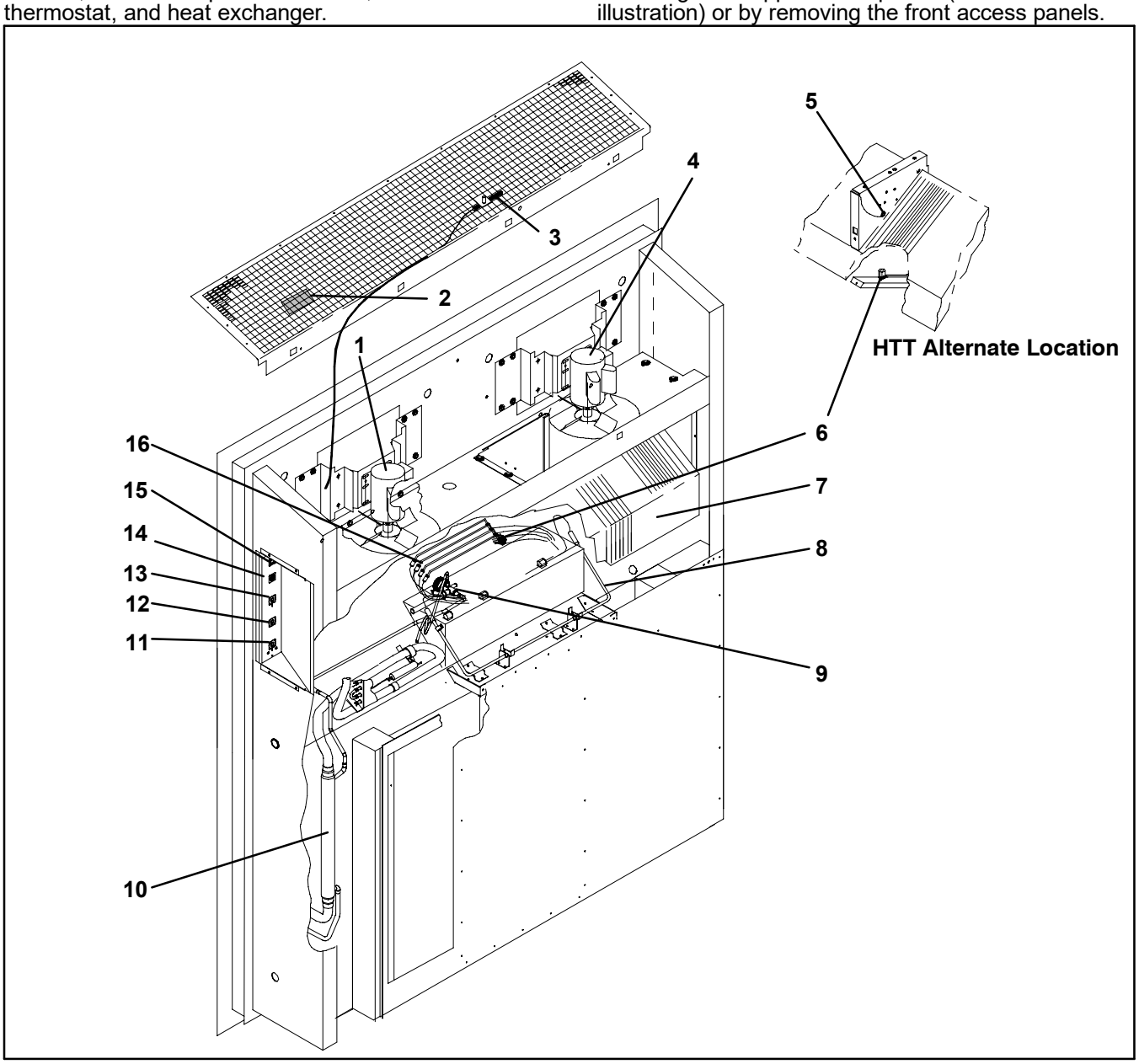
Figure 1. Refrigeration Unit – Front Section

2.1.3 Evaporator Section

The evaporator section (Figure 2) contains the return air temperature sensor, thermostatic expansion valve, dual-speed evaporator fans (EM1 and EM2), evaporator coil and heater, drain pan heater, defrost heaters, defrost temperature sensor, heat termination thermostat, and heat exchanger.

The evaporator fans circulate air through the container by pulling it in the top of the unit, directing it through the evaporator coil, where it is heated or cooled, and discharging it at the bottom.

The evaporator components are accessible by removing the upper rear panel (as shown in the illustration) or by removing the front access panels.



1. Evaporator Fan Motor #1
2. Humidity Sensor
3. Return Air Temperature Sensor
4. Evaporator Fan Motor #2
5. Defrost Temperature Sensor
6. Heater Termination Thermostat
7. Evaporator Coil
8. Drain Pan Heater
9. Thermostatic Expansion Valve
10. Heat Exchanger
11. Interrogator Connector (Rear)
12. USDA Probe Receptacle PR2
13. USDA Probe Receptacle PR1
14. USDA Probe Receptacle PR3
15. Cargo Probe Receptacle PR4
16. Evaporator Coil Heaters

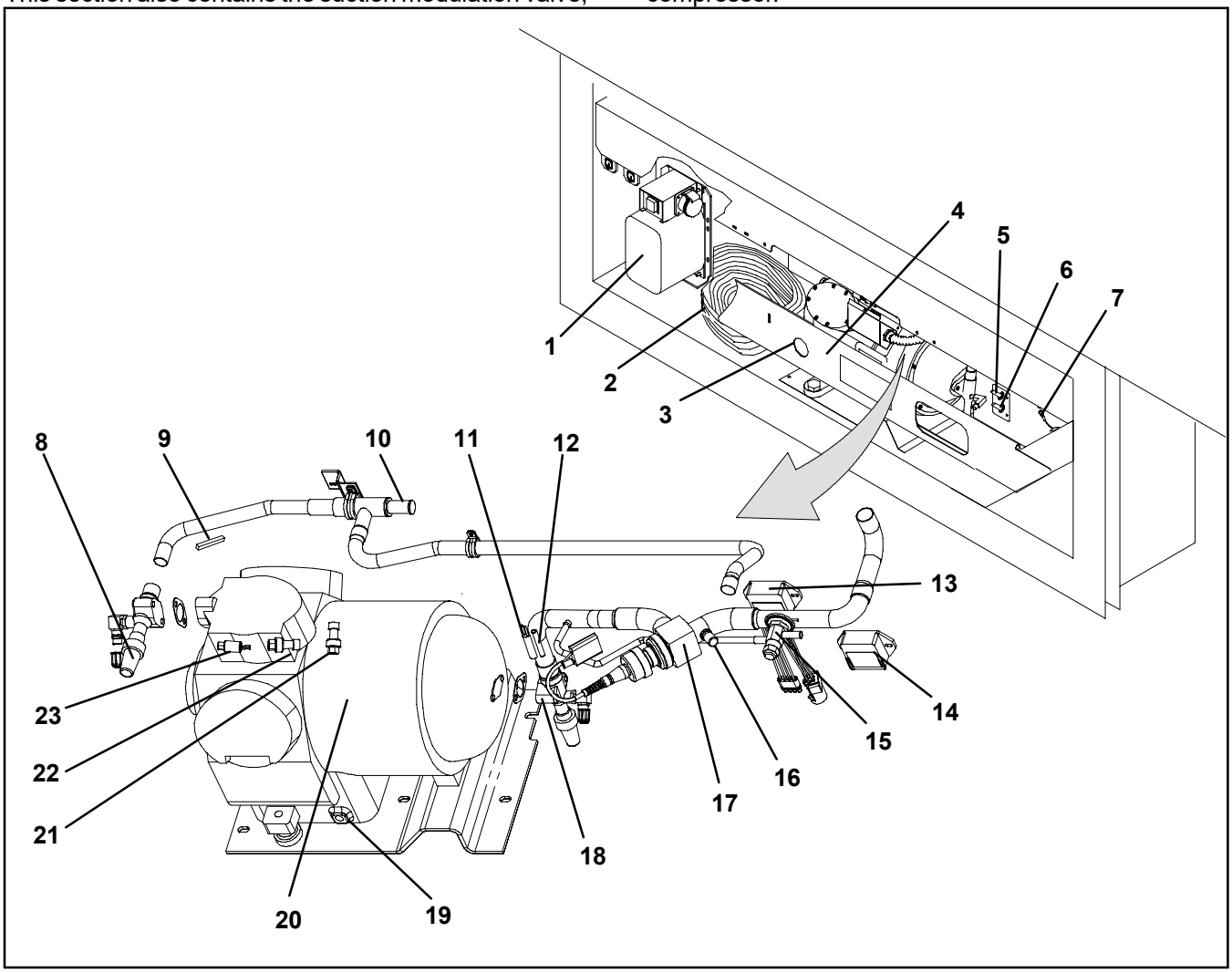
Figure 2. Evaporator Section

2.1.4 Compressor Section

The compressor section includes the compressor (with high pressure switch), power cable storage compartment, and autotransformer

This section also contains the suction modulation valve, modulating valve stepper motor drive, discharge pressure regulator valve and discharge/suction pressure transducers.

The supply temperature sensor, supply recorder sensor and ambient sensor are located at the right side of the compressor.



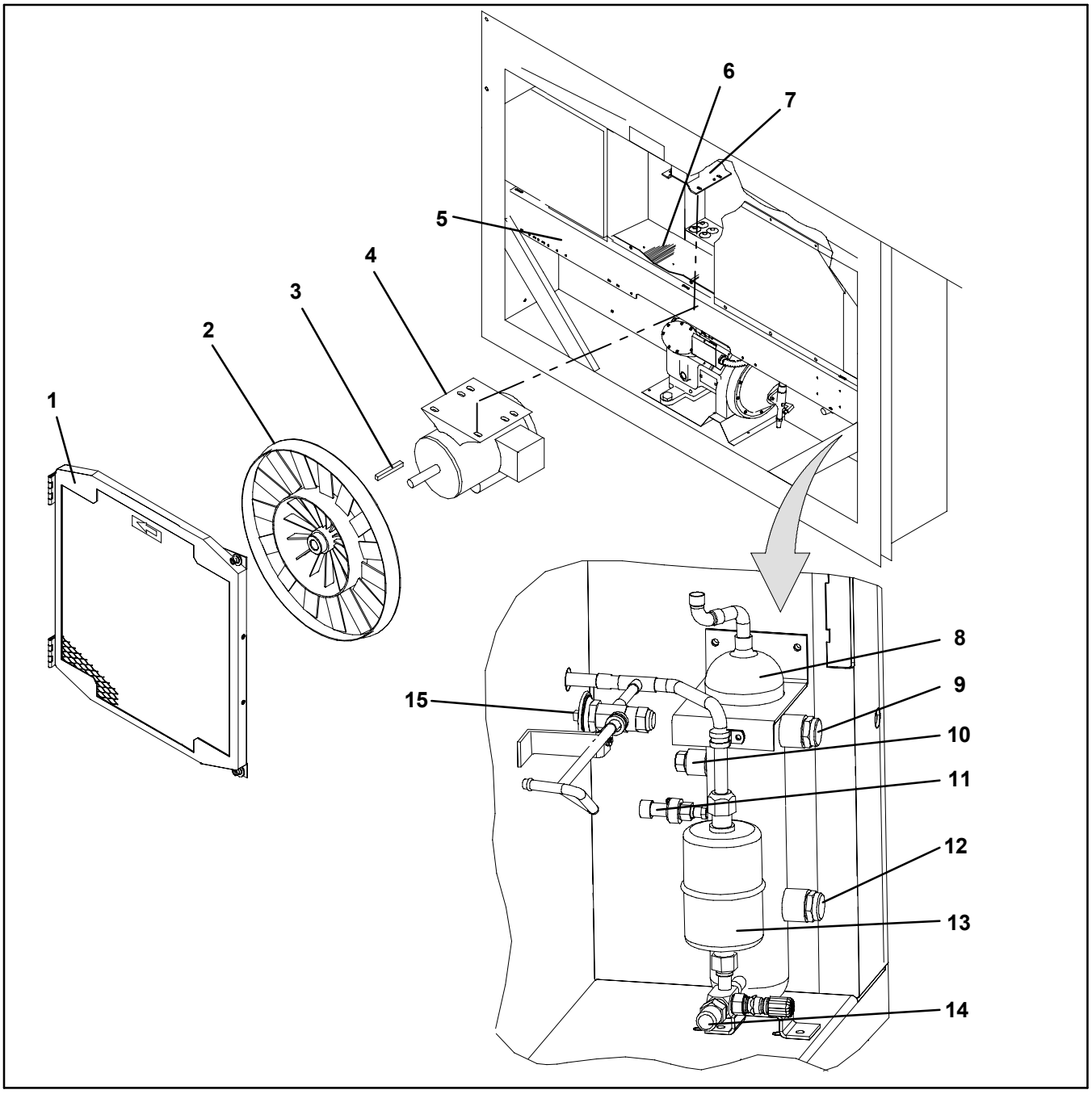
1. Power Autotransformer
2. Power Cables and Plug
3. Compressor Sight Glass View Port
4. Compressor Guard
5. Supply Temperature Sensor
6. Supply Recorder Sensor
7. Ambient Sensor
8. Discharge Service Valve
9. Discharge Temperature Sensor
10. Discharge Pressure Regulator Valve
11. Quench Valve Temperature Bulb
12. Suction Temperature Sensor
13. Stepper Motor Drive (for item 17)
14. Emergency Bypass Module (for item 17)
15. Quench Valve
16. Access Valve
17. Suction Modulation Valve
18. Suction Service Valve
19. Compressor Crankcase Heater
20. Compressor Motor
21. Suction Pressure Transducer
22. Discharge Pressure Transducer
23. High Pressure Switch

Figure 3. Compressor Section

2.1.5 Air Cooled Condenser Section

The air cooled condenser section (Figure 4) consists of the condenser fan, condenser coil, receiver with sight glass/moisture indicator, quench valve, manual liquid line valve, filter-drier, condenser pressure transducer and fusible plug.

The condenser fan pulls air in the bottom of the coil and it is discharged horizontally out through the condenser fan grille.

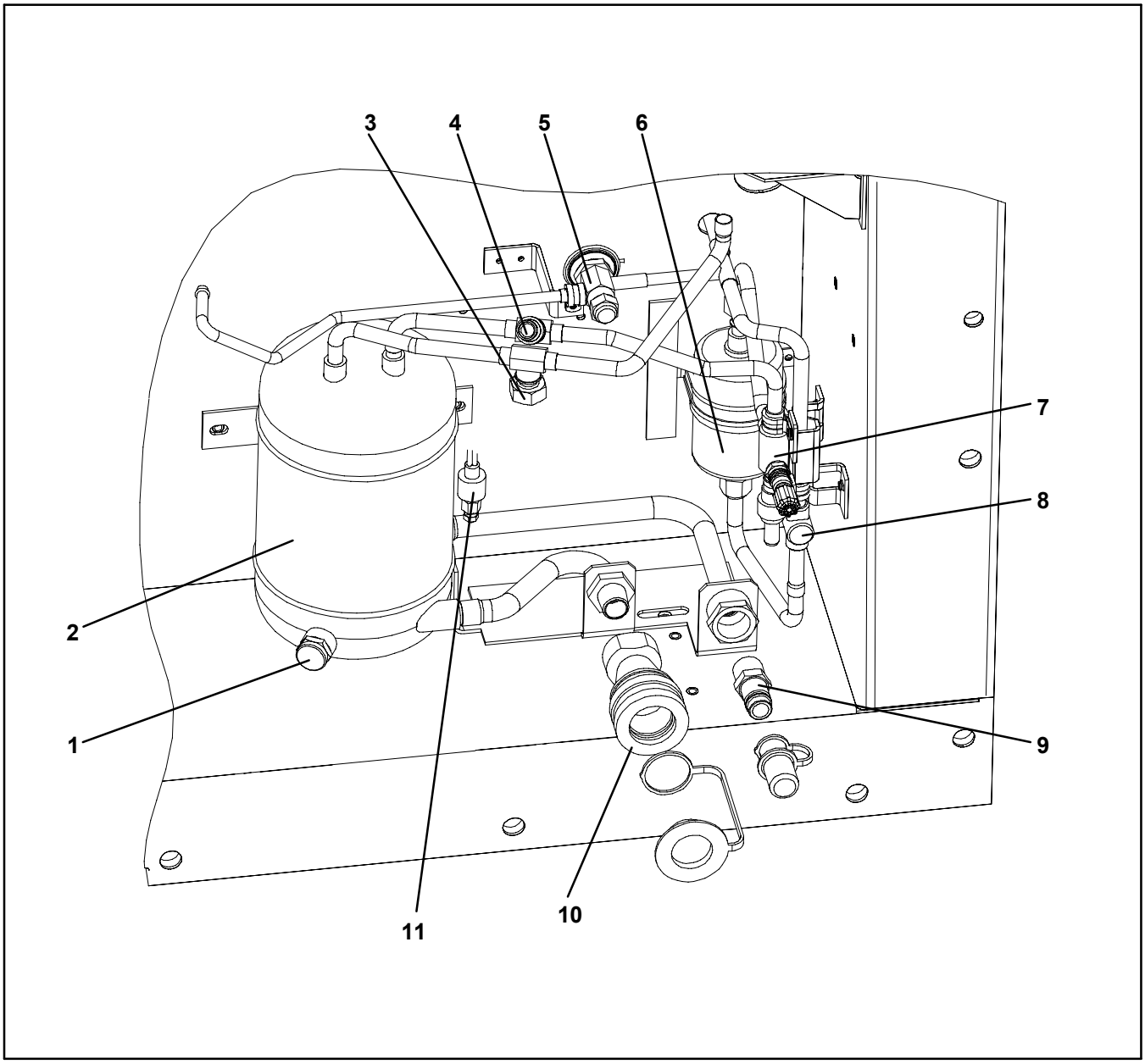


1. Grille and Venturi Assembly
2. Condenser Fan
3. Key
4. Condenser Fan Motor
5. Condenser Coil Cover
6. Condenser Coil
7. Condenser Motor Mounting Bracket
8. Receiver
9. Sight Glass
10. Fusible Plug
11. Condenser Pressure Transducer
12. Sight Glass/Moisture Indicator
13. Filter-Drier
14. Liquid Line service Valve
15. Quench Valve

Figure 4. Condenser Section

2.1.6 Water-Cooled Condenser Section

The water-cooled condenser section (Figure 5) consists of a water-cooled condenser, sight glass, quench expansion valve, rupture disc, condenser pressure transducer, filter-drier, water couplings and water pressure switch. The water-cooled condenser replaces the standard unit receiver.



1. Sight Glass
2. Water-Cooled Condenser
3. Rupture Disc
4. Condenser Pressure Transducer
5. Quench Valve
6. Filter-Drier
7. Liquid Line Service Valve
8. Moisture-Liquid Indicator
9. Coupling (Water In)
10. Self Draining Coupling (Water Out)
11. Water Pressure Switch

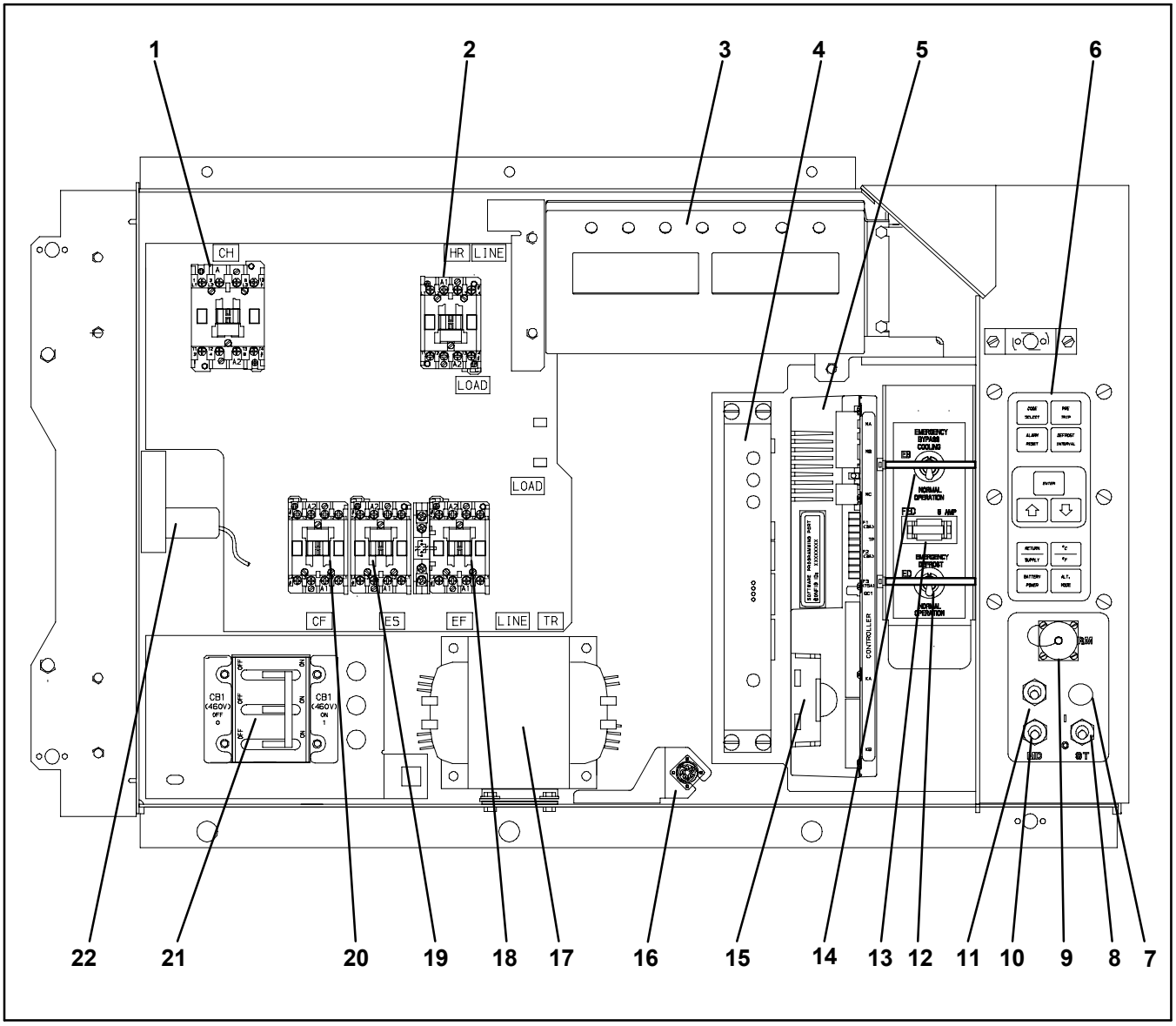
Figure 5. Water-Cooled Condenser Section

2.1.7 Control Box Section

The control box (Figure 6) includes the manual operation switches, circuit breaker (CB-1), compressor, fan and heater contactors, control power transformer, fuses, key pad, display module, current sensor module, refrigeration controller module and the communications interface module.

2.1.8 Communications Interface Module

The communications interface module is a slave module which allow communication with a master central monitoring station. The module will respond to communication and return information over the main power line. Refer to the master system technical manual for further information.



1. Compressor Contactor
2. Heater Contactor
3. Display Module
4. Communications Interface Module
5. Controller/DataCORDER Module (Controller)
6. Key Pad
7. Emergency Defrost Light
8. Start-Stop Switch
9. Remote Monitoring Receptacle
10. Manual Defrost Switch
11. Condenser Fan Switch
12. Emergency Defrost Switch
13. Emergency Defrost Fuse
14. Emergency Bypass Switch
15. Controller Battery Pack
16. Interrogator Connector (Box Location)
17. Control Transformer
18. Evaporator Fan Contactor - High Speed
19. Evaporator Fan Contactor - Low Speed
20. Condenser Fan Contactor
21. Circuit Breaker – 460V
22. Current Sensor Module

Figure 6. Control Box Section

2.2 REFRIGERATION SYSTEM DATA

a. Compressor/Motor Assembly	Number of Cylinders	6		
	Model	06DR		
	CFM	41		
	Weight (Dry)	118 kg (260 lb)		
	Approved Oil	Castrol Icematic – SW20		
	Oil Charge	3.6 liters (7.6 U.S. pints)		
	Oil Sight Glass	The oil level range, with the compressor off, should be between the bottom and one-eighth level of the sight glass.		
b. Expansion Valve Superheat	Verify at –18 °C (0 °F) container box temperature	4.5 to 6.7 °C (8 to 12 °F)		
c. Heater Termination Thermostat	Opens	54 (± 3) °C = 130 (± 5) °F		
	Closes	38 (± 4) °C = 100 (± 7) °F		
d. High Pressure Switch	Cutout	25 (± 1.0) kg/cm^2 = 350 (± 10) psig		
	Cut-In	18 (± 0.7) kg/cm^2 = 250 (± 10) psig		
e. Refrigerant Charge	Unit Configuration	Charge Requirements – R-134a		
		2 row condenser	**3 row condenser**	**4 row condenser**
	Water-Cooled Condenser	4.5 kg (9.0 lbs)	4.9 kg (10.75 lbs)	5.2 kg (11.5 lbs)
	Receiver	3.7 kg (8.3 lbs)	4.0 kg (8.8 lbs)	4.9 kg (10.8 lbs)
NOTE When replacing the following components (f.), (g.) and (h.) , refer to the installation instructions included with the replacement part for additional information.				
f. Fusible Plug	Melting point	99 °C = (210 °F)		
	Torque	6.2 to 6.9 mkg (45 to 50 ft-lbs)		
g. Sight Glass/Moisture Indicator	Torque	8.9 to 9.7 mkg (65 to 70 ft-lbs)		
h. Rupture Disc	Bursts at	35 ± 5% kg/cm^2 = (500 ± 5% psig)		
	Torque (P/N 14-00215-03)	1.4 to 2 mkg (10 to 15 ft-lbs)		
	Torque (P/N 14-00215-04*)	6.2 to 6.9 mkg (45 to 50 ft-lbs)		
i. Condenser Pressure Transducer	Condenser Fan Starts	The condenser fan will start if the condenser pressure is greater than 14.06 kg/cm^2 (200 psig) OR the condenser fan is OFF for more than 60 seconds.		
	Condenser Fan Stops	The condenser fan will stop if the condenser pressure is less than 9.14 kg/cm^2 (130 psig) AND the condenser fan remains ON for at least 30 seconds.		
j. Unit Weight	Refer to unit model number plate.			
k. Water Pressure Switch	Cut-In	0.5 ± 0.2 kg/cm^2 (7 ± 3 psig)		
	Cutout	1.6 ± 0.4 kg/cm^2 (22 ± 5 psig)		
l. Discharge Pressure Regulator	Factory Setting	32.7 ± 2.5 kg/cm^2 (72± 5.5 psig)		

* Rupture Disc, part number 14–00215–04 may be installed as an alternate for the receiver mounted fusible plug.

2.3 ELECTRICAL DATA

a. Circuit Breaker	CB-1 Trips at	29 amps	
	CB-2 (50 amp) Trips at	62.5 amps	
	CB-2 (70 amp) Trips at	87.5 amps	
b. Compressor Motor	Full Load Amps (FLA)	17.6 amps @ 460 vac (with current limiting set at 21 amps)	
c. Condenser Fan Motor		380 vac, Single Phase, 50 hz	460 vac, Single Phase, 60 hz
	Full Load Amps	1.3 amps	1.6 amps
	Horsepower	0.43 hp	0.75 hp
	Rotations Per Minute	1425 rpm	1725 rpm
	Voltage and Frequency	360 – 460 vac ± 2.5 hz	400 – 500 vac ± 2.5 hz
	Bearing Lubrication	Factory lubricated, additional grease not required.	
	Rotation	Counter-clockwise when viewed from shaft end.	
d. Drain Pan Heaters	Number of Heaters	1	
	Rating	750 watts +5 /–10 % @ 460 vac	
	Resistance (cold)	285 ± 7.5% ohms @ 20 °C (68 °F)	
	Type	Sheath	
e. Evaporator Coil Heaters	Number of Heaters	4	
	Rating	750 watts +5/–10% each @ 230 vac	
	Resistance (cold)	66.8 to 77.2 ohms @ 20 °C (68 °F)	
	Type	Sheath	
f. Evaporator Fan Motor(s)		**380 vac/50 hz**	**460 vac/60 hz**
	Full Load Amps High Speed	1.6	2.0
	Full Load Amps Low Speed	0.8	1.0
	Nominal Horsepower High Speed	0.70	0.84
	Nominal Horsepower Low Speed	0.09	0.11
	Rotations Per Minute High Speed	2850 rpm	3450 rpm
	Rotations Per Minute Low Speed	1425 rpm	1750 rpm
	Voltage and Frequency	360 – 460 vac ± 1.25 hz	400 – 500 vac ± 1.5 hz
	Voltage & Frequency using power autotransformer	180 – 230 vac ± 1.25hz	200 – 250 vac ± 1.5 hz
	Bearing Lubrication	Factory lubricated, additional grease not required	
	Rotation	**EFM#1** CW when viewed from shaft end **EFM#2** CCW when viewed from shaft end	
g. Fuses	Control Circuit	10 amps (F3)	
	Controller/DataCORDER	5 amps (F1 & F2)	
	Emergency Defrost	5 amps (FED)	
	Drain Line Heater	5 amps (FDH)	
	Humidity Power Transformer	5 amps (FH)	
h. Compressor Crankcase Heater		180 watts @ 460 vac	

i. Humidity Sensor	Orange wire	Power
	Red wire	Output
	Brown wire	Ground
	Input voltage	5 vdc
	Output voltage	0 to 3.3 vdc
	Output voltage readings verses relative humidity (RH) percentage:	
	30%	0.99 V
	50%	1.65 V
	70%	2.31 V
	90%	2.97 V
j. Controller	Setpoint Range	–30 to +30 °C (–22 to +86 °F)

2.4 SAFETY AND PROTECTIVE DEVICES

Unit components are protected from damage by safety and protective devices listed in the following table. These devices monitor the unit operating conditions and open a set of electrical contacts when an unsafe condition occurs.

Open safety switch contacts on either or both of devices IP-CP or HPS will shut down the compressor.

Open safety switch contacts on device IP-CM will shut down the condenser fan motor.

The entire refrigeration unit will shut down if one of the following safety devices open: (a) Circuit Breaker(s); (b) Fuse (F3/15A); or (c) Evaporator Fan Motor Internal Protector(s) – (IP-EM).

Table 1. Safety and Protective Devices

UNSAFE CONDITION	SAFETY DEVICE	DEVICE SETTING
Excessive current draw	Circuit Breaker (CB-1) – Manual Reset	Trips at 29 amps (460 vac)
	Circuit Breaker (CB-2, 50 amp) –Manual Reset	Trips at 62.5 amps (230 vac)
	Circuit Breaker (CB-2, 70 amp) –Manual Reset	Trips at 87.5 amps (230 vac)
Excessive current draw in the control circuit	Fuse (F3)	10 amp rating
Excessive current draw by the controller	Fuse (F1 & F2)	5 amp rating
Excessive current draw by the emergency defrost circuit	Fuse (FED)	5 amp rating
Excessive current draw by the drain line heater	Fuse (FDH)	5 amp rating
Excessive current draw by the humidity power transformer	Fuse (FH)	5 amp rating
Excessive condenser fan motor winding temperature	Internal Protector (IP-CM) – Automatic Reset	N/A
Excessive compressor motor winding temperature	Internal Protector (IP-CP) – Automatic Reset	N/A
Excessive evaporator fan motor(s) winding temperature	Internal Protector(s) (IP-EM) – Automatic Reset	N/A
Abnormal pressures/temperatures in the high refrigerant side	Fusible Plug – Used on the Receiver Rupture Disc – Used on the Water-Cooled Condenser	99 °C = (210 °F) 35 kg/cm^2 = (500 psig)
Abnormally high discharge pressure	High Pressure Switch (HPS)	Opens at 25 kg/cm^2 (350 psig)

2.5 REFRIGERATION CIRCUIT

Starting at the compressor, (see Figure 7, upper schematic) the suction gas is compressed to a higher pressure and temperature.

The gas flows through the discharge service valve into the pressure regulator valve. During periods of low ambient operation, the pressure regulator valve modulates the flow of refrigerant to maintain a pre set minimum discharge pressure. Refrigerant gas then moves into the air-cooled condenser. When operating with the air-cooled condenser active, air flowing across the coil fins and tubes cools the gas to saturation temperature. By removing latent heat, the gas condenses to a high pressure/high temperature liquid and flows to the receiver which stores the additional charge necessary for low temperature operation.

When operating with the water cooled condenser active (see Figure 7, lower schematic), the refrigerant gas passes through the air cooled condenser and enters the water cooled condenser shell. The water flowing inside the tubing cools the gas to saturation temperature in the same manner as the air passing over the air cooled condenser. The refrigerant condenses on the outside of the tubes and exits as a high temperature liquid. The water cooled condenser also acts as a receiver, storing excess refrigerant.

The liquid refrigerant continues through the liquid line service valve, the filter-drier (which keeps refrigerant clean and dry), and a heat exchanger (that increases subcooling of the liquid) to the thermostatic expansion valve. As the liquid refrigerant passes through the variable orifice of the expansion valve, some of it vaporizes into a gas (flash gas). Heat is absorbed from the return air by the balance of the liquid, causing it to vaporize in the evaporator coil. The vapor then flows through the suction modulation valve to the compressor.

The thermostatic expansion valve is activated by the bulb strapped to the suction line near the evaporator outlet. The valve maintains a constant superheat at the coil outlet regardless of load conditions.

During periods of low load, the suction modulating valve decreases flow of refrigerant to the compressor. This action balances the compressor capacity with the load and prevents operation with low coil temperatures. In this mode of operation, the quench valve will open as required to provide sufficient liquid refrigerant flow into the suction line for cooling of the compressor motor. The quench valve senses refrigerant condition entering the compressor and modulates the flow to prevent entrance of liquid into the compressor.

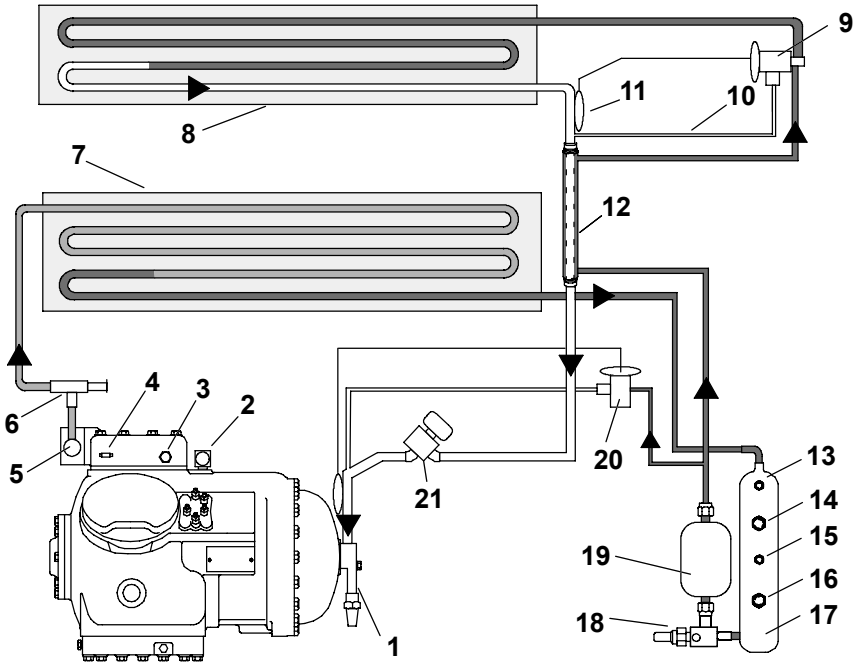
The refrigeration system is also fitted with a condenser pressure transducer which feeds information to the controller. When operating on the air cooled condenser, the controller programming will operate the condenser fan so as to attempt to maintain discharge pressures above 130 psig in low ambients. At ambients below 27°C (80°F), the condenser fan will cycle on and off depending on condenser pressure and operating times.

1 The condenser fan will start if the condenser pressure is greater than 200 psig OR the condenser fan has been OFF for more than 60 seconds.

2 The condenser fan will stop if the condenser pressure is less than 130 psig AND the condenser fan has been running for at least 30 seconds.

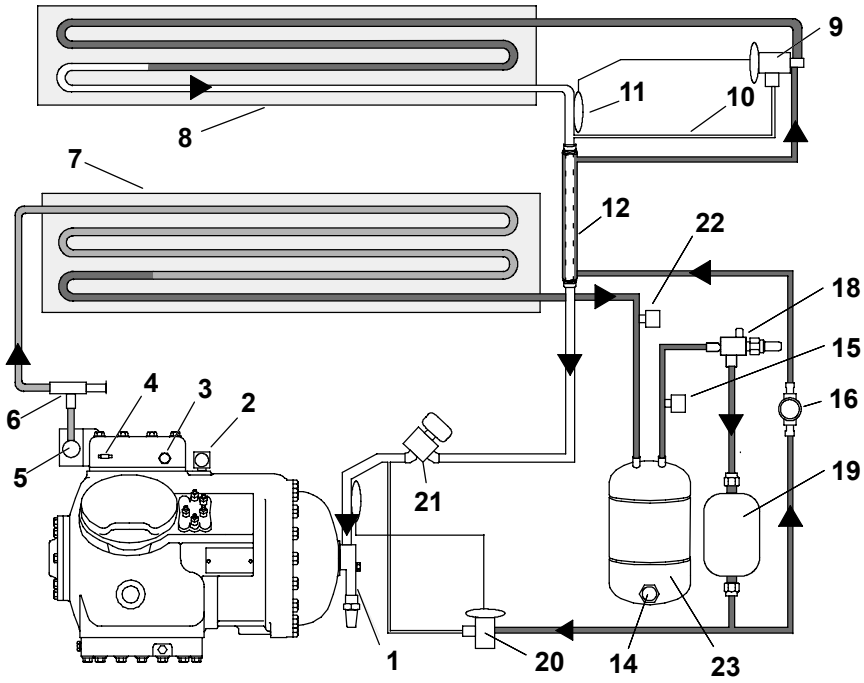
At ambients above 27°C (80°F), condenser pressure control is disabled and the condenser fan runs continuously.

On systems fitted with a water pressure switch, the condenser fan will be off when there is sufficient pressure to open the switch. If water pressure drops below the switch cut out setting, the condenser fan will be automatically started. When operating a system fitted with a condenser fan switch, the condenser fan will be off when the switch is placed in the “O” position. The condenser fan will be on when the switch is placed in the “I” position.



CIRCUIT WITH RECEIVER

1. Suction Service Valve
2. Suction Pressure Transducer
3. Discharge Pressure Transducer
4. High Pressure Switch
5. Discharge Service Valve
6. Discharge Pressure Regulator Valve
7. Air–Cooled Condenser
8. Evaporator
9. Thermostatic Expansion Valve
10. External Equalizer Line
11. Thermostatic Expansion Valve Bulb
12. Heat Exchanger
13. Fusible Plug (Hidden)
14. Sight Glass
15. Condenser Pressure Transduce (Hidden)
16. Sight Glass/Moisture Indicator
17. Receiver
18. Liquid Line Service Valve
19. Filter–Drier
20. Quench Valve
21. Suction Modulating Valve
22. Rupture Disc
23. Water–Cooled Condenser



CIRCUIT WITH WATER–COOLED CONDENSER

LEGEND
DISCHARGE
LIQUID
SUCTION

Figure 7. Refrigeration Circuit Schematic

SECTION 3
MICROPROCESSOR

3.1 TEMPERATURE CONTROL MICROPROCESSOR SYSTEM

The temperature control Micro-Link 2i microprocessor system (see Figure 8) consists of a key pad, display module, control module (controller) and interconnecting wiring. The refrigeration controller houses the temperature control software and the DataCORDER Software. The temperature control software functions to operate the unit components as required to provide the desired cargo temperature and humidity. The DataCORDER software functions to record unit operating parameters and cargo temperature parameters for future retrieval. Coverage of the temperature control software begins with section 3.2. Coverage of the DataCORDER software is provided in section 3.6.

The key pad and display module serve to provide user access and readouts for both of the controller functions, temperature control and DataCORDER. The functions are accessed by key pad selections and viewed on the display module. The components are designed to permit ease of installation and removal. Interaction of the temperature control microprocessor and controlled atmosphere microprocessor is accomplished through a network connection. For information on the controlled atmosphere microprocessor refer to Section 9.

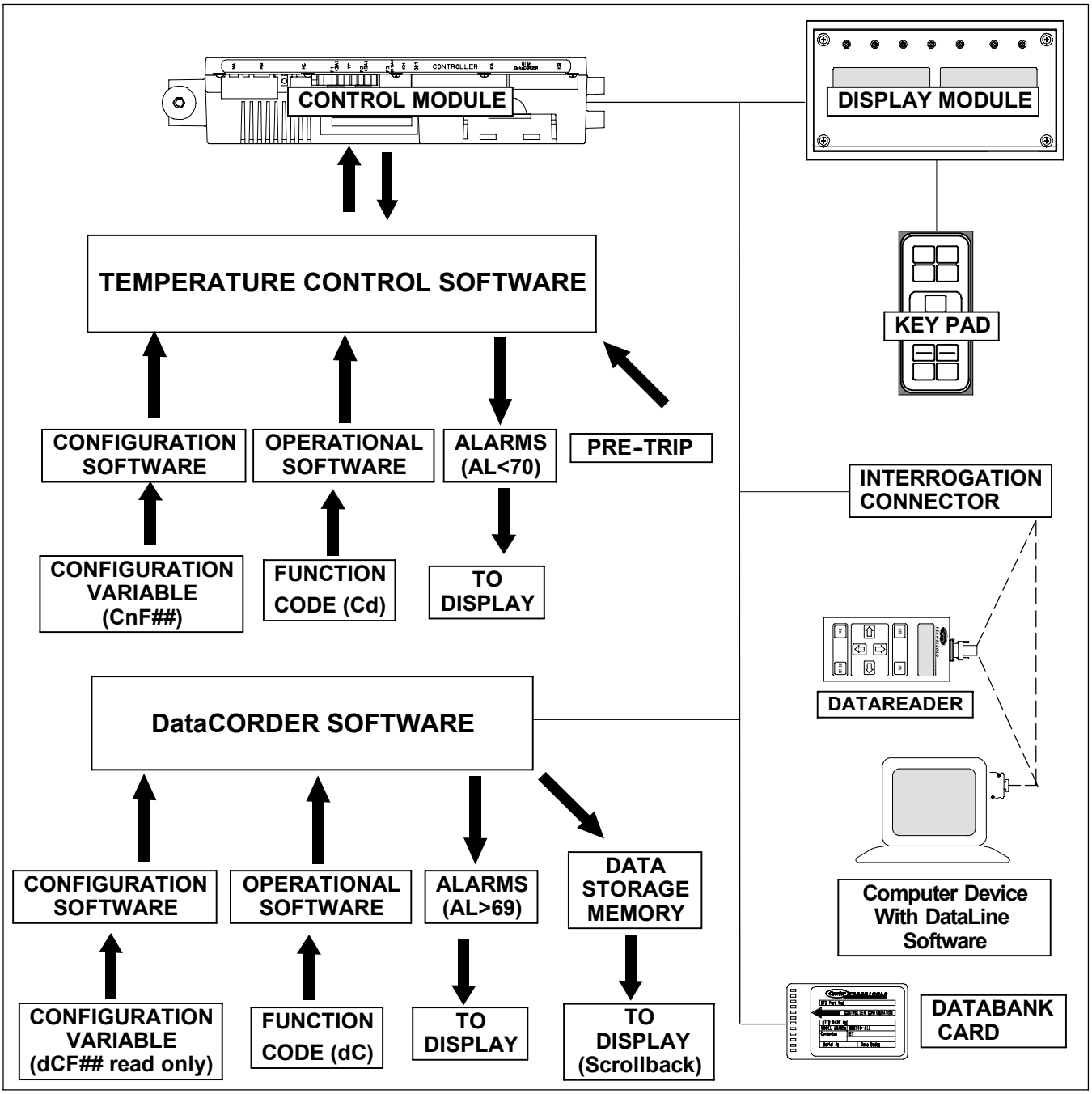


Figure 8. Temperature Control System

3.1.1 Key Pad

The key pad (Figure 9) is mounted on the right-hand side of the control box. The key pad consists of eleven push button switches. Refer to Table 2 for switch function descriptions.

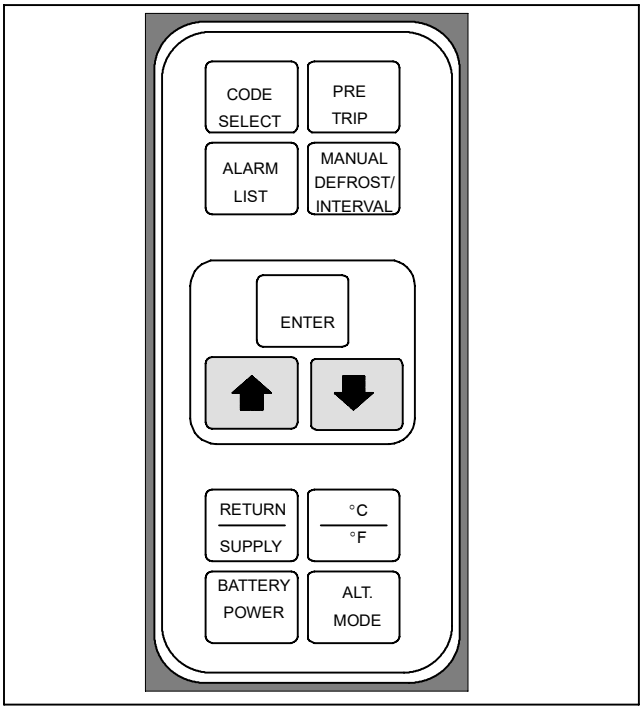


Figure 9. Key Pad

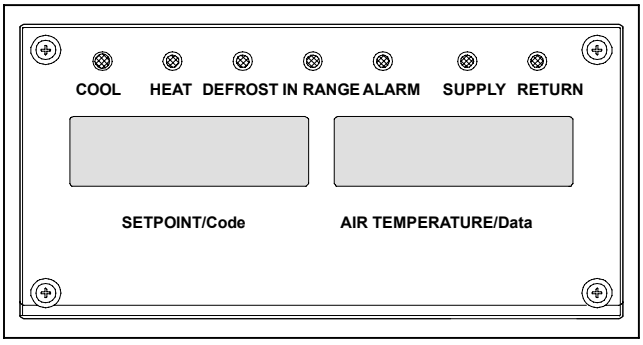


Figure 10. Display Module

3.1.2 Display Module

The display module (Figure 10) consists of two backlighted five digit LCD displays and seven indicator lights. The indicator lights include:

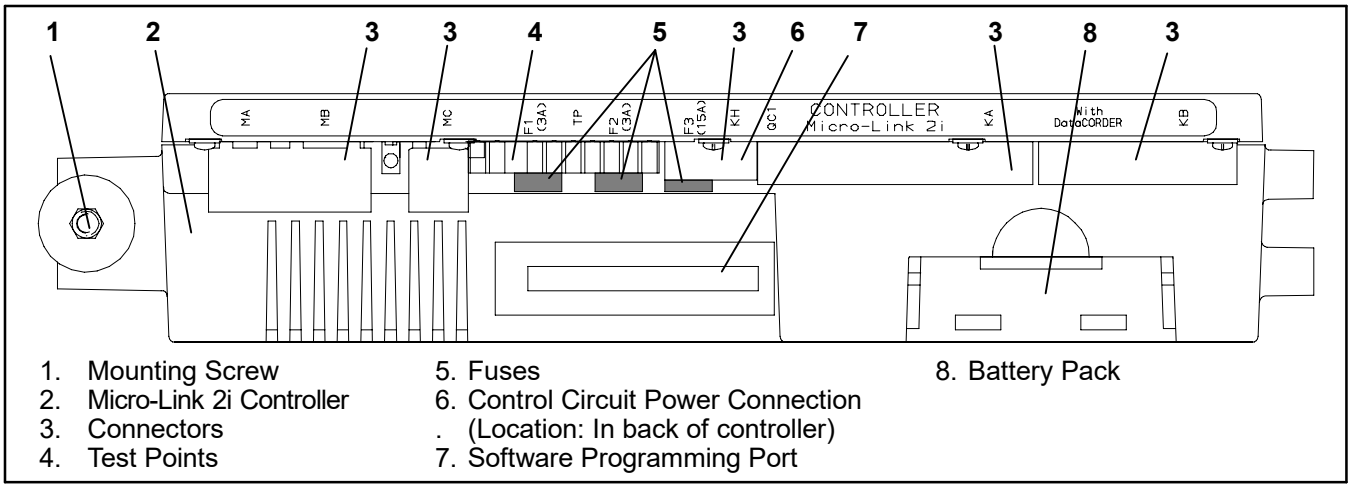
1. Cool – White LED: Energized when the refrigerant compressor is energized.
2. Heat – Orange LED: Energized to indicate heater operation in the heat or defrost mode.
3. Defrost – Orange LED: Energized when the unit is in the defrost mode.
4. In-Range – Green LED: Energized when the controlled temperature probe is within specified tolerance of set point.
5. Supply – Yellow LED: Energized when the supply air probe is used for control. When this LED is illuminated, the temperature displayed in the AIR TEMPERATURE display is the reading at the supply air probe. This LED will flash if dehumidification or humidification is enabled.
6. Return – Yellow LED: Energized when the return air probe is used for control. When this LED is illuminated, the temperature displayed in the AIR TEMPERATURE display is the reading at the return air probe. This LED will flash if dehumidification or humidification is enabled.
7. Alarm – Red LED: Energized when there is an active or an inactive shutdown alarm in the alarm queue.

Table 2. Key Pad Function

KEY	FUNCTION
Code Select	Accesses function codes.
Pre-Trip	Displays the pre-trip selection menu. Discontinues pre-trip in progress.
Alarm List	Displays alarm list and clears the alarm queue .
Manual Defrost/ Interval	Displays selected defrost mode. Depressing and holding the Defrost interval key for five (5) seconds will initiate defrost using the same logic as if the optional manual defrost switch was toggled on. The Manual Defrost function can also be selected by simultaneously pressing and holding the Pre–Trip and Alt. Mode buttons.
Enter	Confirms a selection or saves a selection to the controller
Arrow Up	Change or scroll a selection upward Pre-trip advance or test interruption.
Arrow Down	Change or scroll a selection downward. Pre-trip repeat backward
Return/ Supply	Displays non-controlling probe temperature (momentary display).
°C/°F	Displays alternate English/Metric scale (momentary display). When set to °F, pressure is displayed in psig and vacuum in “/hg. “P” appears after the value to indicate psig and “i” appears for inches of mercury. When set to °C. pressure readings are in bars. “b” appears after the value to indicate bars.
Battery Power	Initiate battery backup mode to allow set point and function code selection if AC power is not connected.
ALT. Mode	This key is pressed to switch the functions from the temperature software to the DataCORDER Software. The remaining keys function the same as described above except the readings or changes are made to the DataCORDER programming.

NOTE

The controlling probe in the perishable range will be the SUPPLY air probe and the controlling probe in the frozen range will be the RETURN air probe.



1. Mounting Screw
2. Micro-Link 2i Controller
3. Connectors
4. Test Points
5. Fuses
6. Control Circuit Power Connection
. (Location: In back of controller)
7. Software Programming Port
8. Battery Pack

Figure 11. Micro-Link 2i Controller

3.1.3 Controller

⚠ CAUTION

Do not remove wire harnesses from controller unless you are grounded to the unit frame with a static safe wrist strap.

⚠ CAUTION

Unplug all controller wire harness connectors before performing arc welding on any part of the container.

NOTE

Do not attempt to service the controller. Breaking the seal will void the warranty.

The Micro-Link 2i controller is a single module microprocessor as shown in Figure 11 . It is fitted with test points, harness connectors and a software card programming port.

3.2 REFRIGERATION CONTROLLER SOFTWARE

The controller software is a custom designed program that is subdivided into the Configuration Software and the Operational Software. The controller software performs the following functions:

a. Control supply or return air temperature to required limits, provide modulated refrigeration control, electric heat control and defrost. Defrost is performed to clear build up of frost and ice from the coil to ensure continuous conditioned air delivery to the load.

b. Provide default independent readouts of set point and supply or return air temperatures.

c. Provide ability to read and (if applicable) modify the Configuration Software Variables, Operating Software Function Codes and Alarm Code Indications.

d. Provide a Pre-Trip step-by-step checkout of refrigeration unit performance including: proper component operation, electronic and refrigeration control operation, heater operation, probe calibration, pressure limiting and current limiting settings.

e. Provide battery powered ability to access or change selected codes and set point without AC power connected

f. Provide the ability to reprogram the software through the use of a memory card. The memory card automatically downloads new software to the controller when inserted.

3.2.1 Configuration Software (Configuration Variables)

The Configuration Software is a variable listing of the components available for use by the Operational Software. This software is factory installed in accordance with the equipment fitted and options listed on the original purchase order. Changes to the Configuration Software are required only when the original software has been lost or a physical change has been made to the unit such as the addition or removal of an option. A Configuration Variable list is provided in Table 5, page 30. Change to the factory installed Configuration Software is achieved via a configuration card.

3.2.2 Operational Software (Function Codes)

The Operational Software is the actual operation programming of the controller which activates or deactivates components in accordance with current unit operation conditions and operator selected modes of operation.

The programming is divided into function codes. Some of the codes are read only while the remaining codes may be user configured. The value of the user configurable codes can be assigned in accordance with user desired mode of operation. A list of the function codes is provided in Table 6 page 31.

To access the function codes, perform the following:

a. Press the CODE SELECT key, then press an arrow key until the left window displays the desired code number.

b. The right window will display the value of this item for five seconds before returning to the normal display mode.

c. If a longer time is desired, press the ENTER key to extend the time to 30 seconds.

3.3 MODES OF OPERATION

The Operational Software responds to various inputs. These inputs come from the temperature and pressure sensors, the temperature set point, the settings of the the configuration variables and the function code assignments. The action taken by the Operational Software will change if any one of the inputs changes. Overall interaction of the inputs is described as a "mode" of operation. The modes of operation include, perishable (chill) mode and frozen mode. Descriptions of the controller interaction and modes of operation are provided in the following sub paragraphs.

3.3.1 Temperature Control – Perishable Mode

With configuration variable CnF26 set to –10°C the perishable mode of operation is active with set points above –10°C (+14°F). With the variable set to –5°C, the perishable mode is active above –5°C (+23°F). (Refer to Table 5, page 30).

When in the perishable mode the controller maintains the supply air temperature at set point, the SUPPLY indicator light will be illuminated on the display module and the default reading on the display window will be the supply temperature sensor reading.

When the supply air temperature enters the in-range temperature tolerance (as selected at function code Cd30), the in-range light will energize.

3.3.2 Evaporator Fan Operation

Opening of an evaporator fan internal protector will shut down a unit with Normal Evaporator Fan Operation. (CnF32 set to 2EFO).

3.3.3 Defrost Interval

Function code Cd27 may be operator set to initiate defrost at intervals of 3, 6, 9, 12 or 24 hours. The factory default is 12 hours. (Refer to Table 6, page 31).

3.3.4 Failure Action

Function code Cd29 may be operator set to allow continued operation in the event the control sensors are reading out of range. The factory default is full system shutdown. (Refer to Table 6, page 31).

3.3.5 Generator Protection

Function codes Cd31 and Cd32 may be operator set to control start up sequence of multiple units and operating current draw. The factory default allows on demand starting of units and full current draw. (Refer to Table 6, page 31).

3.3.6 Condenser Pressure Control

When configuration variable CnF14 is set to "In" the condenser pressure control logic is activated to maintain discharge pressures above 130 psig in low temperature ambients. The logic turns the condenser fan on or off in accordance with the condenser pressure transducer reading. (Refer to Table 5, page 30). The function is enabled when the following conditions are met:

1. The ambient sensor reading is less than or equal to 27°C (80°F)
2. Voltage/Frequency ratio is less than or equal to 8.38

When the above conditions are met, either pressures or timers may dictate a change of state from OFF to ON, or ON to OFF. If the condenser fan is OFF, it will be energized if saturated condensing pressure is greater than 200 psig OR if the condenser fan has been OFF for a variable time period of up to sixty seconds depending on the ambient temperature. As the ambient temperature increases, the amount of time that the condenser fan is energized will correspondingly increase towards the maximum

If the condenser fan is ON, it will de-energize only if the saturated condensing pressure is less than 130 psig and the condenser fan has been running for a minimum of thirty seconds depending on the ambient temperature.

3.3.7 Arctic Mode

With arctic mode enabled, (configuration variable CnF29 set to "In") there will be a 30 minute time delay at startup if the ambient is colder than –10.0°C. (14 °F) When the START/STOP switch is placed in the "I" (ON) position the controller will energize the compressor crankcase heater . Operation of the heater will warm the oil and boil off any liquid refrigerant that may be present in the crankcase.

If Pre-Trip is initiated during the 30 minute time period, Pre-Trip will be allowed to run normally. Once Pre-Trip is over, the controller will revert to its normal control mode logic. (Refer to Table 5, page 30).

3.3.8 Perishable Mode – Conventional

The unit is capable of maintaining supply air temperature to within ±0.25°C (±0.5°F) of set point. Supply air temperature is controlled by positioning of the suction modulation valve (SMV), cycling of the compressor and cycling of the heaters.

When pulling down from a temperature that is more than 5°C (9°F) above set point, the SMV will open to reduce the pulldown time. However, pressure and current limit functions may restrict the valve, if either exceeds the preset value.

The Operational Software is designed so the SMV will begin to close as the set point is reached. The SMV will continue to close and restrict refrigerant flow until the capacity of the unit and the load are balanced.

If the temperature drops below the set point, the compressor will remain running for a few minutes. This is to accommodate any initial undershoot which might occur. After this time has expired and the temperature is 0.2°C (0.4°F) or greater below the set point, the compressor will be turned OFF.

If the temperature drops to 0.5°C (0.9°F) below set point, the heaters will be energized . The heaters will de-energize when the temperature rises to 0.2°C

(0.4°F) below the set point. The compressor will not restart until the temperature rises to 0.2°C (0.4°F) above the set point and three minutes have elapsed since the last compressor turn off.

3.3.9 Perishable Mode – Economy

The economy mode is an extension of the conventional mode and is applicable to units with two speed evaporator fan motors. The mode is activated when the setting of function code Cd34 is "ON". Economy mode is provided for power saving purposes. Economy mode could be utilized in the transportation of temperature tolerant cargo or non-respiration items which do not require high airflow for removing respiration heat. There is no active display indicator that economy mode has been activated. To check for economy mode, perform a manual display of code Cd34.

In order to achieve economy mode, a perishable set point must be selected prior to activation. When economy mode is active, the evaporator fans will be controlled as follows:

At the start of each cooling or heating cycle, the evaporator fans will be run in high speed for three minutes. They will then be switched to low speed any time the supply air temperature is within ± 0.25°C (0.45°F) of the set point and the return air temperature is less than or equal to the supply air temperature + 3°C (5.4°F). The fans will continue to run in low speed for one hour. At the end of the hour, the evaporator fans will switch back to high speed and the cycle will be repeated.

3.3.10 Perishable Mode – Dehumidification

The dehumidification mode is provided to reduce the humidity levels inside the container. The mode is activated when a humidity value is set at function code Cd33. The display module SUPPLY led will flash ON and OFF every second to indicate that the dehumidification mode is active. Once the Mode is active and the following conditions are satisfied, the refrigeration controller will activate the heat relay to begin dehumidification.

1. The humidity sensor reading is above the set point.
2. The Supply air temperature is less than 0.25°C above set point.
3. The heater debounce timer (three minutes) has timed out.
4. Heater termination thermostat (HTT) is closed.
5. The Controlled Atmosphere vent mode or pre-trip mode is not initiated.

If the above conditions remain true for at least one hour the evaporator fans will switch from high to low speed operation. The evaporator fan speed will switch every hour thereafter as long as all conditions are met (see Bulb Mode section for different evaporator fan speed options). If any condition except for item (1) becomes false OR if the relative humidity sensed is 2% below the dehumidification set point, OR the controlled atmosphere (CA) is active, the high speed evaporator fans will be energized.

In the dehumidification mode power is applied to the defrost and drain pan heaters. This added heat load causes the controller to open the suction modulating valve to match the increased heat load while still holding the supply air temperature very close to the set point.

Opening the modulating valve reduces the temperature of the evaporator coil surface, which increases the rate at which water is condensed from the passing air. Removing water from the air reduces the relative humidity. When the relative humidity sensed is 2% below the set point , the controller de-energizes the heat relay. The controller will continue to cycle heating to maintain relative humidity below the selected set point. If the mode is terminated by a condition other than the humidity sensor, e.g., an out-of-range or compressor shutdown condition, the heat relay is de-energized immediately.

Two timers are activated in the dehumidification mode to prevent rapid cycling and consequent contactor wear. They are:

1. Heater debounce timer (three minutes).
2. Out-of-range timer (five minutes).

The heater debounce timer is started whenever the heater contactor status is changed. The heat contactor remains energized (or de-energized) for at least three minutes even if the set point criteria are satisfied.

The out-of-range timer is started to maintain heater operation during a temporary out-of-range condition. If the supply air temperature remains outside of the user selected in-range setting for more than five minutes, the heaters will be de-energized to allow the system to recover. The out-of-range timer starts as soon as the temperature exceeds the in-range tolerance value set by function code Cd30.

3.3.11 Perishable, Dehumidification – Bulb Mode

Bulb mode is an extension of the dehumidification mode which allows changes to the evaporator fan speed and/or defrost termination set points.

Bulb mode is active when configuration code Cd35 is set to "Bulb". Once the bulb mode is activated, the user may then change the dehumidification mode evaporator fan operation from the default (speed alternates from low to high each hour) to constant low or constant high speed. This is done by toggling function code Cd36 from its default of "alt" to "Lo" or "Hi" as desired. If low speed evaporator fan operation is selected, this gives the user the additional capability of selecting dehumidification set points from 60 to 95% (instead of the normal 65 to 95%).

In addition, if bulb mode is active, function code Cd37 may be set to override the previous defrost termination thermostat settings. (Refer to section 4.10.4) The temperature at which the defrost termination thermostat will be considered "open" may be changed [in 0.1°C (0.2°F) increments] to any value between 25.6°C (78°F) and 4°C (39.2°F). The temperature at which the defrost termination thermostat is considered closed for interval timer start or demand defrost is 10°C (50°F) for "open values from 25.6°C down to a 10°C setting. For "open" values lower than 10°C, the "closed" values will decrease to the same value as the "open" setting. Bulb mode is terminated when:

1. Bulb mode code Cd35 is set to "Nor."
2. Dehumidification code Cd33 is set to "Off."
3. The user changes the set point to one that is in the frozen range.

When bulb mode is disabled by any of the above, the evaporator fan operation for dehumidification reverts to "alt" and the DTS termination setting resets to the value determined by controller configuration variable CnF41.

3.3.12 Temperature Control – Frozen Mode

With configuration variable CnF26 set to –10°C the frozen mode of operation is active with set points at or below –10°C (+14°F). With the variable set to –5°C, the frozen mode is active at or below –5°C (+23°F).

When in the frozen mode the refrigeration controller maintains the return air temperature at set point, the RETURN indicator light will be illuminated on the display module and the default reading on the display window will be the return air probe reading.

When the return air temperature enters the in-range temperature tolerance as selected at function code Cd30, the in-range light will energize.

3.3.13 Frozen Mode – Conventional

Frozen range cargos are not sensitive to minor temperature changes. The method of temperature control employed in this range takes advantage of this fact to greatly improve the energy efficiency of the unit. Temperature control in the frozen range is accomplished by cycling the compressor on and off as the load demand requires. The unit will operate in the conventional frozen mode when the refrigeration controller set point is at or below the frozen range and function code Cd34 is set to "OFF"

If the return air temperature in the container drops 0.2°C (0.4°F) below the set point, the compressor is cycled off. When the temperature is greater than 0.2°C (0.4°F) above the set point and the three minute time delay has been met, the compressor will restart. The unit will always operate at full capacity, and the suction modulation valve will open as allowed by current and pressure limiting.

NOTE

On start up of the unit, SMV will reset to a known open position. This is accomplished by assuming the valve was fully open, driving it fully closed, resetting the percentage open to zero, then opening to a known 21% staging position.

To prevent rapid cycling of the compressor, a three minute compressor off time must be satisfied before the compressor will restart. Under a condition of rapidly changing return air temperature, the time delay may allow the return air temperature to rise slightly above set point temperature before the compressor can restart.

3.3.14 Frozen Mode – Economy

In order to activate economy frozen mode operation, a frozen set point temperature must be selected. The economy mode is active when function code Cd34 is set to "ON". When economy mode frozen is active, the system will perform normal frozen mode operations except that the entire refrigeration system, excluding the controller, will be turned off when the control temperature is less than or equal to the set point – 2°C. After an off-cycle period of 60 minutes, the unit will turn on high speed evaporator fans for three minutes, and then check the control temperature. If the control temperature is greater than or equal to the set point + 0.2°C., the unit will restart the refrigeration system and continue to cool until the previously mentioned off-cycle temperature criteria are met. If the control temperature is less than the set point + 0.2°C, the unit will turn off the evaporator fans and restart another 60 minute off-cycle.

3.4 CONTROLLER ALARMS

Alarm display is an independent refrigeration controller software function. If an operating parameter is outside of expected range or a components does not return the correct signals back to the controller an alarm is generated. A listing of the alarms is provided in Table 7, page 35.

The alarm philosophy balances the protection of the refrigeration unit and that of the refrigerated cargo. The action taken when an error is detected always considers the survival of the cargo. Rechecks are made to confirm that an error actually exists.

Some alarms requiring compressor shutdown have time delays before and after to try to keep the compressor on line. An example is alarm code "LO", (low main voltage), when a voltage drop of over 25% occurs, an indication is given on the display, but the unit will continue to run.

An alarm is indicated by flashing an alarm code on the display panel, and for some alarms, by the alarm light illuminating.

When an Alarm Occurs:

a. The red alarm light will illuminate for "20 series" alarms, and alarm code number AL55.

b. If a detectable problem is found to exist, its alarm code will be alternately displayed with the set point on the left display.

c. The user should scroll through the alarm list to determine what alarms exist or have existed. Alarms must be diagnosed and corrected before the Alarm List can be cleared.

To Display Alarm Codes :

a. While in the Default Display mode, press the ALARM LIST key. This accesses the Alarm List Display Mode, which displays any alarms archived in the Alarm Queue.

b. The alarm queue stores up to 16 alarms in the sequence in which they occurred. The user may scroll through the list by depressing an ARROW key.

c. The left display will show "AL##," where ## is the alarm number sequentially in the queue.

d. The right display will show the actual alarm code. "AA##" will display for an active alarm, where "##" is the alarm code. Or "IA##" will display for an inactive alarm, See Table 7, page 35.

e. "END" is displayed to indicate the end of the alarm list if any alarms are active.

f. "CLEAr" is displayed if all alarms are inactive. The alarm queue may than be cleared by pressing the ENTER key. The alarm list will clear and "– – – – – –" will be displayed.

3.5. UNIT PRE-TRIP DIAGNOSTICS

Pre–Trip Diagnostics is an independent controller function which will suspend normal refrigeration controller activities and provide preprogrammed test routines. The test routines include Auto Mode testing, which automatically preforms a pre programmed sequenced of tests, or Manual Mode testing, which allows the operator to select and run any of the individual tests.

⚠ CAUTION

Pre-trip inspection should not be performed with critical temperature cargoes in the container.

⚠ CAUTION

When Pre-Trip key is pressed, dehumidification and bulb mode will be deactivated. At the completion of Pre-Trip activity, dehumidification and bulb mode must be reactivated.

Testing may be initiated by use of the Key Pad or via communication, but when initiated by communication the controller will execute the entire battery of tests (auto mode).

At the end of a pre-trip test, the message “P,” “rSLts” (pretest results) will be displayed. Pressing the ENTER key will allow the user to see the results for all subtests. The results will be displayed as “PASS” or “FAIL” for all the tests run to completion.

A detailed description of the pre-trip tests and test codes is provided in Table 8, page 38. detailed operating instructions are provided in section 4.6, page 46.

3.6 DataCORDER

3.6.1 Description

The Carrier Transicold “DataCORDER,” software is integrated into the controller and serves to eliminate the temperature recorder and paper chart. The DataCORDER functions may be accessed by key pad selections and viewed on the display module. The unit is also fitted with interrogation connections (See Figure 8, page 17) which may be used with the Carrier Transicold Data Reader to down load data. A personal computer with Carrier Transicold Data View software may also be used to download data and configure settings. The resulting file uses a proprietary file format that protects it from potential tampering or altering of date. Therefore, once downloaded, all dcx files shall be considered secured. The DataCORDER consists of:

Configuration Software
Operational Software
Data Storage Memory
Real Time Clock (with internal battery backup)
Six thermistor inputs
Interrogation Connections
Power supply (battery pack).

The DataCORDER performs the following functions:

a. Logs data at 15, 30, 60 or 120 minute intervals and stores two years’ of data (based on one hour interval).

b. Records and displays alarms on the display module.

c. Records results of pre–trip testing.

d. Records DataCORDER and temperature control software generated data and events as follows:
Container ID Change
Software Upgrades
Alarm Activity
Battery Low (Battery Pack)
Data Retrieval
Defrost Start and End
Dehumidification Start and End
Power Loss (w/wo battery pack)
Power Up (w/wo battery pack)
Remote Probe Temperatures in the Container (USDA Cold treatment and Cargo probe recording)
Return Air Temperature
Set Point Change
Supply Air Temperature
Real Time Clock Battery (Internal Battery) Replacement
Real Time Clock Modification
Trip Start
ISO Trip Header (When entered via Interrogation program)
Economy Mode Start and End
“Auto 2” Pre-Trip Start and End
Bulb Mode Start
Bulb Mode changes
Bulb Mode End
USDA Trip Comment
Humidification Start and End
USDA Probe Calibration
CTD Controlled Atmosphere Information
Controlled Atmosphere Control Module Communication Responding
Controlled Atmosphere Control Module Communication Not Responding
Controlled Atmosphere (CA) Set Point Change (CO_2, O_2)
CA Alarm Activity
CA Alarm Reset
CA Pre-Trip Start and End
CA O_2 Air Calibration
CA CO_2 Zero Calibration
CA Gas Calibration
CA Controller Lockout Start and End
CA Controller Configuration Change
CA Nitrogen Test
CA Controller Service Activity
CA Controller Software Upgrade
CA Controller Replacement
CA Door lock
CA Door unlock
CA Vent Start And End
CA 24 volt on/off

3.6.2 DataCORDER Software

The DataCORDER Software is subdivided into the Configuration Software, Operational Software and the Data Memory.

a. Operational Software

The Operational Software reads and interprets inputs for use by the Configuration Software. The inputs are labeled Function Codes. There are 37 functions (see Table 6, page 31) which the operator may access to examine the current input data or stored data. To access these codes, do the following:

1 Press the ALT. MODE & CODE SELECT keys.

2 Press an arrow key until the left window displays the desired code number. The right window will display the value of this item for five seconds before returning to the normal display mode.

3 If a longer time is desired, press the ENTER key to extend the time to 30 seconds.

b. Configuration Software

The configuration software controls the recording and alarm functions of the DataCORDER. Reprogramming to the factory installed configuration is achieved via the same configuration card as the unit control module software. Changes to the software may be made made using the Data View integration device. A listing of the configuration variables is provided in Table 3. Descriptions of DataCORDER operation for each variable setting are provided in the following paragraphs.

3.6.3 Sensor Configuration (dCF02)

Two modes of operation may be configured, the Standard Mode and the Generic Mode.

a. Standard Mode

In the standard mode, the user may configure the DataCORDER to record data using one of seven standard configurations. The seven standard configuration variables, with their descriptions, are listed in Table 4, page 25.

The six thermistor inputs (supply, return, USDA #1, #2, #3 and cargo probe) and the humidity sensor input will be generated by the DataCORDER. The three Controlled Atmosphere inputs will be read over a network from the controlled atmosphere control module. The controlled atmosphere readings will be the oxygen, carbon dioxide and nitrogen levels. An example of a report using a standard configuration is shown in Figure 12, page 26.

NOTE

The supply and return sensors used by the DataCORDER software are not the same sensors used by the temperature control software.

Table 3. DataCORDER Configuration Variables

CONFIGURATION NO.	TITLE	DEFAULT	OPTION
dCF01	(Future Use)	--	--
dCF02	Sensor Configuration	2	2,5,6,9,54,64,94
dCF03	Logging Interval (Minutes)	60	15,30,60,120
dCF04	Thermistor Format	Short	Low, Normal
dCF05	Thermistor Sampling Type	A	A,b,C
dCF06	Controlled Atmosphere/Humidity Sampling Type	A	A,b
dCF07	Alarm Configuration USDA Sensor 1	A	Auto, On, Off
dCF08	Alarm Configuration USDA Sensor 2	A	Auto, On, Off
dCF09	Alarm Configuration USDA Sensor 3	A	Auto, On, Off
dCF10	Alarm Configuration Cargo Sensor	A	Auto, On, Off

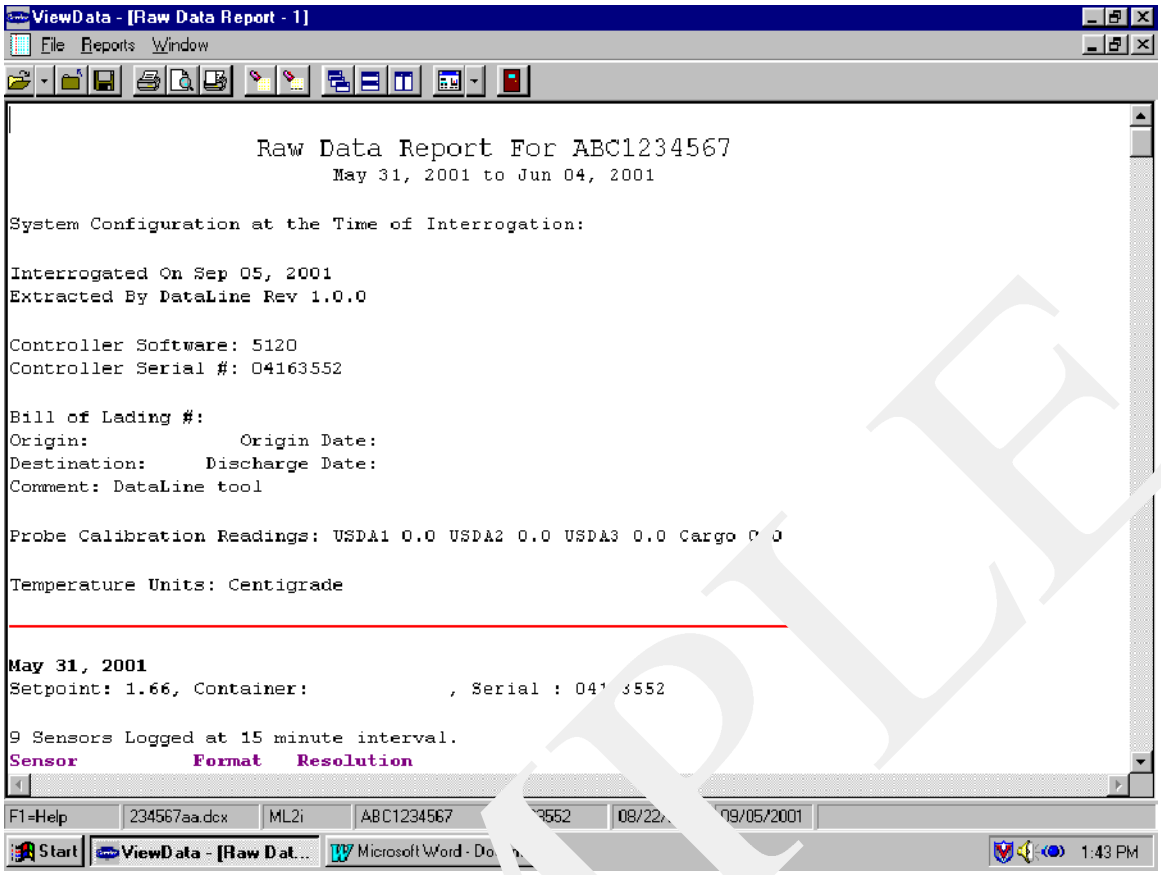
b. Generic Mode

The generic recording mode allows user selection of the network data points to be recorded. The user may select up to a total of eight data points for recording. A list of the data points available for recording follows. Changing the configuration to generic and selecting which data points to record may be done using the Carrier Transicold Data Retrieval Program.

1. Control mode
2. Control temperature
3. Frequency
4. Humidity
5. Phase A current
6. Phase B current
7. Phase C current
8. Main voltage
9. Suction modulation valve percentage
10. Discrete outputs (Bit mapped – require special handling if used)
11. Discrete inputs (Bit mapped – require special handling if used)
12. Ambient sensor
13. Compressor suction sensor
14. Compressor discharge sensor
15. Return temperature sensor
16. Supply temperature sensor
17 Defrost temperature sensor
18. Discharge pressure transducer
19. Suction pressure transducer
20. Condenser pressure transducer
21. Controlled Atmosphere (CA) oxygen concentration
22. CA carbon dioxide concentration
23. CA nitrogen concentration
24.. CA return temperature
25. CA membrane temperature
26. CA discrete inputs
27. CA discrete outputs

Table 4. DataCORDER Standard Configurations

Standard Config.	Description
2 sensors (dCF02=2)	2 thermistor inputs (supply & return)
5 sensors (dCF02=5)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs
6 sensors (dCF02=6)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs 1 humidity input
9 sensors (dCF02=9)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs 3 Controlled Atmosphere inputs 1 humidity input
6 sensors (dCF02=54)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs 1 cargo probe (thermistor input)
7 sensors (dCF02=64)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs 1 humidity input 1 cargo probe (thermistor input)
10 sensors (dCF02=94)	2 thermistor inputs (supply & return) 3 USDA thermistor inputs 3 Controlled Atmosphere inputs 1 humidity input 1 cargo probe (thermistor input)



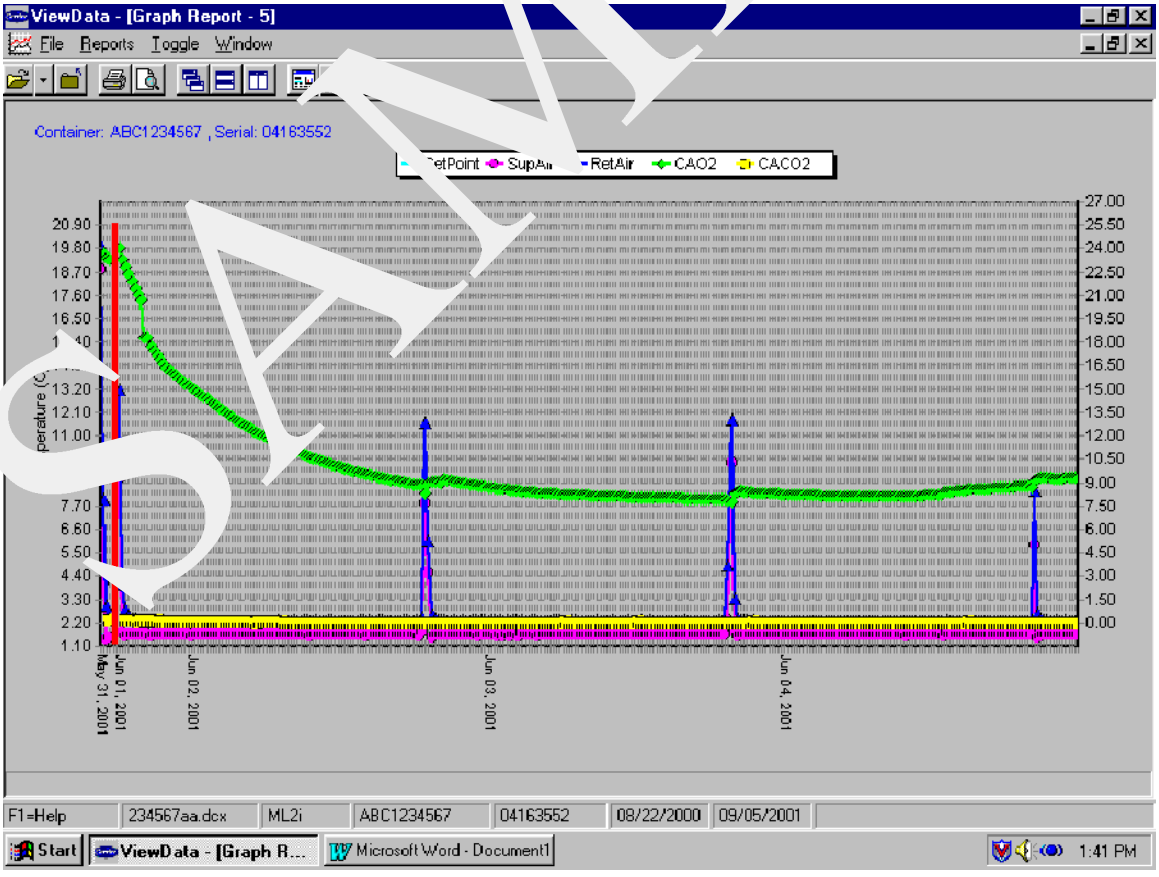


Figure 12. Standard Configuration Report

3.6.4 Logging Interval (dCF03)

The user may configure four time intervals between data recordings. Data is logged at exact intervals in accordance with the real time clock. The clock is factory set at Greenwich Mean Time.

3.6.5 Thermistor Format (dCF04)

The user may configure the format in which the thermistor readings are recorded. The low resolution is a 1 byte format and the normal resolution is a 2 byte format. The low requires less memory and records temperature in 0.255C (0.455F) steps when in the perishable mode or 0.55C (0.95F) steps when in the frozen mode. The normal records temperature in 0.015C (0.025F) steps for the entire range.

3.6.6 Sampling Type (dCF05 & dCF06)

Three types of data sampling are available, average, snapshot and USDA. When configured to average, the average of readings taken every minute over the recording period is recorded. When configured to snapshot, the sensor reading at the log intervale time is recorded. When USDA is configured the supply and return temperature readings are averaged and the 3 USDA probe readings are snapshot.

3.6.7 Alarm Configuration (dCF07 – dCF10)

The USDA and cargo probe alarms may be configured to OFF, ON or AUTO.

If a probe alarm is configured to OFF, then the alarm for this probe is always disabled.

If a probe alarm is configured to ON, then the associated alarm is always enabled.

If the probes are configured to AUTO, they act as a group. This function is designed to assist users who keep their DataCORDER configured for USDA recording, but do not install the probes for every trip. If all the probes are disconnected, no alarms are activated. As soon as one of the probes is installed , then all of the alarms are enabled and the remaining probes that are not installed will give active alarm indications.

The DataCORDER will record the initiation of a pre-trip test (refer to section 3.5, page 22) and the results of each of the tests included in pre–trip. The data is time-stamped and may be extracted via the Data Retrieval program. Refer to Table 10, page 43 for a description of the data stored in the DataCORDER for each corresponding Pre-Trip test.

3.6.8 DataCORDER Power-Up

The DataCORDER may be powered up in any one of four ways:

1. *Normal AC power:* The DataCORDER is powered up when the unit is turned on via the stop-start switch.

2. *Controller DC battery pack power:* If a battery pack is installed, the DataCORDER will power up for communication when an interrogation cable is plugged into an interrogation receptacle.

3. External *DC battery pack power:* A 12 volt battery pack may also be plugged into the back of the interrogation cable, which is then plugged into an interrogation port. No controller battery pack is required with this method.

4. *Real Time Clock demand:* If the DataCORDER is equipped with a charged battery pack and AC power is not present, the DataCORDER will power up when the real time clock indicates that a data recording should take place. When the DataCORDER is finished recording, it will power down.

3.6.9 Pre-Trip Data Recording

On every DataCORDER power-up, while using battery-pack power, the controller will first perform a hardware voltage check on the battery. If the hardware check passes, the Controller will energize the appropriate circuitry and perform a software battery voltage check before DataCORDER logging. If either the hardware or software battery test fails, the real time clock battery-backed power-up will be disabled until the next AC power cycle. Further DataCORDER temperature logging will be prohibited until that time.

If the DataCORDER has a battery pack, then the battery voltage will be tested once every five minutes. An alarm will be generated when the battery voltage transitions from good to bad indicating that the battery pack needs recharging. If the alarm condition persists for more than 24 hours on continuous AC power, the battery pack needs replacement.

3.6.10 DataCORDER Communications

Data retrieval from the DataCORDER can be accomplished by using one of the following; DataReader, DataLine/DataView or a communications interface module.

NOTE

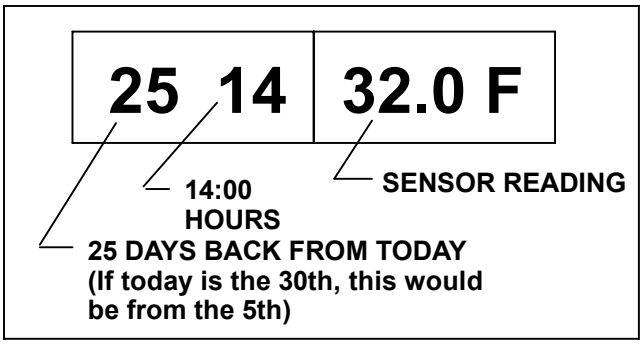
A DataReader, DataLine/DataView or a communications interface module display of Communication Failed is caused by faulty data transfer between the datacorder and the data retrieval device. Common causes include:

1. Bad cable or connection between DataCORDER and data retrieval device.
2. PC communication port(s) unavailable or misassigned.
3. Chart Recorder Fuse (FCR) blown .

a. Scroll Back

The DataCORDER will display probe values for the six temperature probes. the display may be up to 99 hours back from the current hour or up to 30 days back, depending on software revision installed. To display the probe values do the following:

1. Depress the ALT. MODE key and then depress the UP or DOWN ARROW keys until “dCdSP” is shown in the left display window and then depress the ENTER key.
2. The sensor to display can then be chosen by depressing the UP or DOWN ARROW key until the desired sensor (S for supply; r for return; P1, P2, P3 for USDA; and C4 for Cargo) is shown in the left display window and then depressing the ENTER key.
3. For 99 hour displays, a temperature value will appear in the right display window and 1 (with sensor designation) will appear in the left display window to signify the temperature displayed is the most recent reading.
   For 30 day displays, the display will show the reading day and hour on the left display and the sensor reading on the right. For example:



4. Each press of the DOWN ARROW key displays the temperature one hour earlier while each press or the UP ARROW displays the temperature one hour earlier.

5. Use the ENTER key to alternate between sensors and times/temperatures. Use the ARROW keys for scrolling. The display will return to normal if 15 seconds lapse without a key being pressed.

b. DataReader

The Carrier Transicold Data Reader (see Figure 13) is a simple to operate hand held device designed to extract data from the DataCORDER and then upload it to a personal computer. The Data Reader has the ability to store multiple data files. Refer to Data Retrieval manual 62-10629 for a more detailed explanation of the DataReader

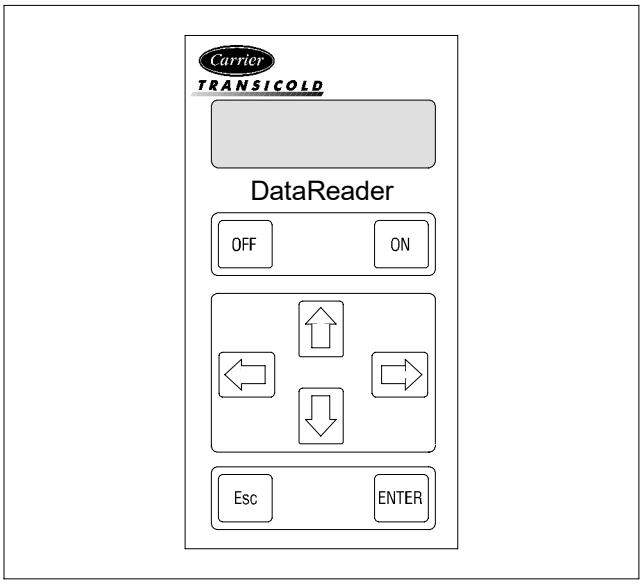


Figure 13. Data Reader

c. DataLINE

The DataLINE software for a personal computer is supplied on both a floppy disk and CD. This software allows interrogation, configuration variable assignment, screen view of the data, hard copy report generation, cold treatment probe calibration, cold treatment initialization and file management. Refer to Data Retrieval manual 62-10629 or www.carrier.transicold.com for a more detailed explanation of the DataLINE interrogation software.

d. Communications Interface Module

The communications interface module is a slave module which allows communication with a master central monitoring station. The module will respond to communication and return information over the main power line.

With a remote monitoring unit installed, all functions and selectable features that are accessible at the unit may be performed at the master station. Retrieval of all DataCORDER reports may also be performed. Refer to the master system technical manual for further information.

3.6.11 USDA Cold Treatment

Sustained cold temperature has been employed as an effective postharvest method for the control of Mediterranean and certain other tropical fruit flies. Exposing infested fruit to temperatures of 2.2 degrees Celsius (36_F) or below for specific periods results in the mortality of the various stages of this group of insects.

In response to the demand to replace fumigation with this environmentally sound process, Carrier has integrated Cold Treatment capability into its microprocessor system. These units have the ability to maintain supply air temperature within one-quarter degree Celsius of setpoint and record minute changes in product temperature within the DataCORDER memory, thus meeting USDA criteria. Information on USDA is provided in the following subparagraphs:

a. USDA Recording

A special type of recording is used for USDA cold treatment purposes. Cold treatment recording requires three remote temperature probes be placed at prescribed locations in the cargo. Provision is made to connect these probes to the DataCORDER via receptacles located at the rear left-hand side of the unit. Four or five receptacles are provided. The four three-pin receptacles are for the probes and fifth, five pin, receptacle is the rear connection for the the Interrogator. The probe receptacles are sized to accept plugs with tricam coupling locking devices. A label on the back panel of the unit shows which receptacle is used for each probe.

The standard DataCORDER report displays the supply and return air temperatures. The cold treatment report displays USDA #1, #2, #3 and the supply and return air temperatures. Cold treatment recording is backed up by a battery so recording can continue if AC power is lost.

b. USDA/ Message Trip Comment

A special feature is incorporated which allows the user to enter a USDA (or other) message at the head of a data report. The maximum message length is 78 characters. Only one message will be recorded per day.

3.6.12 USDA Cold Treatment Procedure

The following is a summary of the steps required to initiate a USDA Cold Treatment.

a. Calibrate the three USDA probes by ice bathing the probes and performing the calibration function with the DataReader or a personal computer. This calibration procedure determines the probe offsets and stores them in the controller for use in generating the cold treatment report. Refer to the Data Retrieval manual 62-10629 for more details.

b. Pre-cool the container to the treatment temperature or below.

c. Install the DataCORDER module battery pack (if not already installed).

d. Place the three probes. The probes are placed into the pulp of the fruit (at the locations defined in the following table) as the product is loaded.

Sensor 1	Place in pulp of the product located next to the return air intake.
Sensor 2	Place in pulp of the product five feet from the end of the load for 40 foot containers, or three feet from the end of the load for 20 foot containers. This probe should be placed in a center carton at one-half the height of the load.
Sensor 3	Place in pulp of product five feet from the end of the load for 40 foot containers or three feet from the end of the load for 20 foot containers. This probe should be placed in a carton at a side wall at one-half the height of the load.

e. To initiate USDA Recording, connect the personal computer and perform the configuration as follows:

1. Fill in ISO header information
2. Add a trip comment if desired
3. Configure for five probes (s, r, P1, P2, P3)
4. Configure for one hour logging interval
5. Set the sensor configuration at USDA
6. Configure for two byte memory storage format
7. Do a trip start

3.6.13 DataCORDER Alarms

Alarm display is an independent DataCORDER function. If an operating parameter is outside of the expected range or a component does not return the correct signals back to the DataCORDER an alarm is generated. The DataCORDER contains a buffer of up to eight alarms. A listing of the DataCORDER alarms is provided in Table 11, page 44. Refer to section 3.6.7, page 27 for configuration information.

To display alarm codes:

a. While in the Default Display mode, press the ALT. MODE & ALARM LIST keys. This accesses the DataCORDER Alarm List Display Mode, which displays any alarms stored in the Alarm Queue.

b. To scroll to the end of the alarm list press the UP ARROW. Depressing the DOWN ARROW key will scroll the list backward.

c. The left display will show “AL#” where # is the alarms number in the queue. The right display will show “AA##,” if the alarm is active, where ## is the alarm number. “IA##,” will show if the alarm is inactive

d. “END” is displayed to indicate the end of the alarm list if any alarms are active. “CLEAr” is displayed if all the alarms in the list are inactive.

e. If no alarms are active, the Alarm Queue may be cleared. The exception to this rule is the DataCORDER Alarm Queue Full alarm (AL91) , which does not have to be inactive in order to clear the alarm list. To Clear the Alarm List:

1. Press the ALT. MODE & ALARM LIST keys.
2. Press the UP/DOWN ARROW key until “CLEAr” is displayed.
3. Press the ENTER key. The alarm list will clear and “------” will be displayed.
4. Press the ALARM LIST key. “AL” will show on the left display and “------” on the right display when there are no alarms in the list.
5. Upon clearing of the Alarm Queue, the Alarm light will be turned off.

Table 5. Controller Configuration Variables

CONFIGURATION NUMBER	TITLE	DEFAULT	OPTION
CnF01	Bypass Valve Enable	In	Out
CnF02	Evaporator Fan Speed	dS (Dual)	SS (Single)
CnF03	Control Sensors	FOUr	duAL
CnF04	Dehumidification Mode	On	OFF
CnF05	Reserved for future use	-----	n/a
CnF06	Condenser Fan Speed Select	OFF (Single)	On (Variable)
CnF07	Unit Selection, 20FT/ 40FT/45FT	40ft	20ft,45
CnF08	Single Phase/Three Phase Motor	1Ph	3Ph
CnF09	Refrigerant Selection	r134a	r12, r22, bLEnd
CnF10	Two Speed Compressor Logic	Out (Single)	In (Dual)
CnF11	Defrost “Off” Selection	noOFF	OFF
CnF12	TXV/Solenoid Quench Valve	Out (TXV)	In (Solenoid)
CnF13	Unloader	Out	In
CnF14	Condenser Pressure Control (CPC)	In	Out
CnF15	Discharge Temperature Sensor	Out	In
CnF16	DataCORDER Present	On (Yes)	OFF (No)
CnF17	Discharge Pressure Sensor	Out (No)	In (Yes)
CnF18	Heater	Old (Low Watt)	nEW (High Watt)
CnF19	Controlled Atmosphere	Out (No)	In (Yes)
CnF20	Suction Pressure Sensor	Out (No)	In (Yes)
CnF21	Autotransformer	Out	In
CnF22	Economy Mode Option	OFF	Std, Full
CnF23	Defrost Interval Timer Save Option	noSAv	SAv
CnF24	Advanced Pre-Trip Enhanced Test Series Option	Auto	Auto2, Auto 3
CnF25	Pre-Trip Test Points/Results Recording Option	rSLtS	dAtA
CnF26	Heat Lockout Change Option	Set to -10°C	Set to -5°C
CnF27	Suction Temperature Display Option	Out	In
CnF28	Bulb Mode Option	NOr	bULb
CnF29	Arctic Mode	Out	In
CnF30	Compressor Size	41 CFM	37 CFM
CnF31	Probe Check Option	Std	SPEC
CnF32	Single Evaporator Fan Option	2EF0	1EF0
CnF33	Snap Freeze Option	OFF	SnAP
CnF34	Degree Celsius Lockout Option	bOth	°F
CnF35	Humidification Mode	OFF	On
CnF36	SMV Type	1 (standard)	2, 3 (stepper)
CnF37	Electronic Temperature Recorder	rEtUR	SUPPL, bOth
CnF38	Quench Bypass Valve	Out	In
CnF39	Expanded Current Limit Range	Out	In
CnF40	Demand Defrost	Out	In
CnF41	Lower DTT Setting	Out	In
CnF42	Auto Pre-trip Start	Out	In
CnF47	Fresh Air Vent Position Sensor	OFF	UPP, LOW
CnF48	CFS Override	OFF	On
CnF49	Datacorder Configuration Restore	OFF	On
CnF50	Enhanced Bulb Mode Selection	OFF	Bulb, dEHUM
CnF51	Timed Defrost Disable	0	0-out, 1-in

Note: Configuration numbers not listed are not used in this application. These items may appear when loading configuration software to the controller but changes will not be recognized by the controller programming.

Table 6. Controller Function Codes (Sheet 1 of 4)

Code No.	TITLE	DESCRIPTION
Note: If the function is not applicable, the display will read "– – – – – –"		
Display Only Functions		
Cd01	Suction Modulation Valve Opening (%)	Displays the SMV percent open. The right display reads 100% when the valve is fully open and 0% when the valve is fully closed. The valve will usually be at 21% on start up of the unit except in very high ambient temperatures.
Cd02	Quench Valve	Displays state of the solenoid quench valve, open or closed.
Cd03	Not Applicable	Not used
Cd04 Cd05 Cd06	Line Current, Phase A Line Current, Phase B Line Current, Phase C	The current sensor measures current on two legs. The third unmeasured leg is calculated based on a current algorithm. The current measured is used for control and diagnostic purposes. For control processing, the highest of the Phase A and B current values is used for current limiting purposes. For diagnostic processing, the current draws are used to monitor component energization.. Whenever a heater or a motor is turned ON or OFF, the current draw increase/reduction for that activity is measured. The current draw is then tested to determine if it falls within the expected range of values for the component. Failure of this test will result in a pre-trip failure or a control alarm indication.
Cd07	Main Power Voltage	The main supply voltage is displayed.
Cd08	Main Power Frequency	The value of the main power frequency is displayed in Hertz. The frequency displayed will be halved if either fuse F1 or F2 is bad (alarm code AL21).
Cd09	Ambient Temperature	The ambient sensor reading is displayed.
Cd10	Compressor Suction Temperature	Compressor suction temperature sensor reading is displayed.
Cd11	Compressor Discharge Temperature	Compressor discharge temperature sensor reading is displayed.
Cd12	Compressor Suction Pressure	Compressor suction pressure transducer reading is displayed.
Cd13	Condenser Pressure	Condenser pressure transducer reading is displayed.
Cd14	Compressor Discharge Pressure	Compressor discharge pressure transducer reading is displayed.
Cd15	Unloader Valve (On–Off)	Not used in this application
Cd16	Compressor Motor Hour Meter	Records total hours of compressor run time. Total hours are recorded in increments of 10 hours (i.e., 3000 hours is displayed as 300).
Cd17	Relative Humidity (%)	Humidity sensor reading is displayed. This code displays the relative humidity, as a percent value.
Cd18	Software Revision #	The software revision number is displayed.
Cd19	Battery Check	This code checks the Controller/DataCORDER battery pack. While the test is running, "btest" will flash on the right display, followed by the result. "PASS" will be displayed for battery voltages greater than 7.0 volts. "FAIL" will be displayed for battery voltages between 4.5 and 7.0 volts, and "– – – – – –" will be displayed for battery voltages less than 4.5 volts. After the result is displayed for four seconds, "btest" will again be displayed, and the user may continue to scroll through the various codes.
Cd20	Config/Model #	This code indicates the dash number of the model for which the Controller is configured (i.e., if the unit is a 69NT40-489-100, the display will show "89100").
Cd21	Humidity Water Pump/Atomizer Status	This code displays the status of the humidity water pump (– – – – – –, forward, reverse or off). If not configured, the mode is permanently deactivated and will display "– – – – – –."

Table 6 Controller Function Codes (Sheet 2 of 4)

Cd22	Compressor Speed	The status of the compressor is displayed (high, low or off).
Cd23	Evaporator Fan	Displays the current evaporator fan state (high, low or off).
Cd24	Controlled Atmosphere State	Not used in this application
Cd25	Compressor Run Time Remaining Until Defrost	This code displays the time remaining until the unit goes into defrost (in tenths of an hour). This value is based on the actual accumulated compressor running time.
Cd26	Defrost Temperature Sensor Reading	Defrost temperature sensor reading is displayed.
Configurable Functions		
NOTE Function codes Cd27 through Cd37 are user-selectable functions. The operator can change the value of these functions to meet the operational needs of the container.		
Cd27	Defrost Interval (Hours or Automatic)	There are two modes for defrost initiation, user–selected or automatic control. The user–selected values are (OFF), 3, 6, 9, 12, or 24 hours with a factory default of 12 hours. Automatic defrost starts with an initial defrost at 3 hours and then adjusts the interval to the next defrost based on the accumulation of ice on the evaporator coil. Following a start–up or after termination of a defrost, the time will not begin counting down until the defrost temperature sensor (DTS) reading falls below set point. If the reading of DTS rises above set point any time during the timer count down, the interval is reset and the countdown begins over. If DTS fails, alarm code AL60 is activated and control switches over to the the return temperature sensor. The controller will act in the same manner as with the DTS except the return temperature sensor reading will be used. *Defrost Interval Timer Value (Configuration variable CnF23):* If the software is configured to “SAv” (save) for this option, then the value of the defrost interval timer will be saved at power down and restored at power up. This option prevents short power interruptions from resetting an almost expired defrost interval, and possibly delaying a needed defrost cycle. **NOTE** The defrost interval timer counts only during compressor run time.
Cd28	Temperature Units (°C or °F)	This code determines the temperature units (°C or °F) which will be used for all temperature displays. The user selects °C or °F by selecting function code Cd28 and pushing the ENTER key. The factory default value is Celsius units. **NOTE** This function code will display “– – – – –“ if Configuration Variable CnF34 is set to °F.
Cd29	Failure Action (Mode)	If all of the control sensors are out of range (alarm code AL26) or there is a probe circuit calibration failure (alarm code AL27), the unit will enter the shutdown state defined by this setting. The user selects one of four possible actions as follows: A – Full Cooling (stepper motor SMV at maximum allowed opening) B – Partial Cooling (stepper motor SMV 11% open) C – Evaporator Fan Only D – Full System Shutdown – Factory Default
Cd30	In-Range Tolerance	The in-range tolerance will determine the band of temperatures around the set point which will be designated as in-range. If the control temperature is in-range, the in-range light will be illuminated. There are four possible values: 1 = ± 0.5°C (± 0.9°F) 2 = ± 1.0°C (± 1.8°F) 3 = ± 1.5°C (± 2.7°F) 4 = ± 2.0°C (± 3.6°F) – Factory Default

Table 6 Controller Function Codes (Sheet 3 of 4)

Cd31	Stagger Start Offset Time (Seconds)	The stagger start offset time is the amount of time that the unit will delay at start-up, thus allowing multiple units to stagger their control initiation when all units are powered up together. The eight possible offset values are: 0 (Factory Default), 3, 6, 9, 12, 15, 18 or 21 seconds
Cd32	Current Limit (Amperes)	The current limit is the maximum current draw allowed on any phase at any time. Limiting the unit's current reduces the load on the main power supply. This is accomplished by reducing the SMV position until current draw is reduced to the set point. When desirable, the limit can be lowered. Note, however, that capacity is also reduced. The five values for 460vac operation are: 15, 17, 19, 21 (Factory Default), 23
Cd33	Perishable Mode Dehumidification/Humidification Control (% RH)	Relative humidity set point is available only on units configured for dehumidification. When the mode is activated, the control probe LED flashes on and off every second to alert the user. If not configured, the mode is permanently deactivated and "– – – – – –" will display. The value can be set to "OFF." "TEST," or a range of 65 to 95% relative humidity in increments of 1%. [If bulb mode is active (code Cd35) and "Lo" speed evaporator motors are selected (code Cd36) then set point ranges from 60 to 95%.] When "TEST" is selected or test set point is entered, the heat LED should illuminate, indicating that dehumidification mode is activated. After a period of five minutes in the "TEST" mode has elapsed, the previously selected mode is reinstated. **NOTE** If humidification (CnF35) is enabled, then humidification will be enabled and dehumidification locked out at set points of 75% and above. At set points below 75%, dehumidification will be enabled and dehumidification locked out.
Cd34	Economy Mode (On–Off)	Economy mode is a user selectable mode of operation provided for power saving purposes.
Cd35	Bulb Mode	Bulb mode is a user selectable mode of operation that is an extension of dehumidification control (Cd33). If dehumidification is set to "Off," code Cd35 will display "Nor" and the user will be unable to change it. After a dehumidification set point has been selected and entered for code Cd33, the user may then change code Cd35 to "bulb." After bulb has been selected and entered, the user may then utilize function codes Cd36 and Cd37 to make the desired changes.
Cd36	Evaporator Speed Select	This code is enabled only if in the dehumidification mode (code Cd33) and bulb mode (Cd35) has been set to "bulb". If these conditions are not met, "alt" will be displayed (indicating that the evaporator fans will alternate their speed) and the display cannot be changed. If a dehumidification set point has been selected along with bulb mode then "alt" may be selected for alternating speed, "Lo" for low speed evaporator fan only, or "Hi" for high speed evaporator fan only. If a setting other than "alt" has been selected and bulb mode is deactivated in any manner, then selection reverts back to "alt."
Cd37	Defrost Termination Temperature Setting (Bulb Mode)	This code, as with function code Cd36, is used in conjunction with bulb mode and dehumidification. If bulb mode is active, this code allows the user to change the defrost termination thermostat settings. If bulb mode is deactivated, the DTS setting returns to the default.

Table 6 Controller Function Codes (Sheet 4 of 4)

Display Only Functions - Continued		
Cd38	Secondary Supply Temperature Sensor	Code Cd38 will display the current secondary supply temperature sensor reading for units configured for four probes. If the unit is configured with a DataCORDER, Cd38 will display "------." If the DataCORDER suffers a failure, (AL55) Cd38 will display the supply recorder sensor reading.
Cd39	Secondary Return Temperature Sensor	Code Cd39 will display the current secondary return temperature sensor reading for units configured for four probes. If the unit is configured with a DataCORDER, Cd39 will display "------." If the DataCORDER suffers a failure, (AL55) Cd39 will display the return recorder sensor reading.
Cd40	Container Identification Number	Code Cd40 is configured at commissioning to read a valid container identification number. The reading will not display alpha characters, only the numeric portion of the number will display.
Cd41 Cd42	Not Applicable	Scroll Units Only
The following Configuration Codes (Cd43-45) highlighted in gray apply to Software Revisions 5123 and 5124 ONLY.		
Cd43	Air Slide Mode	This code is only applicable to units with Auto Fresh. If not configured, the mode is permanently deactivated and CD 43 will display "- - - - -". When mode is available, it can be set to "OFF", "AUTO", "USER", or "TEST". After "AUTO" or "USER" mode has been selected and entered, the user may use function code 45 and 46 to make desired changes.
Cd44	Air Slide Opening	This code is only applicable to units with Auto Fresh. If not configured, the percent opening is permanently deactivated and Cd44 will display "- - - - - ". When percent opening is available, it can be set to 0% to 100%.
Cd45	Air Slide Timer	This code is enabled only if Air Slide Mode is "AUTO" or "USER". If not, Cd45 will display "- - - - -".
In software revision 5125, Codes Cd43-Cd45 were consolidated into Code Cd43, and Codes Cd44-Cd45 were reassigned.		
Cd43	AutoFresh Mode	Code Cd43 is a user selectable mode of operation that allows the opening and closing of a mechanical air vent door via a stepper motor. These selection modes are as follows: OFF - Air makeup vent will remain closed. User - Allows for manual selection of the setting. Delay -The opening of the door is based on selected time, return temperature and flow rate (percent opened). gASLM - The opening is based percent open and CO2 and O2 selectable limits (LM). This selection is only active if the unit has a CO2 sensor. TEST/ CAL (CO2 sensor option units only) - The door will fully open and close to allow the user to inspect its operation. If CAL is selected the controller will zero calibrate the CO2 sensor input. If the unit is not configured with AutoFresh the CD43 will display "----".
Cd44	AutoFresh Values	Code Cd44 will display CO2 and O2 concentrations and limits. If the unit is not configured for AutoFresh or a CO2 sensor is not installed , CD44 will display"----" .
Cd45	Vent Position Sensor (VPS)	Code Cd45 will display whenever the control detects movement via the sensor unless alarm 50 is active. The code will display for 30 seconds, then time out and return to the normal display mode. If the Temperature unit is °F, the VPS units will be CFM and in °C the VPS units shall be CMH.
Cd46	Not Used	-
Cd47	Variable Economy Temperature Setting	The variable temperature "°C or °F" setting is used with economy mode. Function code is "----" when unit is not configured for economy mode.
Cd48	Dehumidification/ Bulb Mode Parameter Selection	Code CD48 is used to determine limits (between 60%-95%) for dehumidification and/or bulb mode (CNF28) when active.
Cd49	Days Since Last Successful Pre-Trip	Code CD49 will display the number of days since the last successful Auto1, Auto2 or Auto3 pre-trip sequence.

Table 7 Controller Alarm Indications (Sheet 1 of 3)

Code No.	TITLE	DESCRIPTION
AL11	Evaporator Motor 1 IP Trip	Alarm 11 is applicable to units with Single Evaporator Fan Capability (CnF32 set to 1EFO) only. The alarm is triggered if the evaporator fan motor #1 internal protector opens. If the alarm is active, probe check is deactivated.
AL12	Evaporator Motor 2 IP Trip	Alarm 12 is applicable to units with Single Evaporator Fan Capability (CnF32 set to 1EFO) only. The alarm is triggered if the evaporator fan motor #2 internal protector opens. If the alarm is active, probe check is deactivated.
AL20	Control Circuit Fuse Open (24 vac)	Alarm 20 is triggered by control power fuse (F3) opening and will cause the software shutdown of all control units. This alarm will remain active until the fuse is replaced.
AL21	Micro Circuit Fuse Open (18 vac)	Alarm 21 is triggered by one of the fuses (F1/F2) being opened on 18 volts AC power supply to the Controller. The suction modulation valve (SMV) will be opened and current limiting is halted. Temperature control will be maintained by cycling the compressor.
AL22	Evaporator Fan Motor Safety	Alarm 22 responds to the evaporator motor internal protectors. On units with Normal Evaporator Fan Operation (CnF32 set to 2EFO) the alarm is triggered by opening of either internal protector. It will disable all control units until the motor protector resets. On units with Single Evaporator Fan Capability (CnF32 set to 1EFO) the alarm is triggered by opening of both internal protectors. It will disable all control units until a motor protector resets.
AL23	KA2–KB10 Jumper Disconnected	Alarm 23 is triggered by a missing jumper wire. The alarm will stay active until the jumper wire is reconnected. On units with Single Evaporator Fan Capability (CnF32 set to 1EFO) this alarm is deactivated.
AL24	Compressor Motor Safety	Alarm 24 is triggered by the opening of the compressor motor internal protector. This alarm will disable all control units except for the evaporator fans and will remain active until the motor protector resets. This alarm triggers the failure action code set by Function Code Cd29.
AL25	Condenser Fan Motor Safety	Alarm 25 is triggered by the opening of the condenser motor internal protector and will disable all control units except for the evaporator fans. This alarm will remain active until the motor protector resets. This alarm is deactivated if the unit is operating on water cooled condensing.
AL26	All Supply and Return temperature Control Sensors Failure	Alarm 26 is triggered if the Controller determines that all of the control sensors are out-of-range. This can occur for box temperatures outside the range of −50°C to +70°C (−58°F to +158°F). This alarm triggers the failure action code set by Function Code Cd29.
AL27	Probe Circuit Calibration Failure	The Controller has a built-in Analog to Digital (A-D) converter, used to convert analog readings (i.e. temperature sensors, current sensors, etc.) to digital readings. The Controller continuously performs calibration tests on the A-D converter. If the A-D converter fails to calibrate for 30 consecutive seconds, this alarm is activated.This alarm will be inactivated as soon as the A-D converter calibrates.
AL50	Fresh Air Position Sensor (VPS)	Alarm 50 is activated whenever the sensor is outside the valid range. There is a 5 minute adjustment period where the user can change the vent position without generating an alarm event. The sensor requires 5 minutes of no movement to confirm stability. If the vent position changes at any point beyond the 5 minute adjustment period, the sensor will generate an alarm event. The alarm is triggered off when the unit power cycles and the sensor is within valid range.
AL51	Alarm List Failure	During start-up diagnostics, the EEPROM is examined to determine validity of its contents. This is done by testing the set point and the alarm list. If the contents are invalid, Alarm 51 is activated. During control processing, any operation involving alarm list activity that results in an error will cause Alarm 51 to be activated. Alarm 51 is a “display only” alarm and is not written into the alarm list. Pressing the ENTER key when “CLEAr” is displayed will result in an attempt to clear the alarm list. If that action is successful (all alarms are inactive), Alarm 51 will be reset.
AL52	Alarm List Full	Alarm 52 is activated whenever the alarm list is determined to be full; at start-up or after recording an alarm in the list. Alarm 52 is displayed, but is not recorded in the alarm list. This alarm can be reset by clearing the alarm list. This can be done only if all alarms written in the list are inactive.

Table 7 Controller Alarm Indications (Sheet 2 of 3)

AL53	Battery Pack Failure	Alarm 53 is caused by the battery pack charge being too low to provide sufficient power for battery-backed recording. Renew replaceable batteries. If this alarm occurs on start up, allow a unit fitted with rechargeable batteries to operate for up to 24 hours to charge rechargeable batteries sufficiently to deactivate the alarm
AL54	Primary Supply Temperature Sensor Failure (STS)	Alarm 54 is activated by an invalid primary supply temperature sensor reading that is sensed outside the range of –50 to +70°C (–58°F to +158°F) or if the probe check logic has determined there is a fault with this sensor. If Alarm 54 is activated and the primary supply is the control sensor, the secondary supply sensor will be used for control if the unit is so equipped. If the unit does not have a secondary supply temperature sensor, and AL54 is activated, the primary return sensor reading, minus 2°C will be used for control. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm
AL55	DataCORDER Failure	This alarm activates to indicate the DataCORDER has a software failure. To clear this alarm, reconfigure the unit to the current model number. This failure may be the result of a voltage dip in excess of 25%.
AL56	Primary Return Temperature Sensor Failure (RTS)	Alarm 56 is activated by an invalid primary return temperature sensor reading that is outside the range of –50 to +70°C (–58°F to +158°F). If Alarm 56 is activated and the primary return is the control sensor, the secondary return sensor will be used for control if the unit is so equipped. If the unit is not equipped with a secondary return temperature sensor or it fails, the primary supply sensor will be used for control. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm.
AL57	Ambient Temperature Sensor Failure	Alarm 57 is triggered by an ambient temperature reading outside the valid range from –50°C (–58°F) to +70°C (+158°F).
AL58	Compressor High Pressure Safety	Alarm 58 is triggered when the compressor high discharge pressure safety switch remains open for at least one minute. This alarm will remain active until the pressure switch resets, at which time the compressor will restart.
AL59	Heat Termination Thermostat	Alarm 59 is triggered by the opening of the heat termination thermostat and will result in the disabling of the heater. This alarm will remain active until the thermostat resets.
AL60	Defrost Temperature Sensor Failure	Alarm 60 is an indication of a probable failure of the defrost temperature sensor (DTS). It is triggered by the opening of the heat termination thermostat (HTT) or the failure of the DTS to go above set point within two hours of defrost initiation. After one-half hour with a frozen range set point, or one-half hour of continuous compressor run time, if the return air falls below 7°C (45°F), the Controller checks to ensure the DTS reading has dropped to 10°C or below. If not, a DTS failure alarm is given and the defrost mode is operated using the return temperature sensor. The defrost mode will be terminated after one hour by the Controller.
AL61	Heaters Failure	Alarm 61 is triggered by detection of improper amperage resulting from heater activation or deactivation. Each phase of the power source is checked for proper amperage.This alarm is a display alarm with no resulting failure action, and will be reset by a proper amp draw of the heater.
AL62	Compressor Circuit Failure	Alarm 62 is triggered by improper current draw increase (or decrease) resulting from compressor turn on (or off). The compressor is expected to draw a minimum of 2 amps; failure to do so will activate the alarm.This is a display alarm with no associated failure action and will be reset by a proper amp draw of the compressor.
AL63	Current Over Limit	Alarm 63 is triggered by the current limiting system. If the compressor is ON and current limiting procedures cannot maintain a current level below the user selected limit, the current limit alarm is activated.This alarm is a display alarm and is inactivated by power cycling the unit, changing the current limit via the code select Cd32, or if the suction modulation valve (SMV) is open beyond the controller desired point.

Table 7 Controller Alarm Indications (Sheet 3 of 3)

AL64	Discharge Temperature Over Limit	Alarm 64 is triggered if the discharge temperature sensed is greater than 135°C (275°F) for three continuous minutes, if it exceeds 149°C (300°F), or if the sensor is out of range. This is a display alarm and has no associated failure action.	
AL65	Discharge Pressure Transducer Failure	Alarm 65 is triggered by a compressor discharge transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.	
AL66	Suction Pressure Transducer Failure	Alarm 66 is triggered by a suction pressure transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.	
AL67	Humidity Sensor Failure	Alarm 67 is triggered by a humidity sensor reading outside the valid range of 0% to 100% relative humidity. If alarm AL67 is triggered when the dehumidification mode is activated, then the dehumidification mode will be deactivated.	
AL68	Condenser Pressure Transducer Failure	Alarm 68 is triggered by a condenser pressure transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.	
AL69	Suction Temperature Sensor Failure	Alarm 69 is triggered by a suction temperature sensor reading outside the valid range of –60°C (–76°F) to 150°C (302°F). This is a display alarm and has no associated failure action.	
NOTE If the Controller is configured for four probes without a DataCORDER, the DataCORDER alarms AL70 and AL71 will be processed as Controller alarms AL70 and AL71.			
ERR #	Internal Microprocessor Failure	The Controller performs self-check routines. if an internal failure occurs, an “ERR” alarm will appear on the display. This is an indication the Controller needs to be replaced.	
		ERROR	**DESCRIPTION**
		ERR 0 – RAM failure	Indicates that the Controller working memory has failed.
		ERR 1 – Program Memory failure	Indicates a problem with the Controller program.
		ERR 2 – Watchdog time–out	The Controller program has entered a mode whereby the Controller program has stopped executing.
		ERR 3 – On board timer failure	The on board timers are no longer operational. Timed items such as; defrost, etc. may not work.
		ERR 4 – Internal counter failure	Internal multi-purpose counters have failed. These counters are used for timers and other items.
		ERR 5 – A-D failure	The Controller’s Analog to Digital (A-D) converter has failed.
Entr StPt	Enter Setpoint (Press Arrow & Enter)	The Controller is prompting the operator to enter a set point.	
LO	Low Main Voltage (Function Codes Cd27–38 disabled and NO alarm stored.)	This message will be alternately displayed with the set point whenever the supply voltage is less than 75% of its proper value.	

Table 8 Temperature Controller Pre-Trip Test Codes (Sheet 1 of 4)

Code No.	TITLE	DESCRIPTION
		NOTE "Auto" or "Auto1" menu includes the: P, P1, P2, P3, P4, P5, P6 and rSLts. "Auto2" menu includes P, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10 and rSLts."Auto3 menu includes P, P1, P2, P3, P4, P5, P6, P7, P8 and rSLts
P	Pre-Trip Initiated	All lights and display segments will be energized for five seconds at the start of the pre-trip. Since the unit cannot recognize lights and display failures, there are no test codes or results associated with this phase of pre-trip.
P1-0	Heaters Turned On	**Setup:** Heater must start in the OFF condition, and then be turned on. A current draw test is done after 15 seconds. **Pass/Fail Criteria:** Passes if current draw change is within the range specified.
P1-1	Heaters Turned Off	**Setup:** Heater must start in the ON condition, and then be turned off. A current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if current draw change is within the range specified.
P2-0	Condenser Fan On	**Requirements:** Water pressure switch (WP) input must be closed. **Setup:** Condenser fan is turned ON, a current draw test is done after 15 seconds. **Pass/Fail Criteria:** Passes if current draw change is within the range specified.
P2-1	Condenser Fan Off	**Setup:** Condenser fan is turned OFF, a current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if current draw change is within the range specified.
P3	Low Speed Evaporator Fans	**Requirements:** The unit must be equipped with a low speed evaporator fan, as determined by the Evaporator Fan speed select configuration variable. **NOTE** If the unit is configured for single evaporator fan operation, Pre-Trip tests P3-0, P3-1, P4-0 and P4-1 will fail immediately if Controller alarm codes AL11 or AL12 are active at the start of testing.
P3-0	Low Speed Evaporator Fan Motors On	**Setup:** The high speed evaporator fans will be turned on for 10 seconds, then off for two seconds, then the low speed evaporator fans are turned on. A current draw test is done after 60 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.
P3-1	Low Speed Evaporator Fan Motors Off	**Setup:** The low speed Evaporator Fan is turned off, a current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.
P4-0	High Speed Evaporator Fan Motors On	**Setup:** The high speed Evaporator Fan is turned on, a current draw test is done after 60 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.
P4-1	High Speed Evaporator Fan Motors Off	**Setup:** The high speed Evaporator Fan is turned off, a current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.
P5-0	Supply/Return Probe Test	**Setup:** The High Speed Evaporator Fan is turned on and run for eight minutes, with all other outputs de-energized. **Pass/Fail Criteria:** A temperature comparison is made between the return and supply probes. **NOTE** If this test fails, "P5-0" and "FAIL" will be displayed. If both Probe tests (this test and the PRIMARY/ SECONDARY) pass, the display will read "P5" "PASS."

Table 8 Temperature Controller Pre-Trip Test Codes (Sheet 2 of 4)

P5-1	Supply Probe Test	**Requirements:** For units equipped with secondary supply probe only. Pass/Fail Criteria: The temperature difference between primary and secondary probe (supply) is compared. **NOTE** If this test fails, “P5-1” and FAIL will be displayed. If both Probe tests (this and the SUPPLY/ RETURN TEST) pass, because of the multiple tests, the display will read ’P 5’ ’PASS’.
P5-2	Return Probe Test	**Requirements:** For units equipped with secondary return probe only. **Pass/Fail Criteria:** The temperature difference between primary and secondary probe (return) is compared. **NOTES** 1. If this test fails, “P5-2” and “FAIL” will be displayed. If both Probe tests (this test and the SUPPLY/ RETURN) pass, because of the multiple tests, the display will read “P 5,” “PASS.” 2. The results of Pre-Trip tests 5-0, 5-1 and 5-2 will be used to activate or clear control probe alarms.
P-6		Not Applicable
P6-0	Compressor On	**Setup:** A current draw test is performed before the compressor is started. The compressor is started. SMV is opened and another current draw test is performed. **Pass/Fail Criteria:** Passes if the change in compressor current draw is within the specified range.
P6–H & P6L		Not Applicable
P6-2	Suction Modulation Valve (Open and Closed)	**Setup:** The compressor and fans continue to run from the previous test. The quench valve (if configured) will operate as in normal control mode. The SMV is closed to 0% open, current and condenser pressure readings are taken. The SMV is opened to 50% with continuous current and condenser pressure readings taken to establish maximum values. The SMV is returned to 0% open and final readings are taken. **Pass/Fail Criteria:** Passes if the calculated difference in current at the 50% open position are above a specified value before and after opening of the SMV, OR the calculated difference in condenser pressure at the 50% open position are above a specified value before and after opening of the SMV
P6-3	Quench Valve Test	**Setup:** The compressor suction temperature is measured with the Quench valve closed. The Quench valve is energized and the suction temperature drop is checked. **Pass/Fail Criteria:** Passes if suction temperature is within the valid range.
P6-4	Not Applicable	Not Used
P6-5	Not Applicable	Not Used
NOTE P7-0 & P8 are included with the “Auto2 & Auto 3” only. P9-0 through P10 are included with “Auto2” only		
P7–0	High Pressure Switch Closed	**Setup:** When the unit is running, the condenser fan is de-energized, and a 15 minute timer is started. The right display shows discharge pressure if the unit is equipped with a discharge pressure transducer (DPT). If no DPT is installed, the condenser pressure transducer (CPT) reading will be displayed. **Pass/Fail Criteria:** The test fails if high pressure switch fails to open in 15 minutes.

Table 8 Temperature Controller Pre-Trip Test Codes (Sheet 3 of 4)

P7-0	High Pressure Switch Closed (Continued)	**Note, this test is skipped if the unit does NOT have:** A compressor discharge sensor (CPDS). A discharge pressure transducer (DPT). Condenser pressure transducer (CPT).
		In addition, this test is skipped if: The sensed ambient temperature is less than 7°C (45°F). The return air temperature is less than –17.8°C (0°F). The water pressure switch (WP) is open, indicating that the unit is operating with a water-cooled condenser.
		Pass/Fail Criteria: Under conditions of the above NOTE; the test immediately fails if the following inputs are sensed to be invalid: Compressor discharge sensor (CPDS). Discharge pressure transducer (DPT). Condenser pressure transducer (CPT). **OR,** if any one of the following inputs are sensed to be invalid: Return temperature sensor (RTS). Ambient sensor (AMBS).
		In addition, the test will fail if: The high pressure switch (HPS) fails to open within 15 minutes. The discharge temperature exceeds 138°C (280°F). The discharge temperature is less than or equal to ambient temperature plus 5°C (9°F). The condenser pressure transducer (CPT) or discharge pressure transducer (DPT) pressure exceeds 27.42 kg/cm$_2$ (390 psig).
P7-1	High Pressure Switch Open	**Requirements:** Test P7-0 must pass for this test to execute. Setup: The condenser fan is started and a 60 second timer is started. **Pass/Fail Criteria:** Passes the test if the high pressure switch (HPS) closes within the 60 second time limit, otherwise, it fails.
P8-0	Perishable Mode Heat Test	**Setup:** If the container temperature is below 15.6°C (60°F), the set point is changed to 15.6°C, and a 60 minute timer is started. The left display will read "P8-0." The control will then heat the container until 15.6°C is reached. If the container temperature is above 15.6°C at the start of the test, then the test proceeds immediately to test P8-1 and the left display will change to "P8-1." **Pass/Fail Criteria:** The test fails if the 180 minute timer expires before the control temperature reaches set point. The display will read "P8-0," "FAIL."
P8-1	Perishable Mode Pull Down Test	**Requirements:** Control temperature must be at least 15.6°C (60°F). **Setup:** The set point is changed to 0°C (32°F), and a 180 minute timer is started. The left display will read "P8-1," the right display will show the supply air temperature. The unit will then start to pull down the temperature to the 0°C set point. **Pass/Fail Criteria:** The test passes if the container temperature reaches set point before the 180 minute timer expires.

Table 8 Temperature Controller Pre-Trip Test Codes (Sheet 4 of 4)

P8-2	Perishable Mode Maintain Temperature Test	**Requirements:** Test P8-1 must pass for this test to execute. **Setup:** The left display will read "P8-2," and the right display will show the supply air temperature. A 60 minute timer is started. The unit will be required to maintain the 0°C temperature to within + or – 0.5°C (0.9°F) of set point until a DataCORDER recording is executed. The recorder supply probe temperature running total (and its associated readings counter) will be zeroed out for the remainder of the recording period at the start of this test, so that the actual value recorded in the DataCORDER will be an average of only this test's results. Once a recording interval is complete, the average recorder supply temperature will be recorded in the DataCORDER, as well as stored in memory for use in applying the test pass/fail criteria. **Pass/Fail Criteria:** If the recorded temperature is within +/– 0.5°C. of set point from test start to DataCORDER recording, the test passes. If the average temperature is outside of the tolerance range at the recording, the test fails.
P9-0	Defrost Test	**Setup:** The defrost temperature sensor (DTS) reading will be displayed on the left display. The right display will show the supply air temperature. The unit will run FULL COOL for 30 minutes maximum until the DTT is considered closed. Once the DTT is considered closed, the unit simulates defrost by running the heaters for up to two hours, or until the DTT is considered open. **Pass/Fail Criteria:** The test fails if: the DTT is not considered closed after the 30 minutes of full cooling, HTT opens when DTT is considered closed or if return air temperature rises above 248°C (120°F).
P10-0	Frozen Mode Setup Test	**Setup:** After completion of the defrost test, the testing proceeds directly to test P10–1 if the container temperature is above 7°C (45°F). If the container temperature is below 7°C, a 180 minute timer will be started, the set point will be set to 7°C and the control will be placed in normal heat. The left display will read "P10–0" and the unit will continue in operation until the temperature is raised to set point. **Pass/Fail Criteria:** If the temperature does not reach set point(less –0.3°C or 6.7 F) before the timer times out display will read "P100," "FAIL". The test will not auto–repeat.
P10-1	Frozen Mode (Pull Down) Test	**Setup:** When the container temperature is greater than or equal to the 7.2°C (45°F) set point which was set in the frozen mode heat test, the left display will read "P10–1" and the right display will show the return air temperature. The set point will then be changed to –17.7°C (0°F). The unit will then have a maximum of three hours to pull the container temperature down to the –17.7°C set point. **Pass/Fail Criteria:** If this occurs within the three hour time limit, the test passes. If pulldown is not completed within the three hour time, the test fails.
P10-2	Frozen Mode Maintain Temperature Test	**Setup:** After the unit has successfully completed frozen pulldown test, the left display will read "P10–2" and the right display will show return air temperature. The unit will then be required to maintain –17.7°C (0°F) temperature within +/– 0.5°C (0.9°F) of set point until a DataCORDER recording is executed. The recorder return probe temperature running total (and its associated counter) will be zeroed for the remainder of the recording period at the start of this test, so that the actual recorded value will be an average of only this test's results. Once the recording interval is complete, the average return temperature will be recorded in the DataCORDER, and stored in memory for use in applying the test pass/fail criteria. **Pass/Fail Criteria:** If the recorded temperature is within +/– 0.5°C of set point from test start to DataCORDER recording, the test passes. If temperature is outside of the tolerance range at the DataCORDER recording, the test fails.

Table 9 DataCORDER Function Code Assignments

NOTE Inapplicable Functions Display "– – – – –"		
To Access: Press ALT. MODE key		
Code No.	**TITLE**	**DESCRIPTION**
dC1	Recorder Supply Temperature	Current reading of the supply recorder sensor.
dC2	Recorder Return Temperature	Current reading of the return recorder sensor.
dC3-5	USDA 1,2,3 Temperatures	Current readings of the three USDA probes.
dC6-13	Network Data Points 1-8	Current values of the network data points (as configured). Data point 1 (Code 6) is generally the humidity sensor and its value is obtained from the Controller once every minute.
dC14	Cargo Probe 4 Temperature	Current reading of the cargo probe #4.
dC15-19	Future Expansion	These codes are for future expansion, and are not in use at this time.
dC20-24	Temperature Sensors 1-5 Calibration	Current calibration offset values for each of the five probes: supply, return, USDA #1, #2, and #3. These values are entered via the interrogation program.
dC25	Future Expansion	This code is for future expansion, and is not in use at this time..
dC26,27	S/N, Left 4, Right 4	The DataCORDER serial number consists of eight characters. Function code dC26 contains the first four characters. Function code dC27 contains the last four characters. (This serial number is the same as the Controller serial number)
dC28	Minimum Days Left	An approximation of the number of logging days remaining until the DataCORDER starts to overwrite the existing data.
dC29	Days Stored	Number of days of data that are currently stored in the DataCORDER.
dC30	Date of last Trip start	The date when a Trip Start was initiated by the user. In addition, if the system goes without power for seven continuous days or longer, a trip start will automatically be generated on the next AC power up.
dC31	Battery Test	Shows the current status of the optional battery pack. **PASS**: Battery pack is fully charged. **FAIL**: Battery pack voltage is low.
dC32	Time: Hour, Minute	Current time on the real time clock (RTC) in the DataCORDER.
dC33	Date: Month, Day	Current date (month and day) on the RTC in the DataCORDER.
dC34	Date: Year	Current year on the RTC in the DataCORDER.
dC35	Cargo Probe 4 Calibration	Current calibration value for the Cargo Probe. This value is an input via the interrogation program.

Table 10 DataCORDER Pre-Trip Result Records

Test No.	TITLE	DATA
1-0	Heater On	Pass/Fail/Skip Result, Change in current for Phase A, B and C
1-1	Heater Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
2-0	Condenser Fan On	Pass/Fail/Skip Result, Water pressure switch (WPS) – Open/Closed, Change in currents for Phase A, B and C
2-1	Condenser Fan Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
3-0	Low Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
3-1	Low Speed Evaporator Fan Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
4-0	High Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
4-1	High Speed Evaporator Fan Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
5-0	Supply/Return Probe Test	Pass/Fail/Skip Result, STS, RTS, SRS and RRS
5-1	Secondary Supply Probe Test	Pass/Fail/Skip Result
5-2	Secondary Return Probe Test	Pass/Fail/Skip Result
6-0	Compressor On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
6-1	Not Applicable	Not Used
6-2	Suction Modulation Valve Open and Closed	Pass/Fail/Skip Result, Is current or pressure limit in effect (Y,N)
6-4	Not Applicable	Not Used
6-5	Not Applicable	Not Used
7-0	High Pressure Switch Closed	Pass/Fail/Skip Result, AMBS, DPT or CPT (if equipped) Input values that component opens
7-1	High Pressure Switch Open	Pass/Fail/Skip Result, STS, DPT or CPT (if equipped) Input values that component closes
8-0	Perishable Heat	Pass/Fail/Skip Result, STS, time it takes to heat to 16°C (60°F)
8-1	Perishable Pull Down	Pass/Fail/Skip Result, STS, time it takes to pull down to 0°C (32°F)
8-2	Perishable Maintain	Pass/Fail/Skip Result, Averaged DataCORDER supply temperature (SRS) over last recording interval.
9-0	Defrost Test	Pass/Fail/Skip Result, DTS reading at end of test, line voltage, line frequency, time in defrost.
10-0	Frozen Mode Set-up	Pass/Fail/Skip Result, STS, time unit is in heat.
10-1	Frozen Mode Pull Down	Pass/Fail/Skip Result, STS, time to pull down unit to –17.8°C (0°F).
10-2	Frozen Mode Maintain	Pass/Fail/Skip Result, Averaged DataCORDER return temperature (RRS) over last recording interval.

Table 11 DataCORDER Alarm Indications

To Access: Press ALT. MODE key		
Code No.	**TITLE**	**DESCRIPTION**
dAL70	Recorder Supply Temperature Out of Range	The supply recorder sensor reading is outside of the range of −50°C to 70°C (−58°F to +158°F) or, the probe check logic has determined there is a fault with this sensor. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm.
dAL71	Recorder Return Temperature Out of Range	The return recorder sensor reading is outside of the range of −50°C to 70°C (−58°F to +158°F) or, the probe check logic has determined there is a fault with this sensor. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm.
dAL72-74	USDA Temperatures 1, 2, 3 Out of Range	The USDA probe temperature reading is sensed outside of −50 to 70°C (−58 to 158°F) range.
dAL75	Cargo Probe 4 Out of Range	The cargo probe temperature reading is outside of −50 to 70°C (−58 to 158°F) range.
dAL76, 77	Future Expansion	These alarms are for future expansion, and are not in use at this time.
dAL78-85	Network Data Point 1 – 8 Out of Range	The network data point is outside of its specified range. The DataCORDER is configured by default to record the supply and return recorder sensors. The DataCORDER may be configured to record up to 8 additional network data points. An alarm number (AL78 to AL85) is assigned to each configured point. When an alarm occurs, the DataCORDER must be interrogated to identify the data point assigned. When a humidity sensor is installed, it is usually assigned to AL78.
dAL86	RTC Battery Low	The Real Time Clock (RTC) backup battery is too low to adequately maintain the RTC reading.
dAL87	RTC Failure	An invalid date or time has been detected. This situation may be corrected by changing the Real Time Clock (RTC) to a valid value using DataLINE.
dAL88	DataCORDER EEPROM Failure	A write of critical DataCORDER information to the EEPROM has failed.
dAL89	Flash Memory Error	An error has been detected in the process of writing daily data to the non-volatile FLASH memory.
dAL90	Future Expansion	This alarm is for future expansion, and is not in use at this time.
dAL91	Alarm List Full	The DataCORDER alarm queue is determined to be full (eight alarms).

SECTION 4
OPERATION

4.1 INSPECTION (Before Starting)

⚠ WARNING

Beware of unannounced starting of the evaporator and condenser fans. The unit may cycle the fans and compressor unexpectedly as control requirements dictate.

⚠ DANGER

HAZARDOUS ATMOSPHERE INSIDE. LOW OXYGEN INSIDE CONTAINER CAN CAUSE DEATH.

Performing service on, or entering a CA equipped unit can be extremely dangerous. Refer to the Safety section of this manual before servicing or entering the container.

a. If container is empty, check inside for the following:
1. Check channels or "T" bar floor for cleanliness. Channels must be free of debris for proper air circulation.
2. Check container panels, insulation and door seals for damage. Effect permanent or temporary repairs.
3. Visually check evaporator fan motor mounting bolts for proper securement (refer to section 6.16, page 70).
4. Check for dirt or grease on evaporator fan or fan deck and clean if necessary.
5. Check evaporator coil for cleanliness or obstructions. Wash with fresh water.
6. Check defrost drain pans and drain lines for obstructions and clear if necessary. Wash with fresh water.
7. Check panels on refrigeration unit for loose bolts and condition of panels. Make sure T.I.R. devices are in place on access panels.

b. Check condenser coil for cleanliness. Wash with fresh water.
c. Open control box door. Check for loose electrical connections or hardware.
d. Check color of moisture-liquid indicator.
e. Check oil level in compressor sight glass.

4.2 CONNECT POWER

⚠ WARNING

Do not attempt to remove power plug(s) before turning OFF start-stop switch (ST), unit circuit breaker(s) and external power source.

⚠ WARNING

Make sure the power plugs are clean and dry before connecting to any power receptacle.

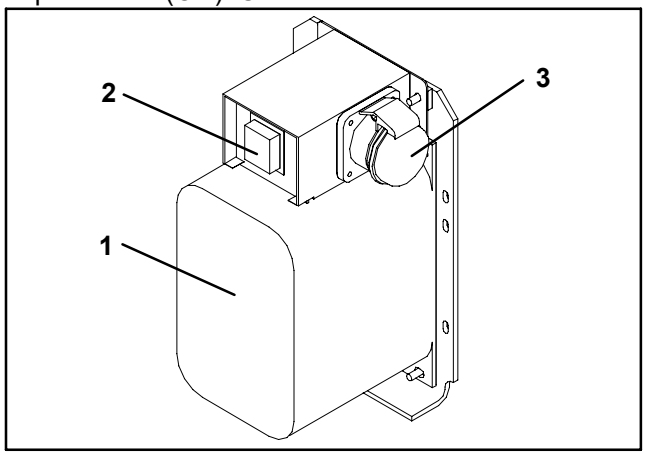
4.2.1 Connection To 380/460 vac Power

1. Make sure start-stop switch (ST, on control panel) and circuit breaker (CB-1, in the control box) are in position "0" (OFF).
2. Plug the 460 vac (yellow) cable into a de-energized 380/460 vac, 3-phase power source. Energize the power source. Place circuit breaker (CB-1) in position "I" (ON). Close and secure control box door.

4.2.2 Connection to190/230 vac Power

An autotransformer (Figure 14) is required to allow operation on nominal 230 volt power. It is fitted with a 230 vac cable and a receptacle to accept the standard 460 vac power plug. The 230 volt cable is black in color while the 460 volt cable is yellow. The transformer may also be equipped with a circuit breaker (CB-2). The transformer is a step up transformer that will provide 380/460 vac, 3-phase, 50/60 hertz power to the unit when the 230 vac power cable is connected to a 190/230 vac, 3-phase power source.

1. Make sure that the start-stop switch (ST, on control panel) and circuit breakers CB-1 (in the control box and CB-2 (on the transformer) are in position "0" (OFF). Plug in and lock the 460 vac power plug at the receptacle on the transformer
2. Plug the 230 vac (black) cable into a de-energized 190/230 vac, 3-phase power source. Energize the power source. Set circuit breakers CB-1 and CB2 to position "I" (ON). Close and secure control box door.



1. Dual Voltage Modular Autotransformer
2. Circuit Breaker (CB-2) 230V
3. 460 vac Power Receptacle

Figure 14. Autotransformer

4.3 ADJUST FRESH AIR MAKEUP VENT

The purpose of the fresh air makeup vent is to provide ventilation for commodities that require fresh air circulation. The vent *must be closed* when transporting frozen foods and when the controlled atmosphere system is in operation.

Air exchange depends on static pressure differential, which will vary depending on the container and how the container is loaded.

4.3.1 Upper Fresh Air Makeup Vent

Two slots and a stop are designed into the disc for air flow adjustments. The first slot allows for a 0 to 30% air flow, and the second slot allows for a 30 to 100% air flow. To adjust the percentage of air flow, loosen the wing nut and rotate the disc until the desired percentage of air flow matches with the arrow. Tighten the wing nut. To

clear the gap between the slots, loosen the wing nut until the disc clears the stop. Figure 15 gives air exchange values for an empty container. Higher values can be expected for a fully loaded container.

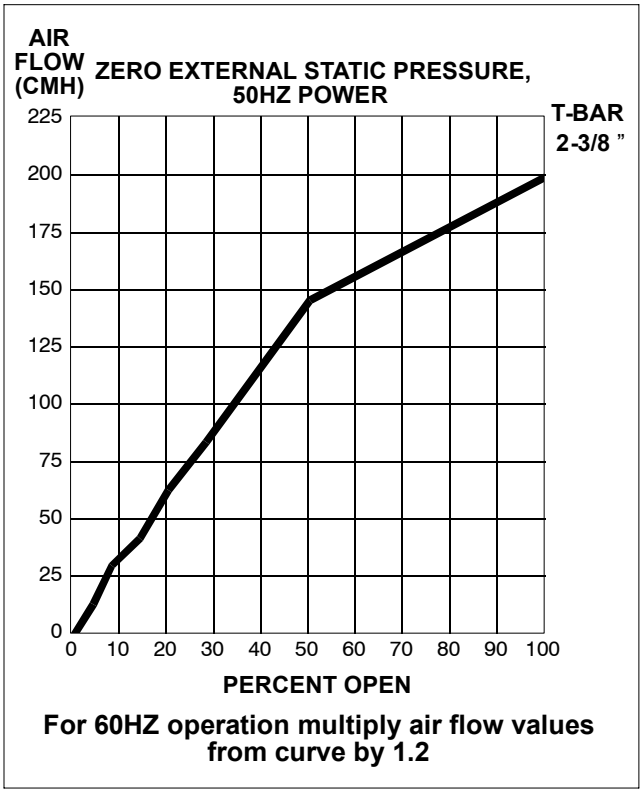


Figure 15. Make Up Air Flow Chart

4.4 CONNECT WATER-COOLED CONDENSER

The water-cooled condenser is used when cooling water is available and heating the surrounding air is objectionable, such as in a ship's hold. If water cooled operation is desired, connect in accordance with the following subparagraphs.

4.4.1 Water-Cooled Condenser with Water Pressure Switch

a. Connect the water supply line to the inlet side of condenser and the discharge line to the outlet side of the condenser. (See Figure 5, page 9.)

b. Maintain a flow rate of 11 to 26 liters per minute (3 to 7 gallons per minute). The water pressure switch will open to de-energize the condenser fan relay. The condenser fan motor will stop and will remain stopped until the water pressure switch closes.

c. To shift to air-cooled condenser operation,disconnect the water supply and the discharge line to the water-cooled condenser. The refrigeration unit will shift to air-cooled condenser operation when the water pressure switch closes.

4.4.2 Water-Cooled Condenser with Condenser Fan Switch

a. Connect the water supply line to the inlet side of condenser and the discharge line to the outlet side of the condenser. (See Figure 5, page 9.)

b. Maintain a flow rate of 11 to 26 lpm (3 to 7 gpm).

c. Set the condenser fan switch to position "O". This will de-energize the condenser fan relay. The condenser fan motor will stop and remain stopped until the CFS switch is set to position "I."

⚠ CAUTION

When condenser water flow is below 11 lpm (3 gpm) or when water-cooled operation is not in use, the CFS switch MUST be set to position "1" or the unit will not operate properly.

d. To shift to air-cooled condenser operation, stop the unit, set the CFS switch to position "I" and restart the unit. Disconnect the water lines to the water-cooled condenser.

4.5 CONNECT REMOTE MONITORING RECEPTACLE

If remote monitoring is required, connect remote monitor plug at unit receptacle. (See item 9, Figure 6, page 10.) When the remote monitor plug is connected to the remote monitoring receptacle, the following remote circuits are energized:

CIRCUIT	FUNCTION
Sockets B to A	Energizes remote cool light
Sockets C to A	Energizes remote defrost light
Sockets D to A	Energizes remote in-range light

4.6 STARTING AND STOPPING INSTRUCTIONS

⚠ WARNING

Make sure that the unit circuit breaker(s) (CB-1 & CB-2) and the START-STOP switch (ST) are in the "O" (OFF) position before connecting to any electrical power source.

4.6.1 Starting the Unit

1. With power properly applied, the fresh air damper set and (if required) the water cooled condenser connected, (refer to section 4.2, page 45, section 4.3, page 45 and section 4.4, page 46) place the START-STOP switch to "I" (ON).
2. Continue with Start Up Inspection, section 4.7, page 46.

4.6.2 Stopping the Unit

To stop the unit, place the START-STOP switch in position "0" (OFF).

4.7 START-UP INSPECTION

4.7.1 Physical Inspection

a. Check rotation of condenser and evaporator fans.
b. Check compressor oil level. (Refer to section 6.8.6, page 65).

4.7.2 Check Controller Function Codes

Check and, if required, reset refrigeration controller Function Codes (Cd27 through Cd39) in accordance with desired operating parameters.

DataCORDER

a. Check and, if required, reset DataCORDER Configuration Variables in accordance with desired recording parameter. (Refer to section 3.6.3, page 24).

b. Start the DataCORDER. To start the Data CORDER, do the following:

1. Depress the ALT MODE key and scroll to Code dC30.
2. Depress and hold the ENTER key for five seconds.
3. The DataCORDER will start recording and enter the date in the trip start data.

4.7.3 Complete Inspection

Allow unit to run for 5 minutes to stabilize conditions and perform a pre−trip diagnosis in accordance with the following paragraph.

4.8 PRE-TRIP DIAGNOSIS

⚠ CAUTION

Pre-trip inspection should not be performed with critical temperature cargoes in the container.

⚠ CAUTION

When Pre-Trip key is pressed, dehumidification and bulb mode will be deactivated. At the completion of Pre-Trip activity, dehumidification and bulb mode must be reactivated.

Pre-Trip diagnosis provides automatic testing of the unit components using internal measurements and comparison logic. The program will provide a “PASS” or “FAIL” display to indicate test results.

The testing begins with access to a pre-trip selection menu. The user may have the option of selecting one of three automatic tests (depending on software revision installed). These tests will automatically perform a series of individual pre−trip tests. The user may also scroll down to select any of the individual tests. The contents of the menus are as follows:

PRE-TRIP SELECTION MENU		
Auto or Auto 1	**Auto 2***	**Auto 3**
P1, P2, P3, P4, P5, P6, rSLts	P, P, P1, P2, P3, P4,P, P5, P6, P7, P8, P9, P10, rSLts	P1, P2, P3, P4, P5, P6, P7, P8, rSLts

A detailed description of the pre-trip test codes is listed in Table 8, page 38. If no selection is made, the pre-trip menu selection process will terminate automatically. However, dehumidification and bulb mode must be reactivated manually if required.

Scrolling down to the “rSLts” code and pressing ENTER will allow the user to scroll through the results of the last pre−trip testing run. If no pre−testing has been run (or an individual test has not been run) since the unit was powered up “−−−−” will be displayed.

To start a pre−trip test, do the following:

NOTE

1. Prior to starting tests, verify that unit voltage (Function Code Cd 07) is within tolerance and unit amperage draw (Function Codes Cd04, Cd05, Cd06) is within expected limits. Otherwise, tests may fail incorrectly.
2. All alarms must be rectified and cleared before starting tests.
3. Pre-trip may also be initiated via communications. The operation is the same as for the key pad initiation described below except that should a test fail, the pre-trip mode will automatically terminate. When initiated via communications, a test may not be interrupted with an arrow key, but the pre-trip mode can be terminated with the PRE-TRIP key.

a. Press the PRE-TRIP key. This accesses a test selection menu.

b. TO RUN AN AUTOMATIC TEST: Scroll through the selections by pressing the UP ARROW or DOWN ARROW keys to display AUTO, AUTO 2 or AUTO 3 as desired and then press the AUTO key.

1. The unit will execute the series of tests without any need for direct user interface. These tests vary in length, depending on the component under test.
2. While tests are running, “P#-#” will appear on the left display, where the #’s indicate the test number and sub-test. The right display will show a countdown time in minutes and seconds, indicating how much time there is left remaining in the test.

⚠ CAUTION

When a failure occurs during automatic testing the unit will suspend operation awaiting operator intervention.

When an automatic test fails, it will be repeated once . A repeated test failure will cause “FAIL” to be shown on the right display, with the corresponding test number to the left. The user may then press the DOWN ARROW to repeat the test, the UP ARROW to skip to the next test or the PRE−TRIP key to terminate testing. The unit will wait indefinitely, until the user manually enters a command.

⚠ CAUTION

When Pre−Trip test Auto 2 runs to completion without being interrupted, the unit will terminate pre-trip and display “Auto 2” “end.” The unit will suspend operation until the user depresses the ENTER key, or a 2 hour time interval has elapsed.

When an Auto test runs to completion without a failure, the unit will exit the pre-trip mode, and return to normal control operation. If configuration variable CnF41 is set to IN, a datacorder trip start will be entered. If CnF41 is set to OUT, the trip start will not be entered. However, dehumidification and bulb mode must be reactivated manually if required.

c. TO RUN AN INDIVIDUAL TEST: Scroll through the selections by pressing the UP ARROW or DOWN ARROW keys to display an individual test code. Pressing ENTER when the desired test code is displayed.

1. Individually selected tests, other than the LED/Display test, will perform the operations necessary to verify the operation of the component. At the conclusion, PASS or FAIL will be displayed. This message will remain displayed for up to three minutes, during which time a user may select another test. If the three minute time period expires, the unit will terminate pre-trip and return to control mode operation.
2. While the tests are being executed, the user may terminate the pre-trip diagnostics by pressing and holding the PRE-TRIP key. The unit will then resume normal operation. If the user decides to terminate a test but remain at the test selection menu, the user may press the UP ARROW key. When this is done all test outputs will be de-energized and the test selection menu will be displayed.
3. Throughout the duration of any pre-trip test except the P-7 high pressure switch tests, the current and pressure limiting processes are active .

d. Pre-Trip Test Results

At the end of the pre-trip test selection menu, the message “P,” “rSLts” (pre–trip results) will be displayed. Pressing the ENTER key will allow the user to see the results for all subtests (i.e., 1-0, 1-1, etc). The results will be displayed as “PASS” or “FAIL” for all the tests run to completion since power up. If a test has not been run since power up, “– – – – –” will be displayed. Once all pre–test activity is completed, dehumidification and bulb mode must be reactivated manually if required.

4.9 OBSERVE UNIT OPERATION

4.9.1 Crankcase Heater

When the crankcase heater is installed, it will be operational whenever the compressor is off and there is power to the unit. The heater is connected to a set of normally closed auxiliary contacts on the compressor contactor.

4.9.2 Probe Check

If the DataCORDER is off or in alarm the controller will revert to a four probe configuration which includes the DataCORDER supply and return air probes as the secondary controller probes. The controller continuously performs probe diagnosis testing which compares the four probes. If the probe diagnosis result indicates a probe problem exists, the controller will perform a probe check to identify the probe(s) in error.

a. Probe Diagnostic Logic – Standard

If the probe check option (controller configuration code CnF31) is configured for standard, the criteria used for comparison between the primary and secondary **control** probes is:

1°C (1.8°F) for perishable set points or 2°C (3.6°F) for frozen set points.

If 25 or more of 30 readings taken within a 30 minute period are outside of the limit, then a defrost is initiated and a probe check is performed.

In this configuration, a probe check will be run as a part of every normal (time initiated) defrost.

b. Probe Diagnostic Logic – Special

If the probe check option is configured for special the above criteria are applicable. A defrost with probe check will be initiated if 25 of 30 readings or 10 consecutive readings are outside of the limits.

In this configuration, a probe check will not be run as a part of a normal defrost, but only as a part of a defrost initiated due to a diagnostic reading outside of the limits.

c.The 30 minute timer will be reset at each of the following conditions:

1. At every power up.
2. At the end of every defrost.
3. After every diagnostic check that does not fall outside of the limits as outlined above.

d. Probe Check

A defrost cycle probe check is accomplished by energizing just the evaporator motors for eight minutes at the end of the normal defrost. At the end of the eight minute period the probes will be compared to a set of predetermined limits. The defrost indicator will remain on throughout this period.

Any probe(s) determined to be outside the limits will cause the appropriate alarm code(s) to be displayed to identify which probe(s) needs to be replaced. The P5 Pre-Trip test must be run to inactivate alarms.

4.10 SEQUENCE OF OPERATION

General operation sequences for cooling, heating and defrost are provided in the following subparagraphs. Schematic representation of controller action are provided in Figure 16 and Figure 17, page 49. Refer to Section 3 for detailed descriptions of special events and timers that are incorporated by the controller in specific modes of operation. Refer to section 4.11, page 52 for emergency modes of operation.

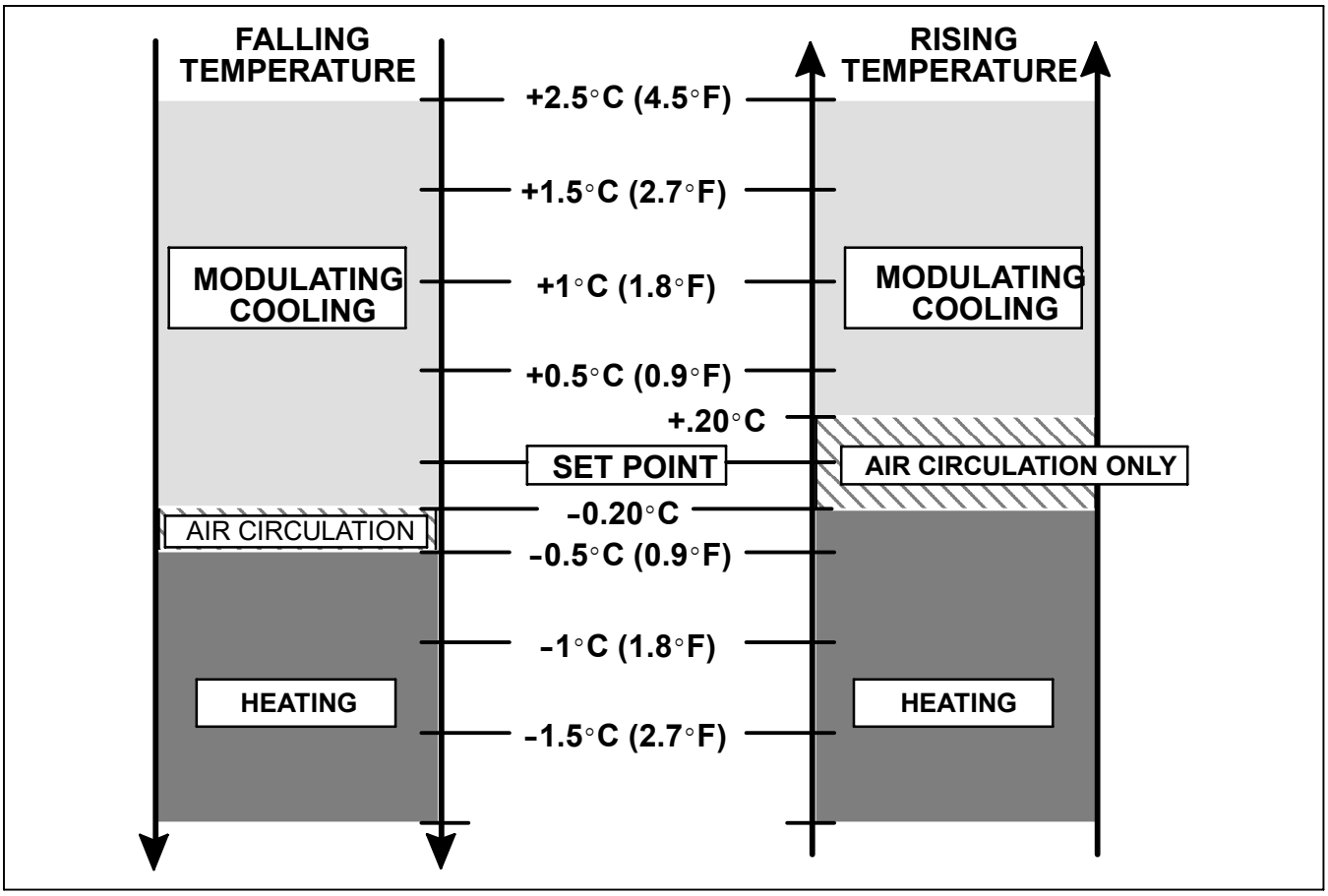


Figure 16. Controller Operation – Perishable Mode

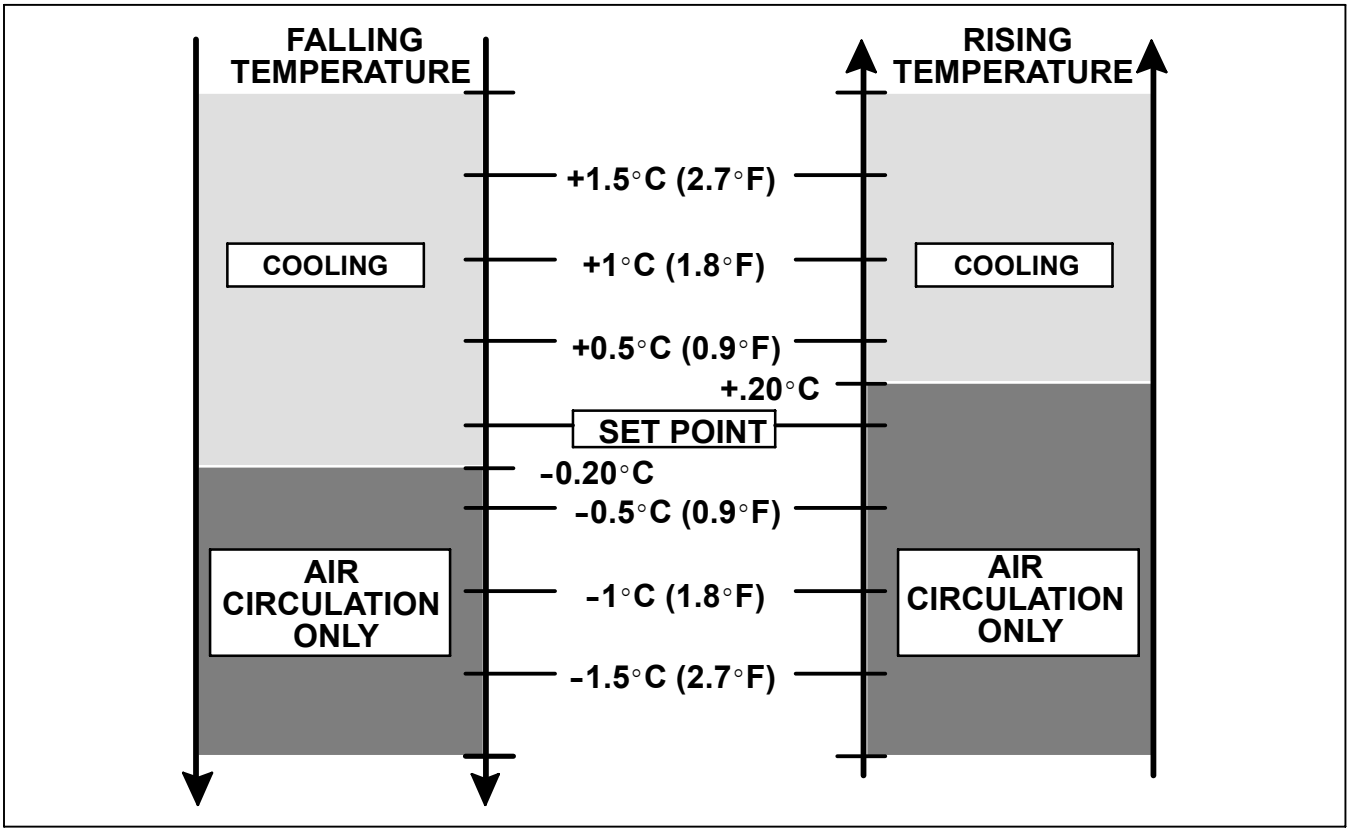


Figure 17. Controller Operation – Frozen Mode

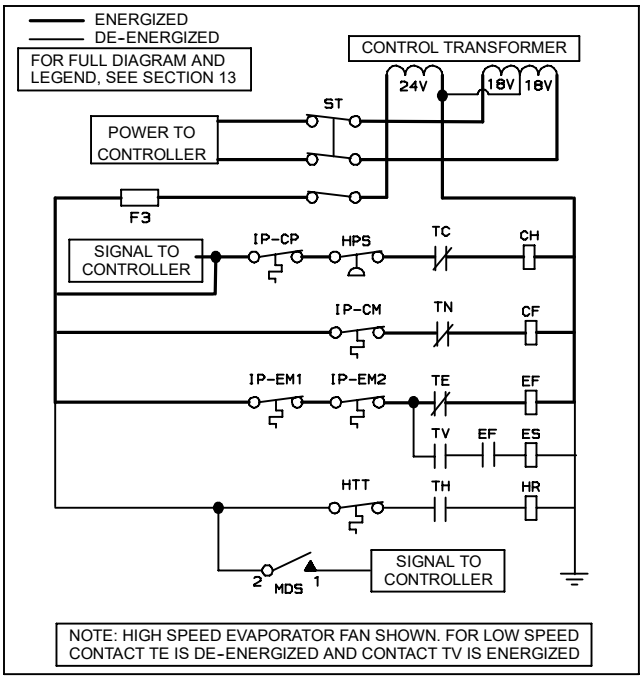


Figure 18. Perishable Mode

4.10.1 Sequence Of operation - Perishable Mode Cooling

NOTE

In the Conventional Perishable Mode of operation the evaporator motors run in high speed. In the Economy Perishable Mode the fan speed is varied.

NOTE

In low temperature ambients the condenser fan will be cycled by the controller to maintain proper condensing pressure.

a. With supply air temperature above set point and decreasing, the unit will be cooling with the condenser fan motor (CF), compressor motor (CH), evaporator fan motors (EF) energized and the COOL light illuminated. (See Figure 18.)

b. When the air temperature decreases to a predetermined tolerance above set point, the in-range light is illuminated.

c. As the air temperature continues to fall, modulating cooling starts at approximately 2.5°C (4.5°F) above set point. (See Figure 16)

d. The refrigeration controller monitors the supply air. Once the supply air falls below set point and 0% SMV position is reached, the controller periodically records the supply air temperature, set point and time. A calculation is then performed by subtracting the set point reading from the supply air and multiplying the result by the time reading. The result is negative number.

e. When the calculation reaches -250, contacts TC and TN are opened to de-energize compressor and condenser fan motors. The cool light is also de-energized.

f. The evaporator fan motors continue to run to circulate air throughout the container. The in-range light remains illuminated as long as the supply air is within tolerance of set point.

g. When the supply air temperature increases to 0.2°C (0.4°F) above set point and the three minute off time has elapsed, relays TC and TN are energizes to restart the compressor and condenser fan motors. The cool light is also illuminated.

4.10.2 Sequence Of Operation - Perishable Mode Heating

NOTE

The unit will heat only when in the Perishable Mode, relay TH is electronically locked out when in the Frozen Mode.

a. If the air temperature decreases 0.5°C (0.9°F) below set point, the system enters the heating mode. (See Figure 16). The controller closes contacts TH (see Figure 19) to allow power flow through the heat termination thermostat (HTT) to energize the heaters (HR). The HEAT light is also illuminated. The evaporator fans continue to run to circulate air throughout the container.

b. When the temperature rises to 0.2°C (0.4°F) above set point, contact TH opens to de-energize the heaters. The HEAT light is also de-energized. The evaporator fans continue to run to circulate air throughout the container.

c. A safety heater termination thermostat (HTT), attached to an evaporator coil support, will open the heating circuit if overheating occurs.

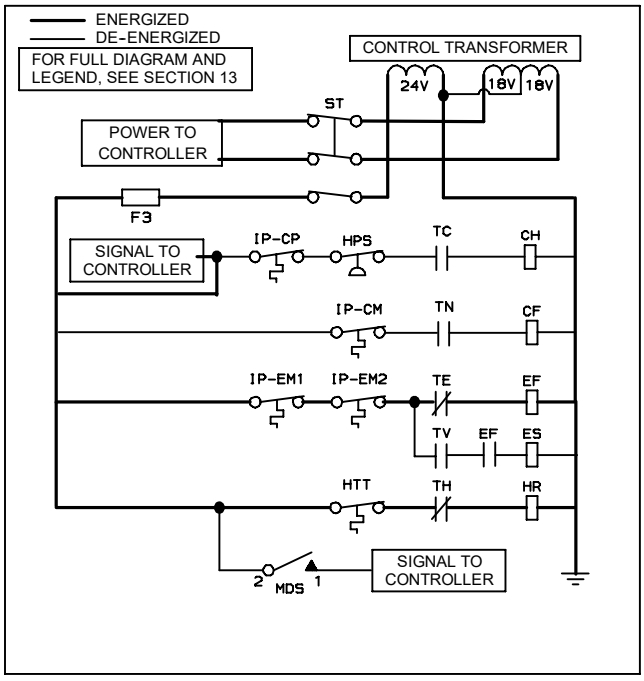


Figure 19. Perishable Mode Heating

4.10.3 Sequence Of Operation - Frozen Mode Cooling

NOTES

1. In the Frozen Mode of operation the evaporator motors run in low speed.

2. In low temperature ambients the condenser fan will be cycled by the controller to maintain proper condensing pressure.

a. With supply air temperature above set point and decreasing, the unit will be cooling with the condenser fan motor (CF), compressor motor (CH), evaporator fan motors (ES) energized and the COOL light illuminated. (See Figure 20.)

b. When the air temperature decreases to a predetermined tolerance above set point, the in-range light is illuminated.

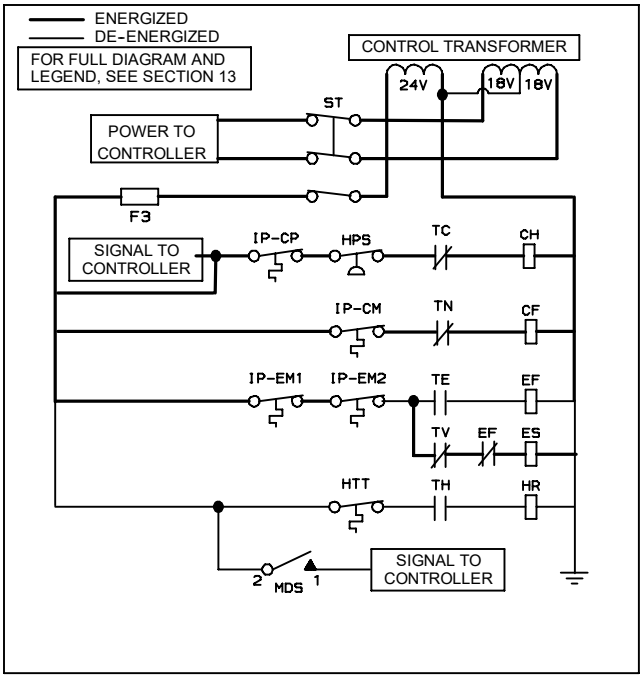


Figure 20. Frozen Mode

c. Contacts TC and TN are opened to de-energize the compressor and condenser fan motors when the return air temperature decreases to 0.2°C (0.4°F) below set point. The cool light is also de-energized.

d. The evaporator fan motors continue to run to circulate air throughout the container. The in-range light remains illuminated as long as the return air is within tolerance of set point.

e. When the return air temperature increases to 0.2°C (0.4°F) above set point and the three minute off time has elapsed, relays TC and TN are energizes to restart the compressor and condenser fan motors. The cool light is also illuminated.

4.10.4 Sequence Of Operation – Defrost Mode

NOTE

Unit will not initiate defrost if the EverFresh Controlled Atmosphere (CA) system is in the Vent or Pre-trip mode.

The defrost cycle may consist of up to three distinct operations. The first is de-icing of the coil, the second is a probe check cycle and the third is snap freeze.

Defrost may be requested by any one of the following methods:

1. The manual defrost switch (MDS) is closed by the user.
2. The user sends a defrost request by communications.
3. The defrost interval timer (controller function code Cd27) reaches the defrost interval set by the user.
4. The controller probe diagnostic logic determines that a probe check is necessary based on the temperature values currently reported by the supply and return probes.
5. The controller Demand Defrost configuration variable (CnF40) is set to “In” and the unit has been in pull down operation for over 2.5 hours without reaching set point.

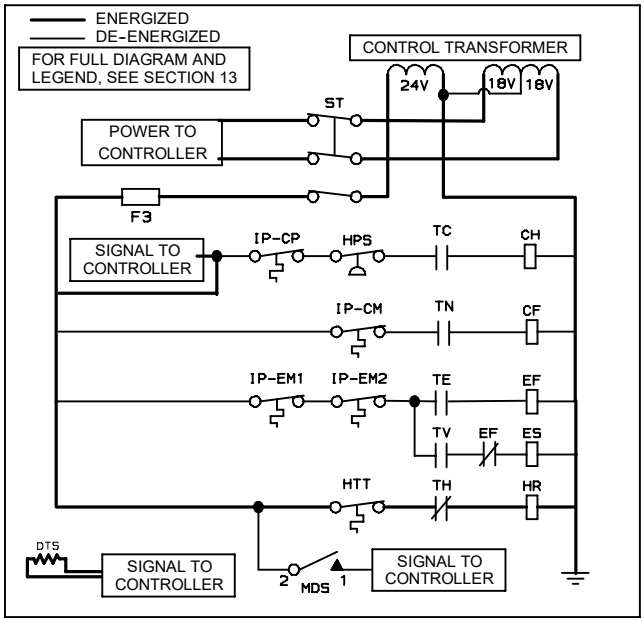


Figure 21. Defrost Mode

Processing of a defrost request is controlled by the Defrost Termination Thermostat. The Defrost Termination Thermostat is not a physical component. It is a software point that acts as a thermostat, allowing defrost when it is considered “closed” and preventing or terminating defrost when it is considered “open”. The actual temperatures used to make the “open” or “closed” determinations are dependent on the type of defrost request made and the operator setting of configuration variable CnF41. Configuration variable CnF41may be factory set at the default value of 25.6°C(78°F) or a lower value of 18°C(64°F).

When a request for defrost is made by the use of the Manual Defrost Switch or Communications, the unit will enter defrost when the reading at the Defrost Temperature Sensor is at or below the CnF41 setting. Defrost will terminate when the Defrost Sensor Temperature reading rises above the CnF41 setting.

When a request for defrost is made by probe check, the unit will enter defrost when the Defrost Temperature Sensor reading is at or below 25.6°C(78°F). The unit will terminate defrost when the Defrost Temperature Sensor reading rises above 25.6°C(78°F)

When a request for defrost is made by demand defrost , the unit will enter defrost when the reading at the Defrost Temperature Sensor is at or below 18°C (64.4°F). Defrost will terminate when the Defrost Sensor Temperature reading rises above the CnF41 setting.

When a defrost has terminated, the defrost interval timer will begin counting when the reading at the Defrost Temperature Sensor is at or below 10°C(50°F). Once the timer has counted the required time, the unit will enter defrost if the Defrost Temperature Sensor is at or below 25.6°C(78°F). Defrost will terminate when the Defrost Sensor Temperature reading rises above the CnF41 setting.

When the unit enters defrost, the controller opens contacts TC, TN and TE (or TV) to de-energize the compressor, condenser fan and evaporator fans. (See Figure 21.) The COOL light is also de–energized.

The controller then closes TH to supply power to the heaters. The defrost light is illuminated.

When the defrost temperature sensor reading rises to the applicable Defrost Termination Thermostat “opening” point the de–icing operation is terminated.

If defrost does not terminate correctly and temperature reaches the set point of the heat termination thermostat (HTT) the thermostat will open to de–energize the heaters. If termination does not occur within 2.0 hours, the controller will terminate defrost. An alarm will be given of a possible DTS failure.

If probe check (controller function code CnF31) is configured to special, the unit will proceed to the next operation (snap freeze or terminate defrost). If the code is configured to standard, the unit will perform a probe check. The purpose of the probe check is to detect malfunctions or drift in the sensed temperature that is too small to be detected by the normal sensor out of range tests. The system will run for eight minutes in this condition. At the end of the eight minutes, probe alarms will be set or cleared based on the conditions seen.

When the return air falls to 7°C (45°F), the controller checks to ensure the defrost temperature sensor (DTS) reading has dropped to 10°C or below. If it has not, a DTS failure alarm is given and the defrost mode is operated by the return temperature sensor (RTS).

If controller function code CnF33 is configured to snap freeze, the controller will sequence to this operation. The snap freeze consists of running the compressor without the evaporator fans in operation for a period of four minutes with the suction modulation valve at maximum allowed opening. When the snap freeze is completed, defrost is formally terminated.

4.11 EMERGENCY OPERATION

Operation by the refrigeration controller may be overridden by use of the EMERGENCY BYPASS or by use of the EMERGENCY DEFROST switch. The EMERGENCY BYPASS switch functions to bypass the controller in the event of controller failure, The EMERGENCY DEFROST switch functions to bypass the controller and place the unit in the defrost mode.

4.11.1 Emergency Bypass Operation

To place the unit in the emergency bypass mode of operation, cut the wire tie installed at the switch mounting (see Figure 6) and place the switch in the EMERGENCY BYPASS COOLING position.

The switch is a normally open four pole switch which is placed in the EMERGENCY BYPASS COOLING position to:

a. Provide power to the compressor contactor with the high pressure switch and compressor motor internal protector in line.
b. Provide power to the condenser fan motor contactor with the water pressure switch and condenser motor internal protector in line.
c. Provide power to the evaporator fan motor high speed contactors with the evaporator fan motor internal protectors in line.
d. Provide power to the bypass module (item14, Figure 3, page 7). The bypass module supplies power to the stepper motor drive to bring the valve to the full open position.

⚠ CAUTION

The unit will remain in the full cooling mode as long as the emergency bypass switch is in the BYPASS position. If the cargo may be damaged by low temperatures, the operator must monitor container temperature and manually cycle operation as required to maintain temperature within required limits.

To return the unit to normal operation, place the switch in the NORMAL OPERATION position. When emergency oparation is no longer required, re–install the wire tie at the switch mounting.

4.11.2 Emergency Defrost Operation.

To place the unit in the emergency defrost mode of operation, cut the wire tie installed at the switch mounting (see Figure 6) and place the switch in the EMERGENCY DEFROST position.

NOTE

1. If the unit is in the emergency bypass cooling mode, the emergency defrost switch will override this mode and place the unit in defrost.
2. The IN–RANGE LIGHT is de–energized when in the emergency defrost mode.

The switch is a normally open four pole switch which is placed in the EMERGENCY DEFROST position to:

a. De–energize the compressor, condenser fan and evaporator fan contactors.
b. Illuminate the EMERGENCY DEFROST LIGHT.
c. Energize the heater contactor.
d. Illuminate the DEFROST LIGHT.

⚠ CAUTION

The unit will remain in the DEFROST mode as long as the emergency defrost switch is in the DEFROST position. To prevent cargo damage, the operator must monitor container temperature and manually cycle operation as required to maintain temperature within required limits.

To return the unit to normal operation, place the switch in the NORMAL OPERATION position. When emergency defrost is no longer required, re–install the wire tie at the switch mountiing.

SECTION 5
TROUBLESHOOTING

NOTE

This troubleshooting chart is to be used for refrigeration troubleshooting only, for Controlled Atmosphere troubleshooting refer to Section 11, page 115.

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.1 UNIT WILL NOT START OR STARTS THEN STOPS		
No power to unit	External power source OFF	Turn on
	Start-Stop switch OFF or defective	Check
	Circuit breaker tripped or OFF	Check
	Autotransformer not connected	4.2.2, page 45
Loss of control power	Circuit breaker OFF or defective	Check
	Control transformer defective	Replace
	Fuse (F3) blown	Check
	Start-Stop switch OFF or defective	Check
Component(s) Not Operating	Evaporator fan motor internal protector open	6.16, page 70
	Condenser fan motor internal protector open	6.11, page 66
	Compressor internal protector open	6.8, page 61
	High pressure switch open	5.7, page 55
	Heat termination thermostat open	Replace
Compressor hums, but does not start	Low line voltage	Check
	Single phasing	Check
	Shorted or grounded motor windings	6.8, page 61
	Compressor seized	6.8, page 61
5.2 UNIT OPERATES LONG OR CONTINUOUSLY IN COOLING		
Container	Hot load (Failure to Pre-Cool)	Normal
	Defective box insulation or air leak	Repair
Refrigeration System	Unit in Emergency Bypass mode.	4.11.1, page 52
	Shortage of refrigerant	6.7.1, page 60
	Evaporator coil covered with ice	5.6, page 54
	Evaporator coil plugged with debris	6.15, page 70
	Evaporator fan(s) rotating backwards	6.15, page 70 6.16, page 70
	Defective evaporator fan motor/capacitor	6.17, page 71
	Air bypass around evaporator coil	Check
	Controller set too low	Reset
	Compressor service valves or liquid line shutoff valve partially closed	Open valves completely
	Dirty condenser	6.10, page 66
	Compressor worn	6.8, page 61
	Current limit (function code Cd32) set to wrong value	3.3.5, page 20
	Suction modulation valve malfunction	6.18, page 71

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.3 UNIT RUNS BUT HAS INSUFFICIENT COOLING		
Compressor	Compressor valves defective	6.8, page 61
Refrigeration System	Abnormal pressures	5.7, page 55
	Controller malfunction	5.9, page 55
	Evaporator fan or motor defective	6.16, page 70
	Suction modulation valve malfunction	6.18, page 71
	Condenser Pressure Transducer defective	Check
	Shortage of refrigerant	6.7.1, page 60
5.4 UNIT WILL NOT HEAT OR HAS INSUFFICIENT HEATING		
No operation of any kind	Start-Stop switch OFF or defective	Check
	Circuit breaker OFF or defective	Check
	External power source OFF	Turn ON
No control power	Circuit breaker or fuse defective	Replace
	Control Transformer defective	Replace
	Evaporator fan internal motor protector open	6.16, page 70
	Heat relay defective	Check
	Heater termination switch open	6.15, page 70
Unit will not heat or has insufficient heat	Heater(s) defective	6.15, page 70
	Heater contactor or coil defective	Replace
	Evaporator fan motor(s) defective or rotating backwards	6.16, page 70 6.17, page 71
	Evaporator fan motor contactor defective	Replace
	Refrigeration Controller malfunction	5.9, page 55
	Defective wiring	Replace
	Loose terminal connections	Tighten
	Low line voltage	2.3, page 12
5.5 UNIT WILL NOT TERMINATE HEATING		
Unit fails to stop heating	Refrigeration Controller improperly set	Reset
	Refrigeration Controller malfunction	5.9, page 55
	Heater termination thermostat remains closed along with the heat relay	6.15, page 70
5.6 UNIT WILL NOT DEFROST PROPERLY		
Will not initiate defrost automatically	Defrost timer malfunction (Cd27)	Table 6, page 31
	Loose terminal connections	Tighten
	Defective wiring	Replace
	Defrost temperature sensor defective or heat termination thermostat open	Replace
	Heater contactor or coil defective	Replace
Will not initiate defrost manually	Manual defrost switch defective	Replace
	Defrost temperature sensor open	4.10.4 , page 51
Initiates but relay (DR) drops out	Low line voltage	2.3, page 12

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.6 UNIT WILL NOT DEFROST PROPERLY –Continued		
Initiates but does not defrost	Heater contactor or coil defective	Replace
	Heater(s) burned out	6.15, page 70
Frequent defrost	Wet load	Normal
Will not terminate defrost	Unit in Emergency Defrost mode	4.11.2, page 52
5.7 ABNORMAL PRESSURES (COOLING)		
High discharge pressure	Condenser coil dirty	6.10, page 66
	Condenser fan rotating backwards	6.11, page 66
	Condenser fan inoperative	6.11, page 66
	Refrigerant overcharge or noncondensibles	6.7.1, page 60
	Discharge pressure regulator valve defective	6.19, page 73
	Discharge service valve partially closed	Open
	Suction modulation valve malfunction	6.18, page 71
Low suction pressure	Suction service valve partially closed	Open
	Filter-drier partially plugged	6.13, page 68
	Low refrigerant charge	6.7.1, page 60
	Expansion valve defective	6.14, page 68
	No evaporator air flow or restricted air flow	6.15, page 70
	Excessive frost on evaporator coil	5.6, page 54
	Evaporator fan(s) rotating backwards	6.17.1, page 71
	Discharge pressure regulator valve defective	6.19, page 73
	Suction modulation valve malfunction	6.18, page 71
Suction and discharge pressures tend to equalize when unit is operating	Heat exchanger defective	Replace
	Compressor valves defective	6.8, page 61
	Compressor cycling/stopped	Check
5.8 ABNORMAL NOISE OR VIBRATIONS		
Compressor	Loose mounting bolts	Tighten
	Worn bearings	6.8, page 61
	Worn or broken valves	6.8, page 61
	Liquid slugging	6.14, page 68
	Insufficient oil	6.8.6, page 65
Condenser or Evaporator Fan	Bent, loose or striking venturi	Check
	Worn motor bearings	6.11, page 66 6.16, page 70
	Bent motor shaft	6.11, page 66 6.16, page 70
5.9 REFRIGERATION CONTROLLER MALFUNCTION		
Will not control	Defective Sensor	6.22, page 75
	Defective wiring	Check
	Fuse (F1, F2) blown	Replace
	Stepper motor suction modulation valve circuit malfunction	6.18, page 71

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.10 NO EVAPORATOR AIR FLOW OR RESTRICTED AIR FLOW		
Evaporator coil blocked	Frost on coil	5.6, page 54
	Dirty coil	6.15, page 70
No or partial evaporator air flow	Evaporator fan motor internal protector open	6.16, page 70
	Evaporator fan motor(s) defective	6.16, page 70
	Evaporator fan(s) loose or defective	6.16, page 70
	Evaporator fan contactor defective	Replace
5.11 THERMOSTATIC EXPANSION VALVE MALFUNCTION		
Low suction pressure with high superheat	Low refrigerant charge	6.7.1, page 60
	External equalizer line plugged	Open
	Wax, oil or dirt plugging valve or orifice Ice formation at valve seat	6.14, page 68
	Superheat too high	6.7.1, page 60
	Power assembly failure	6.14, page 68
	Loss of element/bulb charge	
	Broken capillary	
	Foreign material in valve	
High suction pressure with low superheat	Superheat setting too low	6.14, page 68
	External equalizer line plugged Ice holding valve open	Open
	Foreign material in valve	6.14, page 68
Liquid slugging in compressor	Pin and seat of expansion valve eroded or held open by foreign material	6.14, page 68
Fluctuating suction pressure	Improper bulb location or installation	
	Low superheat setting	
5.12 AUTOTRANSFORMER MALFUNCTION		
Unit will not start	Circuit breaker (CB-1 or CB-2) tripped	Check
	Autotransformer defective	6.20, page 74
	Power source not turned ON	Check
	460 VAC power plug is not inserted into the receptacle	4.2.2, page 45
5.13 WATER-COOLED CONDENSER OR WATER PRESSURE SWITCH		
High discharge pressure	Dirty coil	6.12, page 67
	Noncondensibles	
Condenser fan starts and stops	Water pressure switch malfunction	Check
	Water supply interruption	Check

SECTION 6

SERVICE

NOTE

To avoid damage to the earth's ozone layer, use a refrigerant recovery system whenever removing refrigerant. When working with refrigerants you must comply with all local government environmental laws. In the U.S.A., refer to EPA section 608.

⚠ DANGER

HAZARDOUS ATMOSPHERE INSIDE. LOW OXYGEN INSIDE CONTAINER CAN CAUSE DEATH.

Performing service on, or entering a CA equipped unit can be extremely dangerous. Refer to the Safety section of this manual before servicing or entering the container.

⚠ WARNING

Never use air for leak testing. It has been determined that pressurized, mixtures of refrigerant and air can undergo combustion when exposed to an ignition source.

6.1 SECTION LAYOUT

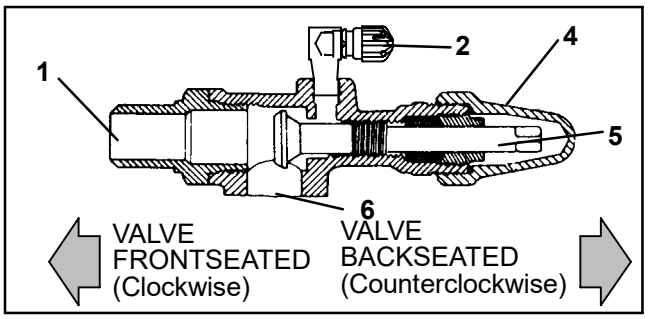
Service procedures are provided herein beginning with refrigeration system service, then refrigeration system component service, electrical system service and general service. Refer to the Table of Contents to locate specific topics.

6.2 SERVICE VALVES

The compressor suction, compressor discharge and liquid line service valves (see Figure 22) are provided with a double seat and a gauge connection which enable servicing of the compressor and refrigerant lines. Turning the valve stem clockwise (all the way forward) will frontseat the valve to close off the suction, discharge or liquid line and open the gauge port to the compressor or low side. Turning the stem counterclockwise (all the way out) will backseat the valve to open the connections and close off the port.

With the valve stem midway between frontseat and backseat, the lines are open to both the connections and the gauge connection.

For example, the valve stem is first fully backseated when connecting a manifold gauge to measure pressure. Then, the valve is opened 1/4 to 1/2 turn to measure the pressure.



1. Suction, Discharge or Liquid Line Connection
2. Service Port
3. Stem Cap
4. Valve stem
5. Compressor Or Filter Drier Inlet Connection

Figure 22. Service Valve

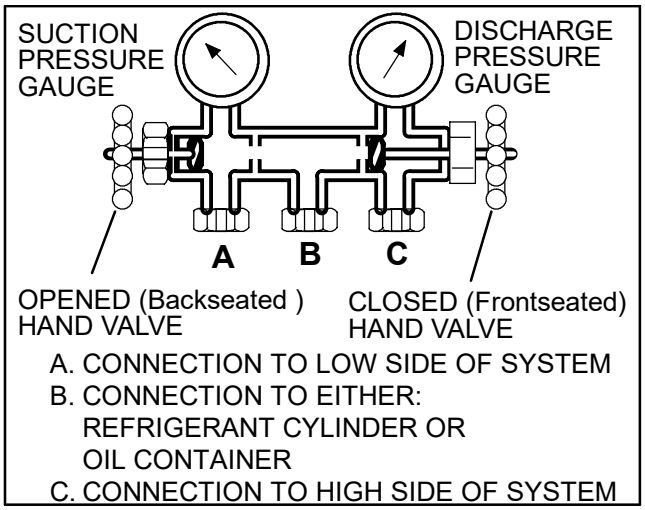


Figure 23. Manifold Gauge Set

6.3. MANIFOLD GAUGE SET

The manifold gauge set (see Figure 23) is used to determine system operating pressure, add refrigerant charge, and to equalize or evacuate the system.

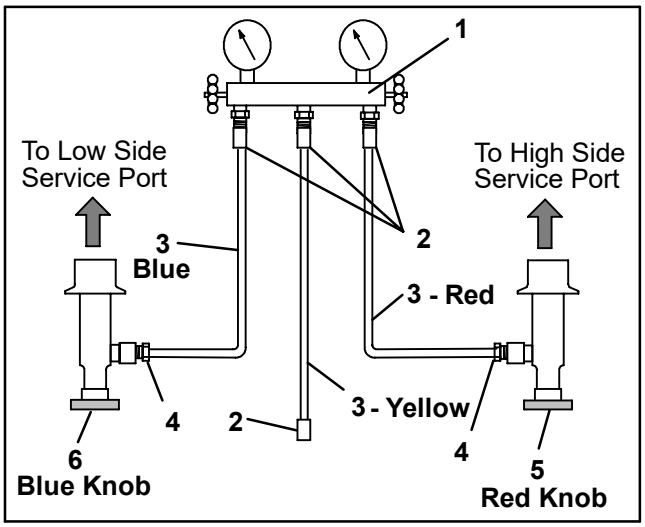
When the suction pressure hand valve is frontseated (turned all the way in), the suction (low) pressure can be checked. When the discharge pressure hand valve is frontseated, the discharge (high) pressure can be checked. When both valves are open (turned counter-clockwise all the way out), high pressure vapor will flow into the low side. When the suction pressure valve is open and the discharge pressure valve shut, the system can be charged. Oil can also be added to the system.

A R-134a manifold gauge/hose set with self-sealing hoses (see Figure 24, page 58) is required for service of the models covered within this manual. The manifold

gauge/hose set is available from Carrier Transicold. (Carrier Transicold P/N 07-00294-00, which includes items 1 through 6, Figure 24, page 58.) To perform service using the manifold gage/hose set, do the following:

a. Preparing Manifold Gauge/Hose Set For Use

1. If the manifold gauge/hose set is new or was exposed to the atmosphere it will need to be evacuated to remove contaminants and air as follows:
2. Back seat (turn counterclockwise)both field service couplings (see Figure 24, page 58) and midseat both hand valves.
3. Connect the yellow hose to a vacuum pump and refrigerant 134a cylinder.
4. Evacuate to 10 inches of vacuum and then charge with R-134a to a slightly positive pressure of 0.1 kg/cm^2 (1.0 psig).
5. Front seat both manifold gauge set valves and disconnect from cylinder. The gauge set is now ready for use.



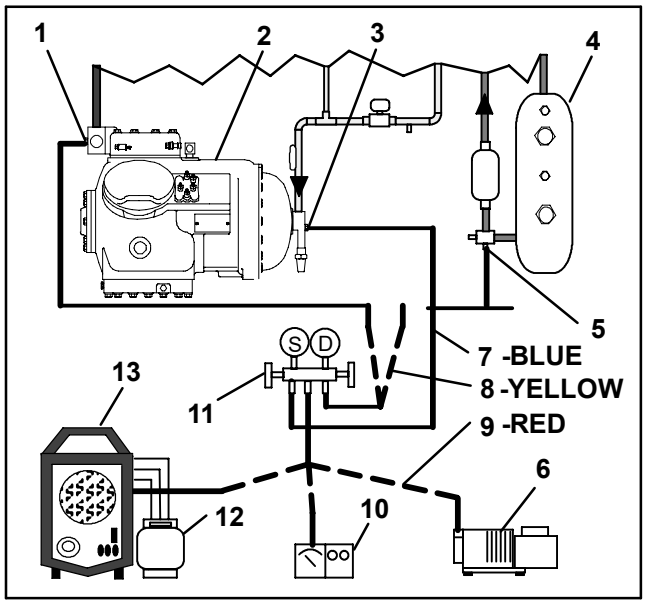
1. Manifold Gauge Set
2. Hose Fitting (0.5-16 Acme)
3. Refrigeration and/or Evacuation Hose
. (SAE J2196/R-134a)
4. Hose Fitting w/O-ring (M14 x 1.5)
5. High Side Field Service Coupling
6. Low Side Field Service Coupling

Figure 24. R-134a Manifold Gauge/Hose Set

b. Connecting Manifold Gauge/Hose Set

Connection of the manifold gauge/hose set (see Figure 24) is dependent on the component being serviced. If only the compressor is being serviced, the high side coupling is connected to the discharge service valve. For service of the low side (after pump down), the high side coupling is connected to the liquid line service valve. The center hose connection is brought to the tool being used. To connect the manifold gauge/hose set, do the following.

1. Remove service valve stem caps and check to make sure they are backseated. Remove service port caps. (See Figure 22)
2. Connect the high side field service coupling (see Figure 24) to the discharge or liquid line valve service valve port.
3. Turn the high side field service coupling knob (red) clockwise, which will open the high side of the system to the gauge set.
4. Connect the low side field service coupling to the suction service valve port.
5. Turn the low side field service coupling knob (blue) clockwise, which will open the low side of the system to the gauge set.
6. To read system pressures: slightly midseat the high side and suction service valves.



1. Discharge Service Valve
2. Compressor
3. Suction Service Valve
4. Receiver or Water Cooled Condenser
5. Liquid Service Valve
6. Vacuum Pump
7. Low Side Hose
8. Center Hose
9. High Side Hose
10. Electronic Vacuum Gauge
11. Manifold Gauge Set
12. Refrigerant Cylinder
13. Reclaimer

Figure 25. Refrigeration System Service Connections

⚠ CAUTION

To prevent trapping liquid refrigerant in the manifold gauge set be sure set is brought to suction pressure before disconnecting.

c. Removing the Manifold Gauge Set

1. While the compressor is still ON, backseat the high side service valve.
2. Midseat both hand valves on the manifold gauge set and allow the pressure in the manifold gauge set to be drawn down to suction pressure. This returns any liquid that may be in the high side hose to the system.
3. Backseat the suction service valve. Backseat both field service couplings and frontseat both manifold set valves. Remove the couplings from the service ports.
4. Install both service valve stem caps and service port caps (finger-tight only).

6.4 PUMPING THE UNIT DOWN

To service the filter-drier, moisture-liquid indicator, expansion valve, suction modulation valve, quench valve or evaporator coil, pump the refrigerant into the high side as follows:

a. Attach manifold gauge set to compressor service valves. Refer to section 6.3, page 57.

b. Start the unit and run in a cooling mode for 10 to 15 minutes. Frontseat the liquid line service valve. Place start-stop switch in the OFF position when the suction reaches a positive pressure of 0.1 kg/cm^2 (1.0 psig).

c. Frontseat the suction service valve. The refrigerant will be trapped between the compressor suction service valve and the liquid line valve.

d. Before opening up any part of the system, a slight positive pressure should be indicated on the pressure gauge. If a vacuum is indicated, emit refrigerant by cracking the liquid line valve momentarily to build up a slight positive pressure.

e. When opening up the refrigerant system, certain parts may frost. Allow the part to warm to ambient temperature before dismantling. This avoids internal condensation which puts moisture in the system.

f. After repairs have been made, be sure to perform a refrigerant leak check (refer to section 6.5), and evacuate and dehydrate the low side (refer to section 6.6).

g. Check refrigerant charge (refer to section 6.7).

6.5 REFRIGERANT LEAK CHECKING

⚠ WARNING

Never use air for leak testing. It has been determined that pressurized, air-rich mixtures of refrigerants and air can undergo combustion when exposed to an ignition source.

a. The recommended procedure for finding leaks in a system is with a R-134a electronic leak detector. Testing joints with soapsuds is satisfactory only for locating large leaks.

b. If the system is without refrigerant, charge the system with refrigerant 134a to build up pressure between 2.1 to 3.5 kg/cm^2 (30 to 50 psig). Remove refrigerant cylinder and leak-check all connections.

NOTE

Only refrigerant 134a should be used to pressurize the system. Any other gas or vapor will contaminate the system, which will require additional purging and evacuation of the system.

c. If required, remove refrigerant using a refrigerant recovery system and repair any leaks.

d. Evacuate and dehydrate the unit. (Refer to section 6.6.)

e. Charge unit per section 6.7.

6.6 EVACUATION AND DEHYDRATION

6.6.1 General

Moisture is the deadly enemy of refrigeration systems. The presence of moisture in a refrigeration system can have many undesirable effects. The most common are copper plating, acid sludge formation, “freezing-up” of metering devices by free water, and formation of acids, resulting in metal corrosion.

6.6.2 Preparation

a. Evacuate and dehydrate only after pressure leak test. (Refer to section 6.5.)

b. Essential tools to properly evacuate and dehydrate any system include a vacuum pump (8 m^3/hr = 5 cfm volume displacement) and an electronic vacuum gauge. (The pump is available from Carrier Transicold, P/N 07-00176-11.)

c. If possible, keep the ambient temperature above 15.6°C (60°F) to speed evaporation of moisture. If the ambient temperature is lower than 15.6°C (60°F), ice might form before moisture removal is complete. Heat lamps or alternate sources of heat may be used to raise the system temperature.

d. Additional time may be saved during a complete system pump down by replaceing the filter-drier with a section of copper tubing and the appropriate fittings. Installation of a new drier may be performed during the charging procedure.

6.6.3 Procedure - Complete system

a. Remove all refrigerant using a refrigerant recovery system.

b. The recommended method to evacuate and dehydrate the system is to connect three evacuation hoses (see Figure 26, page 60) to the vacuum pump and refrigeration unit. Be sure the service hoses are suited for evacuation purposes.

c. Test the evacuation setup for leaks by backseating the unit service valves and drawing a deep vacuum with the vacuum pump and gauge valves open. Shut off the pump and check to see if the vacuum holds. Repair leaks if necessary.

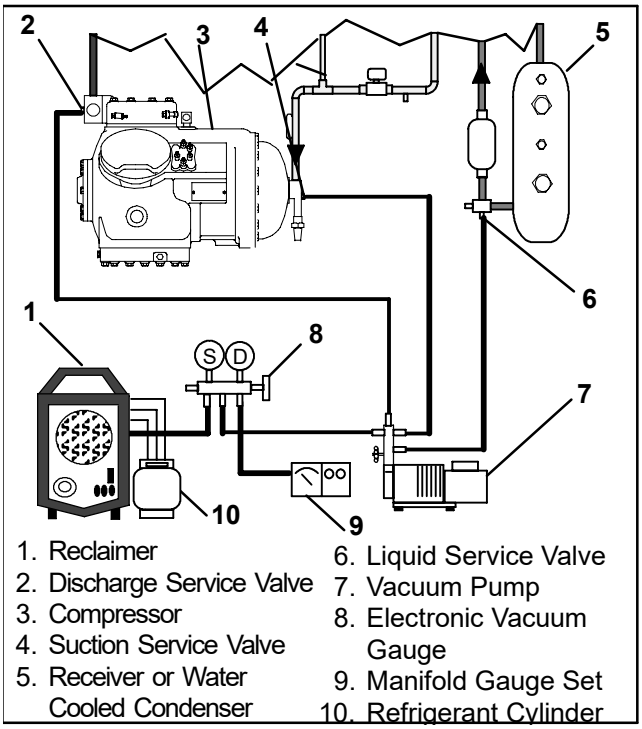
d. Midseat the refrigerant system service valves.

e. Open the vacuum pump and electronic vacuum gauge valves, if they are not already open. Start the vacuum pump. Evacuate unit until the electronic vacuum gauge indicates 2000 microns. Close the electronic vacuum gauge and vacuum pump valves. Shut off the vacuum pump. Wait a few minutes to be sure the vacuum holds.

f. Break the vacuum with clean dry refrigerant 134a gas. Raise system pressure to approximately 0.2 kg/cm^2 (2 psig), monitoring it with the compound gauge.

g. Remove refrigerant using a refrigerant recovery system.

h. Repeat steps e.and f. one time.



1. Reclaimer
2. Discharge Service Valve
3. Compressor
4. Suction Service Valve
5. Receiver or Water Cooled Condenser
6. Liquid Service Valve
7. Vacuum Pump
8. Electronic Vacuum Gauge
9. Manifold Gauge Set
10. Refrigerant Cylinder

Figure 26. Compressor Service Connections

i. Remove the copper tubing and change the filter-drier. Evacuate unit to 500 microns. Close the electronic vacuum gauge and vacuum pump valves. Shut off the vacuum pump. Wait five minutes to see if vacuum holds. This procedure checks for residual moisture and/or leaks.

j. With a vacuum still in the unit, the refrigerant charge may be drawn into the system from a refrigerant container on weight scales. Continue to section 6.7.

6.6.4 Procedure - Partial System

a. If the refrigerant charge has been removed from the compressor for service, evacuate only the compressor by connecting the evacuation set–up at the compressor service valves. Follow evacuation procedures of the preceding paragraph except leave compressor service valves frontseated until evacuation is completed.

b. If refrigerant charge has been removed from the low side only, evacuate the low side by connecting the evacuation set–up at the compressor service valves and liquid service valve except leave the service valves frontseated until evacuation is completed.

c. Once evacuation has been completed and the pump has been isolated, fully backseat the service valves to isolate the service connections and then continue with checking and, if required, adding refrigerant in accordance with normal procedures.

6.7 REFRIGERANT CHARGE

6.7.1 Checking the Refrigerant Charge

NOTE

To avoid damage to the earth's ozone layer, use a refrigerant recovery system whenever removing refrigerant. When working with refrigerants you must comply with all local government environmental laws. In the U.S.A., refer to EPA section 608.

a. Connect the gauge manifold to the compressor discharge and suction service valves. For units operating on a water cooled condenser, change over to air cooled operation.

b. Bring the container temperature to approximately 1.7°C (35°F) or –17.8°C (0°F). Then set the controller set point to –25°C (–13°F) to ensure that the suction modulation valve is at maximum allowed open position.

c. Partially block the condenser coil inlet air. Increase the area blocked until the compressor discharge pressure is raised to approximately 12 kg/cm^2 (175 psig).

d. On units equipped with a receiver, the level should be between the glasses. On units equipped with a water cooled condenser, the level should be at the center of the glass. If the refrigerant level is not correct, continue with the following paragraphs to add or remove refrigerant as required.

6.7.2 Adding Refrigerant to System (Full Charge)

a. Evacuate unit and leave in deep vacuum. (Refer to section 6.6.)

b. Place cylinder of R-134a on scale and connect charging line from cylinder to liquid line valve. Purge charging line at liquid line valve and then note weight of cylinder and refrigerant.

c. Open liquid valve on cylinder. Open liquid line valve half-way and allow the liquid refrigerant to flow into the unit until the correct weight of refrigerant (refer to section 2.2, page 11) has been added as indicated by scales.

NOTE

It may be necessary to finish charging unit through suction service valve in gas form, due to pressure rise in high side of the system. (Refer to section section 6.7.3)

d. Backseat manual liquid line valve (to close off gauge port). Close liquid valve on cylinder.

e. Start unit in cooling mode. Run approximately 10 minutes and check the refrigerant charge.

6.7.3 Adding Refrigerant to System (Partial Charge)

a. Examine the unit refrigerant system for any evidence of leaks. Repair as necessary. (Refer to section 6.5, page 59.)

b. Maintain the conditions outlined in section 6.7.1c. Fully backseat the suction service valve and remove the service port cap.

d. Connect charging line between suction service valve port and cylinder of refrigerant R-134a. Open VAPOR valve.

e. Partially frontseat (turn clockwise) the suction service valve and slowly add charge until the refrigerant appears at the proper level.

6.8 COMPRESSOR

⚠ WARNING

Make sure power to the unit is OFF and power plug disconnected before replacing the compressor.

NOTES

1 The compressor should not operate in a vacuum greater than 500 mm/hg (20 inches/hg).

2 The service replacement compressor is sold without shutoff valves (but with valve pads), and without terminal box and cover. Customer should retain the original terminal box, cover, and high pressure switch for use on replacement compressor.

3 Check oil level in service replacement compressor. (Refer to section 6.8.6, page 65.)

4 A compressor terminal wiring kit must be ordered as a separate item when ordering replacement compressor. Appropriate installation instructions are included with kit.

5 Refer to Table 17, page 82 and Table 18, page 83 for applicable compressor wear limits and torque values.

6 See to Figure 54, page 85 for charts on compressor pressure, temperature and motor current curves.

6.8.1 Removal and Replacement of Compressor

a. Remove the protective guard from lower section of the unit.

b. Pump down low side (refer to section 6.4, page 59) or frontseat compressor service valves and remove refrigerant from compressor using a refrigerant recovery system.

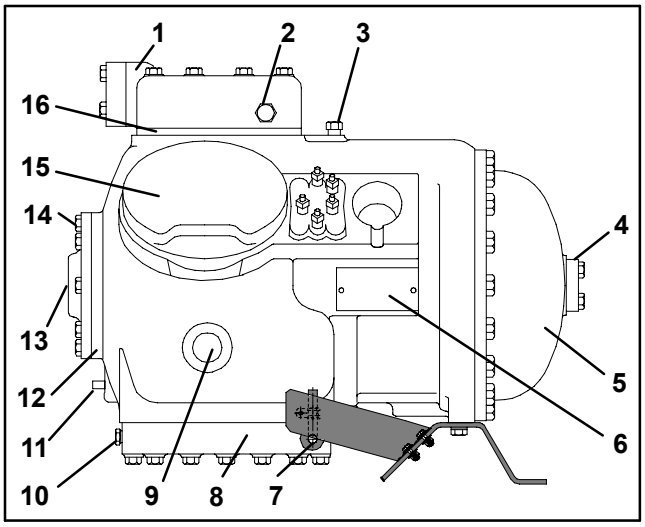
c. Locate the compressor junction box. Tag and disconnect wiring from compressor terminals and remove compressor junction box.

d. Loosen service valve mounting bolts, break seal and then remove bolts.

e. Remove compressor plate mounting bolts.

f. Remove compressor and mounting plate. Refer to section 2.2, page 11 for weight of compressor.

g. Remove high pressure switch (HPS) from compressor and check operation of switch (refer to section 6.9.2, page 66).



1. Discharge Valve Flange
2. High Side Pressure Connection
3. Low Side Pressure Connection
4. Suction Valve Flange
5. Motor End Cover
6. Serial/Model No. Plate
7. Crankcase Heater
8. Bottom Plate
9. Sight Glass
10. Oil Drain Plug
11. Oil Charging Valve
12. Bearing Head
13. Oil Pump
14. Oil Fill Plug
15. Cylinder Head
16. Valve Plate

Figure 27. Compressor

h. Remove compressor mounting bolts from mounting plate and install mounting plate on replacement compressor.

i. Install replacement compressor terminal wiring kit, following instructions included with kit.

j. Install high pressure switch on compressor.

k. Install compressor and mounting plate in unit.

l. Connect junction box(es) to compressor and connect all wiring per wiring diagram. Install junction box cover(s).

m. Install new gaskets on service valves.

n. Install mounting bolts in service valves and torque to 2.77 to 4.15 mkg (20-30 ft/lb).

o. Attach two hoses (with hand valves near vacuum pump) to the suction and discharge service valves. Dehydrate and evacuate compressor to 500 microns (75.9 cm Hg vacuum = 29.90 inches Hg vacuum). *Turn off valves on both hoses to pump.*

p. Fully backseat (open) both suction and discharge service valves.

q. Remove vacuum pump lines.

r. Start unit and check refrigerant charge. (Refer to section 6.7, page 60.)

s. Check moisture-liquid indicator for wetness. Change filter-drier if necessary. (Refer to section 6.13, page 68.)

t. Check compressor oil level per section 6.8.6, page 65. Add oil if necessary.

6.8.2 Compressor Disassembly

⚠ WARNING

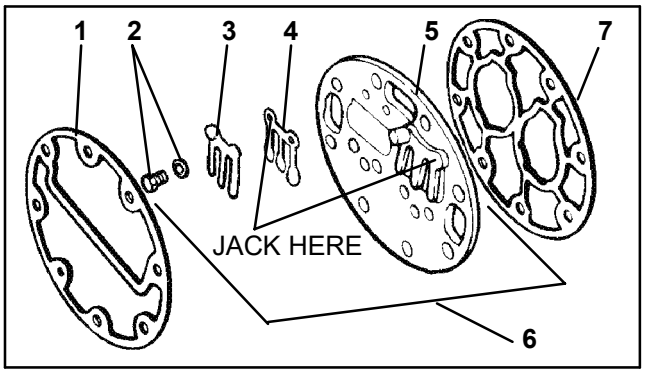
Before disassembly of any external compressor component make sure to relieve possible internal pressure by loosening the bolts and tapping the component with a soft hammer to break the seal.

⚠ CAUTION

Removing the compressor motor press-fit stator in the field is not recommended. The rotor and stator are a matched pair and should not be separated.

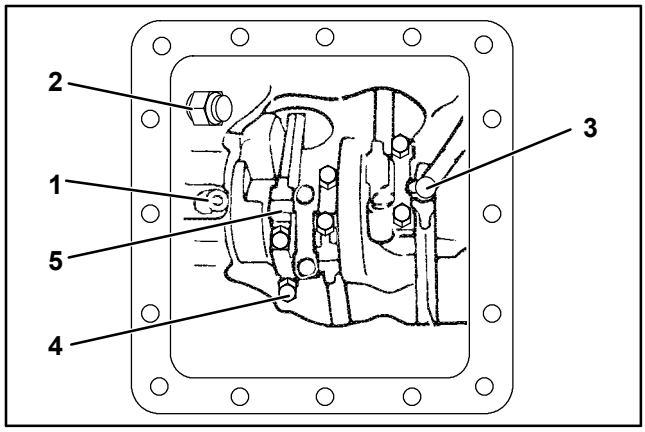
When disassembling compressor, matchmark parts so they may be replaced in their same relative positions. (See Figure 27.) Refer to Table 17, page 82 and Table 18, page 83 for compressor wear limits and bolt torque values.

a. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil fill plug (see Figure 27, page 61) to vent the crankcase. Loosen the drain plug in bottom plate and allow the oil to drain out slowly. Remove the plug slowly to relieve any crankcase pressure. Some units have a plug in the bottom center of the crankcase which may be removed for draining the motor end more quickly.



1. Cylinder Head Gasket
2. Discharge Valve Screw & Lockwasher
3. Discharge Valve Stop
4. Discharge Valve
5. Valve Plate
6. Valve Plate Assembly
7. Valve Plate Gasket

Figure 28. Exploded View of Valve Plate



1. Oil Pressure Relief Valve
2. Oil Return Check Valve
3. Oil Suction Tube
4. Capscrew
5. Connecting Rod and Cap Assembly

Figure 29. Bottom Plate Removed

b. Loosen cylinder head capscrews. If the cylinder head is stuck, tap the center of the cylinder head with a wooden or lead mallet. Do not strike the side of the cylinder head. Be careful not to drop the head or damage the gasket sealing surface. Remove cylinder head bolts and gasket (see Figure 28).

c. Remove valve stops and valves. After they have been removed, free the valve plate from the cylinder deck by using the outside discharge valve hold-down capscrew as a jack screw through the tapped hole of the valve plate. Remove the valve plate gasket.

d. Turn the compressor on its side and remove the bottom plate oil suction screen and screen hold down plate. Inspect the screen for holes or an accumulation of dirt. The screen can be cleaned with a suitable solvent.

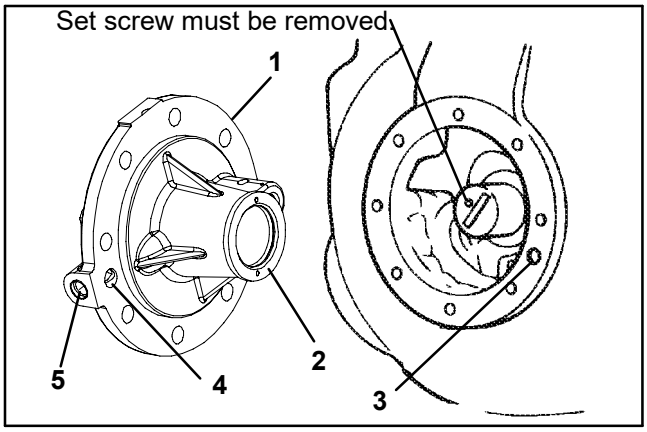
e. Match mark each connecting rod cap (see Figure 29) and connecting rod for correct reassembly. Remove the bolts and connecting rod caps. Push the piston rods up as far as they will go without having the piston rings extend above the cylinders.

⚠ CAUTION

The copper tube which connects to the oil suction strainer extends out the bottom with the bottom plate removed. Take precautions to avoid bending or breaking it while changing crankcase positions.

f. If necessary, remove the oil return check valve. (See Figure 29.) Inspect it for proper operation (flow in one direction only). Replace the assembly with a new unit if check valve operation is impaired.

g. To remove the oil pump (see Figure 30) remove eight capscrews, oil pump bearing head assembly, gasket and thrust washer.

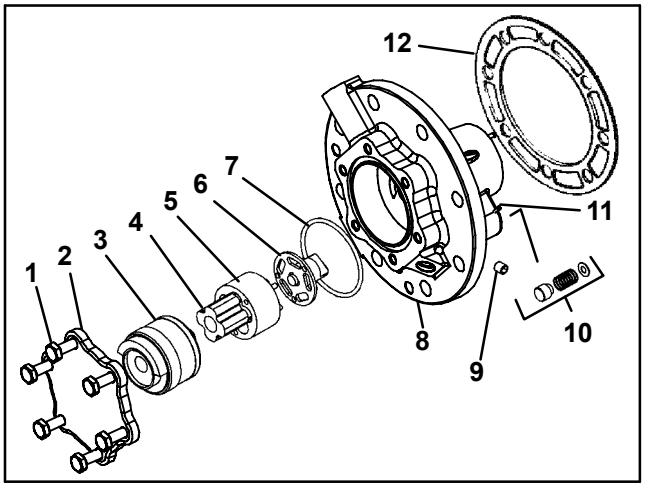


1. Oil Pump & Bearing Head
2. Thrust Washer
3. Oil Pickup Tube
4. Oil Inlet Port
5. Oil Pump Inlet

Figure 30. Oil Pump and Bearing Head

NOTE

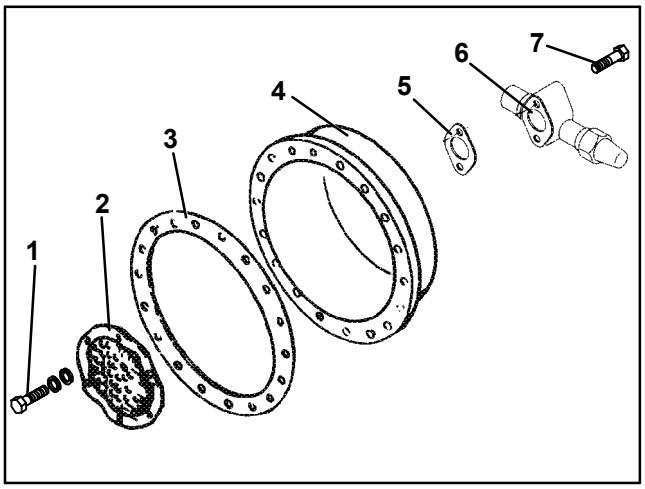
If the oil pump was not operating properly, the entire oil pump & bearing head assembly must be replaced. Individual parts are not available. If the pump requires inspection or cleaning, disassemble and reassemble by referring to Figure 31 . Clean all parts and coat all moving parts with compressor oil before proceeding with reassembly.



1. Capscrews
2. Cover
3. Reversing Assembly
4. Pinion
5. Gear
6. Drive
7. O-Ring
8. Oil Pump & Bearing
9. Set Screw
10. Relief Valve
11. Pin
12. Gasket

Figure 31. Low Profile Oil Pump

h. Be very careful not to damage the motor windings when removing the motor end cover (see Figure 32), as the cover fits over the winding coils. Loosen the cap screws, break the seal and then remove all capscrews except one in the top of the cover. While holding the cover in place, remove the remaining capscrew. Do not allow the cover to drop from its own weight. To prevent striking the winding, remove the cover horizontally and in line with the motor axis.



1. Strainer Screws and Washers
2. Suction Strainer
3. Motor End Cover Gasket
4. Motor End Cover
5. Valve Gasket
6. Suction Service Valve
7. Valve Capscrew

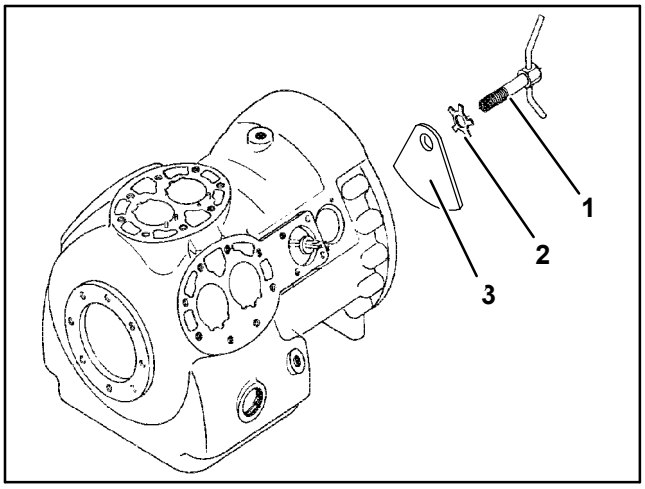
Figure 32. Motor End Cover

i. Remove the refrigerant suction strainer. If it is removed with ease it may be cleaned with solvent and replaced. If the strainer is broken, corroded or clogged with dirt that is not easily removed, replace the strainer. Install new gaskets upon reassembly.

j. Block the compressor crankshaft so that it cannot turn. Use a screwdriver to bend back the tabs on the lockwasher and remove the equalizer tube and lock screw assembly. (See Figure 33.) The slingers at the end of the tube draw vapor from the crankcase. Remove the rotor using a jack bolt. Insert a brass plug into the rotor hole to prevent damage to the end of the crankshaft.

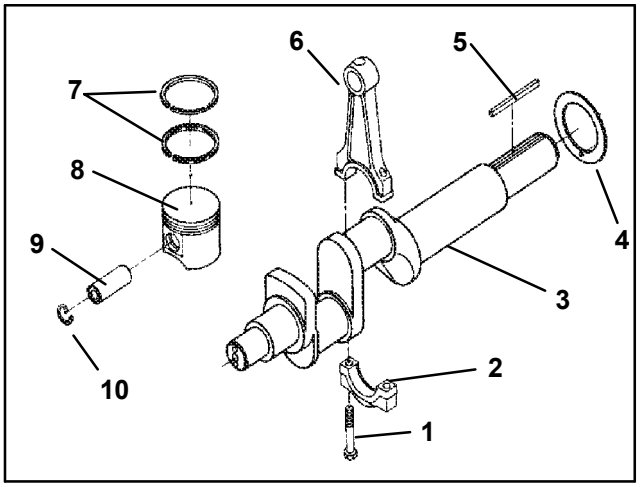
k. If the piston rings extend beyond the cylinder tops, the pistons can be pulled through the bottom plate opening after the piston rings are compressed. A piston ring compresser will facilitate removal. Each piston pin is locked in place by lock rings which are snapped into grooves in the piston wall. (See Figure 34.)

l. Since the stator cannot be replaced in the field, the terminal plate assembly need not be disturbed unless a leak exists and the plate assembly needs to be replaced. If no terminal plate repair is required, proceed with reassembly.



1. Equalizer Tube and Lock Screw Assembly
2. Lockwasher
3. Counterweight – Motor End

Figure 33. Equalizing Tube and Lock Screw Assembly



1. Capscrew
2. Cap
3. Crankshaft
4. Thrust Washer
5. Rotor Drive Key
6. Connecting Rod
7. Compression Ring
8. Piston
9. Pin
10. Retainer

Figure 34. Crankshaft Assembly

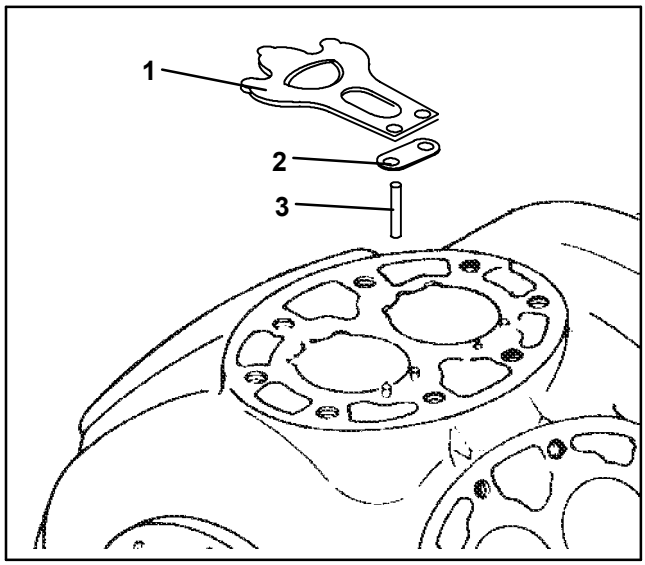
6.8.3 Compressor Reassembly

Clean all compressor parts, use a suitable solvent with proper precautions. Coat all moving parts with the proper compressor oil before assembly. Refer to Table 18, page 83 for applicable compressor torque values.

6.8.4 Preparation

a. Suction and Discharge Valves

If the valve seats look damaged or worn, replace valve plate assembly. Always use new valves because it is difficult to reinstall used valves so that they will seat as before removal. Any valve wear will cause leakage.



1. Suction Valve
2. Suction Valve Positioning Spring
3. Valve Plate Dowel Pin

Figure 35. Suction Valve & Positioning Springs

Suction valves are positioned by dowel pins (see Figure Figure 35). Do not omit the suction valve positioning springs. Place the springs so that the ends bear against the cylinder deck (middle bowed away from cylinder deck). Use new gaskets when reinstalling valve plates and cylinder heads.

b. Compression Rings

The compression ring is chamfered on the inside circumference. This ring is installed with the chamfer toward the top. Stagger the ring end gaps so they are not aligned.

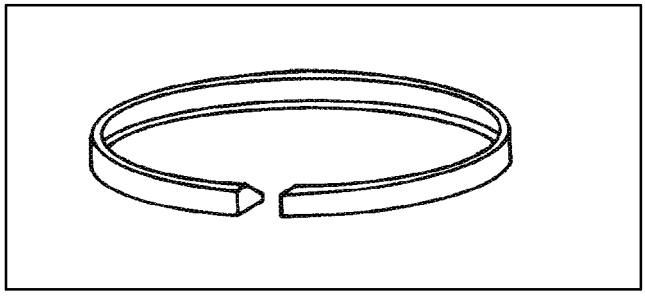


Figure 36. Piston Ring

The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore approximately one inch below the top of the bore. Square the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are 0.33 and 0.127 mm (0.013 and 0.005 inch) respectively.

6.8.5 Installing the Components

a. Push pistons from the inside of the crankcase through the cylinders, being careful not to break the rings. Place rods so that the chamfered side will be against radius of crankpins. Install the crankshaft and thrust washer through the pump end of the compressor. Ensure thrust washer is fitted on locating pin. Do not damage main bearings. Bring rods in position against crank bearings.

b. Install the pump end thrust washer on the two dowel pins located on the bearing head. (See Figure 30, page.)

⚠ CAUTION

Ensure that thrust washer does not fall off dowel pins while installing oil pump.

⚠ CAUTION

The set screw on the crankshaft must be removed for this type of oil pump. (See Figure 30, page 63.)

c. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand, ensuring that the thrust washer remains on the dowel pins. The tang on the end of the drive engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase and should be oriented with the oil pick up tube and oil inlet port aligned as shown in Figure 30, page 63.

d. Align the gasket and install the eight capscrews in the mounting flange. Refer to Table 18, page 83 for applicable torque values.

e. Install matching connecting rod caps Be sure rod is not bound and crankshaft will turn correctly as each set of rod bolts is torqued.

f. Be sure key fits properly when installng rotor on shaft Screw on equalizer tube and lock screw assembly with lock washer and bend over tabs of lock washer. Assemble suction strainer to motor and cover and bolt cover to crankcase. Assemble valve plates and gaskets. Assemble cylinder heads and gaskets. Turn the shaft by hand to see that it moves freely.

g. Install the oil suction screen, the oil suction screen hold down plate and the bottom plate.

6.8.6 Compressor Oil Level

⚠ CAUTION

Use only Carrier Transicold approved Polyol Ester Oil (POE) – Castrol-Icematic SW20 compressor oil with R-134a. Buy in quantities of one quart or smaller. When using this hygroscopic oil, immediately reseal. Do not leave container of oil open or contamination will occur.

a. Checking the Oil Level in the Compressor.

1. Operate the unit in cooling mode for at least 20 minutes.
2. Check the front oil sight glass on the compressor to ensure that no foaming of the oil is present after 20 minutes of operation. If the oil is foaming excessively after 20 minutes of operation, check the refrigerant system for flood-back of liquid refrigerant. Correct this situation before performing the following step.
3. Turn unit off to check the oil level. The correct oil level range should be between the bottom to one-eighth level of the sight glass. If the level is above one-eighth, oil must be removed from the compressor. To remove oil from the compressor, follow step d in this section. If the level is below the bottom of the sight glass, add oil to the compressor following step b below.

b. Adding Oil with Compressor in System

1. The recommended method is to add oil using an oil pump at the oil fill valve (see item 11, Figure 27, page 61)
2. In an emergency where an oil pump is not available, oil may be drawn into the compressor through the suction service valve.

   Connect the suction connection of the gauge manifold to the compressor suction service valve port, and immerse the common connection of the gauge manifold in an open container of refrigeration oil. Extreme care must be taken to ensure the manifold common connection remains immersed in oil at all times. Otherwise air and moisture will be drawn into the compressor. Crack the suction service valve and gauge valve to vent a small amount of refrigerant through the common connection and the oil to purge the lines of air. Close the gauge manifold valve.

   With the unit running, frontseat the suction service valve and induce a vacuum in the compressor crankcase. SLOWLY crack the suction gauge manifold valve and oil will flow through the suction service valve into the compressor. Add oil as necessary.

c. Adding Oil to Service Replacement Compressor

Service replacement compressors are shipped without oil. If oil is present in the crankcase, it must be tested to ensure it is the correct oil and that the moisture level is acceptable.

When adding oil to a service replacement compressor add three liters (6.3 pints) using an oil pump at the oil fill valve (see item 11, Figure 27, page 61). This quantity is recommended to allow for return of any oil that may be in the refrigerant system. Install compressor and recheck oil level after it is placed in operation.

d. Removing Oil from the Compressor

1 If the oil level is above one-eighth sight glass, oil must be removed from the compressor.

2 Close (frontseat) suction service valve and pump unit down to 1.2 to 1.3 kg/cm^2 (2 to 4 psig). Frontseat discharge service valve and removeremaining refrigerant.

3 Loosen the oil drain plug on the bottom plate of the compressor and drain the proper amount of oil from the compressor to obtain the correct level. *Backseat the suction and discharge service valves*

4 Repeat step a to ensure proper oil level.

6.9 HIGH PRESSURE SWITCH

6.9.1 Replacing High Pressure Switch

a. Turn unit start-stop switch OFF. Frontseat both suction and discharge service valves to isolate compressor. Remove the refrigerant from the compressor.

b. Disconnect wiring from defective switch. The high pressure switch is located on the center head and is removed by turning counterclockwise. (See Figure 3, page 7.)

c. Install a new high pressure switch after verifying switch settings. (Refer to section 6.9.2., page 66)

d. Evacuate and dehydrate the compressor per section 6.6, page 59.

6.9.2 Checking High Pressure Switch

⚠ WARNING

Do not use a nitrogen cylinder without a pressure regulator. Do not use oxygen in or near a refrigeration system as an explosion may occur.

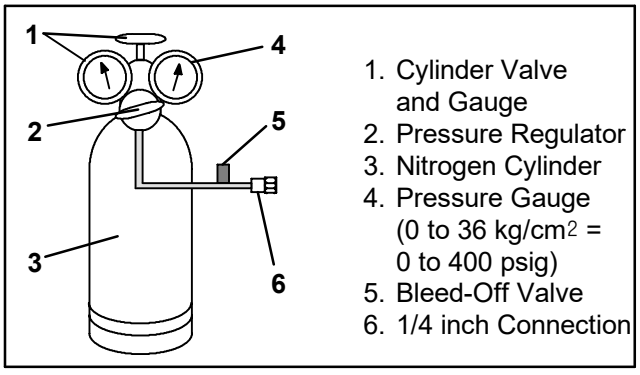
NOTE

The high pressure switch is non-adjustable.

a. Remove switch as outlined in section 6.9.1

b. Connect ohmmeter or continuity light across switch terminals. Ohm meter will indicate no resistance or continuity light will be illuminated if the switch closed after relieving compressor pressure.

c. Connect hose to a cylinder of dry nitrogen. (See Figure 37.)



1. Cylinder Valve and Gauge
2. Pressure Regulator
3. Nitrogen Cylinder
4. Pressure Gauge (0 to 36 kg/cm^2 = 0 to 400 psig)
5. Bleed-Off Valve
6. 1/4 inch Connection

Figure 37. High Pressure Switch Testing

d. Set nitrogen pressure regulator at 26.4 kg/cm^2 (375 psig) with bleed-off valve closed.

e. Close valve on cylinder and open bleed-off valve.

f. Open cylinder valve. Slowly close bleed-off valve to increase pressure on switch. The switch should open at a static pressure up to 25 kg/cm^2 (350 psig). If a light is used, light will go out. If an ohmmeter is used, the meter will indicate open circuit.

g. Slowly open bleed-off valve to decrease the pressure. The switch should close at 18 kg/cm^2 (250 psig).

6.10 CONDENSER COIL

The condenser consists of a series of parallel copper tubes expanded into copper fins. The condenser coil must be cleaned with fresh water or steam so the air flow is not restricted. To replace the coil, do the following:

⚠ WARNING

Do not open the condenser fan grille before turning power OFF and disconnecting power plug.

a. Using a refrigerant reclaim system, remove the refrigerant charge.

b. Remove the condenser coil guard.

c. Unsolder discharge line and remove the line to the receiver or water-cooled condenser.

d. Remove coil mounting hardware and remove the coil.

e. Install replacement coil and solder connections.

f. Leak-check the coil connections per section 6.5, page 59. Evacuate the unit per section 6.6, page 59 then charge the unit with refrigerant per section 6.7 page 60.

6.11 CONDENSER FAN AND MOTOR ASSEMBLY

⚠ WARNING

Do not open condenser fan grille before turning power OFF and disconnecting power plug.

The condenser fan rotates counter-clockwise (viewed from front of unit), pulls air through the the condenser coil, and discharges horizontally through the front of the unit. To replace motor assembly:

a. Open condenser fan screen guard.

b. Loosen two square head set screws on fan. (Thread sealer has been applied to set screws at installation.) Disconnect wiring from motor junction box.

⚠ CAUTION

Take necessary steps (place plywood over coil or use sling on motor) to prevent motor from falling into condenser coil.

c. Remove motor mounting hardware and replace the motor. It is recommended that new locknuts be used when replacing motor. Connect wiring per wiring diagram.

d. Install fan loosely on motor shaft (hub side in). DO NOT USE FORCE. If necessary, tap the hub only, not the hub nuts or bolts. Install venturi. Apply “Loctite H” to fan set screws. Adjust fan within venturi so that the outer edge of the fan projects 3.2 to 6.4 mm (3/16” $\pm$1/16”) back from edge of the venturi. Spin fan by hand to check clearance.

e. Close and secure condenser fan screen guard.

f. Apply power to unit and check fan rotation. If fan motor rotates backward, reverse wire numbers 5 and 8.

6.12 WATER COOLED CONDENSER CLEANING

The water-cooled condenser is of the shell and coil type with water circulating through the cupro-nickel coil. The refrigerant vapor is admitted to the shell side and is condensed on the outer surface of the coil.

Rust, scale and slime on the water-cooling surfaces inside of the coil interfere with the transfer of heat, reduce system capacity, cause higher head pressures and increase the load on the system.

By checking the leaving water temperature and the actual condensing temperature, it can be determined if the condenser coil is becoming dirty. A larger than normal difference between leaving condensing water temperature and actual condensing temperature, coupled with a small difference in temperature of entering and leaving condensing water, is an indication of a dirty condensing coil.

To find the approximate condensing temperature, with the unit running in the cooling mode, install a gauge 0 to 36.2 kg/cm^2 (0 to 500 psig) on the compressor discharge service valve.

Example: Discharge pressure is 10.3 kg/cm^2 (146.4 psig). Referring to Table 19, page 84 (R-134a pressure/ temperature chart), the 10.3 kg/cm^2 (146.4 psig) value converts to 43°C (110°F).

If the water-cooled condenser is dirty, it may be cleaned and de-scaled by the following procedure:

a. Turn unit off and disconnect main power.

b. Disconnect water pressure switch tubing by loosening the two flare nuts. Install one-quarter inch flare cap on water-cooled condenser inlet tube (replaces tubing flare nut). De-scale tubing if necessary.

What You Will Need:

1. Oakite Aluminum Cleaner® 164 available as a powder in 20 kg (44 lb) pails and 205 kg (450 lb) drums.
2. Oakite composition No. 32, available as a liquid in cases, each containing 3.785 liters (4 U.S. gallon) bottles and also in carboys of 52.6 kg (116 lbs) net.

NOTE

When Oakite compound No. 32 is being used for the first time, the local Oakite Technical Service representative should be called in for their suggestions in planning the procedure. The representative will advise the reader on how to do the work with a minimum dismantling of equipment: how to estimate the time and amount of compound required; how to prepare the solution; how to control and conclude the de-scaling operation by rinsing and neutralizing equipment before putting it back into service. The representative's knowledge of metals, types of scale, water conditions and de-scaling techniques will be highly useful.

3. Fresh clean water.
4. Acid proof pump and containers or bottles with rubber hose.

Summary of Procedure:

a. Drain water from condenser tubing circuit.

b. Clean water tubes with Oakite Aluminum Cleaner 164 to remove mud and slime.

c. Flush.

d. De-scale water tubes with Oakite No. 32 to remove scale.

e. Flush.

f. Neutralize.

g. Flush.

h. Put unit back in service under normal load and check head (discharge) pressure.

Detailed Procedure:

1. Drain and flush the water circuit of the condenser coil. If scale on the tube inner surfaces is accompanied by slime, a thorough cleaning is necessary before de-scaling process can be accomplished.
2. To remove slime or mud, use Oakite Aluminum Cleaner 164, mixed 170 grams (6 ounces) per 3.785 liters (1 U.S. gallon) of water. Mix cleaner in one half the volume of water, while stirring, and then add remaining water. Warm this solution and circulate through the tubes until all slime and mud has been removed.
3. After cleaning, flush tubes thoroughly with fresh clean water.
4. Prepare a 15% by volume solution for de-scaling, by diluting Oakite compound No. 32 with water. This is accomplished by slowly adding 0.47 liter (1 U.S. pint) of the acid (Oakite No. 32) to 2.8 liters (3 U.S. quarts) of water.

⚠ WARNING

Oakite No. 32 is an acid. Be sure that the acid is slowly added to the water. DO NOT PUT WATER INTO THE ACID – this will cause spattering and excessive heat.

⚠ WARNING

Wear rubber gloves and wash the solution from the skin immediately if accidental contact occurs. Do not allow the solution to splash onto concrete.

5. Fill the tubes with this solution by filling from the bottom. See Figure 38.

NOTE

It is important to provide a vent at the top for escaping gas.

6 Allow the Oakite No. 32 solution to soak in the tube coils for several hours, periodically pump-circulating it with an acid-proof pump.

An alternate method may be used whereby a pail (see Figure 39) filled with the solution and attached to the coils by a hose can serve the same purpose by filling and draining. The solution must contact the scale at every point for thorough de-scaling. Air pockets in the solution should be avoided by regularly opening the vent to release gas. *Keep flames away from the vent gases.*

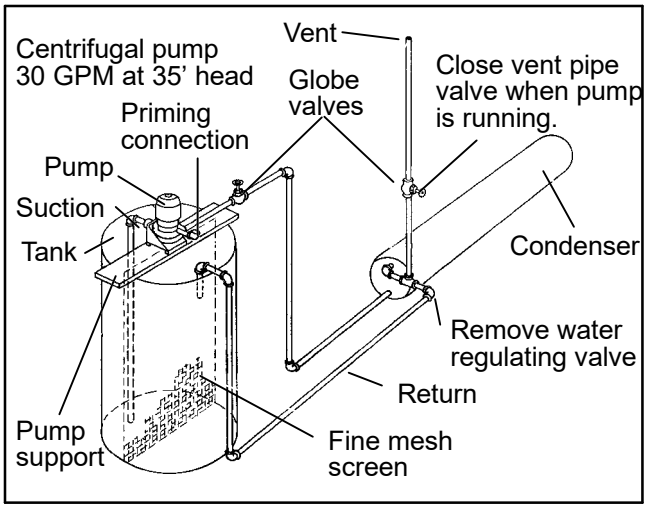


Figure 38. Water-Cooled Condenser Cleaning – Forced Circulation

7 The time required for de-scaling will vary, depending upon the extent of the deposits. One way to determine when de-scaling has been completed is to titrate the solution periodically, using titrating equipment provided free by the Oakite Technical Service representative. As scale is being dissolved, titrate readings will indicate that the Oakite No. 32 solution is losing strength. When the reading remains constant for a reasonable time, this is an indication that scale has been dissolved.

8 When de-scaling is complete, drain the solution and flush thoroughly with water.

9 Following the water flush, circulate a 56.7 gram (2 ounce) per 3.785 liter (1 U.S. gallon) solution of Oakite Aluminum Cleaner 164 thru the tubes to neutralize. Drain this solution.

10 Flush the tubes thoroughly with fresh water.

NOTE

If the condenser cooling water is not being used as drinking water or is not re-circulated in a closed or tower system, neutralizing is not necessary.

11 Put the unit back in service and operate under normal load. Check the head pressure. If normal, a thorough de-scaling has been achieved.

What You Can Do For Further Help:

Contact the Engineering and Service Department of the OAKITE PRODUCTS CO., 675 Central Avenue, New Providence, NJ 07974 U.S.A. (or visit www.oakite.com) for the name and address of the service representative in your area.

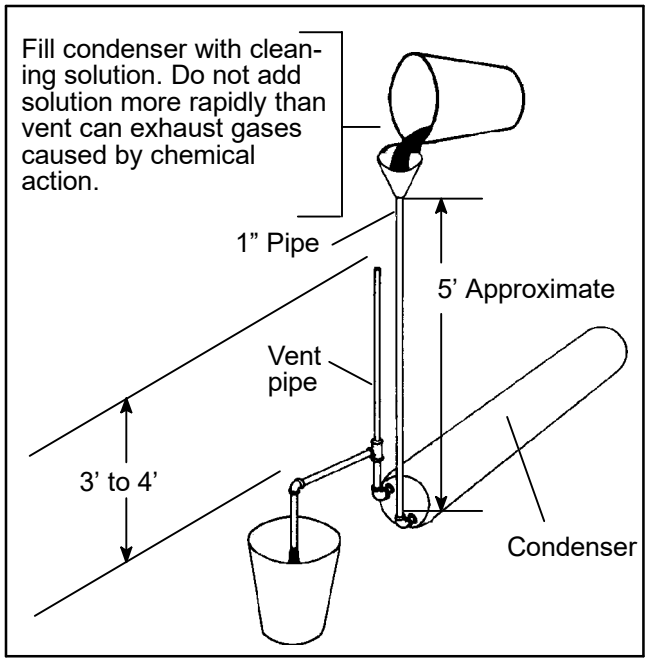


Figure 39. Water Cooled Condenser Cleaning - Gravity Circulation

6.13 FILTER-DRIER

On units equipped with a water-cooled condenser, if the sight glass appears to be flashing or bubbles are constantly moving through the sight glass when the suction modulation valve is fully open, the unit may have a low refrigerant charge or the filter-drier could be partially plugged.

a. To Check Filter-Drier

1. Test for a restricted or plugged filter-drier by feeling the liquid line inlet and outlet connections of the drier cartridge. If the outlet side feels cooler than the inlet side, then the filter-drier should be changed.
2. Check the moisture-liquid indicator if the indicator shows a high level of moisture, the filter-drier should be replaced.

b. To Replace Filter-Drier

1. Pump down the unit (refer to section 6.4, page 59) and replace filter-drier.
2. Evacuate the low side in accordance with section 6.6, page 59.
3. After unit is in operation, inspect for moisture in system and check charge.

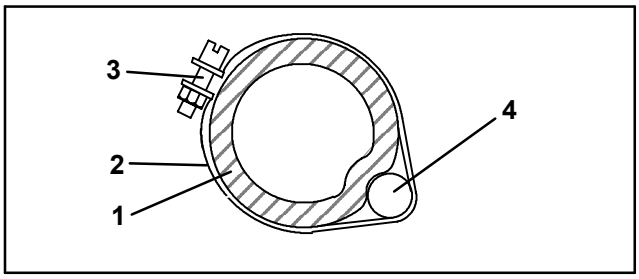
6.14 THERMOSTATIC EXPANSION VALVE

The thermal expansion valve (see Figure 2, page 6) is an automatic device which maintains constant superheat of the refrigerant gas leaving the evaporator, regardless of suction pressure.

The valve functions are:

1. Automatic control of the refrigerant flow to match the evaporator load.
2. Prevention of liquid refrigerant entering the compressor.

Unless the valve is defective, it seldom requires maintenance other than periodic inspection to ensure that the thermal bulb is tightly secured to the suction line and wrapped with insulating compound. (See Figure 40.)



1. Suction Line
2. TXV Bulb Clamp
3. Nut and Bolt
4. TXV Bulb

Figure 40. Thermostatic Expansion Valve Bulb

6.14.1 Checking Superheat.

NOTE

Proper superheat measurement should be completed at –18°C (0°F) container box temperature where possible.

a. Open the heater access panel (see Figure 1, page 5) to expose the expansion valve .

b. Attach a temperature sensor near the expansion valve bulb and insulate. Make sure the suction line is clean and that firm contact is made with the sensor.

c. Connect an accurate gauge to the service port directly upstream of the suction modulating valve

d. Set the temperature set point to –18°C (0°F), and run unit until conditions stabilize.

e. The readings may cycle from a high to a low reading. Take readings of temperature and pressure every three to five minutes for a total of 5or 6 readings

f. From the temperature/pressure chart (Table 19, page 84), determine the saturation temperature corresponding to the evaporator outlet test pressures at the suction modulation valve.

g. Subtract the saturation temperatures determined in step f. from the temperatures measured in step e. The difference is the superheat of the suction gas. Determine the average superheat It should be 4.5 to 6.7 °C (8 to 12 °F)

6.14.2 Hermetic Valve Replacement

a. Removing the Expansion Valve

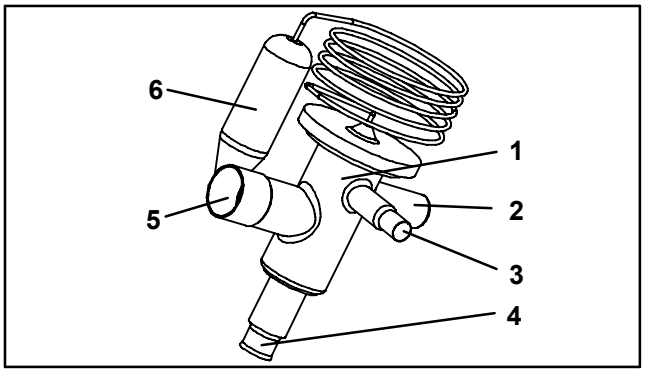
NOTES

1. The TXV is a hermetic valve and does not have adjustable superheat.

2. All connections on the hermetic TXV are bi–metallic, copper on the inside and stainless on the outside.

3. All joints on the hermetic TXV (inlet, outlet and equalizer lines) are brazed.

4. Bi–metallic connections heat up very quickly.



1. Hermetic Thermostatic Expansion Valve
2. Non-adjustable Superheat Stem
3. Equalizer Connection
4. Inlet Connection
5. Outlet Connection
6. Hermetic Expansion Valve Bulb

Figure 41. Hermetic Thermostatic Expansion Valve

1. Pump down the unit per section 6.4, page 59.

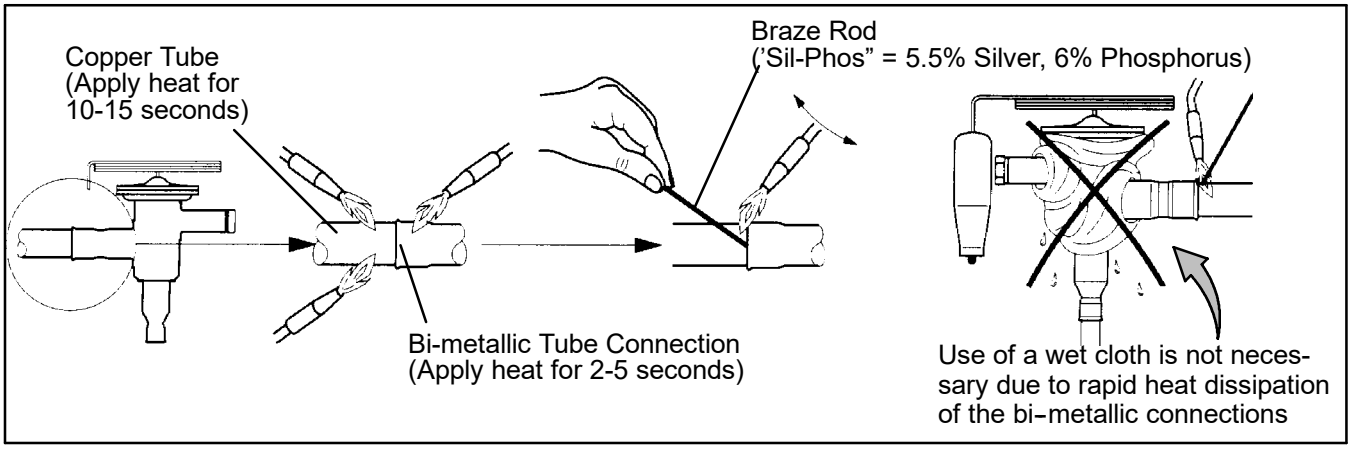


Figure 42. Hermetic Thermostatic Expansion Valve Brazing Procedure

2. Remove cushion clamps located on the inlet and outlet lines.
3. Unbraze the equalizer connection (1/4”), the outlet connection (5/8”) and then the inlet connection (3/8”). See Figure 42. Be careful to protect the insulation on the heaters and their wires.
4. Remove insulation (Presstite) from expansion valve bulb.
5. Unstrap the bulb, located below the center of the suction line (4 o’clock position), and remove the valve.

b. Installing the Expansion Valve

1. Clean the suction line with sandpaper before installing bulb to ensure proper heat transfer. Apply thermal grease to the indentation in the suction line.
2. Strap the thermal bulb to the suction line, making sure bulb is placed firmly into the suction line. See Figure 40 for bulb placement.
3. Insulate the thermal bulb.
4. Braze inlet connection to inlet line, see Figure 42.
5. Braze outlet connection to outlet line.
6. Reinstall the cushion clamps on inlet and outlet lines.
7. Braze the equalizer connection to the equalizer line.
8. Check superheat (refer to step 6.14.1).

6.15 EVAPORATOR COIL AND HEATER ASSEMBLY

The evaporator section, including the coil, should be cleaned regularly. The preferred cleaning fluid is fresh water or steam. Another recommended cleaner is Oakite 202 or similar, following *manufacturer’s instructions.*

The two drain pan hoses are routed behind the condenser fan motor and compressor. The drain pan line(s) must be open to ensure adequate drainage.

6.15.1 Evaporator Coil Replacement

a. Pump unit down. (Refer to section 6.4, page 59.)

b. With power OFF and power plug removed, remove the screws securing the panel covering the evaporator section (upper panel).

c. Disconnect the defrost heater wiring.

d. Disconnect the defrost temperature sensor (see Figure 2, page 6) from the coil.

e. Remove middle coil support.

f. Remove the mounting hardware from the coil.

g. Unsolder the two coil connections, one at the distributor and the other at the coil header.

h. After defective coil is removed from unit, remove defrost heaters and install on replacement coil.

i. Install coil assembly by reversing above steps.

j. Leak check connections per section 6.5. Evacuate the unit per section 6.6 and add refrigerant charge per section 6.7.

6.15.2 Evaporator Heater Replacement

a. Before servicing unit, make sure the unit circuit breakers (CB-1 & CB-2) and the start-stop switch (ST) are in the OFF position, and that the power plug and cable are disconnected.

b. Remove the lower access panel (Figure 1, page 5) by removing the T.I.R. locking device lockwire and mounting screws.

c. Determine which heater(s) need replacing by checking resistance on each heater. Refer to section 2.3, page 12 for heater resistance values.

d. Remove hold-down clamp securing heaters to coil.

e. Lift the bent end of the heater (with the opposite end down and away from coil). Move heater to the side enough to clear the heater end support and remove.

6.16 EVAPORATOR FAN AND MOTOR ASSEMBLY

The evaporator fans circulate air throughout the container by pulling air in the top of the unit. The air is forced through the evaporator coil where it is either heated or cooled and then discharged out the bottom of the refrigeration unit into the container. The fan motor bearings are factory lubricated and do not require additional grease. To remove the fan and motor assembly, do the following:

WARNING

Always turn OFF the unit circuit breaker (CB-1) and disconnect main power supply before working on moving parts.

a. Remove upper access panel (see Figure 1, page 5) by removing mounting bolts and T.I.R. locking device. Reach inside of unit and remove Ty-Rap securing wire harness loop.

b. Remove the two lower mounting bolts that secure the motor-fan assembly to the unit. Loosen the two upper bolts as the motor mount upper holes are slotted.

c. Remove motor, fan, and wiring from unit. Place fan motor and fan on a support. Remove the wiring and fan.

d. Lubricate fan motor shaft with a graphite-oil solution (Never-Seez). Apply thread sealer (Loctite H, brown in color) to the two fan set screws. Install fan on motor. Locate at dimension shown in Figure 43.

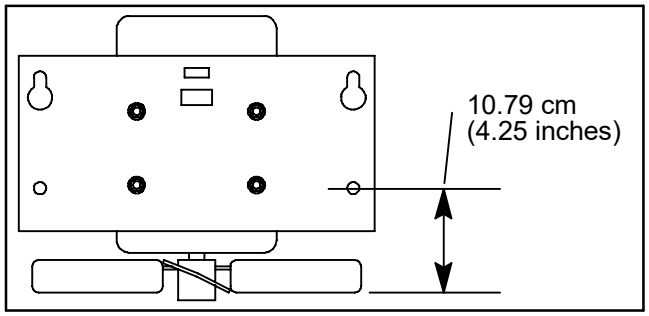


Figure 43. Evaporator Fan Locating Dimension

e. Connect wiring per applicable wiring diagram and install motor and fan assembly in unit. Apply power momentarily, to check fan rotation. (Refer to section 6.16, page 70 for rotation direction.) If fan spins backwards, check capacitors.

f. Replace access panel, making sure panel does not leak. Make sure that the T.I.R. locking device is lockwired.

6.17 EVAPORATOR FAN MOTOR CAPACITORS

Units are equipped with one of 2 types of evaporator fan motors, single, and dual capacitor. The evaporator fan motors are of the permanent-split capacitor type.

6.17.1 When To Check For A Defective Capacitor

a. Fan motor will not change speed. For example: in the conventional perishable mode, the motors should run in high speed. In the economy perishable mode they should switch speeds and in the frozen mode, the motors should run in low speed.

NOTE

The evaporator fan motors will always start in high speed.

b. Motor running in wrong direction (after checking for correct wiring application).

c. Motor will not start, and IP-EM's are not open.

6.17.2 Removing The Capacitor

WARNING

Make sure power to the unit is OFF and power plug disconnected before removing capacitor(s).

The capacitors are located on the motor and above the evaporator fan deck they may be removed by two methods:

1 *If container is empty*, open upper rear panel of the unit. The capacitor may be serviced after disconnecting power plug.

2 *If container is full,* turn the unit power OFF and disconnect power plug. Remove the evaporator fan motor access panel. (See Figure 1, page 5). For removal of the evaporator fan assembly, refer to section 6.16, page 70.

WARNING

With power OFF discharge the capacitor before disconnecting the circuit wiring.

6.17.3 Checking The Capacitor

If the capacitor is suspected of malfunction, you may choose to simply replace it. Direct replacement requires a capacitor of the same value. Two methods for checking capacitor function are:

1. Volt-ohmmeter set on RX 10,000 ohms.

Connect ohmmeter leads across the capacitor terminals and observe the meter needle. If the capacitor is good, the needle will make a rapid swing toward zero resistance and then gradually swing back toward a very high resistance reading.

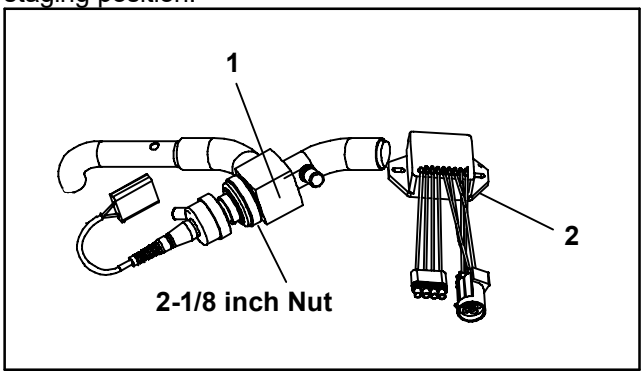
If the capacitor has failed open, the ohmmeter needle will not move when the meter probes touch the terminals. If the capacitor is shorted, the needle will swing to zero resistance position and stay there.

2. Capacitor analyzer:

The function of the analyzer is to read the microfarad value of a capacitor and to detect insulation breakdown under load conditions. The important advantages of a analyzer are its ability to locate capacitors that have failed to hold their microfarad ratings, or those that are breaking down internally during operation. It is also useful in identifying capacitors when their microfarad rating marks have become unreadable.

6.18 SUCTION MODULATION VALVE

On start up of the unit, the valve will reset to a known open position. This is accomplished by assuming the valve was fully open, driving it fully closed, resetting the percentage open to zero, then opening to a known 21% staging position.



1. Suction Modulation Valve (SMV)
2. Stepper Drive (SD)

Figure 44. Suction Modulation Valve (SMV)

6.18.1 Precheck Procedure

a. Check unit for abnormal operation.

b. Check charge. If refrigerant is low repair as required and again check operation.

c. If sufficient capacity cannot be maintained or unit is tripping excessively on high pressure switch (HPS) in high ambients, check coils and clean if required.

d. If capacity or control cannot be maintained turn unit OFF, then back ON. This will reset the valve in the event the controller lost communication with the valve, and may correct the problem.

NOTE

Carefully listen to the valve. During reset, the valve will make a ratcheting noise that may be heard or felt as it is attempting to close. If this can be heard or felt, it indicates that the controller and drive module are attempting to close the valve, and may serve as a quick indication that the drive module is in working order.

e. During the first few minutes of unit operation, compressor reliability enhancement logic (CREL) may be in effect. This places the valve at a 21% staging position and is sufficient to drive the temperature of the supply probe down several degrees during this interval.

f. After the CREL time-out has been met, the valve will start responding to the control logic and open or close, relative to the demand. Scrutinize the unit operation for a few minutes. While in pulldown the unit will open the SMV to a maximum discharge pressure of 325 psig in high ambient conditions, or as much as the current setting and control logic will allow. The current level should be high. A lower discharge pressure will be seen in lower ambient temperatures. Once the unit has reached set point, the SMV will go

into control mode. Both the discharge/suction pressures, and current draw will go significantly lower. Once below set point, the suction pressure should go into a vacuum within several minutes. Should the operation differ as mentioned, the SMV, drive module, or wiring may be faulty.

g. Check for correct wire location at the drive module (SD) and the environmental connector (EC). Make sure that the wires terminate in accordance with the wire markings (addresses).

h. Attach a manifold gauge set, refer to section 6.3, page 57. If the unit is operating in the perishable mode, proceed to step i. If the unit is operating in the frozen mode, proceed to step j.

i. **Perishable operation:** If the operation of the unit is in question, place the set point to approximately 6°C (11°F) less than the current box temperature, so the unit goes into pulldown. Run the unit for approximately one minute. Record readings on gauges and current draw. The current draw and pressures should go up. Place set point to 0.5°C (0.9°F) above current box temperature to fully modulate valve, and run for approximately one minute.

NOTE

The unit may shut off for a short time. Wait until the unit self starts and sufficient time has elapsed to cause the valve to fully modulate.

Record new gauge readings and current draw. The suction pressure should go into a vacuum and the current draw should have gone down. If little or no change to the suction pressure or current draw occurs, this is an indication of a malfunctioning SMV.

j. **Frozen operation:** In frozen mode the valve will tend to stay open as much as possible. Again, this is dependent upon current limit setting and control logic. Turn the unit OFF and ON, as in the perishable mode, and watch the gauges. The valve will run at 21% open if CREL logic is active, and will open to maximum allowable after this. Dependent on ambient conditions, there should be an increase in suction pressure and current draw as the valve opens, however, this may be difficult at times to fully determine.

k. If the unit still does not operate properly, stop unit, and proceed to the following step to check out the SMV system.

6.18.2 Checking The Stepper valve

a. Checking with ohmmeter

Disconnect the four pin connector to the stepper SMV. With a reliable digital ohmmeter, check the winding resistance. In normal ambient, the valve should have 72 to 84 ohms measured on the red/green (a-b terminals) and on the white/black (c-d terminals) leads. If an infinite or zero reading occurs, check connections and replace the motor. If near normal or normal reading occurs, proceed to step 6.18.4 to check out the controller.

b. Checking with SMA-12 portable stepper drive tester

The SMA-12 portable stepper drive tester (Carrier Transicold P/N 07-00375-00) is a battery operated stepper drive which will open and close the SMV, which allows a more thorough check of the motor.

To check operation:

1. Stop the unit, disconnect the four pin connector from the stepper module to the valve (see Figure 44) and attach the SMA-12 stepper drive to the connector going to the valve.
2. Set the SMA-12 pulse per second (PPS) to one PPS and either open or close valve. Each LED should light sequentially until all four are lit. Any LED failing to light indicates an open on that leg which indicates a poor connection or an open coil. Repair or replace as required to achieve proper operation.
3. Restart unit, set the step rate to 200 PPS on SMA-12 for the valve, and close stepper valve while watching the suction gauge. Within one minute the suction pressure will go into a vacuum. This is an indication that the valve is moving.
4. If no change in suction pressure is detected, check for resistance (refer to step 6.18.2), and check connections for proper continuity and retest. If the valve is functioning and all connections and motor resistance are good, check the drive module. (Refer to step 6.18.3)
5. If the valve is determined as faulty after completing the above steps, perform a low side pump down. Remove valve powerhead assembly, and replace with a NEW valve powerhead assembly, torque nut to 35 ft-lb, evacuate low side, and open all service valves.

⚠ CAUTION

DO NOT disassemble piston from NEW suction modulating valve powerhead assembly. Doing so may result in damage to piston.

6.18.3 Checking The Drive Module

a. Turn unit OFF.

b. Disconnect the four pin connector to the SMV.

c. With voltmeter set to read 24 volts AC, attach the positive lead to the drive module outlet pin “A” (wire 1A) of the four pin connector and the negative lead to the “B” pin (wire 1B).

d. Turn ON unit, and watch the volt meter. After a short delay, the reading should rise to approximately 12 volts.

e. Repeat for pins “C” and “D” (wires 2 A and 2 B).

f. If only one set of pins reads a voltage, check connections and retest.

g. If the retest reads out the same, the drive module or controller is faulty.

h. If no voltage is present in any step, the output from the controller to the drive module may be faulty, and will require checking the connections and wires from the controller to the drive module. Refer to step 6.18.4, page 72.

i. To replace the drive module, disconnect all connectors, unscrew from mounting, and replace with a NEW drive module in reverse order.

6.18.4 Checking The Controller

a. Turn the unit OFF.

b. Disconnect the six pin connector to the stepper drive from the controller.

c. With the voltmeter set to read 50 volts DC, attach the positive lead to outlet pin “A” of the six pin connector, and the negative lead to pin “B” or TP-9 of the controller.

d. Turn ON the unit for 40 seconds, and watch the voltmeter. There should be approximately 24 to 32 VDC shown on pin “A”.

e. There should be zero volts on pin “B”.

f. After a short delay, the reading should rise to approximately 24 to 32 VDC on pin “E”.

g. Pins “C” and “D” will have zero to 5 volts transistor logic (TTL) signals present, however, this can only be checked with the connector assembled as this is an open collector type circuit.

By checking the outputs on “A,” “B,” and “E” it can be verified that the controller is supplying power to the drive module. To be thorough, and if it is desired, the signals on pins “C” and “D” can be checked as follows:

1. Install a jumper assembly (Carrier part number 07−00408−00) to connect the drive module and controller connectors as shown in Figure 45.
2. Connect the positive lead of the voltmeter to test connector socket “C” and negative lead to socket “B,” and run as before by resetting unit.
3. Repeat for sockets “D” and “B.”

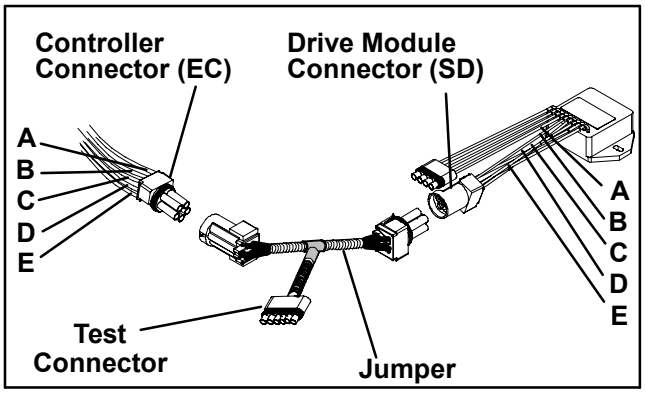


Figure 45. Jumper Assembly

There should be approximately five volts DC on sockets “C” and “D” (S1 and S2) when measured as above. If not the connections or controller is faulty.

If any of these pins are not consistent, the connections or controller is suspect. Check and replace as required.

6.18.5 Emergency Repair Procedures:

In the event that the SMV system has a failure and replacement components are not readily available the system can be by−passed by removing the valve piston. to remove the piston, do the following:

a. Perform a low side pump down. Refer to section 6.4, page 59.

b. Remove SMV powerhead by loosening the 2-1/8 inch diameter nut (see Figure 45) to relieve any pressure and then , sliding the powerhead out.

c. Remove the piston by loosening the Allen screw and removing the piston and screw.

d. Install the powerhead assembly (without the piston), torque to 35 to 40 foot-lbs.

e. Open all valves.

f. Start the unit.

g. Adjust the suction service valve so that the approximate temperature OR current limit is maintained. For perishable loads, it is recommended that the adjustment be made so that the available capacity is slightly larger than the load, the unit will cycle OFF and ON.

h. Once repair parts become available, repair as required.

6.19 DISCHARGE PRESSURE REGULATOR VALVE CHECK PROCEDURE

The discharge pressure regulator valve (DPRV) is designed to maintain a minimal level of pressure within the compressor. Refer to paragraph 2.2, page 11, for valve setting.

The following procedure can be used to perform a functional check:

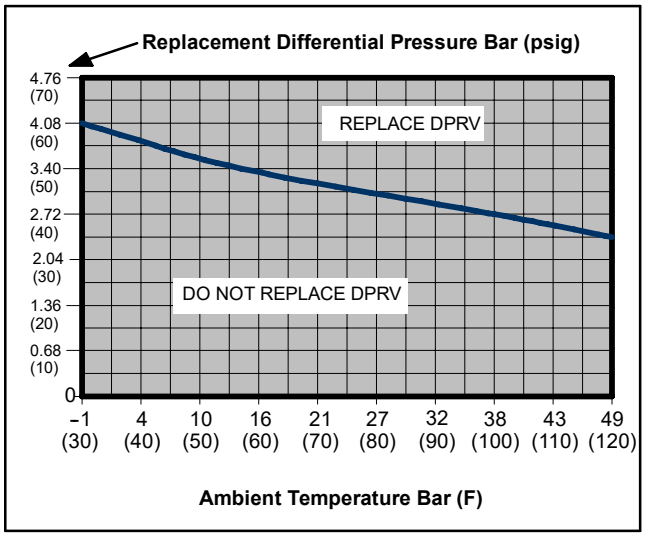
a. Install a high pressure gauge at the discharge service valve.

b. Install another high pressure gauge at the liquid line service valve.

c. Run unit with -18 C (0 F) set point.

d. After five minutes, read both gauges and subtract the liquid line pressure from the discharge pressure. This is the actual differential pressure.

e. Using the ambient temperature and the chart below, determine the replacement differential pressure.



DPRV Replacement Value Chart

NOTE

1. This test should not be run below -1.1 C (30 F) or above 49 C (120 F). If the actual differential pressure is close to the replacement differential pressure, it is recommended that the readings be taken several times at two minutes intervals.

2. If valve cap is found to be leaking it may be replaced using cap & O-ring (Carrier Part Number 40-50024-00).

6.20 AUTOTRANSFORMER

If the unit does not start, check the following:

a. Make sure the 460 vac (yellow) power cable is plugged into the receptacle (item 3, Figure 22, page 57) and locked in place.

b. Make sure that circuit breakers CB-1 and CB-2 are in the “ON” position. If the circuit breakers do not hold in, check voltage supply.

c. There is no internal protector for this transformer design, therefore, no checking of the internal protector is required.

d. Using a voltmeter, and with the primary supply circuit ON, check the primary (input) voltage (460 vac). Next, check the secondary (output) voltage (230 vac). The transformer is defective if output voltage is not available.

6.21 REFRIGERATION CONTROLLER

6.21.1 Handling Controller

⚠ CAUTION

Do not remove wire harnesses from controller unless you are grounded to the unit frame with a static safe wrist strap.

⚠ CAUTION

Unplug all controller connectors before performing arc welding on any part of the container.

The guidelines and cautions provided herein should be followed when handling the Controller/DataCORDER module. These precautions and procedures should be implemented when replacing the module, when doing any arc welding on the unit, or when service to the refrigeration unit requires handling and removal of the controller.

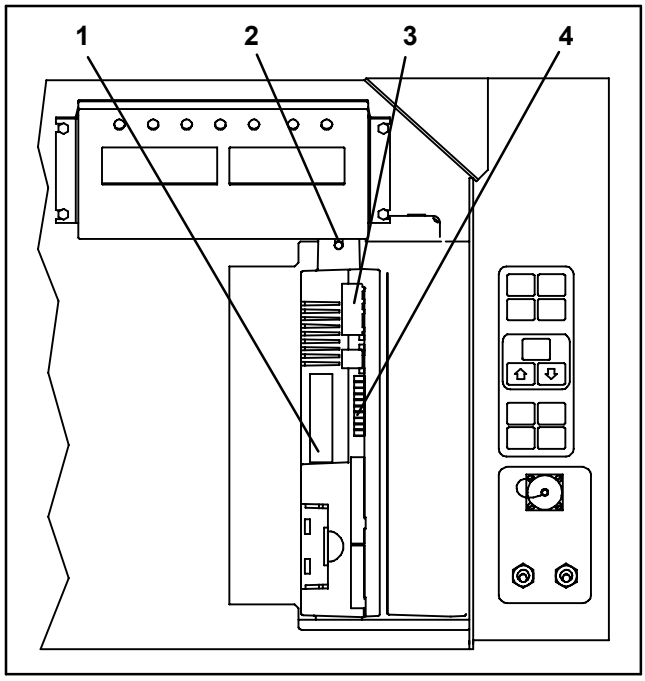
a. Obtain a grounding wrist strap (Carrier Transicold part number 07-00304–00)and a static dissipation mat (Carrier Transicold part number 07-00304–00. The wrist strap, when properly grounded, will dissipate any potential buildup on the body. The dissipation mat will provide a static-free work surface on which to place and/or service the controller.

b. Disconnect and secure power to the unit.

c. Place strap on wrist and attach the ground end to any exposed unpainted metal area on the refrigeration unit frame (bolts, screws, etc.).

d. Carefully remove the Controller. Do not touch any of the electrical connections if possible. Place the module on the static mat.

e. The strap should be worn during any service work on the controller, even when it is placed on the mat.



1. Controller Software Programming Port
2. Mounting Screw
3. Controller
4. Test Points

Figure 46. Controller Section of the Control Box

6.21.2 Controller Trouble-Shooting

A group of test points (TP, see Figure 46) are provided on the controller for trouble-shooting electrical circuits (see schematic diagram, section 13). A description of the test points follows:

NOTE

Use a digital voltmeter to measure ac voltage between TP’s and ground (TP9), except for TP8.

TP2

This test point enables the user to check if the internal protector for the compressor motor (IP-CP) or high pressure switch is open.

TP3

This test point enables the user to check if the water pressure switch (WP) contact is open or closed.

TP 4

This test point enables the user to check if the internal protector for the condenser fan motor(IP-CM) is open or closed.

TP 5

This test point enables the user to check if the internal protectors for the evaporator fan motors (IP-EM1 or IP-EM2) are open or closed.

TP 6

This test point enables the user to check if the controller water tank heater relay (TQ) is open or closed

TP 7

This test point is not used in this application.

TP 8

This test point is not applicable to the units covered herein.

TP 9

This test point is the chassis (unit frame) ground connection.

TP 10

This test point enables the user to check if the heat termination thermostat (HTT) contact is open or closed.

6.21.3 Controller Programming Procedure

To load new software into the module, the programming card is inserted into the programming/software port.

⚠ CAUTION

The unit must be OFF whenever a programming card is inserted or removed from the controller programming port.

⚠ CAUTION

All 69NT40-511-3XX units must use software revision 5108 or higher to enable stepper motor. Optional features may require higher software revision levels to enable functionality.

NOTE

The metal door (pins) on the programming card must be facing to the left when inserting ML2/2i cards. ML3 cards (PCMICA) may be used in ML2/ML2i controllers using a PC Card Adapter (Part Number 07–00461–00). The PC Adapter is a printed circuit board that enables use of the ML3 cards in ML2/ML2i controllers.

a. Procedure for loading Operational Software

1. Turn unit OFF, via start-stop switch (ST).
2. Insert the programming card for Operational Software into the programming/software port. (See Figure 46)
3. Turn unit ON, via start-stop switch (ST).
4. The Display module will alternate back and forth between the messages “rEV XXXX” and “Press EntR”. (If a defective card is being used the Display will blink the message “bAd CArd”. Turn start-stop switch OFF and remove the card.)
5. Press the ENTER key on the keypad.
6. The Display will show the message “Pro SoFt.” This message will last for up to one minute.
7. The Display module will read “Pro donE” when the software loading has loaded. (If a problem occurs while loading the software: the Display will blink the message “Pro FAIL” or “bad 12V”. Turn start-stop switch OFF and remove the card.)
8. Turn unit OFF, via start-stop switch (ST).
9. Remove the programming card from the programming/software port and return the unit to normal operation by placing the start-stop switch in the ON position.

b. Procedure for loading Configuration Software

1. Turn unit OFF using start-stop switch (ST).
2. Insert the programming card, for Configuration Software, into the programming/software port. (See Figure 46.)
3. Turn unit ON using start-stop switch (ST).
4. The Display module will show “489” on the left LCD display and “###” on the right . The “###” will be the dash number for a given unit model number, use the UP or DOWN ARROW key to scroll through the list to obtain the proper model dash number. For example, to program a model number 69NT40-489-100, press the UP or DOWN ARROW key until the display shows “489” on the left display and “100” on the right. (If a defective card is being used, the Display will blink the message “bAd CArd”. Turn start-stop switch OFF and remove the card.)
5. Press the ENTER key on the keypad.
6. When the software loading has successfully completed, the Display will show the message “EEPrM donE.” (If a problem occurs while loading the software, the Display will blink the message “Pro FAIL” or “bad 12V.” Turn start-stop switch OFF and remove the card.)
7. Turn unit OFF using start-stop switch (ST).
8. Remove the programming card from the programming/software port and return the unit to normal operation by placing the start-stop switch in the ON position.

6.21.4 Removing and Installing the Controller

a. Removal:

1. Disconnect all front wire harness connectors (MA, MB, MC, KA & KB) and move wiring out of way.
2 The lower controller mounting is slotted, loosen the top mounting screw (see Figure 46) and lift up and out.
3 Disconnect the two back connectors (EC) and remove module.
4 When removing the replacement controller from its packaging , note how it is packaged. When returning the old controller for service, place it in the packaging in the same manner as the replacement. The packaging has been designed to protect the controller from both physical and electrostatic discharge damage during storage and transit.

b.Installation:

Install the module by reversing the removal steps.

Torque values for mounting screws (item 2, see Figure 46) are 0.23 mkg (20 inch-pounds). Torque value for the connectors (MA, MB, MC, KA & KB) is 0.12 mkg (10 inch-pounds).

6.21.5 Battery Replacement

If required, use tool 07-00418-00.

6.22 TEMPERATURE SENSOR SERVICE

Procedures for service of the Return Recorder, Return Temperature, Supply Recorder, Supply Temperature, Ambient, Defrost Temperature, Compressor Discharge and Compressor Suction temperature sensors are provided in the following sub paragraphs.

6.22.1 Sensor Checkout Procedure

To check a sensor reading, do the following:

a. Remove the sensor and place in a 0°C (32°F) ice-water bath. The ice-water bath is prepared by filling an

insulated container (of sufficient size to completely immerse bulb) with ice cubes or chipped ice, then filling voids between ice with water and agitating until mixture reaches 0°C (32°F) measured on a laboratory thermometer.

b. Start unit and check sensor reading on the control panel. The reading should be 0°C (32°F). If the reading is correct, reinstall sensor; if it is not, continue with the following.

c. Turn unit OFF and disconnect power supply.

d. Refer to section 6.21 and remove controller to gain access to the sensor plugs.

e. Using the plug connector marked "EC", that is connected to the back of the controller, locate the sensor wires (RRS, RTS, SRS, STS, AMBS, DTS, CPDS OR CPSS as required). Follow those wires to the connector and using the pins of the plug, measure the resistance. Values are provided in Table 12, page 76.

Table 12. Sensor Temperature/Resistance Chart

Temperature Centigrade	Temperature Fahrenheit	Resistance (Ohms)
RRS, RTS, SRS and STS:		
0	32	32,650 ± 91
25	77	10,000 ± 50
AMBS and DTS		
0	32	32,650 + 1720 − 1620
25	77	10,000 + 450 − 430

Due to the variations and inaccuracies in ohmmeters, thermometers or other test equipment, a reading within 2% of the chart value would indicate a good sensor. If a sensor is defective, the resistance reading will usually be much higher or lower than the resistance values given.

6.22.2 Sensor Replacement

a. Turn unit power OFF and disconnect power supply.

b. For two wire sensors, cut cable 5 cm (2 inches) from shoulder of defective sensor and discard the defective sensor only. For three wire sensors cut at 23 cm (9 inches). Slide the cap and grommet off well mounted sensor and save for possible reuse. **Do not cut the grommet.**

c. If required, prepare the replacement sensor by cutting sensor wire(s) back 40 mm (1-1/2 inch). For three wire sensors the black wire should be cut at the middle length and the red/white wire cut to the shorter length. (See Figure 47)

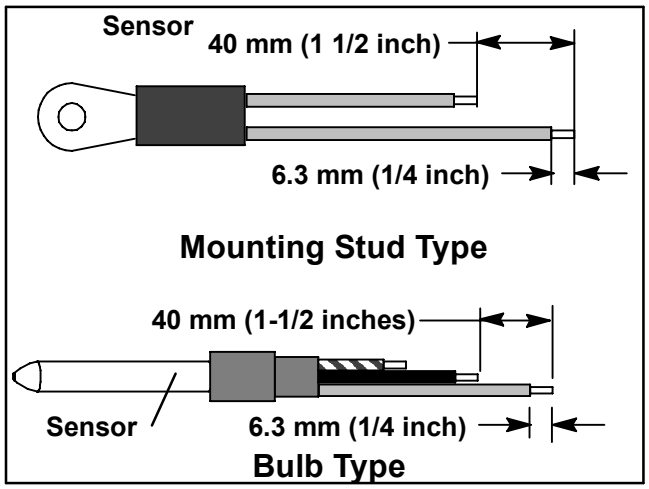


Figure 47. Sensor Types

d. Prepare the cables by cutting wires to the opposite of the sensor. (See Figure 48.)
When installing a two wire sensor, cut one (or opposite color) wire of existing two wire cable 40 mm (1-1/2 inch) shorter than the other wire.
When replacing two single sensors with a combination (three wire) sensor, the black wires of the cables should be cut to the same length and the red wire of one cable cut to the shorter length.
When replacing an original three wire sensor, cut the black wire to the middle length and the red wire to the shorter length.

e. If replacing a two wire sensor with a three wire sensor, do not strip insulation on the red/white wire. Otherwise, strip back insulation on all wiring 6.3 mm (1/4 inch).

f. Slide a large piece of heat shrink tubing over the cable, and place small pieces of heat shrink tubing, one over each wire, before adding crimp fittings as shown in Figure 48.

g. If required, slide the cap and grommet assembly onto the replacement sensor. If the replacement sensor is of a larger diameter than the original, a different grommet may be required.

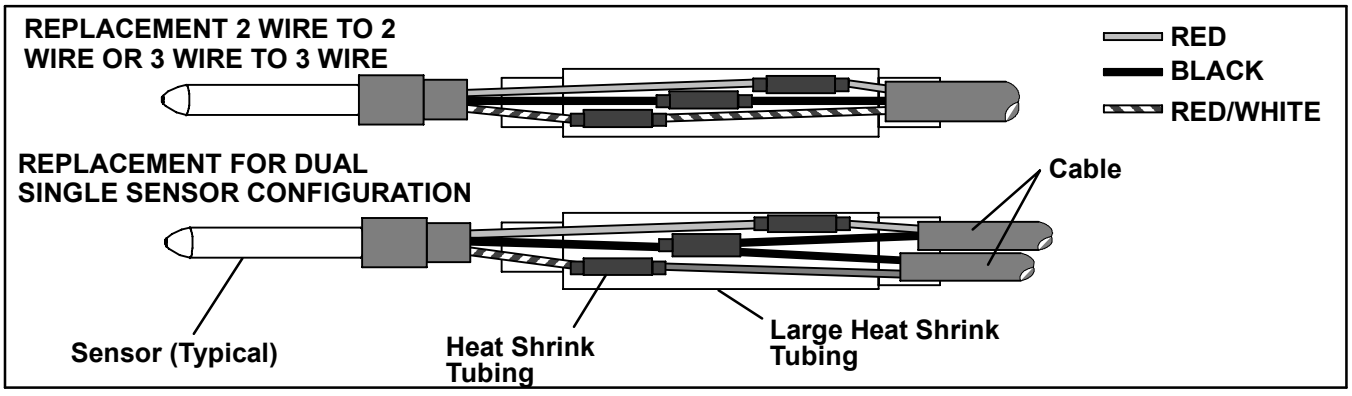


Figure 48. Sensor and Cable Splice

h. Slip crimp fittings over dressed wires (keeping wire colors together). Make sure wires are pushed into crimp fittings as far as possible and crimp with crimping tool. Cap off unused red/white wire if replacing a two wire sensor with a three wire sensor

i. Solder spliced wires with a 60% tin and 40% lead Rosincore solder.

j. Slide heat shrink tubing over splice so that ends of tubing cover both ends of crimp as shown in Figure 48.

k. Heat tubing to shrink over splice. Make sure all seams are sealed tightly against the wiring to prevent moisture seepage.

l. Slide large heat shrink tubing over both splices and shrink.

⚠ CAUTION

Do not allow moisture to enter wire splice area as this may affect the sensor resistance.

m. Reinstall sensor, refer to section 6.22.3, page 77.

NOTE

The P5 Pre-Trip test must be run to inactivate probe alarms (refer to section 4.8, page 47).

6.22.3 Sensor Re-Installation

a. Sensors STS/SRS

To properly position a supply sensor, the sensor must be fully inserted into the probe holder. This positioning will give the sensor the optimum amount of exposure to the supply air stream, and will allow the Controller to operate correctly. Insufficient probe insertion into the probe holder will result in poor temperature control due to the lack of air flow over the sensor.

It is also necessary to ensure that the probe tip does not contact the evaporator back panel. The design minimum clearance of 6 mm (1/4 inch) should be maintained (see Figure 49).

b. Sensor RTS/RRS

Reinstall the return sensor as shown in Figure 50, page 77. For proper placement of the return sensor, be sure to position the seal section of the sensor against the the side of the mounting clamp.

c. Sensor DTS

The DTS sensor must have insulating material placed completely over the sensor to insure the coil metal temperature is sensed.

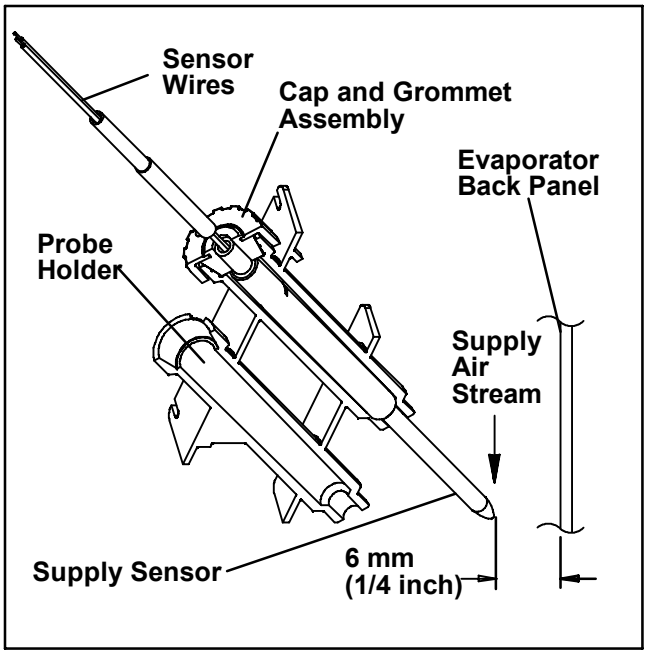


Figure 49. Supply Sensor Positioning

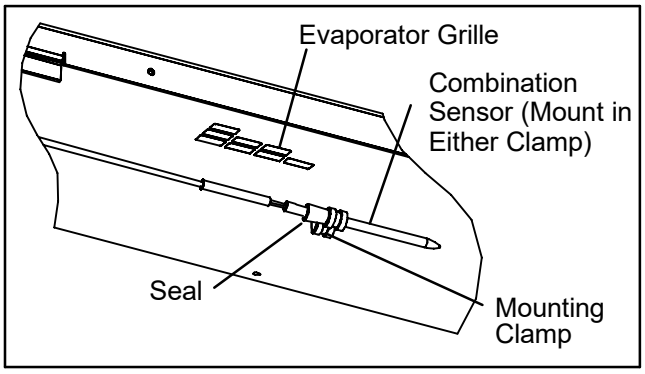


Figure 50. Return Sensor Positioning

6.23 MAINTENANCE OF PAINTED SURFACES

The refrigeration unit is protected by a special paint system against the corrosive atmosphere in which it normally operates. However, should the paint system be damaged, the base metal can corrode. In order to protect the refrigeration unit from the highly corrosive sea atmosphere, or if the protective paint system is scratched or damaged, clean area to bare metal using a wire brush, emery paper or equivalent cleaning method. Immediately following cleaning, spray or brush on zinc-rich primer. After the primer has dried, spray or brush on finish coat of paint to match original unit color.

6.24 COMPOSITE CONTROL BOX REPAIRS

6.24.1 Introduction

This procedure provides instructions for repair of the Carrier Transicold composite control box. Damage to the control box may be in the form of a chip or hole, a crack, a damaged thread insert or damage to the door hinge inserts. Generally, the object of the repair must be to ensure sufficient strength is restored to the damaged area and the repair must keep the box water tight. Information on repair kits and repair procedures for each type of damage is provided in the following paragraphs. Ambient temperature must be above 7°C (45°F) for proper curing of epoxy repairs.

6.24.2 Cracks

Cracks in the control box are repaired using a fiberglass patch over the damaged area. Materials required are included in the Fiberglass Patch Kit supplied with Crack Repair Kit, Carrier Transicold part number 76-00724-00SV (refer to Table 13, page 79).

a. The surface must be clean and dry. Roughen the surface with sandpaper to ensure a good bond.

b. Cut the fiberglass cloth to allow a 25mm (1–inch) overlap around the area to be repaired.

c. Stretch and position the cloth over the area to be repaired and secure it with masking tape.

d. Make up sufficient epoxy glue to cover the cloth by mixing equal parts of resin and hardener. Saturate the cloth with the epoxy glue, spreading evenly.

e. Remove the tape and overlap the edge of the cloth approximately 6 to 12 mm (1/4" to 1/2") with glue.

f. Epoxy will dry in 45–60 minutes. When completely cured (12 hours), use sandpaper to smooth edges of the patch.

6.24.3 Chips And Holes

Chips and holes in the control box are repaired using a piece of aluminum or stainless steel to cover the damaged area. The material can be cut to suit and riveted in place. An adhesive sealant must be used to make the repair watertight. The adhesive sealant (Sikaflex 221) is included in Crack Repair Kit Carrier Transicold part number 76-00724-00SV (refer to Table 13, page 79). **Do not use an acetone based silicone sealant** (Which can be identified by a vinegar–like odor).

a. To make up the patch, cut a piece of aluminum or stainless steel so that it will overlap the damaged area by at least 40 mm (1 1/2") on all sides.

b. Choose rivet locations and drill the rivet holes in the corresponding locations on the control box and patch piece.

c. Apply the adhesive sealant around the damaged area to form a seal between the control box and the patch piece.

d. Rivet the patch piece in place.

e. File smooth any rough edges (including rivets) that may come into contact with wires.

6.24.4 Inserts

The threaded brass inserts that are molded into the control box will need to be replaced if the threads become stripped, or if the insert becomes loose. The inserts and epoxy are contained in repair kit, Carrier Transicold part number 76-50084-00 (see Table 14, page 79). There are 6 different inserts used in the control box. Refer to Figure 52 for the locations of the various inserts.

NOTE

An epoxy application gun is also needed, Carrier Transicold part number 07–00391–00.

The damaged insert must be removed from the control box. Table 15 identifies the drill size and drill depth to be used for each insert. A stop ring should be used on the drill bit to limit the depth.

a. Center the drill bit on the insert and drill to the prescribed depth.

b. Remove the chips from the drilled hole.

c. Mix the two component epoxy and fill the hole 1/2 way to the top with epoxy.

d. Press the insert in until it is flush with the surface.

e. Wipe away any excess epoxy. The part is ready for service after the bond material has hardened and is tack free (approximately 20 minutes)

6.24.5 Door Hinge Inserts

If the door hinges have been pulled from the control box drill and reinstall the hinge as shown in Figure 51, page 78 and described in the following steps:

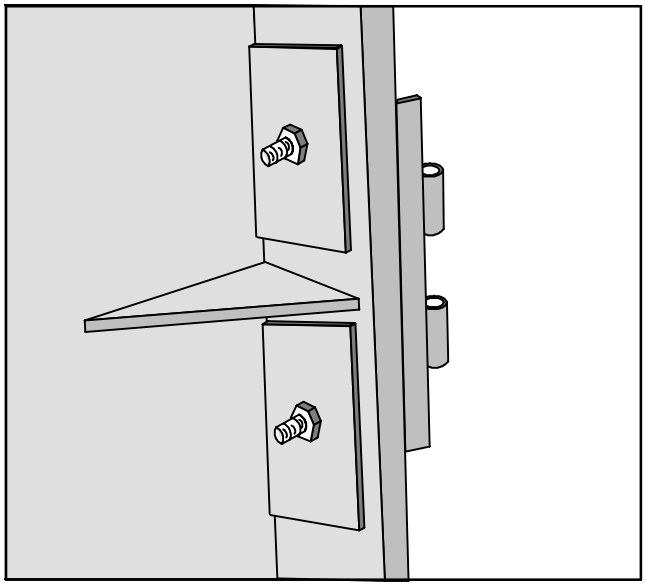


Figure 51. Door Hinge Repair

Materials needed:

1. Cut two square pieces of 3 mm thick (1/8 inch) aluminum or stainless steel approximately 40 mm (1 5/8") square. These squares will serve as backing plates.
2. Two nuts, bolts (10 – 24 x 1") and washers for each insert that needs repair.

a. Drill a 1/4" hole in the center of each square backing plate.

b. Pass the bolts through the bolts holes in the door hinge, then through the control box at the location where the hinge insert pulled out.

c. From inside the control box, slide the backing plates over the bolts and secure in place with the washers and nuts.

Table 13. Crack, Chip & Hole Repair Kit

ITEM	DESCRIPTION	PART NUMBER	Qty
1	Crack Repair Kit – Includes	76–00724–00SV	1
2	. . . Fiberglass Patch Kit (Loctite FK–98 or 80265)	76–00724–00Z	10
3	. . . Sikaflex 221 Adhesive Sealant (Sikaflex 232–361)	02–00067–02Z	10
4	. . . Instruction Sheet	98–02339–00	10

Table 14. Insert Repair Kit

ITEM	DESCRIPTION	PART NUMBER	Qty
1	Insert Repair Kit – Includes	76–50084–00	1
2	. . . Insert - 17.53 x 9.91 mm (..690 x .390 in) 1/4–20 Threads	34–06231–01	10
3	. . . Insert - 15.88 x 6.35 mm (.625 x .250 in) 10-24 Threads	34–06231–03	10
4	. . . Insert - 25.15 x 7.54 mm (.990 x .297 in) 10-24 Threads	34–06231–04	10
5	. . . Insert - 10.16 x 9.53 mm (.400 x .375 in) 10-24 Threads	34–06231–05	10
6	. . . Insert - 12.7 x 9.91 mm (.5 x .390 in) 1/4–20 Threads	34–06231–06	10
7	. . . Insert - 9.53 x 6.76 mm (.375 x .266 in) 10-24 Threads	34–06231–07	10
8	. . . Durabond Epoxy E20–HP (Loctite 29314)	02–0082–00	1
9	. . . Static Mixing Tube (Loctite 983440)	07–00390–00	1
10	. . . Instruction Sheet	98–02338–00	1

Note: Insert repair procedures require use of an Application Gun, Carrier part number 07–00391–00 (Loctite 983435)

Table 15. Drill Information

Item	Insert part number	Drill size and depth
1	34- 06231- 01	10.3 mm x 17.8 mm deep (.404 in. x .700 in. deep)
2	34- 06231- 03	6.8 mm x 16.3 mm deep (.266 in. x .640 in. deep)
3	34- 06231- 04	7.9 mm x 25.4 mm deep (.3125 in. x 1.0 in. deep)
4	34- 06231- 05	6.9 mm (.270 in.) Drill completely through.
5	34- 06231- 06	10.3 mm (.404 in.) Drill completely through.
6	34- 06231- 07	6.8 mm (.266 in.) Drill completely through.

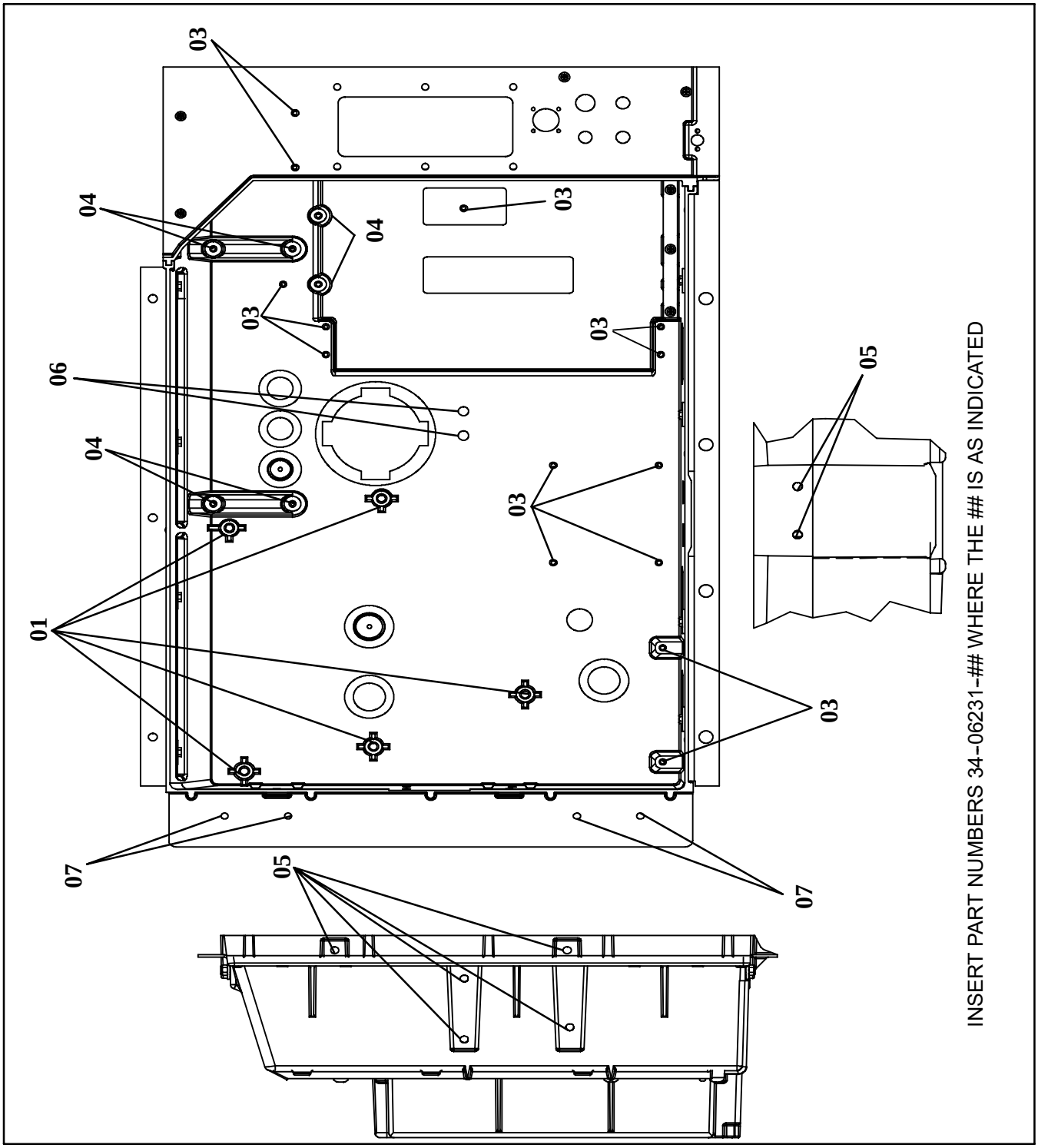


Figure 52. Insert Locations

6.25 COMMUNICATIONS INTERFACE MODULE INSTALLATION

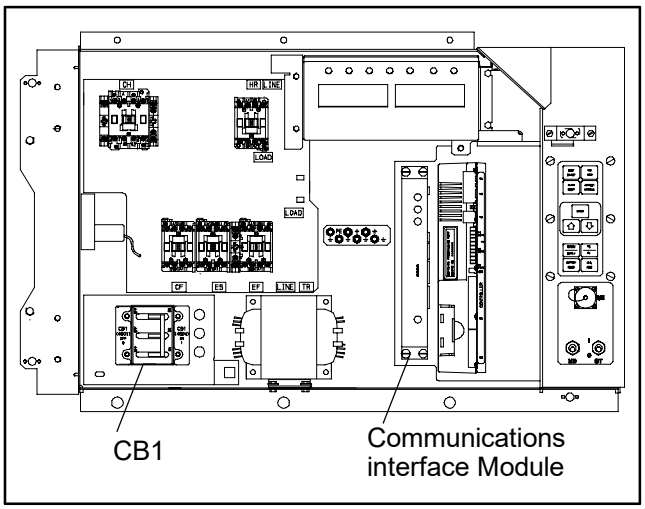


Figure 53. Communications Interface Installation

Units with communication interface module provision have the required wiring installed. The provision wiring kit (part number 76–00685–00), includes three pre–addressed wires installed between the circuit breaker and communication interface module locations. These wires are to be connected to the module and circuit breaker to allow the module to communicate over the power system. To install the module, do the following:

WARNING

THE UNIT POWER PLUG MUST BE DISCONNECTED TO REMOVE POWER FROM CIRCUIT BREAKER CB1

a.. CB1 is connected to the power system, see wiring schematic. Ensure that the unit power is off AND that the unit power plug is disconnected.

b.. Open control box, see and remove low voltage shield. Open high voltage shield.

c.. Remove the circuit breaker panel, with circuit breaker, from the control box.

d.. Locate, wires CB21/CIA3, CB22/CIA5 and CB23/CIA7 that have been tied back in the wire harness. Remove the protective heat shrink from the ends of the wires.

e.. Attach the three wires as addressed to the LOAD side of the circuit breaker.

f.. Refit the circuit breaker panel.

g. Fit the new RMU into the unit.

h. Remove plugs CIA, CIB and CID from the wiring harness and attach to the module.

.i. Replace the low voltage shield.

Table 16. Recommended Bolt Torque Values

BOLT DIA.	THREADS	TORQUE	MKG
FREE SPINNING			
#4	40	5.2 in-lbs	0.05
#6	32	9.6 in-lbs	0.11
#8	32	20 in-lbs	0.23
#10	24	23 in-lbs	0.26
1/4	20	75 in-lbs	0.86
5/16	18	11 ft-lbs	1.52
3/8	16	20 ft-lbs	2.76
7/16	14	31 ft-lbs	4.28
1/2	13	43 ft-lbs	5.94
9/16	12	57 ft-lbs	7.88
5/8	11	92 ft-lbs	12.72
3/4	10	124 ft-lbs	17.14
NONFREE SPINNING (LOCKNUTS ETC.)			
1/4	20	82.5 in-lbs	0.95
5/16	18	145.2 in-lbs	1.67
3/8	16	22.0 ft-lbs	3.04
7/16	14	34.1 ft-lbs	4.71
1/2	13	47.3 ft-lbs	6.54
9/16	12	62.7 ft-lbs	8.67
5/8	11	101.2 ft-lbs	13.99
3/4	10	136.4 ft-lbs	18.86

6.26 POWER FACTOR CORRECTOR CAPACITORS (PFC)

The power factor corrector capacitors are of the permanent-split capacitor type. There are a total of three capacitors with discharge resistors enclosed in a single case.

a. When to check for a defective capacitor

The capacitors assist in correcting current draw by the compressor. If one or more of the capacitors is faulty, there will be an imbalance in current. In addition, the power consumption of the unit will increase.

b. Removing the capacitor

⚠ WARNING

Make sure power to the unit is OFF and power plug disconnected before removing capacitor(s).

⚠ WARNING

Before removing the capacitors the terminals must be checked for voltage with a multimeter. The discharge resistors installed on the unit (capacitors) should bring the voltage to a safe level in a minute. However, there may be a broken resistor that retains voltage for a longer period, it is highly recommended to wait 15 minutes and to check for voltage.

1. The capacitors are located on the unit sidewall above the evaporator fan deck, and may be removed by two methods:
   (a.) *If container is empty*, open upper rear panel of the unit. The capacitors will be on the right and may be serviced after disconnecting power plug.
   (b.) *If container is full,* turn the unit power OFF and disconnect power plug. Remove the upper fresh air makeup vent.

WARNING

With power OFF discharge the capacitor and disconnect the circuit wiring.

c. Checking the capacitor

If the capacitor is suspected of malfunction, you may choose to simply replace it. Direct replacement requires a capacitor of the same value. Two methods for checking capacitor function are:

1. Volt-ohmmeter set on RX 10,000 ohms.

Connect ohmmeter leads across the capacitor terminals and observe the meter needle. If the capacitor is good, the needle will make a rapid swing toward zero resistance and then gradually swing back toward a very high resistance reading. The reading should read about 330,000 ohms (for a good capacitor) due to the discharge resistors.

If the capacitor has failed open, the ohmmeter needle will not move when the meter probes touch the terminals. If the capacitor is shorted, the needle will swing to zero resistance position and stay there.

2. Capacitor analyzer:

The function of the analyzer is to read the microfarad value of a capacitor and to detect insulation breakdown under load conditions. The important advantages of a analyzer are its ability to locate capacitors that have failed to hold their microfarad ratings, or those that are breaking down internally during operation. It is also useful in identifying capacitors when their microfarad rating marks have become unreadable.

Table 17. Wear Limits For Compressors

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	inches	mm	inches	mm	inches	mm
MAIN BEARING						
Main Bearing Diameter	1.6268	41.3207			.0020	0.0508
Main Bearing Journal Diameter			1.6233	41.2318	.0020	0.0508
PUMP END						
Main Bearing Diameter	1.3760	34.9504			.0020	0.0508
Main Bearing Journal Diameter			1.3735	34.8869	.0020	0.0508
CONNECTING ROD	1.3768	34.9707			.0020	0.0508
Piston Pin Bearing			0.6878	17.4701	.0010	0.0254
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw	1.072	27.2288	1.070	27.1780		
THRUST WASHER (Thickness)	0.154	3.9116	0.1520	03.8608	.0250	0.6350
CYLINDERS						
Bore	2.0010	50.8254			.0020	0.0508
Piston (Diameter)			1.9860	50.4444	.0020	0.0508
Piston Pin (Diameter)			0.6873	17.4574	.0010	0.0254
Piston Ring Gap	0.013	00.3302	0.0050	00.1270	.0250	0.6350
Piston Ring Side Clearance	0.002	00.0508	0.0010	00.0254	.0020	0.0508

Table 18. Compressor Torque Values

SIZE DIAMETER (inches)	THREADS PER INCH	TORQUE RANGE		USAGE
		ft-lb	mkg	
1/16	27 (pipe)	8 – 12	1.11 – 1.66	Pipe Plug – Crankshaft
1/8	20 (pipe)	6 – 10	0.83 – 1.38	Oil Return Check Valve – Crankcase
1/4	20 (pipe)	20 – 25	2.77 – 3.46	Pipe Plug – Gauge Connection
1/4	20	10 – 12	1.38 – 1.66	Connecting Rod Capscrew
1/4	28	12 – 15	1.66 – 2.07	Baffle Plate – Crankcase
		12 – 16	1.66 – 2.21	Side Shield
		6 – 10	0.83 – 1.38	Oil Pump Drive Segment
		12 – 16	1.66 – 2.21	Unloader Valve
5/16	18	16 – 20	2.21 – 2.77	Cover Plate – Plate End
				Bearing Head
				Terminal Block Cap Screws
		20 – 30	2.77 – 4.15	Suction Valve
				Discharge Valve
3/8	16	40 – 50	5.53 – 6.92	Pump End Bearing Head
				Bottom Plate – Crankcase Compressor Foot
				Cylinder Head
7/16	14	55 – 60	7.61 – 8.30	Motor End Cover – Crankcase
5/8	11	25 – 30	3.46 – 4.15	Crankshaft
5/8	18	60 – 75	8.30 – 10.37	Oil Bypass Plug – Crankcase
#10	32	4 – 6	0.55 – 0.83	Oil Pump Drive Segment
1-1/2	18 NEF	35 – 45	4.84 – 6.22	Oil Level Sight Glass

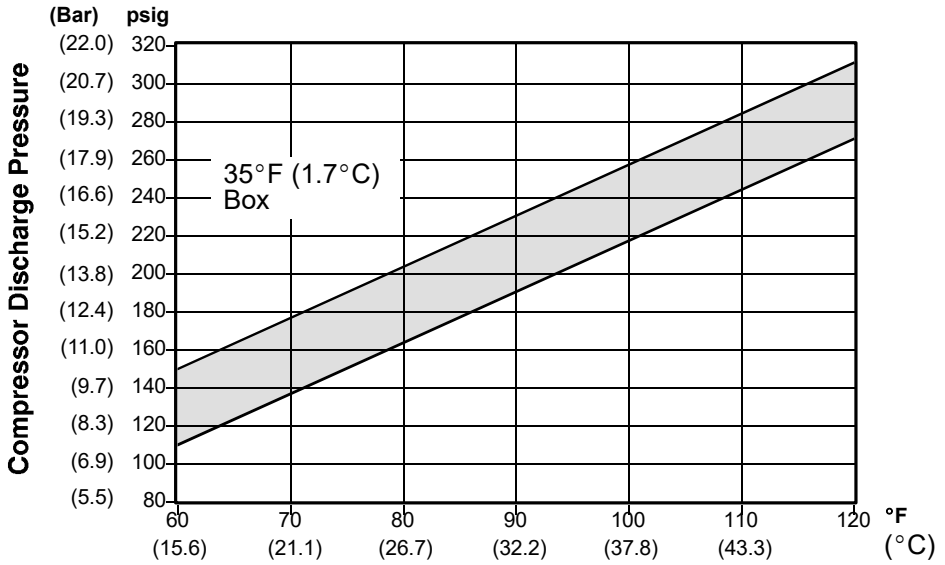
NEF – National Extra Fine

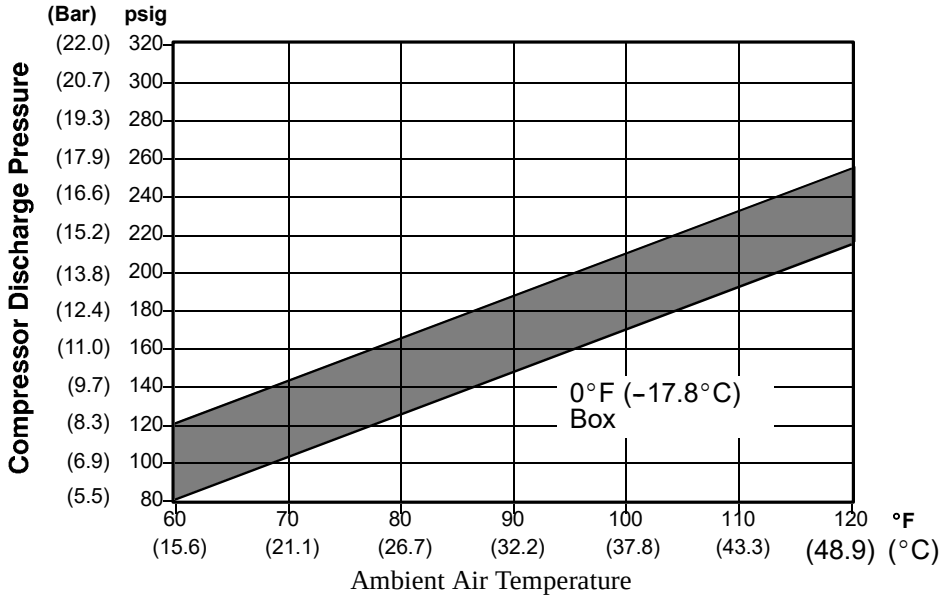
Table 19. R-134a Temperature - Pressure Chart

Temperature		Vacuum			
°F	°C	"/hg	cm/hg	kg/cm2	bar
−40	−40	14.6	49.4	37.08	0.49
.35	.37	12.3	41.6	31.25	0.42
−30	−34	9.7	32.8	24.64	0.33
−25	−32	6.7	22.7	17.00	0.23
−20	−29	3.5	11.9	8.89	0.12
−18	−28	2.1	7.1	5.33	0.07
−16	−27	0.6	2.0	1.52	0.02
Temperature		**Pressure**			
°F	°C	psig	kPa	kg/cm2	bar
−14	−26	0.4	1.1	0.03	0.03
−12	−24	1.2	8.3	0.08	0.08
−10	−23	2.0	13.8	0.14	0.14
−8	−22	2.9	20.0	0.20	0.20
−6	−21	3.7	25.5	0.26	0.26
−4	−20	4.6	31.7	0.32	0.32
−2	−19	5.6	36.6	0.39	0.39
0	−18	6.5	44.8	0.46	0.45
2	−17	7.6	52.4	0.53	0.52
4	−16	8.6	59.3	0.60	0.59
6	−14	9.7	66.9	0.68	0.67
8	−13	10.8	74.5	0.76	0.74
10	−12	12.0	82.7	0.84	0.83
12	−11	13.2	91.0	0.93	0.91
14	−10	14.5	100.0	1.02	1.00
16	−9	15.8	108.9	1.11	1.09
18	−8	17.1	117.9	1.20	1.18
20	−7	18.5	127.6	1.30	1.28
22	−6	19.9	137.2	1.40	1.37
24	−4	21.4	147.6	1.50	1.48
26	−3	22.9	157.9	1.61	1.58

Temperature		Pressure			
°F	°C	psig	kPa	kg/cm2	bar
28	−2	24.5	168.9	1.72	1.69
30	−1	26.1	180.0	1.84	1.80
32	0	27.8	191.7	1.95	1.92
34	1	29.6	204.1	2.08	2.04
36	2	31.3	215.8	2.20	2.16
38	3	33.2	228.9	2.33	2.29
40	4	35.1	242.0	2.47	2.42
45	7	40.1	276.5	2.82	2.76
50	10	45.5	313.7	3.20	3.14
55	13	51.2	353.0	3.60	3.53
60	16	57.4	395.8	4.04	3.96
65	18	64.1	441.0	4.51	4.42
70	21	71.1	490.2	5.00	4.90
75	24	78.7	542.6	5.53	5.43
80	27	86.7	597.8	6.10	5.98
85	29	95.3	657.1	6.70	6.57
90	32	104.3	719.1	7.33	7.19
95	35	114.0	786.0	8.01	7.86
100	38	124.2	856.4	8.73	8.56
105	41	135.0	930.8	9.49	9.31
110	43	146.4	1009	10.29	10.09
115	46	158.4	1092	11.14	10.92
120	49	171.2	1180	12.04	11.80
125	52	184.6	1273	12.98	12.73
130	54	198.7	1370	13.97	13.70
135	57	213.6	1473	15.02	14.73
140	60	229.2	1580	16.11	15.80
145	63	245.6	1693	17.27	16.93
150	66	262.9	1813	18.48	18.13
155	68	281.1	1938	19.76	19.37

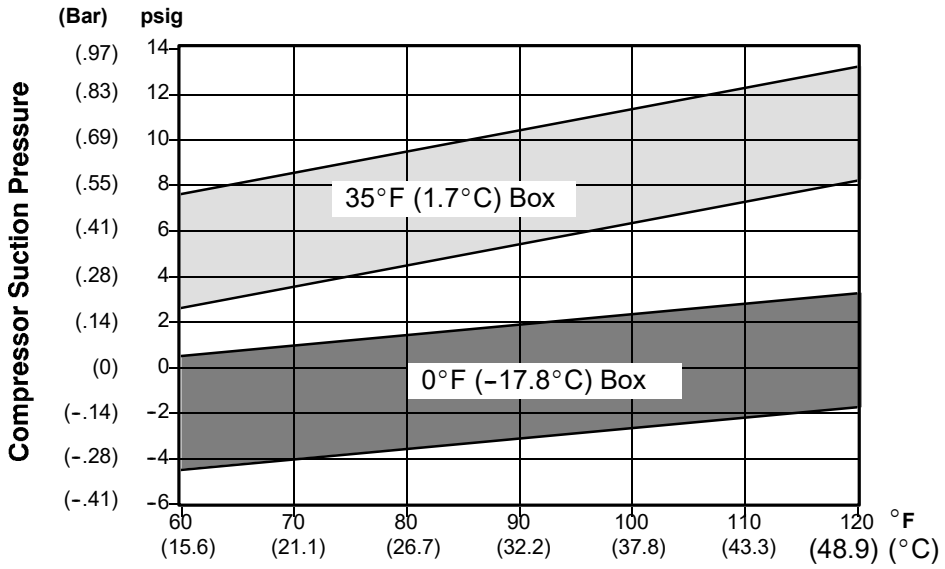
Note: Curves to be used as troubleshooting guide only for model series 69NT40 with fresh air makeup vent closed, unit powered on 460 VAC/60hz and SMV 100% open.



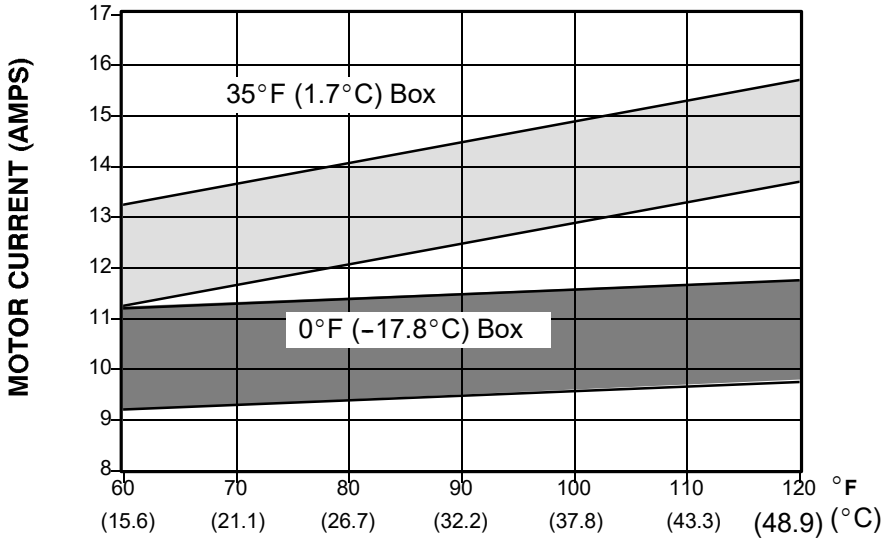


Compressor Discharge Pressure Versus Ambient Air Temperature at Stable Box Temperature

Figure 54. R-134a Compressor Pressure and Motor Current Curves Versus Ambient Temperature
(Sheet 1 of 2)



Compressor Suction Pressure Versus Ambient Air Temperature at Stable Box Temperature



Compressor–Motor Current Versus Ambient Air Temperature At Stable Box Temperature

Figure 54. R-134a Compressor Pressure and Motor Current Curves Versus Ambient Temperature
(Sheet 2 of 2)

PART TWO - CONTROLLED ATMOSPHERE SYSTEM

SECTION 7

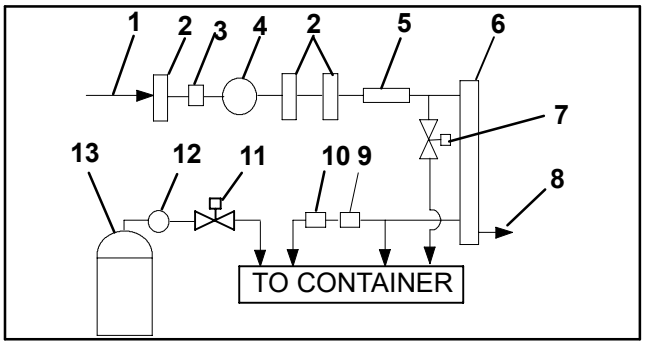
INTRODUCTION

⚠ DANGER

THE DANGER STATEMENTS MUST BE STRICTLY ADHERED TO. REFER TO CONTROLLED ATMOSPHERE (CA) SAFETY SECTION LOCATED IN THE SAFETY SUMMARY, SAFETY-1.

7.1 INTRODUCTION

The Carrier Transicold Everfresh controlled atmosphere system extends cargo life and reduces cargo degradation by providing precise management of the gases in the atmosphere surrounding the cargo. The system reduces the amount of oxygen and carbon dioxide in the cargo atmosphere by replacing them with nitrogen. Also, when high concentration of carbon dioxide is required, the system has the ability to monitor and inject it from a customer supplied cylinder. Provision is made for connection of the cylinder at the outside or inside of the container.



1. Ambient Air
2. Filter
3. Accumulator
4. Compressor
5. Heater
6. Nitrogen Separator
7. Oxygen Solenoid Valve
8. Gas Mixture Released
9. Carbon Dioxide Sensor
10. Oxygen Sensor
11. Carbon Dioxide Solenoid Valve
12. Regulator
13. CO_2 Cylinder

Figure 55. Basic Schematic for the CA System

The basic controlled atmosphere (CA) system consists of an air compressor, filters, accumulator, air heater and nitrogen separator. The system is also fitted with oxygen and carbon dioxide sensors to provide concentration level information to the controller. An oxygen solenoid valve is supplied to allow ambient air into the container. The carbon dioxide injection equipment consists of the customer supplied cylinder with regulator and a controller operated solenoid valve. A detailed description of the system is provided in section 8.4 page, 96.

Operation of the system is managed by a separate controlled atmosphere microprocessor. Once the CA Controller is set at the desired level of gas concentration, the unit will operate automatically to maintain specified levels of oxygen (O_2) and carbon dioxide (CO_2).

Main power (at nominal 460 volt) and control power(at 18 and 24 volts AC) is supplied from the refrigeration system power.

⚠ DANGER

LOW OXYGEN LEVELS INSIDE CONTAINER. VENTILATE CONTAINER BEFORE ENTERING. STAY AWAY FROM DOORS WHILE VENTING.

The unit requires installation of a door interlock system on the rear doors of the container. Verification of this installation (a visual inspection during pre-trip) is a necessary precaution prior to CA operation of the unit.

Once the oxygen sensor detects an oxygen level BELOW a safe level (19.8%), the CA Controller energizes the door interlock solenoid to prevent entrance into the hazardous atmosphere of the container.

⚠ DANGER

IT IS THE RESPONSIBILITY OF THE OPERATOR TO ENSURE THAT THE REAR CONTAINER DOORS AND DOOR HANDLES ARE PROPERLY CLOSED PRIOR TO CA SYSTEM USAGE. THE DOOR INTERLOCK SYSTEM MAY NOT SECURE THE DOORS UNLESS THE HANDLES ARE CLOSED PROPERLY.

Certain temperature and mechanical conditions must be met before the CA system is allowed to operate. The temperature controller monitors these conditions and provides a signal to the CA controller once operation is allowed. If at anytime the Temperature Controller detects a change in any of the required conditions, it will deactivate the CA system. See Section 9.

SECTION 8

DESCRIPTION

8.1 GENERAL DESCRIPTION

8.1.1 CA Equipment Location – front Section

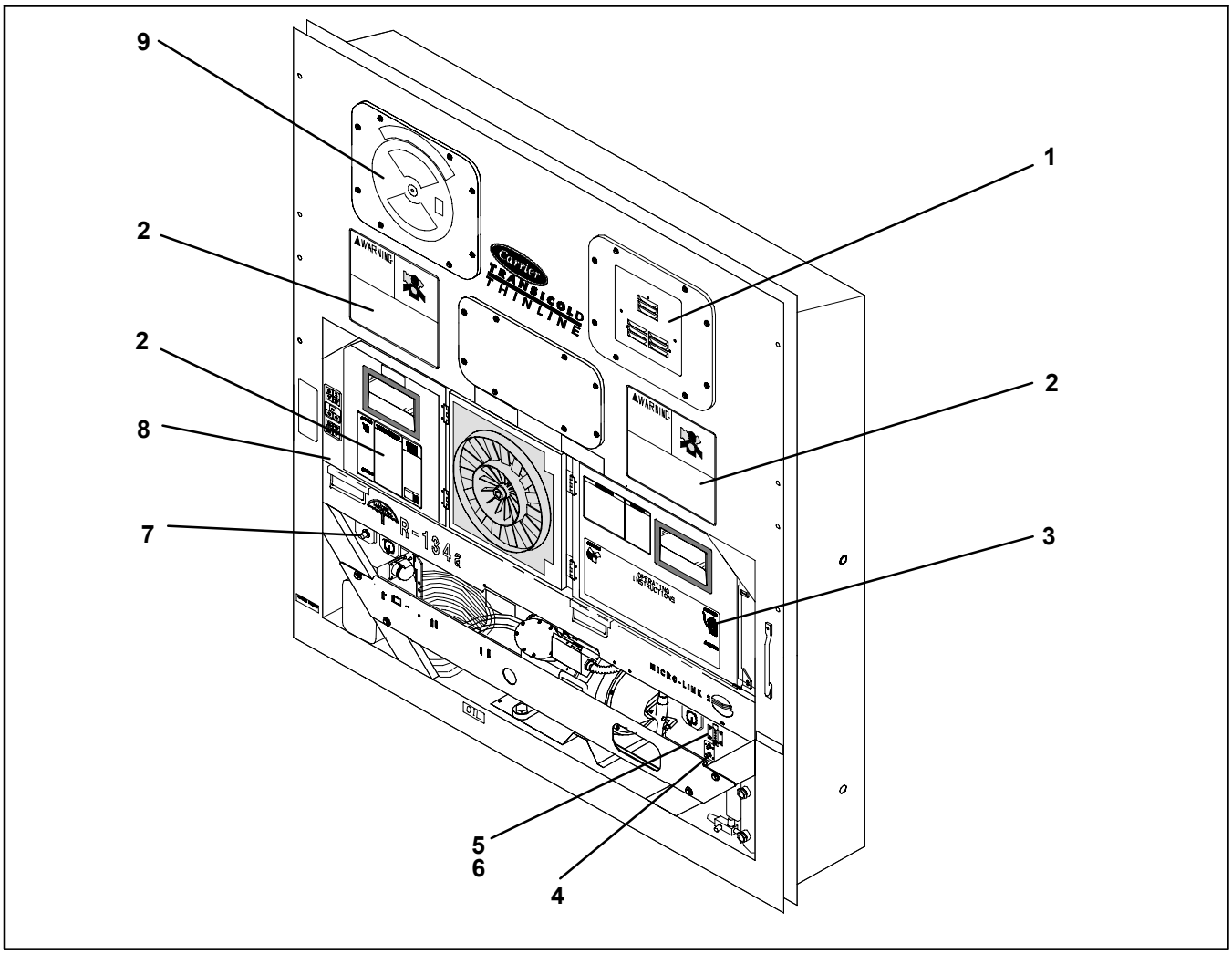
Many of the Controlled Atmosphere (CA) components are accessible from the front of the unit. These items, see Figure 56, include the intake air filter and pressure relief (breather) valve mounted in the right upper access panel, three access ports, flow meter, and the controlled atmosphere control box.

8.1.2 Calibration, Gas Charge and Pressurization/ Gauge Ports

The calibration gas, CO_2 charge and pressurization/gauge ports are all located on the front of the unit, see Figure 56. A second CO_2 charge port is located in the evaporator section, see Figure 57, page 90.

Functions of the various ports are:

- Pressurization/gauge ports are used to leak check the container by pressurizing with one port and attaching a pressure gauge onto the other port and monitoring for leakage.
- A calibration gas port is used with the Controlled Atmosphere (CA) Controller and a calibration gas tank to calibrate the oxygen sensor and to check the carbon dioxide sensor.
- Carbon dioxide charge ports are used for applications requiring increased concentration levels of carbon dioxide.



1. Air Intake Filter, Pressure Relief (Breather) Valve & Access Panel
2. CA Warning Labels
3. Refrigeration Unit Control Box
4. Pressurization/Gauge Ports (For Container Leak Check)
5. Flow Meter (gas calibration)
6. Gas Calibration Port (Used to calibrate the O_2 sensor and to check the CO_2 sensor)
7. Front Carbon Dioxide Gas Charge Port (Used to attach a CO_2 bottle)
8. Controlled Atmosphere Control Box
9. Fresh Air Makeup Vent & Access Panel

Figure 56. Controlled Atmosphere Components – Front Section

8.1.3 CA Components in the Refrigeration Evaporator Section

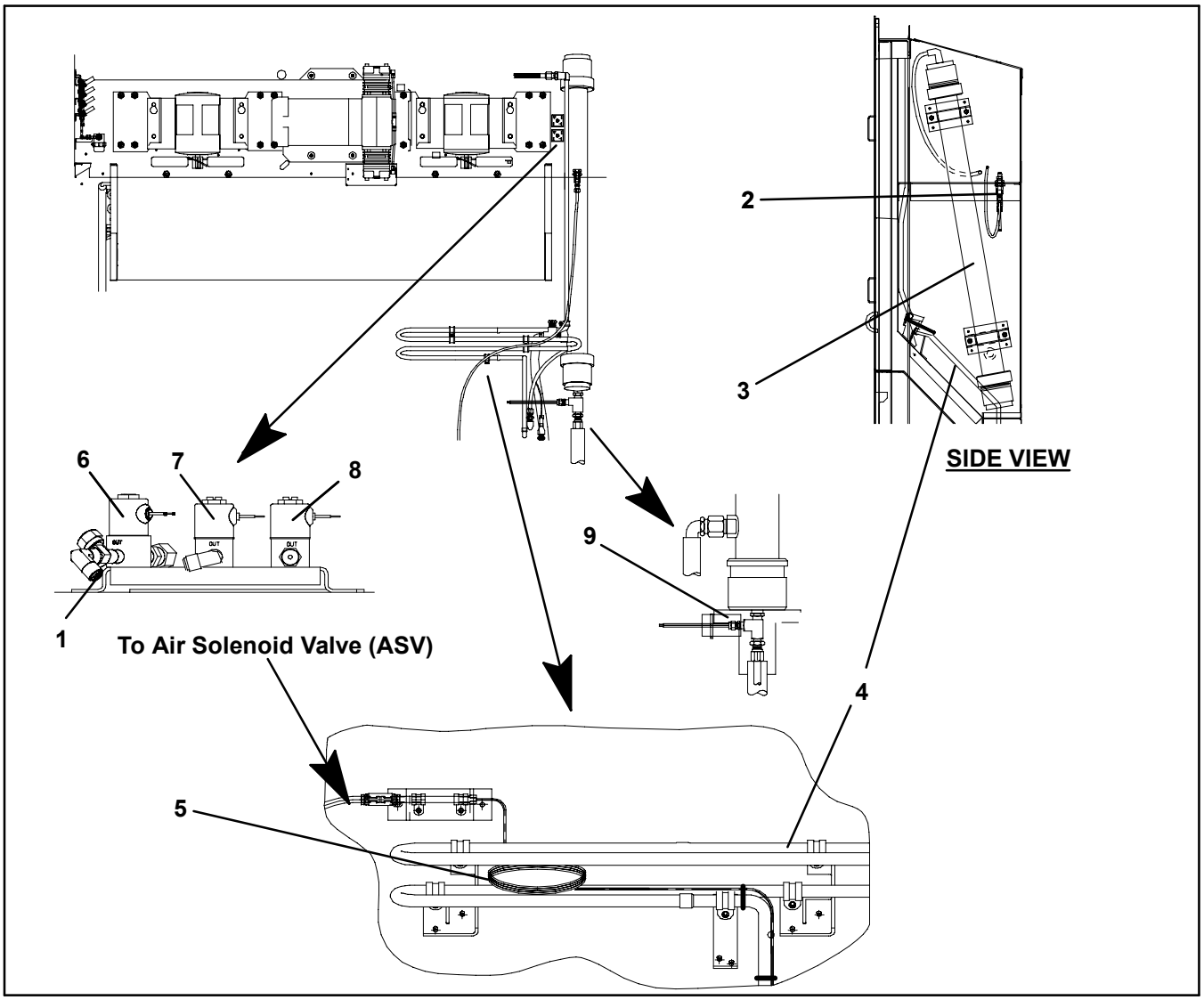
The refrigeration evaporator section (see Figure 57 or Figure 58, page 91) contains an air compressor, nitrogen membrane separator, an oxygen solenoid valve, a carbon dioxide solenoid valve and various sampling solenoid valves and sensors.

Also in this section are a condensing line that helps to condense the moisture in the air so that the membrane air filters can remove it more efficiently. It is located under the refrigeration evaporator coil.

The air compressor takes ambient air and compresses it to a higher pressure that is in turn filtered and heated, then passed on to the nitrogen membrane separator. The membrane temperature sensor is used to control the air temperature entering the nitrogen membrane separator, and a nitrogen purity valve is used to control the flow of air through the nitrogen membrane separator.

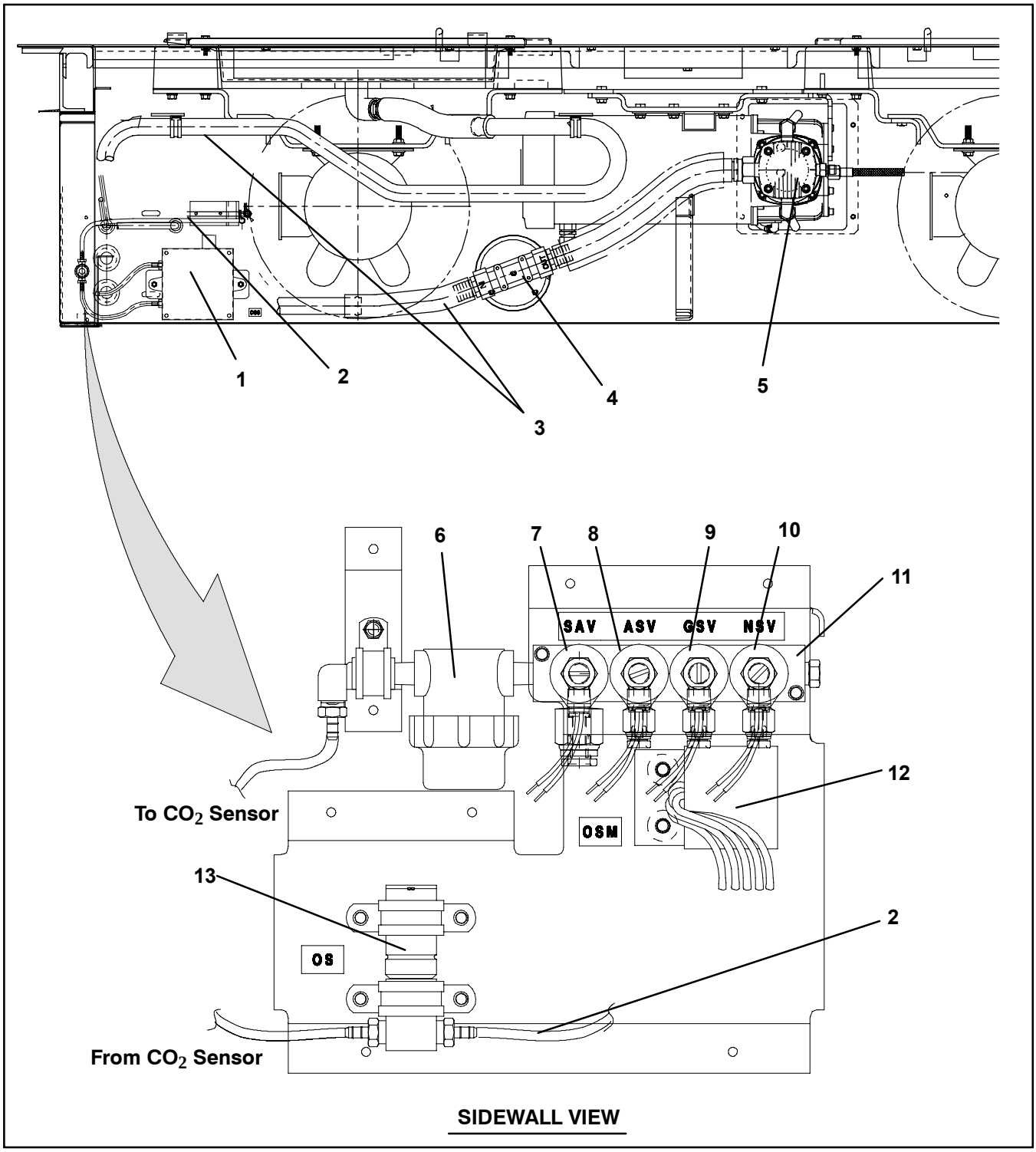
The nitrogen membrane separator takes the heated pressurized air and generates high purity nitrogen for use in the cargo area of the container. Oxygen and other gases that have been separated during this process are discharged out through the front of the container.

The side wall mounted solenoid valves, near the evaporator fan, sample air from various points of use in the system. Data is then supplied to the CA Controller from the oxygen and carbon dioxide sensors to control such factors as calibration, and oxygen and carbon dioxide levels and to perform diagnostic checks.



1. Nitrogen (N_2) Discharge
2. Carbon Dioxide Gas Charge Port (Used to attach a CO_2 bottle)
3. Nitrogen Membrane Separator
4. Condensing Line
5. Air Calibration Capillary
6. Nitrogen Purity Valve (NPV)
7. Oxygen Solenoid Valve (OSV)
8. Carbon Dioxide Solenoid Valve (CSV)
9. Membrane Temperature Sensor (MTS)

Figure 57. Controlled Atmosphere Components – Evaporator Section

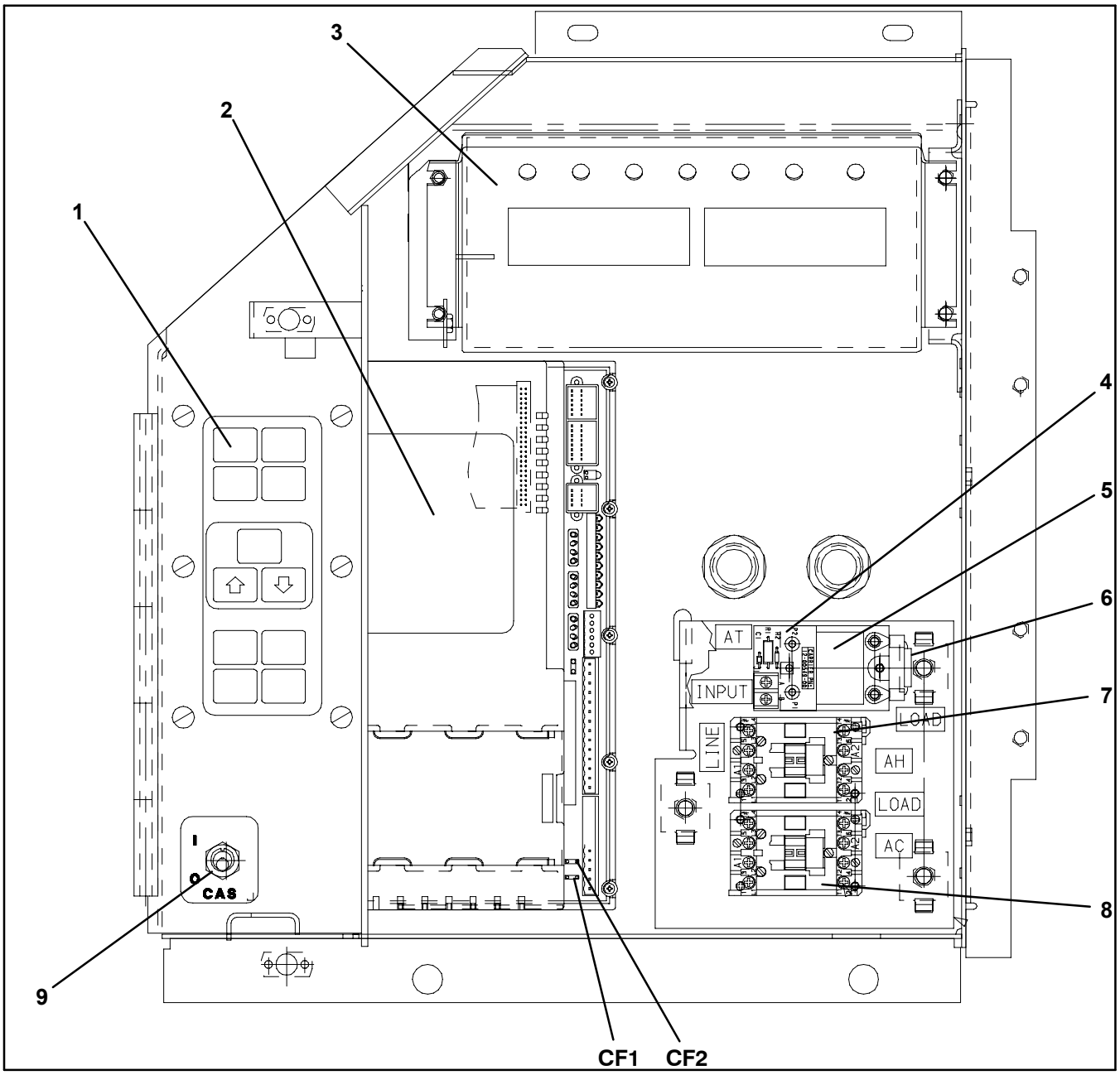


1. Carbon Dioxide Sensor (COS)
2. Air Sample Outlet Tube
3. Condensing Line
4. Accumulator
5. Air Compressor Motor (AM)
6. Air Sample Filter Assembly
7. Sample Air Solenoid Valve (SAV)
8. Air Calibration Solenoid Valve (ASV)
9. Gas Calibration Solenoid Valve (GSV)
10. Nitrogen Sample Solenoid Valve (NSV)
11. Solenoid Manifold Valve Assembly (Includes items 7, 8, 9 & 10)
12. Oxygen Sensor Module (OSM)
13. Oxygen Sensor (OS)

Figure 58. Controlled Atmosphere Components – Evaporator Fan Deck Section

8.1.4 Control Box

The control box (see Figure 59) includes a manual start-stop switch, air heater triac, voltage surge suppressor, contactors, fuses, key pad, display module, and the CA Controller module.



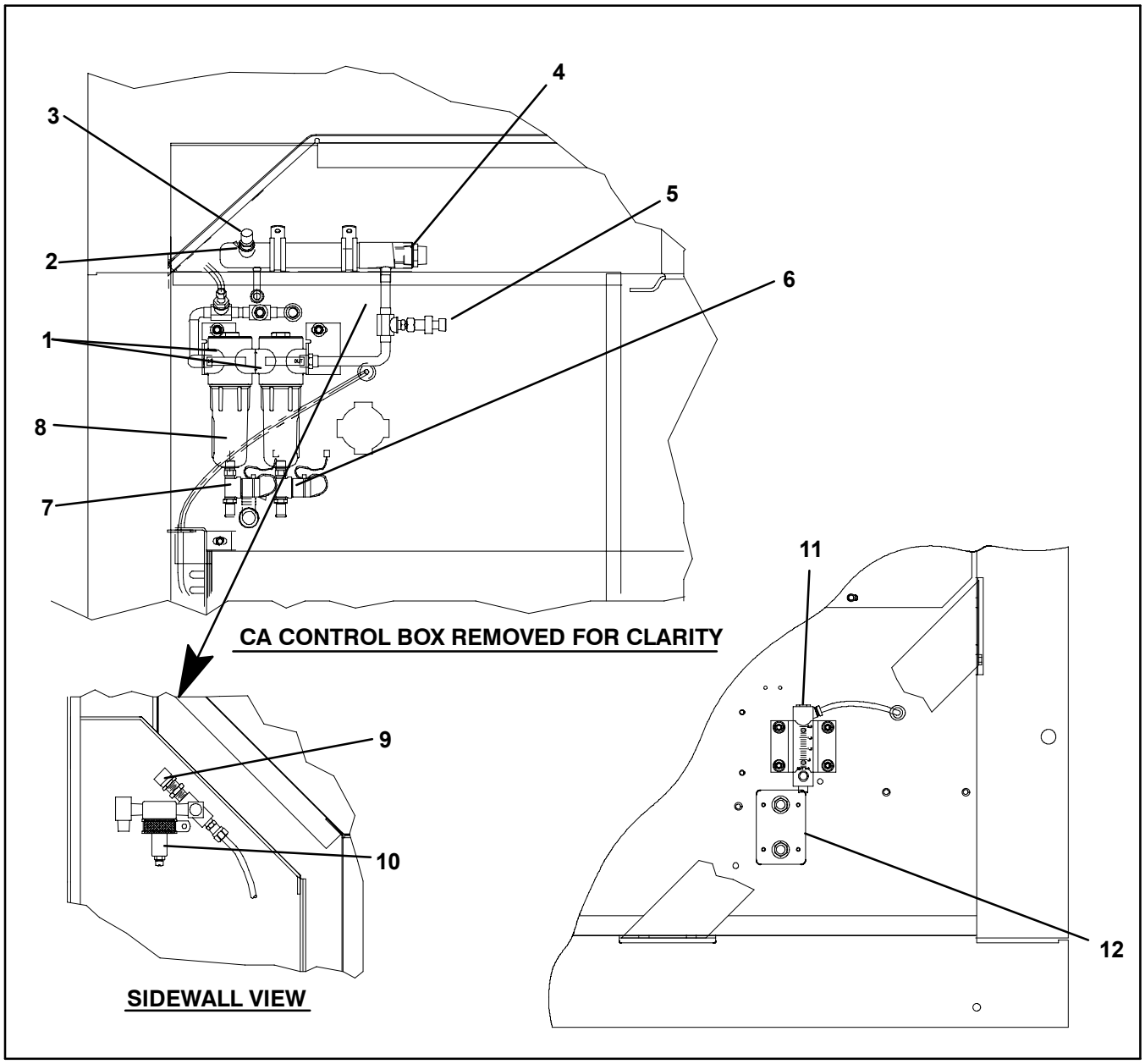
1. Keypad
2. Controlled Atmosphere Controller Module
3. Controlled Atmosphere Display Module
4 Heater Interface Module (HIM)
5. Air Heater Triac (AT)
6. Voltage Surge Suppressor
7. Air Heater Contactor (AH)
8. Air Compressor Contactor (AC)
9. Controlled Atmosphere Start-Stop Switch (CAS)

Figure 59. Controlled Atmosphere Components – Control Box

8.1.5 CA Components in the Refrigeration Condenser Section

The refrigeration condenser section (see Figure 60) contains an air filter assembly, air heater, membrane pressure transducer, pressure relief valve and pressure regulator.

The air filter assembly removes dirt and moisture from the ambient atmosphere. The air filter employs two drain solenoids to periodically release collected water. An air heater is used to warm the ambient air, and the high air temperature switch is used to protect the CA system from overheating. A membrane pressure transducer is used to monitor system performance during normal operation and CA Pre-Trip. A pressure relief valve is used to protect the air compressor and system components from over pressurization due to system obstructions. A pressure regulator maintains an optimum pressure level for air compressor and nitrogen membrane separator performance. An air pressure gauge can be added for testing purposes.

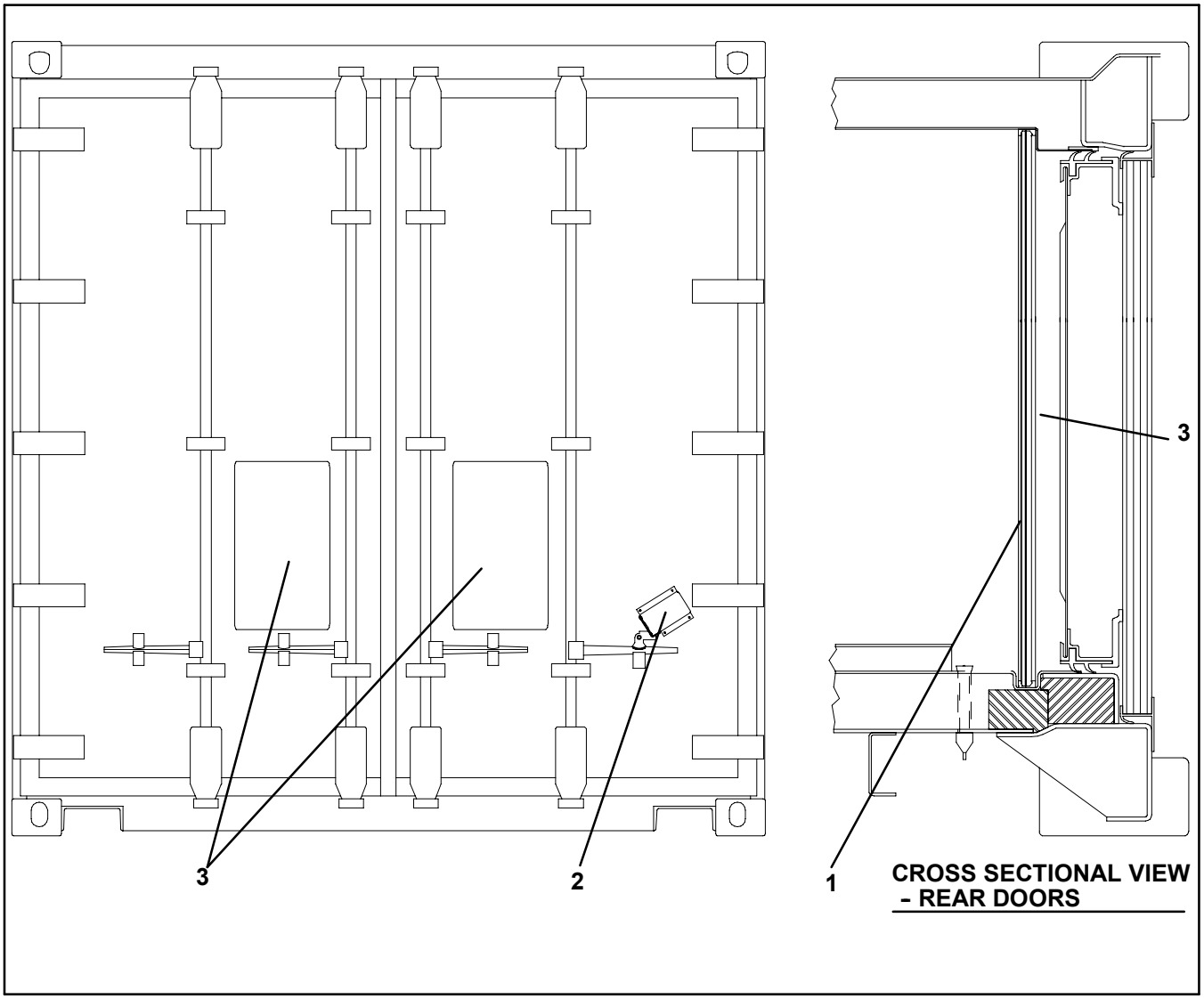


1. Membrane Air Filter Assembly
2. Pressure Port
3. High Air Temperature Switch (HATS)
4. Air Heater
5. Membrane Pressure Transducer (MPT)
6. Drain Solenoid Valve #2 (DS2)
7. Drain Solenoid Valve #1 (DS1)
8. Permeate Screen Assembly
9. Pressure Relief Valve
10. Pressure Regulator
11. Flow Meter and Calibration Gas Port
12. Pressurization/Gauge Ports

Figure 60. Controlled Atmosphere Components – Condenser Section

8.1.6 Container Rear Door Section

The container (See Figure 61) doors have a built-in safety feature called the door interlock system, which is used to prevent anyone from entering the container when there is a hazardous atmosphere present. Also, a pre-trip kit has been provided, one of its components (plastic curtain) is used to help prevent leakage through the rear doors.



1. Container Poly Sheet Curtain
2. Door Interlock System
3. CA Warning Labels

Figure 61. Controlled Atmosphere Components – Container Rear Door

8.2 CONTROLLED ATMOSPHERE SYSTEM DATA

a. Air Compressor	Number of Cylinders	2
	Type	Three Phase Induction
	Weight	34 kg (75 lb)
b. Pressure Relief Valves/ Regulator	Pressure Relief (Breather) Valve (located in access panel with air intake filter, see Figure 56, page 89)	
	Opens	*52* mm (2 inch WG)
	Pressure Relief Valve (located upstream of the nitrogen membrane filter assembly, see Figure 62, page 97)	
	Opens	8.44 kg/cm^2 (120 psi)
	Pressure Regulator (located upstream of the nitrogen membrane filter assembly, see Figure 62, page 97)	
	Opens	8 kg/cm^2 (115 psi)
c. High Air Temperature Switch	Opens	82 ± 3 °C (180 ± 5 °F)
	Closes	70 ± 5 °C (158 ± 9 °F)

8.3 ELECTRICAL DATA

a. Air Compressor Motor	Full Load Amps (FLA)	2.15 Amps @ 380 vac 2.30 Amps @ 460 vac
	Voltage and Frequency	190/380/vac/1ph/50 Hz ±10% 230/460 vac/1ph/60 Hz ±10%
	Speed	1425 rpm @ 50 Hz 1725 rpm @ 60 Hz
	Horsepower	1.5 @ 380/460 vac/50/60 Hz
b. Air Heater	Rating	600 watts (+5/–10%) @ 230/460 vac
	Resistance (at ambient)	75 to 88 ohms @ 230 vac 301 to 352 ohms @ 460 vac
c. Fuses	Control Circuit	10 Amps (F3)
	Controller Circuit	5 Amps (F1 & F2)

8.4 CONTROLLED ATMOSPHERE (CA) FLOW CIRCUIT

Starting at the right-hand side access panel (see Item 1, Figure 56, page 89), the air intake filter (Figure 62, page 97 item 2) filters dust from the air. A compressor suction air accumulator (see Figure 62, page 97, item 3) collects moisture from the compressor inlet air stream. The condensate is collected in the water separator tank and drained to the front of the unit. The air is then compressed in the compressor.The pressurized air then passes through the condensing line (item 5), located under the refrigeration evaporator coil, which condenses the moisture in the air. This pressurized air is then passed through an air filter assembly (item 9) to remove dirt and moisture. The moisture is discharged every one-half hour by two normally closed drain solenoids (items 10 & 11) to an area outside of the container. The pressurized filtered air is heated by the air heater (item 13), allowing the nitrogen membrane separator (item 15) to work more efficiently. The CA Controller ensures this efficiency by using the membrane temperature sensor (item 16) to maintain the temperature of the compressed air entering the nitrogen membrane separator. The high air temperature switch (item 14) is a safety device that protects the membrane from being overheated.

When the heated, pressurized air enters the nitrogen membrane separator the nitrogen (N_2) is separated and delivered to the inside of the container. The rate of nitrogen separated is determined by the flow of air through the membrane. The flow rate is established by a two stage solenoid valve called the nitrogen purity valve (NPV) (item 17). When de-energized, the NPV allows a very pure stream of nitrogen to pass into the container (used to decrease the amount of oxygen).

To decrease the amount of CO_2 in the container, the NPV is energized. When energized, the NPV introduces a higher flow rate of less-pure nitrogen that purges the excess CO_2. Other gases that have been separated from the air during this process are passed to an outlet that delivers these gases to a point outside of the container.

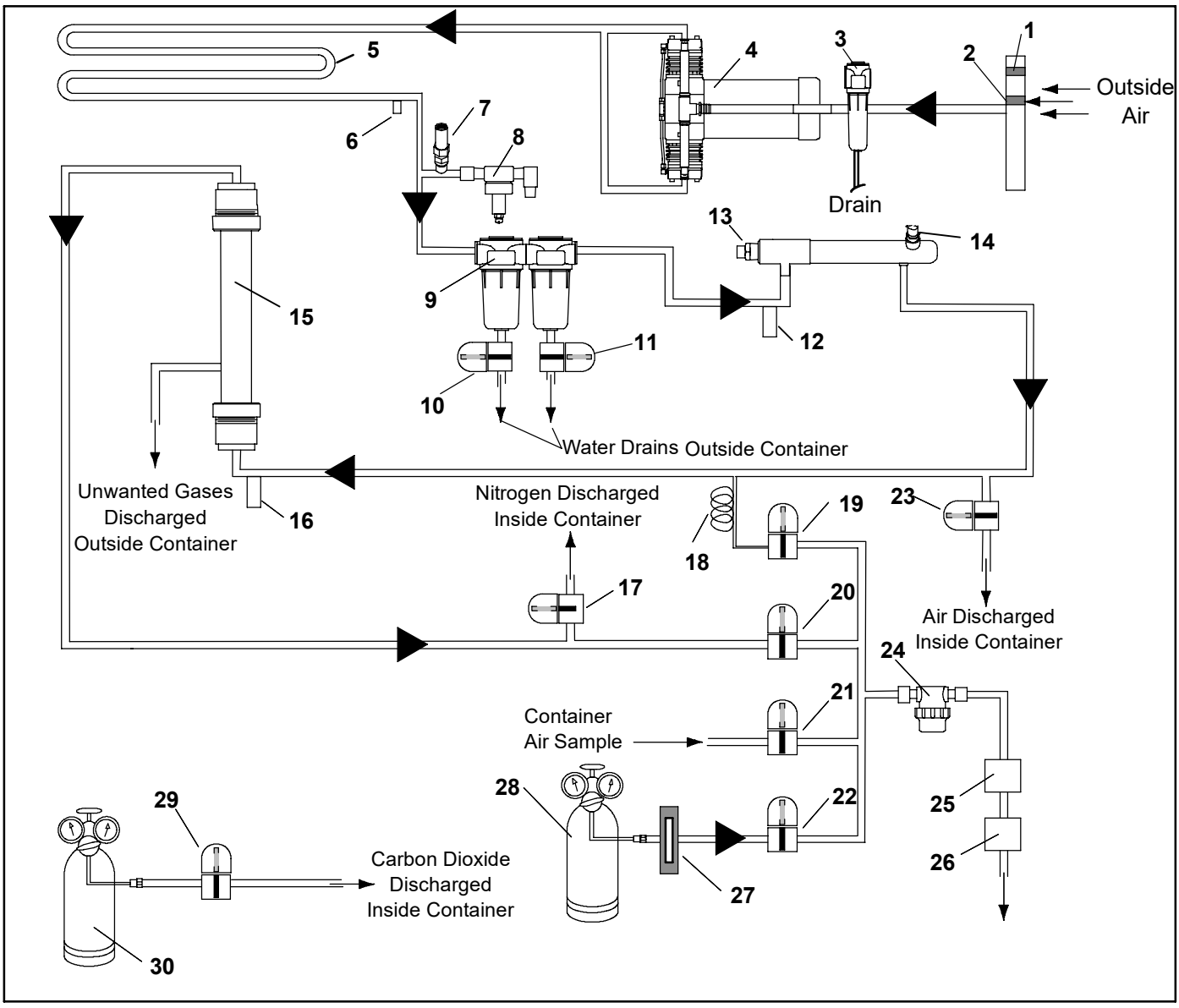
To increase the level of oxygen in the container, a normally closed oxygen solenoid valve (item 23, OSV) is energized. This allows pressurized, filtered air to bypass the membrane and flow directly into the container.

The CA Controller monitors the amount of oxygen (O_2) and carbon dioxide (CO_2) inside the container by using carbon dioxide and oxygen sensors (items 25 & 26).

A sample of the container air to be sensed is drawn in through a normally closed sample air solenoid valve (item 21) and passed through the sensor filter assembly (item 24). The oxygen sensor (item 26) and carbon dioxide sensor (item 25) need to be calibrated, refer to section 9.1, page 99 for a more detailed explanation.

The CA Controller uses solenoid valves (items 19, 20 & 22) for calibration and monitoring system performances, refer to section 9.1.7, page 106 for a more detailed explanation.

In some instances, a high level of carbon dioxide (CO_2) is needed to transport particular products. In order to achieve this, CO_2 charge ports have been added to the container inside the bulkhead wall, as well as on the outside of the unit. Once the CO_2 source (item 30) has been connected and the CA Controller initiated, the carbon dioxide solenoid valve (item 29) energizes when a higher concentration of carbon dioxide is required.



1. Pressure (Breather) Relief Valve
2. Air intake Filter
3. Accumulator
4. Air Compressor Motor
5. Condensing Line
6. Pressure Port (Shrader Valve)
7. Pressure Relief Valve
8. Pressure Regulating Valve
9. Air Filter Assembly
10. Drain Solenoid Valve #1 (DSV1)
11. Drain Solenoid Valve #2 (DSV2)
12. Membrane Pressure Transducer (MPT)
13. Air Heater
14. High Air Temperature Switch (HTS)
15. Nitrogen Membrane Seperator
16. Membrane Temperature Sensor (MTS)
17. Nitrogen Purity Solenoid Valve (NPV)
18. Air Sample Capillary
19. Air Calibration Solenoid Valve (ASV)
20. Nitrogen Sample Solenoid Valve (NSV)
21. Sample Air Solenoid Valve (SAV)
22. Gas Calibration Solenoid Valve (GSV)
23. Oxygen Solenoid Valve (OSV)
24. Sensor Filter Assembly
25. Carbon Dioxide Sensor (COS)
26. Oxygen Sensor (OS)
27. Flow Meter
28. Calibration Gas Cylinder
29. Carbon Doixide Solenoid Valve (CSV)
30. Carbon Dioxide Cylinder

Figure 62. Controlled Atmosphere System – Flow Circuit

8.5 FRESH AIR MAKEUP VENT

The purpose of the vent is to provide ventilation for commodities that require fresh air circulation and *must be closed* when transporting frozen foods, or CA loads.

NOTE

The fresh air makeup vent must be closed for all Controlled Atmosphere loads.

The fresh air makeup vent is also used to vent the container prior to the door interlock system opening and user entry, refer to section 10.7, page 113.

8.6 SAFETY AND PROTECTIVE DEVICES

System components are protected from damage by safety and protective devices listed in Table 20. These devices monitor the system operating conditions and open a set of electrical contacts when an unsafe condition occurs.

The entire CA system will shut down if one of the following safety devices open:

- Control Contactor Fuse (F3)
- Control Circuit Fuse (F1, F2)
- Air Compressor Overload (IP-AM)
- Circuit Breakers (CB-1 or CB-2) of the refrigeration unit

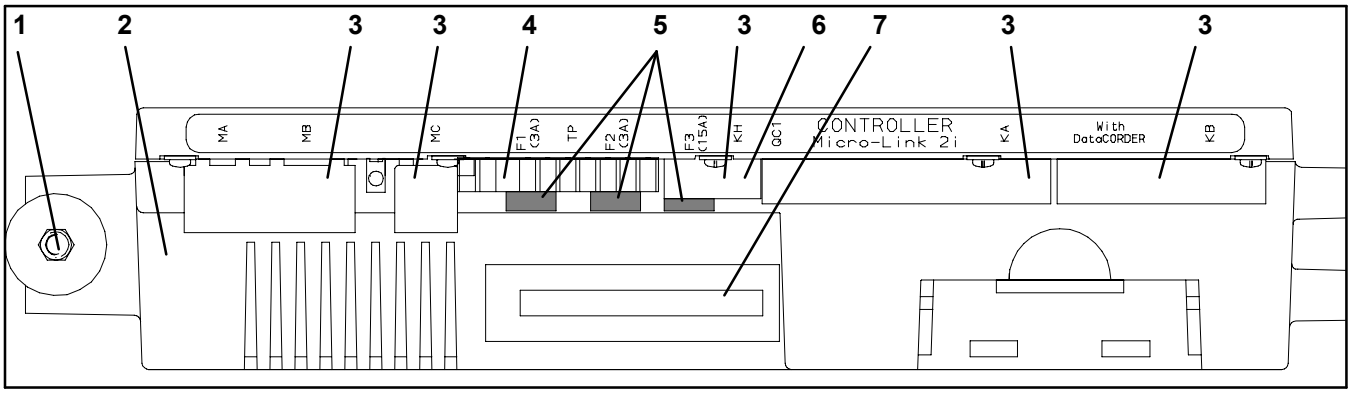
Table 20. Controlled Atmosphere Safety and Protective Devices

UNSAFE CONDITIONS	SAFETY DEVICES	DEVICE SETTING
Excessive current draw on control circuit	Fuse (F3)	Opens at 10 amps
Excessive current draw by the microprocessor	Fuse (F1 & F2)	Opens at 5 amps
Excessive air compressor motor temperature	Internal Protector (IP-AM) – Automatic Reset	N/A
Abnormal pressures in the CA system	Pressure Relief Valve	Opens at 10.55 kg/cm^2 (150 psig)
Abnormal temperature in the air heater	High Air Temperature Switch (HATS)	Opens at 82 ± 3 °C (180 ± 5 °F). Closes at 70 ± 5 °C (158 ± 9 °F).

SECTION 9

MICROPROCESSOR

9.1 CONTROLLED ATMOSPHERE CONTROLLER MODULE



1. Mounting Screw
2. CA Controller Module
3. Connectors
4. Test Points
5. Fuses
6. Control Circuit Power Connection (Location: In back of connector)
7. Software Programming Port

Figure 63. Controlled Atmosphere Controller Module

9.1.1 Brief Description

WARNING

Do not attempt to service the CA Controller module. Breaking the warranty seal will void the warranty.

CAUTION

Remove all Controller modules and unplug all wire harness connectors before performing any arc welding on any part of the container.

Do not remove wire harnesses from modules unless you are grounded to the unit frame with a static safe wrist strap.

The Carrier Transicold CA module (identical to the ML2i Temperature Controller used in the refrigeration system with the exception of the software) is a custom-designed microprocessor which incorporates electronic logic to:

a. Wait for proper refrigeration system conditions before enabling start-up of the CA.

b. Control oxygen and carbon dioxide levels within a refrigeration container, and monitor the percentage level of nitrogen being generated.

c. Control The addition of carbon dioxide from an independent source.

d. Provide dual independent readouts of set points and concentration levels for oxygen and carbon dioxide.

e. Provide digital readout and ability to select data. Refer to Table 22, page 102 for CA Controller Function Codes. For CA Controller alarm digital display identification refer to Table 24, page 105.

f. Provide a pre-trip step-by-step checkout of CA system performance, proper component operation, proper electronic control operation, proper heater operation and automatic sensor calibration.

g. Provide the ability to select function codes and change selectable function codes, configuration variables and set points. Refer to section 9.1.4, page 102.

h. Provide memory reprogramability and configuration through a memory card. The memory card automatically downloads new software to the CA Controller when inserted, and controls output to the display of programming status information. (See section 12.14.1, page 133)

9.1.2 CA Controller Programming (Memory) Card

The programming card is used for loading the software into the CA Controller. This is the same concept as using a floppy diskette to load software into a personal computer.

The software that can be loaded into the CA Controller module combines the operational and configuration software. Operational software enables the CA Controller module to perform its functions. Refer to Table 23 for Configuration parameters.

A programming card with the operational software is available thru CTD Replacement Components Group.

The use of a programming card in the field should only occur under unusual circumstances. Some of these circumstances may include:

a. A CA Controller module has an older version of Operational Software, and the need exists to upgrade to a newer version of the software.

b. A CA Controller module was damaged in such a way that the integrity or existence of software within the module is questionable.

Procedure for loading software:

Refer to section 12.14.1, page 133.

9.1.3 General Layout of the CA Controller Section

The CA Controller consists of a key pad, display module, start-stop switch, and a CA Controller module. Connectors are used to attach the wiring of the unit to the CA Controller module. The CA Controller module is designed to permit ease of installation and removal.

All control functions are accessed by key pad selections and viewed on the display module. They are designed for optimum user friendliness and convenience.

The key pad (see Figure 64) is mounted on the left-hand side of the control. The key pad consists of 11 push-energized membrane switches that act as the user interface with the CA Controller.

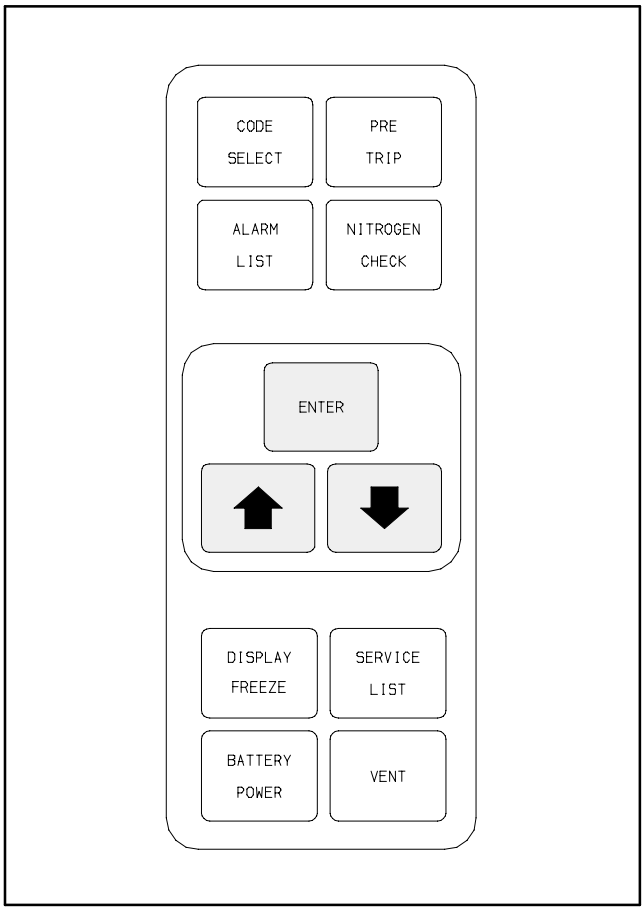


Figure 64. CA Controller Key Pad

TABLE 21 CA KEY PAD FUNCTION	
KEY	**FUNCTION**
Alarm List	Displays alarm list and clears the alarm queue (when followed by *Enter* key) for the CA Controller.
Arrow Up	Change set point upward. Change codes upward. Scan alarm list upward. Change user selectable features upward. Pre-trip advance forward. Pre-trip test interruption.
Arrow Down	Change set point downward. Change codes downward. Scan alarm list downward. Change user selectable features downward. Pre-trip repeat backward.
Battery Power	Initiate battery backup mode to allow set point and function code selection if no AC power is present.
Code Select	Access function codes (see arrow up and arrow down) for the CA Controller.
Display Freeze	Freezes the display for one minute when followed by *Enter* key.
Enter	Entering a set point change. Extending to 30 seconds the time a chosen function code is displayed. Executing a code select mode. Entering the value of a user selectable mode. Clearing the alarm list and initiating pre-trip.
Nitrogen Check	Alternates a choice of “ntest” or “rslts”. When followed by the *Enter* key, “ntest” performs a 2 minute check of membrane performance and “rslts” displays the results of the last N_2 performance test from Pretrip or “ntest”.
Pre-Trip	Initiate a pre-trip inspection (when followed by the *Enter* key). Discontinues pre-trip in progress.
Service List	Displays last function code if the last function code accessed was between codes 10 and 30 or shows function code #10 when depressed on power-up.
Vent	Initiates the safety procedure for venting the container of hazardous gases before unlocking the rear access doors. See section 10.7.

The display module (see Figure 65) is mounted at a 20 degree downward tilt to aid in visibility when stacked in close quarters. The display module consists of:

a. Two – 25mm (1 inch) high, five digit LCD displays which are easily viewed in direct sunlight and back-lighted for superior low-light visibility.

b. Seven Indicators :

- Air Compr – White Lamp: energized when air compressor is energized.
- Standby – Orange LED: energized when CA system is in standby.
- Service – Orange LED: energized when air compressor (Cd#16), membrane air filters (Cd#17) or the oxygen sensor (Cd#14) require service.
- In-Range – Green LED: energized when O_2 set point is in-range (CO_2 set point is in-range when applicable).
- Alarm – Red LED: energized when the following alarms are active or inactive in the alarm queue; AL30, AL31, AL32, AL34, AL36, AL39 and AL48.
- Oxygen – Yellow LED: energized when O_2 concentration and set point are displayed, or during a CA Pre-Trip failure.
- Carbon Dioxide – Yellow LED: energized when CO_2 concentration and set point are displayed, or during a CA Pre-Trip failure.

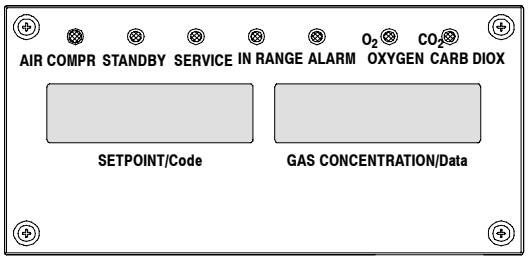


Figure 65 CA Controller Display Module

NOTE

The default display mode will normally alternate for approximately five seconds between O_2 and CO_2 set point and concentration values. Other messages indicating low line voltage or improper operation of the system are sometimes alternated for a third five-second period along with the O_2 and CO_2 information.

9.1.4 CA Controller Function and Data Codes

There are functions which the operator may access to examine the operating status of the unit. To access these functions, perform the following steps: Press the CODE SELECT key, then press an ARROW key until the left window displays the desired code number (see Table 21). For the display-only function codes, the right window will display the value of this item for five seconds before returning to the normal display mode. If a longer display time is desired, pressing the ENTER key will extend the time to 30 seconds after the last pressing of the ENTER key. Below is an explanation of all Function codes.

Table 22. CA Controller Function Code Assignments

CODE	TYPE	TITLE	DESCRIPTION
Input Codes			
Cd01	Display	Membrane Temperature Setpoint	Displays the temperature set point for the nitrogen membrane separator that was set during configuration.
Cd02	Display	Membrane Input Temperature (MTS)	Displays the temperature of the air entering the nitrogen membrane separator.
Cd03	-----	Future Expansion	This code is for future expansion, and is not in use at this time.
Cd04	Display/ Select	Temperature Units	This code determines the temperature units (°C or °F) which will be used for the CA display module. The user selects °C or °F by selecting code 04 and pushing the ENTER key. The factory default value is °C. This code also effects pressure units, i.e., bars or psig.
Cd05	Display	Software Revision	The software revision number is displayed.
Cd06	-----	Future Expansion	This code is for future expansion, and is not in use at this time.
Cd07	Display	Nitrogen Supply Pressure (MPT)	Displays the pressure of the nitrogen membrane separator.
Cd08	Display	O_2 Sensor Value (OS)	Displays the percentage of oxygen in the gas flowing through the oxygen sensor.
Cd09	Display	CO_2 Sensor Value (COS)	Displays the percentage of carbon dioxide in the gas flowing through the carbon dioxide sensor.
Service Codes			
Cd10	Display/ Cal	Time Elapsed Since Last Successful Oxygen (O_2) Span Calibration	Displays the time that has elapsed since the last successful oxygen (O_2) span calibration in hours/minutes (HHMM) format. Will also initiate an O_2 air calibration when accessed, when the ENTER key is pressed and held for five seconds.
Cd11	Display/ Cal	Last O_2 Gas Cal Date	Displays the date of the last successful oxygen (O_2) zero calibration in month/day (MMDD) format. Will also initiate a O_2 gas calibration when accessed, and the ENTER key is pressed and held for five seconds.
Cd12	Display	CA Locked Out By Reefer	Will display a “YES” or “nO”, indicating if the Temperature (refrigeration) Controller is causing the CA Controller to not operate.
Cd13	Display	Last O_2 Span Calibration Voltage in mV	Displays the last oxygen span calibration voltage in millivolts.
Cd14	Display	Oxygen Sensor Life	Displays the current operating status of the oxygen sensor (OS), “good” or “bAd”.
Cd15	Display/ Test	Battery Test	This code checks the internal battery. While the test is running, “btest” will flash on the right display, followed by the result. “PASS” will be displayed for battery voltages greater than 7.0 volts, “FAIL” will be displayed for battery voltages between 4.5 and 7.0 volts, and “-----” will be displayed for battery voltages less than 4.5 volts. After the result is displayed for four seconds, “btest” will again be displayed, and the user may continue to scroll through the various codes.

CODE	TYPE	TITLE	DESCRIPTION
Cd16	Display/ Reset	Hours Since Compressor Service	Records total hours of air compressor run time. Hold the ENTER key for five seconds to reset to “0”.
Cd17	Display/ Reset	Hours Since Filter Change	Displays the number of hours that have elapsed since the membrane air filters were changed. Records actual hours (ie. 100 hours is displayed as 100). Hold ENTER key for five seconds to reset to “0”.
Cd18	Display	Total Run Hours	Records the total number of operational hours for the CA system air compressor. Records total hours in increments of 10 hours. (i.e. 3000 hours displayed as 300)
Output Codes			
Cd19	Display	Air Compressor State (AC)	Displays the current operating status of the air compressor (ON or OFF).
Cd20	Display	Air Heater State (AH)	Displays the current operating status of the air heater (ON or OFF).
Cd21	Display	Air Heater SSR PWM Valve (AT)	Displays the current operating status of the PWM (Pulse Width Modulation) signal that is driving the air heater. The number displayed is a percentage of 100.
Cd22	Display	Sample Air Solenoid Valve State (SAV)	Displays the current operating status of the sample air solenoid valve (OPEN or CLOSED).
Cd23	Display	Air Calibration Solenoid Valve State (ASV)	Displays the current operating status of the air calibration solenoid valve (OPEN or CLOSED).
Cd24	Display	Gas Calibration Solenoid Valve State (GSV)	Displays the current operating status of the gas calibration solenoid valve (OPEN or CLOSED).
Cd25	Display	N_2 Sample Solenoid Valve State (NSV)	Displays the current operating status of the nitrogen sample solenoid valve (OPEN or CLOSED).
Cd26	Display	Oxygen Solenoid Valve State (OSV)	Displays the current operating status of the oxygen solenoid valve (OPEN or CLOSED).
Cd27	Display	Nitrogen Purity Valve State (NPV)	Displays the current operating status of the nitrogen purity valve (OPEN or CLOSED).
Cd28	Display	Drain Valve Solenoid State (DS1 and DS2)	Displays the current operating status of the drain solenoid valve – #1 & #2 (OPEN or CLOSED).
Cd29	Display	CO_2 Input Solenoid Valve State (CSV)	Displays the current operating status of the carbon dioxide solenoid valve (OPEN or CLOSED).
Cd30	Display	Door Lock Solenoid State (DIS)	Displays the current operating status of the door interlock solenoid (OPEN or CLOSED).
Cd31	Display/ Select	CO_2 Concentration in Calibration Gas	Gives the operator the ability to select the purity level of the CO_2 gas being used for calibration. (5%, 20%, OFF)
Cd32	Display/ Select	CA Monitor Mode	Monitor mode provides the ability to monitor CO_2 and O_2 levels while the atmosphere inside the container is not controlled. CO_2 Zero and O_2 Air Calibrations will be prohibited. (IN/OUT)
Cd33	future	future	future
Cd34	Display/ Select	O_2 Lower Setpoint Limit Enable	In the ON position, the O_2 lower setpoint limit is 2.5% with a default setting of 2.5%. In the OFF position, the O_2 lower setpoint limit is 1% with a default setting of 2%. The unit will default with the loading of operational software.

Table 23. CA Controller Configuration Variables

CONFIGURATION NO.	TITLE	OPTIONS	DEFAULT
CnF01	Service Hour Meter Display Disable	In, Out	In
CnF02	O_2 Control Band	0.1 to 2% by 0.1% increments.	0.5%
CnF03	CO_2 Control Band	0.1 to 5% by 0.1% increments, or Off.	0.5%
CnF04	Heater Temperature Set Point	Options 25 to 60°C by 1°C increments.	45°C
CnF05	Monitor Mode Enable	In, Out	In

9.1.5 Configuration Software (Configuration Variables)

The Configuration Software is a variable listing of the components available for use by the Operational Software. This software is factory installed in accordance with the equipment fitted and options listed on the original purchase order. Changes to the Configuration Software are required only when the original software has been lost or a physical change has been made to the unit such as the addition or removal of an option. A Configuration Variable listed in Table 23. Change to the factory installed Configuration Software is achieved via a configuration card.

9.1.6 CA Controller Alarms

The alarm (refer to Table 24, page 105) philosophy balances the protection of the CA system and that of the refrigerated cargo. The action taken when an error is detected always considers the survival of the cargo. Rechecks are made to confirm that an error actually exists.

When an alarm occurs:

- The red alarm light will illuminate when alarms AL30, AL31, AL32, AL34, AL36, AL39 and AL48 are active or inactive in the alarm queue.
- If a detectable problem is found to exist, its alarm code will be alternately displayed with the set point on the left display.
- To determine if alarms have existed, the alarm list must be accessed. The alarm list will store up to 16 alarms, in the sequence in which they occurred.
- When accessing the alarm list, an “IA” or an “AA” will appear to the left of the alarm code number. The “IA” indicates an inactive alarm; one that has occurred, but no longer exists. The “AA” indicates an active alarm; one that is still indicating an improper condition.
- Alarms that disable all control units (”Shut Down” alarms) are AL30, AL31, AL32 and AL36. AL39 is a partial shutdown alarm and when active will cause AL34 and AL48 to become shut down alarms.

To Display Alarm Codes:

The Alarm List Display Mode is entered by pressing the ALARM LIST key while in Set Point Selection or Default Display mode. The user will be able to display any alarms archived in the Alarm Queue. If no alarms, other than those related to the CA Controller memory, are active, the Alarm Queue may be cleared.

When the ALARM LIST key is pushed:

- The left display will show “AL#”, where # is the alarm number of alarms in the queue.
- The right display will show “AAXX”, if the alarm is active, where XX is the alarm number, or “IAXX”, if the alarm is inactive.

The user can look through the alarm queue by depressing the UP ARROW key. At the end of the alarm list, if any alarm(s) in the list are active, “END” is displayed.

If all the alarms in the list are inactive:

- “CLEAr” is displayed at the end of the alarm list.
- At this time if the user pushes the ENTER key, then the alarm list will clear and display “-----” on the right display. The user may also scroll to the end of the alarm list by pushing the DOWN ARROW key after the ALARM LIST key is pushed.
- The DOWN ARROW key being pushed will allow the user to go backward in the alarm list.
- If a user pushes ALARM LIST key when there are no alarms in the list, the “AL” is displayed on the left display and “-----” on the right display. Upon clearing of the Alarm Queue, the Alarm light will be de-energized.

Another alternative for user to get to the end of the alarm list is:

- By pushing the DOWN ARROW key after the ALARM LIST key is pushed. Thus, the DOWN ARROW key being pushed will allow the user to go backward in the alarm list.
- If a user pushes the ALARM LIST key when there are no alarms in the list, the “AL” is displayed on the left display and “-----” on the right display.

Upon clearing of the Alarms Queue, the Alarm light will be de-energized.

Table 24. CA Controller Alarm Indications		
CODE NO.	**TITLE**	**DESCRIPTION**
AL30	Control Contactor Fuse Open (24 vac)	Alarm 30 is triggered by fuse (F3) opening, which causes software shutdown of all control units. This alarm will remain active until the 10 amp fuse is replaced.
AL31	Control Circuit Fuse Open (18 vac)	Alarm 31 is triggered by one of the fuses (F1 or F2) being opened on the 18 volt AC power supply to the CA Controller.
AL32	Air Compressor Safety	Alarm 32 is triggered by the opening of the air compressor motor internal protector (IP-AM). This alarm will disable all control units until the motor protector resets. The carbon dioxide solenoid valve (CSV) and the sample air solenoid valve (SAV) will continue to be energized when the source is available and required.
AL33	Not used	
AL34	Oxygen Sensor Failure	Alarm 34 is triggered by an out of range condition (less than 0% or greater than 25%). This alarm will remain active until the sensor is in-range. While AL34 is active, the compressor will run with the oxygen solenoid valve (OSV) open, unless AL39 is active, whereby all control units will be disabled, except the sample air solenoid valve (SAV).
AL35	Carbon Dioxide Sensor Failure	Alarm 35 is triggered by the voltage output being out of range (less than 0.95v or greater than 5.05v) for 30 minutes, or ten unsuccessful automatic calibration attempts. This alarm will remain active until the sensor is in-range or a successful carbon dioxide ($CO_{2)}$ zero calibration is performed.
AL36	A/D Converter Failure	The CA Controller has a built-in A-D (Analog to Digital) converter, used to convert analog readings (i.e. gas sensors, pressure sensors, etc.) to digital readings. The CA Controller continuously performs calibration tests on the A-D converter. If the A-D converter fails to calibrate for 30 consecutive seconds, this alarm is activated and will result in disabling all control units. This alarm will be inactivated upon a successful A-D converter calibration.
AL37	Communication Error	Alarm 37 is triggered when there is a loss of communication with the Temperature (refrigeration) Controller. This alarm will be inactivated as soon as communication is established or the system is reset.
AL38	Membrane Temperature Sensor Failure	Alarm 38 is triggered by an out of range condition of the membrane temperature sensor (MTS). This alarm will be inactivated when in-range or the system is reset.
AL39	Oxygen Solenoid Valve Failure	Alarm 39 is triggered by a malfunction of the oxygen solenoid valve (OSV). It can be activated in control mode as described below or upon failure of pre-trip step P1-1. Pressure at the membrane temperature sensor (MPT) is measured before and after the oxygen solenoid valve (OSV) opens. The pressure drop must be greater than 20 psig or the alarm will activate. If AL47 is active, two measurements of oxygen (O_2) percentage will be taken one hour apart. If the O_2 percentage has not increased by more than a fixed value the alarm (AL39) will activate. This is a partial shutdown alarm, and will only prevent the compressor from energizing during a demand for O_2 levels to increase.
AL40	Heater Control Failure	Alarm 40 is triggered by failure of the air temperature to reach set point (+0°C/–3°C) within two hours of operation. This is a display alarm, which indicates a possible heater failure.

CODE NO.	TITLE	DESCRIPTION
AL41	O_2 Gas Calibration Failure	Alarm 41 is triggered by an unsuccessful calibration attempt. This alarm will remain active until a successful calibration is performed.
AL42	O_2 Air Calibration Failure	Alarm 42 is triggered by an unsuccessful calibration attempt. This alarm will remain active until a successful calibration is performed.
AL43	Not used	
AL44	Not used	
AL45	Alarm List Failure	Alarm 45 is triggered by an error in the CA Controller involving the alarm queue. This is a display alarm and has no associated failure action.
AL46	Alarm List Full	Alarm 46 is set whenever the alarm list is determined to be full; at start-up or after recording an alarm in the list. AL46 is displayed, but is not recorded in the alarm list. This alarm can be reset by clearing the alarm list. This can only be done if all alarms written in the list are inactive.
AL47	Pressure Sensor Failure	Alarm 47 is triggered by a pressure reading outside of the range between 20 psi and 200 psi after the air compressor has been running for more than 30 seconds. This is a display only alarm and will remain active until the pressure is in range or the system is reset.
AL48	Oxygen Sensor Voltage Failure	Alarm 48 is triggered by an oxygen sensor output voltage less than 15 mv, or greater than 4.1 v. This alarm will remain active until the sensor is in-range. While AL48 is active, the compressor will run with the oxygen solenoid valve (OSV) open, unless AL39 is active, whereby all control units will be disabled, except the sample air solenoid valve (SAV).
AL49	Drain Valve Failure	Alarm 49 is triggered by the controller detects pressure differential greater than 15 psig from the starting pressure of 50 psig. This is a display only alarm and will remain active until the pressure is in range or the system is reset.

9.1.7 Controller CA Control

⚠ WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

The CA Controller controls the percentages of oxygen and carbon dioxide inside the refrigerated container. The level of oxygen and carbon dioxide in the container is lowered by replacing them with nearly pure nitrogen generated by the system. The level of these gases is increased by energizing respective solenoids when required; allowing compressed outside air to flow into the container (for oxygen); and 100% carbon dioxide to flow into the container from an external source provided by the user.

Before the CA system can start, certain conditions of the refrigeration system must be met (refer to section 10.2.a., page 111). If all these conditions are met, the Temperature (refrigeration) Controller enables CA.

Once the oxygen sensor detects an oxygen level BELOW 19.8%, the CA Controller closes the door interlock switch to prevent anyone from entering the hazardous atmosphere of the container.

When the CA Controller starts, air from outside the container enters the air compressor via the air intake filter. The air compressor is protected by an internal temperature switch (IP-AM) that sends a signal to the CA Controller if it reaches an unsafe operating temperature. The ambient air entering the air compressor is compressed. This pressurized air is then filtered by a membrane air filter assembly that removes dirt and moisture before it enters the air heater (AHTR). The first stage of the air filter removes large particulates and moisture. The second stage employs a coalescing feature to remove the remaining moisture and fine particulates. Each stage is equipped with a normally closed drain solenoid valve (DS1 & DS2). The CA Controller energizes those drain solenoid valves for 10 seconds every one-half hour to remove residue accumulated by the filters.

The filtered pressurized air moves to the air heater, where it is heated to operating temperature, for use in the nitrogen membrane separator. The CA Controller monitors the membrane temperature sensor (MTS) to control the operation of the heater, which maintains the temperature of the compressed air entering the nitrogen membrane separator. The high air temperature switch (HATS) is installed to prevent overheating of the membrane.

The heated, pressurized air enters the membrane, where the nitrogen is separated out. The purified

nitrogen is delivered to the cargo area of the container. In turn, Oxygen and other trace gases are discharged through the front of the unit, behind the CA controller, located near the membrane air filter assembly. The rate of gas separation is determined by the flow of air through the membrane. The flow rate through the membrane is determined by the Nitrogen Purity Valve (NPV). When de−energized, the NPV allows a nearly pure stream of nitrogen to pass into the container, used to decrease the amount of oxygen. To decrease the amount of CO_2 in the container the NPV is energized. When energized, the NPV introduces a higher flow rate of less pure nitrogen that purges the excess CO_2. When there is a demand for the O_2 level to increase, the Controller will energize the oxygen solenoid valve (OSV) to allow the filtered, pressurized air to flow directly into the container, bypassing the nitrogen membrane separator.

The CA Controller monitors the amount of oxygen and carbon dioxide in the container by using oxygen and carbon dioxide sensors. In conjunction, the CA Controller uses four electrically actuated solenoid valves that are selectively actuated to provide the desired gas sample flow to these sensors. These four solenoid valves are combined in a manifold block.

The air calibration solenoid valve (ASV) delivers a sample of heated ambient air to the sensors from the same line that supplies air to the nitrogen membrane separator and is used to calibrate the O_2 sensor span.

The nitrogen solenoid valve (NSV) delivers a sample of the nitrogen being supplied to the container from the nitrogen membrane separator to the sensors.

The gas calibration solenoid valve (GSV) delivers a sample of gas from an external calibration bottle. This bottle contains a calibration gas made up of 5% carbon dioxide and 95% nitrogen, is connected temporarily to a fitting located on the outside of the container (see Figure 56, page 89), which is used to zero calibrate the O_2 sensor, and check the CO_2 sensor. Calibration gas flows must be within the range of 0.5 to 1.0 lpm) (approximately 1-2 cuft/hr), an external flow meter must be used. Do not exceed five psig input pressure.

The sample air solenoid valve (SAV) delivers a sample of the atmosphere inside the container , which is used to monitor current concentrations of O_2 and CO_2 within the container.

All of the outputs from the oxygen and carbon dioxide sensors are delivered to the CA Controller to monitor the operation and performance of the CA system.

In some cases, a higher level of carbon dioxide is required to transport some commodities. A physically separate carbon dioxide supply must be provided by the user. Connection ports are located in two different areas: on the outside of the container (see Figure 56, page 89), and on the inside of the container (see Figure 57, page 90). The user must initiate CO_2 set point; the CA Controller will then actuate the solenoid valve (CSV) when required.

9.2 CA PRE-TRIP DIAGNOSTICS

Pre-trip Diagnostics is an independent mode which will suspend the normal Control Mode activities when initiated by the user. With pre-trip diagnostics, either all the pre-trip tests can be executed in a defined sequence (Auto Mode), or one of the pre-trip tests can be selected to be executed (Manual Mode), based on the sequence of key selections made.

a. Starting and Terminating Pre-Trip

Pre-trip is initiated by pressing the PRE-TRIP key. This places the user into a test selection menu. If no selection is made, pre-trip will terminate automatically. While tests are being executed, the user can terminate the pre-trip mode by holding the PRE-TRIP key. The system will then resume normal operation. If the user decides to terminate a test but remain at the test selection menu, the user may press the UP ARROW key. When this is done all machinery outputs will be de-energized and the test selection menu will be displayed.

The pre-trip diagnostics may also be initiated via remote communication, but when initiated will always attempt to execute the entire battery of tests (auto mode).

b. Temperature Controller Approval of Controlled Atmosphere Pre-Trip request

The CA Controller will make a request for CA Pre-Trip from the Temperature (refrigeration) Controller. The Temperature Controller will approve the request, except when the Temperature Controller is in Pre-Trip itself or CA is in standby mode.

In response to the CA Pre-Trip request, the Temperature Controller will have the following response:

- Exit defrost and lock-out defrost until Controlled Atmosphere Pre-Trip is complete.
- Lock-out Temperature Controller Pre-Trip.
- Alternate the message P-CA on the display with the set point until CA Pre-Trip is complete.
- Force the high speed evaporator fans ON.
- Disable Dehumidification.

When CA Pre-Trip requests are not approved, while the Temperature Controller is in Pre-Trip or CA is in standby mode, the display wll read “PPPP PPPP”. This will continue until the user presses the PRE-TRIP key or the UP ARROW key for more than three seconds. When the Temperature Control exits from pre-trip and CA is not in standby mode, CA pre-trip request will be approved. Upon CA being taken out of standby mode, CA pre-trip will re-start the test that was aborted.

CA will request a Pre-trip to continue from the Temperature Controller every minute until the completion of CA pre-trip.

c. Test Codes

A detailed description of the pre-trip test codes are listed in Table 25, page 109.

9.2.1 Pre-Trip

In this mode, the system will automatically test system components using internal measurements and comparison logic, and will provide a “PASS” or “FAIL” display to indicate the results of each test.

If the user depresses the PRE-TRIP key, the unit gives access to a pre-trip selection menu. The contents of the menu is as follows:

PRE-TRIP SELECTION MENU
Auto, P1, P2, P3, P4, P5, P6, rSLts

If the pre-trip was last executed manually since power up, the last menu selection will appear on the left

display. If pre-trip was not executed since power up, then the right display will display “Auto”. The user may scroll through the test selection menu using the ARROW keys.

A given test is selected by pressing ENTER while it is displayed. The entire battery of tests may be run by pressing ENTER while “Auto” is displayed.

During this selection mode, failure to press either an ARROW key or ENTER for five seconds will return the system to its default display and normal operating mode.

Once a test has been selected, the message “CLOSE DOOR” will be displayed. The user then has up to 15 minutes to make sure the container door is closed. If ENTER is pressed during the 15 minute period, the selected test(s) will be run. Otherwise pre-trip will be aborted.

Any test may be interrupted by pressing the UP ARROW key or the PRE-TRIP key. This will return the user to the test selection mode described above, and all machinery outputs will be de-energized.

While a given test is running, “PX-X” will be shown on the left display, where the X’s indicate the test number and sub-test. The right display will show a countdown time in minutes and seconds, indicating how much time is remaining in that particular test.

a. Manual Test Operation

Individually selected tests other than the LED/Display test will perform the operations necessary to verify the operation of the component under test. At the conclusion of the selected test, PASS or FAIL will be displayed. Upon failure, the O_2 and CO_2 LED’s will flash on alternately. This message will remain displayed for up to three minutes, in which time a user may select another test. If the three minute time span expires with no user interaction, the system will terminate pre-trip and return to control mode operation. Following any individually selected test, all outputs will be de-energized.

b. Calibration Gas

Typical calibration gas is composed of 5% carbon dioxide, 95% nitrogen (0% oxygen). The purpose of the “Cal Gas” is to calibrate the oxygen sensor and check the carbon dioxide sensor for accuracy. P4-1 of the Pre-Trip test calibrates the oxygen sensor to 0%. P4-2 of the pretrip test checks the carbon dioxide sensor at 5% for accuracy.

Calibration gas can be purchased locally by specifying to any gas supplier “certified 5% carbon dioxide (4.5% to 5.5% is acceptable), balance nitrogen.” Disposable bottles of calibration gas are available from Carrier Transicold service parts, P/N 07-00322-01. If calibration gas is not available when a pretrip is done, 100% nitrogen can be selected. When nitrogen is selected, test P4-2 (CO_2 check) will be skipped.

The calibration gas must be connected to the “Cal Gas Port” on the front of the unit. The calibration gas is only used during P4-1 and P4-2. The line flow rate should be regulated to .75 l/m (1.5 scfh), and the pressure should be regulated to less than five psi. When calibration gas is connected to the “Cal Gas Port”, a solenoid valve will prevent flow during previous and subsequent tests.

c. Auto Test Operation from Keypad

If auto test is initiated, the system will execute a series of consecutive tests, each related to a identifiable unit component, without any need for direct user interface. These tests vary in length, depending on the component under test.

When an automatic test fails, it will be repeated once automatically. A repeated test failure will cause “FAIL” to be shown on the right display, with the corresponding test number to the left. The user may then press the UP ARROW to repeat the test or the DOWN ARROW to skip to the next test. The system will wait indefinitely for user input. Holding the PRE-TRIP key will terminate the pre-trip mode operation.

When the automatic testing is allowed to run to completion, without being interrupted with an ARROW key being depressed, the system will exit the pre-trip mode and return to normal control operation.

d. Auto Test Operation from Serial Communications

If the refrigeration system is equipped with an RMU, then pre-trip may also be initiated via remote communications. The operation is the same as for the Auto Test mode described above except that should a test fail, the pre-trip mode will automatically terminate. When initiated via communications, a test may not be interrupted with an ARROW key, but the pre-trip mode can be terminated with the PRE-TRIP key.

e. Pre-Trip Test Results

At the end of the pre-trip test selection menu, the message “P” “rSLts” will be displayed. Pressing the ENTER key will allow the user to see the results for all sub tests (i.e. 1-0, 1-1, etc). The results will be displayed as “PASS” or “FAIL” for all tests run to completion since power up. If a test has not been run since power up, “-----” will be displayed.

9.2.2 Pre-Trip Mode

Table 25. Controlled Atmosphere Pre-Trip Test Codes

NOTES		
• Failure results in a single retry prior to the fail message if initiated from “Auto Pre-Trip”. • The total time span of an “Auto Pre-Trip” runs from 39 to 79 minutes.		
CODE NO.	**TITLE**	**DESCRIPTION**
P0	LED/LCD Test	All lights and display segments will be energized for three seconds at the start of the pre-trip. Since the system cannot recognize lights and display failures, there are no test codes or results associated with this phase of pre-trip. **Pass/Fail Criteria:** The individual performing the test will determine through observation if test passes or fails.
P1-0	Drain Valves Test	**Requirements:** The pressure sensor must read at least 50 psig prior to this test. **Setup:** This test will continue with the drain valves closed for 10 seconds, and then run with the drain valves open for 10 seconds. A timer will be displayed during the test. **Pass/Fail Criteria:** Passes for a detected initial pressure greater than 50 psig and pressure drop of greater than 15 psig, after the drain valves open. Fails otherwise.
P1-1	Oxygen Solenoid Valve Test	**Requirements:** The pressure sensor must read at least 50 psig prior to this test. **Setup:** This test will continue with the drain and oxygen solenoid valve (OSV) closed for 10 seconds, and then run with OSV open for 10 seconds. A timer will be displayed during the test. **Pass/Fail Criteria:** Passes for a detected initial pressure greater than 50 psig and pressure drop greater than 20 psig after the oxygen valve opens. Fails otherwise.
P1-2	Nitrogen Purity Valve Test	**Requirements:** The pressure sensor must read at least 50 psig prior to this test. **Setup:** This test will continue with the drain and nitrogen purity valve (NPV) closed for 10 seconds, and then run with NPV open for 10 seconds. A timer will be displayed during the test. **Pass/Fail Criteria:** Passes for a detected initial pressure greater than 50 psig and pressure drop of greater than 10 PSIG, from the 50 psig minimum starting pressure, after the Nitrogen Purity Valve opens. Fails otherwise.
P2-0	Heater Test	**Requirements:** The pressure sensor must read at least 50 psig throughout this test. **Setup:** This test will energize the air heater for up to 30 minutes. The test will end when the temperature comes to and stays within 3°C of the setpoint for 5 minutes. At that point, the controller will open the Nitrogen Purity Valve (NPV) and display the membrane pressure for one minute. **Pass/Fail Criteria:** Passes for maintaining temperature within 3°C for 5 minutes and then pressure for 1 minute. Fails otherwise.
P3-0	Oxygen Sensor Span Calibration	This test will attempt a span calibration of the oxygen sensor using ambient atmospheric air, and will run for up to ten minutes. **Pass/Fail Criteria:** Passes for a successful calibration. Fails otherwise.

Table 25. Controlled Atmosphere Pre-Trip Test Codes – Continued

CODE NO.	TITLE	DESCRIPTION
P4-0	Carbon Dioxide Zero Calibration	This test will attempt a zero-point calibration of the carbon dioxide sensor using the nitrogen stream, and will run for up to 10 minutes and 30 seconds. **Pass/Fail Criteria:** Passes for a successful calibration. Fails otherwise.
P4-1	Oxygen Sensor Zero Calibration	This test will attempt a zero-point calibration of the oxygen sensor using a calibration gas, and will run for up to 12 minutes. **Pass/Fail Criteria:** Passes for a successful calibration. Fails otherwise. **NOTE** If test P4-1 fails, then recheck after test P6-0.
P4-2	Carbon Dioxide Sensor Check	This test will check the span of the carbon dioxide sensor using a calibration gas, and will run for up to eight minutes. **Pass/Fail Criteria:** Passes for a successful check. Fails otherwise.
P5-0	System Performance Tests	**Requirements:** Valid oxygen sensor calibration values must be available. (Zero-point and span.) The membrane temperature should be within 3°C of setpoint. However, this test will not fail if this requirement is not met. **Setup:** This test will check the nitrogen percentage from the membrane, and will run for up to 10 minutes. **Pass/Fail Criteria:** Passes for a successful check with a nitrogen range greater than 97.5%. Fails otherwise.
P5-1	System Performance Tests	**Requirements:** Valid oxygen sensor calibration values must be available. (Zero-point and span.) The membrane temperature should be within 3°C of setpoint. However, this test will not fail if this requirement is not met. **Setup:** This test will check the nitrogen percentage from the membrane while the nitrogen purity valve is energized, and will run for up to 10 minutes. **Pass/Fail Criteria:** Passes, with P5-1 displayed, for a successful check as defined by the following: N2 range between 88 and 97%. Fails otherwise.
P6-0	Carbon Dioxide Zero Calibration	This test will attempt a zero-point calibration of the carbon dioxide sensor using the nitrogen stream, and will run for up to 10 minutes and 30 seconds. **Pass/Fail Criteria:** Passes for a successful calibration. Fails otherwise. P6-0 is the same as, but independent from P4-0, and is not run during the Auto Mode of Pre-Trip.

SECTION 10

OPERATION

10.1 CONTROLLED ATMOSPHERE (CA) PRE-TRIP INSPECTION (Before Starting)

a. Required Materials

1. Pre-Trip Kit
2. Calibration Gas
3. CO_2 Bottles (when required)

CARBON DIOXIDE ADDITION:

When a commodity requires the addition of carbon dioxide to maintain set points, 100% CO_2 gas bottles must be provided. Bottles can be installed inside or outside the container. Provision has been made to connect in either location (see Figure 56, page 89 or Figure 57, page 90). CO_2 bottles should be secured to the container structure.

Set manifold pressure of the CO_2 bottle to 20 psig. The system control will open and close an internal valve to discharge gas into the container.

b. Container Preparation

Inspection:

Check the rear container doors and door handles for proper operating condition. Check for proper installation of labels on the container and refrigeration unit. Always visually check the inside of the container for occupants prior to closing the doors. Check rear door lock for proper installation, and that the solenoid plunger is unobstructed.

Container Curtain:

Refer to section 12.12, page 131 for container curtain installation instructions.

Leak Check Container - (Curtain Installed):

DANGER

HAZARDOUS ATMOSPHERE INSIDE. LOW OXYGEN INSIDE CONTAINER CAN CAUSE DEATH.

Performing service on, or entering a CA equipped unit can be extremely dangerous. Refer to the Safety section of this manual before servicing or entering the container.

Two connection ports are provided on the front of the unit, see Figure 56, page 89. One is used for pressurizing the container and the other is used for a pressure gauge hookup to monitor leakage rates.

1. For static testing the acceptable leakage rate at 0.5 inch water gauge (12.55 mm) is 100 scfh (2.8 cmh) or less.
2. For pressure decay testing, measure the time required for the pressure to decay from 2.0 inches water gauge (38 mm) to 1.0 inch water gauge (25 mm). The acceptable time span is 105 seconds or more for a 40 foot container and 53 seconds or more for a 20 foot container.

If either test results in unacceptable leakage rates, then sealing of the container is required. These leakage rates must be maintained or the Controlled Atmosphere (CA) system will not be able to reach its set points.

Some areas to check for leaks are:

- Check for installation of polysheet curtain.
- Check the unit drain line. Fill with water, if necessary.
- Check the unit access panels.
- Check unit/container box joint. Caulk if necessary.
- Inside the container, check floor drains, check floor to side wall joint, floor to front bulkhead joint, side wall to front bulkhead joint and ceiling to front bulkhead.

Installation of filters:

Install new filters (intake air and sample air), refer to section 12.7, page 127. Make sure all safety labels are in place.

10.2 CONTROLLED ATMOSPHERE (CA) STARTING AND STOPPING INSTRUCTIONS

Starting the CA system

The start up process will occur automatically at each controller RESET or power–up, or whenever the Controlled Atmosphere Run/Stop switch changes from the Stop position to the Run position. The controller will test the system components to ensure proper operations. If any critical test fails, the appropriate error message will display for 5 seconds and then the system will restart.

1. Start refrigeration system. (Refer to section 4.6, page 46)
2. Place the Controlled Atmosphere Start-Stop switch (CAS) to the ON position.
3. The unit will enter the standby mode (standby indicator will be illuminated) unless all of the following conditions are met:
   - Return air temperature set point is below 25 degrees C.
   - The refrigeration unit temperature is “in-range”.
   - The CA air compressor has not run for three minutes.
4. Set O_2 and CO_2 set points.

NOTE

The CA system will require up to 30 minutes for warm-up. The sensors require a warm-up time and will display dashes (– – – – – –) until good values can be displayed. Once the CA compressor starts, the drain valves open.

5. Perform START–UP INSPECTION, refer to section 10.3.

Stopping the CA System

1. Vent (Refer to 10.7 page 113)

⚠ WARNING

Low oxygen levels inside container. Ventilate container (refer to section 10.7 page 113) before entering. Stay away from doors while venting.

2. Move the CAS switch to the OFF position (0).

10.3 START–UP INSPECTION

Once the STANDBY LED has de-energized, proceed as follows:

a. Check “Oxygen Sensor Life”, code Cd14.

b. Check “Hours Since Compressor Service”, code Cd16.

c. Check “Hours Since Filter Change”, code Cd17.

d. Perform Pre-Trip diagnostics.

e. Verify “Door Lock Solenoid State”, code Cd30.

10.4 PRE–TRIP

Pre-Trip diagnosis provides automatic testing of the unit components using internal measurements and comparison logic. The program will provide a “PASS” or “FAIL” display to indicate test results.

The testing begins with access to a pre-trip selection menu. These tests will automatically perform a series of individual pre–trip tests. The user may also scroll down to select any of the individual tests. The contents of the menus are as follows:

PRE-TRIP SELECTION MENU	
Manual	User Selected
Auto	P1–0, P1–1, P1–2, P2–0, P3–0, P4–0, P4–1, P4–2, P5–0, P5–1, P6–0, rSLts

Pre–trip “P” functions are defined as follows:

P1-0 The “Drain Solenoid Valves” are tested.
P1-1 The “Oxygen Solenoid Valve” is tested.
P1-2 The “Nitrogen Purity Valve” is tested.
P2-0 The membrane temperature is brought to set point.
P3-0 An O_2 sensor span calibration is performed (i.e., “O_2 Air Cal”).
P4-0 A CO_2 sensor zero calibration is performed (i.e., “CO_2 Zero Cal”).

P4-1 An CO_2 sensor zero calibration is performed (i.e., the sensor reading is checked against a calibration gas of known 0% O_2 content).

P4-2 A CO_2 sensor span check is performed (i.e., the sensor reading is checked against a calibration gas of known CO_2 content). If code 32 is set to OFF, test is skipped.
P5-0 System performance is tested for N_2 purity at the output from the membrane.
P5-1 System performance is tested for N2 purity at the output from the membrane with the nitrogen purity valve energized.
P6-0 A CO_2 sensor zero calibration is performed (i.e., “CO_2 Zero Cal”) same as, although independent from P4-0.

If no selection is made, the pre-trip menu selection process will terminate automatically.

Scrolling down to the “rSLts” code and pressing ENTER will allow the user to scroll through the results of the last pre–trip testing run. If no pre–testing has been run (or an individual test has not been run) since the unit was powered up “----” will be displayed.

To start a pre–trip test, do the following:

NOTE

1. Prior to starting tests, verify that unit voltage (Function Code Cd 07) is within tolerance and unit amperage draw (Function Codes Cd04, Cd05, Cd06) is within expected limits. Otherwise, tests may fail incorrectly.

2. All alarms must be rectified and cleared before starting tests.

3. Pre-trip diagnosis may also be initiated via communications. The operation is the same as for the key pad initiation described below except that should a test fail, the pre-trip mode will automatically terminate. When initiated via communications, a test may not be interrupted with an arrow key, but the pre-trip mode can be terminated with the PRE-TRIP key.

a. Press the PRE-TRIP key. This accesses a test selection menu.

b. TO RUN AN AUTOMATIC TEST: Scroll through the selections by pressing the UP ARROW or DOWN ARROW keys to display AUTO and then press the ENTER key.

While tests are running, “P#-#” will appear on the left display, where the #’s indicate the test number and sub-test. The right display will show a countdown time in minutes and seconds, indicating how much time there is left remaining in the test.

⚠ CAUTION

When a failure occurs during automatic testing the unit will suspend operation awaiting operator intervention.

When an automatic test fails, it will be repeated once . A repeated test failure will cause “FAIL” to be shown on the right display, with the corresponding test num-

ber to the left. The user may then press the DOWN ARROW to repeat the test, the UP ARROW to skip to the next test or the PRE–TRIP key to terminate testing. The unit will wait indefinitely, until the user manually enters a command.

c. TO RUN AN INDIVIDUAL TEST: Scroll through the selections by pressing the UP ARROW or DOWN ARROW keys to display an individual test code. Pressing ENTER when the desired test code is displayed.

1. Individually selected tests, other than the LED/Display test, will perform the operations necessary to verify the operation of the component. At the conclusion, PASS or FAIL will be displayed. This message will remain displayed for up to three minutes, during which time a user may select another test. If the three minute time period expires, the unit will terminate pre-trip and return to control mode operation.

2. While the tests are being executed, the user may terminate the pre-trip diagnostics by pressing and holding the PRE-TRIP key. The unit will then resume normal operation. If the user decides to terminate a test but remain at the test selection menu, the user may press the UP ARROW key. When this is done all test outputs will be de-energized and the test selection menu will be displayed.

d. Pre-Trip Test Results

At the end of the pre-trip test selection menu, the message "P," "rSLts" (pre–trip results) will be displayed. Pressing the ENTER key will allow the user to see the results for all subtests (i.e., 1-0, 1-1, etc). The results will be displayed as "PASS" or "FAIL" for all the tests run to completion since power up. If a test has not been run since power up, "– – – – – –" will be displayed.

10.5 CONTROLLED ATMOSPHERE SET POINT SELECTION

Press the DISPLAY FREEZE key when the O_2 or CO_2 set point is displayed. Press the UP/DOWN ARROW keys until the left window displays the desired set point value. This value will flash for five seconds. Press the ENTER key within the five seconds to enter new set point. If the ENTER key is not pressed, the set point will remain at the previously entered value.

Oxygen and CO2 concentrations will alternate for approximately 5 seconds each, with setpoint on the left and concentration on the right. Other messages, indicating improper system operation, are sometimes alternated for a third 5 second period along with the Oxygen and CO2 information. If any of the alarm conditions are active, 'AL##' is displayed on the left display, where '##' indicates the most recent active alarm.

When gas sensor values are not available for display, '– – – – –' will be shown rather than the gas concentration. The normal display will not show an O2 reading less than 0.0 or higher than 20.9%, nor a CO2 reading less than 0.0% or higher than 100.0%.

The five second rotations of the default display can be overridden with the DISPLAY FREEZE key. Pressing the DISPLAY FREEZE key will freeze the current display for 1 minute. After pressing the display freeze key again, the display will scroll to the next display and resume alternating the displays (unfreeze).

10.6 CONTROLLED ATMOSPHERE SYSTEM OPERATION

General operations for controlling the CO2 and O2 levels in are accomplished by the controller through the following controller functions.

a. **STANDBY (LOCKOUT)** The Temperature (refrigeration) Controller is preventing the CA Controller from operating, due to pre-set requirements that are not yet satisfied. Refer to section 10.2.a., page 111.

b. **OXYGEN CONTROL STATE 1** The oxygen concentration level is <u>less than</u> set point.

c. **OXYGEN CONTROL STATE 2** The oxygen concentration level is <u>greater than</u> set point.

d. **CARBON DIOXIDE CONTROL STATE 1** The carbon dioxide concentration level is <u>less than</u> the CO_2 set point.

e. **CARBON DIOXIDE CONTROL STATE 2** The carbon dioxide concentration level is <u>greater than</u> the CO_2 set point.

f. **O_2 AIR CAL (Auto. Trigger)** An O_2 sensor span calibration is performed automatically 2 hours after start-up and then once every 24 hours.

Other control variables are available to the user though the controller keypad, refer to Table 20 page 98 for more information.

10.7 CONTROLLED ATMOSPHERE (CA) SYSTEM CONTAINER VENTING PROCEDURE

⚠ WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

Venting the container via the CA Controller (Normal Operating Conditions, i.e., w/power)

1. Set the CAS switch and container ST switch to the ON position (I).
2. On the keypad depress the VENT key, and then depress the ENTER key.
3. Display will show "OPEn Air". Manually open the fresh air makeup vent.
4. Turn the fresh air makeup vent to 100% (fully open), and then depress the ENTER key on the keypad. Avoid any direct breathing of the venting gases from the air makeup vent.
5. Allow the refrigeration unit to run. This allows the evaporator fans to exchange low-oxygen level air with ambient air.
6. The door interlock system will open when O_2 reaches 20 ± 2%.
7. Open both of the container rear doors and pull back the curtain to facilitate the clearing of the hazardous atmosphere. Step away from the container rear doors. Continue refrigeration operation for five minutes prior to entry or unloading of the container. Do not close doors. (Wait 45 minutes before climbing on contents inside of the container.)

Venting the container when a power failure occurs (this procedure should only be used in emergency situations)

In case of a power failure to the unit, there is no emergency provision to unlock the automatic door interlock system:

⚠ DANGER

WHEN OVERRIDING THE CA CONTROLLER, THE OPERATOR MUST BE AWARE OF THE IMMEDIATE DANGER OF UNCONSCIOUSNESS AND DEATH. THE OPERATOR MUST READ AND UNDERSTAND ALL WARNING LABELS AND SAFETY INSTRUCTIONS BEFORE PROCEEDING WITH THE EMERGENCY BYPASS PROCEDURE.

To enter the container in a true emergency situation, do the following:

1 Ensure at least two persons are present. One person is to act in a supervisory manner, and that person is charged with the responsibility to ensure all procedures are performed correctly and all waiting times have expired before allowing entry.

2 Open the fresh air makeup vent 100% (fully open). Avoid any direct breathing of venting gases from the air makeup vent.

3 To enter the container, the interlock system must be removed. To remove the system, remove the center bolt from the catch or remove the four screws holding the interlock system to the container door.

⚠ WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

4 Fully open container doors.

5 Pull back the curtain (poly sheet) to accelerate the time of a complete ambient air exchange.

6 Step away from the container rear doors. Do not close doors. Wait 30 minutes prior to entry or unloading of the container. Wait 45 minutes before climbing on contents inside of the container.

7 If access to the container is necessary (i.e., life and death situations) prior to the safety venting procedures being performed, then: only rescue personnel trained in safety procedures in removing victims from hazardous atmospheres are to be allowed entry into the container at this point.

8 All other personnel are to stay well clear of the doors.

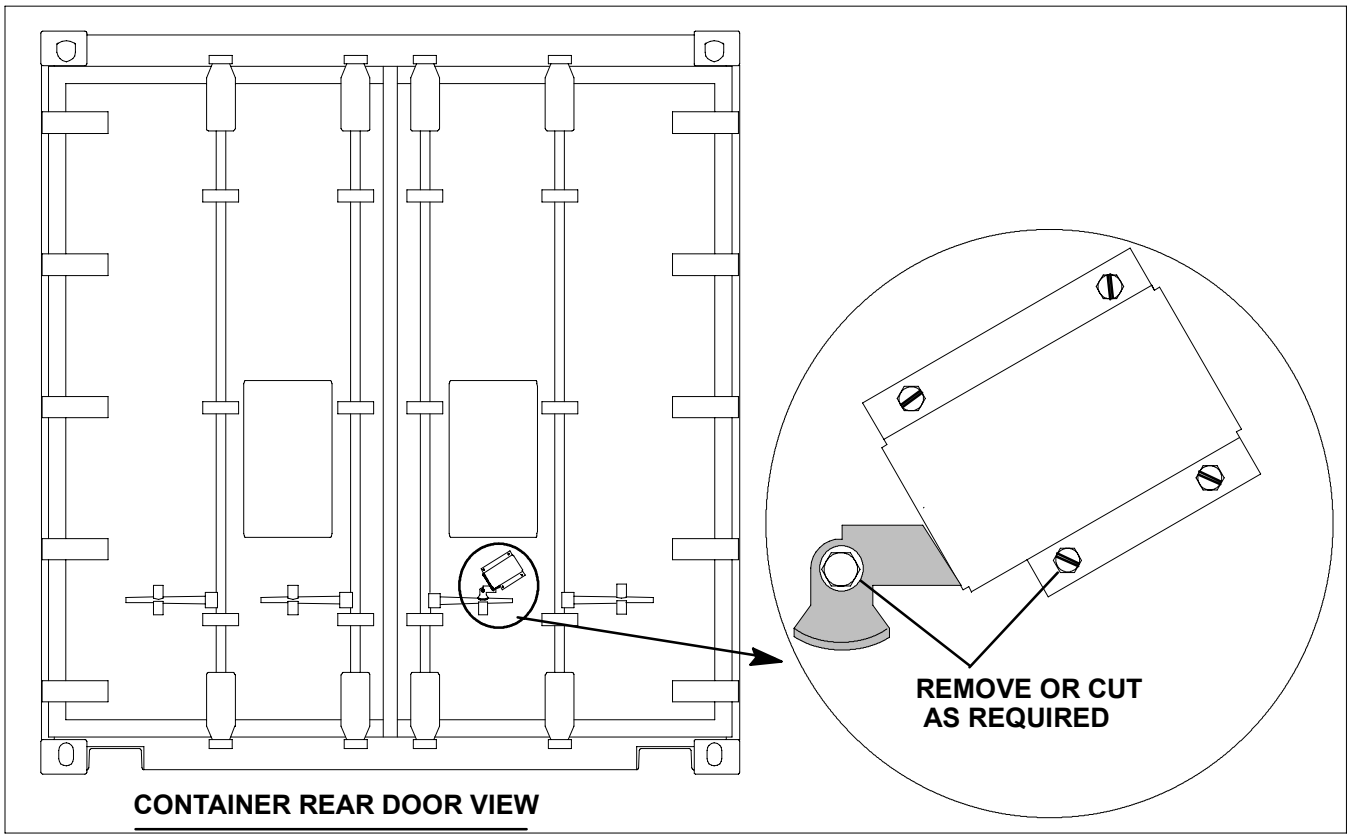


Figure 66 Emergency Bypass for the Door Interlock System

SECTION 11

TROUBLESHOOTING

NOTE

This troubleshooting chart is to be used with Controlled Atmosphere sections only.

INDICATION/ TROUBLE	POSSIBLE CAUSES	REMEDY/ REFERENCE SECTION
11.1 CONTROLLED ATMOSPHERE (CA) SYSTEM WILL NOT START		
No power to unit	External power source OFF	Turn on
	Start-Stop switch (CAS) OFF or defective	Check/Replace
Loss of control power	Fuse blown (F3)	Check
	Start-Stop switch (CAS) OFF or defective	Check/Replace
Loss of control power in respective branch of control circuit only	Air compressor internal protector (IP-AM) open	Check
	High pressure switch (HATS) open	Check
Air compressor hums, but does not start	Low line voltage	Check
	Single phasing	Check
	Shorted or grounded motor windings	Check
	Air compressor seized	Check
11.2 CONTROLLED ATMOSPHERE (CA) SYSTEM MALFUNCTION		
Air compressor will not start	Temperature Controller not configured for CA	Check
	CA in STANDBY mode	Check
	External power source OFF	Turn on
	Air compressor contactor (AC) defective	Replace
	Internal protector (IP-AM) open	Replace
	Unit at set point	Check
	Unit in Pre-trip (Temperature Controller)	Check
Air compressor runs, oxygen % will not come down	Air compressor off more than 3 minutes	Check
	Leaky cylinder head o-ring	Check
	Leaky discharge manifold assembly	Check
	Leaky air solenoid valve (ASV)	Check
	Sensor defective	Check
	Membrane defective	Check
	Heater defective	Check
	Oxygen solenoid valve (OSV) defective	Check/Replace
Heater malfunction	Membrane temperature sensor failure	Replace
	Heating element defective	Check
	Contactor defective (AH)	Check
	Solid State Relay (SSR) defective (AT)	Check
	CA in STANDBY mode (refer to section 10.2)	Check
	High air temperature switch failure	Replace

11.2 CONTROLLED ATMOSPHERE (CA) SYSTEM MALFUNCTION – CONTINUED		
Pressure transducer reading (Low)	Air compressor defective or leaking	Check
	Compressor pressure regulating or relief valve leak	Check
	CA system leak	Check
	Dirty air intake filter element	Check
	Oxygen solenoid valve (OSV) defective	Check
	Membrane filter elements dirty	Check
	Filter drain solenoid valves leaking	Check
Pressure transducer reading (High)	Heater defective	Check
	Nitrogen membrane separator defective	Check
	CA piping clogged or kinked	Check
Inconsistent gas % reading	Incorrect calibration values	Calibrate
	Cal gas calibration error	Calibrate
	Fresh air makeup is open	Close
	Leaky container box	Check
	Leaky air solenoid valve (ASV)	Check
CO_2 level not in range	CO_2 bottle empty	Check
	CO_2 pressure regulator closed or frozen	Check
	Control solenoid valve defective (CSV)	Check
	CO_2 sensor calibration error	Check
	Leaky container box	Check
	CO_2 line leak, clogged or kinked	Check
Gas sensors will not calibrate	CO_2 Cal gas (5%, 20%, OFF) Correct mixture is not selected.	Check
	Controlled Atmosphere system leak	Check

SECTION 12

SERVICE

⚠ WARNING

Before servicing unit, make sure the start-stop switches (CAS & ST) are in the OFF position. Unit circuit breakers (CB-1 and CB-2) and external power sources are turned OFF and tagged to prevent accidental energizing of circuits.

⚠ WARNING

Low oxygen levels inside container, ventilate before entering. Stay away from doors while venting.

NOTE

Prior to performing service work, a thorough review and understanding of the entire manual is recommended.

12.1 MAINTENANCE SCHEDULE

UNIT		OPERATION	REFERENCE SECTION
ON	OFF		
a. Pre-Trip			
	X	Pre-Trip Inspection – before starting	10.1, pg. 111
X		Pre-Trip Inspection – after starting	10.3, pg. 112
X		Check air compressor hours	9.1.4, pg. 102
	X	Replace air intake filter	12.7, pg. 127
	X	Replace sample air filter	12.8, pg. 128
	X	Replace poly sheet curtain and curtain label and ensure that it is correctly installed	12.12, pg. 131
	X	Oxygen sensor (If function code Cd14 is displayed on service list when service “LED” is energized or when “BAD” is displayed on Cd14)	12.9, pg. 128
b. Every 400 Hours (Normal Operating Conditions)			
	X	Change primary and secondary filters of the membrane air filter assembly	12.6, pg. 127
	X	Change crankcase air filter	12.5 pg. 122
	X	Inspect accumulator, drain and condensing lines	12.2 pg. 118
c. Every 5000 Hours			
	X	Minor service rebuild of air compressor – replace piston rings, piston ring expanders, piston skirts, cylinder head valves, o-rings and gaskets. Inspect cylinder sleeves for internal corrosion.	12.2, pg. 118 or 12.5 pg. 122
d. Every 10,000 Hours			
	X	Major service rebuild of air compressor – replace piston and connecting rod assemblies, piston rings, piston ring expanders, piston skirts, cylinder heads, cylinder sleeves, cylinder head valves, o-rings and gaskets	12.2, pg. 118 or 12.5 pg. 122

12.2 AIR COMPRESSOR

⚠ WARNING

Make sure power to the unit is OFF and the power plug is disconnected and tagged before servicing the compressor.

NOTE

Prior to performing compressor (See Figure 67, page 119) service work, a thorough review and understanding of this section , section 12.3, or section 12.4, page 121 is recommended.

NOTE

Do not lubricate the air compressor, it is an oilless design; which employs Teflon piston rings and skirts, and pre-lubricated, sealed-for-life bearings which require no further lubrication.

a. Air Compressor Inlet Cleaning and Inspection

1. Inspect the inlet line for damage and leaks.

2. Clean and inspect accumulator tank for proper drainage:

   a. Remove the flexible line from the aluminum condensing line to the accumulator tank.

   b. Mix a solution of chlorine bleach and distilled water, mix one teaspoon (5 ml) of bleach to one gallon (3.8 L) of water.

   c. Plug the drain line on the outside of the unit; pour one quart or one liter of solution into the accumulator, and let stand for 5 minutes.

   d. Remove the plug and allow the solution to drain.

3. Inspect the accumulator drain line for proper slope making sure that the line is not in contact with the evaporator coil.

4. Check to make sure that all insulation in properly secured, on drain line and compressor inlet tube.

5. Re–attach inlet tube to the accumulator.

6. Check all fitting for tightness; if accumulator–mounting nut is loose re–apply blue Loctite.

b. Removing the Air Compressor

⚠ WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

1. From inside the container: lower the upper panel in the refrigeration evaporator section and support the top grille with a spacer to gain more working area.

2. Cut the wire tie (item 7) and loosen the hose clamp (item 14). Disconnect the PVC tube (item 15) from the tube connection (item 3) of air compressor.

3. Remove four bolts (item 12) and four flat washers (item 13) from the compressor mounting bracket (item 11).

4. Disconnect plug (item (Item 2)).

5. Remove the air compressor (item 1).

6. Remove two screws (item 4), two flat washers (item 5) and two locknuts (item 6) from the compressor mounting bracket.

7. Dismount the compressor mounting bracket (item 11) from the air compressor by removing four bolts (item 8), eight flat washers (item 9) and four locknuts (item 10).

c. Replacing the Air Compressor

1. Install the air compressor by reversing the steps in section 12.2.a.

2. If compressor has been rebuilt or replaced with new, function code Cd16 should be reset to “0”. (see section 9.1.4, page 102).

12.3 AIR COMPRESSOR SERVICE (P/N 18–00052)

Prior to the disassembly of the air compressor, follow the steps in section 12.2.a for removal of the air compressor from the refrigeration unit. When disassembling the compressor, matchmark parts so that they may be replaced in their same relative positions.

Tools needed:

a. Impact wrench, 1/2 inch drive
b. Torque wrench
c. Crescent (adjustable) wrench
d. Allen wrench, 1/4 inch
e. Straight jaw puller
f. Arbor press
g. Ball peen hammer
h. Center Punch

Tools to be made:

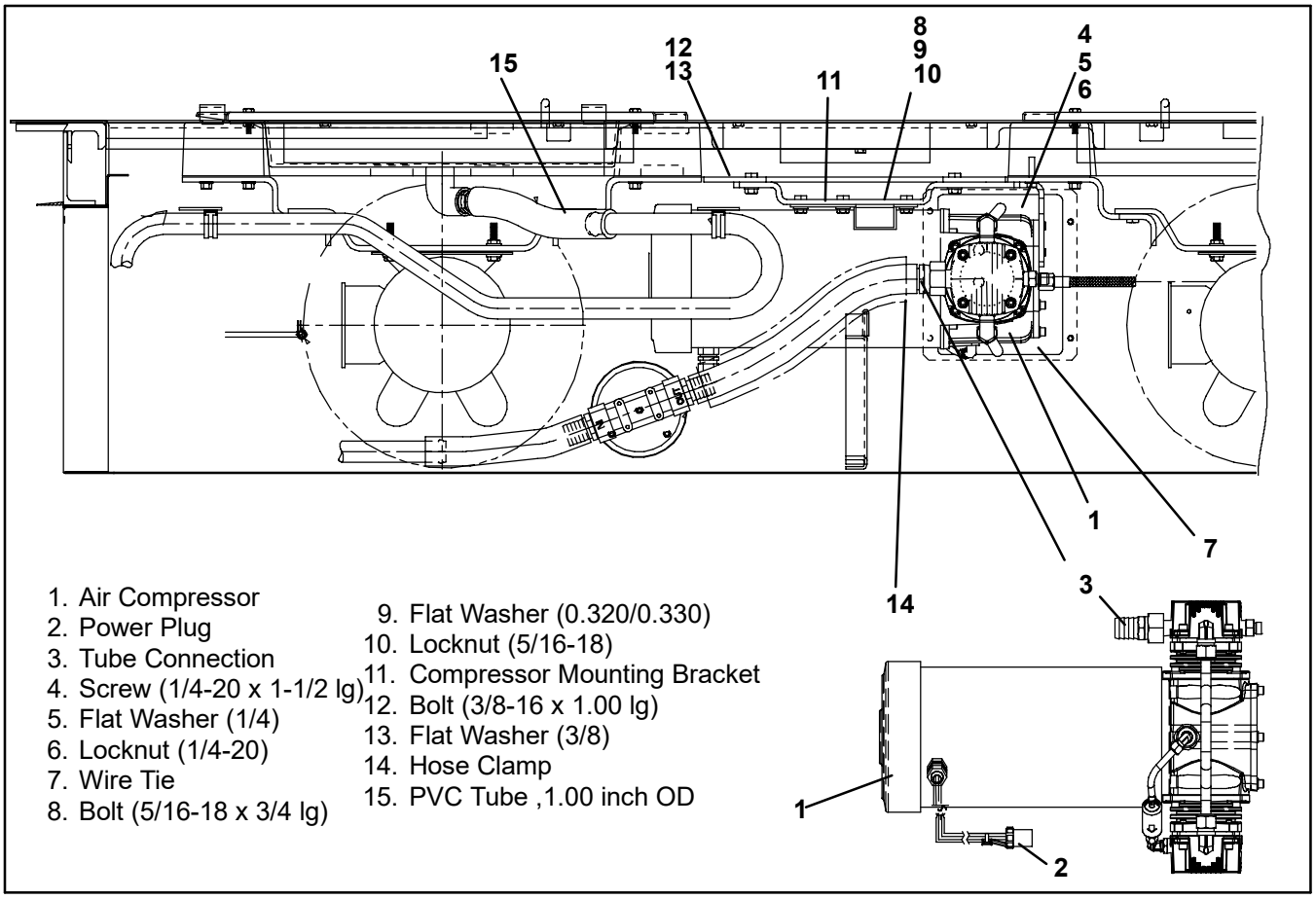
1. Shaft protector (blower end): cut a piece of one-half inch OD cold rolled steel stock one inch long and tack weld to the center of base. For the base, cut a piece of four inch by one-half inch thick bar stock to three inches in length.

2. Shaft protector (cylinder head end); cut a piece of one and one-quarter inch OD x one inch ID steel tubing to two inches long.

3. Puller backing plate; using A2 steel by 0.39 inch thick material, make plate following the dimensions in Figure 68.

Disassembly:

a. Place the compressor in a reasonably clean area where there is an adequate area to disassemble the unit.



1. Air Compressor
2. Power Plug
3. Tube Connection
4. Screw (1/4-20 x 1-1/2 lg)
5. Flat Washer (1/4)
6. Locknut (1/4-20)
7. Wire Tie
8. Bolt (5/16-18 x 3/4 lg)
9. Flat Washer (0.320/0.330)
10. Locknut (5/16-18)
11. Compressor Mounting Bracket
12. Bolt (3/8-16 x 1.00 lg)
13. Flat Washer (3/8)
14. Hose Clamp
15. PVC Tube ,1.00 inch OD

Figure 67. Typical Air Compressor

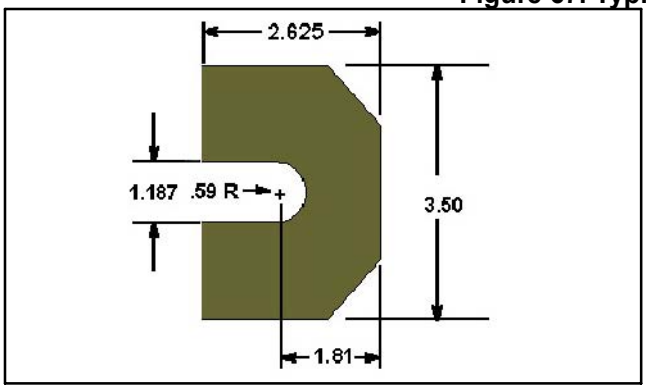


Figure 68. Puller Backing Plate

b. Disconnect the discharge manifold hose from the lower head (swivel end). MAKE SURE NOT TO DISTORT THE MANIFOLD TUBING.

c. Loosen the hose clamp on the clear PVC tubing that is connected to the brass elbow on the cylinder head, and then disconnect the PVC tubing from the elbow.

d. Disconnect the crankcase vent tubing (black) from both cylinder heads.

e. Remove the four 1/4 inch socket head cap screws from the cylinder heads. Remove the cylinder heads being careful not to drop the heads or to damage the machined surfaces. If the cylinder head is stuck, tap the center of the cylinder head with a wooden or lead mallet. DO NOT STRIKE THE SIDE OF THE CYLINDER HEAD!

f. Remove four 1/4 inch socket head cap screws securing each cylinder sleeve to the crankcase. Remove the cylinder sleeves.

g. Remove the four 1/4 inch socket head cap screws from the front crankcase and remove the front of the crankcase housing.

h. Remove the piston skirts from the pistons (two per piston).

i. Removal of the piston rings is accomplished by grasping a ring near its gap and lifting one side of the ring out from the piston ring groove.

⚠ CAUTION

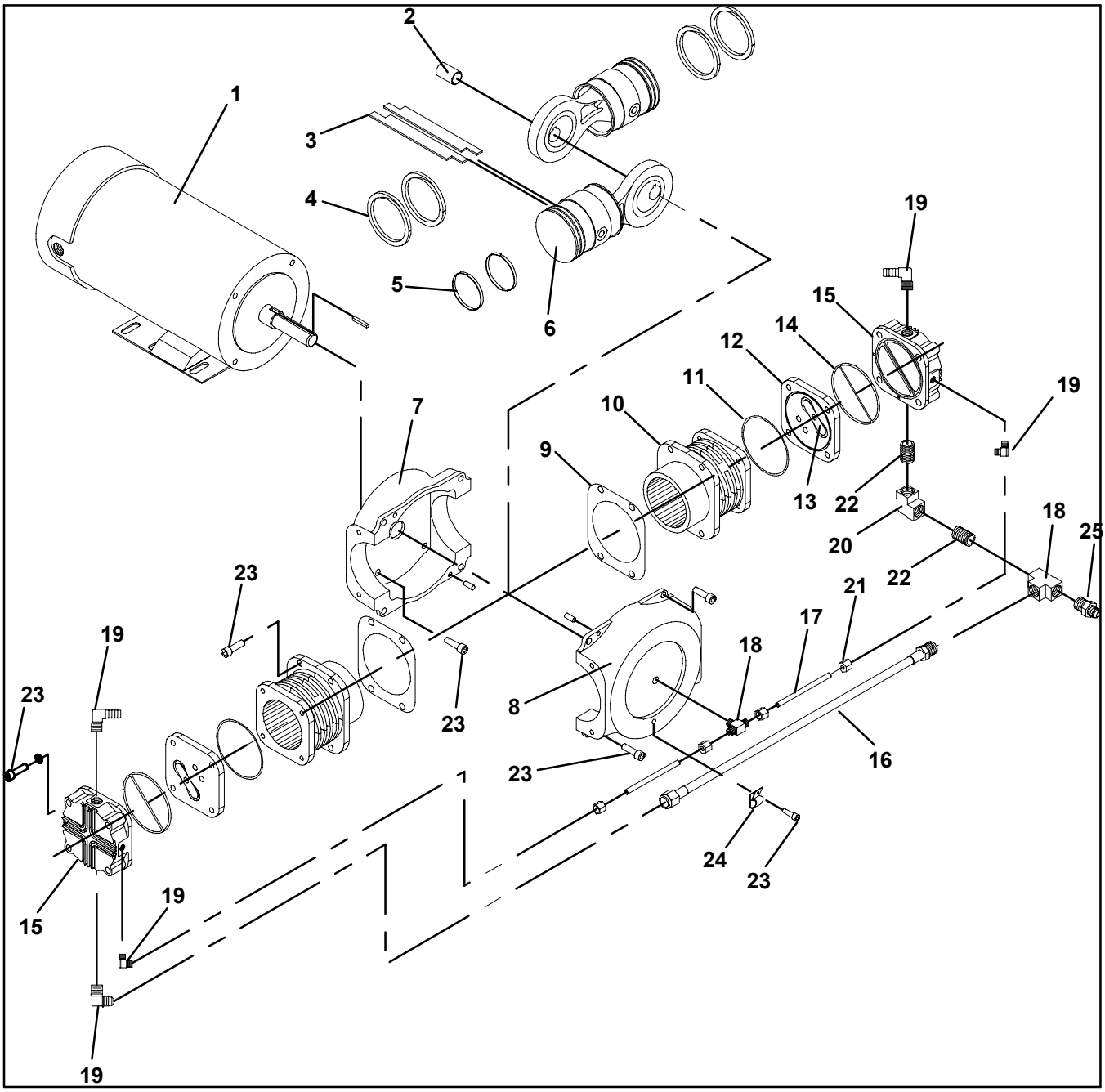
Care must be taken during ring removal because rings are very brittle.

Continue lifting the ring in a circular motion until the ring has been completely removed. Repeat this process until all four piston rings are removed. Then remove the four piston ring expanders.

j. Check to be sure that the motor shaft is rotated so that both of the pistons are at top dead center and insert the puller backing plate. Position the puller backing plate (or bearing puller) so that the slot slides over the motor shaft behind the inboard connecting rod assembly.

k. Gently position the puller jaws behind the puller backing plate and line up the threaded puller rod with the center of the motor shaft. Hand-tighten the puller rod. Place a shop rag around each piston to prevent dam-

age. With a 1/2 inch drive impact wrench, maintain a straight alignment throughout the removal process. This procedure will remove both piston and rod assemblies. Remove the square key and the motor shaft spacer located at the rear of the motor shaft.



1. Motor
2. Motor Shaft Spacer
3. Piston Skirt
4. Piston Rings
5. Piston Ring Expanders
6. Piston and Connecting Rod Assembly
7. Rear Crankcase
8. Front Crankcase
9. Cylinder Sleeve Gasket
10. Cylinder Sleeve
11. O-Ring
12. Valve Plate
13. Valve
14. O-Ring Gasket
15. Cylinder Head
16. Discharge Manifold Assembly
17. Crankcase Vent Tubing
18. Tee
19. Elbow, Male
20. Elbow, Female
21. Compression Nut and Ferrule
22. Nipple
23. 1/4 inch Socket Head Screw
24. Hose Clamp
25. Adapter

Figure 69. Air Compressor (P/N 18-00052) Exploded View

12.4 AIR COMPRESSOR ASSEMBLY (P/N 18-00052)

Prior to the assembly of the air compressor, make sure that all parts are correct, clean, and free of oil, as this is an oil-less air compressor. All references to *right* and *left* are made when viewing the compressor from the cylinder head end.

Installing the Components:

a. Place the motor shaft spacer on the motor shaft and slide it as far as possible to the rear. It should seat against the rear crankcase. Then place the square key in the motor shaft keyway at the front of the motor shaft with half of the square key in the keyway and the other half protruding out from the keyway.

b. Slide the first piston and connecting rod assembly onto the motor shaft, insuring that the offset of the piston and connecting rod faces outward with the piston extending to the right of the motor shaft. The eccentric keyway of the connecting rod assembly should be aligned with the square key in the motor shaft keyway.

c. Place the compressor on a standard arbor press with the blower end face down. Be sure to use a shaft protector (see "Tools to be made", section 12.3, page 118) on the blower end to protect the blower and housing.

d. Use the shaft protector (see "Tools to be made", section 12.3, page 118) for the cylinder head end. Press the first piston and connecting rod assembly onto the motor shaft just far enough to start the installation of the second piston and connecting rod assembly.

e. Slide the second piston and connecting rod assembly onto the motor shaft, insuring that the offset of the piston and connecting rod faces inward with the piston extending to the left of the motor shaft. Installation of the piston and connecting rod assemblies may be made either way without affecting compressor performance as long as each respective connecting rod offset faces the other.

f. The piston and connecting rod assemblies should make positive contact with each other at the point where the raised surfaces of each eccentric meet. The square key must be secure in the keyway of the motor shaft and both connecting rod assembly eccentrics.

g. Using the shaft protector for the cylinder head end, press both of the piston and connecting rod assemblies firmly against the motor shaft spacer with the arbor press. Make sure that the square key is pressed on together with the piston and connecting rod assemblies.

h. After completing the press procedure, peen over the leading edge of the eccentric keyway of the outside connecting rod assembly to prevent movement of the square key. DO NOT PEEN THE MOTOR SHAFT KEYWAY AS DAMAGE TO THE SHAFT MAY RESULT.

i. Install the four piston ring expanders, one in each of the piston ring grooves (two per piston). Position the expander gaps 180° apart.

j. Install the four piston rings, installing the lower ring first. Caution should be exercised when spreading the ring since it can break if spread too far. Each ring lap joint should be 180° from the corresponding piston ring expander gap.

k. Install the four piston skirts, two per piston. Roll form by hand to fit the piston skirt groove contour. Position the piston skirt gaps 180° apart. If desired, the piston skirts may be held in place by rubber bands which must be broken and removed during installation of the cylinder sleeves.

l. To start the cylinder sleeve over the first piston ring, gently compress the ring with one hand while working the leading edge of the cylinder sleeve over the piston ring. Repeat this process for the next piston ring. As the cylinder sleeve is worked onto the piston, insure that each piston skirt is in its proper groove and the skirt joints are 180° apart (Break and remove rubber bands if so used). Complete the above process for the second cylinder sleeve.

m. Insert two of the 5/16-18 x 1.00 inch long, 1/4 inch socket head cap screws into the back half of the sleeves and hand tighten. This will hold the sleeves in place for the next step.

n. At this time the cylinder head and valve assemblies may be installed. Properly align the cylinder head and valve assemblies on the cylinder sleeves and secure in place with four each 5/16-18 x 2-1/2 long, 1/4 inch socket head cap screws. Do not tighten the cylinder head and valve assemblies at this time so as to assist in the ease of installation for the manifold assembly in step o.

o. Install the discharge manifold assembly into the appropriate compression fittings mounted to the bottom of each cylinder head. Make sure not to distort the manifold tubing, Apply "Locktite 569" and torque all eight cylinder head and valve assembly socket head cap screws to 25 ft-lbs. Tighten the compression fittings on the manifold assembly, ensuring that you do not over-tighten the fittings.

p. Apply "Locktite 569" as an adhesive to the front crankcase. Install the front crankcase with four 1/4 inch socket head screws and torque to 25 ft-lbs.

q. Connect and secure the crankcase vent tubing (black) to both cylinder head compression fittings mounted on the front of the heads. Do not over-tighten.

r. Connect the PVC tubing to the brass elbow on the cylinder head and secure with a wire tie. Refer to section 12.2 , page 118 to install the compressor into the unit.

12.5 AIR COMPRESSOR SERVICE (P/N 18-00099)

Prior to the disassembly of the air compressor, follow the steps in section 12.2.a for removal of the air compressor from the refrigeration unit. When disassembling the compressor, matchmark parts so that they may be replaced in their same relative positions.

Tools needed:

a. Open end wrench, 3/16 inch

b. Open end wrench, 7/16 inch

c. Open end wrench, 15/16 inch

d. Torque wrench (in/lb)

e. Allen wrench, 3/16 inch

f. Allen head socket, 3/16 inch

g. Compressor Rebuild Toolkit

CRANKCASE FILTER REPLACEMENT

Locate filter and tubes on top of compressor.

Note

Inspect tube fitting for excessive debris in air passage. Clean air passage of elbow fittings if necessary.

Disassembly:

1. Disconnect the tubes from the compressor using a 7/16 open-end wrench.
2. Remove tube and filter ends from each brass fitting, by carefully pulling on tube at each end of the fitting. Do not remove elbow fittings from crankcase or cylinder head.
3. Discard old filter assembly.

Installation:

1. Install nut/sleeve on tubes at each end of the filter. Position the threaded end of the nut away from the filter. There is an arrow on the side of the filter for direction of air flow. Position the filter so arrow points away from the crankcase fitting and toward the head fitting.
2. Carefully insert each tube end into the appropriate fitting.
3. Connect tubes and tighten fittings with a 7/16 inch open-end wrench.

COMPRESSOR RING REPLACEMENT

Disassembly:

1. Remove compressor from container installation to access the head assembly.
2. Place the compressor in a reasonably clean area where there is an adequate area to disassemble the unit.
3. Locate crankcase filter (Item 3, Figure 77) . Use a 7/16 open-end wrench to completely loosen the nut of the tube fitting near the crankcase. Carefully remove the filter tube from the fitting.
4. Use 15/16 open-end wrench to loosen nuts on manifold elbows. Loosen all 4 nuts.
5. Use 3/16 Allen wrench to remove 8 socket head cap screws (Item 7) from cylinder flange.
6. Mark orientation at cylinder to crankcase to ease re-assembly

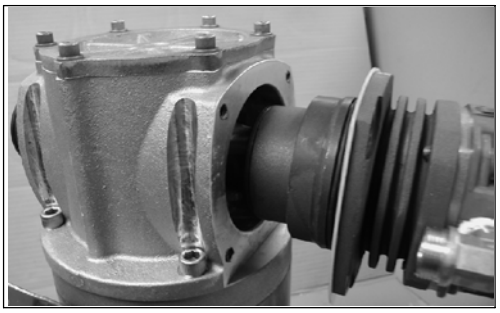


Figure 70 Cylinder Head Removal

7. Pull each cylinder and head assembly away from crankcase. Removing the cylinder may require a slight twist motion back and forth, because of an o-ring seal. Keep cylinder shims with each cylinder. See Figure 70.
8. Remove old manifold sleeve (Item 9, Figure 77) from manifolds
9. Remove o-ring (Item 12) from bottom of each cylinder.
10. Remove piston rings, piston seals, and rider ring from each piston (Items 20-23) .

Inspection:

1. Inspect crankcase filter (Item 3). If filter appears dirty or clogged, replace with filter kit.
2. Inspect cylinder wear surface for scoring or scratches. If scoring is present, replace cylinder.
3. Inspect piston bearings for excessive radial movement (looseness). If bearing exhibits more than .005 radial movement, replace compressor rods with major rebuild kit.

Assembly:

1. Install new piston seals below new piston rings on each piston.
2. Install new rider ring on each piston.
3. Install new manifold sleeves on the end of each manifold. Be sure that nut for manifold elbow is on manifold prior to installation of sleeves.

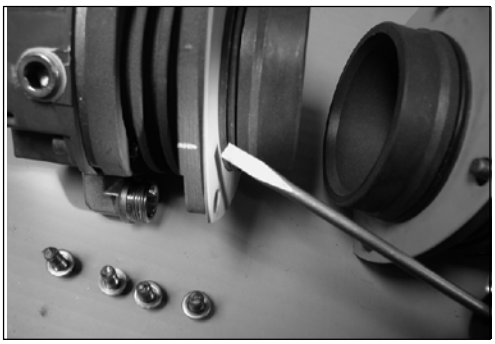


Figure 71 O-Ring Installation

4. Install new o-ring (Item 12) on bottom of each cylinder (Item 17). Place gaskets on bottom of each cylinder. Lubricate o-ring with small amount of silicone lubricant. See Figure 71.

5. Install one cylinder over piston and into crankcase. Remember to keep the same cylinder and cylinder orientation from the removal step.
6. Apply small amount of anti−seize lubricant to cylinder flange bolt threads. Install cylinder flange bolts to a tightening torque of 80 lb−in.
7. Install manifold (Item, 28, Figure 77) into elbows on cylinder. Tighten manifold nut finger tight.
8. Install second compressor cylinder over piston. Carefully align manifold with manifold elbows during installation. Manifold nuts must clear cylinder flange.
9. Apply small amount of anti−seize lubricant to cylinder flange bolt threads. Install cylinder flange bolts to a tightening torque of 80 lb.−in.
10. Install manifold nut onto manifold elbow. Tighten until nut stops on elbow.
11. Carefully attach filter tube to filter. Tighten with 7/16 open end wrench.

VALVE REPLACEMENT

Disassembly:

1. Remove compressor from container installation to access the head assembly.
2. Locate crankcase filter (Item 3, Figure 77). Use a 7/16 open−end wrench to completely loosen the nut of the tube fitting near the crankcase. Carefully remove the filter tube from the fitting.
3. Use 15/16 open−end wrench to loosen nuts on manifold elbows (Item 8) . Loosen all 4 nuts.
4. Mark orientation of head to valve plate and cylinder, for each head assembly, prior to removal. Use 3/16 socket head wrench to remove 4 socket head cap screws from one cylinder head. Remove head, valve plate and valves from the compressor. Discard the valves and o−ring gaskets. Keep head end valve plate for reassembly.
5. Remove manifold from compressor. Remove old manifold sleeves (Item 9) from manifolds.
6. Use 3/16 Allen wrench to remove 4 socket head cap screws (Item 6) from other cylinder head. Remove head, valve plate and valves from the compressor. Discard the valves and o−ring gaskets. Keep head and valve plate for reassembly.

Inspection:

1. Inspect crankcase filter. If filter appears dirty or clogged, replace with filter kit.
2. Inspect cylinder wear surface for scoring or scratches. If scoring is present, replace cylinder.

Assembly:

NOTE

Install one head at a time.

1. Set head on work surface, fin side down. Install Head Gasket in seal groove on head.
2. Identify alignment hole in head. Locate exhaust valve. This valve contains one ink dot near valve alignment hole. Place valve on head with ink dot facing up. Place valve alignment hole (by ink dot) over head alignment hole.
3. Install o−rings into grooves on each side of the valve plate. Lubricate each o−ring with small amount of silicone lubricant.
4. Place the valve plate on the exhaust valve. Notice the valve plate contains two small holes. Orient the valve plate to align the hole that is furthest clockwise, with the exhaust valve and head alignment hole. You may need to turn the valve plate over to the proper alignment.
5. Locate the Inlet valve. This valve contains two ink dots near the alignment hole. Place the valve on the valve plate with the ink dots facing up. Place valve alignment hole (by two ink dots) over head and valve plate alignment holes.
6. Install new o−ring (Item 12) in top of cylinder groove
7. Install rebuilt head assembly onto cylinder. Remember to keep the same head orientation from the removal step. It may be helpful to start two (2) screws in the head assembly to maintain proper alignment. Hold head assembly firm during installation to keep o−rings in proper location.
8. Initially install head bolts (Item 7) finger tight. Fully install head bolts to a tightening torque of 160 lb−in.

NOTE

Confirm nut for manifold elbow is on manifold prior to installation of sleeves.

9. Install new manifold sleeves (Item 9) on the end of each manifold.
10. Install manifold into elbows (Item 8) on head elbows. Tighten manifold nut finger tight.
11. Repeat valve and o−ring replacement on second head assembly
12. Using a 15/16 open−end wrench, install manifold nut onto manifold elbow. Tighten until nut stops on elbow.
13. Install second head assembly onto cylinder, remember to keep the same orientation from the removal step. Carefully align manifold with manifold elbows during installation.
14. Carefully attach filter tube to filter. Tighten with 7/16 open end wrench.

HEAD ASSEMBLY / VALVE REPLACEMENT

Disassembly:

1. Stand unit upright.
2. With motor foot to RIGHT, note indentation marks on head. Marks will be UP and RIGHT.
3. Use 7/16 open end wrench to completely loosen the fitting at bottom of head. Use 15/16 wrench to loosen manifold nuts and 3/16 wrench to loosen 4 head bolts (Item 6).
4. Remove 4 socket head cap screws from one cylinder head. Remove head, valve plate and valves from the compressor. Remove filter elbow from head and save for reassembly. Discard head assembly.
5. Remove old manifold sleeves (Item 9) and nuts from manifolds

Inspection:

1. Inspect crankcase filter. If filter appears dirty or clogged, replace with filter kit.

2. Inspect cylinder wear surface for scoring or scratches. If scoring is present, replace cylinder.

Assembly:

1. Place new nuts and sleeves (nuts first) on manifold.
2. Install new cylinder o–ring (Item 12) in groove. Silicone can be used to keep o–ring in place.
3. Select appropriate head assembly from kit.

NOTE

Each head assembly is specific for each side of compressor. Line up manifolds. Keeping head and valves tight, start 4 head bolts. Watch that clips DO NOT cause cylinder "O" Ring to move. Remove clips and hold head assembly tight to cylinder. Hand tighten 4 screws.

4. Torque 4 screws to 160 in lb.
5. Partially tighten 15/16 manifold nuts.
6. Install elbow and reducer in newly installed head. Note position for filter tube, install tube and tighten 7/16 wrench
7. Repeat disassembly and reassembly of head on opposite side of compressor using the same procedure as above. Retain inlet and outlet fittings for reassembly.
8. Fully tighten all manifold nuts. Tighten until nut stops on elbow.

MAJOR REBUILD

NOTE

Install a Ring Kit when performing a major rebuild.

Disassembly:

1. Remove compressor from container installation and place on work surface in a vertical position.
2. Use 3/16 socket head wrench to remove cover bolts. Set bolts aside for later use. Remove
3. Use 7/16 open end wrench to completely loosen the fitting at bottom of head. Use 15/16 wrench to loosen manifold nuts and 3/16 wrench to loosen 4 head bolts (Item 6).Locate crankcase filter. Use a 7/16 open–end wrench to completely loosen the nut of the tube fitting near the crankcase. Carefully remove the filter tube from the fitting.
4. Mark orientation of head to valve plate and cylinder, for each head assembly, prior to removal. Use 3/16 socket head wrench to remove 4 socket head cap screws from one cylinder head. Remove head, valve plate and valves from the compressor.
5. Use 3/16 socket head wrench to remove 8 socket head cap screws from cylinder flange.
6. Note cylinder orientation and location on compressor. Mark each cylinder and crankcase to assist in correct orientation during reassembly.
7. Carefully pull each cylinder and head assembly away from crankcase. Removing the cylinder may require a slight twist motion back and forth, because of an o–ring seal.
8. Rotate rods to an outward position. Remove retaining ring from end of motor shaft.

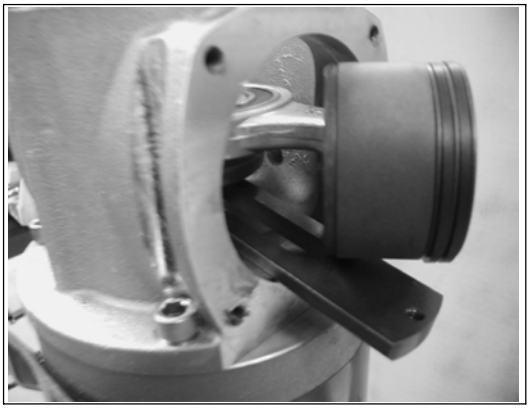


Figure 72 Puller Plate Positioning

9. Insert the puller plate beneath the piston as shown in Figure 72. Rotate 90 degrees around the shaft.

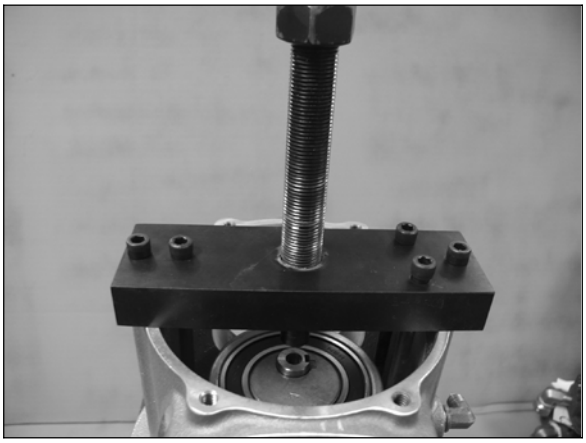


Figure 73 Puller Installation

10. Install the puller on top of the crankcase as shown in Figure 73. Insert three puller bolts into the rod puller and thread into puller plate.
11. Remove crankcase bolts from motor. Add alignment pins in crankcase to prevent puller from rotating.
12. Install brass spacer between puller and shaft.
13. Carefully turn threaded puller shaft with wrench to remove piston rods. Remove puller from crankcase.
14. Remove crankcase from motor.
15. Remove shaft seal (Item 29, Figure 77) from crankcase.

Inspection:

1. Inspect crankcase filter. If filter appears dirty or clogged, replace with filter kit.
2. Inspect head valves for any sign of damage. Valves should seat flat against valve plate. If valves are bent or damaged, replace valves .
3. Inspect crankcase filter. If filter appears dirty or clogged, replace with filter kit.

Assembly:

1. Install shaft seal in crankcase by pushing on the outer edge of the seal.
2. Apply a liberal amount of silicone grease to back side of shaft seal

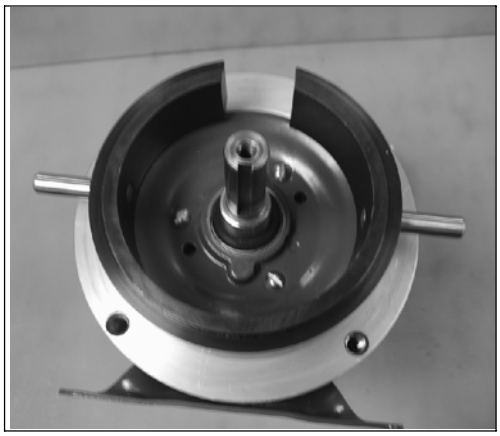


Figure 74 C–Stand Positioning

3. Place C–stand on motor as shown in Figure 74. Place crankcase on top of stand, note proper crankcase orientation to motor.
4. Install Rod assemblies into opening as shown in Figure 75.

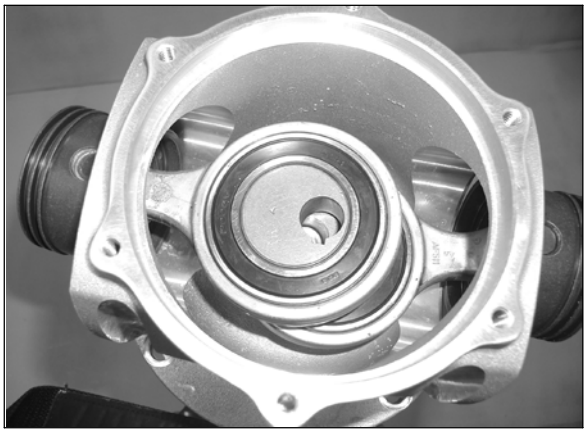
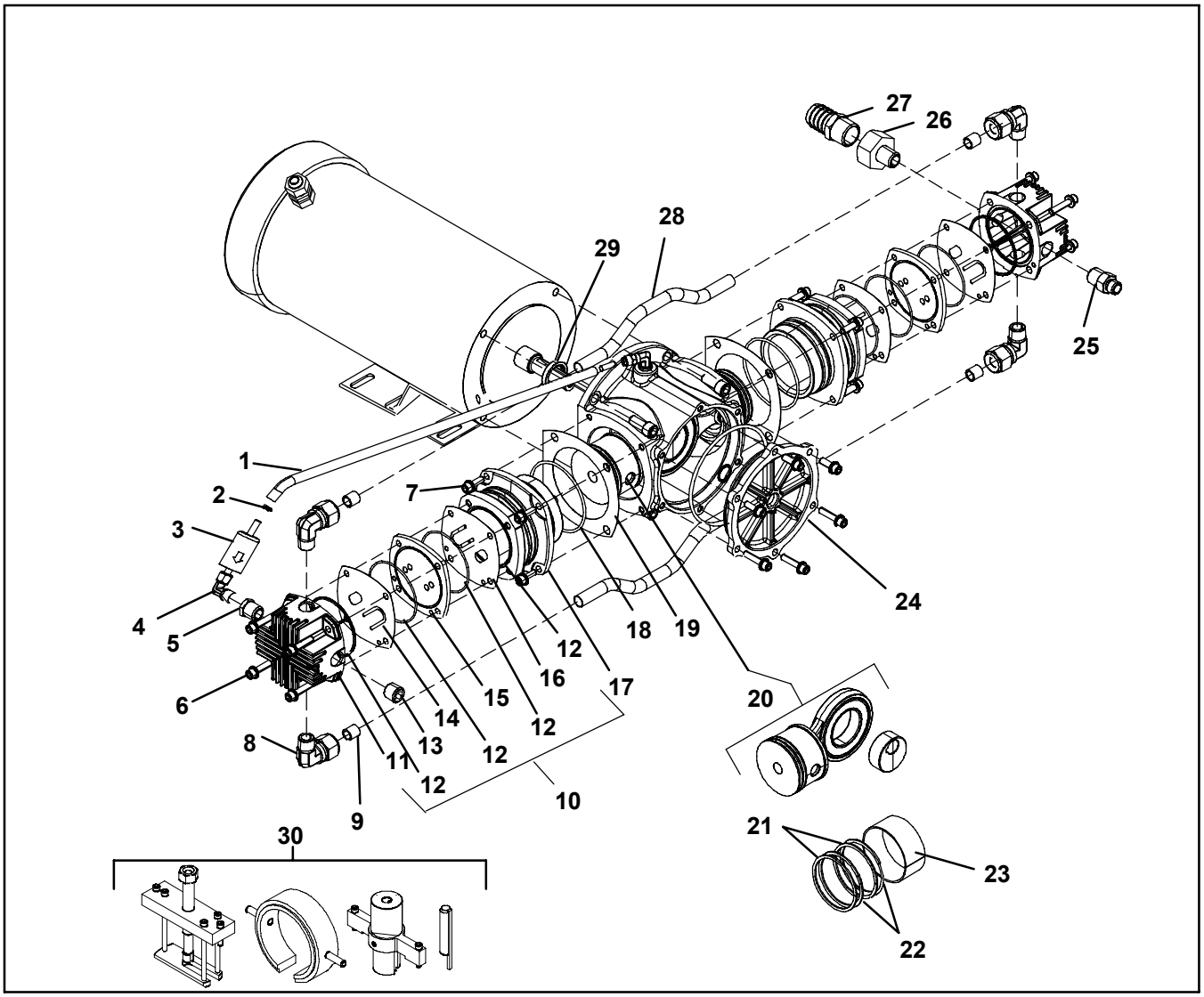


Figure 75 Rod Assembly Positioning

5. Align rod assemblies to motor shaft key–way using alignment pin as shown. Confirm alignment pin rests on top of motor shaft.
6. Support motor shaft from back of motor. Install pusher over shaft and alignment pin and onto crankcase, secure with two screws.

Figure 76 Rod Pusher Installation

7. Carefully raise crankcase enough to remove c–stand.
8. Use a press to push rods and crankcase toward motor shell and into location. Crankcase will stop on motor shell. Remember to support the shaft during this operation. Remove pusher and alignment pin from crankcase.
9. Install key into keyway and retaining ring on shaft.
10. Install crankcase onto motor. Apply an anti–seize compound to bolts and torque crankcase bolts to 20 lb–ft.
11. Install new rings as outlined in **Compressor Ring Replacement,** page 122
12. Install new o–ring on crankcase cover and install cover on crankcase. Install cover bolts to a tightening torque of 80 lb–in.



1. Tube, Filter
2. Tube, Clamp
3. Filter
4. Fitting, Tube
5. Reducing Bushing
6. Head Cap Bolt
7. Head Bolt
8. Elbow (tube)
9. Manifold Sleeve
10. Head and Valve Assembly
11. Head
12. O–Ring
13. Pipe Plug
14. Outlet Valve
15. Valve Plate
16. Intake Valve
17. Cylinder
18. O-Ring, Cylinder
19. Shim
20. Piston Assembly
21. Piston Ring
22. Piston Seal
23. Rider Ring
24. Cover
25. Pipe Plug
26. Pipe Bushing
27. Hose Barb
28. Manifold Tube
29. Shaft Seal
30. Compressor Rebuild Toolkit

Figure 77. Air Compressor (P/N 18/00099) Exploded View

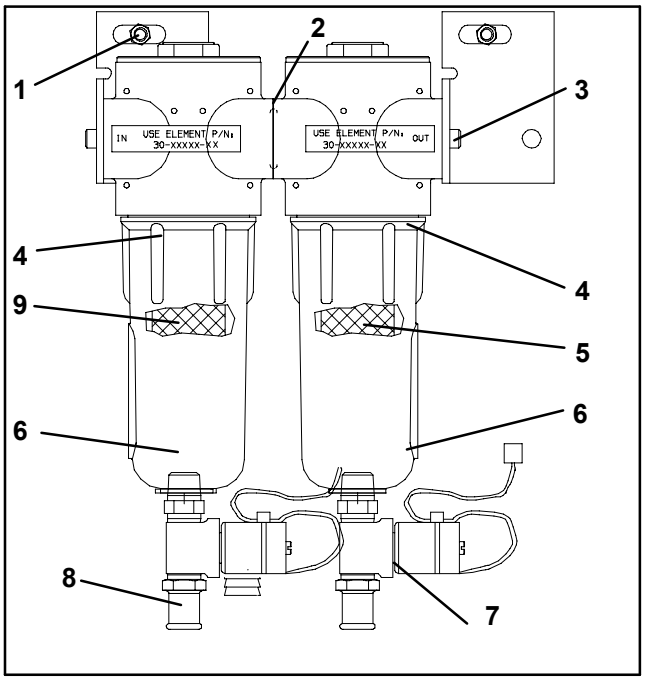
12.6 MEMBRANE AIR FILTER

a. Removing the Membrane Air Filter Element

1. Swing open the controlled atmosphere control box door.
2. Remove two bolts that attach the control box to the unit frame. Remove two bolts that attach the control box to the condenser coil cover. Swing the control box out to access the air filter assembly.
3. Unplug the wire connectors from the solenoid valve on bottom of both filter bowls. (See Figure 78)
4. Unscrew the filter bowl from the filter head assembly. Inspect the filter bowl O-ring, reuse when reinstalling the drain bowls.
5. Remove the filter elements (RB, item 9) and (C, item 5).

b. Replacing the Membrane Air Filter Element

1. Install the membrane air filter elements (RB) and (C) by reversing the above steps.
2. When elements are replaced, function code Cd17 should be reset to “0”. (See section 9.1.4, page 102.)



1. Bolt (1/4-20)
2. Filter Head O-Ring
3. Screw
4. Filter Bowl O-Ring
5. Filter Element (C) – Blue
6. Filter Bowl
7. Solenoid Valve
8. Straight Fitting
9. Filter Element (RB) – Red

Figure 78. Membrane Air Filter Assembly

c. Removing the Membrane Air Filter

1. Swing open the controlled atmosphere control box door.
2. Remove two bolts that attach the control box to the unit frame. Remove two bolts that attach the control box to the condenser coil cover. Swing the control box out to access the air filter assembly.
3. Disconnect tubing and remove the 90° fitting and the straight fitting from the bottom of both filter bowls. (See Figure 78.)
4. Disconnect the copper lines feeding into and out of the membrane air filter head.
5. Remove two bolts (1/4-20) from the filter head bracket.
6. Remove the membrane air filter assembly.

d. Replacing the Membrane Air Filter

1. Install the membrane air filter by reversing the above steps.

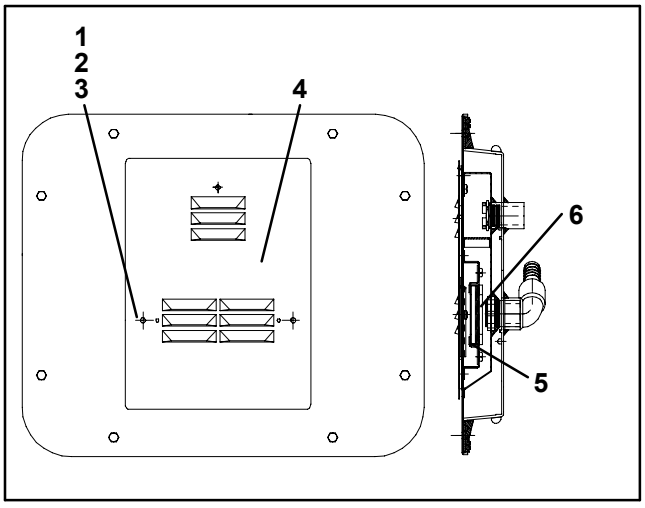
12.7 AIR INTAKE FILTER

a. Removing the Air Intake Filter

1. Remove the louver door from the right-hand side refrigeration evaporator access panel, see Figure 56, page 89 by removing two bolts (#10-24 x 1/2 lg), two flat washers (#10), and two Mylar washers.
2. Loosen four bolts (#10-24 x 1/2 lg) that secure the two brackets holding the air intake filter in place.
3. Remove air intake filter (See Figure 79).

b. Replacing the Air Filter

1. Install the air intake filter by reversing the above steps.



1. Bolt (#10-24)
2. Flat Washer
3. Mylar Washer
4. Louver Door
5. Hold Down Bracket
6. Air Intake Filter Element

Figure 79. Air Intake Filter Assembly

12.8 AIR SAMPLE FILTER

WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

a. Removing the Air Sample Filter Element

When replacing the air sample filter element it can be accessed in two ways: through the right-hand side evaporator access panel (see Figure 56, page 89); or through the inside of the container by lowering the upper evaporator panel (see Figure 57, page 90).

WARNING

Make sure power to the unit is OFF and the power plug is disconnected and tagged before servicing.

1. Follow container venting procedures before performing any maintenance on the air sample filter element.
2. By hand, unscrew and remove the filter cup from the bottom of the air sample filter assembly (item 1, Figure 80).
3. Remove the filter element from the filter assembly.

b. Replacing the Air Sample Filter Element

1. Install the air sample filter element by reversing the above steps.

12.9 OXYGEN SENSOR

WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

a. Removing the Oxygen Sensor

When replacing the oxygen sensor it can be accessed in two ways: through the right-hand side evaporator access panel (see Figure 56, page 89); or through the inside of the container by lowering the upper evaporator panel (see Figure 57, page 90).

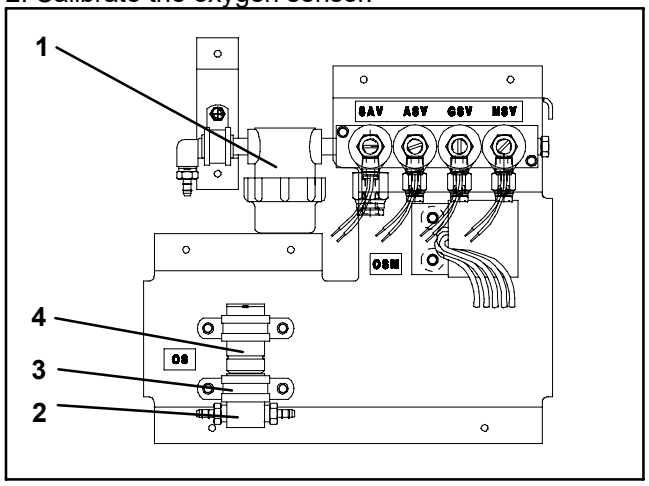
WARNING

Make sure power to the unit is OFF and the power plug is disconnected and tagged before servicing.

1. Follow container venting procedures before performing any maintenance on the oxygen sensor (item 4, Figure 80).
2. Remove the cushion clamp and screws (item 3) that secure the oxygen sensor.
3. Cut the wire tie that secures the wiring to the oxygen sensor body.
4. Unplug the wiring connector from the receptacle.
5. Remove the oxygen sensor from the oxygen sensor housing (item 2).

b. Replacing the Oxygen Sensor

1. Install the oxygen sensor by reversing the above steps.
2. Calibrate the oxygen sensor.



1. Air Sample Filter Assembly and Cup
2. Oxygen Sensor Housing
3. Cushion Clamp and Screws (#10-24 x 1/2 lg)
4. Oxygen Sensor

Figure 80. Solenoid Manifold Valve and Sensor Assemblies

12.10 CARBON DIOXIDE SENSOR

WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

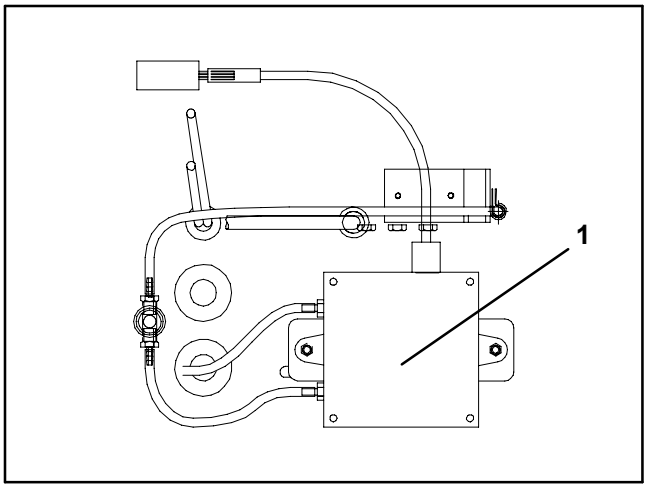
a. Removing the CO_2 Sensor

When replacing the CO_2 sensor it can be accessed in two ways: through the right-hand side evaporator access panel (see Figure 56, page 89); or through the inside of the container by lowering the upper evaporator panel (see Figure 57, page 90). Refer to Figure 81, page 129 for the physical location of the CO_2 sensor.

WARNING

Make sure power to the unit is OFF and the power plug is disconnected and tagged before servicing.

1. Follow container venting procedures before preforming any maintenance on the CO_2 sensor.
2. Remove the electrical connector, and inlet and outlet tubes from the body of the sensor (item 1, Figure 81, page 129).
3. Loosen the screws (item) which holds the CO_2 sensor to the fan deck bracket.
4. Install replacement CO_2 sensor by reversing steps 3 thru 6.
5. Run Pre-Trip 6–0 to zero calibrate the new CO_2 sensor.



1. Carbon Dioxide Sensor

Figure 81. Carbon Dioxide Sensor

12.11 NITROGEN MEMBRANE SEPARATOR

⚠ WARNING

Make sure power to the unit is OFF and the power plug is disconnected and tagged before servicing.

⚠ WARNING

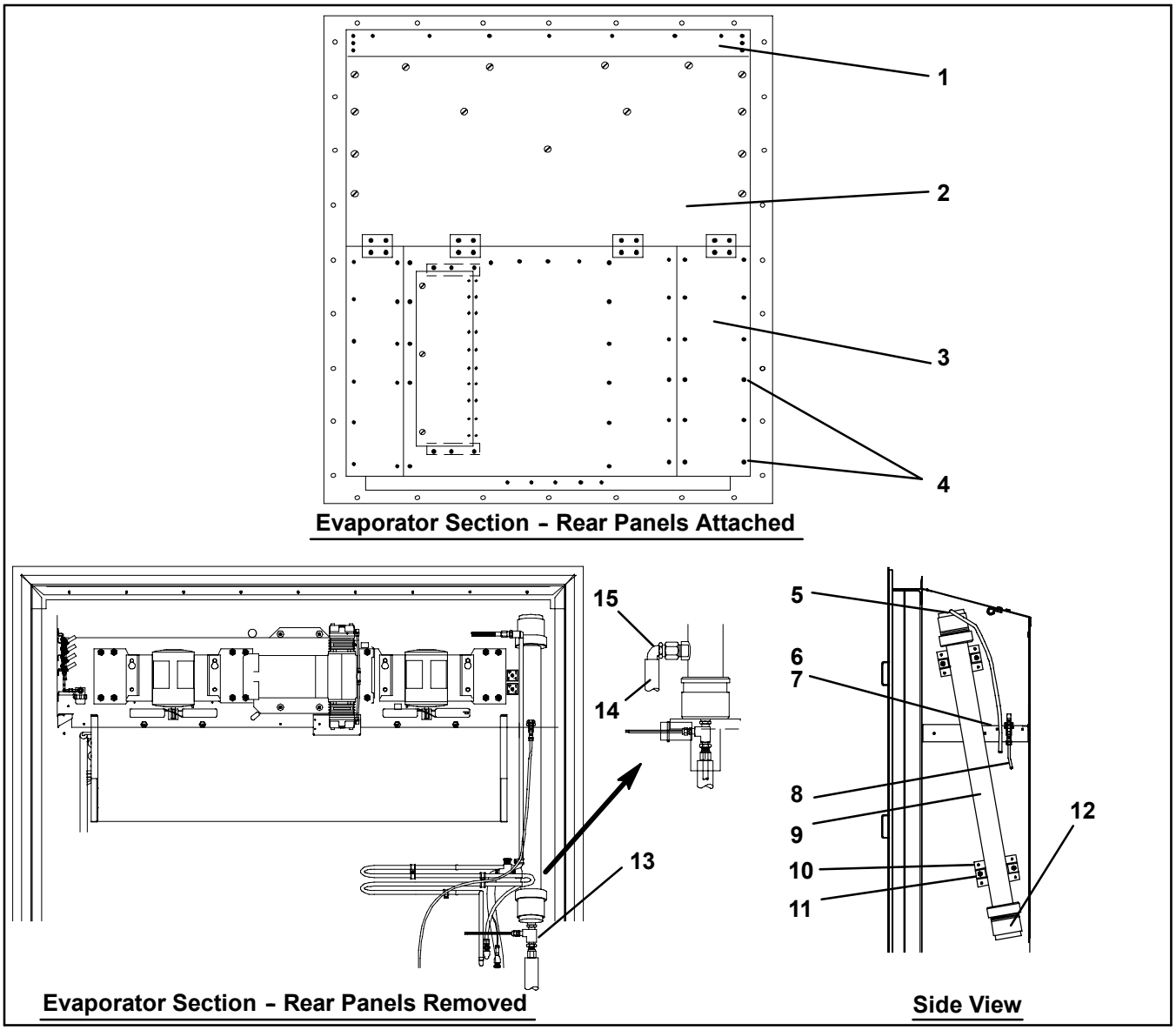
Hazardous atmosphere inside. Ventilate container before access.

a. Removing the Nitrogen Membrane Separator

1. Follow container venting procedures before performing any maintenance on the nitrogen membrane separator.
2. Remove bottom right-side panel (see Figure 82, page 130). Using a 1/8 inch drill bit and drill, remove the heads from the 12 rivets.
3. Remove the bottom fitting from the nitrogen membrane separator.
4. Lower the upper panel and support the top grille with a spacer for an easier removal process.
5. Remove insulation from permeate discharge line, then remove drain line from permeate discharge elbow fitting.
6. Remove carbon dioxide bottle feed line (black hose).
7. Remove four bolts from the plate that is attached to the top of the evaporator fan deck.
8. Remove the hose and the top fitting from the nitrogen membrane separator.
9. Remove the four screws (#10-24 x 1/2 lg) from the membrane mounting bracket assembly.
10. Remove top and bottom insulation caps from the nitrogen membrane separator.
11. Remove the nitrogen membrane separator through the bottom panel area that was removed in step 2 above.

b. Replacing the Nitrogen Membrane Separator

1. Install the nitrogen membrane separator by reversing the above steps.



1. Top Grille
2. Upper Panel
3. Bottom Right-Side Panel
4. Rivet
5. Top Fitting
6. Plate
7. Bolts
8. Carbon Dioxide Bottle Feed Line
9. Nitrogen Membrane Separator
10. Screws
11. Membrane Mounting Bracket Assembly
12. Insulation Caps
13. Bottom Fitting
14. Permeate Discharge Line
15. Permeate Discharge Elbow Fitting

Figure 82. Nitrogen Membrane Separator

12.12 CONTAINER CURTAIN

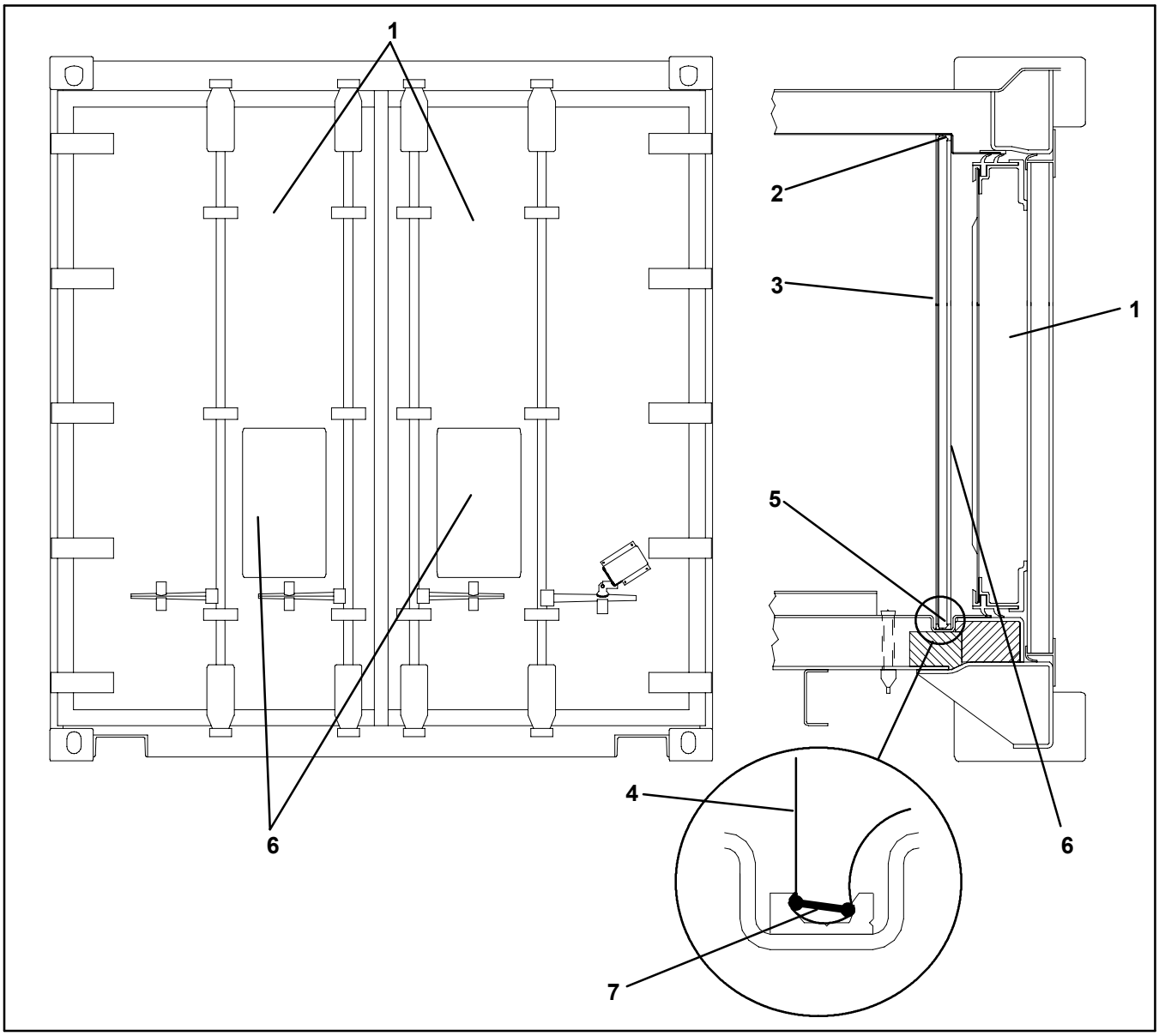
WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

a. Installing the curtain

1. Open the rear doors of the container.
2. Fully unfold the door curtain package, and hold it up to the container opening.
3. Standing outside the container, start at the midpoint of the upper ribbon channel. Insert the curtain (poly sheet) and ribbon into the ribbon channel. Finish inserting the curtain across the entire upper ribbon channel.
4. Insert the curtain into the side channels, finishing the procedure by inserting the curtain into the bottom ribbon channel.

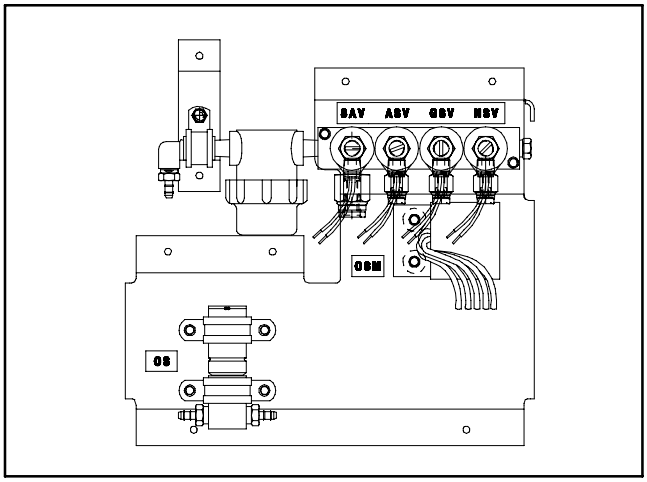
   Eliminate any folds or wrinkles that can lead to air leakage. Check to be sure that the ribbon is completely inserted and the curtain is secure.
5. Place warning label on the outside of the curtain.



1. Rear Door
2. Upper Ribbon Channel
3. Side Ribbon Channel
4. Curtain (Poly Sheet)
5. Bottom Ribbon Channel
6. Warning Labels
7. Ribbon

Figure 83. Installation of Container Curtain

12.13 SOLENOID VALVE

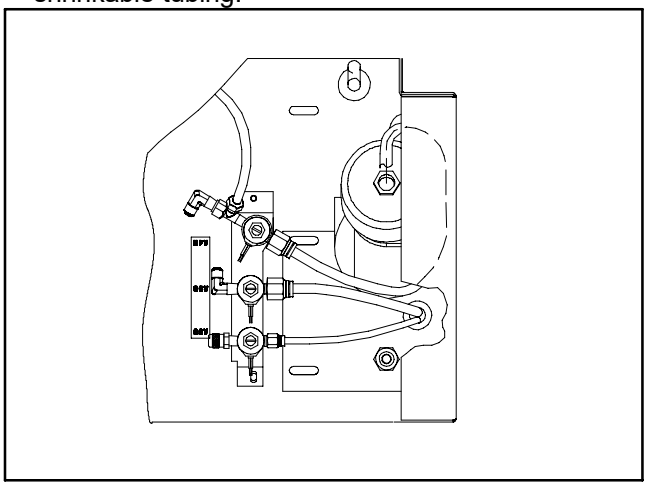


a. Replacing the Coil

WARNING

Low oxygen levels inside container. Ventilate container before entering. Stay away from doors while venting.

1. Cut leads coming from the coil, to approximately two inches back from the coil. Remove screw and washer or nut that secures the coil to the plunger. Lift off coil.
2. Verify part number. This information appears on the coil housing.
3. Insert new coil. Butt splice leads and seal with heat shrinkable tubing.



b. Replacing the Valve

1. Disconnect nylon tubing and remove screws from bottom.
2. Insert new valve.
3. Butt splice leads and seal with heat shrinkable tubing. Reconnect nylon tubing.

12.14 CONTROLLED ATMOSPHERE (CA) CONTROLLER MODULE

a. Handling of Controller

Here is a list of guidelines that should be followed when handling the CA Controller module. These steps should be implemented when doing *any* arc welding on the unit, or *when service to the CA system requires handling and removal of the Controller.*

CAUTION

Remove CA Controller module and unplug all wire harness connectors before performing any arc welding on any part of the container.

Do not remove wire harnesses from module unless you are grounded to the unit frame with a static safe wrist strap.

1. Obtain a grounding wrist strap and a static dissipation mat. The wrist strap, when properly grounded, will dissipate any potential build-up on the body. The dissipation mat will provide a static free work surface on which to place and/or service the Controller. Note: Dissipation mat may be ordered, CTD P/N 07-00277-00.
2. Disconnect and secure power to the unit.
3. Place strap on wrist and attach the ground or clip end of the wrist strap to any exposed, unpainted metal area on the refrigeration unit frame (bolts, screws, etc.).
4. Carefully remove the Controller. Do not touch any of the electrical components if possible. Place the Controller on the static dissipation mat.
5. If you are servicing the CA system, you are free to remove the ground strap from your wrist and complete your work.
6. Upon completion of your service work, put the wrist strap back on, and re-install the Controller into the CA system.

b. Removing and Installing Controller Module

Removal:

1. Disconnect all front wire harness (see Figure 84, page 134) connectors (MA, MB, MC, KA & KB) and move wiring out of way.
2. Loosen one mounting screw (see Figure 84, page 134 item 1) and pull out the top of the Controller module (item2), then lift up and out.
3. Turning the module around will give access to the two back connectors (EC) which the user can now disconnect. Remove module.
4. Remove the new Controller module from its packaging and install it in the CA system. Place the old Controller into the same packaging that accompanied the new module. *Make sure that you package it in the exact same manner.*

NOTE

This packaging has been designed to protect the Controller from both physical and electrostatic discharge damage during storage and transit.

Installation:

Install the Controller module by reversing the above steps.

Torque values for item 1 are 0.23 mkg (20 inch-pounds), and 0.12 mkg (10 inch-pounds) for all connectors.

12.14.1 Programming Procedure

To load new software into the module, the programming card is inserted into the programming/software port.

WARNING

The control box must be OFF whenever a programming card is inserted or removed from the programming/software port.

Procedure for loading Operational Software:

NOTE

The CA start-stop switch (CAS) should remain ON during this procedure.

a. Turn unit OFF, via refrigeration start-stop switch (ST).

b. Insert the programming card for Operational Software into the programming/software port. (See Figure 84, page 134)

c. Turn unit ON, via refrigeration start-stop switch (ST).

d. The Display module will read:

(1.) If the correct card is being used: the Display will alternate back and forth between the messages “rEV XXXX” and “Press EntR”.

(2.) If a defective card is being used: the Display will blink the message “bAd CArd”. (Turn refrigeration start-stop switch [ST] OFF and remove the card.)

e. Press the ENTER key on the keypad.

f. The Display will show the message “Pro SoFt”. This message will last for up to one minute.

g. The Display module will read:

(1.) When the software loading has successfully completed: the Display will show the message “Pro donE”.

(2.) If a problem occurs while loading the software: the Display will blink the message “Pro FAIL” or “bad 12V”. (Turn refrigeration start-stop switch OFF and remove the card.)

h. Turn unit OFF, via refrigeration start-stop switch (ST).

i. Remove the programming card from the programming/software port.

j. Turn unit ON, via refrigeration start-stop switch (ST).

12.14.2 Troubleshooting

A group of test points (tp) is provided on the Controller (see Figure 84, page 134 item 3) for trouble-shooting electrical circuits (refer to Section 11). A description of the test points is as follows:

NOTE

Use a digital voltmeter to measure AC voltage between TP’s and ground (TP9).

TP2

This test point enables the user to check if the internal protector for the air compressor motor (IP–AM) is open or closed.

TP6

This test point enables the user to check if the drain solenoid valves #1 & #2 (DS1 & DS2) contact is open or closed.

TP7

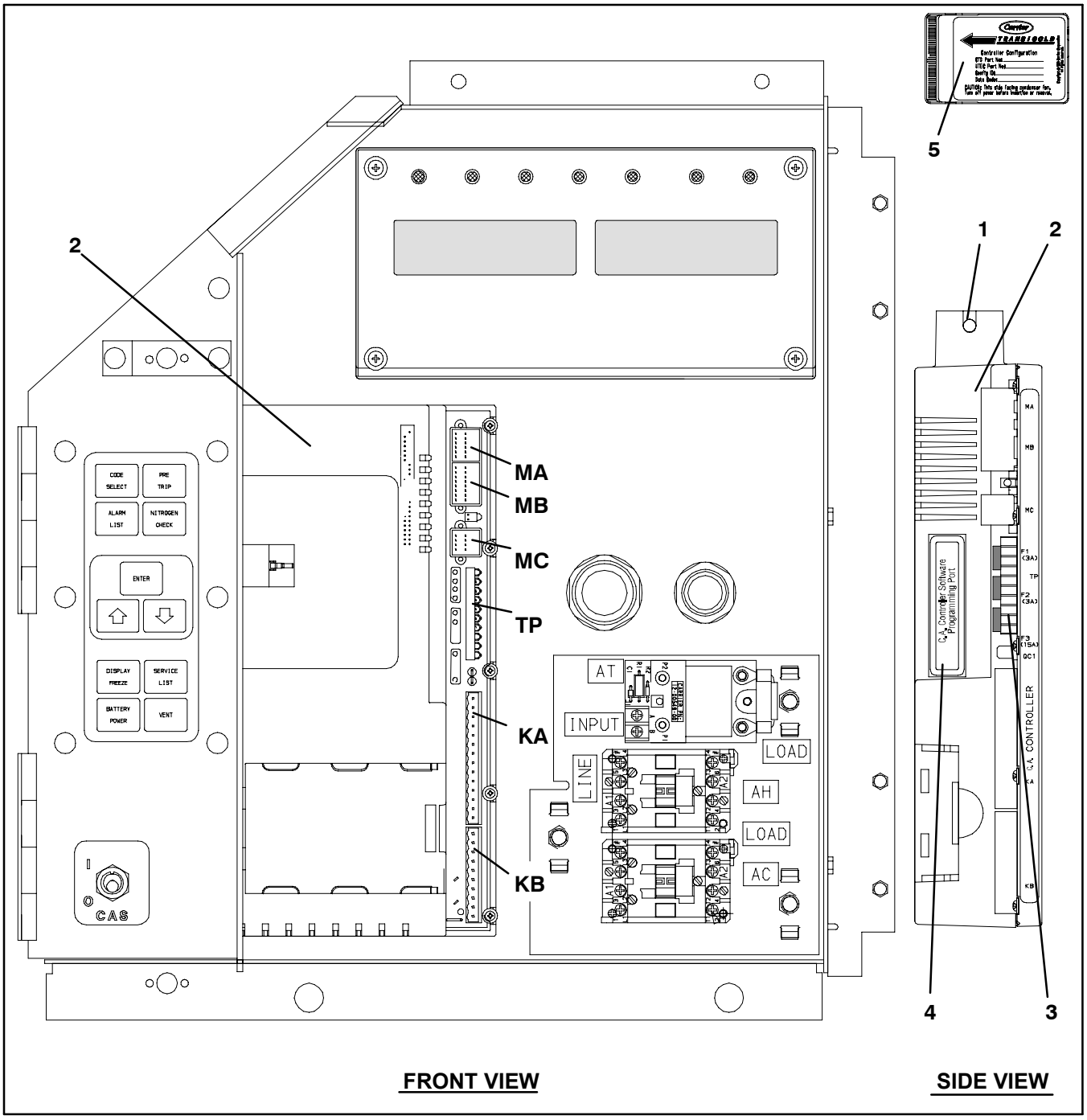
This test point enables the user to check if the oxygen solenoid valve contact is open or closed.

TP9

This test point is the chassis (unit frame) ground connection.

TP10

This test point enables the user to check if the nitrogen purity valve contact is energized.



1. Mounting Screw
2. Controller Module
3. Test Points
4. Controller Software Port
5. Programming Card

Figure 84. Controlled Atmosphere ML2i Control Box

PART THREE - ELECTRICAL WIRING SCHEMATICS AND DIAGRAMS

SECTION 13
REFRIGERATION CONTROLS

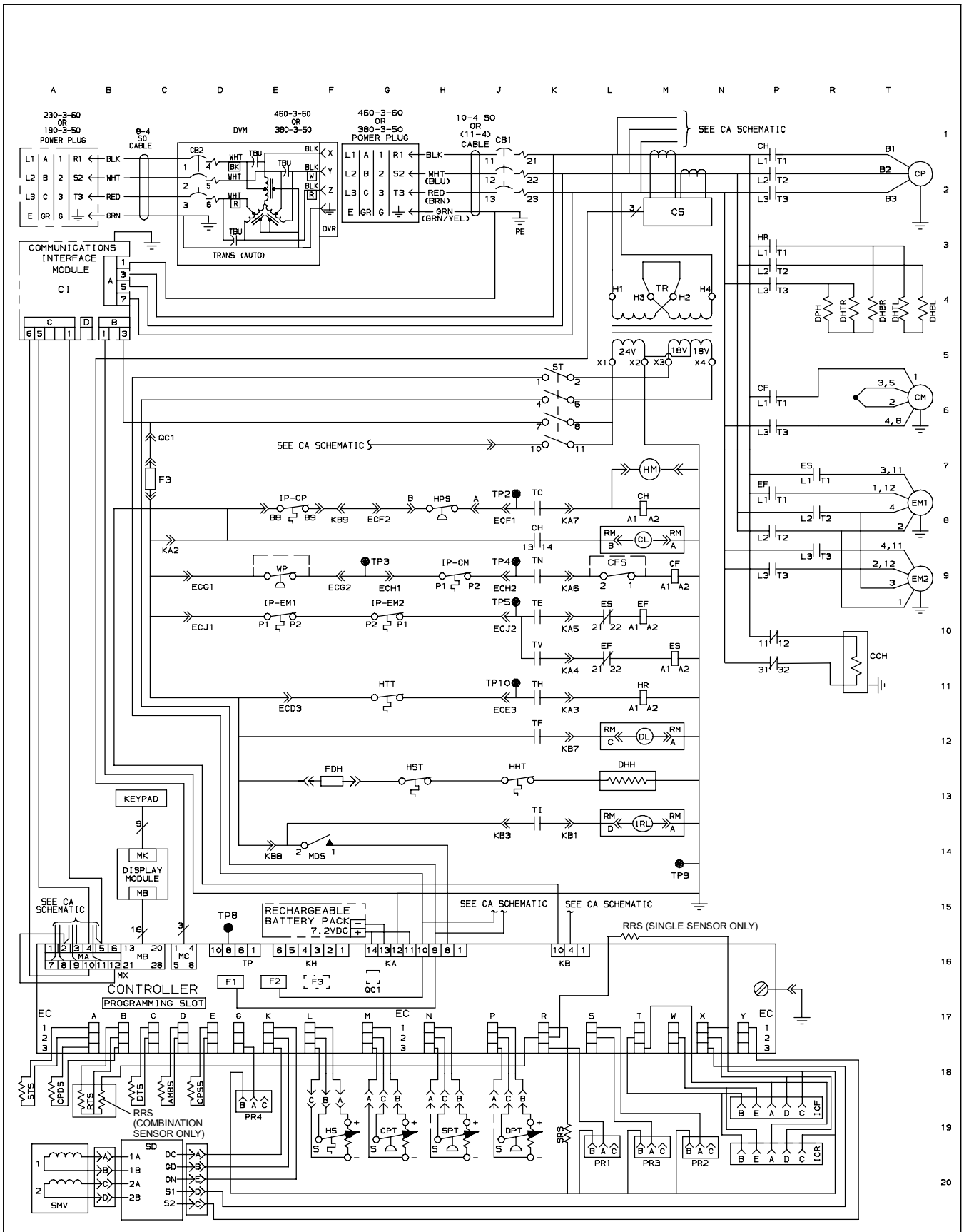
13.1 INTRODUCTION

This section contains the refrigeration unit Schematics and Wiring Diagram. The diagrams are presented as follows:
Figure 85 Provides the legend for use with all figures.
Figure 86 Provides the schematic diagram.
Figure 87 Supplements the Figure 86 and provides schematics for the NatureFRESH.
Figure 88 Provides the wiring diagram.
Sequence of operation descriptions for the various modes of operation are provided in section 4.10, page 48.

LEGEND

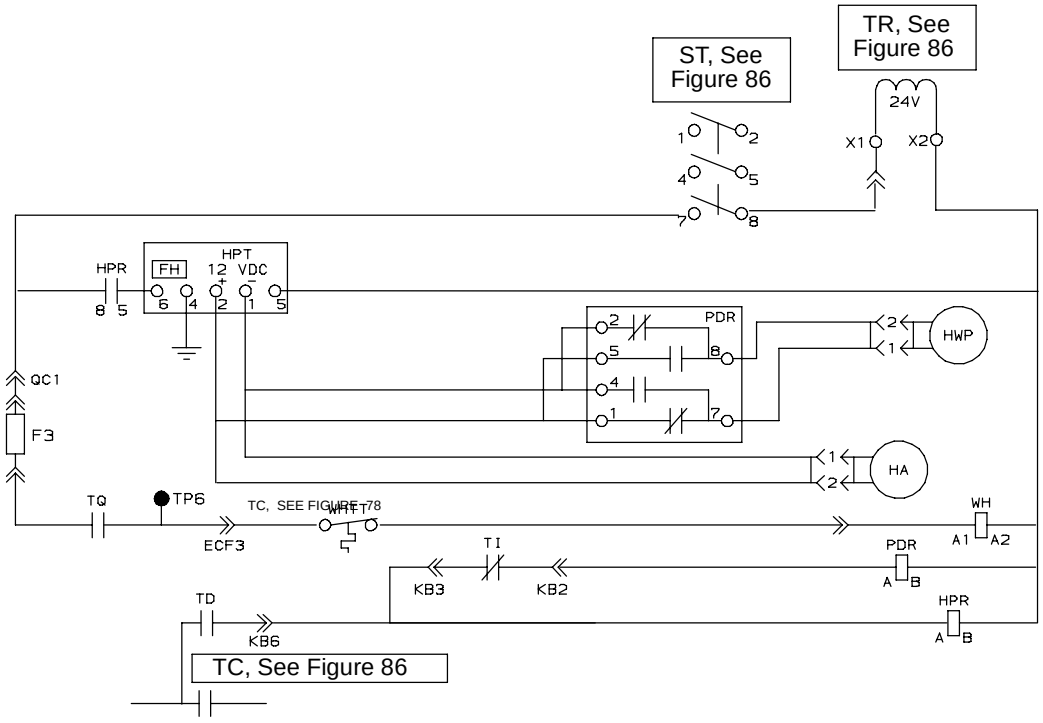
SYMBOL	DESCRIPTION (Schematic Location)
AMBS	AMBIENT SENSOR (C-19)
CB1	CIRCUIT BREAKER - 460 VOLT (J-1)
CB2	CIRCUIT BREAKER - AUTO TRANSFORMER (D-1)
CCH	CRANKCASE HEATER (T-11)
CF	CONDENSER FAN CONTACTOR (M-9, P-6)
CFS	CONDENSER FAN SWITCH (L-9)
CH	COMPRESSOR CONTACTOR (M-8, G-6, P-1)
CI	COMMUNICATIONS INTERFACE MODULE (A-3)
CL	COOL LIGHT (M-8)
CM	CONDENSER FAN MOTOR (T-6)
CP	COMPRESSOR MOTOR (T-1)
CPT	CONDENSER PRESSURE TRANSDUCER (G-20)
CPDS	COMPRESSOR DISCHARGE SENSOR (A-18)
CPSS	COMPRESSOR SUCTION SENSOR (D-18)
CS	CURRENT SENSOR (M-2)
DHBL	DEFROST HEATER - BOTTOM LEFT (T-4)
DHBR	DEFROST HEATER - BOTTOM RIGHT (T-4)
DHH	DRAIN HOSE HEATER (L-13)
DHTL	DEFROST HEATER - TOP LEFT (T-4)
DHTR	DEFROST HEATER - TOP RIGHT (R-4)
DL	DEFROST LIGHT (M-12)
DPH	DRAIN PAN HEATER (R-4)
DPT	DISCHARGE PRESSURE TRANSDUCER (J-19)
DTS	DEFROST TEMPERATURE SENSOR (C-18)
DVM	DUAL VOLTAGE MODULE (E-1)
DVR	DUAL VOLTAGE RECEPTACLE (F-2)
EF	EVAPORATOR FAN CONTACTOR [HIGH] (L-10, M-10, P-8)
EM	EVAPORATOR FAN MOTOR (T-8, T-9)
ES	EVAPORATOR FAN CONTACTOR [LOW] (L-10, M-10, R-8)
F	FUSE (C-7)
FDH	FUSE - DRAIN LINE HEATER (F-13)
FH	FUSE - HUMIDITY (Figure 87)
HA	HUMIDITY ATOMIZER (Figure 87)
HHT	HOSE HEATER THERMOSTAT (J-13)
HM	HOUR METER (M-7)
HPR	HUMIDITY POWER RELAY (Figure 87)
HPS	HIGH PRESSURE SWITCH (J-8)
HPT	HUMIDITY POWER TRANSFORMER (Figure 87)
HR	HEATER CONTACTOR (M-11, P-3)
HS	HUMIDITY SENSOR (F-19)
HST	HOSE HEATER SAFETY THERMOSTAT (G-13)
HTT	HEAT TERMINATION THERMOSTAT (F-11)
HWH	HUMIDITY WATER HEATER (Figure 87)
HWP	HUMIDITY WATER PUMP (Figure 87)
IC	INTERROGATOR CONNECTOR [FRONT/REAR] (P-18, P-19)
IP	INTERNAL PROTECTOR (E-7, E-10, G10)
IRL	IN RANGE LIGHT (M-14)
PDR	PUMP DIRECTION RELAY (Figure 87)
PE	PRIMARY EARTH (J-2)
PR	PROBE RECEPTACLE [USDA] (E-18, L-19, M-19, N-219
RM	REMOTE MONITORING RECEPTACLE (M-8, M-12, M-13)
RRS	RETURN RECORDER SENSOR (C-19 or M15)
RTS	RETURN TEMPERATURE SENSOR (B-19)
SD	STEPPER MOTOR DRIVE (C-19)
SMV	SUCTION MODULATING VALVE (A-19)
SPT	SUCTION PRESSURE TRANSDUCER (H-19)
SRS	SUPPLY RECORDER SENSOR (K-19)
ST	START - STOP SWITCH (K-6)
STS	SUPPLY TEMPERATURE SENSOR (C-190)
TBU	TRANSFORMER BRIDGING UNIT (D-2)
TC	CONTROLLER RELAY - COOLING (K-8)
TD	CONTROLLER RELAY - WATER PUMP/ATOMIZER (Figure 87)
TE	CONTROLLER RELAY - HIGH SPEED EVAPORATOR FANS (Figure 86 = K-10)
TF	CONTROLLER RELAY - DEFROST (K-12)
TH	CONTROLLER RELAY - HEATING (K-13)
TI	CONTROLLER RELAY - IN RANGE (K-3) OR WATER PUMP REVERSE (Figure 87)
TN	CONTROLLER RELAY - CONDENSER FAN (K-9)
TP	TEST POINT (E-15, G-9, J-7, J-10, J-11, M-14, Figure 87)
TQ	CONTROLLER RELAY - WATER TANK HEATER (Figure 87)
TR	TRANSFORMER (M-3)
TRANS	AUTO TRANSFORMER 230/460 (D-3)
TV	CONTROLLER RELAY - LOW SPEED EVAPORATOR FANS (Figure 86 = K-10)
WH	WATER HEATER RELAY (Figure 87)
WHTT	WATER HEATER TERMINATION THERMOSTAT (Figure 87)
WP	WATER PRESSURE SWITCH (E-9)

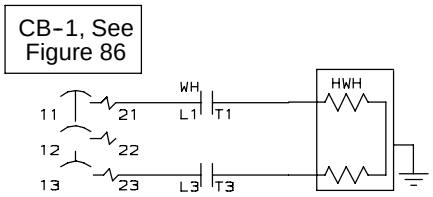
Figure 85. Legend



BASED ON DRAWINGS: 62-01801 Rev A, 62-10339 Rev A, 62-10369 Rev -, 62-10535 Rev A, 62-10541 Rev A, 62-10576 Rev -, 62-01577 Rev -, 62-10638 Rev -, 62-10730 Rev -, 62-10733 Rev - and 62-10734 Rev -,

Figure 86. Schematic Diagram





NatureFresh HUMIDITY MANAGEMENT SYSTEM

Figure 87. Schematic Diagram – Humidity

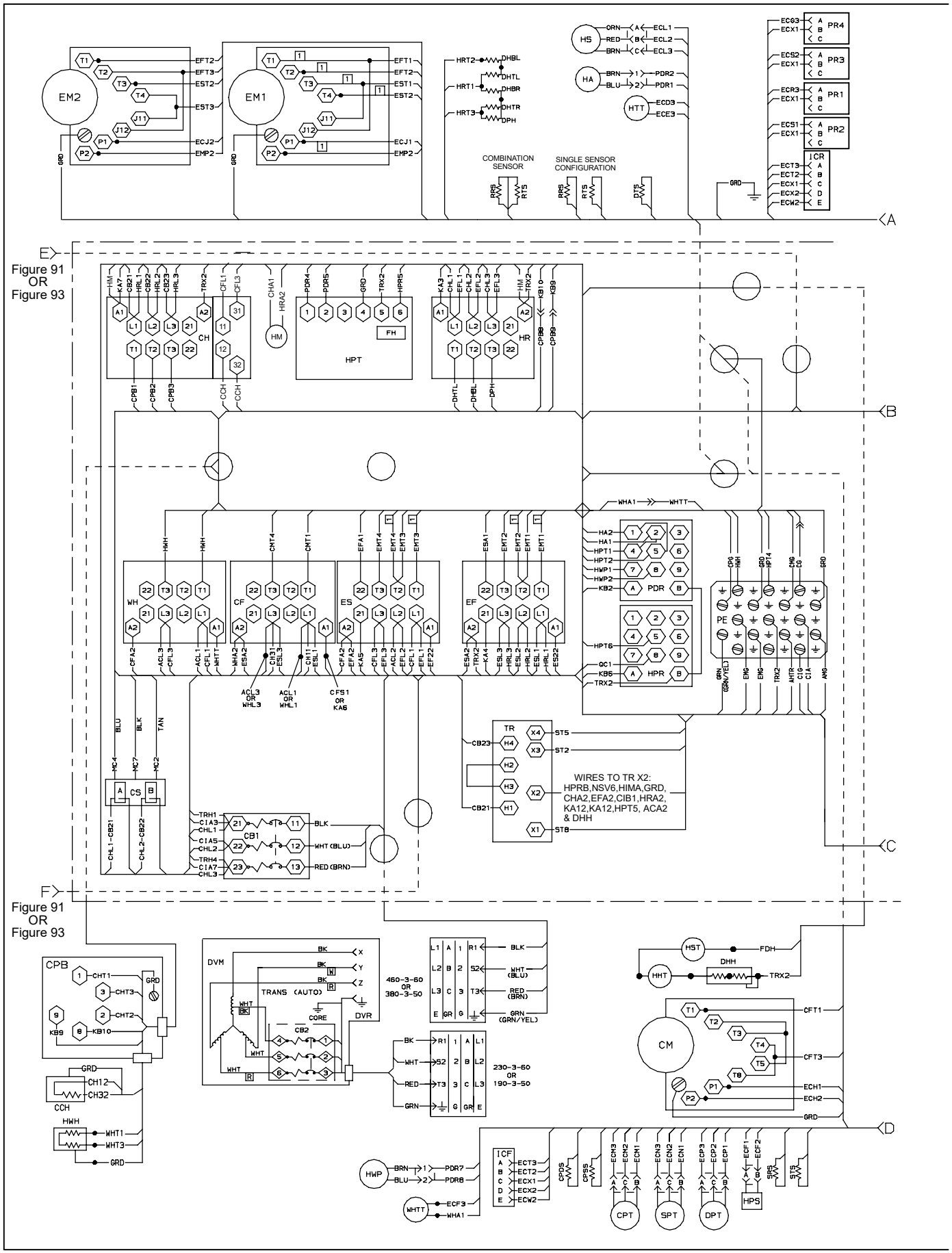


Figure 88. Wiring Diagram (Sheet 1 of 2)

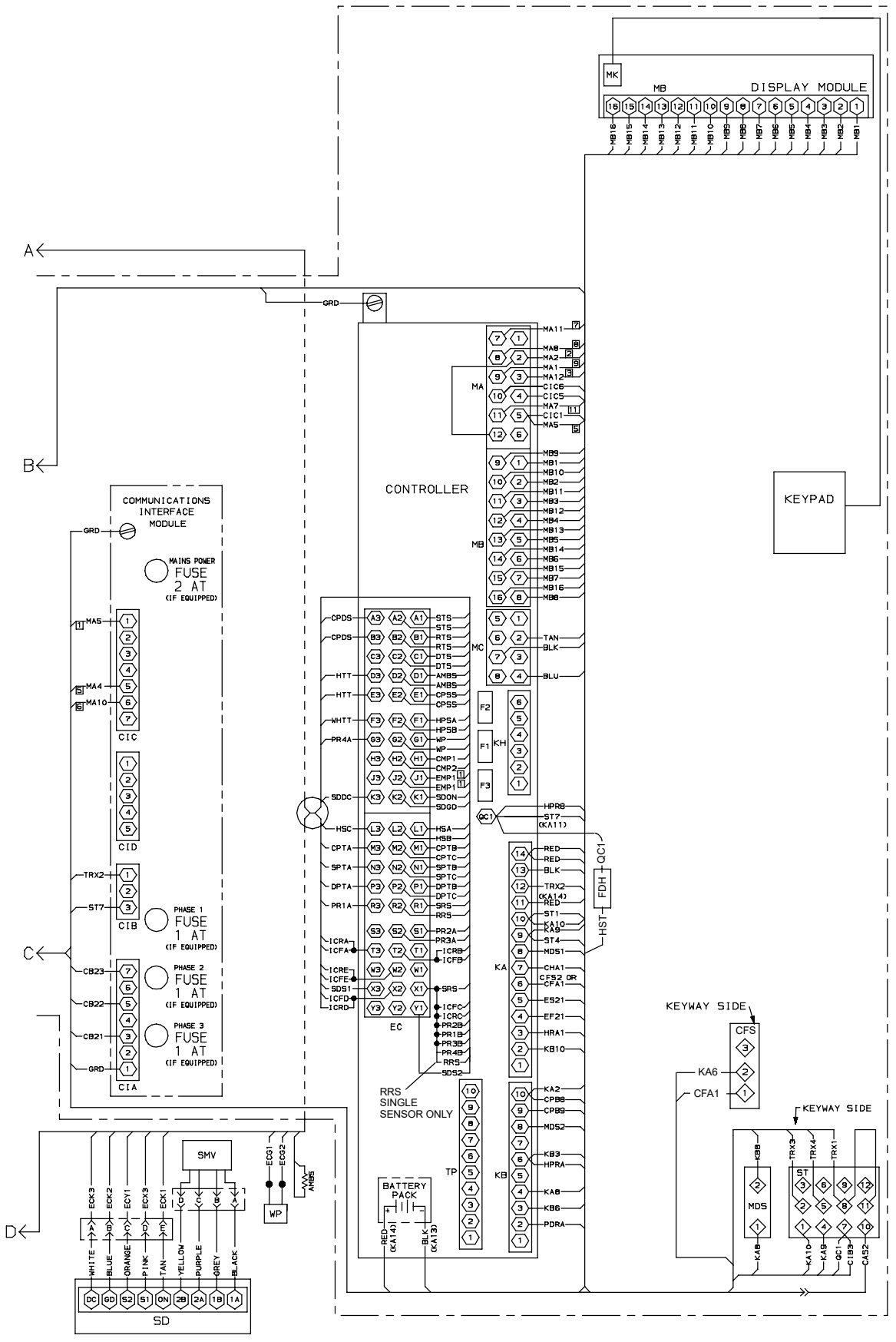


Figure 88. Wiring Diagram – (Sheet 2 of 2)

SECTION 14
CONTROLLED ATMOSPHERE SYSTEM

14.1 INTRODUCTION

This section contains the Electrical Schematic and Wiring Diagrams for the Controlled Atmosphere system. The diagrams are presented as follows:

Figure 89 Provides the legend for use with all figures.

Figure 90 Provides the schematic diagram.

Figure 91 Provides the wiring diagram.

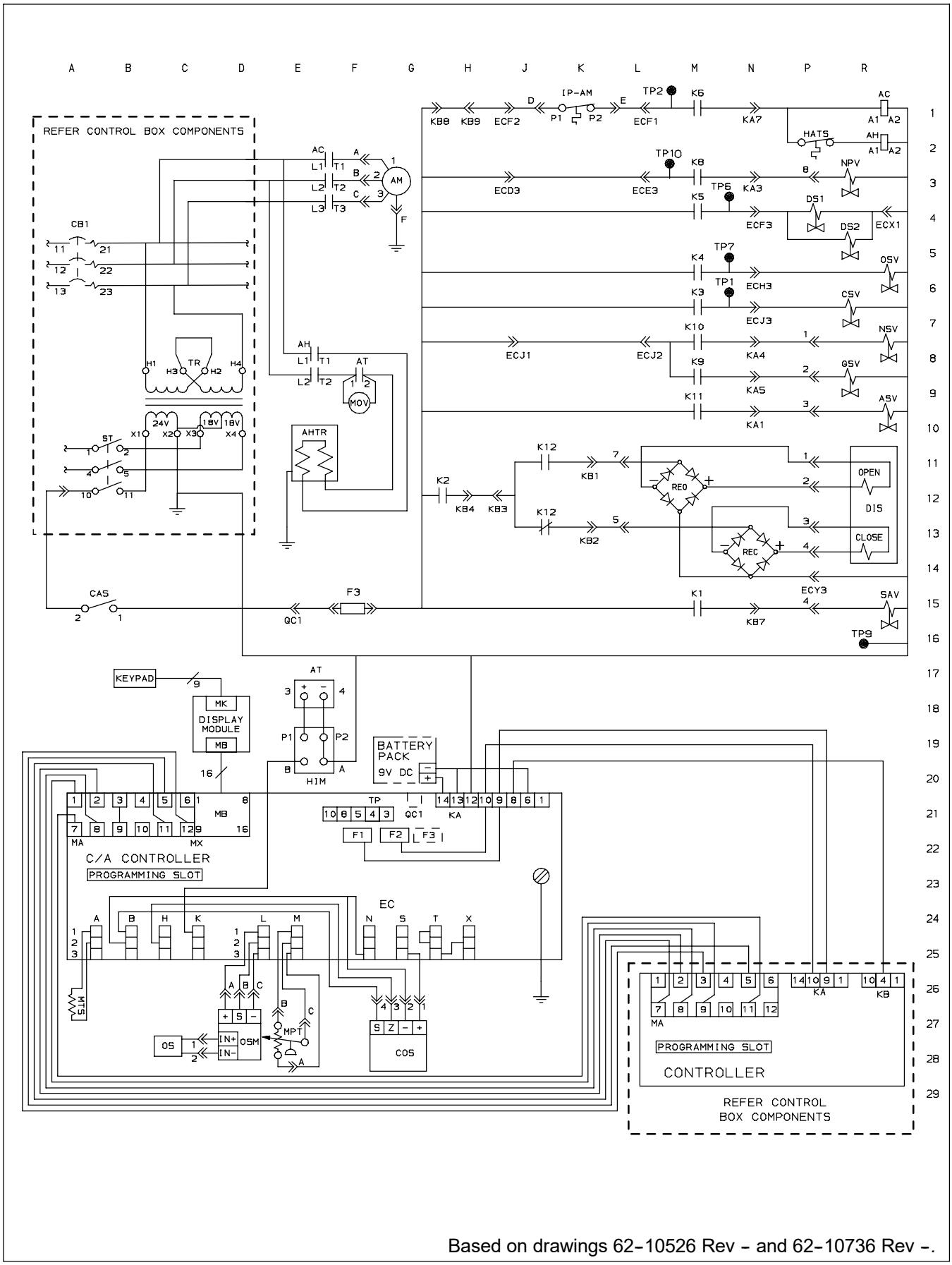
Figure 92 Provides the schematic diagram for CA units that have not been modified to include the Nitrogen Purity Solenoid Valve (NPV).

Figure 93 Provides the wiring diagrams for CA units that have not been modified to include the Nitrogen Purity Solenoid Valve (NPV).

CA LEGEND

SYMBOL	DESCRIPTION (Schematic Location)
AC	AIR COMPRESSOR CONTACTOR (E-3, R-1)
AH	AIR HEATER CONTACTOR (E-8, R-2)
AT	AIR HEATER TRIAC (SOLID STATE RELAY) (F-8, F-17)
AHTR	AIR HEATER (E-11)
AM	AIR COMPRESSOR MOTOR (G-3)
ASV	AIR CALIBRATION SOLENOID VALVE (R-9)
CAS	CONTROLLED ATMOSPHERE START-STOP SWITCH (B-15)
COS	CO_2 SENSOR (G-28)
CSV	CO_2 SOLENOID VALVE (R-6)
DIS	DOOR INTERLOCK SOLENOID (R-12)
DS1	DRAIN SOLENOID VALVE #1 (P-4)
DS2	DRAIN SOLENOID VALVE #2 (R-4)
F	FUSE (E-22, F-22, F-15)
GSV	GAS CALIBRATION SOLENOID VALVE (R-8)
HIM	HEATER INTERFACE MODULE (F-20)
HATS	HIGH AIR TEMPERATURE SWITCH (P-2, Figure 90; K-2, Figure 92)
IP	INTERNAL PROTECTOR (K-1)
K1	CA CONTROLLER RELAY (SAMPLE AIR) (M-15)
K2	CA CONTROLLER RELAY (DOOR INTERLOCK) (H-12)
K3	CA CONTROLLER RELAY (CO2) (M-6)
K4	CA CONTROLLER RELAY (O2 FLOW) (M-5)
K5	CA CONTROLLER RELAY (FILTER DRAIN) (M-3)
K6	CA CONTROLLER RELAY (AIR COMPRESSOR) (M-1)
K8	CA CONTROLLER RELAY (AIR HEATING) (M-3)
K9	CA CONTROLLER RELAY (GAS CALIBRATION) (M-8)
K10	CA CONTROLLER RELAY (N2 PURITY) (M-7)
K11	CA CONTROLLER RELAY (AIR CALIBRATION) (M-9)
K12	CA CONTROLLER RELAY (DOOR INTERLOCK OPEN/CLOSED) (J-11, J-13)
MPT	MEMBRANE PRESSURE TRANSDUCER (E-27)
MOV	METAL OXIDE VARISTOR (F-9)
MTS	MEMBRANE TEMPERATURE SENSOR (A-27)
NSV	N_2 SAMPLE SOLENOID VALVE (R-7)
NPV	N2 PURITY SOLENOID VALVE (R-3, Figure 90)
OS	OXYGEN SENSOR (C-28)
OSM	OXYGEN SENSOR MODULE (D28)
OSV	OXYGEN SOLENOID VALVE (R-5)
REC	RECTIFIER (DOOR INTERLOCK CLOSE) (N-14)
REO	RECTIFIER (DOOR INTERLOCK OPEN) (L-12)
SAV	SAMPLE AIR SOLENOID VALVE (R-15)
TP	TEST POINT (M-1, N-3, N-5, N-6, R-16, F-21)

Figure 89. LEGEND - CA



Based on drawings 62-10526 Rev - and 62-10736 Rev -.

Figure 90. Electrical Schematic - CA

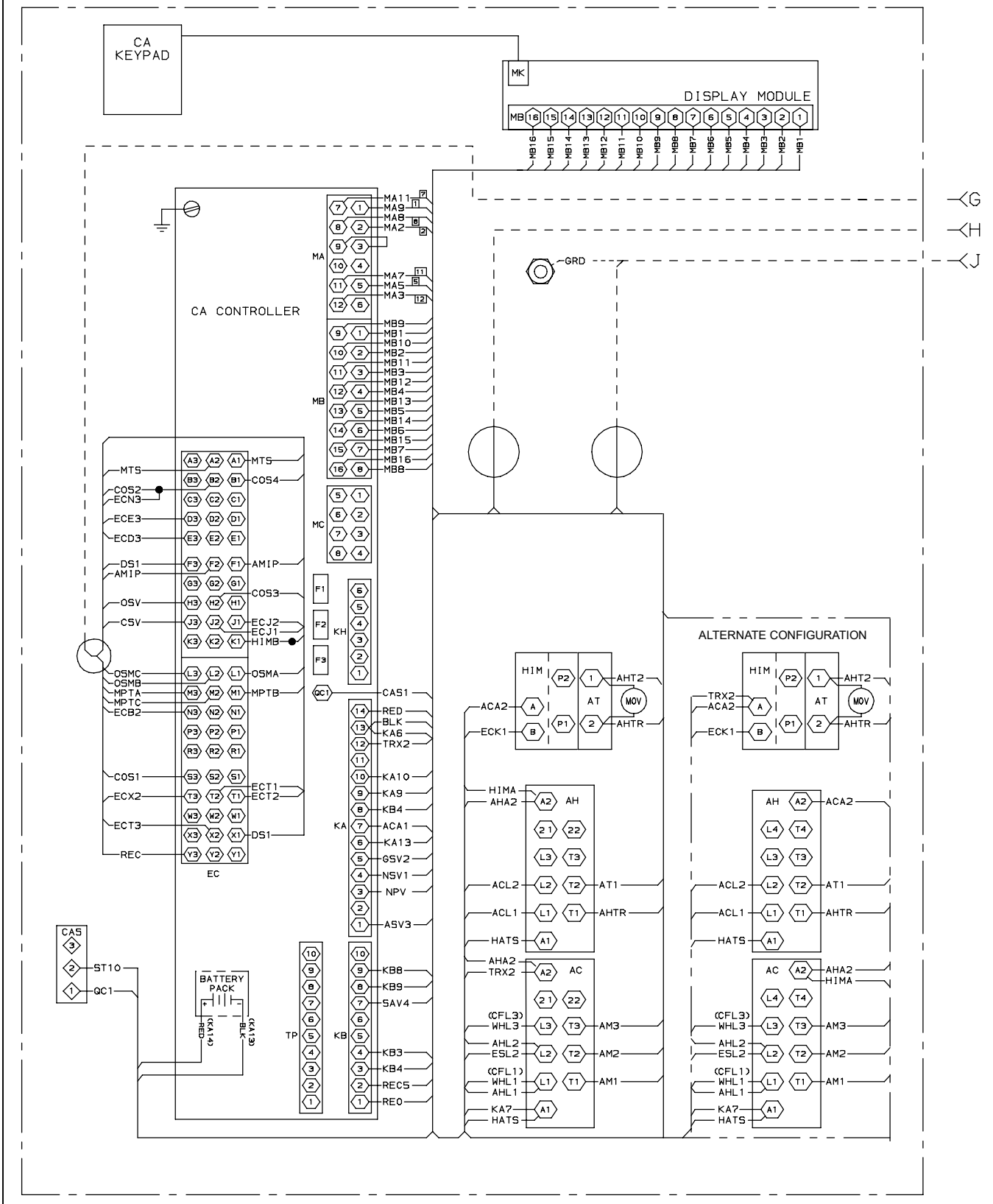


Figure 91. Electrical Wiring Diagram – Controlled Atmosphere (Sheet 1 of 2)

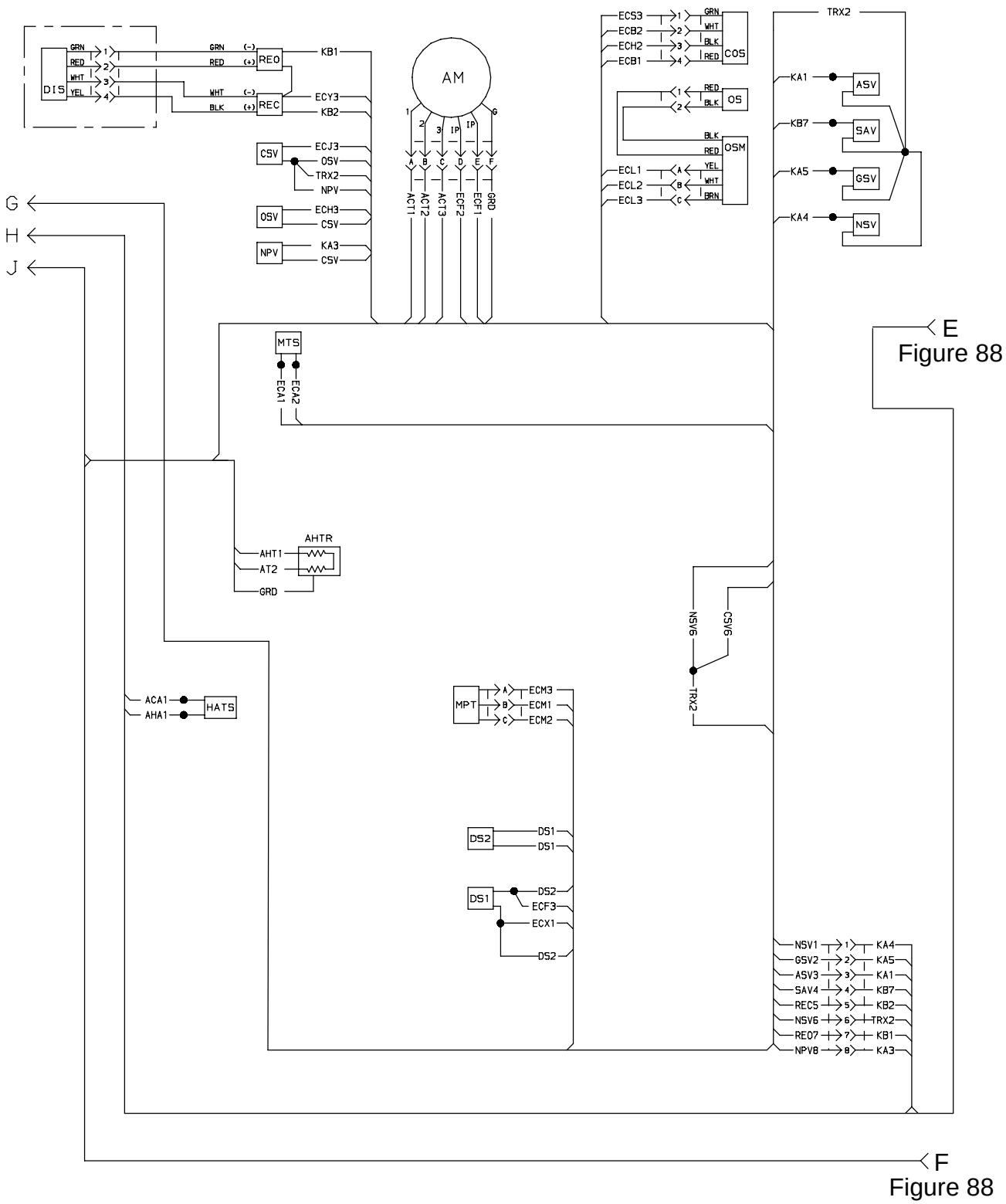


Figure 91. Electrical Wiring Diagram – Controlled Atmosphere (Sheet 2 of 2)

NOTE

THE SCHEMATIC AND WIRING DIAGRAM PROVIDED ON THE FOLLOWING PAGES COVER UNITS THAT HAVE NOT BEEN MODIFIED TO INCLUDE THE NITROGEN PURITY SOLENOID VALVE.

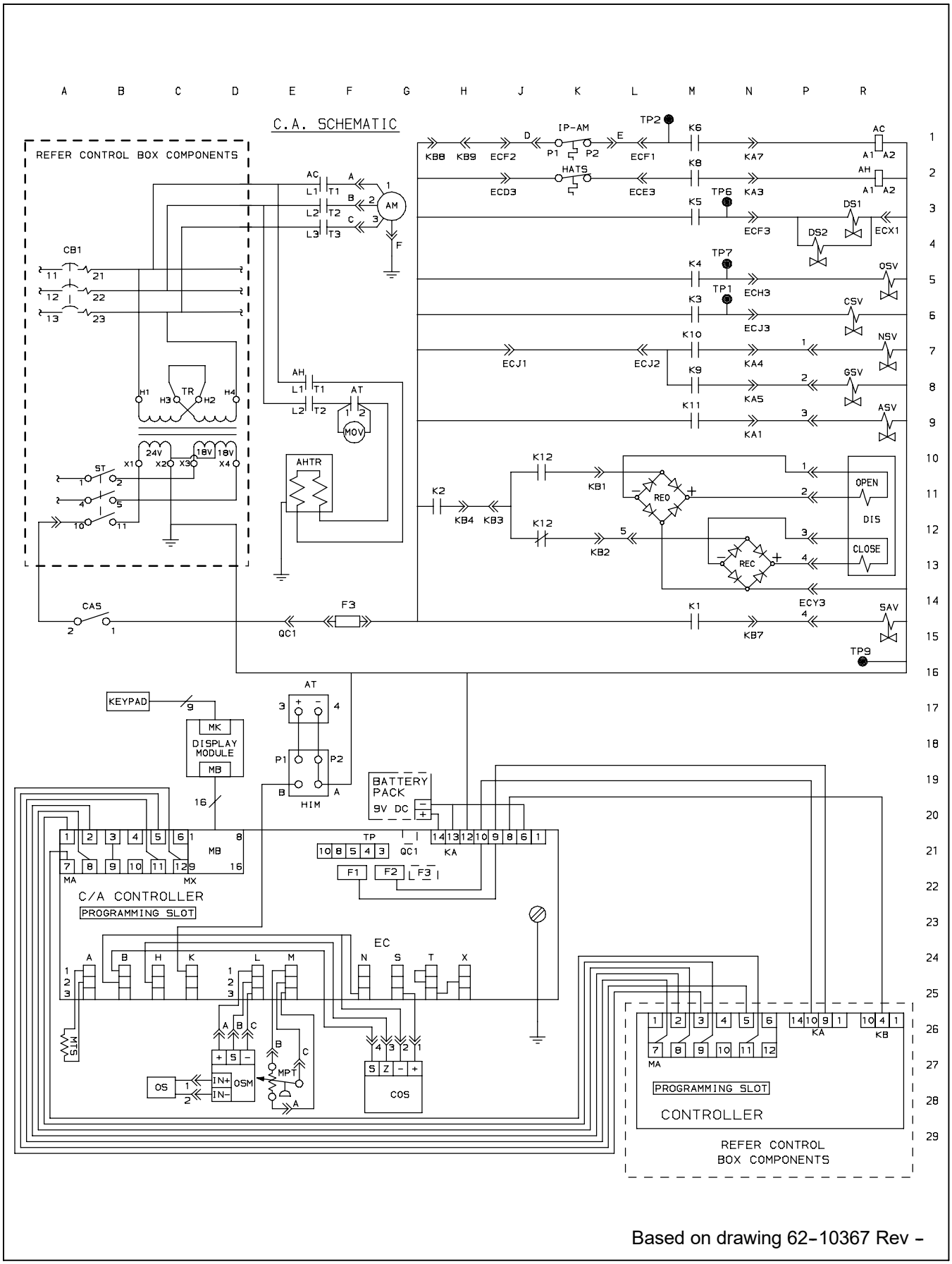


Figure 92. Electrical Schematic

(**U**nits not modified to include the N_2 Purity Solenoid Valve.)

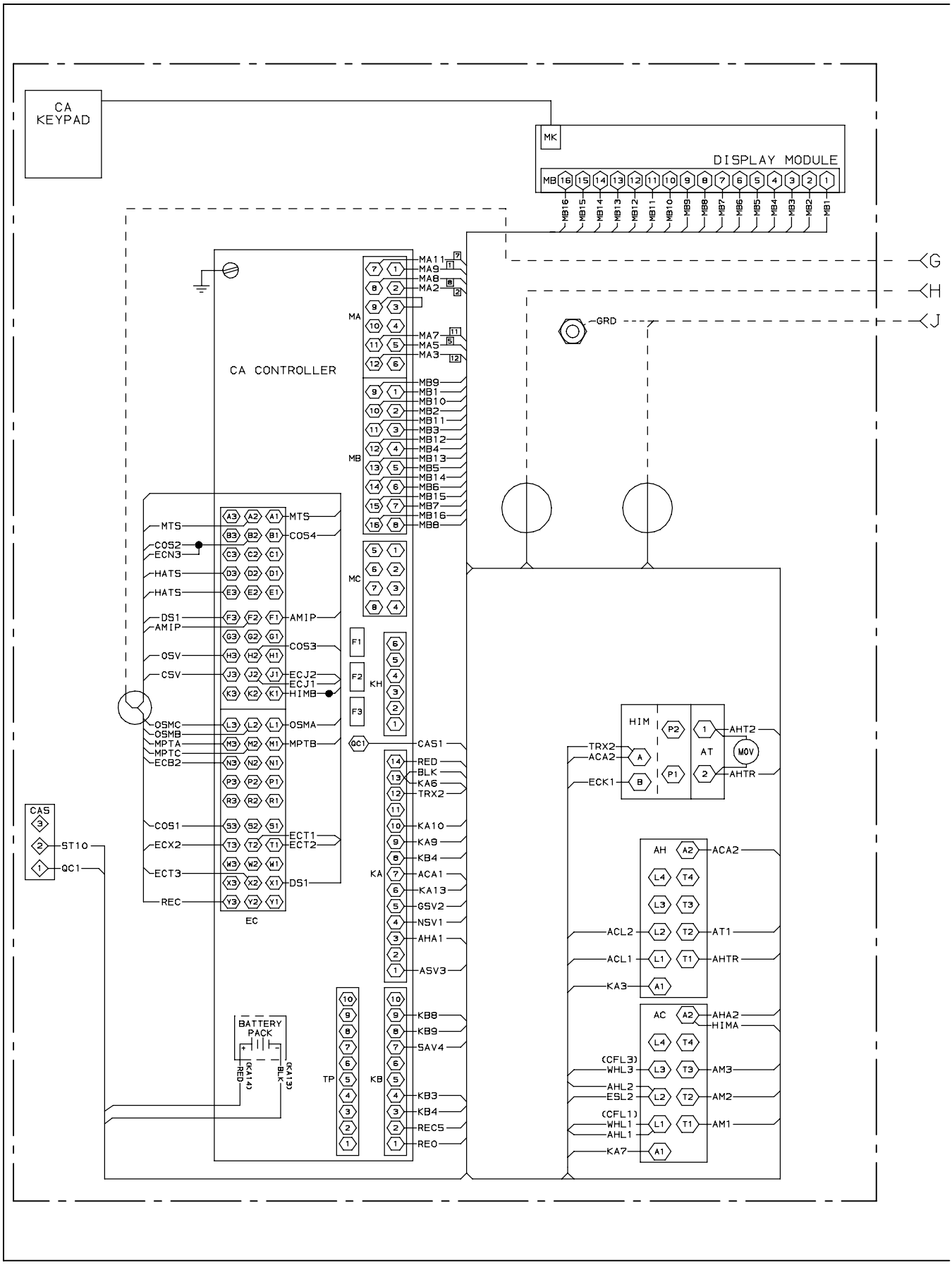


Figure 93. Electrical Wiring Diagram (Sheet 1 of 2)

(Units not modified to include the N_2 Purity Solenoid Valve.)

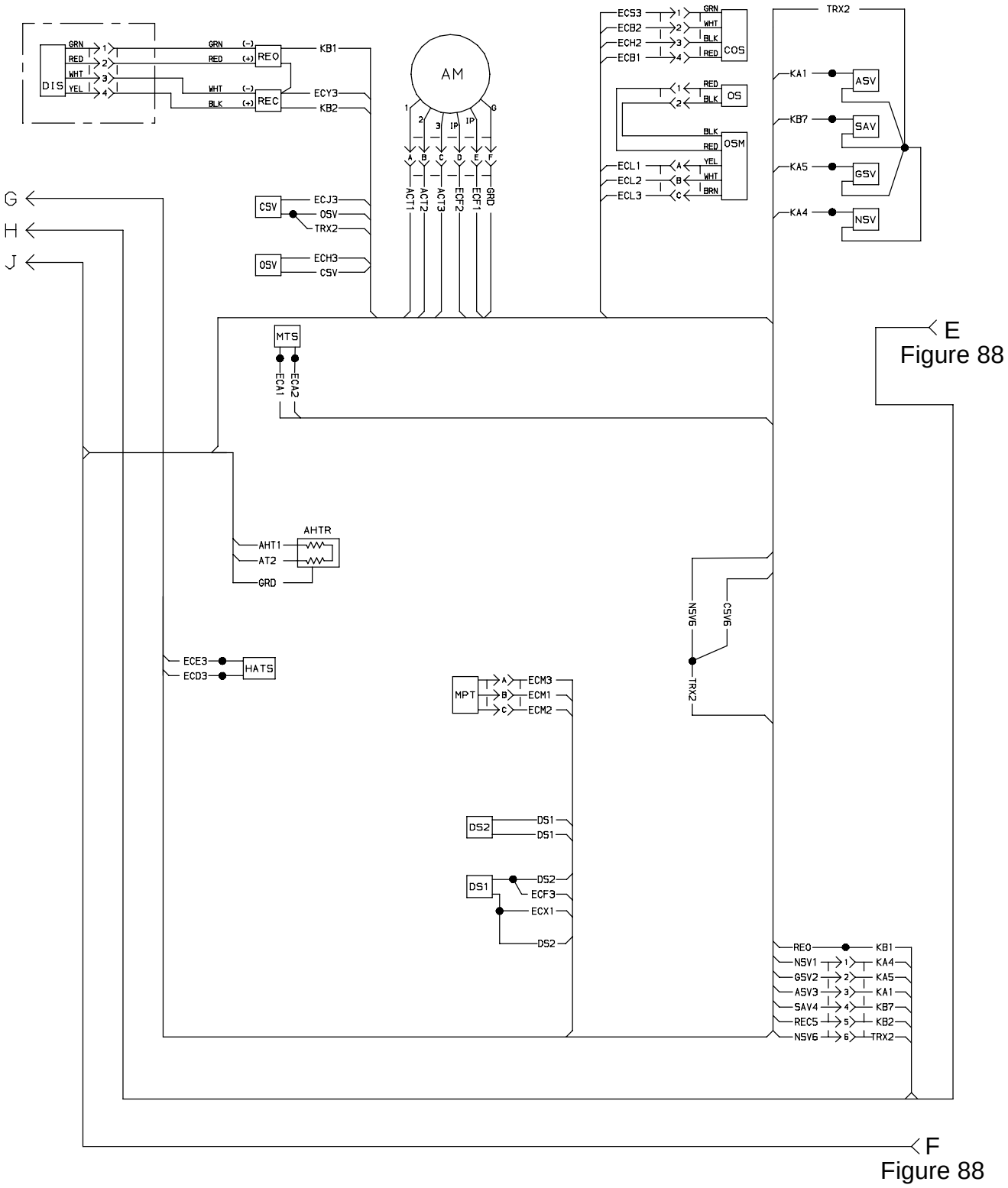


Figure 93. Electrical Wiring Diagram (Sheet 1 of 2)

(Units not modified to include the N_2 Purity Solenoid Valve.)

INDEX

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P

R

S

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U

V

W

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