CO_2 Booster Refrigeration System

INSTALLATION, START-UP & OPERATING MANUAL

Hillphoenix
a DOVER company

ADVANSOR™ flex ONE

Manual Overview

General Information 2
System Information 3-10
System Safety 11-13
System Installation 14
System Pre-Startup 15-16
System Start-Up 17-19
Service Procedures & Maintenance 20-22
Flex One Replacement Parts List 23-24
Appendices 25

To ensure proper functionality and optimum performance, it is strongly recommended that Hillphoenix refrigeration systems be installed/serviced by qualified and certified technicians who have experience working with commercial refrigeration systems. For a list of Hillphoenix authorized installation/service contractors, please visit our Web site: www.hillphoenix.com

Hillphoenix
a DOVER company

Intertek Intertek

Rev 1.0
10/26

Copyright © 2025 by Hillphoenix®

All rights reserved. No part of this document may reproduced or transmitted in any form or by any means - i.e., electronic or mechanical, including photocopying, recording or any other information storage and retrieval system - without express written permission from Hillphoenix®.

DISCLAIMER

This manual is designed to provide only general information. If you need advice about a particular product application or installation, you should consult your Hillphoenix Representative. The applicable specification sheets, data sheets, handbooks, and instructions for Hillphoenix products should be consulted for information about that product, including, without limitation, information regarding the design, installation, maintenance, care, warnings relating to, and proper uses of each Hillphoenix product.

INFORMATION CONTAINED WITHIN THIS MANUAL, IS PROVIDED "AS IS," WITH ALL FAULTS, WITH NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, QUALITY OF INFORMATION, QUIET ENJOYMENT, AND TITLE/NONINFRINGEMENT.

HILLPHOENIX SPECIFICALLY DISCLAIMS ALL LIABILITY FOR ERRORS OR OMISSIONS IN, OR THE MISUSE OR MISINTERPRETATION OF, ANY INFORMATION CONTAINED IN THIS MANUAL. HILL PHOENIX DOES NOT WARRANT THE ACCURACY, COMPLETENESS OR TIMELINESS OF THE INFORMATION CONTAINED IN THIS MANUAL.

Copyright© 2025

Hillphoenix
a DOVER company

Manual Use

Use of this manual is expressly limited to providing guidance to contractors and installers of Hillphoenix supermarket refrigeration systems and other purposes as deemed appropriate by Hillphoenix. Any other uses are prohibited unless specifically approved.

This volume is an Installation and Startup manual.

Technical Applications Group

IMPORTANT

At Hillphoenix®, the safety of our customers and employees, as well as the ongoing performance of our products, are top priorities. To that end, we include important warning messages in all Hillphoenix installation and operations handbooks, accompanied by an alert symbol paired with the word "DANGER", "WARNING", or "CAUTION".

All warning messages will inform you of the potential hazard; how to reduce the risk of case damage, personal injury or death; and what may happen if the instructions are not properly followed.

⚠ DANGER

Indicates an immediate threat of death or serious injury if all instructions are not followed carefully.

⚠ WARNING

Indicates a potential threat of death or serious injury if all instructions are not followed carefully.

⚠ CAUTION

Indicates that failure to properly follow instructions may result in case damage.

Revision History

Rev.	Date	Change Description	Author
1.0	10/26	Advansor Flex One Manual Creation	T.A.G.

GENERAL INFORMATION

Thank you for choosing Hillphoenix for your refrigeration needs. This manual contains important technical information and will assist you with the installation and operation of your new Hillphoenix CO_2 booster system. By closely following the instructions, you can expect peak performance, attractive fit and finish, and long system life.

We are always interested in your suggestions for improvements (e.g. booster design, technical documents, etc.). Please feel free to contact our Marketing Services group at the number listed below. Thank you for choosing Hillphoenix, and we wish you the very best in outstanding food merchandising.

SYSTEM DESCRIPTION

This manual specifically covers the Advansor CO2 Booster Systems' Installation and Start-Up for refrigeration technicians.

RECEIVING FLEX ONE

Inspect Flex One carefully. In the event of shipping damage and/or shortages, please contact the Service Parts Department at the number listed to the right.

FLEX ONE DAMAGE

Claims for obvious damage must be 1) noted on either the freight bill or the express receipt and 2) signed by the carrier's agent; otherwise, the carrier may refuse the claim. If damage becomes apparent after the equipment is unpacked, retain all packing materials and submit a written request to the carrier for inspection within 14 days of receipt of the equipment. **Failure to follow this procedure will result in refusal by the carrier to honor any claims with a consequent loss to the consumer.**

If a UPS shipment has been damaged, retain the damaged material, the carton and notify us at once. We will file a claim.

LOST/MISSING ITEMS

Equipment has been carefully inspected to insure the highest level of quality. Any claim for lost/missing items must be made to Hillphoenix within 48 hours of receipt of the equipment. When making a claim please use the number listed below.

SERVICE PARTS & TECHNICAL SUPPORT

For service parts questions regarding our cases, please contact our Systems Service Parts Department at 800-518-6630 ext. 3205.

For technical questions regarding our cases, please contact our Technical Support Department at 1-833-280-5714.

CONTACTING THE MANUFACTURERS

If you need to contact Hillphoenix regarding a specific fixture, be certain that you have both the model number and serial number of the part.

Hillphoenix, Inc.

2016 Gees Mill Rd
Conyers, GA 30013

Mon.-Fri. (8 a.m to 5 p.m EST)

Website: www.hillphoenix.com

SCOPE OF SPECIFICATIONS

These specifications shall be considered as an addition to the common documentation supplied by the customer for complete installation of the supermarket's refrigeration system and are intended to describe the installation, testing, startup, and operation of a Hillphoenix Advansor Flex One CO_2 Booster Refrigeration System (hereafter referred to as Advansor) only. Failure to follow these specifications will void the manufacturer's warranty.

GENERAL NOTICE

a. The Advansor system (equipment, devices, piping, insulation, etc.) shall be installed per the specifications contained in this "Advansor Flex One CO_2 Booster Refrigeration System Installation, Startup, and Operating Manual," and the system piping diagram and installation drawings (if provided).

b. Any changes not approved by Hillphoenix will void the system warranty.

c. This specification may change without notice. Contact your Hillphoenix representative to verify the most current version of this document and any later developments which have not yet been published.

ADVANSOR SYSTEM BASICS

Indoor refrigeration systems require adequate ventilation for efficient performance.

INTRODUCTION

Advansor CO_2 Booster Refrigeration Systems are the latest option in the Hillphoenix Second Nature product line that for the first time entirely utilize natural refrigerant. The Advansor system is the third type of CO_2 system following the SNLT2 Secondary Coolant system and SNLTX2 Cascade system. Advansor systems, however, are not intended as a replacement to SNLT2, SNLTX2 systems, or any other type of system as each approach has unique characteristics that make them suitable for specific applications.

Advansor systems are considered Transcritical CO_2 systems where the pressure of the CO_2, depending on ambient conditions and other factors, may rise above the critical pressure of CO_2. Operating pressures for these systems are higher than those in conventional direct-expansion systems. The components in the system and the entire system have been engineered to safely and efficiently handle those pressures. Typical operating pressures for Advansor systems are shown in **Appendix B** of this manual.

HOW THE SYSTEM WORKS

CO_2 has several unique properties that make it ideal for use as a refrigerant in general and for booster systems in particular. The critical point of a substance is the point at which its liquid and vapor states cannot be distinguished. The critical point of CO_2 for instance, is around 88° Fahrenheit and is lower than that of other refrigerants such as R-134a (214°F) and R-410a (162°F). Systems using these refrigerants always operate in the subcritical region. Systems using only CO_2 to reject heat to ambient temperatures, on the other hand, do not always operate in the subcritical region. That requires system designers to approach the heat transfer process somewhat differently than they would for more commonly used refrigerants.

As the critical point is approached, the gas and liquid phases of a substance advance toward one another, resulting in only one phase at the critical point: a homogeneous supercritical fluid. There is no distinction between the two phases above this point. Above the critical temperature no additional amount of pressure will cause liquid to form.

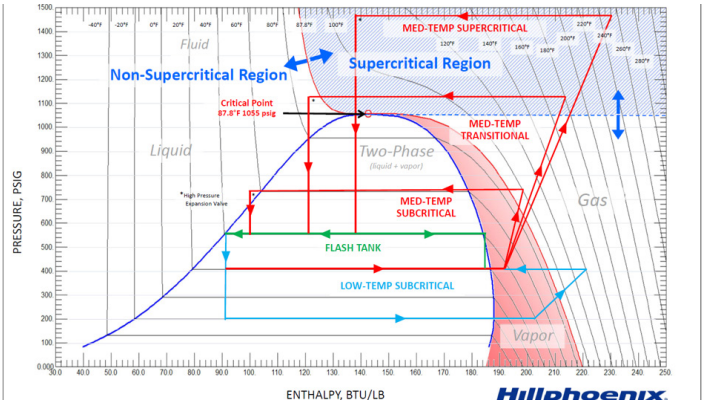


Fig. 1 Critical Point of CO_2

The critical point is important in understanding the operation of the CO_2 booster system. With its use of compressors, the system works in some ways like any other direct expansion (DX) system but with a key difference. In a conventional DX system, the entire operation of the system takes place below the critical point, or in the subcritical region. Within this region, the refrigerant changes back and forth between only vapor and liquid. But as already pointed out, above the critical point another state is reached, that of a supercritical fluid and within that region no further state change such as condensation occurs.

NOTE: The term "critical point" refers to when an indistinct physical state of a substance is reached. It does not in any way imply any difficulty in dealing with the substance. It simply means that at a temperature and pressure above the critical point there is no distinction between the liquid and vapor states of a substance. In fact, above the critical point, a substance is said to exist as a supercritical fluid in which no further state change can occur, only changes in density can take place.

Certain aspects of the Advansor system will be familiar to anyone familiar with DX systems. Like those systems, the Advansor system has four main components that include compressors, evaporators, condensers, and expansion valves. Additionally, the system uses two types of specialized valves: a high-pressure control valve and a flash gas bypass valve.

One key difference from traditional systems is that, in a low temperature system, the system operates as what is known as a two stage booster system. This means the same refrigerant is moving through the compressor twice. The first stage of the compressor is connected to a desuperheater before returning the compressor in the second stage. In other words, the same compressor serves as both the low temperature compressor and the medium temperature compressor.

In a low temperature application, suction gas from the low-temperature display case and/or freezer evaporators enter the compressor at around 200 psig, well below the critical point for CO_2. The low-temp discharge gas at 500-700 psig then combines with the medium temp suction and flash gas distributed from the flash gas bypass line before entering the same compressors. The combined discharge gas leaves the compressors, depending on ambient conditions, anywhere from 600 psig to as much as 1,500 psig, which is above the critical point.

Under warmer conditions in which the pressure rises above 1,055 psig, the system enters the transcritical range. Under either condition, however, hot discharge gas from the medium-temp compressor feeds to a gas cooler where, as with any refrigeration system, the heat is rejected to the outside environment.

Sizing of the compressor of the system is carefully determined to provide optimal capacity control during partial load operation.

The gas cooler design is optimized to accomplish high-performance, even at high ambient temperatures when the system is operating in the transcritical range. (More about how these components work, and their specific operation, is described in greater detail in the next section.)

The CO_2 leaving the gas cooler feeds to a high-pressure control valve that regulates the flow of CO_2 into an intermediate pressure receiver, called a flash tank. The gas enters the valve at 560 psig to 1,450 psig, depending on ambient conditions, and exits at approximately 515 to 850 psig. The valve is designed to work as a hold-back valve in order to maintain optimum pressure through the gas cooler for the most efficient operational performance of the system.

Liquid refrigerant is supplied to the medium or low-temperature evaporators controlled by conventional electronic expansion valves. Vapor from the flash tank is fed through the flash gas bypass valve back to the compressor. The flash gas bypass valve maintains a constant pressure in the flash tank.

MAJOR SYSTEM COMPONENTS

Advansor CO_2 systems use many components that are common to other types of DX systems as well as some that are specifically designed for the application. Like any other DX type of system, the Advansor system relies on the four principal components which include compressors, evaporators, condensers, and expansion valves.

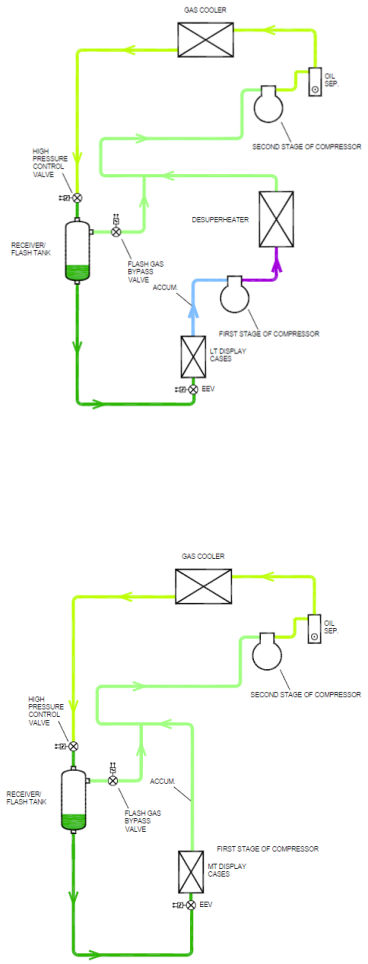


Fig. 2 Simplified Advansor Piping

CO_2 Compressors

Semi-hermetic compressors are used for both low-temp and medium-temp applications. As medium-temp compressors, they discharge at anywhere from 700 psig to 1,500 psig, depending on the ambient conditions. When viewed on a pressure-enthalpy (P-h) chart in Fig. 1, the action of the medium-temp compressors can be seen in the upper section (shaded upper area) of the chart around 385 psig when the gas enters the compressors. From there, again, depending on ambient conditions, the gas may reach to 1,385 psig as it discharges from the compressors and enters the gas cooler. Of course, for the gas to reach that range, the ambient conditions must exceed 80°F.

Compressor Operating Pressures

MT discharge pressure: Approx.:	650 to 1500 psig
Receiver pressure: Approx.:	515 to 850 psig
MT suction pressure: Approx.:	350 to 450 psig
LT suction pressure: Approx.:	170 to 240 psig

Each compressor is installed with some additional features, including:

- Bolted to the frame on oil-resistant polymer mounts
- Service valves on the suction and discharge sides
- Electronic oil floats for active oil level management
- Pressure switches on the discharge side
- Relief valves to ambient (see the manufacturer's operating specifications for more information)
- Crankcase heaters to warm the oil when the compressor is not running
- Variable frequency drives (VFD) on the lead compressor for better capacity control

Oil Separator and Oil Requirements

The Advansor system uses similar oil management components system as those on conventional DX systems, except that they are designed for the higher operating pressures needed for CO2. These include electronic oil level sensors and a separator. Once the medium-temperature or intermediate-temperature discharge gas leaves the compressors, it passes through a highly efficient oil separator using coalescing filters to separate the oil from the refrigerant.

Only manufacturer-approved oil is permissible for use in the Advansor system.

Gas Cooler

At ambient conditions below 80°F, medium-temperature discharge gas enters the gas cooler and rejects heat to the outside air as it passes through the coils of the unit. The main difference between it and a conventional is that when the ambient temperature rises above 80°F, the system begins operating in the transcritical range. This means that the discharge gas passing through the system does not undergo any further state change but instead remains a supercritical gas, or fluid as it is otherwise known. This last point is a key distinction. Under transcritical conditions, the discharge gas enters the gas cooler as a supercritical fluid and stays that way throughout the gas cooler stage to the high-pressure control valve. No condensing of the gas takes place as in a regular condenser. Below 80°F, however, the unit then works just like a in a typical DX system.

The gas cooler fans are controlled in the same way that compressors gain efficiency with variable speed drives. The gas cooler includes a shut-off valve for maintenance or other needs.

High-Pressure Control Valve

Like the gas cooler, the high-pressure control valve works under two modes of operation. It usually controls subcooling in the gas cooler when that unit operates as a condenser. Under conditions during which the gas cooler is working as a gas cooler (above 80°F ambient), the valve controls pressure in it.

Power to the valve is furnished from an uninterrupted power supply (UPS). The valve closes in case of a power failure.

The Carel E2V is a motor-operated, high-pressure control valve designed to regulate the flow of transcritical gas or subcritical liquid flowing from the gas cooler in transcritical CO_2 systems. It exercises control over the temperature differential in the gas cooler/condenser during transcritical operation (when the gas cooler/condenser is operating as a gas cooler) and sub-cooling (when the gas cooler/condenser is operating as a condenser) during subcritical operation. The maximum working pressure for the valve is 2030 psig (140 bar).

By means of a hand magnet, if applicable, the valve can then be operated manually. The valve must be powered from a UPS and will shut down (close) under conditions of a complete power failure.

Flash Gas Bypass Valve

The Carel E2V, or equivalent, flash gas bypass valve is situated between the flash tank/receiver and the suction to the MT compressors. The valve is an electric stepper motor valve, maintaining a constantly adjusted pressure in the receiver.

In case of power failure, the valve will shut down by means of a required UPS in the control panel.

Oil System Components

The oil system for the CO_2 booster system refrigeration CDU contains most of the normal oil system components, and is optimized by use of the following components:

- Oil Level Regulator located on the compressor
- Oil separator with either an internal or external reservoir
- Inline Oil Filter

Separator

The system is equipped with a highly efficient mechanical oil seperator. This is a non-serviciable hermetic coalescing oil separator.

Flash Tank

The expanded gas from the high-pressure control valve flows into the flash tank. The flash tank is equipped with a flash gas bypass valve that maintains a set pressure in the tank. When opened, the valve bypasses excess vapor from the tank to the suction side of compressors.

Stainless Steel Piping

Schedule 40 (SCH 40) 304L Stainless Steel Pipe Specifications for Field-Installed Piping*		
Nominal Size (Inches)	**Wall Thickness (Inches)**	**MAWP**
1/2”	0.109	4538 psig/312 barg
3/4"	0.113	3683 psig/253 barg
1”	0.133	3436 psig/236 barg
1-1/4"	0.14	2827 psig/194 barg
1-1/2”	0.145	2523 psig/173 barg
2”	0.154	2131 psig/146 barg
2-1/2”	0.203	2334 psig/160 barg
3”	0.216	2015 psig/138 barg
4”	0.237	1711 psig/117 barg
6”	0.28	1363 psig/93 barg

Schedule 80 (SCH 80) 304L Stainless Steel Pipe Specifications for Field-Installed Piping*		
Nominal Size (Inches)	**Wall Thickness (Inches)**	**MAWP**
1/2”	0.147	6394 psig/440 barg
3/4"	0.154	5205 psig/358 barg
1”	0.179	4785 psig/329 barg
1-1/4"	0.191	3958 psig/272 barg
1-1/2”	0.2	3596 psig/247 barg
2”	0.218	3088 psig/212 barg
2-1/2”	0.276	3248 psig/223 barg
3”	0.3	2871 psig/197 barg
4”	0.337	2479 psig/170 barg
6”	0.432	2146 psig/147 barg

Piping

A high volumetric capacity is one of the benefits of CO_2. This allows for smaller diameter piping to be used than would otherwise be needed for an HFC system of similar capacity. In fact, smaller diameters add to the overall advantages of the system since they decrease the refrigerant charge and handle higher pressures. Piping and elbows to and from the gas cooler should be either C-194 copper or stainless steel and should be installed to comply with appropriate standards. The steel piping that is welded must be coated with primer and varnish. During operation, the pipes can get hot (i.e., 250°F) and insulation is recommended anywhere they might be touched.

Note: All pressure conversions are shown in barg (gauge).

Piping Specifications for a Typical R-744 (CO2) Booster System[1]		
Item	**Design Pressure**	**Field-Installed Line Type**
Low Temp (LT) Suction	90 Bar (1305psig)	C194 copper or Steel[2,3,4]
Medium Temp (MT) Suction	90 Bar (1305psig)	C194 copper or Steel[2,3,4]
To/From Gas Cooler	1,885 psig (130 barg)	C194 copper or Steel[2,3,4]
Liquid Line	90 Bar (1305psig)	C194 copper or Steel[2,3,4]

NOTE 1: Design pressures are job specific

NOTE 2: Carbon steel per ASTM A106 or ANSI/ASME B36.10

NOTE 3: Stainless steel per ASTM A312 or ANSI/ASME B36.19

NOTE 4: Butt weld or socket weld connections are acceptable

Line sizes for any type of CO_2 system are generally one to two sizes smaller than those used for HFC applications. The installation drawings for the job usually specify the line sizes required. However, if line sizes have not been provided or are missing, contact the Hillphoenix representative for the job.

⚠ CAUTION

Always keep in mind that any deviation from the line sizes specified by Hillphoenix can result in improper operation of the system.

Liquid supply lines are sized to ensure a proper and evenly distributed pressure drop and velocity of the CO_2 liquid. A minimum line size of 3/8” OD is used for both liquid and suction lines. Line sizes are specified by engineering drawings for the specific project and should be strictly adhered to. Changing 3/8” liquid lines to 1/2” size is not recommended as it increases the charge of CO_2 required for proper system operation.

NOTE: The pressure-temperature chart for CO_2 is located in **Appendix B** at the end of this manual.

Suction return lines carrying vapor CO_2 and small amounts of oil in both horizontal and vertical configurations are sized to ensure the effective return of oil back to the compressors.

Any time a suction line turns vertically upward, this is considered a vertical riser. Follow the line size as specified for vertical risers on the refrigeration schedule or drawings.

Mueller Streamline Copper Products

Refrigeration brazing is commonly performed at 900°F to 1300°F.

Note: Temperatures in this range involve sufficient heat to anneal copper.

Therefore, the working pressure ratings for all Streamline copper tube and wrot fittings should be based on performance in the annealed state—this is true whether referring to actual field brazing or to an annealing furnace. Following years of testing, the Mueller company is able to offer copper products rated for continuous up to 700 psi at 250°F. All of these values have already been de-rated for brazing.

Refrigeration Systems With Pressures Higher Than 700 psi (250°F)

In refrigeration applications such as transcritical CO_2 systems where internal pressures can exceed 700 psi, piping manufactured using a Copper-Iron alloy such as C19400 becomes necessary.

In the event the evaporator is a high-standstill model, it is reccomended to install XHP 90 or XHP 130 copper on all lines, independent of the operating pressure.

The Mueller Streamline Company manufactures tube and fittings made from alloy C19400. This Streamilne XHP tube is made to meet the dimensional (OD), mechanical, cleanness, and eddy current testing requirements for the applicable specification of ASTM B280 (Seamless Copper Tube for Refrigeration Field Service). Similarly, Streamline XHP fittings are made to meet the dimensional requirements and other applicable specifications of ASME B16.22 (Wrought Copper and Copper Alloy Pressure Fittings).

The Streamline XHP Copper Iron Tube is applicable for use in refrigeration applications. Available sizes ranging from 3/8 to 2-5/8" for continuous 90 bar/1,300 PSI pressure ratings or 130 Bar/1885 PSI pressure ratings at 120°C/250°F

In any case, the specific local system operating pressures must be accounted for prior to the selection and installation of any piping.

Other Manufacturers of Copper-Iron Alloy Products

Another manufacturer of alloy C19400 copper products is the Wieland Copper Products company. Their high strength copper-iron alloy product is known as K-65. This K-65 copper piping product is available at a pressure rating of 120 bar (1740 psi), making it viable for use in transcritical R-744 systems. This piping may be used in the high or low side system piping.

Note: K-65 piping is not approved for use in some areas.

Thus, it is advisable for refrigeration contractors to check and verify local code requirements.

Other Important Notes Applicable to Piping and Brazing

Always be aware that R-744 (CO_2) systems operate at higher pressures than traditional DX systems. In addition, as with traditional DX refrigeration systems, short radius fittings are not recommended for piping installation. Long radius elbows are available from a number of different manufacturers. Always be certain to install only appropriate pressure-rated fittings.

All welded/brazed joints should be made up using 15% silver "Silphos" solder Phos-Copper Silver Brazing Alloy. Use 45% to 56% High Silver Brazing Alloy "Easy Flo" solder for brazing dissimilar materials such as sweat valves and other control devices. There is an additional, essential practice that is crucial to brazing refrigeration lines. Whenever pipe brazing operations are being performed, it is very important to know it is required to flow dry nitrogen through the interior of the piping being joined.

⚠ CAUTION

It is always important to ensure that the silver braze being used is pulled into the full depth of every joint (full penetration).

Brazing

Joints in the copper piping for the CO_2 system are brazed the same way as for conventional refrigeration systems. Nitrogen must be used to reduce oxidation of the piping during the brazing process.

Mechanical Joints

Threaded or flared joints should be avoided to reduce the likelihood of leaks developing over the lifetime of the system.

If these joints must be used, the following guidelines should be applied to ensure a leak-free joint.

Threaded Joint Sealants

Threaded joints applied to Advansor systems must only be used with Permabond MH052 thread sealant. The tape should be spiral wrapped around each joint. Use of thread sealants other than Permabond may result in improper system operation and leakage of CO_2. The sealant can be obtained from the manufacturer.

Permabond LLC
14 Robinson St.
732-868-1372
Pottstown, PA 19464
permabond.com

Slope of Refrigeration Lines

All CO_2 suction return lines must be installed to slope or pitch downward towards the machine room to enable proper return of refrigerant oil. This is the same practice used for conventional DX systems with HFCs (example slope: 1" per 20' or greater).

Expansion Loops

Installation of expansion loops is recommended to minimize stress on the piping network. Most expansion requirements can be accommodated through the normal direction changes of the piping network. Long straight runs of pipe should include extra changes in direction to accommodate this expansion; a horizontal offset or expansion loop can be applied in these circumstances. Additional information regarding expansion joints can be found in the ASHRAE HVAC Systems and Equipment Handbook (Chapter 46 - Pipes, Tubes and Fittings in the 2012 edition).

Traps

Traps must be installed in all suction lines when transitioning to piping that runs vertically upward (risers) to assist with oil return. Typically, the riser pipe size should be one to two sizes smaller than the horizontal pipe size. Transition from the horizontal to the riser size should be made at the outlet of the p-trap. Inverted or reverse traps are recommended on booster system piping. All liquid line drops must come off of the side of the liquid header/liquid line. When rise exceeds 14 to 16' double traps must be installed at the mid section.

Inverted Traps

With all risers, an inverted trap must be installed into the top of the main suction loop from the riser.

Safety Relief Valves

Relief valves are used in positions where the maximum design pressure may be exceeded. Relief valves are either factory-installed or must be field-installed as per the system piping schematic.

Relief valves used for CO_2 applications are designed for use on cryogenic systems and should not be replaced with relief devices typically installed on conventional refrigeration systems. Relief valve manufacturers recommend replacing any that have blown.

Vapor relief valves mounted at the CDU are piped to a common header from which a vent line must be field installed to terminate outside the building, as required per local code.

Obtain replacement relief valves from the Hillphoenix Service Parts Department at 800-518-6630 ext. 3205.

On all pipe sections that can be isolated when valves are closed, safety valves are installed to protect those areas. Fittings and accessories should be easily accessible and thus positioned to ensure safe operation as well as maintenance. The valves should also be situated so that the release of any pressure does not affect surrounding piping, components, or material. All outlets from the vapor safety valves should be joined and connected to the outside through hoses or type C194.

Ultimately, the system is equipped with high-pressure switches that ensure that the compressor is cut-off before they can reach the maximum acceptable pressure and prior to blowing the safety valves on the high-pressure side.

Pressure switches installed on the system are incorporated into the energy management system controls.

Supports

All insulated pipes should use supports that have a plastic (e.g. PVC) or metal saddle with a smooth bearing surface, have a length of at least three (3) times the external diameter of the insulation, and cradle the bottom 120 degrees of the pipe. Edges should be rounded to minimize cutting into the insulation. This will reduce possible stress concentrations and protect the insulation from damage.

A minimum air space of one inch (1") should be provided between insulated lines to prevent condensation on the surface of the insulation.

Closed trenches (not open and accessible) should be used for underground piping. These should be designed so that the pipe can be installed without damage to the insulation.

Rigid clamps should not be used to directly support the piping as they conduct heat from the piping, are difficult to insulate, and will cause continuous condensation during system operation.

General Insulation Guidelines

Insulation should generally be applied in accordance with local building codes, the consulting engineers, and insulation manufacturer's specifications.

The use of any insulation material other than those listed in this manual requires the written approval of Hillphoenix and the customer.

Piping system should always be insulated in order to reduce heat transfer between the fluid lines and the surrounding ambient air. Insulating the lines also prevents condensation or ice formation on the pipe surfaces and minimizes corrosion of the piping materials. When insulation requirements are determined, the following major factors should be considered:

- Application (Fluid) Temperature
- Ambient Conditions including:
  - Dry-Bulb Temperature
  - Relative Humidity
  - Surrounding Air Velocity
- Insulation Material
- Desired Performance

The application temperature used in this manual is for an Advansor system with a low temp CO_2 evaporating temperature of -5 to -30°F. For systems with significantly higher or lower evaporating temperatures, consult the insulation manufacturer about proper thickness recommendations.

Insulation sizing is determined based on either of these two different ambient conditions:

- Normal Conditions: Maximum severity of 85°F dry bulb temperature, 70% relative humidity, and 0 ft/min air velocity.
- Severe Conditions: Maximum severity of 90°F dry bulb temperature, 80% relative humidity, and 0 ft/min air velocity.

Hillphoenix recommends the use of insulation sized for "Normal Conditions" for typical indoor air-conditioned space and insulation sized for "Severe Conditions" for outdoor applications and non- conditioned spaces.

The normal condition is applicable for most indoor air-conditioned environments in North America. A typical supermarket indoor design point of 75°F dry bulb temperature and 55% relative humidity can be considered equivalent to this normal condition for the purpose of sizing insulation. Although insulation thickness is given for the more difficult condition of "severe", determining which of these to use depends on local ambient conditions and should be evaluated for each installation site. It is also important to consider that even in some air-conditioned environments, air at or near the ceiling or roof can be much hotter than elsewhere in the store and that evaluating these conditions is extremely important for systems containing overhead piping.

The insulation sizes recommended in this section are designed to limit heat gain into the piping network and as a rule, are one size larger than those needed for control of condensation only. Although insulation could be sized and installed for the purpose of prevention of condensation only, the additional heat transfer through the insulation would result in lower energy efficiency of the refrigeration system, and possible system malfunction during peak load and/or high ambient conditions.

All valves, controls, and fittings in contact with CO_2 should be insulated to allow easy removal for component servicing. Components should also be insulated to minimize air pockets or voids, which can collect moisture over time.

Running piping in non-air-conditioned spaces should be avoided wherever possible in order to minimize insulation thickness requirements and reduce heat gain.

Insulation Materials

The recommended insulation materials for field-installed Advansor system piping are:

- Flexible Closed-Cell Elastomeric Foam
- Styrofoam
- Trymer

The most common materials used for field-installed piping are flexible, closed-cell, elastomeric materials. Products of this type are manufactured by both Armacell and Nomaco. Technical information and detailed installation instructions for these materials may be obtained from the manufacturer.

Armacell LLC
7600 Oakwood St. Ext.
Mebane, NC 27302
919.304.3846
www.armaflex.com

Nomaco K-Flex
100 Nomaco Drive
Youngsville, NC 27596
800.765.6475
www.kflexusa.com

Styrofoam and Trymer are also acceptable for field-installed piping. Both products of the Dow Chemical Company, these materials are manufactured in rectangular bunstock and fabricated into sheets, pipes, and fittings. Styrofoam is an expanded, extruded, closed-cell polystyrene foam and Trymer is a polyurethane-modified polyisocyanurate cellular foam. Both have a minimum required thickness and should be covered with an appropriate vapor-barrier (e.g. Saran) and jacketing material. Additional information on these materials may be obtained from:

Dow Plastics
PO Box 1206
Midland, MI 48641
866.583.2583
www.dow.com

Recommended Insulation Thickness of Elastomeric and Rigid Insulation Materials for Field Piping						
Pipe Size (OD)	Normal Conditions 85°F (29°C) Dry Bulb 70% RH, 0 fpm			Severe Conditions 90°F (32°C) Dry Bulb 80% RH, 0 fpm		
	Liquid	LT Suction Return	MT Suction Return	Liquid	LT Suction Return	MT Suction Return
3/8"	3/4"	3/4"	3/4"	1"	1-1/2"	1"
1/2"	3/4"	3/4"	3/4"	1"	1-1/2"	1"
5/8"	3/4"	1"	3/4"	1"	1-1/2"	1"
7/8"	3/4"	1"	3/4"	1"	1-1/2"	1"
1-1/8"	3/4"	1"	3/4"	1"	1-1/2"	1"
1-3/8"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
1-5/8"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
2-1/8"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"

NOTE: Additional thickness may be needed beyond the minimum requirements due to design and surrounding conditions.

UNDER FLOOR AND UNDERGROUND PIPE INSTALLATIONS

Where piping overhead is not feasible, under-floor piping is permitted, though not recommended. Under floor piping should be insulated inside of PVC piping or equivalent rigid pipe to prevent damage to the insulation material.

The void between the insulation and the PVC pipe, where the insulated piping exits the PVC, should be filled with expanded polyurethane foam to prevent air from entering the pipe.

Hillphoenix does not recommend "direct burial" of insulated piping.

Labeling Recommendations

All CO_2 piping, whether factory or field installed, should be labeled to indicate:

- Fluid type (i.e., Carbon Dioxide)
- Arrows indicating direction of flow

In general, it is recommended that labeling comply with ANSI/ ASME Standard A13.1-81, "Scheme for the Identification of Piping Systems".

Pipe labeling materials may be obtained from a number of suppliers, including Brimar Industries and Seton.

Brimar Industries
64 Outwater Lane
Garfield, NJ 07026
800.274.6271
www.brimar.com

Seton
20 Thompson Road
Branford, CT 06405
800.243.6624
www.seton.com

SAFETY NOTICE

Hillphoenix recommends that the installers and technicians installing and conducting maintenance of our refrigerated cases must take reasonable care of their own health and safety. As such, Hillphoenix requires the use of safety glasses, ear plugs, steel toed shoes, gloves, arm sleeves, knee guards, back supports, and other such personal protective equipment as deemed reasonable for one's safety and protection during the installation and maintenance of our cases, or as otherwise required by local ordinance, the general contractor, or other governing authority.

CO_2 PROPERTIES AND HANDLING

Before handling Carbon Dioxide (CO_2), the contractor should be familiar with the Material Safety Data Sheet (MSDS) and the materials physical properties. An MSDS for CO_2 is available from any supplier of industrial gases or the Compressed Gas Association– see page 11.

Carbon Dioxide is a colorless, odorless, slightly acidic gas that is approximately 50% heavier than air. It is non-flammable and will not support combustion. Table 1 shows selected properties of CO_2.

Carbon Dioxide has excellent thermodynamic properties which make it ideally suited for use as a refrigerant. Table 1 shows the thresold limit value and time weighted average for selected properties of CO_2.

Table 1

Molecular Weight	44.01
Boiling Point @ 1 atm.	-109.1°F
Triple Point @ 60.4 psig	- 69.8°F
Critical Temperature	87.9°F
Critical Pressure	1056 psig
Specific Gravity of Gas @ 1 atm.	1.53
OSHA TLV-TWA[1]	5,000 ppm (0.5%)

Table 2 shows selected thermodynamic properties of CO_2 at -20°F and +20°F. A detailed pressure-temperature chart for CO_2 is also shown in **Appendix B**.

Table 2

Property	@-20°F	@+20°F
Saturation Pressure, Psig	200.2	407.2
Liquid Density, Lb/Ft3	66.9	60.3
Vapor Density, Lb/Ft3	2.40	4.94
Heat of Vaporization, Btu/Lb	129.6	107.5

CO_2 SAFETY

Carbon Dioxide is a naturally occurring substance present in air at concentrations of 300-400 parts per million (ppm) or 0.030%-0.040%. The Occupational Safety and Health Administration (OSHA) has listed for CO_2 a TLV-TWA level of 5,000 ppm or 0.5%. This (Threshold Limit Value–Time Weighted Average) is the time-weighted average concentration for a normal 8-hour workday and 40-hour workweek, to which nearly all persons may be repeatedly exposed to without adverse effects. CO_2 compares favorably to the TLV-TWA value of 3,000 ppm for typical HFC refrigerants (R-404A and R-507).

More information on the safe use and handling of CO_2 can be found in the Compressed Gas Association, Standard CGA-G-6-1997 “Carbon Dioxide.” This and other related standards can be obtained from:

Compressed Gas Association
4221 Walney Road, 5th Floor
703.788.2700
Chantilly, VA 20151
www.cganet.com

CO_2 LEAK DETECTION

Since CO_2 is both present in the atmosphere at concentrations of 300-400 ppm and is also a byproduct of human respiration and other processes, detection of leaks in a piping network can be more difficult than with conventional refrigerants (Fig. 3).

Fig. 3 CO_2 Concentration Monitor

Leaks occurring on liquid lines will often be visible, emitting a small amount of CO_2 vapor which can appear cloudy. Larger leaks will show evidence of a very cold ice-ball and possibly the formation of dry ice on the outside of the insulation.

Leaks can be detected using either hand-held or fixed probes (Fig. 4).

Fig. 4 Examples of Carbon Dioxide Leak Detectors

For detecting small liquid or vapor leaks, hand-held detectors are available. These typically consist of a detector element connected to a hand-held display containing the electronics. Response time on these instruments can be slower and should be taken into consideration when moving the detector element from one position to another. Different examples of leak detectors which have been used successfully are in Fig. 4.

Inficon manufactures a hand-held, portable detector that is similar in operation to portable meters used for HFC and HCFC leak detection.

Response time is quick; this is the preferred leak detector for use with CO_2. Vaisala also manufactures a variety of detectors for both mechanical room (wall-mounted), duct-mounted, and hand-held applications. Response time for the Vaisala hand-held probe is slower (20-30 seconds) and is less well-suited for finding leaks in the field.

Additional information on CO_2 leak detectors can be obtained from:

Inficon
Two Technology Place
East Syracuse, NY 13057
315.434.1100
www.inficon.com

Vaisala Inc.
10-D Gill Street
Woburn, MA 01801
781.933.4500
www.vaisala.com

A variety of manufacturers (Carel, CPC/Copeland, Danfoss, etc.) supply fixed-location probes for CO_2 monitoring of mechanical rooms and other non-refrigerated spaces including suppliers of CDU controllers for commercial refrigeration systems (Fig. 5). The recommended range for fixed-location probes is 0-10,000 ppm. CO_2 sensors should not be mounted near sources of combustion including furnaces, gas heaters, and loading docks, as higher levels of CO_2 can be present in these locations.

Fig. 5 Copeland Leak Detection System

CO_2 PURITY

Carbon Dioxide purchased for use in refrigeration systems must be of a purity level high enough to prevent accumulation of non-condensable gases and moisture in the condenser-evaporator. A build-up of these gases can block the heat transfer surface and cause inefficient operation or malfunction of the system. Remove non-condensables, which may get charged into the system, by using an available access valve in the system to vent

off CO_2. Examples of various grades of CO_2 are shown in Table 3.

Note: Hillphoenix recommends using Instrument (99.99% purity) CO_2 which contains less than 0.01% non-condensable gases and moisture.

Table 4 shows typical specifications for Instrument Grade CO_2.

To determine if a cylinder has a cap-charge, measure the tank pressure using a regulator and compare this with the saturation pressure at the approximate storage temperature of the tanks. Tanks with a cap-charge will have a pressure significantly higher (>200 psig) than the corresponding saturation pressure.

⚠ WARNING

Some CO_2 gas suppliers offer a "cap-charge" of helium or other inert gases for liquid cylinders which increases tank pressure to speed the charging process. DO NOT accept any cylinders with this cap-charge; use only cylinders that are PURE CO_2. Use of cylinders with a cap-charge will likely introduce large amounts of non-condensable gas, rendering the system inoperable, and require purging, evacuating, and recharging the entire system.

Table 3. Common Grades of CO_2

Industrial	99.5%
Bone-Dry	99.8%
Anaerobic	99.9%
Instrument	99.99%
Research	99.999%
Ultra-Pure	99.9999%

Table 4. Specifications of Instrument Grade CO_2

Minimum Purity of CO_2	99.99%
Nitrogen, N_2	< 50 ppm
Oxygen, O_2	< 20 ppm
Water, H_2O	< 10 ppm

Introduction of lower-grade CO_2 with purity-levels less than those of Instrument Grade is not recommended and should only be done in emergency situations.

In an emergency situation, a purity level lower than 99.99% may be used, however, the lower purity CO_2 must be completely replaced with 99.99% purity CO_2 when available. Using CO_2 with purity levels less than that recommended by Hillphoenix is acceptable provided that the following precautions are taken:

a. Include a filter drier in the line as part of the charging process.

b. Throughly check for non-condensables, which may get charged into the system and have available a means for removing.

Use of Carbon Dioxide of a higher purity level than 99.99% is also acceptable though typically neither cost effective nor readily available in the quantities usually needed to charge an entire system. To ensure that refrigeration systems operate properly, it is necessary that the purity of the CO_2 (R-744) utilized in R-744 refrigeration systems meets certain standards.

Carbon Dioxide Refrigerant (R-744) and its Allowable Levels of Contaminants		
	Reporting Units	R-744
Characteristics		
Sublimation Point[1]	°C at 101.3 kPa	-78.4
Sublimation PointRange	K	±0.3
VAPOR PHASE[2]		
Air and other non-condensables, Maximum	% by volume at 10°C below the critical temperature and measure non-condensable directly	1.5
LIQUID PHASE[3]		
Water, Maximum	ppm by weight	10
High Boiling Residue, Maximum	% by weight	0.0005
Particulates/Solids	Pass or Fail	Visually clean
Minimum Purity	% by weight	99.9
Table above is copied from AHRI Standard 700-2015, page 11. Table 1C.		

CO_2 CYLINDERS

CO_2 is available in both liquid and vapor form and in a variety of cylinder sizes. The most common types and sizes of CO_2 cylinders are shown schematically in Figure 6 and are:

- High-Pressure Vapor Cylinder, 50 lbs. of CO_2
- High-Pressure Liquid Cylinder, 50 lbs. of CO_2
- Low-Pressure Liquid/Vapor Cylinder, 350 lbs of CO_2

Note: Low-Pressure Liquid/Vapor cylinders cannot be used on booster systems due to their lower pressure ratings.

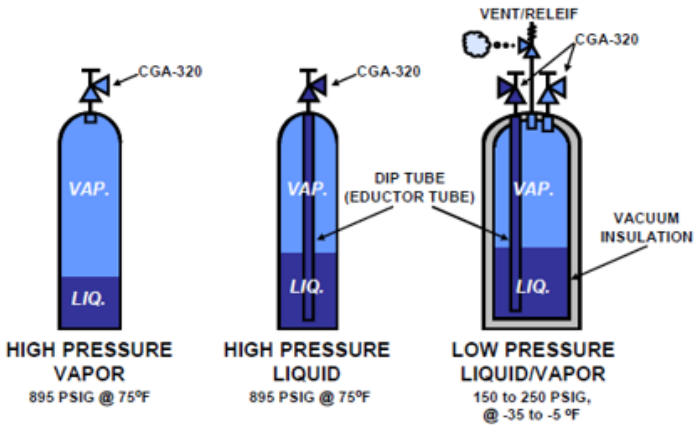


Fig. 6 CO_2 Cylinder Types and Sizes

CO_2 CYLINDERS (cont.)

High-pressure cylinders contain CO_2 at a saturation pressure corresponding to the temperature of their surroundings. At a room temperature of 75°F this corresponds to 895 psig. CO_2 can be stored in high-pressure cylinders indefinitely.

Low-pressure cylinders contain CO_2 at a saturation pressure corresponding to the pressure setting of the vent/relief valve installed on the tank, typically between 200 to 300 psig, maintaining the temperature of the CO_2 between -20°F and 0°F. The cylinder is a double-walled construction with a vacuum between the inner and outer-tanks which acts as insulation to minimize heat transfer. As heat enters the tank, the CO_2 pressure rises until the vent/relief valve opens, releasing vapor CO_2. This causes a small amount of CO_2 liquid to evaporate, cooling the remaining CO_2 in the tank and lowering the pressure. The frequency and duration of the opening of the relief valve varies and depends on the valve setpoint and the temperature of the surroundings. CO_2 stored in low-pressure cylinders will last for 1-5 months before completely venting through the relief valves.

CO_2 can be charged in both liquid and vapor form. Breaking the vacuum and initial system pressurization must be performed using vapor. Field experience has shown that once this has been completed, the remainder of the charging should be performed using high-pressure liquid tanks. The various equipment needed for both methods of charging and the different procedures that are required are detailed in the System Start-Up section.

ADVANSOR INSTALLATION, START-UP & OPERATING PROCEDURES

The specific steps described here are only for the installation, testing, and initial start-up of an Advansor refrigeration system. Failure to follow these specifications may void the manufacturer's warranty.

Note: Installation must be carried out in accordance with national, state, and local codes.

As with any other type of CDU system, Advansor systems must be installed on a flat, level and stable surface capable of supporting the weight of the equipment. The CDU may be mounted on vibration isolation to prevent any vibration from spreading to the rest of the building.

The CDU should only be installed in properly ventilated, fire-protected, dedicated spaces. Such spaces should be ones that are not subject to excessive heat or cooling, as well as the risk of collision from other equipment or associates that can occur in non-dedicated spaces. Given those considerations, the system can be installed either indoors or outdoors. For outdoor installation, the system must be installed in an enclosure.

The installation site should also have available adequate lighting and working space in which to access and carry out service and maintenance tasks safely.

RIGGING AND HANDLING

Prior to installation, check local and national codes for installation requirements. Recommended dimensions are case and site specific. Refer to **Appendix E** for more information.

PIPING INSTALLATION

Evaporator Piping

- Liquid lines from the Flash Tank Outlet to the Low or Medium Temperature Evaporators should be installed and insulated per the construction plan set. Field installed piping must be pressure rated at, or above, the factory installed Flash Tank Pressure Relief Valve for normal operation and not for the standstill operation.
- Low Temperature Suction Lines must be insulated, and pressure rated at, or above, the factory installed Low Temperature Suction Header Pressure Relief Valve.
- Medium Temperature Suction Lines must be insulated, and pressure rated at, or above, the factory installed Medium Temperature Suction Header Pressure Relief Valve.

Specific steps for installing piping to the evaporator include:

1. MT suction piping needs to be installed using copper pipe rated to 1305 psig [90 barg], unless specified otherwise.
2. LT suction piping needs to be installed using copper pipe rated to 1305 psig [90 barg], unless specified otherwise.
3. All liquid lines must be rated to at least 1305 psig [90 barg], unless specified otherwise.
4. Piping selected and supported based on standard refrigeration industry practices.
5. Pressure ratings are based upon the system design and factory installed pressure reliefs. Verify pressure ratings for each specific project.

NOTE: See System Information - Piping details on pages 6-7 for max pipe size and type of copper.

ELECTRICAL CONNECTIONS

Advansor CDUs come from the factory with the control panel and all internal electrical connections pre-wired. As with any other system, a certified electrician must make all field connections.

Specific aspects of the electrical connections to take note of include the required electrical power for the system, which depends on job site and refrigeration system requirements.

Refer to local codes and the NEC for wiring requirements.

Electrical connections for the Flex One can be found in Figure 7a. Electrical connections are made by creating a hole where the Recommended Service Entrance sticker is located and connecting the field power through the hole.

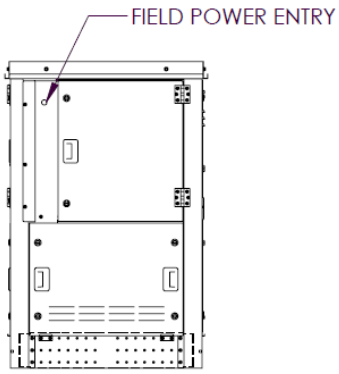


Fig. 7a Flex One field power entry

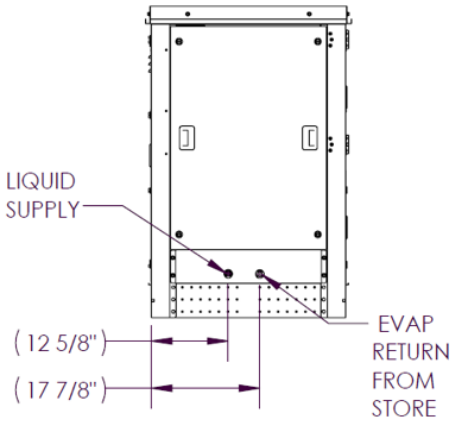
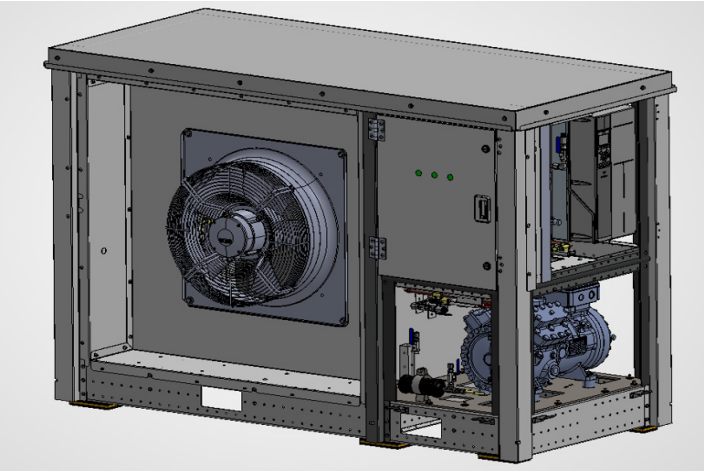


Fig. 7b Flex One liquid supply and evap return



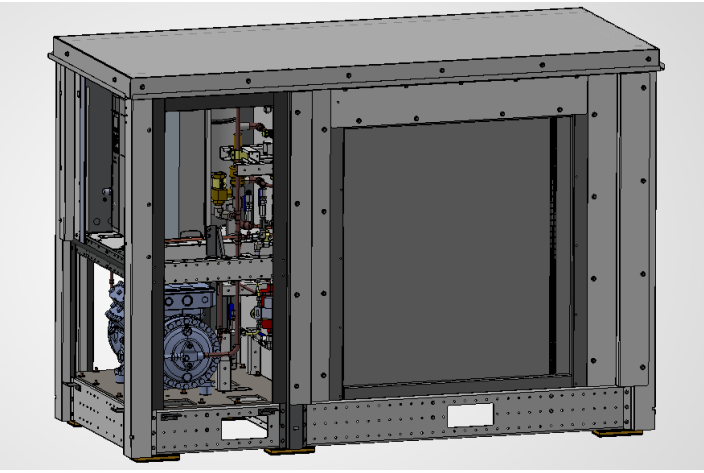


Fig. 8 Flex One

PRIOR TO STARTUP

Piping System Installation

The piping system must be properly installed as per state and local codes, as well as regulatory requirements.

Assembly of Carbon/Stainless Steel, or High Pressure Copper/ Iron Pipes, C19400 Copper Alloy, to Gas Cooler.

All welding processes shall utilize Argon purge gas, and all brazing processes shall utilize Dry Nitrogen purge gas.

Steel connections are joined by means of TIG-welding.

Care must be taken to avoid slag inside the pipe during welding.

Copper connections must be brazed using industry standard brazing methods.

15% silver solder joining copper to copper

45% silver solder joining copper to steel

Assembly must be carried out by a certified welder in accordance with state and local building codes.

Note: Contractors will be responsible for providing copper-to-steel transition fittings in the event steel piping is used for installation of the high-pressure side piping.

Assembly of pipes to evaporators.

Medium Temperature (MT) suction piping needs to be installed using copper pipe rated to 1305 psig [90 barg] unless specified otherwise.

Low Temperature (LT) suction piping needs to be installed using copper pipe rated to 1305 psig [90 barg] unless specified otherwise.

All liquid lines must be rated to at least 1305 psig [90 barg] unless specified otherwise.

Piping selection and support method based on approved piping practices and construction plan sets and project specifications.

System Leak Check

Leak checking the system can either be done by isolated sections during the system installation or after the entire system has been field installed.

1) Conduct Pre-Check

a) Visually inspect refrigerant lines and joints for proper piping assembly and installation.

b) Ensure that there are no metal-to-metal contact points.

c) Manually verify that all mechanical joints are tight.

2) Open all valves.

a) Open all valves to all associated components of the systems.

b) Any normally closed or electronically controlled valves will require a means to either manually remain open or field install copper piping around the component so both sides of the valve are open to the leak check process.

3) Evacuation of the system

a) Using a vacuum pump, pull the system pressure down to a vacuum. This is to ensure the gas utilized for leak checking is distributed throughout the entire system.

4) Conduct Pressure Testing

a) Provide a means to monitor the pressure within the system during the pressure test.

b) Isolating sections of the system may be required to reduce the time needed to locate a leak.

c) Charge the system with dry nitrogen and, if needed, a trace gas such as an HFC refrigerant, to 350 psig.

d) Monitor the system pressure while leak checking for any drop in pressure. If the pressure should drop below 300 psig, repressurize the system with dry nitrogen and trace gas to 350 psig then continue to leak check.

e) If a leak is located, isolate the section around the leak and repair it. Open all valves used to isolate the leak and repressurize the system to 350 psig.

System High Pressure Test

1) Pressure Testing with Nitrogen and Vented

a) To Protect Transducers during High Pressure Test, close respective isolation valves.

b) The CDU is pressure tested at the factory to 10% above the rated relief pressure for each section of the system prior to installing relief valves.

c) Field pressure test should be performed per local building codes or customer specifications (if supplied).

i) Note: In the case of test pressures being above pressure relief valve ratings, pressure relief valves need to be removed and replaced with field supplied pressure relief valve pressure rated at least 10% above intended field test pressure. Replace factory installed pressure relief valves after completion of pressure test.

d) Regardless of pressure testing method, Hillphoenix requires the following minimum test pressures which shall be held for a minimum of 24 hours allowing for pressure variations due to ambient air temperature changes.

i) Note: Relief valves do not need to be removed for pressure tests below the valve ratings below.

ii) LT Suction: 1305 psig [90 barg] relief – test pressure 1050 psig

iii) MT Suction/Liquid: 1305 psig [90 barg] relief – test pressure 1050 psig

iv) MT/Intermediate Discharge: 130 barg (1885 psig) relief – test pressure 1500 psig

System Triple Evacuation

Valve Position for Evacuation

1) Open all service valves on compressors, oil system valves and all system isolation or electronically controlled valves located on the refrigeration system.

a. For electronically controlled valves on the CDU, make sure to turn ON control circuit power, but keep compressor power OFF and crankcase heaters OFF.

b. Use the CDU control system or remove actuator from the high pressure valve and use the provided magnet to turn clockwise to open valve 100%.

c. For stepper valves, manually open with either a field supplied stepper driver or the CDU control system.

2) Open All Valves on the Store/Circuit Piping Systems.

3) To Protect Transducers, Close Respective Isolation Valves.

USE THE FOLLOWING PROCEDURE WITH AN ELECTRONIC MICRON METER. IF CUSTOMER HAS A VACUUM EVACUATION SPECIFICATION THAT IS MORE STRIGENT, FOLLOW THAT.

Evacuation Procedure

1) Change oil in the vacuum pump prior to first evacuation.

2) System vacuum testing must be verified with an electronic vacuum micron meter which should be placed at the furthest possible location from vacuum pump.

3) 1st vacuum hold at 1500 microns for minimum of an hour.

a. Ensure that ALL portions of the system are under vacuum.

4) Break to positive pressure (1 or 2 psi) with dry nitrogen.

a. Change oil in vacuum pump.

5) 2nd vacuum hold at 1000 microns for minimum of an hour.

6) Break to positive pressure (1 or 2 psi) with CO_2 VAPOR.

a. Change oil in vacuum pump.

b. Install filter drier core(s) and suction filter(s) as applicable.

7) 3rd vacuum to below 500 microns, or below 300 microns for GreenChill requirements, and must maintain for 2 hours with no more than 100 microns increase with vacuum pump OFF and isolated.

8) REPEAT step #7 (3rd vacuum step) until test is completed successfully.

9) Upon completion of Evacuation, pre-charge the system to 150 psig with CO_2 Vapor.

Electrical Systems

Main Power and Service Power

1) All refrigeration systems and gas cooler circuit breakers and switches are OFF.

2) Main Building Power Circuit breaker is On. Verify Voltage on each phase of power.

3) Main Building Service Power Circuit breaker is On. Verify Voltage on phase of power.

4) Verify Voltage on each phase of power to Refrigeration System Main Breaker. Switch On breaker.

For more details on starting the system and using the controller, please refer to the Quick Start-Up Guide.

STARTUP

Compressor Oil Charging

NOTE: Only compressor manufacturer's approved oil can be used for the application and contractor supplied additional oil will be required on site to complete startup.

1) Compressor Oil fill instructions

a. Verify oil alarm for each compressor is active when no oil is present in the compressors.

c. First, close the ball valve after the oil separator and close the compressor suction and discharge service valve

d. Using the access port after the oil separator, if needed, lower the pressure of the oil line and compressor.

g. Ensure that the compressor circuit breaker is OFF and the electronic oil controller is ON. If the oil controller goes into failure, cycle control breaker power to begin filling again. Pump oil into the compressor oil line, using the access valve between the compressor and oil filter/drier.

h. Watch the oil level controller on the compressor and continue filling the compressor with oil until the compressor's oil level is satisfied.

i. Refer to compressor oil capacity table for recommended oil charges.

2) Energize all crankcase heaters

System Charging

1) Prepare System for Liquid Charging

a. Manually override All Circuit Electronic Expansion Valves (EEV) closed via the CDU controller.

b. Open suction line ball valves for both MT and LT suction groups.

c. Close liquid line ball valve at flash tank outlet.

d. Ensure all manual isolation valves are open

e. Pressure transducer isolation valves.

f. Flash Gas Bypass Valve isolation valve.

g. Verify Compressor crankcase heaters are ON.

h. Turn ON power to gas cooler, check rotation direction of fans on gas cooler.

i. Manually ramp fans to 0%, 25%, 50%, 100% to ensure proper control of all fans (make sure all fans run at appropriate levels).

ii. Validate gas cooler alarm signal and functionality.

i. CDU controller and related gas cooler controls should be in automatic mode and ready to operate.

j. For safety precautions, remove compressor suction and discharge service valve caps and verify all valves are open. Replace caps and gaskets after a MT compressor has started and operating automatically.

k. Turn ON power (breakers in control panel) to compressors.

2) Begin Liquid Charging

a. Add liquid CO_2 to the system via the flash tank liquid access port.

i. Run the CO_2 charging line over the top of the CDU prior to connecting to the flash tank liquid access port.

ii. Check the low sight glass to see if liquid is seen.

b. The Flash Gas Bypass Valve (FGBV) should be automatically controlled and closed until setpoint is reached. As pressure rises above flash tank pressure control setting 515-650 psig (34 – 38 barg) the FGBV will start to open and provide pressure to the MT suction group. A compressor should start at this time to keep the pressure from continuing to rise.

i. Check and confirm that FGBV opens and operates correctly.

ii. Check compressor operation: if a VFD is supplied, check the compressor operates as it should.

iii. Check compressor amperage reading when running to verify reading is within range for each specific compressor.

c. Charge and maintain liquid CO_2 level in receiver to first (bottom) sight glass level (ball will float in sight glass) until system is fully operational.

Note: The maximum charge limit on Flex One CDU is 19.5 pounds. Exceeding this charge limit will cause liquid slugging in the compressor and failure of the system.

System Operation Verification and Optimization

1) Flex One and Case Verification (recommend minimum of 12 hours after completed startup)

a. Watch compressor cycle counts and ensure that excessive short cycling is not occurring - recommend no more than 6 cycles per hour (cycle count recommendation for fully loaded system after startup is completed).

b. Run cases/circuits through an Off Cycle or Electric Defrost cycle.

i. For Flex One, it is recommended that all circuits defrost together to prevent excessive short cycling.

ii. Verify insulation/wiring is not in contact with defrost heaters and drain heaters are properly installed.

iii. Make sure the defrost termination probe, if applicable, is mounted in the correct location and that it approaches the case specified defrost temperature during defrost.

DURING STARTUP

- Shut valves:
  - All EEV valves at the evaporators,
  - Main Liquid Line Ball Valve to the store.
- Check all valves for correct positioning before pre-pressurizing, charging, and operation.
  - Check that all compressors service valves are open.
  - Ensure all compressors have oil — Green lights on the oil sensors, on each compressor are ON (illuminated).
  - Check oil system valves for proper operation.
  - Check valves for store/circuit pipe system.
- Turn on the compressor crankcase heaters.
- Verify that EMS is programmed and installed, ready to operate.
- Charge liquid refrigerant.
  - Until CO_2 receiver level reaches the first sight glass but does not exceed the maximum system charge.
  - Check and confirm that Flash Gas Bypass Valve opens and operates correctly.
- Start Compressor.
  - Continue to monitor refrigerant level and add as necessary to maintain minimum level in vessel (CO_2 should always be visible in the bottom sight glass).
- Check and confirm that the receiver pressure and gas cooler pressure regulate correctly.
  - Compare sensor inputs with the corresponding pre-programmed reference set points in the controller.
- Continue running system until temperature setpoints are reached, fine-tuning the system.
  - Closely observe the compressor suction temperature.
    - Make sure that no liquid returns from evaporator.
    - Check pressure and ambient sensors (S2) at the cases and confirm that the amount of superheat is correct compared to the degree of EEV opening.
  - Inspect the oil system.
    - Make sure that all compressors are supplied with oil.
  - Compare sensors.
  - Check compressor capacity step control.
  - Check evaporator control.
- Test, confirm, and adjust for proper operation of:
  - Defrost
  - Pumpdown
  - All other functions
  - All safeties

CDU Control System and Wiring Verification

Controller Information

The Advansor Flex One uses a Copeland CDU controller on a Site Supervisor hardware platform. The controller comes pre-programmed with the recommended settings. The following information gives detail about logging into the controller and other general information.

The detailed connection information can be found in the “Copeland Site Supervisor Controller: Quick Startup Guide”.

1. Network Connection

a. If using the Wireless access point, please follow the instructions that are provided with the access point.

b. Ethernet connection is the default way to connect the main controller to either a local laptop or the installation site system.

c. ETH1 is designed to be used for directly connecting to laptop, PC, or optional touchscreen with a CAT5 network cable.

d. The default IP for ETH1 is 192.168.1.250.

2. Logging into the controller

a. Launch a web browser.

b. Enter the IP Address of the device.

c. Enter the Username/Password (default user/pass) and Login.

3. General System Information

a. Once logged in, you will be able to see the general system information, shown in Fig. 9.

b. From here, to view details of a specific application or IO board, enter any of the previews.

Fig. 9 Flex One general system information

c. To view the layout screen, utilize the layout symbol at the top (Fig. 10). This provides a general system overview for easy viewing (Fig. 11).

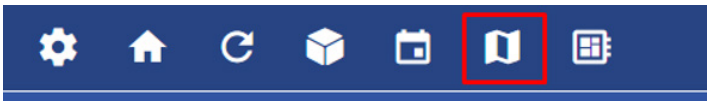


Fig. 10 Layout symbol

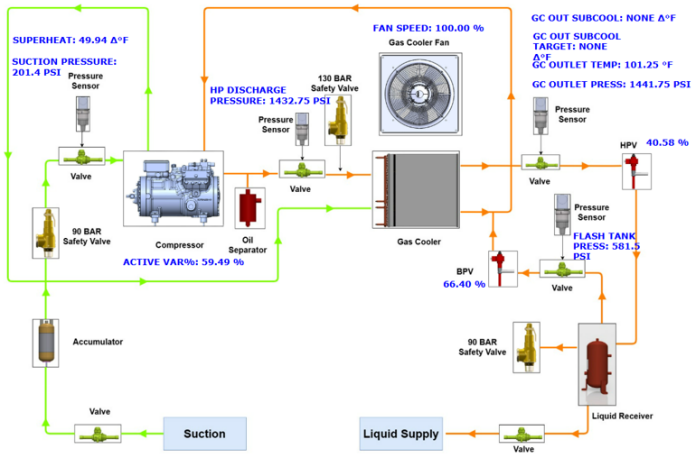


Fig. 11 General system overview

4. Controller Startup Guide

a. For information regarding using the controller during startup of the unit, please refer to the “Advansor Flex One Quick Start-Up Guide”.

b. The Quick Start-Up Guide covers setting suction setpoint, evacuation control, and connecting shutdown outputs.

5. System Upstream/Downstream Control

a. Fig. 12 shows the capability of the controller of upstream/downstream control from the factory.

	FlexOne – CP HP-Flex	
	Base Features	3rd Party Augmentations
BMS Connection	BACnet-OTT	E3 peer to peer, BACnet-OTT
Gateway to connect to BMS	N/A	N/A
Cases / Evap.	Supports via wire connection. (e.g. 24V signal)	Supports via wire connection. Serial: XR75, XM670, XM678, XM679
Circuits	0	5
Serial Connectivity	No	Yes.
Gas Detector Connectivity	1 x MRLDS-450	3 x MRLDS-450
Device Count	N/A	Maximum 12

Fig. 12 Flex One Copeland controller

CDU Controller

1) Contact Hillphoenix Field Support or Technical Support if programming issues arise or operational issues occur.

2) Proof all CDU sensors and transducers for location, calibration, mounting method and pressure rating in addition to communicating with the CDU Controller.

3) Verify and check all the parameters for the Variable Frequency Drive are correct and alarm outputs to CDU controller inputs function correctly.

4) If a component that requires parameter input is not working properly and it is believed that parameter verification is required, contact Hillphoenix Field Support or Technical Support.

Circuit Evaporator Instrumentation Verification

1) Verify all circuit controls are complete, operational, and coordinated correctly (i.e. – controls operate correct circuit).

2) Verify all temperature probes are located and installed as per evaporator coil or case manufacturer’s specifications.

3) Verify all circuit pressure transducers are correctly installed to prevent oil from accumulating in transducers (never install transducer pointed downward).

4) Verify that all circuit probes and transducers are communicating properly with both case controller and CDU control system.

5) Verify EEV pressure transducer readings to ensure the measured pressure value matches the corresponding saturated evaporation temperature.

a. For CO_2 (R-744), Room Temperature Example: 75°F = 895 psig.

b. For CO_2 (R-744), Operating Temperature Example: -20.0°F = 200 psig .

6) Verify temperature probes to ensure that measured temperature value match actual temperature of the evaporator or air for the intended functionality of the probe.

a. Ensure that probes and controller are wired and landed correctly by means of cold spray or warming by hand with verification of temperature input fluctuation reported by the controller.

7) Refer to controller manufacturer’s literature for more detailed information.

Service Procedures

Pump Down for Standstill Purposes (i.e., Servicing)

- Verify that the Flash Gas Bypass Service Valve into the medium temp suction (manual bypass valve, if factory installed) is closed.
- Close the Flash Tank Outlet Service Valve (main liquid supply isolation ball valve) feeding the store loads.
- If the CO_2 liquid at or below the highest site glass and the compressors have pumped down and cycled off (i.e., suction pressure no longer rising):
    - Close the Flash Gas Bypass Service Valve
    - Close the Flash Tank Inlet Service Valve
- Turn Off compressor panel switches

The CO_2 refrigeration system at this point is now pumped down and the receiver is isolated from the rest of the system.

- If the CO_2 liquid level rises above the highest sight glass during Pump-Down:
    - Immediately Close the Flash Gas Bypass Service Valve
    - Immediately Close the Flash Tank Inlet Service Valve

    Note: The compressors will go offline on high discharge pressure.

    - Turn Off all compressor switches
    - Vent CO_2 liquid from store piping system down to 200 psig
    - Vent MT suction line down to 200 psig
    - Vent LT suction line down to 200 psig
    - Shut down all circuits, Close all EEVs on all cases, coolers, freezers, etc., turn Off all fans and all defrost heaters
    - Vent Gas cooler down to 200 psig
    - Monitor all store piping to ensure CO_2 pressures do not rise and vent if necessary

Coming out of Pump Down - for Normal Operation

- Open the Flash Tank Inlet Service Valve.
- Turn on the panel switches.
- Slowly Open the Flash Gas Bypass Service Valve.
- Open the Oil Vent Line Service Valve.
- Continuously check system pressure and the receiver liquid level.
- Slowly Open the Flash Tank Outlet Service Valve.
- Stage each circuit individually On. Ensure associated fans, defrost heaters and EEV's are operational per circuit.

Maintenance Procedures - Annual and Periodic

Any service performed on the system must be in accordance with local code requirements, as well as the directions in this manual in order to maintain the safe and reliable operation of the system. Service should be only performed by authorized contractors, or customer-designated technicians. Hillphoenix strongly recommends that any technician working on the system have attended a Hillphoenix Learning Center training course for Advansor systems. See hillphoenixlc.com for more information.

In addition to the tools, components, parts and materials needed for service, this section covers the procedures for:

- Checking the system's general condition including compressors, valves, pipes and insulation, and receiver
- Checking oil and refrigerant levels in compressors and reservoir
- Checking safety pressure switch and safety valves
- Checking instruments and gauges
- Changing oil filters
- Changing suction filters
- Checking system for the presence of moisture
- Extraction of oil samples for acid and water content

Maintenance of the compressors, pressure vessels and pipe systems should be conducted as specified by Hillphoenix and the component manufacturers. A logbook should be kept with the system to note:

- Any changes (loss and additions) to the system's refrigerant charge
- Problems with, and corrections/repairs made to, the system

Service and visual inspection of the pipe system and vessels should be performed on a regular basis. Pressure switches have to be checked every year and service on vessels equipped with safety valves should be carried out every other year. Safety valves on vessels and pipes should always be inspected every other year.

Tools and Components Needed for Service

These in general include:

- Hydraulic or hand pump for oil charging
- Hand magnet for the E2V valves, if applicable
- Tubes, fittings, and pressure gauges suitable for the system's operating pressures to secure the fitter during filling of the system. High-pressure electronic gauges rated for 1900 psig or higher are recommended.

Parts and Materials Needed During Service

- Replacement Discharge Oil Separator(s) Oil Filter, per the manufacturers recommendation, including O-rings or gaskets
- R-744 (CO_2): Instrument-grade (99.99%) or better
- Oil: refer to the compressor manufacturer's specifications for the type of oil required
- Thread sealing: Permabond MH052
- Paint for frames
- Gasket/screen Castel type 9151E/R16 service kit
- Insulation material: appropriate for the service conditions

Service after Startup

Perform the following checks after startup:

- Refrigerant charged to the proper level – add if necessary
- Oil in the compressors, charged to the proper level – add if necessary
- Oil is uncontaminated and clear – change oil and oil filter if necessary
- Pressure and temperatures are within the specifications:
    - MT: suction/ pressure: 350 to 475 psig with 20 to 50 degrees of superheat
    - MT: discharge/pressure at 900 to 1100 psig high-pressure gas at approximately 230 °F
    - LT: suction/pressure at 189 to 363 psig with 20 to 50 °F of superheat, high-pressure gas at approximately 149 °F

Service after 3 to 4 Weeks of Operation

- Change oil separator filters if they exhibit differential pressure above 12 psid (0.9 barg) across the separator under normal operating conditions.
- Add oil if necessary
- Check for leakage and tighten fittings, and repair, if leaks are found
- Check for pressure drop across suction filteres and change gasket/screen and clean filter if the pressure drop is found above 8 psig
- Add refrigerant if necessary
- Make any other adjustment and repairs that are necessary for the safe and efficient operation of the system

Ongoing Service Procedures

Following the startup and initial service of the system, annual and periodic procedures listed to the right should be performed.

Annual Service (or otherwise as noted)

Compressor Service	
Inspect each compressor prior to service. Investigate any unusual sounds or vibrations to determine the cause and repair or replace as necessary.	
Specific components to check include: Vibration isolation mounts Oil system Compressor oil levels Reservoir oil level Solenoid operation Insulation Flex tubes	Note the condition and steps taken in the log book: Check that the vibration isolation mounts are intact and investigate any wear that is apparent to determine and correct the cause. Check the oil system, retightening any fittings that are loose. Check compressors oil levels via sight glass (typically medium-temp) and sensors (medium and low-temp). Test all solenoids and switches. Inspect insulation and repair any damage or deterioration. Inspect and tighten any flex tubes as necessary.
Collect an oil sample to submit for analysis.	Oil sample – see below
Receiver and Piping System Service	
Carefully inspect and repair any insulation for the receiver, piping, or piping system component that shows signs of damage or deterioration.	Examine the insulation for the receiver, piping and all components including valves, manometers, and safety valves for corrosion or any other condition requiring repair or replacement.
Inspect the oil piping system on a regular basis – at least 3 to 4 times a year. Any stains, spills or other indications of leaks should be carefully examined and corrected.	Check that the oil piping system and fittings are tight and free of corrosion — tighten, repair and repaint as necessary. Be sure to include all valves and solenoids when checking for operation and tightness.
Note any spills or leaks found, and the actions taken to correct them in the logbook.	
Gas Cooler Service	
Inspect the gas cooler to make sure the fans are operating properly and that any problems are corrected.	Confirm that the fans are operating and running in the right direction. Check for dirt on the coils and remove and clean as necessary.
Oil Separator Filter	
Visually inspect oil in the system. Verify there is a pressure drop across the Separator of no more than 12 psid.	Change the filter cartage if the oil is cloudy or discolored, or if the pressure drop across the oil separator is high.
Oil Sample Collection	
Test oil for water and acid contents annually.	Take oil samples from either the oil separator or reservoir.

Safety Equipment Inspection	
Inspect safety pressure switches for proper operation.	Replace if necessary.
Inspect safety valves.	Refer to local code requirements and regulations pertaining to the testing and replacement of safety valves.
Check all installed refrigerant leak detectors. Verify operation and all associated components.	Repair or replace if necessary.
Instruments and Pressure Gauges	
Check all pressure gauges, transducers and temperature probes.	Verify readings, mounting method, and calibrations. Repair or replace if necessary.
UPS Electric System	
Check the Uninterruptable Power Supply (UPS).	Repair or replace if necessary.
Suction Strainer	
Check for pressure loss across the strainer.	Change the gasket and clean filter if the pressure loss is greater than 8 psig.

Flex One Piping Parts Replacement List		
FNE_1+0x0_M0010_L0000_0000_BO_E_0_V2	FNE_1+0x0_M0010_L0000_0000_BO_E_0_V4	
FNE_1+0x0_M0018_L0000_0000_BO_E_0_V2	FNE_1+0x0_M0018_L0000_0000_BO_E_0_V4	
FNE_1+0x0_M0032_L0000_0000_BO_E_0_V2	FNE_1+0x0_M0032_L0000_0000_BO_E_0_V4	
FNE_0+0x1_M0000_L0025_0000_DR_E_0_V2	FNE_0+0x1_M0000_L0025_0000_DR_E_0_V4	
FNE_0+0x1_M0000_L0034_0000_DR_E_0_V2	FNE_0+0x1_M0000_L0034_0000_DR_E_0_V4	
Critical Parts Kits		
Category	**Part Number**	**Description**
Relief Valves	106361	Discharge / Gas Cooler
Relief Valves	104734-1	Suction
Relief Valves	104734-1	Liquid Receiver
Instrumentation/Sensors	101720	Pressure Transducer
Instrumentation/Sensors	80464	High Temperature Sensor
Instrumentation/Sensors	85875	Temperature Sensor
Instrumentation/Sensors	111060	Compressor Oil Control
Instrumentation/Sensors	111311	Compressor Oil Control Cable 1
Instrumentation/Sensors	111310	Compressor Oil Control Cable 2
Electrical/Controls	111424	All Controller Kit
Electrical/Controls	111422	Main Controller
Electrical/Controls	103323	Valve Driver
Electrical/Controls	111441	Expansion Board
Electrical/Controls	110617	Supercap
Electrical/Controls	102820	Main Transformer
Electrical/Controls	99809	Control Transformer
Electrical/Controls	105934	Control Relay
Valves	102566	High Pressure Valve
Valves	102566	Gas Cooler Bypass Valve
Fitting	111570	HPV/GBV Valve Fitting
Gas Cooler	111313	460V Gas Cooler Fan
Gas Cooler	111384	208V Gas Cooler Fan
Service/Maintenance Parts		
Category	**Part Number**	**Description**
Maintenance Parts	101807	Oil Inline Filter - DMT Drier
Maintenance Parts	111261	Discharge Oil Seperator
Maintenance Parts	02921	2A Fuse
Maintenance Parts	03293	5A Fuse
Maintenance Parts	111291	Valve Magnetic Tool
Maintenance Parts	01963	Teflon tape
Maintenance Parts	05503	Permabond
Maintenance Parts	108090	Suction Strainer Screen/Mesh

Flex One Piping Parts Replacement List			
Model: 460V	**Model: 208V**	**Maximum Liquid Charge***	**Maximum Oil Charge****
FNE_1+0x0_M0010_ L0000_0000_B0_E_0_V2	FNE_1+0x0_M0010_ L0000_0000_B0_E_0_V4	19.5 (lb)	3 liters
FNE_1+0x0_M0018_ L0000_0000_B0_E_0_V2	FNE_1+0x0_M0018_ L0000_0000_B0_E_0_V4	19.5 (lb)	3 liters
FNE_1+0x0_M0032_ L0000_0000_B0_E_0_V2	FNE_1+0x0_M0032_ L0000_0000_B0_E_0_V4	19.5 (lb)	3 liters
FNE_0+0x1_M0000_ L0025_0000_DR_E_0_V2	FNE_0+0x1_M0000_ L0025_0000_DR_E_0_V4	19.5 (lb)	3 liters
FNE_0+0x1_M0000_ L0034_0000_DR_E_0_V2	FNE_0+0x1_M0000_ L0034_0000_DR_E_0_V4	19.5 (lb)	3 liters

***This is 80% receiver capacity. Actual charge capacities may vary by store and application. Please follow charge guidelines mentioned in this manual.**
****This is compressor sump capacity. Actual charge capacities may vary by store and application. Please follow charge guidelines mentioned in this manual.**

Recommended Initial Charge

Liquid: 15 pounds
Oil: 0.5 gallons

Note: For every 100 feet of field piping, add 0.25 gallons*

***Different store configurations will require more liquid charge. Please refer to the liquid charge section for more details.**

A.....TRANSCRITICAL CO_2 OIL MANAGEMENT SYSTEM FAQS

B.....CO_2 PRESSURE-TEMPERATURE CHART

C.....QUICK SUMMARY START-UP CHECKLIST

D.....PARTS LIST

E.....FLEX ONE LIFTING DIAGRAM

F.....HPX WARRANTY VALIDATION CHECKLIST

G.....PRODUCT NOMENCLATURE

A1: TRANSCRITICAL CO_2 OIL MANAGEMENT SYSTEM FAQS

1. Q: Why is oil management critical in CO2 systems?

A: Oil management is crucial in CO2 systems because it ensures proper lubrication of moving parts in compressors, prevents compressor damage due to oil starvation or contamination, and maintains overall system efficiency. Effective oil management also helps prevent oil from accumulating in unwanted areas like evaporators, which can reduce heat transfer efficiency.

2. Q: How does oil migrate in CO2 systems?

A: Oil can migrate with CO2 gas through the system if the oil separator filter was clogged and not maintained properly, potentially accumulating in areas like evaporators, suction lines, or other low-velocity zones. This migration can lead to oil-related issues if not properly managed through design and operational strategies.

3. Q: What's the role of oil separators?

A: Oil separators play a key role in removing oil from CO2 gas discharged by compressors. They help return separated oil back to the compressors for lubrication, ensuring efficient operation and minimizing oil accumulation in other parts of the system.

4. Q: How often should oil be checked?

A: Oil levels and condition should be checked regularly as part of routine maintenance. The frequency depends on system design, operating conditions, and manufacturer recommendations. Typically, checks are more frequent during initial system startup and after significant operational changes.

5. Q: What issues arise from poor oil management?

A: Poor oil management can lead to compressor damage due to inadequate lubrication, reduced system efficiency, oil fouling in heat exchangers, and potential system failures. It can also increase maintenance needs and operational costs.

6. Q: What's the best oil type for CO2 systems?

A: POE (Polyolester) oils are commonly used in CO2 systems due to their compatibility and performance characteristics. However, it's essential to consult compressor and system manufacturer recommendations for specific oil type and viscosity requirements.

7. Q: Can oil management affect system capacity?

A: Yes, poor oil management can reduce system capacity and efficiency by causing issues like oil fouling in heat exchangers or inadequate compressor lubrication, leading to reduced performance.

8. Q: How do you troubleshoot oil-related issues?

A: Troubleshooting involves checking oil levels, separator function, system pressures, and looking for signs of oil accumulation in unwanted areas. Consult system logs, manufacturer guidance, and expert advice if issues persist.

9. Q: What's the purpose of oil level sensors at compressors?

A: Oil level sensors monitor and maintain optimal oil levels in compressors, triggering alarms or shutdowns if levels get too low, protecting the compressor from damage.

10. Q: How do oil separators interact with oil reservoirs?

A: Oil separators typically return collected oil to an oil reservoir, which then supplies oil back to compressors as needed, maintaining a balanced oil level.

A2: TRANSCRITICAL CO_2 OIL MANAGEMENT SYSTEM FAQS

11. Q: Can oil foaming impact oil management?

A: Yes, oil foaming can affect oil level readings and separator efficiency. Use anti-foam additives if needed and ensure proper system design to minimize foaming issues.

12. Q: How often should oil filters be changed?

A: Change oil filters according to manufacturer recommendations or when pressure drop indicates clogging, typically during routine preventive maintenance or when contamination is suspected.

13. Q: What's the role of in-line strainers in oil management?

A: Inline Strainers protect compressors and other components by catching debris in the oil circuit, preventing damage and contamination issues.

14. Q: What happens if oil filters aren't changed regularly?

A: Clogged filters can lead to reduced oil flow, increased pressure drop, and potential compressor damage due to inadequate lubrication or contamination.

15. Q: How do you select the right oil filter for a CO2 system?

A: Consult manufacturer recommendations for filter type, micron rating, and flow capacity to ensure compatibility and effective contamination control.

16. Q: Are oil filter changes part of routine preventive maintenance?

A: Yes, regularly checking and changing oil filters and strainers is a key part of preventive maintenance to ensure reliable system operation and compressor protection.

B1: CO_2 PRESSURE- TEMPERATURE CHART

Hillphoenix Pressure-Temperature Chart for CO2

Temp °F	CO2 (R-744) Pressure psi(g)	CO2 (R-744) Pressure bar(g)	Temp °C
-39	134.2	9.3	-39.4
-38	137.2	9.5	-38.9
-37	140.3	9.7	-38.3
-36	143.5	9.9	-37.8
-35	146.7	10.1	-37.2
-34	149.9	10.3	-36.7
-33	153.2	10.6	-36.1
-32	156.5	10.8	-35.6
-31	159.9	11.0	-35.0
-30	163.3	11.3	-34.4
-29	166.8	11.5	-33.9
-28	170.3	11.7	-33.3
-27	173.9	12.0	-32.8
-26	177.5	12.2	-32.2
-25	181.2	12.5	-31.7
-24	185.0	12.8	-31.1
-23	188.7	13.0	-30.6
-22	192.6	13.3	-30.0
-21	196.5	13.5	-29.4
-20	200.4	13.8	-28.9
-19	204.4	14.1	-28.3
-18	208.5	14.4	-27.8
-17	212.6	14.7	-27.2
-16	216.7	14.9	-26.7
-15	221.0	15.2	-26.1
-14	225.2	15.5	-25.6
-13	229.6	15.8	-25.0
-12	234.0	16.1	-24.4
-11	238.4	16.4	-23.9
-10	242.9	16.7	-23.3
-9	247.5	17.1	-22.8
-8	252.1	17.4	-22.2
-7	256.8	17.7	-21.7
-6	261.5	18.0	-21.1
-5	266.3	18.4	-20.6
-4	271.2	18.7	-20.0
-3	276.1	19.0	-19.4
-2	281.1	19.4	-18.9
-1	286.1	19.7	-18.3
0	291.2	20.1	-17.8
1	296.4	20.4	-17.2
2	301.7	20.8	-16.7
3	307.0	21.2	-16.1

Low Temp Suction, Typical

Temp °F	CO2 (R-744) Pressure psi(g)	CO2 (R-744) Pressure bar(g)	Temp °C
4	312.3	21.5	-15.6
5	317.8	21.9	-15.0
6	323.2	22.3	-14.4
7	328.8	22.7	-13.9
8	334.4	23.1	-13.3
9	340.1	23.5	-12.8
10	345.9	23.8	-12.2
11	351.7	24.3	-11.7
12	357.6	24.7	-11.1
13	363.6	25.1	-10.6
14	369.7	25.5	-10.0
15	375.8	25.9	-9.4
16	382.0	26.3	-8.9
17	388.2	26.8	-8.3
18	394.5	27.2	-7.8
19	400.9	27.6	-7.2
20	407.4	28.1	-6.7
21	414.0	28.5	-6.1
22	420.6	29.0	-5.6
23	427.3	29.5	-5.0
24	434.0	29.9	-4.4
25	440.9	30.4	-3.9
26	447.8	30.9	-3.3
27	454.8	31.4	-2.8
28	461.9	31.8	-2.2
29	469.0	32.3	-1.7
30	476.3	32.8	-1.1
31	483.6	33.3	-0.6
32	491.0	33.9	0.0
33	498.5	34.4	0.6
34	506.0	34.9	1.1
35	513.6	35.4	1.7
36	521.4	35.9	2.2
37	529.2	36.5	2.8
38	537.1	37.0	3.3
39	545.0	37.6	3.9
40	553.1	38.1	4.4
41	561.2	38.7	5.0
42	569.5	39.3	5.6
43	577.8	39.8	6.1
44	586.2	40.4	6.7
45	594.7	41.0	7.2
46	603.2	41.6	7.8

Medium Temp Suction, Typical

B2: CO_2 PRESSURE- TEMPERATURE CHART

Hillphoenix Pressure-Temperature Chart for CO2

Temp °F	CO2 (R-744) Pressure		Temp °C
	psi(g)	bar(g)	
47	611.9	42.2	8.3
48	620.7	42.8	8.9
49	629.5	43.4	9.4
50	638.5	44.0	10.0
51	647.5	44.6	10.6
52	656.7	45.3	11.1
53	665.9	45.9	11.7
54	675.2	46.6	12.2
55	684.6	47.2	12.8
56	694.2	47.9	13.3
57	703.8	48.5	13.9
58	713.5	49.2	14.4
59	723.3	49.9	15.0
60	733.3	50.6	15.6
61	743.3	51.2	16.1
62	753.4	51.9	16.7
63	763.6	52.7	17.2
64	774.0	53.4	17.8
65	784.4	54.1	18.3
66	795.0	54.8	18.9
67	805.7	55.5	19.4
68	816.4	56.3	20.0
69	827.3	57.0	20.6
70	838.3	57.8	21.1
71	849.4	58.6	21.7
72	860.7	59.3	22.2
73	872.0	60.1	22.8
74	883.5	60.9	23.3
75	895.1	61.7	23.9
76	906.9	62.5	24.4
77	918.7	63.3	25.0
78	930.7	64.2	25.6
79	942.8	65.0	26.1
80	955.1	65.9	26.7
81	967.5	66.7	27.2
82	980.0	67.6	27.8
83	992.7	68.4	28.3
84	1005.6	69.3	28.9
85	1018.6	70.2	29.4
86	1031.8	71.1	30.0
87	1045.1	72.1	30.6
87.8	1055.5	72.8	31

*All data from NIST Refprop 8.0 [Barometric Press=14.50377psi]

Transcritical Gas Cooler
Pressure and Temperature correlations

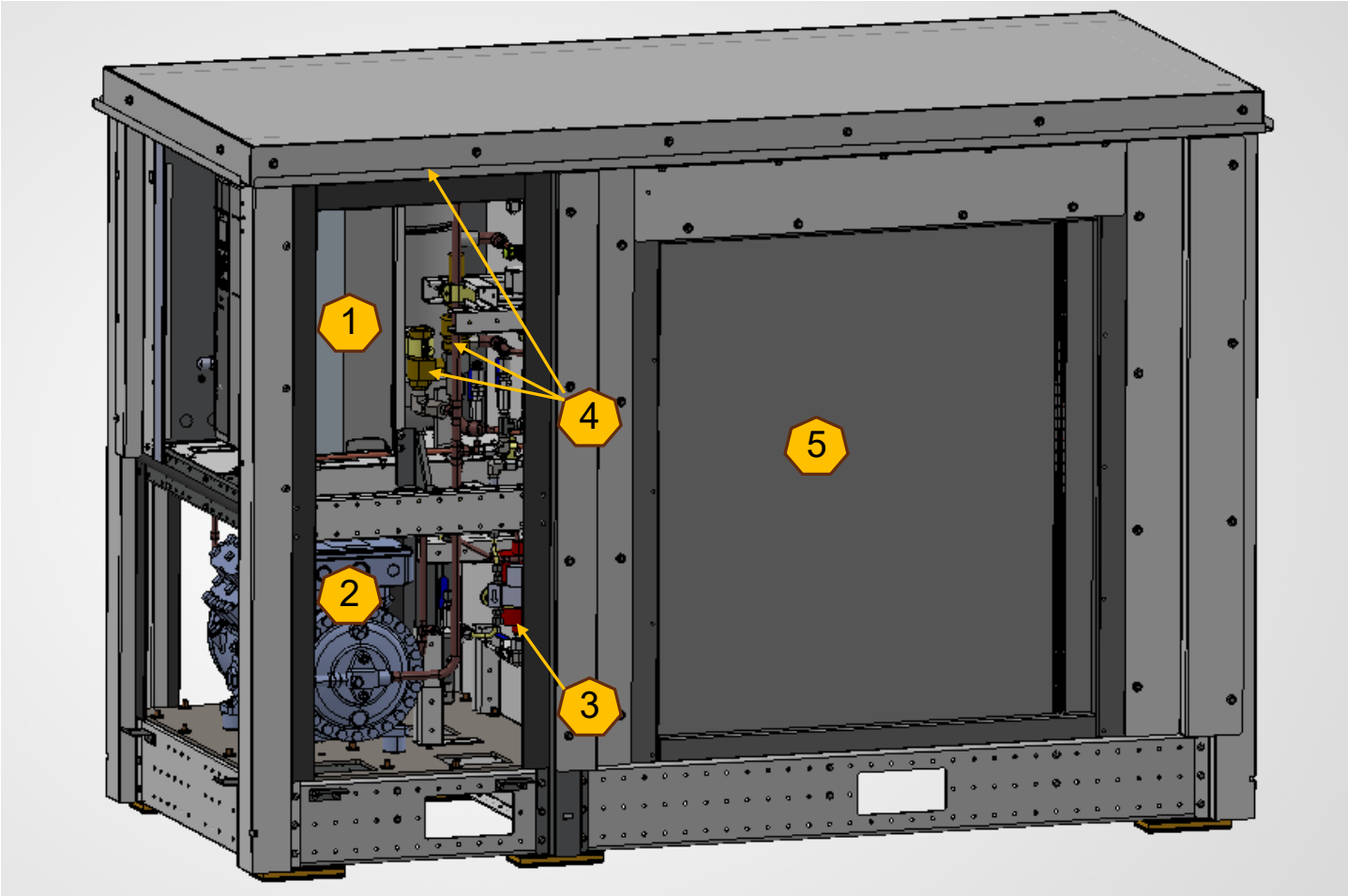
Below are approximate gas cooler pressures at *dropleg temperatures* that a system might be subject to

Dropleg Temp °F	*Gas Cooler* CO2		Dropleg Temp °C
	psi(g)	bar(g)	
81	1037	71.5	27.2
82	1055	72.8	27.8
83	1073	74.0	28.3
84	1091	75.2	28.9
85	1109	76.5	29.4
86	1127	77.7	30.0
87	1145	79.0	30.6
88	1163	80.2	31.1
89	1180	81.4	31.7
90	1198	82.6	32.2
91	1216	83.9	32.8
92	1234	85.1	33.3
93	1252	86.3	33.9
94	1270	87.6	34.4
95	1288	88.8	35.0
96	1306	90.1	35.6
97	1323	91.2	36.1
98	1341	92.5	36.7
99	1359	93.7	37.2
100	1377	95.0	37.8
101	1395	96.2	38.3
102	1413	97.4	38.9
103	1431	98.7	39.4
104	1449	99.9	40.0
104+	1450	100.0	40.0+

C1: QUICK SUMMARY START-UP CHECKLIST

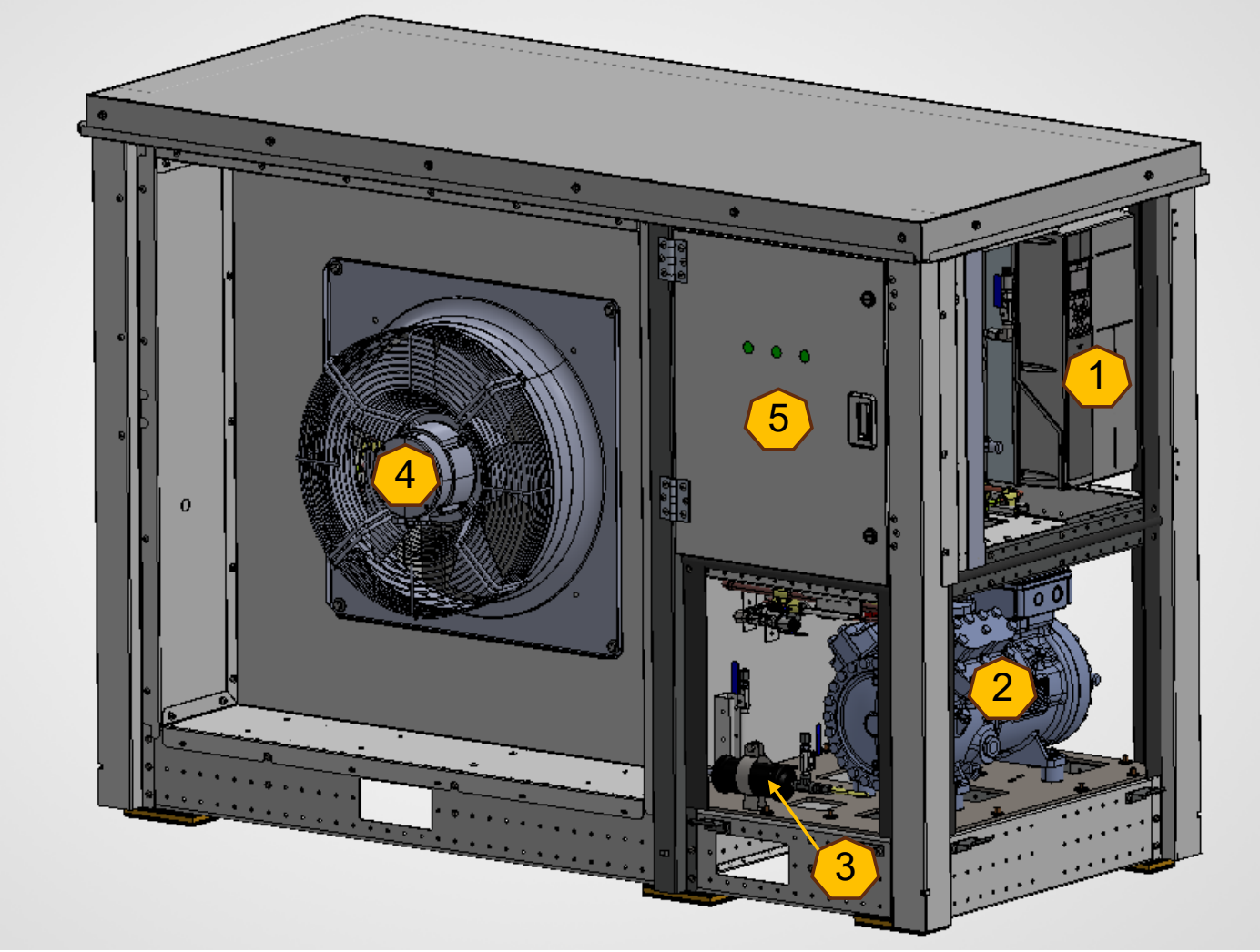
- ☐ 1. HPV valve is operating correctly
- ☐ 2. HPV/CCM controllers is operating correctly
- ☐ 3. CO2 Liquid level alarm is operating correctly
- ☐ 4. Compressor Oil Failure operation to shut off and alarm is operating correctly
- ☐ 5. Validate VFD alarm is operating correctly
- ☐ 6. Validate Gas Cooler alarm is operating correctly
- ☐ 7. Validate high-pressure mechanical controls & compressor Safety circuits for each compressor is operating correctly
- ☐ 8. Case shutdown validated to shut off case groupings as per load sequences

D1: PARTS LIST



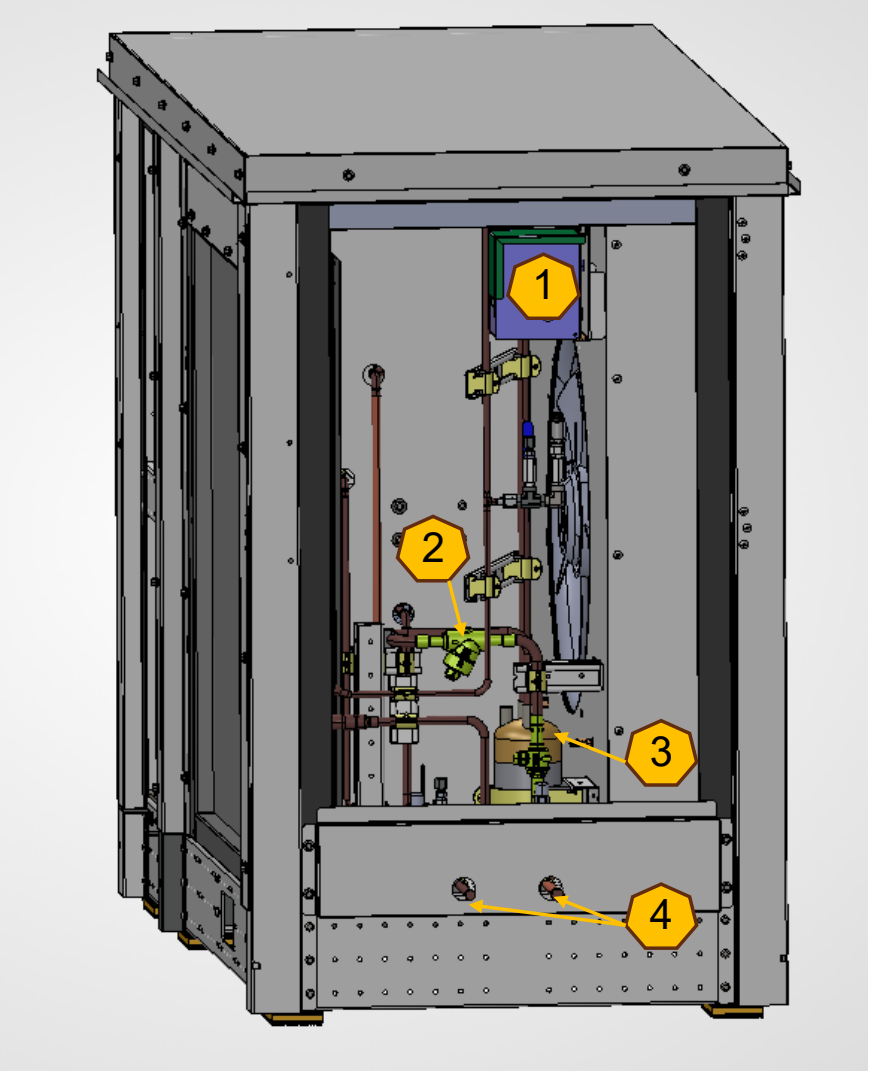
1	VFD
2	Compressor
3	Oil Separator
4	Relief Valves
5	Gas Cooler Coil

D2: PARTS LIST



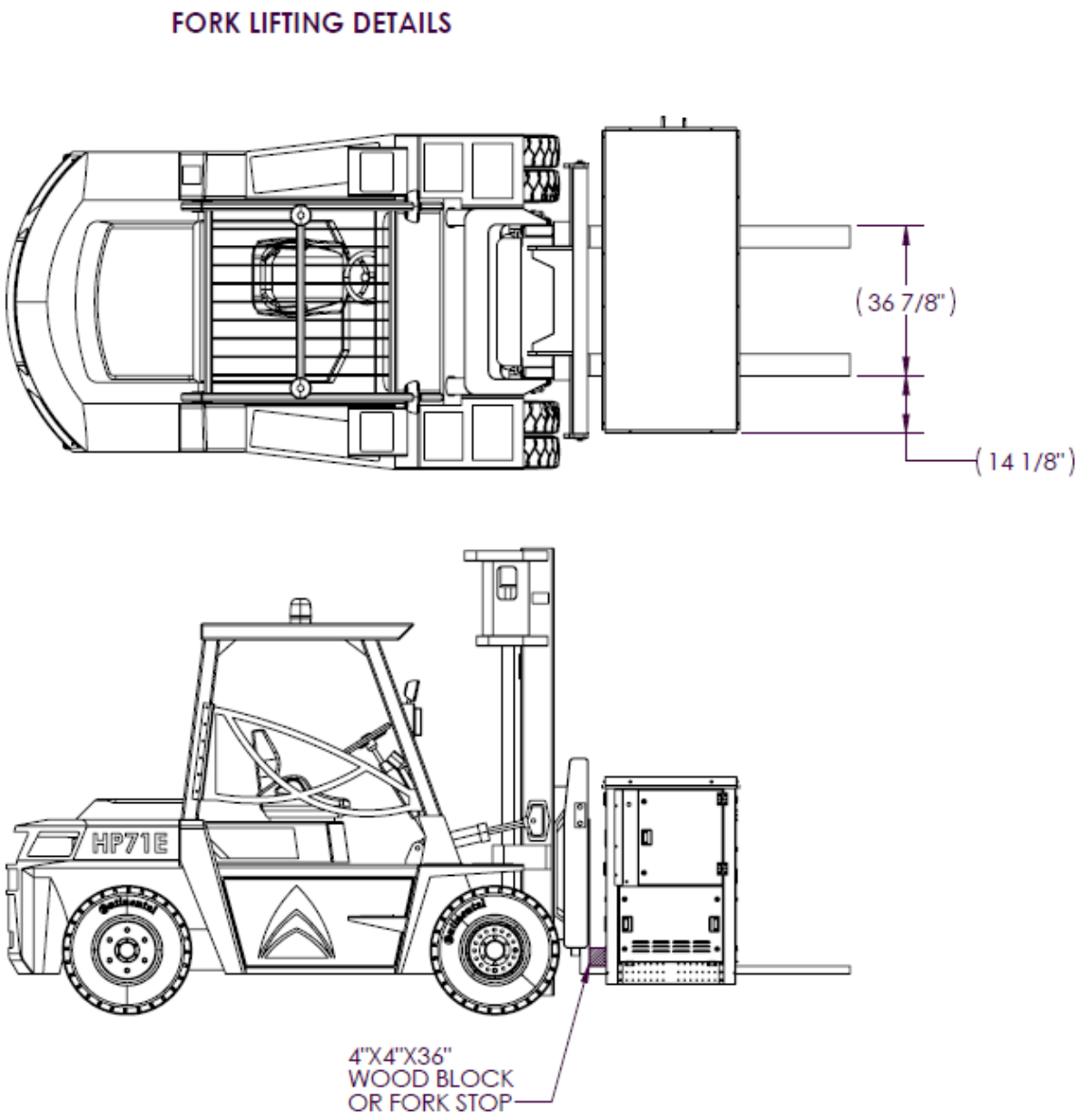
1	VFD
2	Compressor
3	Oil Filter
4	Gas Cooler Fan
5	Control Panel

D3: PARTS LIST



1	Control Transformer
2	Suction Strainer
3	Suction Accumulator
4	Suction/Liquid Lines

E1: FLEX ONE LIFTING DIAGRAM



F1: WARRANTY VALIDATION CHECKLIST

This checklist provides the means for confirming that the steps and procedures required to start up the Advansor system, as laid out in the guide, have been properly performed. Sign (on the following page) and submit the completed checklist to Hillphoenix for validation of warranty coverage.

Mail: Systems Operations 2016 Gees Mill Rd. Conyers, GA 30013 Fax: 770.285.3080 Email: info@Hillphoenix.com Or your local Field Service Engineer	Contact Information Technician performing checks: Name: _____ Phone: _____ Email: _____

Prior to Startup

☐ **Mechanical & Electrical Systems**

1. Properly installed per code and regulator requirements
2. All Circuit Breaker and Switches are OFF

☐ **Piping Installed**

3. Black steel or stainless-steel pipes or C194 copper to condenser assembled (**Note:** *Connections TIG-welded by a certified welder*)
4. Copper pipe to evaporators assembled **(NOTE**: *Piping selected per HP CO2 piping chart*)
5. System pressure tested and vented per HP recommendations

☐ **All Valves Checked for Evacuation Positioning**

6. All compressor service valves OPEN
7. All system isolation valves OPEN
8. High-pressure regulating valve OPEN
9. All inputs and outputs verified operational

☐ **System Triple--Evacuated**

10. All subsystems Included for min. 24 hrs.
11. 1st flush with nitrogen, 2nd & 3rd with CO2 vapor
12. Filter/drier cores installed
13. Leak test and pressurize to 150 psig (10 bar-g)

☐ **Oil Charged - After 2nd Evacuation**

14. With approx. 1 gal. of compressor manufacturer-specified oil per compressor

☐ **Wiring Completed**

15. EMS verified
16. All inputs and outputs installed and confirmed
17. All sensors, transducers, valves, and VFDs checked and proofed
18. All pressure transducers and temperature sensors at each evaporator tested and working properly
19. Safety switches set

During Startup

☐ **Valves Closed**

1. All EEVs at the evaporators
2. Main loop isolation valves
3. Main liquid line ball valve to the store

☐ **Pre-Start Checks Completed**

4. All valves checked for Start position
5. EMS and controllers verified ready to operate
6. Compressors verified ready to start
7. Crankcase heaters ON
8. Condenser fans rotational direction checked

☐ **Liquid Charged CO2**

9. Until receiver level reaches the middle of first sightglasses
10. Flash gas bypass valve verified operational

☐ **Compressors Started**

11. Continue to monitor refrigerant level and add as needed
12. Main liquid line ball valve slowly OPENED
13. One evaporator started at a time
14. As many evaporators as possible allowed to pull down to temperature
15. Compressor verified operating as it starts
16. Flash gas bypass valve and high-pressure regulating valve verified as operating correctly
17. Remaining circuits to the store OPENED until operating conditions as close to full capacity

☐ **Test, Confirm & Adjust for Proper Operation**

18. Continue running system until each evaporator's setpoints are reached
19. Oil system confirmed operating and oil added if needed
20. Flash gas bypass valve and high-pressure regulating valve verified operating correctly
21. Compressor capacity step-control verified operating correctly

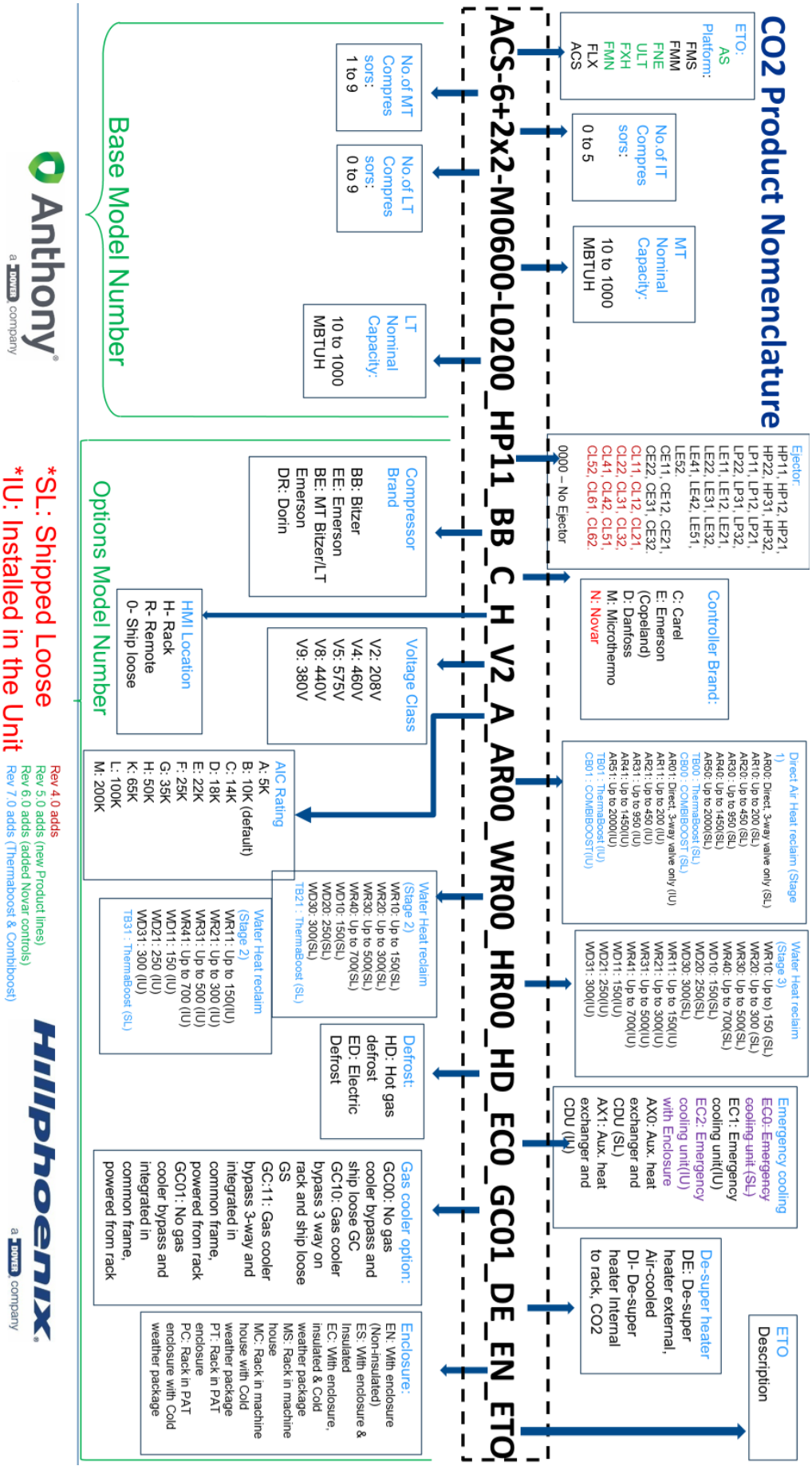
F2: WARRANTY VALIDATION CHECKLIST

22. Evaporators checked for proper operation including correct super heat
23. Refrigerant Level monitored and maintained as necessary

Signature: _____

Date: _____

G1: PRODUCT NOMENCLATURE



Hillphoenix

A DOVER COMPANY

LIMITED & GENERAL WARRANTY TERMS

Hill Phoenix, Inc's. (hereinafter "Hillphoenix") products are warranted to be free from defects in materials and workmanship under normal use and maintenance for a period of 14 months from date and place of shipment from Hillphoenix (the "Base Warranty Period"), provided that the installation and maintenance of such products have been performed strictly in accordance with Hillphoenix's designated specifications.

Anthony products supplied as original equipment on Hillphoenix products receive Hillphoenix warranty.

All warranty repairs must be approved in advance before services are started. In the event of a qualifying warranty claim, the extent of Hillphoenix's liability under the Warranty is limited to the repair or replacement, at Hillphoenix's option, of any non-conforming products without charge. If required, a new or rebuilt part to replace any defective part will be provided without charge and will be shipped via standard ground freight, with shipping charges being covered by Hillphoenix during the base warranty period. The replacement part is covered under this warranty for the remainder of the applicable Base Warranty Period. In order to be eligible for warranty coverage, customer must: (i) notify Hillphoenix in writing within twenty-four hours upon discovery of a warrant defect, and (ii) comply with the warranty claim procedures provided by Hillphoenix from time to time. These warranty terms are incorporated into and governed by the Hill Phoenix Terms and Conditions of Sale.

This equipment warranty does not include labor or other costs incurred for diagnosing, repairing, removing, installing, shipping, servicing, or handling of either defective parts or replacement parts. Unauthorized modifications to set-points, parameters, and controls may result in deteriorated performance and/or equipment failure. Any unauthorized modifications could result in the warranty being voided.

The warranty shall not apply:

1. To any unit or any part thereof which has been subject to an accident, alteration, negligence, misuse or abuse, or which has not been operated in accordance with the manufacturer's recommendations, or in conditions outside of Manufacturer's specifications, or if the serial number of the unit has been altered, defaced, or removed.
2. When the unit, or any part thereof, is damaged by fire, flood, or other act of God.
3. To products that are impaired or damaged due to improper installation.
4. When installation and startup forms are not properly completed or returned within two weeks after startup.
5. If the defective part is not returned to the Manufacturer.
6. To service, maintenance or wear and tear parts (such as lights, starters and ballasts).
7. To cosmetic damage (e.g., scratches, dents, chips, and other damage to appliance finishes), unless such damage results from defects in materials and workmanship and is reported to Hillphoenix within 30 days from date of purchase.
8. To shipping damage.
9. To use in a non-commercial application.
10. Corrosion, discoloration, oxidation, or rust due to exposure to predisposed corrosive environments/atmospheres or contact with product damaging material/chemicals.
11. To service trips where no problem is diagnosed or found in the discretion of Hillphoenix.
12. To Removal/reinstallation of product for repair if installed in an inaccessible location.
13. To use of non-OEM parts for warrantable repair unless directed by Hillphoenix.
14. To repair/service tools/items.
15. To service trips to teach customer how to use product.
16. To product pick-up or delivery for repair purposes; repairs should take place on the customer's site unless directed by Hillphoenix.
17. To misdiagnosis or misrepair, including subsequent labor/component repair or replacement.
18. To stolen components.
19. To replacement service parts lost or misplaced on arrival by receiving personnel.
20. To service events on non-DFR products.
21. To excess repair time.
22. To excess required consumables charges, at the discretion of Hillphoenix.
23. If a service contractor takes longer than 120 days from the date of repair completion to submit a warranty invoice/claim.
24. To component/equipment failures, equipment shutdowns, operational performance degradation due to deviations and unauthorized changes to required and/or recommended set-points, parameters, and controls.

Examples of non-warrantable situations include, but are not limited to:

- Non-factory electrical connection or component issues
- Product is operated on low or improper voltages
- Use of extension cords to power the product

- Lack of basic preventative maintenance as outlined by product manuals
- Installation into a mobile application
- Failures or symptoms that result from site mechanical or electrical failures
- Loading of food or other content that prevents the product from operating properly
- 'Yellowing' of lighting products
- Any physical modifications or changes to product(s) will invalidate the warranty

MODIFICATIONS TO GENERAL WARRANTY

The following sets forth certain modifications to the General Warranty for specific products of Manufacturer:

DISPLAY CASE AND SPECIALTY PRODUCTS CLEARVOYANT® LED LIGHTING

The warranty period for Clearvoyant LED lighting components within the Clearvoyant lighting system is five years from date of shipment.

NO WARRANTY FOR NON-STANDARD PRODUCTS

A " Non-Standard Product" is any product that is different in any manner from any Hillphoenix product that has been previously designed and manufactured by Hillphoenix in accordance with its standard specifications. A Non-Standard Product also includes any standard Hillphoenix product that has been specially designed or modified to meet a particular Buyer specification, or that contains any additional or substituted product, part, accessory, equipment, fixture, component or material, or that has been assembled, manufactured, produced, or installed by any method or process, which is different from Hillphoenix' s standard specifications for such product. Hillphoenix expressly disclaims and makes no warranties, express or implied, as to the condition, design, utility, quality, adequacy, or capacity with respect to any standard or Non-Standard Product, including, without limitation, any warranty of merchantability or fitness of such product for a particular purpose or intended use, whether or not such product has been designated by Hillphoenix as a Non-Standard Product. All Non-Standard Products, whether sold separately, or incorporated and/or attached to standard Hillphoenix products, and all services relating to such products, are sold to and accepted by Buyer " as is" and "with all faults". Without limiting any other provision of this purchase order, Hillphoenix shall have no liability to Buyer for any claim, loss, damage, consequential damages or expenses associated with any Non-Standard Product and/or its use or operation, or any other equipment or property of Buyer caused by or alleged by to be caused by any such product or its use or operation, whether directly, indirectly, incidentally or consequentially, or by any inadequacy thereof or deficiency or defect therein. The foregoing exclusion of warranty cannot be modified or waived except as expressly set forth in a writing signed by an officer of Hillphoenix authorized to make such modification or waiver.

REMEDY LIMITATION/DAMAGES EXCLUSION

THE REMEDY OF REPAIR OR PROVISION OF A REPLACEMENT PART WITHOUT CHARGE SHALL BE THE EXCLUSIVE REMEDY FOR ANY WARRANTY CLAIM HEREUNDER. WITHOUT LIMITING THE FOREGOING, HILLPHOENIX SHALL NOT BE LIABLE UNDER ANY CIRCUMSTANCES FOR INCIDENTAL, INDIRECT, LIQUIDATED OR CONSEQUENTIAL DAMAGES, INCLUDING LOSS OF PROFIT, LABOR COST, LOSS OF REFRIGERANT OR FOOD PRODUCTS.

EXCLUSIVE WARRANTY

THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY WITH RESPECT TO THE PRODUCTS. ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED AND EXCLUDED. NO IMPLIED WARRANTY SHALL BE DEEMED CREATED BY COURSE OF DEALING OR USAGE OF TRADE. NO OTHER PERSON IS AUTHORIZED TO EXPAND OR CREATE ANY OBLIGATION GREATER THAN OR MORE EXPANSIVE THAN THE WARRANTY PROVIDED HEREIN.

THE ABOVE WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. HILLPHOENIX SHALL NOT BE RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING BUT NOT LIMITED TO INJURY TO PERSONS OR PROPERTY. NOTWITHSTANDING ANYTHING TO THE CONTRARY, HILLPHOENIX'S ENTIRE LIABILITY, AND BUYER'S EXCLUSIVE REMEDY, IN LAW AND EQUITY OR OTHERWISE, WITH RESPECT TO ANY PRODUCTS PROVIDED BY HILLPHOENIX IS SOLELY LIMITED TO THE AMOUNT PAID BY BUYER FOR THE PRODUCTS TO WHICH THE APPLICABLE CLAIM RELATES.

THIS DOCUMENT DOES NOT GOVERN EXTENDED WARRANTIES AND ANY EXTENDED WARRANTIES PROVIDED BY HILLPHOENIX SHALL BE GOVERNED BY A SEPARATE DOCUMENT AGREED UPON BY HILLPHOENIX

Submit warranty claims to: hpx-warranty-wa-invoices@doverfoodretail.com

For warranty service, please contact Hill Phoenix at: Phone: 1-833-280-5714