MODEL RS
HELIUM COMPRESSOR

Installation, Operation & Maintenance Manual

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THE LINDE GROUP

Linde

COMPRESSOR SAFETY

I. GENERAL

Linde Cryogenics designs and manufactures all of its products so they can be operated safely. However, the responsibility for safe operation rests with those who use and maintain these products. The following safety precautions are offered as a guide, which will minimize the possibility of accidents throughout the useful life of this equipment.

Only those who have been trained and delegated to do so, and who have read and understand this Operator's Manual should operate and/or maintain the compressor. Failure to follow the instructions, procedures and safety precautions in this manual can result in accidents and injuries.

NEVER start the compressor unless it is safe to do so. DO NOT attempt to operate the compressor with a known unsafe condition. Tag the compressor and render it inoperative by disconnecting and locking out all power at source or otherwise disabling its ability to operate so other personnel cannot attempt to operate it until the unsafe condition is corrected.

Install, use and operate the compressor only in full compliance with all pertinent Federal, National, State, Provincial, and Local codes, standards and regulations.

DO NOT modify the compressor and/or controls in any way unless given written factory approval.

While not specifically applicable to all compressor models, most of the precautionary statements contained herein are applicable to most compressor models and the concepts behind these statements are generally applicable to all compressor models.

II. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Prior to installing or operating the compressor, employers and users should become familiar with, and comply with any pertinent safety codes and regulations, Material Safety Data Sheets, as well as any pertinent Federal, National, State, Provincial, and Local codes, standards, and regulations relative to PPE. PPE should be considered for, but not limited to, eye, facial, respiratory, and extremity protection, protective clothing, shields and barriers, shock hazard protection, and noise exposure protection. Additionally, familiarity with any pertinent administrative and/or engineering controls is considered imperative.

III. PRESSURE RELEASE

All relief valves, if required by Federal, National, State, Provincial, or Local codes, standards, or regulations, are to be piped to exhausts with appropriate sizing and locations.

The compressor is provided with a pump-out connection to facilitate reducing the pressure in the compressor, and it should be connected to a pump-out compressor if required by Federal, National, State, Provincial, or Local codes, standards, or regulations. Otherwise, if compressor is vented, it should be done in keeping with any pertinent regulatory requirements.

Whenever working on any piping, tubing or other connections, ensure that the compressor is blown-down to atmospheric pressure. Even when blown-down, caution must be exercised when loosening

connections, due to localized pressure pockets that can be present even though all compressor pressure gauges show no pressure indication.

IV. FIRE AND EXPLOSION

Lubricant or other combustible spills should be cleaned up immediately.

Shut off the compressor and allow it to cool. Keep sparks, flames, and other ignition sources away and **DO NOT** permit smoking in the vicinity of compressor when checking or adding lubricant.

Disconnect and lock out all power sources prior to attempting any repairs or cleaning of the compressor.

Keep electrical wiring, including all terminals and pressure connectors, in good condition. Replace any wiring that has cracked, cut, or otherwise compromised or degraded insulation, or terminals that are worn, discolored, or corroded. Keep all terminals and pressure connectors tight and clean.

To avoid arcing, keep grounded and/or conductive objects, e.g., tools, away from exposed live electrical parts such as terminals.

Keep appropriate service, fully charged fire extinguishers in close proximity when operating or running compressor.

Keep oily rags, trash, leaves, paper and other combustible litter out of and away from the compressor at all times.

DO NOT operate the compressor with improper flow of cooling medium or lubricant, or with degraded lubricant.

DO NOT attempt to operate the compressor in any hazardous environment unless the compressor has been specially designed and manufactured for such service.

V. MOVING PARTS

Keep hands, arms and other parts of the body and clothing away from couplings, fans and other moving parts.

DO NOT attempt to operate compressor with protective hardware or equipment removed.

Wear snug fitting clothing and confine long hair when working around moving parts, or hot surfaces, of the compressor.

Keep access doors closed except when servicing or making repairs or adjustments.

Ensure all unnecessary personnel are out of and/or clear of compressor prior to starting or operating the compressor.

Disconnect and lock out all power sources and verify, at the compressor, that all required circuits are de-energized so as to minimize the possibility of accidental start-up or operation, prior to making repairs or adjustments. **THIS IS ESPECIALLY IMPORTANT IF COMPRESSORS ARE CONTROLLED REMOTELY.**

Keep hands, shoes, floors, controls and walking surfaces clean and free of oil, water or other liquids to help minimize possibility of slipping or falling.

VI. HOT SURFACES AND SHARP EDGES AND CORNERS

Avoid bodily contact with hot oil or coolant medium, hot surfaces and sharp edges or corners.

Keep all body parts away from all points of gas discharge, including all safety relief devices.

Wear all pertinent and/or required PPE when working on or around the compressor.

Always have a first aid kit in close proximity to address medical assistance promptly. DO NOT ignore small cuts, nicks, or burns as they can become infected if left unattended.

VII. TOXIC AND IRRITATING SUBSTANCES

Operate compressor only in a properly ventilated area.

Coolants, adsorber materials and lubricants used in the compressor are typical of the industry. Care should be taken to avoid accidental ingestion, inhalation, or skin contact. In the event of ingestion, promptly seek medical attention. In the case of skin contact, wash with soap and water.

REFER TO MATERIAL SAFETY DATA SHEETS PROVIDED WITH COMPRESSOR FOR MEDICAL ATTENTION RECOMMENDED FOR SPECIFIC EXPOSURE EVENTS.

VIII. ELECTRICAL SHOCK

This compressor should be installed and maintained in full compliance with Federal, National, State, Provincial, and Local codes, standards and regulations, including, but not limited to the National Electrical Code or an equivalent code, including those relative to equipment grounding conductors, and only by personnel trained, qualified, and properly delegated to do so.

Keep all parts of the body and any hand-held tools or other conductive objects away from exposed live electrical parts of the electrical system. Maintain a dry footing, stand on an insulating surface, and DO NOT contact any other portion of the compressor when making adjustments or repairs to exposed live parts of the electrical system. Make all such adjustments or repairs with one hand only, so as to minimize the possibility of creating a current path through the heart.

Repairs should be made in clean, dry, and well-lighted and ventilated areas.

DO NOT leave compressor unattended with open electrical enclosures. If necessary to do so, then disconnect, lock out and tag all power at source so that others can not inadvertently restore power.

Disconnect, lock out, and tag all power at source prior to attempting repairs or adjustments and prior to handling any ungrounded conductors.

IX. LIFTING

DO NOT lift compressor skid assembly, regardless of equipment used, except by utilizing forklift truck pockets on bottom edges of skid. Eyebolts on compressor pump proper can only be used to remove the compressor pump from the skid once it's properly disconnected and unbolted from skid.

Prior to lifting compressor skid assembly, inspect Lifting points for cracked welds, and fractured, bent, corroded or otherwise degraded members, and for loose bolts or nuts.

Make certain entire lifting, rigging, and supporting structure has been inspected, is in good condition and has rated capacity of at least the weight of the compressor. If necessary, weigh the compressor skid assembly prior to lifting.

Any lifting hooks utilized must have functional safety latches or equivalent device, and must be fully engaged and latched in slings or other associated lifting devices.

If compressor skid assembly is lifted using a hoisting device, guide ropes should be utilized to preclude rotation and swinging of compressor once it's clear of the ground.

If utilizing a hoisting device for lifting compressor skid assembly, DO NOT lift in high wind conditions.

Keep all personnel, and their extremities, from underneath compressor skid assembly whenever it is suspended.

Lift compressor skid assembly no higher than absolutely necessary to facilitate installation.

Keep compressor skid assembly in constant attention whenever it's suspended.

Ensure compressor skid assembly is placed only on flat, level surfaces capable of supporting its weight in addition to whatever lifting/transport equipment is utilized.

When moving compressor skid assembly by forklift truck, utilize fork pockets, when provided. Otherwise, utilize a pallet, if provided. If neither fork pockets or a pallet are provided, then ensure compressor skid assembly is secure and well balanced on forks prior to attempting to either raise or transport it.

Ensure forklift truck forks are fully engaged and correctly tilted before compressor skid assembly is raised or transported.

When using forklift truck to move compressor skid assembly, it should not be raised any higher than necessary to clear any floor level obstructions, and transport and cornering speeds should be the minimal speed practical.

If compressor skid assembly is to be moved while on a pallet, ensure that it is securely attached to pallet prior to lifting or transport.

NEVER attempt to move a compressor skid assembly, that isn't properly secured to its transporting equipment, as uneven transport surfaces or sudden stops can cause it to fall from pallet possibly causing personal injury or property damage.

X. LABELS

Safety labels are not intended to provide complete safety guidance for operators, service, or maintenance personnel. The labels are intended to guide authorized personnel to concise information provided in the Operating & Maintenance Manual provided with each compressor skid assembly.

XI. MODIFICATIONS / REPLACEMENT PARTS

Compressor should not be modified from its original configuration without written concurrence of Linde Cryogenics, nor should any replacement parts, other than those specified by manufacturer be used for service and/or repair.

TABLE OF CONTENTS

MODEL RS COMPRESSOR

TABLE OF CONTENTS

MODEL RS COMPRESSOR

TABLE OF CONTENTS

MODEL RS COMPRESSOR

FIGURES

TABLE OF CONTENTS

APPENDICES

Chapter 1

INTRODUCTION

1.1 Purpose and Scope of the Manual

This manual has been prepared for the general instruction of personnel in the technique of installing, operating and maintaining the Model RS Helium Compressor. It also serves as a reference for standard operating procedures and contains troubleshooting procedures for determining the probable cause and correction of the most common types of malfunction.

1.2 Introduction to the Model RS Helium Compressor

The Model RS Helium Compressor is a skid-mounted assembly consisting of hermetically sealed vertical screw compressor pump with motor, oil injection and separation system, water-cooled aftercooler and oil cooler and control panel containing instrumentation and controls.

No special foundations are normally required.

1.3 Safety

The Model RS compressor is manufactured in accord with codes pertinent to the United States of America, and is labeled accordingly.

The Model RS compressor is designed for use with helium gas, and other applications could damage the equipment.

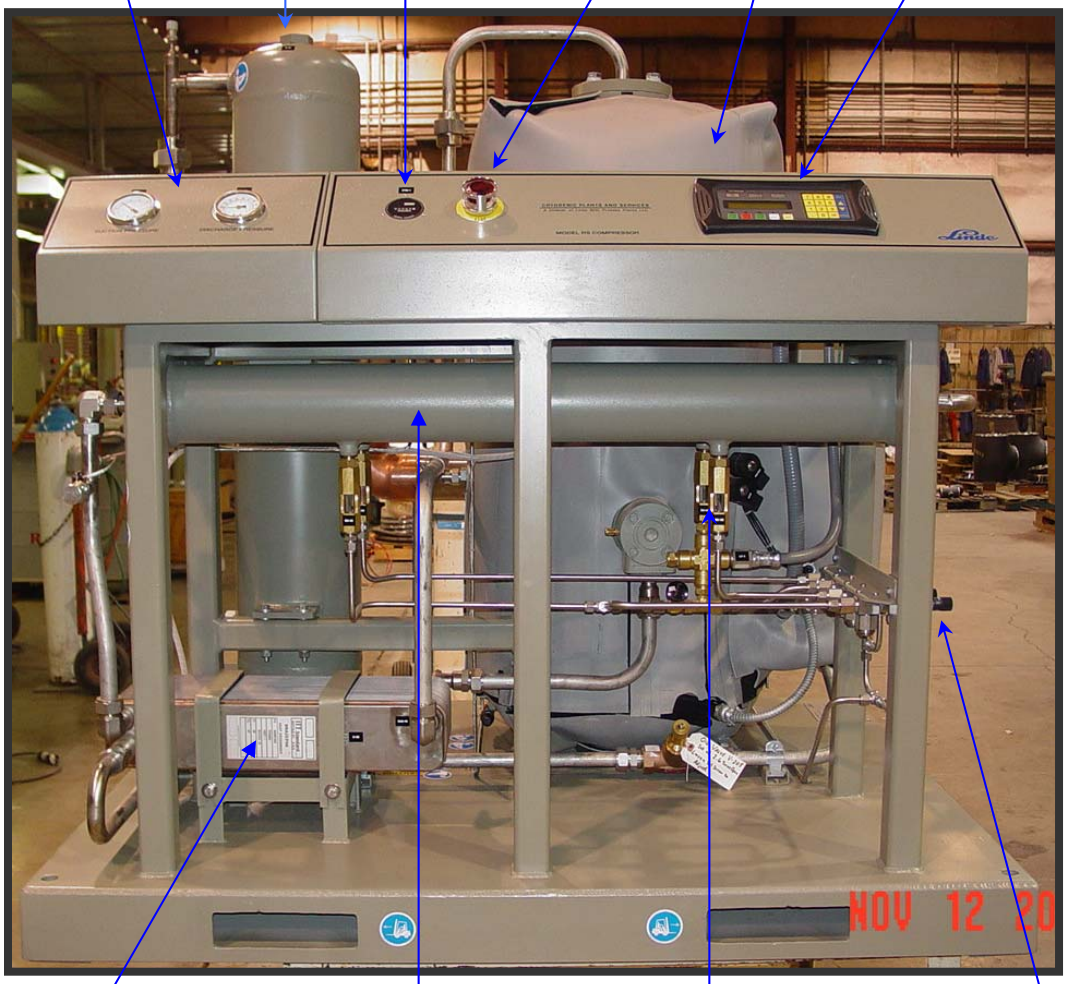


FIGURE 1-1
RS COMPRESSOR

MODEL RS COMPRESSOR TECHNICAL DATA

Helium Gas:

Nominal Suction Pressure: .....1.05 Atm (0.735 psig)
Nominal Discharge Pressure: .....18 Atm (250 psig)
Flow Rate: ..... 395 Nm^3/hr (240 SCFM) @ nominal conditions
..... 18.0 grams/second @ 60 Hz / 15.0 grams/second @ 50Hz

Cooling Water:

Flow Rate/Inlet Temperature: ..... 57 lpm minimum @ 24°C; 76 lpm @ 32°C
(15 gpm minimum @ 75°F; 20 gpm @ 90°F)

Required Inlet Pressure:..... 3.1 bar (45 psig)

Lubricating Fluid/Oil:

Type:..... Heli-Lube 68

Capacity:..... 53 liters (14 US gallons)

Electric Motor:

Rotational Speed..... 3500 RPM at 60Hz (2916 RPM at 50 Hz)

Dimensions:

Length x Width x Height..... 1448 mm x 1346 mm x 1473 mm
(57 in. x 53 in. x 58 in.)

Weight: .....1135 kg (2500 lb.)

Power Consumption:..... 95kW, 3 phase at 60 Hz (STD)
80kW, 3 phase at 50 Hz (STD)

Airborne Noise Emission Level:

L_{Aeq} (Equivalent Continuous A-weighted Sound Pressure Level):.....83 dB(A),
using sound attenuation blanket.

Chapter 2

SYSTEM DESCRIPTION

2.1 The Model RS Helium Compressor

The RS Helium Compressor consists of the following components: 1.) An oil cooled, vertical helical screw compressor pump with drive motor; 2.) An oil injection and separation system; 3.) A cooling system; and 4.) Instrumentation, controls and protective devices.

NOTE: Refer to the flow diagram located in Appendix B for details of the helium gas, oil, and water flows, as well as the functional relationship of the components mentioned in this section.

Helium gas enters the screw compressor pump and is pressurized as described in the following sections. Warm high pressure gas discharged from the screw compressor pump flows through an aftercooler, then through a series of four oil coalescers and an adsorber, both of which are part of the oil separation system, then out through the final filter and gas discharge fitting. Between the coalescers and the adsorber, a backpressure regulator maintains a discharge pressure of 12.4 bar (180 psig). The oil injection and separation system as well as the cooling system are described below.

2.1.1 The Screw Compressor Pump (Refer to Fig. 2-1)

The screw compressor pump is semi-hermetic, positive displacement, helical-axial flow, oil-injected specifically designed for compression of helium. The double-screw pump consists of two inter-meshing helical rotors, a female drive rotor and a male driven rotor in a stationary housing with suction and discharge gas port. The operation of the compressor pump is best understood by following the travel of one lobe of the male rotor and the interlobe space of the female rotor through one revolution as follows:

2.1.1.1 Suction Phase (Refer to Fig. 2-2)

As a lobe of the male rotor begins to un-mesh from an interlobe space in the female rotor, a void is created and gas is drawn in through the inlet port. As the rotors continue to turn, the interlobe space increases in size and gas flows continuously into the compressor. Just prior to the point at which the interlobe

space leaves the inlet port, the entire length of the interlobe space is completely filled with gas at the operating suction pressure.

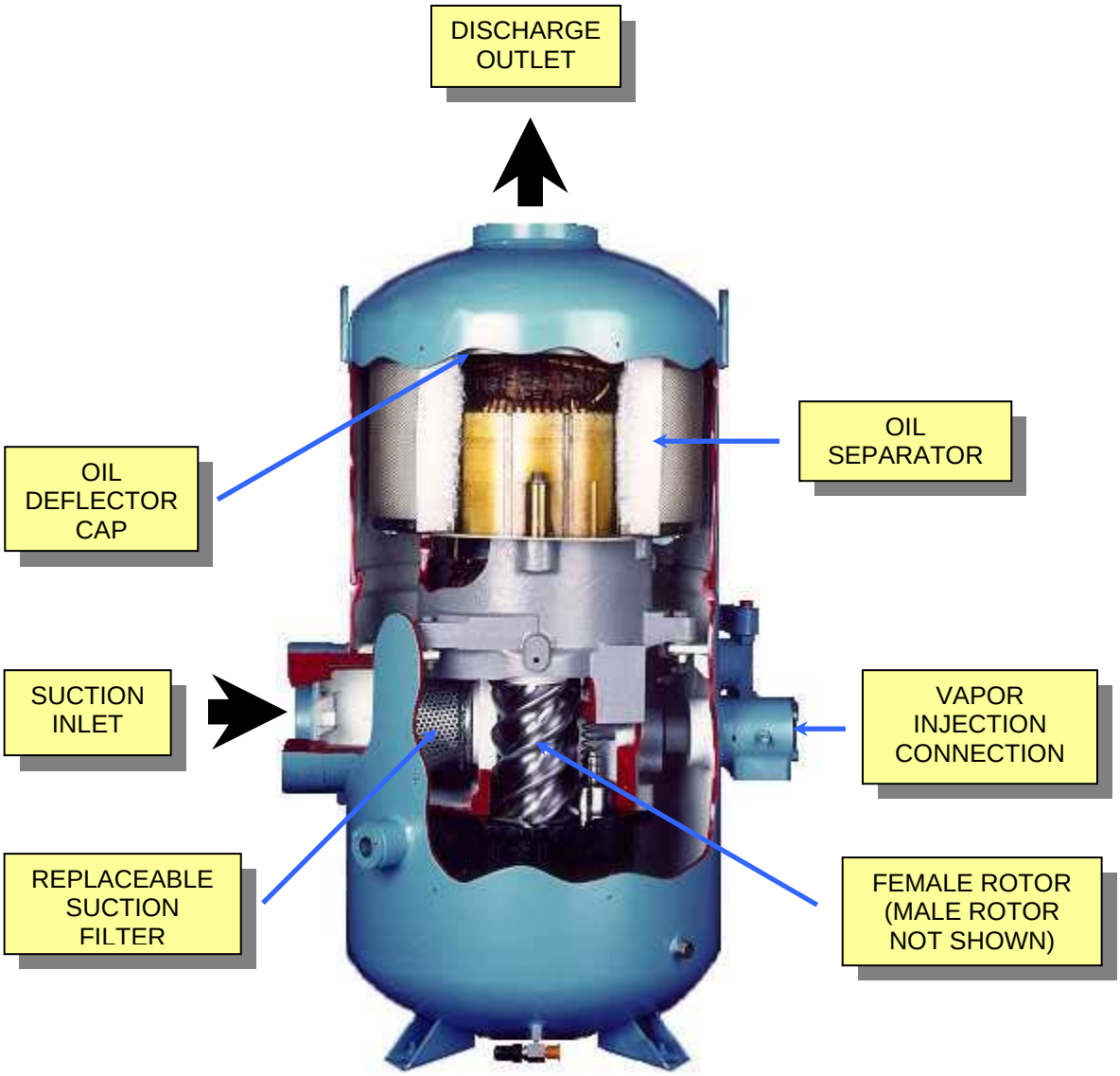


FIGURE 2-1
COMPRESSOR INTERNAL MECHANISM

2.1.1.2 Compression Phase (Refer to Fig. 2-2)

As rotation continues, the gas in the interlobe space is carried circumferentially around the compressor pump housing. Further rotation meshes a male lobe with the interlobe space on the suction end and compresses the gas axially in the direction of the discharge port. Thus, the occupied volume of the trapped gas within the interlobe space is decreased and the gas pressure consequently increased.

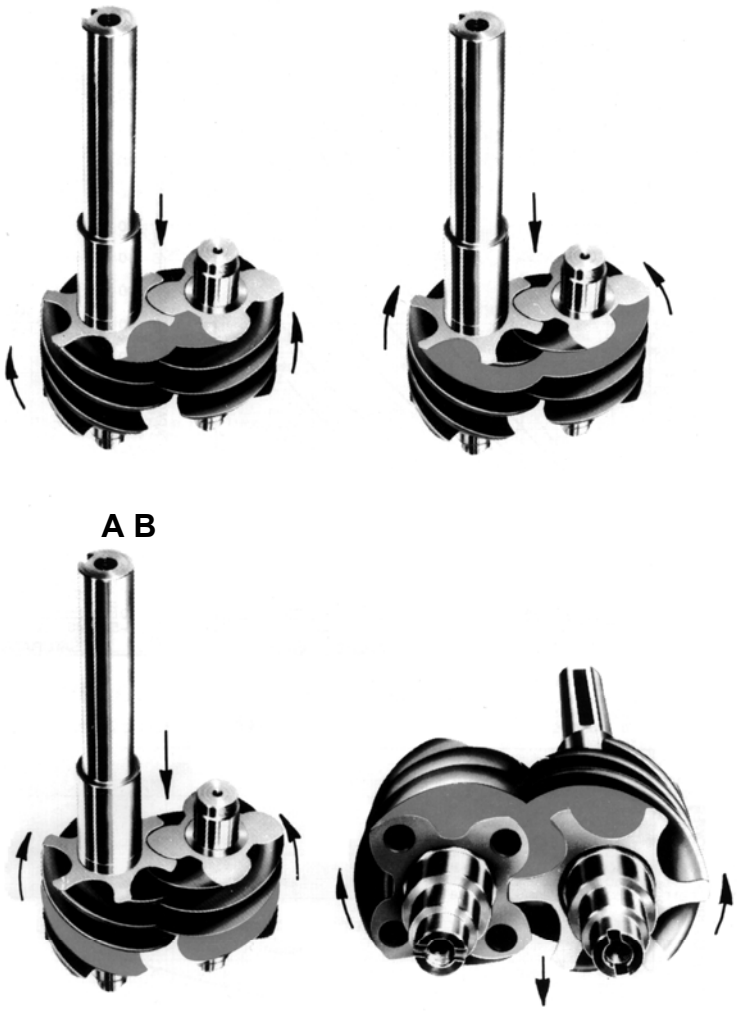


FIGURE 2-2
COMPRESSOR OPERATION

2.1.1.3 Discharge Phase (Refer to Fig. 2-2)

At a point determined by the designed "built-in" compression ratio, the discharge port is uncovered and the compressed gas is discharged by further meshing of the lobe and interlobe space. Since all the compressed gas is discharged, there is no residual gas volume. While the meshing point of a pair of lobes is moving axially, the next charge is being drawn into the un-meshed portion and the working phases of the compressor cycle are repeated. A very smooth, continuous flow of gas and uniform torque are obtained as several inlet and discharge cycles involving pairs of lobes are occurring at the same time.

2.1.1.4 Capacity Control

The screw compressor pump contains a slide valve for capacity control. The slide valve is located within the rotor housing with its required control signals supplied by two solenoid valves externally flange mounted to compressor shell.
(Reference Appendix K for detailed operation description.)

After the compressor is properly installed and set-up, no manual adjustment of slide valve is necessary to achieve desired compressor operation.

NOTE: A minimum inlet/discharge differential pressure of 4.1 bar (60 psig) is required for proper operation of compressor unloader mechanism.

2.1.1.5 Reference Photo (Fig. 2-4)

This photograph shows the moving parts within the compression chamber of the pump. They are bearings, helical rotors and slide valve. The female rotor is connected directly to the shaft of the driving motor, which is the only other moving part within the pump pressure enclosure.

FIGURE 2-4
COMPRESSOR CHAMBER MOVING PARTS

2.2 The Oil Circulation and Separation System

The compressor oil performs a number of functions: 1.) It lubricates moving parts, 2.) Provides a seal in the gap between the male rotor and the interlobe space of the female rotor, 3.) Removes the heat of compression from the gas, and 4.) Cools the motor windings and rotors. Oil is distributed throughout the compressor by the pressure differential. No separate oil pump is required for oil circulation.

NOTE: A minimum inlet/discharge differential pressure of 2.1 bar (30 psig) must be maintained for proper compressor lubrication.

In order to achieve the high, gas outlet purity levels, there are six stages of oil separation. The initial stage occurs within the screw compressor pump housing. The screw compressor pump is provided with an oil impingement plate and coalescing element located within its enclosure. After impacting the plate and coalescing on the element, most of the oil separates from the gas stream and drains into the sump and the gas passes through the discharge port.

Helium gas then flows through a water-cooled aftercooler and then through four coalescing elements connected in series. Each coalescing element has a sight glass and an adjustable metering valve located on the oil drain line.

Oil is separated from the gas stream by the coalescing elements. The oil flows into a common line and is returned to the gas-inlet line of the screw compressor pump.

Helium gas flows from the final coalescer through a backpressure regulator and into an adsorber where granulated charcoal removes the last traces of particulate and vaporous oil. Oil is adsorbed by the charcoal, therefore during scheduled maintenance, the contaminated charcoal is removed and replaced. The gas leaving the Model RS Helium Compressor skid will have total hydrocarbon impurities in the ppb range.

There are four metering valves that are adjusted to control the oil drain process. These valves are factory preset. The correct initial settings are listed below for operator reference:

Metering Valve V31 : Two (2) turns open
Metering Valve V36 : One (1) turn open
Metering Valve V38 : One-half (1/2) turn open
Metering Valve V39 : One-half (1/2) turn open

NOTE: An additional valve, V40, is not a flow control valve, and is to remain closed at all times except when functional testing of high oil level optical switch is being performed as described in Section 4.0 of this manual.

2.3 The Cooling System

The cooling system consists of an integral oil/aftercooler. It is a stacked heat exchanger cooled by water. Water flows through the aftercooler first, where it cools the high-pressure discharge gas from the screw compressor pump. The water then cools oil taken from the screw compressor sump before it's re-injected back into the screw compressor pump.

Water flow to oil/aftercooler is factory set by a metering valve and no further adjustment is normally required.

Oil flow is also factory set by a metering valve, and, like the water flow metering valve, normally requires no further adjustment.

2.4 Indicators, Controls, and Protective Devices

2.4.1 Indicators

Two pressure gauges are located on the compressor skid control panel. One measures suction pressure, the other measures discharge pressure.

An elapsed time meter mounted in the control panel displays total operating hours.

Error messages are displayed on the Operator Interface Terminal screen that is also mounted in the control panel.

2.4.2 Controls

The Operator Interface Terminal touch-pad panel provides 5 pushbuttons, 3 indicator lights, a number key pad, and a 2 line text display for indication of the compressor operating status.

The “START” button starts the compressor; indicated by a Green compressor status indicator light.

A Red compressor status indicator light indicates compressor is not running, and a Yellow compressor status indicator light notes an error.

The “LOAD” button permits the compressor to run at its maximum capacity. Consecutive, repeated operation of the “LOAD” button will load and unload the compressor. "LOAD" button's associated indicator light is Green when compressor is loaded, and is off when it is unloaded.

The “STOP” button stops the compressor operation, and automatically unloads the compressor.

The "ERROR RESET" button clears all displayed error messages.

The "LOCAL/REMOTE CONTROL" button is used to alternate the compressor between 2 available control modes, when so equipped. An associated indicator light is provided to display control mode status; its colors are Green for "LOCAL" and Yellow for "REMOTE".

The number pad is available for use in any programming that's deemed necessary.

The "EMERGENCY STOP" button on the compressor skid front panel offers an additional, readily accessible means of stopping and automatically unloading the compressor in situations demanding minimal response times.

2.4.3 Protective Devices

For more information on Operator Interface Terminal, refer to Appendix U of this manual.

2.4.3.1 Compressor Shutdowns

NOTE: The compressor shutdowns are to stop the compressor operation at the moment of the fault. The reset button on the compressor panel must be pressed to clear the shutdown condition.

TS-1. The solid state motor protection consists of two major components: sensor elements and a control module.

1. Sensors - Three fine wire sensing elements, which are encapsulated in a plastic film, are embedded in the motor windings. When the motor temperature increases, the resistance of these sensors increases. The control module senses this increased resistance.
2. Module - The control module contains a modified solid state bridge circuit interlocked to a relay. With the module energized and the sensors at a safe temperature, the relay is closed; when the temperature of the motor increases beyond a safe limit, the increase in sensor resistance is sensed by the module and the relay opens, which de-energizes the control circuit shutting off the compressor. As the motor cools, the process is reversed and the relay will close when the motor reaches a safe operating temperature.

TAHH-11. A temperature signal from thermocouple located on the helium gas discharge line between the screw compressor pump and the aftercooler. The default set point is 77°C (170°F).

TALL-12. A temperature signal from thermocouple located on the suction line of the compressor. The default set point is -10°C (14°F).

PAHH-11. Shutdown is based on a signal from the discharge pressure transmitter (PT-11) located in the discharge line between the aftercooler and the first stage coalescer. The default set point is 18.6 bar (270 psig).

PALL-12. Shutdown is based on a signal from the suction pressure transmitter (PT-12) located in the helium gas suction line between the inlet connection and the screw compressor pump. Its signal is utilized to shut off the compressor when suction pressure is <10″ Hg for >90 seconds.

PALL-11. This shutdown is generated based on a signal from the discharge pressure transmitter (PT-11). The default set point is 10.3 bar (150 psig) for 10 seconds.

ES-1. Power quality switch is located in starter box and will stop the compressor if either voltage or phase rotation is incorrect.

OL-1. Current draw relay is located in starter box and stops the compressor if motor current exceeds the preset value.

2.4.3.2 Compressor Alarms

Compressor alarms are displayed on the operator panel, and can also be displayed on a Data Acquisition Personal Computer (DAQ PC), as well. Abbreviation "TSH" means "temperature switch high" and "TSL" is "temperature switch low".

LS-1. If the oil level in the sump falls below a predetermined level, this optical switch generates an alarm to alert the operator.

LS-2. Oil presence switch is located on sight glass of the third stage of the coalescer. In case of detection of oil in the glass, an alarm is generated.

TAH-11. A temperature signal from thermocouple TE-11 located on the helium gas discharge line between the screw-compressor pump and the aftercooler. The default set point is 74°C (165°F).

TAL-12. A temperature signal from thermocouple TE-12 located on the helium gas inlet to the compressor. The default set point is 0°C (32°F).

PAH-11. A pressure signal from transmitter PT-11. The default set point is 18.3 bar (265 psig).

PAL-11. A pressure signal from transmitter PT-11. The default set point is 11.0 bar (160 psig).

2.4.3.3 Pressure Reliefs and Valves

C-6. A self-sealing coupling at the discharge of the compressor prevents the loss of helium and prevents contamination of the compressor during periods when it becomes necessary to separate the helium compressor assembly from the related system equipment.

V-285. A relief valve is located on the screw-compressor pump for release of excess pressure build-up in the system. The relief pressure set point is 19.7 bar (285 psig).

V-287. A relief valve is located between adsorber and final filter. Like V-285, the relief pressure set point is 19.7 bar (285 psig).

V-212. A check valve located at the inlet of the screw-compressor pump that prevents reverse rotation of the screw and subsequent oil back flow into the suction line.

V-213. A check valve located downstream of the adsorber prevents the backflow of helium gas if the compressor is operated in parallel with another compressor.

V-201. A manually operated service valve.

V-202. The backpressure regulator maintains pump discharge pressure at 12.4 bar (180 psig) to limit the velocity of the helium gas through the oil removal system.

V-203. A manually operated, factory set, flow control valve.

V-204. A manual ball valve for accessing suction line, when required.

V-205. A manually operated, factory set, flow control valve.

FIGURE 2-4-1
RS COMPRESSOR

FIGURE 2-4-2
RS COMPRESSOR
LEFT SIDE VIEW

FIGURE 2-4-3
RS COMPRESSOR
RIGHT SIDE VIEW

Chapter 3

INSPECTION, INSTALLATION, AND OPERATION

This chapter describes the inspection, installation, operation and storage of the Model RS Helium Compressor. Inspection includes both inspection for shipping damage and an investigation of the pressure integrity of the compressor that was shipped leak tested in a dehydrated and charged condition. Any questions concerning inspection, installation, and operation should be directed to the LC field representative. Any damage or missing parts must be immediately documented with the carrier.

3.1 Inspection

NOTE: If any damage is noted, notify transportation carrier and field representative immediately for instructions. Should the crate or skid show definite signs of being dropped, such damage must be reported since it may have caused internal damage to the compressor pump.

A.) Upon receipt, remove the crating and inspect the exterior of the compressor for physical damage.
B.) Check the pressure indicated on the pressure gauges and record it.
C.) Inspect for oil leaks, especially in the vicinity of the piping and joints.
D.) Determine the oil level in the compressor sight glass. Oil should be visible on the sump sight glass.

3.2 Installation

3.2.1 Initial Preparation

The user is responsible for installing all electrical and piping interconnections between the compressor and the other modules that make up the system. A clearance of 1 meter (~3 feet) all around the skid is ideal for servicing of the Model RS Compressor.

The installer should discuss the installation progress with the field representative prior to the startup visit. If questions arise during the installation, these should be discussed and resolved with the field representative prior to the startup visit.

Mechanical and electrical installation drawings for the Model RS Compressor are included as part of this manual.

NOTE: The information on these drawings supersedes any information provided either prior to receipt of the shipment or in this manual if there is a conflict.

A flat foundation or floor which can support the weight 1135kg (~2500 lbs.) of the equipment must be provided since the unit must be level for proper operation. When installing the unit, shim the compressor base as necessary to insure that the compressor base is level and is properly supported.

WARNING: Load bearing for lifting and transport of compressor skid assembly is to be from bottom of skid only at forklift truck pockets provided. Skid assembly must never be hoisted using lifting eyes of compressor pump.

3.2.2 Cooling Water

A flow of 57 lpm (15 gpm) of cooling water at 24°C (75°F) or less at a minimum pressure of 3.1 bar (45 psig) is necessary for each individual compressor. Calcium Carbonate water "hardness" should not exceed 500 PPM. Air vent valves should be installed at all high points in the water system.

It is possible to compensate for cooling water temperatures as high as 32°C (90°F) by increasing the water flow rate to 76 lpm (20 gpm) at 4.1 bar (60 psig) supply pressure.

3.2.3 Electrical

Compare the nameplate data with the local service available. All wiring must comply with the National Electrical Code and/or equivalent Federal, National, State, Provincial, or Local codes.

DESIGN VOLTAGES	USE VOLTAGES MIN.	MAX.	STANDARD APPLICABLE NETWORK VOLTAGES
200/3/60	180	220	200, 208
230/3/60	207	253	220, 230, 240
380/3/60	342	418	380, 400, 415
460/3/60	414	506	440, 460, 480
575/3/60	518	632	550, 575, 600
200/3/50	180	220	200
220/3/50	198	242	220
400/3/50	360	440	380, 400, 415
500/3/50	450	550	500

NOTE: The screw compressor pump is uni-directional and must not be allowed to rotate in reverse direction. It is mandatory that power leads be re-checked for proper phase sequence immediately prior to operation for the first time and any time thereafter that power leads are disconnected and reconnected to compressor.

To avoid possible damage to the motor, the 3-phase voltage unbalances should never reach 2 percent. Should an unbalance over 1 percent persist, the power supply line load distribution should be checked and corrected or the power company should be contacted to correct the situation.

Unbalance can be calculated as follows:

$$\% \text{ Voltage Unbalance} = \frac{100 \times (\text{Max. Voltage Deviation from Avg. Voltage})}{\text{Average Voltage}}$$

A voltage unbalance over 2% will result in a current unbalance of over 15%, and a 3.5% voltage unbalance will result in over 25% current unbalance.

Should the connected voltage consistently vary more than +/-3% percent of the design voltage, the customer should contact the power company so that supply voltage can be adjusted to more closely match the nominal nameplate designation. This will help ensure the maximum operating life of the equipment.

NOTE: Starting the Model RS Compressor must be limited to no more than 4 starts per hour in order to avoid possible motor damage. Compressor is not to be loaded/unloaded any more frequently than once every 3 minutes.

3.2.4 Piping Installation

Refer to the installation drawing supplied with the equipment.

When installing the interconnecting piping, ensure sufficient flexibility to allow the couplings to be disengaged without having to move the equipment. Plan piping for a minimum number of joints using as few elbows and other fittings as possible. However, make sure to provide sufficient flexibility to absorb any vibration.

All helium piping practices must be in accordance with local codes and/or the latest edition of the ANSI/ASME B31.5 Refrigeration Piping Code. To ensure trouble-free operation, the following conditions should be observed:

A.) When brazing or soldering, valves are to be disassembled, or wrapped in a wet cloth to prevent damage by heat. To prevent formation of oxide on the

inside of the copper tubing, nitrogen or inert gas must be passed through the piping continuously while brazing joints.

B.) If tubing or pipes are cut from open stock, they should be thoroughly cleaned before they are fitted. All lines should be flushed with a suitable cleaner/solvent and dried out using dry nitrogen gas.

C.) Never leave a dehydrated line exposed to the atmosphere longer than is absolutely necessary for the installation.

D.) Contamination often results from carelessness or mishandling during storage and/or assembly of the tubing components. All filings, chips, flux, scale, dust and dirt must be periodically cleaned from the piping during assembly and thoroughly cleaned after final assembly.

3.2.4.1 Brazing Alloys

A.) For brazing copper to copper or brass to copper

1.) Brazing alloy: BAg-5
2.) Flux: 4A, White flux
3.) Brazing temperature range: 743°C-843°C (1370°F-1550°F)

B.) For brazing copper to stainless steel or brass to stainless steel

1.) Brazing alloy: BAg-24
2.) Flux: 3A, Black flux
3.) Brazing temperature range: 707°C-843°C (1305°F-1550°F)

C.) For brazing copper to copper only

1.) Brazing alloy BCuP-5
2.) Flux: No flux required
3.) Brazing temperature range: 704°C-815°C (1300°F-1500°F)

3.2.4.2 Joint Compounds

All pipe joints should be made up using an appropriate pipe joint compound applied to the male pipe member only. Epoxy or Neolube® may be used if available.

3.2.4.3 Vibration and Noise in Piping

Vibration transmitted through or generated in refrigerant piping, and objectionable noise which results, can be eliminated or minimized by proper design and support of piping.

The two undesirable effects of vibration of refrigerant piping are the physical damage to the piping and the transmission of noise. To reduce the effect of compressor vibration from being transmitted to the piping, run the water, suction and discharge lines at least 15 pipe diameters in each of two or three directions before securing the first hanger. In this manner, the piping can adsorb the vibrations without being over-stressed.

Flexible metal hose is suggested to absorb vibration transmitted in the piping. For greatest effectiveness, it should be installed at right angles to the compressor piping.

When piping passes through walls, floors or inside furring, precaution should be taken to see that the piping does not touch any part of the building and is only supported by the hangers provided in order to prevent transmission of vibration to the building, and thereby to preclude the possibility of walls or ceilings acting as sounding boards.

3.2.4.4 Leak Check of Interconnecting Piping

All piping that is to be used for interconnecting the compressor with other components must be leak checked before it is interconnected.

The recommended line test pressures for the interconnecting piping is as follows:

Compressor Suction/Low pressure side: 2.8 bar (40 psig)

Compressor Discharge/High pressure side: 25.9 bar (375 psig)

If no leak is found during pressure testing, evacuate the system by using a clean vacuum pump.

If the system is properly evacuated, the air contaminants are eliminated before the system is ever started.

A good vacuum system having a vacuum pump capable of operating in the 50 mTorr range and an electronic vacuum gauge capable of reading high vacuum levels is imperative. To properly evacuate a system and insure maximum dehydration, connect the vacuum pump to the lines and open all valves in the system via a 15.9mm (5/8") minimum OD connecting line.

To use the vacuum pump most efficiently, a triple evacuation method should be used. This involves establishing a vacuum level of at least 300 mTorr on the system. The vacuum should then be maintained for a minimum period of one

hour while the vacuum pump continues running. Warming the line to approximately 38°C (100°F) while evacuating will help facilitate obtaining the 300 mTorr vacuum level. Isolate the vacuum pump from the system, and then break-back the vacuum to atmospheric pressure using dry helium. A second vacuum should then be established, held, and broken-back to atmospheric pressure using all the same parameters noted previously for the first evacuation cycle. A third vacuum should be established on the system. This time the system should again be evacuated to at least 300 mTorr, but then the vacuum pump should then be isolated and shut down to permit accessing system vacuum integrity for 12 hours. The highest pressure acceptable at the end of the 12-hour period is 500 mTorr.

If the system doesn't meet the above pressure criteria, it should be rechecked for small leaks, the leaks repaired, and the above procedure repeated.

Besides ensuring that the connecting line between the vacuum pump and the refrigeration system is sufficiently large enough to prevent pressure drop there are 2 key precautions which also have to be kept in mind:

A.) An ordinary compound gauge is not useful. It is absolutely necessary to use a gauge capable of measuring high vacuum.

B.) A vacuum pump can compensate for small leaks. It can pull air and moisture in one end of a system and push it out the pump exhaust.

3.3 Preliminary Check-Out

Verify that the following conditions exist:

A.) All interconnecting wiring is complete, properly connected and safely routed. All electrical enclosures are properly secured and closed.

B.) Proper phase sequencing has been verified.

C.) Adequate electrical power supply is available and the 3-phase power disconnect switch for the compressor is in the “ON” position.

D.) All helium piping interconnections are complete. Gas management system is complete.

E.) The compressor has been decontaminated if it's been opened to atmosphere.

F.) The compressor-suction manual valve and any other in-line manual valves in the helium piping are opened.

G.) All water supply/return valves are properly set, and adequate cooling water is available. Bleed air off the highest points in the water system if necessary to assure system is not air bound.

3.4 Operating

A.) Press "START".

B.) Check suction pressure and discharge pressure indicators.

NOTE: Immediately shut down compressor if Supply Pressure gauge rises to, and remains at, a pressure 2.1 bar (30 psig). Check for proper power phasing, and if it's incorrect, interchange any 2 of the 3-phase power leads at the compressor motor starter. The compressor is uni-directional; if it's operated in its reverse direction for more than a few seconds severe compressor damage can occur.

C.) Check oil level on pump oil sight glass.

D.) Depress "LOAD" push button to load compressor, and observe suction and discharge pressures ensuring they are correct.

E.) Record the operating conditions in a logbook.

F.) To shut down the compressor, press the "STOP" push-button.

NOTE: The screw-compressor pump automatically unloads when the compressor is shut down.

3.5 Storage

The screw-compressor pump must be protected from any gas contaminants during storage; therefore, it must be maintained under positive pressure of approximately 1.7 bar (25 psig) helium. A weekly inspection with a gauge reading recorded on a log is suggested to ensure internal pressure is properly maintained. For prolonged storage, it is recommended that a plastic cover be placed over the screw-compressor pump to protect the electrical terminal box from dust and other atmospheric contaminants.

Chapter 4

MAINTENANCE

This chapter contains procedures for the maintenance of the Model RS Compressor. Maintenance by the user is limited to: 1.) adding oil to the screw-compressor pump, 2.) removing oil from the screw-compressor pump, 3.) replacing the charcoal in the adsorber, 4.) removing the screw-compressor pump, and 5.) installing the screw compressor pump. The only recommended maintenance is replacement of the adsorber charcoal every 8000 hours. The operator should inspect the compressor and update a logbook weekly.

4.1 Inspecting the Level of the Oil in the Screw Compressor Pump

A.) The sight glass on the side of the compressor pump is used to determine the oil level in which the compressor can safely operate. Verify that the oil level in the sight glass is approximately at the midpoint (between 1/4 and 3/4 full) with the compressor running.

NOTE: The actual oil level can only be determined if the compressor is running. Therefore, when oil has to be added, it should only be added with the compressor running.

B.) If oil level is below the sight glass, evaluate the cause of the oil loss. Under normal operating conditions the compressor should not lose any significant quantity of oil.

NOTE: The compressor can operate with the oil level below the sight glass as the oil level sensor will protect the compressor against a low oil condition.

4.2 Adding Oil to the Screw Compressor Pump

A.) Oil is usually added to the compressor after performing major maintenance or after replacing the screw compressor pump.

B.) Heli-Lube 68 is the only oil recommended for use in the screw compressor pump and is supplied in a sealed oil-charging container. The charging container is used to add oil when the compressor is operating. At the time of use, the oil-charging container should be pressurized with pure helium gas to approximately 16.5 bar (240 psig).

C.) The oil-charging container is fitted with a relief valve set at 20.7 bar (300 psig). Do not exceed 19.0 bar (275 psig) if pressurizing the container.

D.) The oil-charging container must always be in the upright position when oil is being transferred to the compressor. (The discharge is via a standpipe).

E.) Whenever adding oil, the screw-compressor pump must be operating at a discharge pressure less than 14.5 bar (210 psig).

1.) Verify that the compressor is running at the proper operating conditions.

2.) Remove the dust caps from the oil-charging container and from the oil-charging fitting at the bottom of the compressor pump.

3.) Connect the oil-charging container to the oil-charging fitting.

4.) Gradually open the oil-charging container valve and add oil until the oil level rises to approximately the halfway point in the sight glass. Close the container valve. Avoid overfilling.

5.) When the transfer has been complete, disconnect the oil-charging container and replace the dust caps on the oil-charging fitting connected to the screw compressor pump and the oil-charging container.

NOTE: The oil charging container should be stored pressurized with helium gas.

6.) If oil level is above the sight glass, remove the excess.

NOTE: Excessive oil charge can damage the screw compressor pump.

4.3 Removing Oil From the Screw Compressor Pump

NOTE: If too much oil is added to the screw-compressor pump, indicated by oil rising above the top of the sight glass, the excess oil must be removed until the level reaches the approximate halfway point in the sight glass. The actual oil level can only be determined if the compressor is running. Ensure the unit is running when making oil level determination.

WARNING: OIL REMOVED FROM COMPRESSOR CAN BE HOT ENOUGH TO CAUSE BURNS.

NOTE: Never re-use oil that has been removed from the compressor.

A.) Remove the dust caps from the oil removal tool and from the oil-charging fitting.

B.) Connect the oil removal tool to the oil-charging fitting; and, using a suitable container, gradually open the valve on the tool and allow the oil to drain into the container.

C.) When oil level reaches the approximate halfway point in the sight glass shut the valve.

D.) Disconnect the oil-removal tool and replace the dust caps on the oil-charging fitting and oil-removal tool.

4.4 Replacing Adsorber Charcoal

A.) Recommended replacement interval is 8000 operating hours.

NOTE: Refer to specification 35421040 in Appendix J of this manual; it outlines the correct maintenance procedure for the adsorber.

WARNING: ADSORBER MUST BE DEPRESSURIZED PRIOR TO SERVICING.

4.5 Removing Screw Compressor Pump

WARNING: DO NOT PERFORM ANY WORK ON SCREW COMPRESSOR PUMP UNTIL IT HAS BEEN DE-PRESSURIZED AND DISCONNECTED FROM INTERCONNECTING PIPING AND ELECTRICAL WIRING.

A.) Shut off all electrical power to the unit. Disconnect all electrical leads from the screw-compressor pump electrical terminal box. Tag all removed electrical leads to insure proper connection during reassembly.

B.) Disconnect all interconnecting piping to the water inlet and outlet fittings located on the rear of the compressor cabinet.

C.) Remove oil from the screw-compressor pump.

D.) Depressurize the compressor through the evacuation and charging fitting located upstream of the backpressure regulator.

E.) Close the Suction Service Valve, V201.

NOTE: The exterior parts of the compressor tube fittings and the adjacent compressor-housing surface should be cleaned before disassembly. Use a stiff brush and a solvent to remove dirt from all grooves, crevices, and holes. Some typical solvents for cleaning painted surfaces are detergents, Dupont 49®, and Ponsolv®. Lint free wiping cloths or absorbent paper towels should be used. When using solvents, care must be exercised to keep solvent clean.

WARNING: SOME SOLVENTS CONTAIN MATERIALS THAT REQUIRE PERSONNEL TO UTILIZE SPECIFIC RESPIRATORY PROTECTION AND/OR ADDITIONAL VENTILATION PRECAUTIONS.

F.) Disconnect tubing from the compressor housing as follows:

1.) Remove the discharge line located between the compressor pump and the aftercooler by disconnecting the tubing fitting.

2.) Disconnect the oil tubing from the lower compressor housing.

3.) Have a container ready to catch any oil present, remove the four bolts securing the tube fitting to the Suction Check Valve, V212, and remove the suction tubing.

G.) Attach an appropriate sling to lifting eyes and associated hoisting device.

H.) Remove mounting fasteners securing the screw-compressor pump to skid.

I.) Check to insure that all interconnecting tube fittings are disconnected; also check that all electrical leads are disconnected from the screw-compressor pump terminal box.

J.) Using an overhead hoist, carefully lift and remove the screw-compressor pump from the cabinet.

K.) Install protective caps on all removed tube fittings to prevent foreign matter from being introduced into the compressor.

4.6 Locating and Repairing Leaks

4.6.1 Locating Leaks

If a leaking component has been identified, isolate it from mating components by disengaging the self-sealing couplings or closing valves; then pressurize the component with helium gas and search for the leak.

WARNING: DO NOT EXCEED NORMAL SYSTEM

OPERATING PRESSURE OF 17.2 bar (250 psig) WHEN

PRESSURIZING THE SYSTEM COMPONENTS.

The most effective means for leak detection is a helium mass spectrometer leak detector. If such equipment is available, carefully scan all parts of the defective component. Bear in mind that the most likely points of leakage in order of probability are mechanical joints, connecting fittings, O-rings, brazed joints, and welded joints. In many cases, oil leakage or evidence of mechanical damage will offer starting points for the testing procedure.

NOTE: Because most lines on the compressor contain oil,

depressurize and slowly break connections to avoid exposure to

spraying oil.

If a helium mass spectrometer leak detector is not available, the next most effective method is a bubble test with Leak-Tec®, or an equivalent leak detection fluid.

NOTE: Some bubble test solutions are corrosive and must be

completely rinsed from parts after leak testing is complete.

Ordinary soap or detergent solutions, such as those used for

testing pneumatic piping, are generally ineffective for small helium

leaks.

Using a soft, camel's-hair or sable artist's brush, apply an even coating of the bubble test solution. If the leak is small, apply the coating to several joints at one time, wait for 5 -10 minutes, and then carefully look for a small area of white foam. Smaller size leaks can be located by employing a magnifying glass and considerable patience. If the leak is large, apply the coating to one joint at a time; then watch for 1 or 2 large bubbles as the brush passes over the leak.

4.6.2 Repairing Leaks

If the cause of leakage is an O-ring, disassemble the particular component and clean the O-ring groove with a clean cloth moistened with a suitable solvent.

Inspect the groove carefully looking for scratches or other damage. If such defects are found they must be repaired. After any necessary repairs are completed, lightly coat the replacement O-ring with vacuum grease and reinstall it.

If the leak is at a mechanical joint or a self-sealing coupling, carefully tighten the joint using 2 wrenches. After the joint has been tightened, recheck for leaks as before. If the coupling still leaks, and if it is of the gasketed self-sealing type, remove the gasket and O-rings, then carefully clean and inspect the sealing surfaces. If there is no evidence of damage, replace the O-rings and gasket and recheck for leaks as before. If leak persists, replace the fitting.

Carefully clean the area where any repairs were made ensuring that no contaminants remain either on the inside or the outside of the component.

4.7 Decontaminating the Screw-Compressor

4.7.1 Evacuation

All the components in the helium compressor system must be free of air and moisture and contain only pure helium at the time of use.

If the screw compressor pump has been replaced or the oil exposed to the atmosphere, the screw compressor pump must be evacuated to expel any traces of air or moisture.

The following procedures should be followed for removing contaminants from the system components:

A.) Disconnect the self-sealing coupling located on the compressor discharge line and install the dust caps.

B.) Close the Suction Service Valve V-201.

C.) Using a mechanical vacuum pump capable of a blank-off pressure of < 50 mTorr and a capacity of > 8.5m^3/hr (5 scfm), evacuate the screw compressor pump using both the evacuation connection downstream of the adsorber and the connection upstream of the back pressure regulator.

D.) Evacuate the system to a pressure of < 300 mTorr; this will normally require a minimum of approximately 4 hours. Continue evacuation overnight, or for at least a minimum of 12 hours.

E.) Valve off the vacuum pump and pressurize the compressor to 14.5 bar (210 psig) using pure helium.

4.7.2 Purging the Compressor (Charge & Discard Method)

Helium must be circulated through the compressor at operating temperature to remove moisture adsorbed in the oil during exposure to humid atmosphere. Circulation should be confined to the compressor and a minimal amount of system piping.

A.) Using the evacuation and charging fitting, charge the compressor to 14.5 bar (210 psig).

B.) Start the compressor. Depress "LOAD" push-button to fully load the compressor.

C.) "Throttle" the flow at the External Bypass Valve, V-345, as necessary, to establish a discharge pressure of 17.2 bar (250 psig) and a suction pressure of 10" H_2O; add or bleed-off gas as necessary to achieve these conditions.

D.) Operate the compressor for half an hour.

E.) Stop the compressor and blow down the gas.

F.) Evacuate the system to a pressure of <300 mTorr.

G.) Repeat steps A through F a minimum of 3 times.

H.) When the purging is completed, ensure the system is returned to the desired status.

4.7.3 Purging the Compressor (Cryogenic Adsorber Method)

Linde recommends that a cryogenic adsorber be used as an effective means of purging a helium compressor. The cryogenic adsorber should be installed in a closed circuit with interconnecting lines and a suitable bypass manifold connected to the compressor's high-pressure discharge line. The cryogenic adsorber has a maximum capacity of 102 m^3/hr (60 scfm) @ 17.2 bar (250 psig). The adsorber must be piped into the system to permit a partial flow of compressor output through the cryogenic adsorber.

Compressor purging is accomplished as follows:

A.) Fill a clean cryogenic adsorber with the correct amount of LN_2; allow a minimum of 1-hour for temperature stabilization.

B.) Attach the cryogenic adsorber inlet and outlet lines to the correct bypass manifold connections.

C.) Charge the compressor to 14.5 bar (210 psig) with clean helium gas.

D.) Start the compressor; obtain the desired supply and return pressures of 17.2 bar (250 psig) and 10" H_2O, respectively.

E.) Operate the compressor for a minimum of 4 hours; monitoring the cryogenic adsorber to ensure it's operating properly.

F.) Depress "STOP" button to shutdown the compressor.

G.) Disconnect cryogenic adsorber, set it aside for regeneration, and ensure all valves are restored to their normal operating positions.

4.8 Thread Sealant Application

A recommended procedure for the application of thread sealant, i.e., Neo- Lube®, or an equivalent product, is described below. This procedure is to be used in conjunction with recommendations of the sealant manufacturer, and it is applicable to all threaded joints.

A.) Inspect both male and female threaded sections for dirt or damaged threads. Clean both joint halves thoroughly.

B.) Thread mating parts together to insure that both male and female threads fit properly. Unthread mating parts after verifying correct fit of parts.

C.) Apply sealant to the male thread whenever possible taking care not to get sealant on first thread.

D.) Make up the threaded assembly hand tight; then remove and apply additional sealant as in Step C.

E.) Make up the threaded assembly hand tight, and then fully set the components with appropriate wrenches.

F.) Tighten fitting into proper orientation. Do not back-off fittings to obtain proper alignment.

G.) Clean excess sealant from threaded joint.

H.) Allow time for recommended curing or setting of sealant before pressurization.

4.9 Loosening Epoxy Sealed Threaded Connections

Epoxy resin is used as a sealant, on selected pipe thread connections, that are not likely to be disengaged. It provides a reliable seal that neither ages or loosens. Disengaging such joints should be avoided whenever possible because there is considerable risk of damage to the parts. However, if a joint must be loosened, heat the epoxy joint to 93°C-99°C (200°F-210°F) to soften the epoxy before breaking the joint bond using a wrench.

4.10 Coalescer High Oil Level Sensor Test Procedure

A.) While operating compressor in "LOAD" mode, close valve V-31 to cause Sight Glass SG-21 to fill with oil.

B.) Close valve V-38 and slowly open valve V-40; this will cause Sight Glass SG-28 to fill with enough oil to rise above the level of the optical switch mounted at Number 3 Coalescer sight glass.

NOTE: After a timed delay, an alarm will be displayed on the compressor operator panel because of actuating high oil level relay LS-2. If alarm fails to display as described, repair to control circuit is advised prior to normal compressor operation.

C.) Drain the oil from Sight Glass SG-28 by closing valve V-40 and opening valve V-38. Alarm display will disappear from the panel.

D.) Verify operation of the LS-2 relay by repeating steps A-C above.

E.) Finally, ensure all coalescer Oil Drain Valves V-31, V-36, V-38, and V39 are properly set for normal operation, and that valve V-40 is securely closed.

Chapter 5

TROUBLESHOOTING

This chapter covers some of the difficulties that may occur in the day-to-day operation of the system. It is assumed that the Operator has read the preceding chapters and is thoroughly familiar with the mechanical and electrical details of the equipment. The techniques given here will enable the operator to identify and correct operating difficulties.

The two most important aids in troubleshooting are the operator's experience with the system and log sheets kept while the system was operating properly. If the operator has become accustomed to the sounds usually associated with the system and is familiar with the normal pressure levels and operating characteristics, then deviations from the normal operation will be more readily recognizable.

Table 5-1

TROUBLESHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	REMEDY
1.) Compressor will not start.	a.) Power off.	a.) Check main disconnect switch.
	b.) Main line open.	b.) Check main fuses.
	c.) Loose/fouled terminals.	c.) Tighten/clean terminals.
	d.) Control circuit fault.	d.) Evaluate condition of the protective shutdown devices listed in Chapter 2.
	e.) Motor failure.	e.) Contact a LC Field Representative.
2.) Compressor "hums" but will not start.	a.) Low voltage.	a.) Voltage must be within 10% of compressor's nameplate rating. Check voltage drop between main entrance and compressor terminals.
	b.) No power on 1 phase of power	b.) Check fuses and wiring.
	c.) Motor failure.	c.) Contact a LC Field Representative
	d.) Rotors locked.	d.) Contact a LC Field Representative
3.) Compressor runs, but without a pressure differential across compressor inlet and discharge.	a.) Unit phased incorrectly; motor is turning in wrong direction.	a.) Shut down compressor immediately; swap any 2 compressor motor power leads.
	b.) No backpressure developed.	b.) Check operation and setting of Back Pressure Regulator, V202
4.) Compressor stops running.	a.) Control circuit fault.	a.) See remedy 1.d
	b.) Improper supply voltage.	b.) See remedy 2.a
	c.) Motor failure.	c.) Contact a LC Field Representative.

SYMPTOM	PROBABLE CAUSE	REMEDY
5.) Compressor will hold LOAD, UNLOAD, PARTIAL LOAD.	a.) Pad mounted unloader not operatin properly.	a.) Evaluate unloader function by referencing Appendix "K", Hartford Compressor Bulletin Y1110-0002-01, Unloader Pad Schematic, Operation, and Troubleshooting.
6.) Oil backs-up into first coalescing filter sight glass.	a.) Oil drain valve settings are not properly set.	a.) Check, and/or reset, flow control valves V31, V36, V38, and V39.
	b.) Metering valve orifice blocked.	b.) Close all metering valves. Then open each valve completely and drain it individually.
7.) High oil carryover out of compressor.	a.) Adsorber charcoal saturated.	a.) Ensure oil separation system is functioning properly.
8.) Compressor oil level is "LOW".	a.) Leak in oil piping or seals.	a.) Locate leaks and repair, accordingly.
9.) Oil/gas leaks into LOW side piping when the system is shut down; higher than normal Suction pressure indicated on PI-1.	a.) Check valve V212 is not seating properly.	a.) Remove and thoroughly clean valve; check sealing surfaces for scratches and imperfections.
10.) Compressor shuts down on high discharge temperature.	a.) Inadequate cooling water supply.	a.) Check temperature and flow of water supply; check setting of valve V203.
11.) Compressor shuts down on HIGH discharge pressure, PT-11.	a.) Backpressure Regulator, V202, not set properly.	a.) Adjust regulator to a backpressure of 13.8 bar (200 psig).
	b.) Bypass valve located on customer piping not set correctly.	b.) Adjust regulator to maintain 17.2 bar (250 psig) on the HIGH side of system.
	c.) Pressure switch PT-11 not functioning properly.	c.) Evaluate, and if necessary reset, pressure switch PT-11.
12.) Compressor shuts down on LOW suction pressure, PT-12.	a.) Inadequate pure helium gas make up supply.	a.) Evaluate gas management system; verify that compressor is adequately charged with helium prior to start-up.
	b.) Pressure switch PT-12 not functioning properly.	b.) Evaluate, and if necessary reset, pressure switch PT-12.
13.) Compressor vibration is excessive.	a.) Compressor skid base not properly shimmed and leveled.	a.) Re-shim and re-level the compressor's skid base.

5.1 Check Out of Compressor Motor Protection System, TS-1

If the compressor will not operate in a normal manner and the compressor motor protection system is suspect, the following checks should be made:

A.) Check wiring connections to the motor-winding protective device and insure that all wiring connections are sound and correct.

B.) Connect a jumper wire between terminals TB 3/8 and TB 3/9, and try running the compressor. The compressor will not run; fault is not in the motor protection system. If the compressor runs, shut it off and proceed to determine why the motor-winding protective device, TS1, is not allowing it to run.

C.) Disconnect the leads between the motor-winding protective device, TS1 and sensor terminals; and, using a 6-Volt maximum ohmmeter, check resistance of the sensors. The resistance between the common post "C" and each sensor terminal should be between 75 ohms with the motor cool and 105 ohms with the motor hot. If resistance of any of the sensors is not within the specified resistance readings, then the screw compressor pump must be removed and replaced in accordance with the procedures in Section 4.5. Contact the field service representative for disposition of the removed screw compressor pump.

D.) If, 1.) The compressor runs with the jumper wire between TB 3/8 and TB 3/9, 2.) The resistance of the sensors is within limits, and 3.) The motor is not overheating or being overloaded, the motor-winding protective device, TS1, should be replaced.

NOTE: Motor winding protective device, TS1, is sealed unit. Do not attempt to disassemble it.

MODEL RS COMPRESSOR

APPENDICES

Appendix	Description
A	Equipment List - Compressor Assembly 8015983G140
B	Compressor Flow Diagram 8015730
C	Electrical Schematic 8015905
D	Installation / Interface Drawing 8015601
E	Wiring Diagram 8015906
F	Electrical Interface Drawing 8016097 (Customer Specific)
G	Control Cabinet Assembly 8015982 and Bill of Material
H	Starter Panel Wiring Diagram 8015909
I	Adsorber Maintenance Kit 8015436
J	Adsorber Carbon Repacking Procedure - Specification 35421040
K	Loading Valve Troubleshooting, Hartford Compressor
--	Service Bulletin Y-1110-0002-01
L	Oil Level Switch, Hartford Compressor
--	Service Bulletin Y-1100-0014-05
M	Optical Oil Level Sensor (LS-1), Hartford Compressor
--	Service Bulletin SB-21
N	Aeroquip Coupling Information (5400 Series)
O	Texas Instruments Motor Protector
P	Motor Protection Module, Hartford Compressor
--	Service Bulletin SB-22B
Q	Logbook Data Sheet - RS Series Compressor
R	MSDS - Heli-Lube 68 Lubricating Fluid
S	MSDS - Charcoal Activated Carbon
T	MSDS - Helium Gas (Compressed)
U	Compressor Operator Interface Terminal
V	Optical Oil Presence Sensor (LS-2) Information

EQUIPMENT LIST

"CE" MODEL RS HELIUM COMPRESSOR

University of Cologne

Tag No.	Item Description	Linde Part Number	Manufacturer	Remarks
C1	Oil Charge Connector (1/2" size at E20)	0511525	Aeroquip (5400 Series)	Adapter - Linde P/N 0510178
C2	Evacuation & Charging Port Connector (1/2" size at E21)	0511525	Aeroquip (5400 Series)	Adapter - Linde P/N 3592354
C3	Test Port Connector (1/4" size at E21/E28)	0511524	Aeroquip (5400 Series)	Adapter - Linde P/N 3762029P3
C4	Test Port Connector (1/4" size at E27)	0511524	Aeroquip (5400 Series)	Adapter - Linde P/N 3762029P3
C5	Evacuation Port Connector (1/2" size at E27 & F1)	0511525	Aeroquip (5400 Series)	Adapter - Linde P/N 3592354
C6	Gas Discharge (1" size at F1)	0511585	Aeroquip (5400 Series)	Adapter - Linde P/N 0512116
E-20	Rotary Screw Compressor Pump	35452145 P5	Dunham-Bush	Model RS 400V / 50Hz / 3Ph
E-21	Oil Coalescing Filter	8015737 G1	Linde Cryogenics	Stage 1 & 2
E-24/E-22	Oil Cooler/Aftercooler	204955	ITT Industries	
E-27	Adsorber	8015724	Linde Cryogenics	
E-28	Oil Coalescing Filter	8015737 G2	Linde Cryogenics	Stage 3 & 4
ETM-1	Elapsed Time Meter	203134	ENM	
F-1	Discharge Filter	35421646	AMF-CUNO	Element - Linde P/N 35421647
F-21	Mist Return Filter	204500	Swagelok	
F-26	Mist Return Filter	204500	Swagelok	
F-28	Mist Return Filter	204500	Swagelok	
F-29	Mist Return Filter	204500	Swagelok	
LS-1	Oil Level Switch	204612	----------	Compressor OEM
LS-2	Oil Level Switch	205117	Henry Mfg.	
OP-1	Operator Control Panel	204963	EZAutomation	
PI-1	Suction Pressure Gauge	204771	ENFM	
PI-2	Discharge Pressure Gauge	204772	ENFM	
PT-11	Discharge Pressure Transmitter 0-300 PSIA	205030	Endress + Hauser	
PT-12	Suction Pressure Transmitter 0-30 PSIA	205029	Endress + Hauser	

Compressor Assembly: 8015983G140

EQUIPMENT LIST

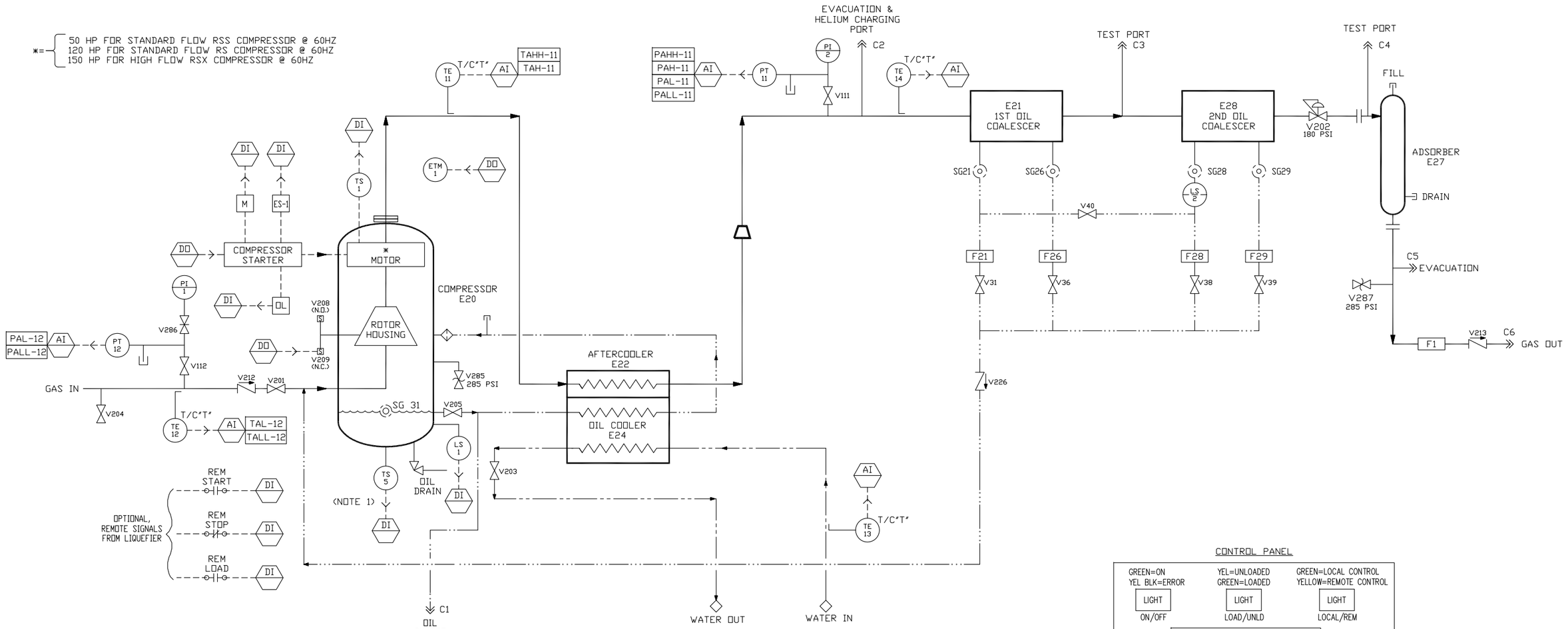
"CE" MODEL RS HELIUM COMPRESSOR

University of Cologne

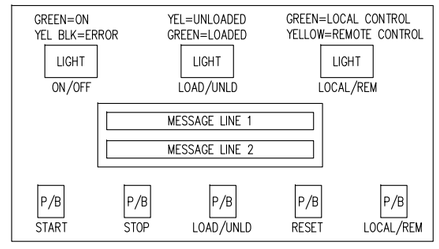
Tag No.	Item Description	Linde Part Number	Manufacturer	Remarks
SG-21	Oil Sight Glass	0578378	Lube Devices	
SG-26	Oil Sight Glass	0578378	Lube Devices	
SG-28	Oil Sight Glass	0578378	Lube Devices	
SG-29	Oil Sight Glass	0578378	Lube Devices	
SG-31	Compressor Pump Sight Glass	204939	----------	Compressor OEM
TS-1	Motor Winding Temperature Switch	205190	----------	Compressor OEM
TS-5	Oil Thermostat Temperature Switch	----------	----------	Compressor OEM
V-31	Oil Drain Metering Valve	201805	Swagelok	
V-36	Oil Drain Metering Valve	201805	Swagelok	
V-38	Oil Drain Metering Valve	201805	Swagelok	
V-39	Oil Drain Metering Valve	201805	Swagelok	
V-40	LS-2 Oil Sensor Calibration Valve	0511478	Swagelok	
V-111	Pressure Snubber	0513474	Mid-West Instrument	
V-112	Pressure Snubber	0513474	Mid-West Instrument	
V-201	Suction Service Valve	----------	Mueller A-15589	Compressor OEM
V-202	Back Pressure Regulator	0540261	Parker	
V-203	Needle Valve	204563	Deltrol Fluid Products	
V-204	Suction Drain Valve	0513486	Jamesbury	
V-205	Needle Valve	204563	Deltrol Fluid Products	
V-208	Unload Solenoid Valve	----------	----------	Compressor OEM
V-209	Load Solenoid Valve	----------	----------	Compressor OEM
V-212	Suction Check Valve	0515479	Crane	
V-213	Discharge Check Valve	0515458	Generant	
V-226	Oil Drain Check Valve	201806	Swagelok	
V-285	Relief Valve - 285 PSIG	206309	Flow-Safe	CE
V-286	Gauge Protector	0541083	Circle-Seal	
V-287	Relief Valve - 285 PSIG	206309	Flow-Safe	CE

Compressor Assembly: 8015983G140

*= 50 HP FOR STANDARD FLOW RSS COMPRESSOR @ 60HZ
120 HP FOR STANDARD FLOW RS COMPRESSOR @ 60HZ
150 HP FOR HIGH FLOW RSX COMPRESSOR @ 60HZ



CONTROL PANEL



LEGEND

AI - ANALOG INPUT
DI - DISCRETE INPUT
DO - DISCRETE OUTPUT
P/B - PUSHBUTTON

GAS
OIL
OIL/GAS
WATER
ELECTRICAL
FLANGE CONNECTION

CONTROL PANEL
PANEL MOUNTED
LOCAL
LOCATED BEHIND PANEL
GAUGE PROTECTOR
MANUAL VALVE
RELIEF VALVE
CHECK VALVE

SOLENOID VALVE
BACK PRESSURE REGULATOR
SELF SEALING COUPLING
OIL SIGHT GLASS
COMPRESSION FITTING
COMPRESSION FITTING WITH ORIFICE
PLUG
C - CONNECTION PORT

E - EQUIPMENT
ES - POWER QUALITY SWITCH
ETM - ELAPSED TIME METER
F - FILTER
HTR - HEATER
LS - LEVEL SWITCH
N.C. - NORMALLY CLOSED
N.O. - NORMALLY OPEN
OL - OVERLOAD RELAY
PI - PRESSURE INDICATOR
PT - PRESSURE TRANSMITTER
SG - SIGHT GLASS
TE - TEMPERATURE SENSOR
T/C - THERMOCOUPLE
TS - TEMPERATURE SWITCH
V - VALVE
M - MOTOR CONTROLLER, CONTACTOR

NOTES:
1. TS-5 ONLY ON RS/RSX COMPRESSOR. (DISCONTINUED AFTER FEB. 01, 2012)

NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
2	REVISED PER RFC #13-962	FM	FM		NC	May 15, 13
1	REVISED PER RFC #08-849	FM	FM		WU	11/24/08
0	RELEASED PER DEO 10287	BC	MAK		WGC	6/10/04

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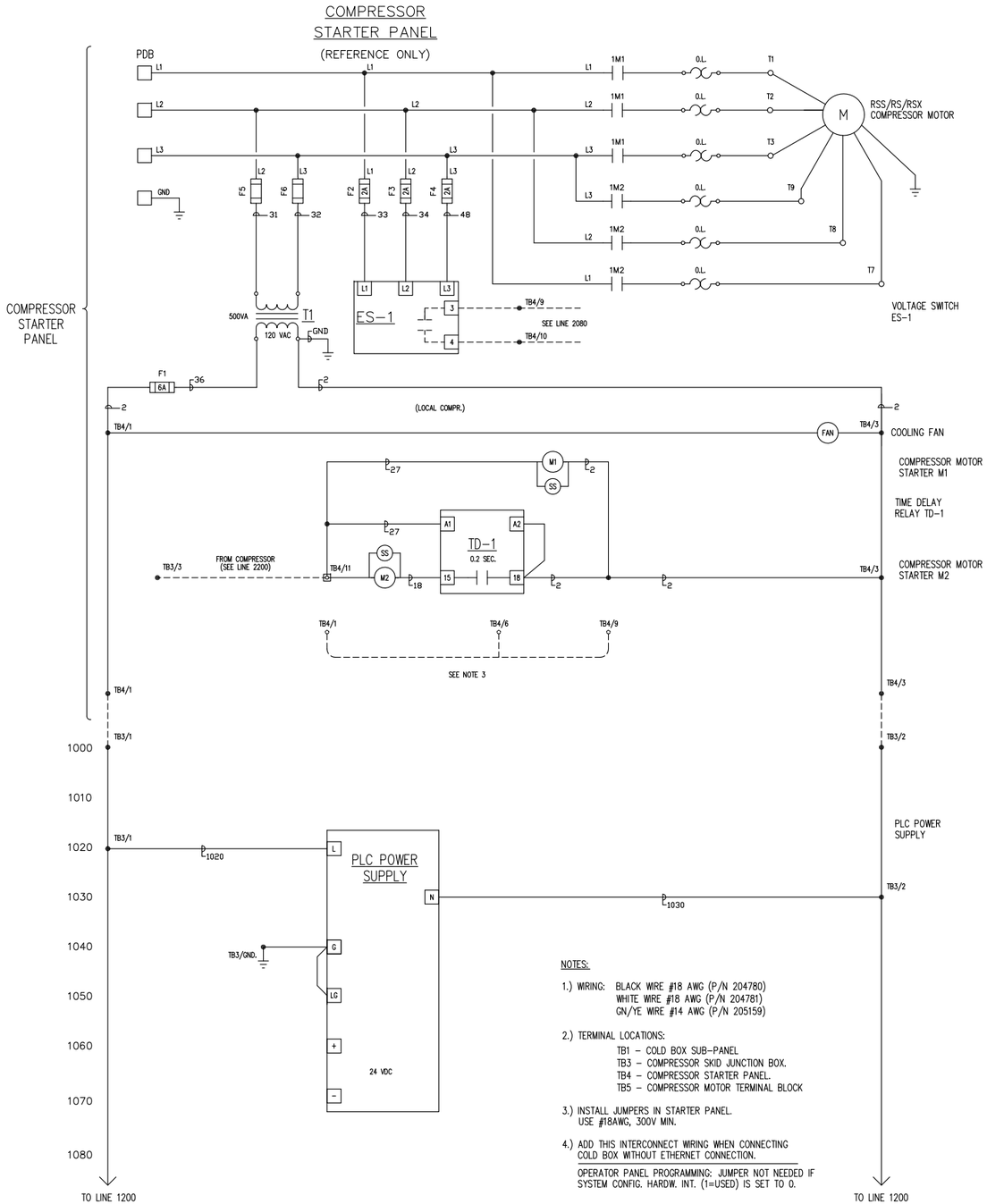
DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONAL ± ANGULARMACH ± 0'-30' BEND ± 2'
TWO PLACE DECIMAL ± THREE PLACE DECIMAL ± FINISHED SURFACE RMS BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

FLOW DIAGRAM MODEL RSS/RS/RSX COMPRESSOR W/DATA ACQUISITION CONTROL

SIZE B | DWG. NO. 8015730 | REV. 2
CAD FILE NO. 8015730 | SCALE NONE | SHEET 1 OF 1



NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
1	REVISED PER RFC #13-973	FM	FM	FB	NC	Feb 06, 14
0	RELEASED PER DEO #10408	FM	FM	DD	WU	Feb 26, 10

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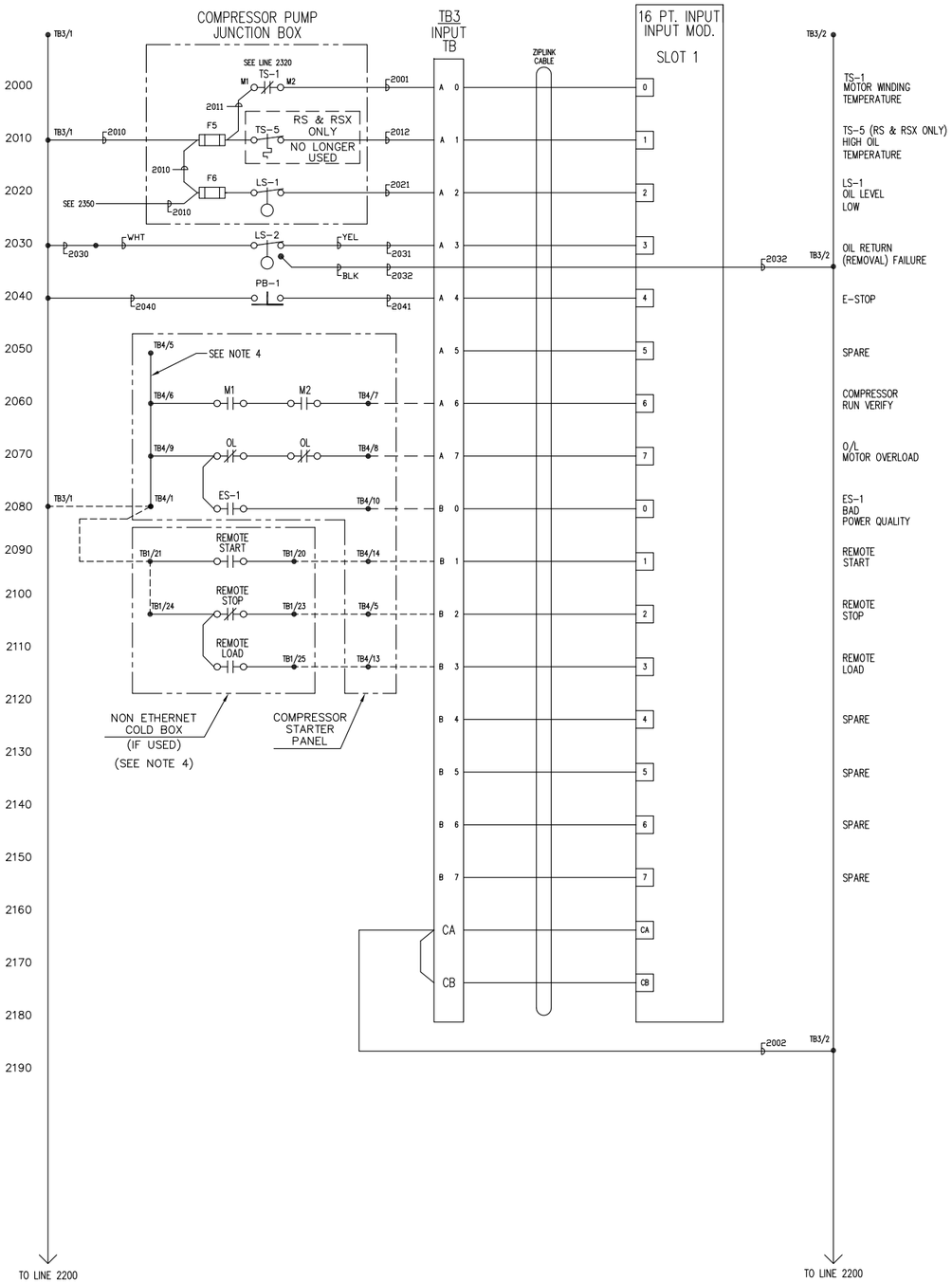
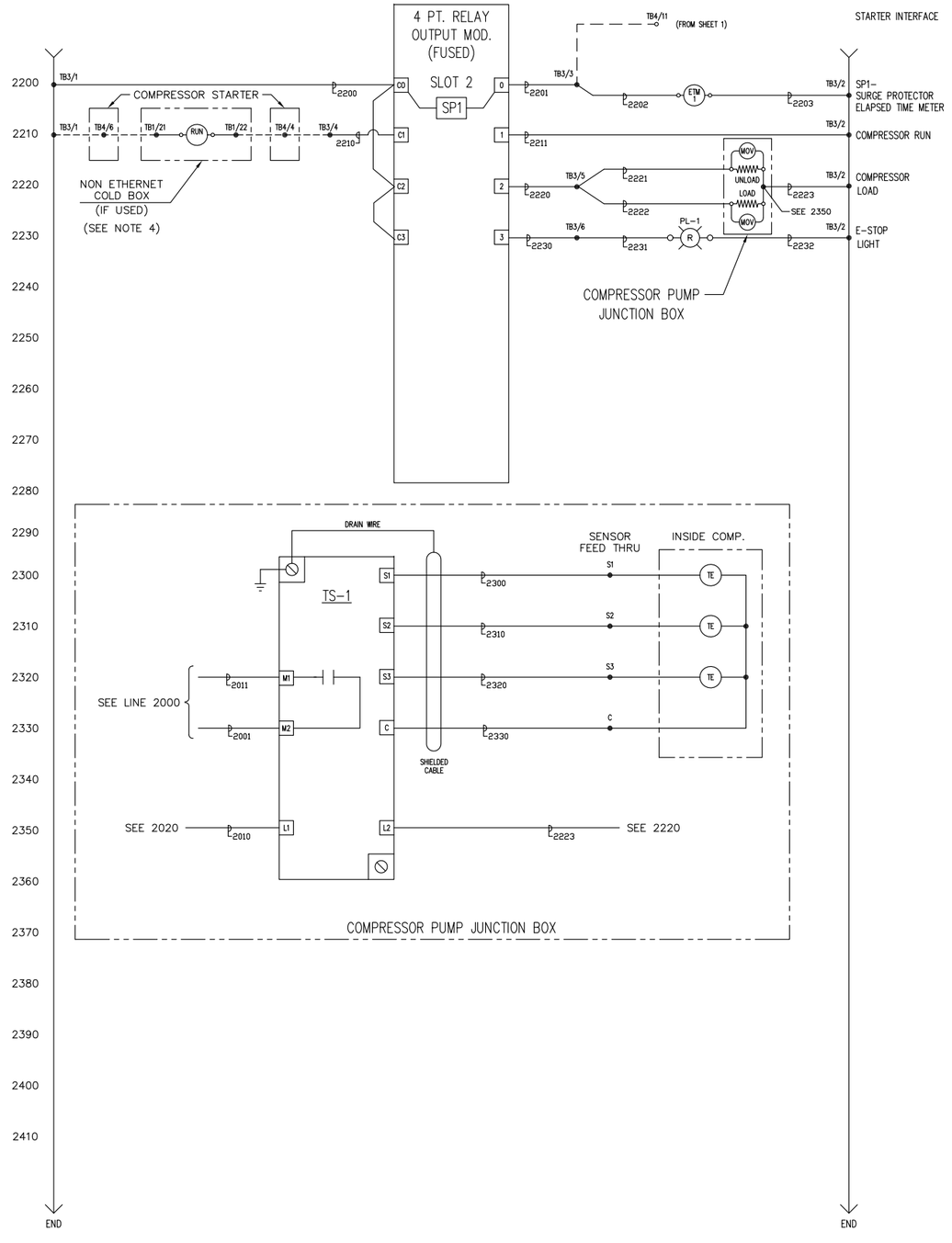
THE LINDE GROUP

UNLESS OTHERWISE SPECIFIED		REMOVE ALL BURRS
DIMENSIONS ARE IN INCHES.	TWO PLACE DECIMAL ±	DO NOT SCALE THIS DRAWING
TOLERANCES:	THREE PLACE DECIMAL ±	
FRACTIONAL ±	FINISHED SURFACE RMS	THIRD ANGLE PROJECTION
ANGULARMACH ± 0'-30' BEND ± 2'	BREAK CORNERS IN: OUT:	

RSS/RS/RSX COMPRESSOR ELECTRICAL SCHEMATIC 120 VAC CONTROL, PART WIND STARTING PLC CONTROL

SIZE	DWG. NO.	REV.
B	8015905	1
CAD FILE NO. 8015905/905s1	SCALE NONE	SHEET 1 OF 3





SEE SHEET 1 FOR REVISIONS

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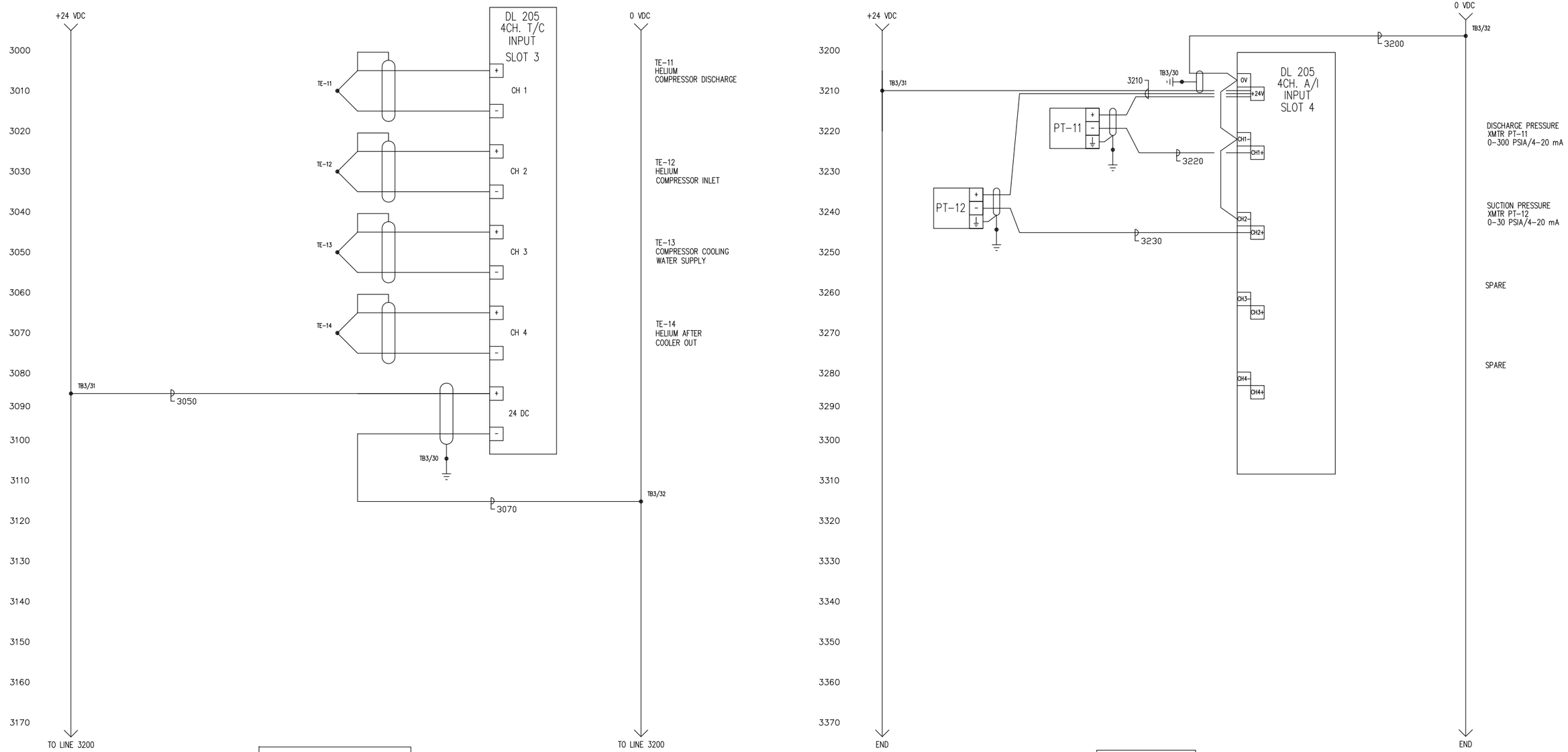
DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONAL ±
ANGULARMACH ± 0'-30' BEND ± 2°
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

RSS/RS/RSX COMPRESSOR ELECTRICAL SCHEMATIC 120 VAC CONTROL, PART WIND STARTING PLC CONTROL

SIZE	DWG. NO.	REV.
B	8015905	1
CAD FILE NO. 8015905/905s2	SCALE NONE	SHEET 2 OF 3



T/C MODULE
JUMPER CONFIG.

0 ○—○ 1 } 4 CHANNELS

2 ○ ○
3 ○—○ 4 } T/C TYPE "T"
5 ○—○

6 ○ ○
7 ○—○ } UNITS IN "C"

A/I MODULE
JUMPER CONFIG.
JMP1 = ON
JMP2 = OFF

TO SELECT TWO
CHANNELS

SEE SHEET 1 FOR REVISIONS

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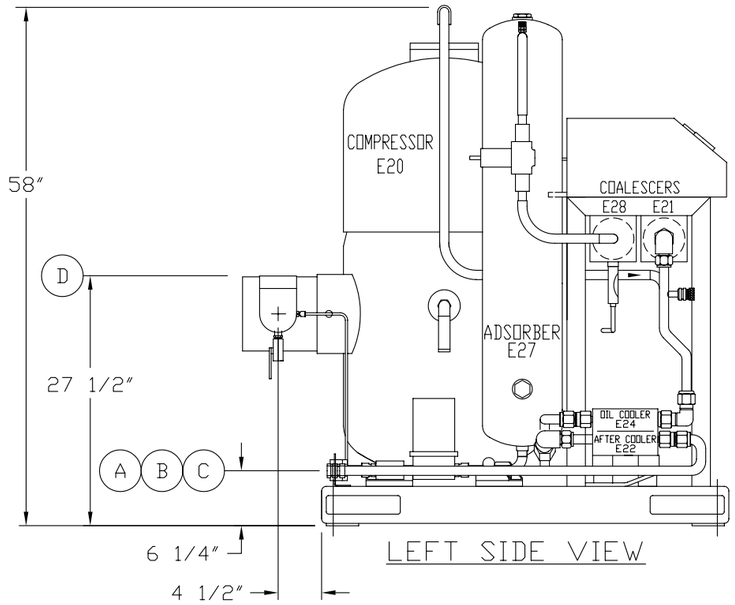
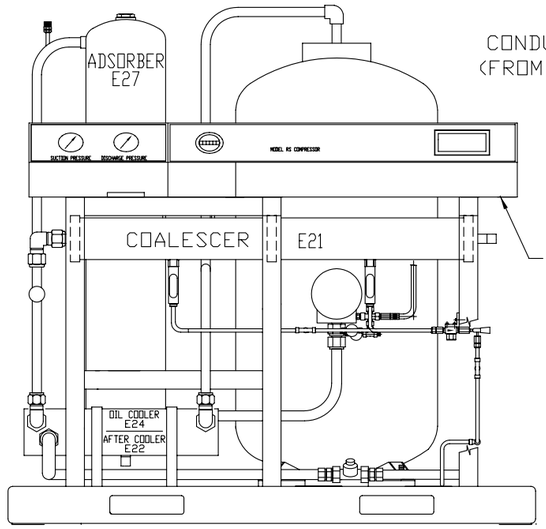
ANGULARMACH ± 0'-30' BEND ± 2°
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

RSS/RS/RSX COMPRESSOR ELECTRICAL SCHEMATIC 120 VAC CONTROL, PART WIND STARTING PLC CONTROL

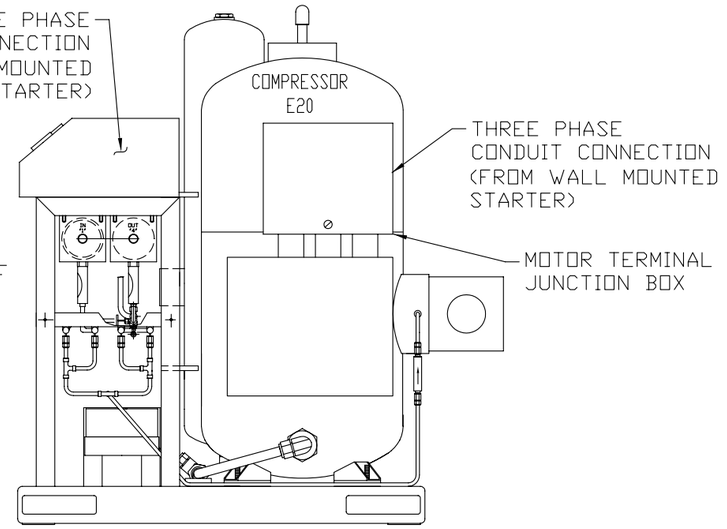
SIZE	DWG. NO.	REV.
B	8015905	1
CAD FILE NO. 8015905/905s3	SCALE NONE	SHEET 3 OF 3



LEFT SIDE VIEW



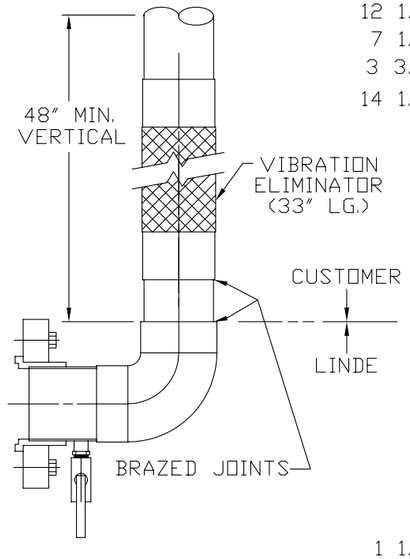
FRONT VIEW



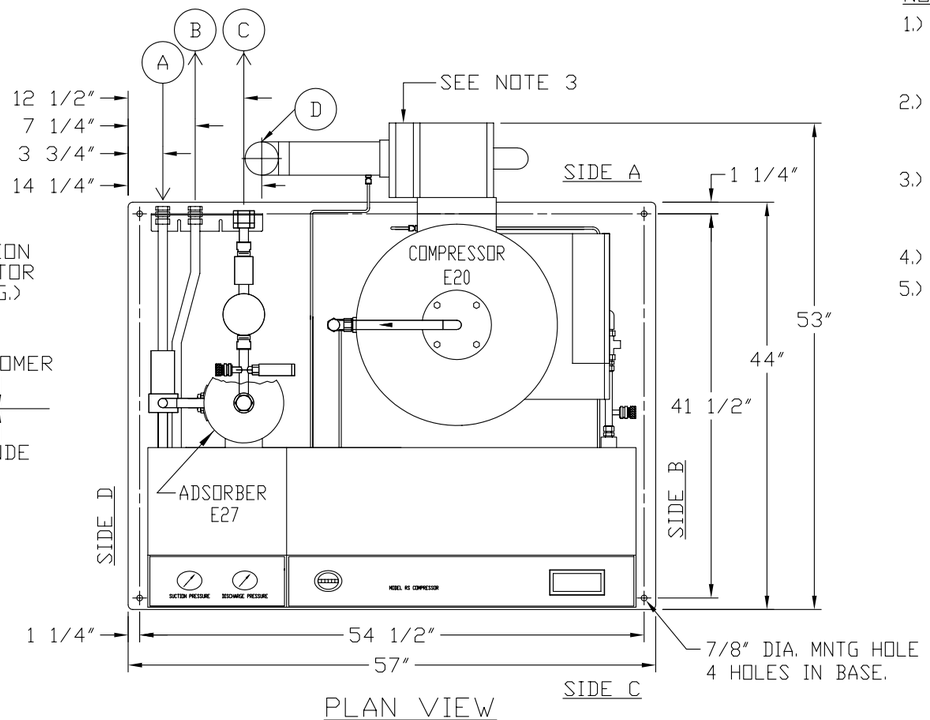
RIGHT SIDE VIEW

DETAIL "A"
REF. PIPING CONNECTIONS (A) & (B)
SCALE = 1/8

DETAIL "B"
REF. PIPING CONNECTION (C)
SCALE = 1/8



DETAIL "C"
REF. PIPING CONNECTION (D)
SCALE = 1/8



PLAN VIEW

NOTES:

1.) CLEARANCES RECOMMENDED:
SIDE A-24 INCHES SIDE C-36 INCHES
SIDE B-30 INCHES SIDE D-24 INCHES

2.) PIPING CONNECTORS SUPPLIED BY LINDE UNLESS NOTED OTHERWISE (PACKAGED AND SHIPPED SEPARATELY). TUBING REQUIRED FOR INSTALLATION SUPPLIED SEPARATELY.

3.) THE SUCTION CHECK VALVE MUST BE INSTALLED WITH THE PIVOT ROD VERTICAL AND THE FLAPPER SPRINGS ON THE DOWNSTREAM SIDE (COMPRESSOR SIDE) OF THE VALVE.

4.) WEIGHT: APPROXIMATELY 2500 LBS.

5.) SEE COMPRESSOR NAMEPLATE FOR ELECTRICAL VOLTAGE REQUIREMENTS.

PIPING CONNECTION TABLE		
LETTER	FUNCTION	CONNECTION
(A)	WATER INLET	1″ OD TUBE FITTING SEE DETAIL A
(B)	WATER OUTLET	1″ OD TUBE FITTING SEE DETAIL A
(C)	HELIUM OUTLET (HIGH PRESSURE)	1″ MALE COUPLING HALF AEROQUIP 5400-S2-16 SEE DETAIL B
(D)	HELIUM INLET (LOW PRESSURE)	4 1/8″ OD COPPER SOCKET CONNECTION SEE DETAIL C

NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
2	REVISED PER RFC #08-849	FM	FM		WU	11/24/08
1	REVISED PER RFC #04-729	BC	WGC		WGC	4/2/04
0	RELEASED PER DEO #10050	SG	DD	MAK	JBU	3/1/01

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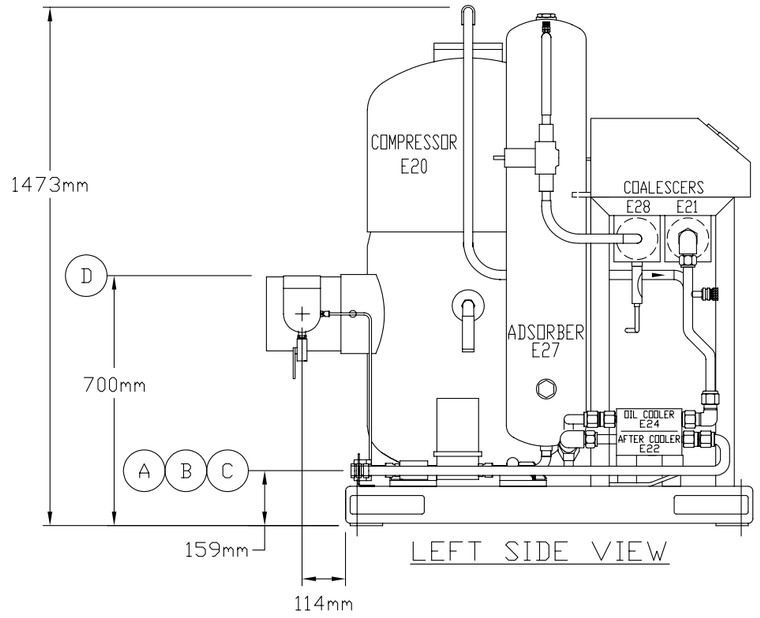
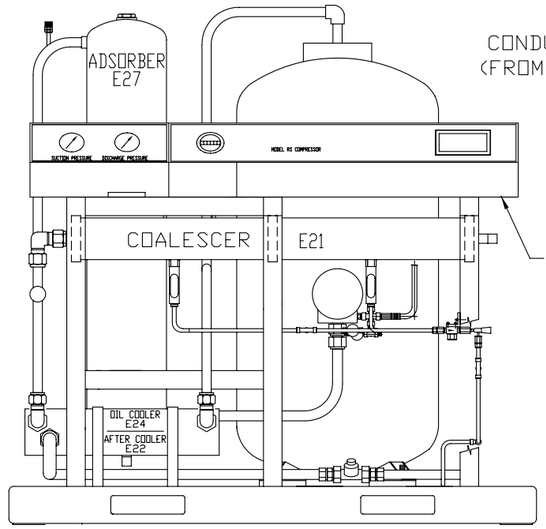
TWO PLACE DECIMAL ± THREE PLACE DECIMAL ± FINISHED SURFACE RMS BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

INSTALLATION/INTERFACE MODEL RS/RSX COMPRESSOR IMPERIAL UNITS

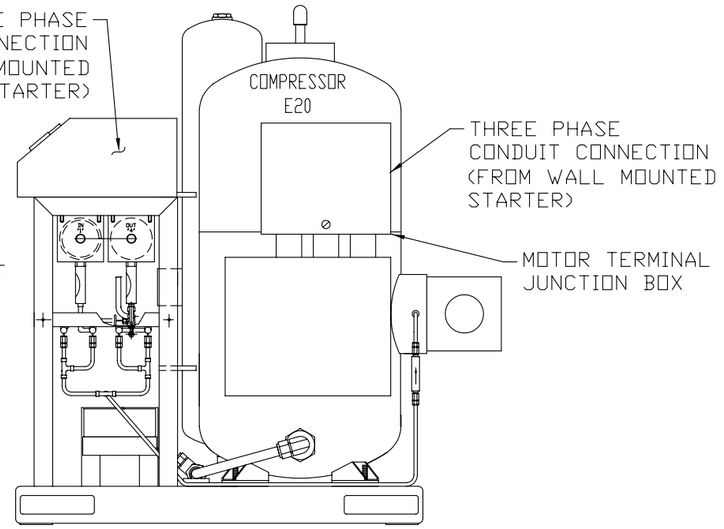
SIZE B | DWG. NO. 8015601 | REV. 2
CAD FILE NO. 8015601/601s1 | SCALE 1/16=1'-0" | SHEET 1 OF 2



LEFT SIDE VIEW



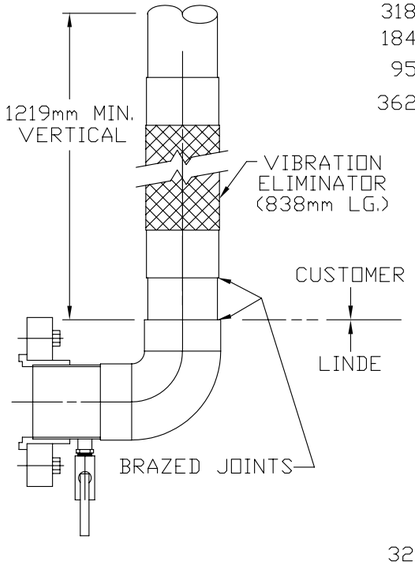
FRONT VIEW



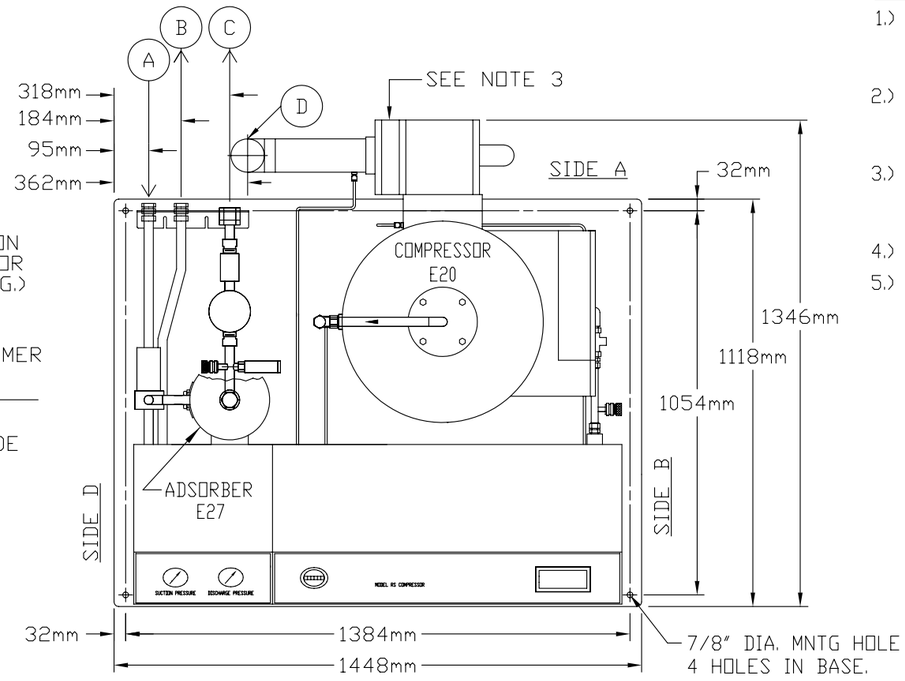
RIGHT SIDE VIEW

DETAIL "A"
REF. PIPING CONNECTIONS (A) & (B)
SCALE = 1/8

DETAIL "B"
REF. PIPING CONNECTION (C)
SCALE = 1/8



DETAIL "C"
REF. PIPING CONNECTION (D)
SCALE = 1/8



PLAN VIEW

SIDE C

NOTES:

1.) CLEARANCES RECOMMENDED:
SIDE A-610mm SIDE C-914mm
SIDE B-762mm SIDE D-610mm

2.) PIPING CONNECTORS SUPPLIED BY LINDE UNLESS NOTED OTHERWISE (PACKAGED AND SHIPPED SEPARATELY). TUBING REQUIRED FOR INSTALLATION SUPPLIED SEPARATELY.

3.) THE SUCTION CHECK VALVE MUST BE INSTALLED WITH THE PIVOT ROD VERTICAL AND THE FLAPPER SPRINGS ON THE DOWNSTREAM SIDE (COMPRESSOR SIDE) OF THE VALVE.

4.) WEIGHT: APPROXIMATELY 1135 Kg.

5.) SEE COMPRESSOR NAMEPLATE FOR ELECTRICAL VOLTAGE REQUIREMENTS.

PIPING CONNECTION TABLE		
LETTER	FUNCTION	CONNECTION
(A)	WATER INLET	1" OD TUBE FITTING SEE DETAIL A
(B)	WATER OUTLET	1" OD TUBE FITTING SEE DETAIL A
(C)	HELIUM OUTLET (HIGH PRESSURE)	1" MALE COUPLING HALF AEROQUIP 5400-S2-16 SEE DETAIL B
(D)	HELIUM INLET (LOW PRESSURE)	4 1/8" OD COPPER SOCKET CONNECTION SEE DETAIL C

SEE SHEET 1 FOR REVISIONS

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Tulsa, Oklahoma U.S.A.

Linde Engineering

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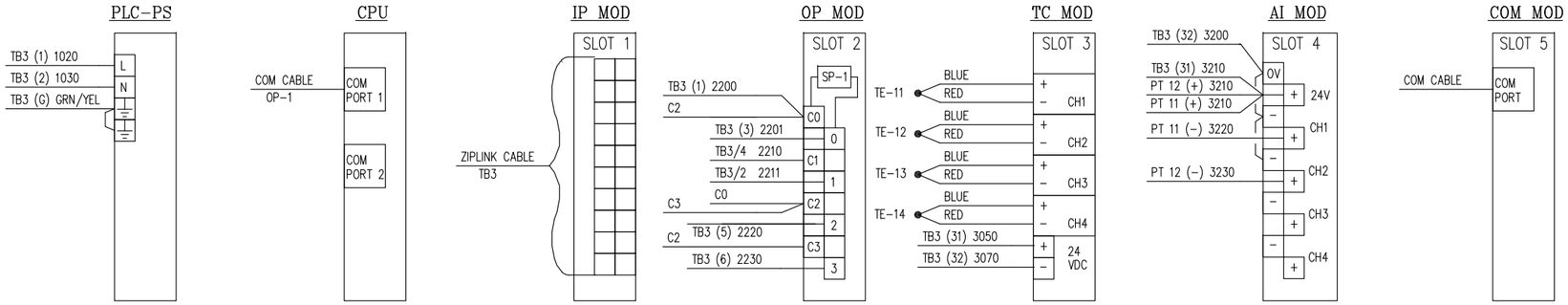
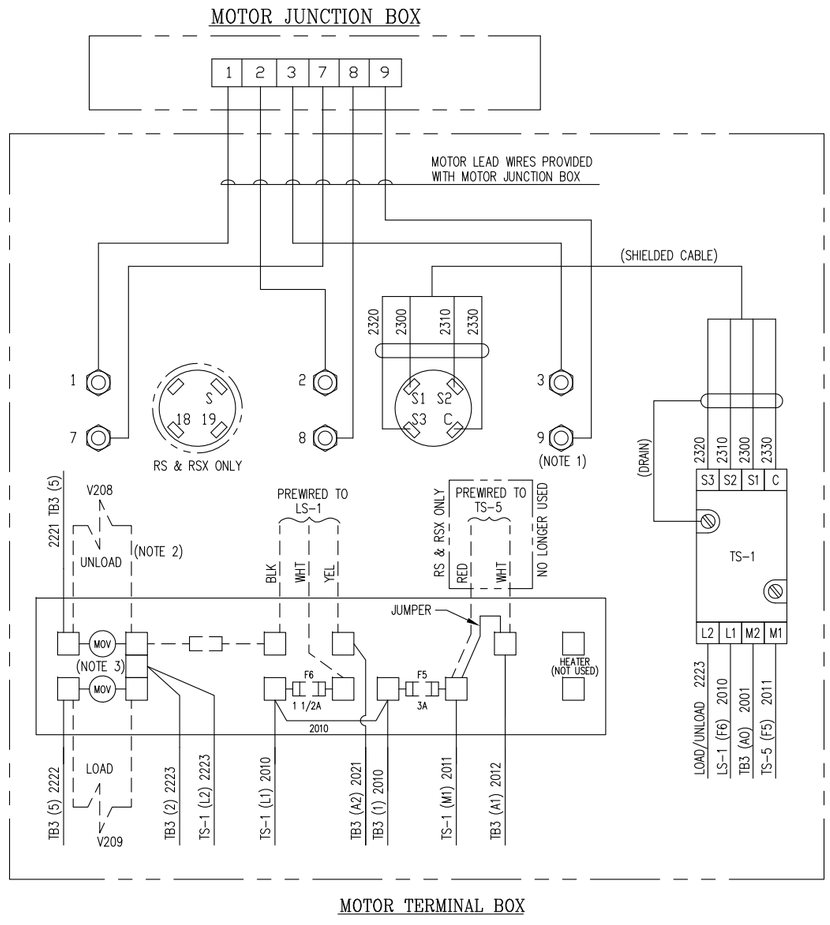
TOLERANCES:
FRACTIONAL ±
ANGULARMACH ± 0'-30' BEND ± 2'
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:

REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

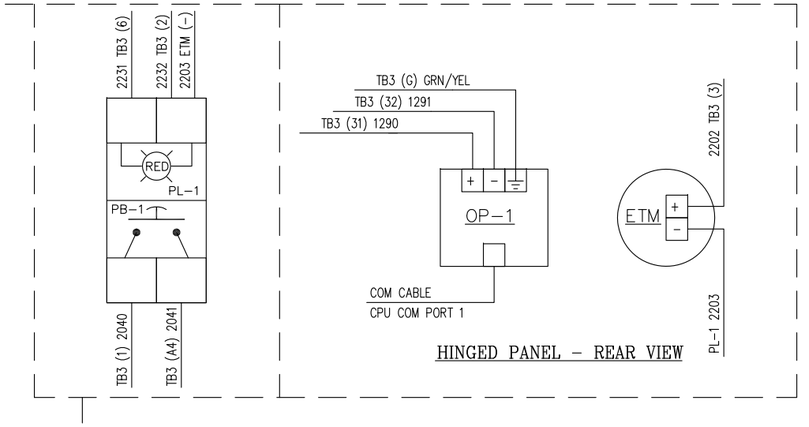
INSTALLATION/INTERFACE MODEL RS/RSX COMPRESSOR METRIC UNITS

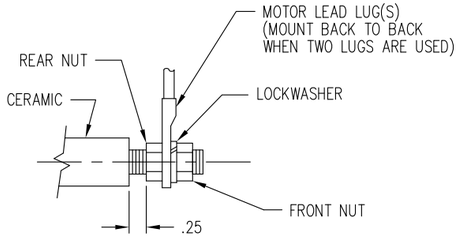
SIZE	DWG. NO.	REV.
B	8015601	2
CAD FILE NO. 8015601/601s2	SCALE 1/16=1'-0"	SHEET 2 OF 2





MOTOR TERMINAL BOX

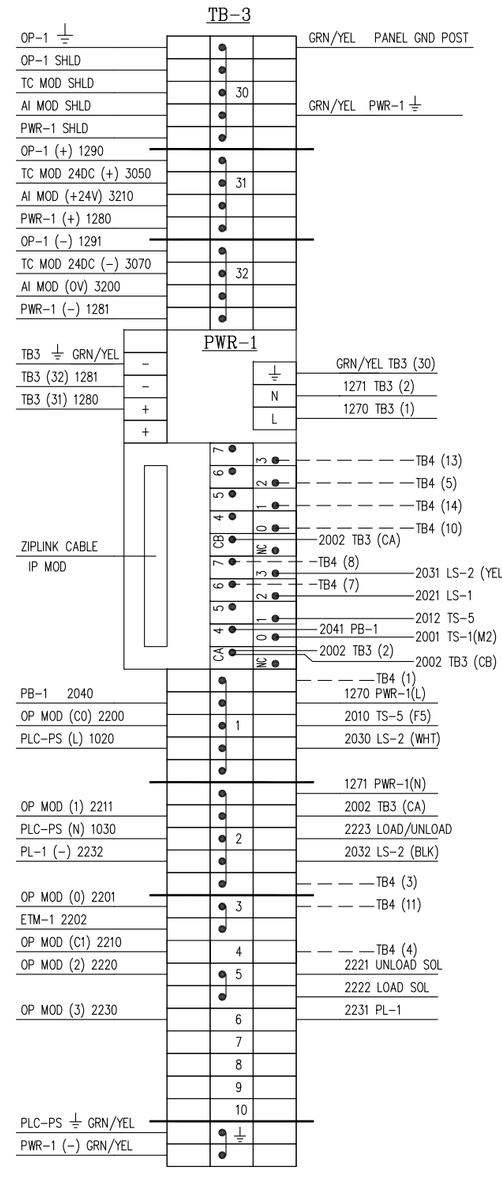




DETAIL "A"
TYPICAL 6 PLC.
(SEE NOTE 1)

NOTES:

1) HOLD REAR NUT STILL WHILE SECURING FRONT NUT. DO NOT EXCEED 8 FT-LB TORQUE! SEE DETAIL "A".
2) - - - - - - - - LINE DENOTES EXISTING PRE-WIRED COMPONENTS.
3) LOCATE VARISTOR FOR V208 AND V209 IN MOTOR TERMINAL BOX, INSULATE VARISTOR LEADS WITH HEATSHRINK AND INSERT INTO SAME FEMALE QUICK-DISCONNECTS AS WIRING FROM TB3.
4) WIRE, #18AWG 600V WHITE (NEUTRAL), WIRE, #18AWG 600V BLACK (POWER), UNLESS OTHERWISE SPECIFIED.



NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
1	REVISED PER RFC #13-973	FM	FM		NC	Feb 06, 14
0	RELEASED PER DEO #10408	FM	FM	DD	WU	Feb 26, 10

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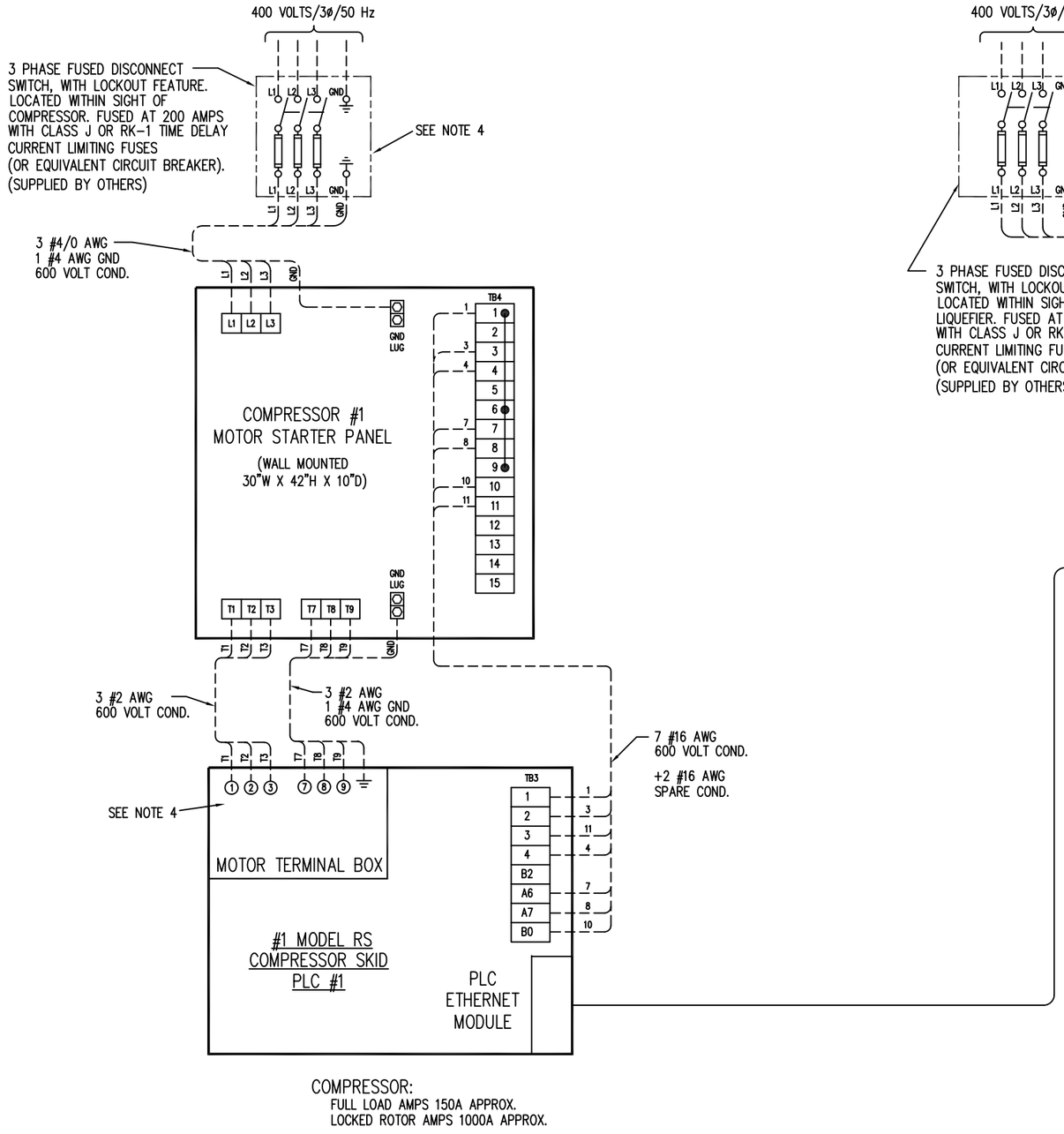
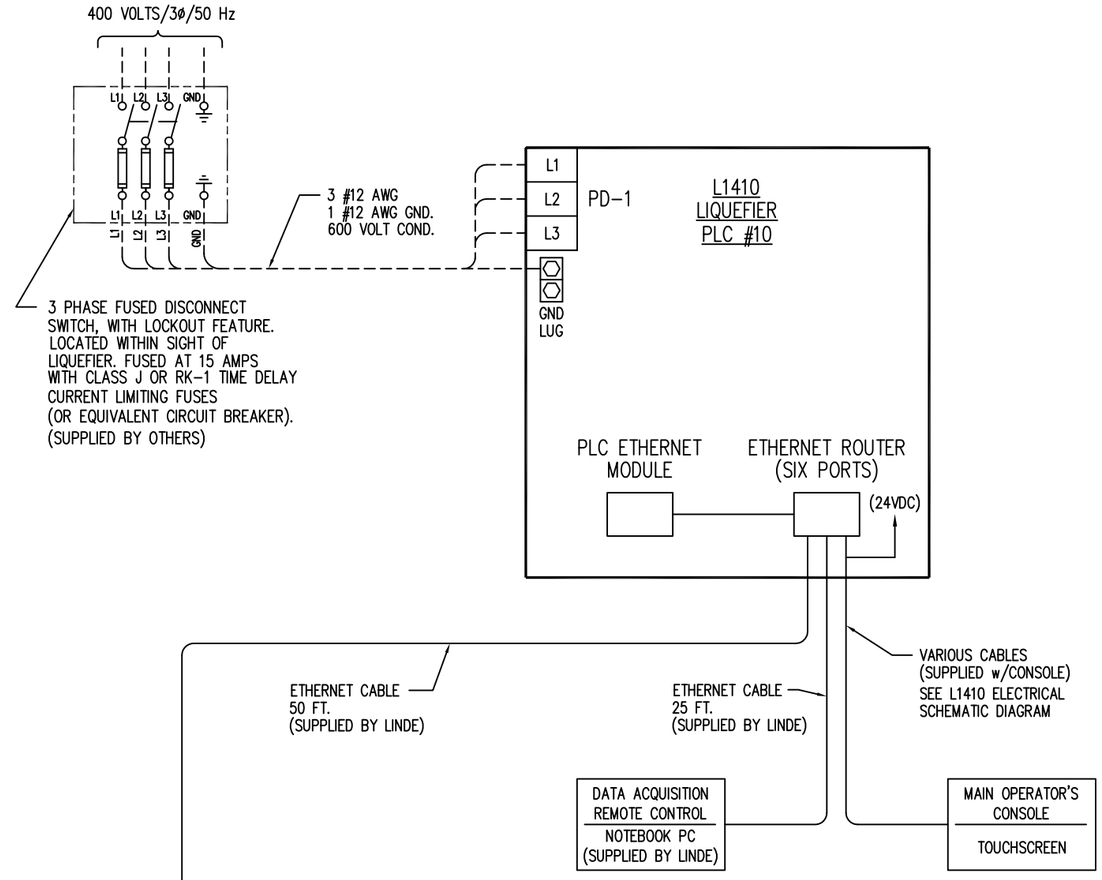
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

MODEL RSS/RS/RSX COMPRESSOR WIRING DIAGRAM 120V, P/W, PLC/DAQ CONTROL, CE

SIZE B | DWG. NO. 8015906 | REV. 1
CAD FILE NO. 8015906 | SCALE NONE | SHEET 1 OF 1





NOTES:

1) ALL ELECTRICAL DISCONNECTS AND WIRING SHOWN IS SUPPLIED AND INSTALLED BY THE CUSTOMER, UNLESS NOTED OTHERWISE.
2) GROUND CONNECTIONS SHALL COMPLY WITH APPLICABLE LOCAL ELECTRICAL CODES.
3) WIRE SIZE IS BASED ON N.E.C. TABLE 310-16 FOR WIRE TYPE THHN. SEE N.E.C. FOR OTHER TYPES OF WIRE. WIRE GROUNDING SIZE BASED ON N.E.C. TABLE 250-122 FOR COPPER WIRE.
4) CAUTION: SCREW-COMPRESSOR PUMP IS UNI-DIRECTIONAL AND MUST NOT BE ALLOWED TO ROTATE FOR ANY LENGTH OF TIME IN REVERSE DIRECTION. PROPER ROTATION IS ASSURED BY POWER MONITOR, PART OF THE STARTER PANEL.

NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
0	RELEASED PER DEO #10508	FM	FM		JF	Jul 13, 15

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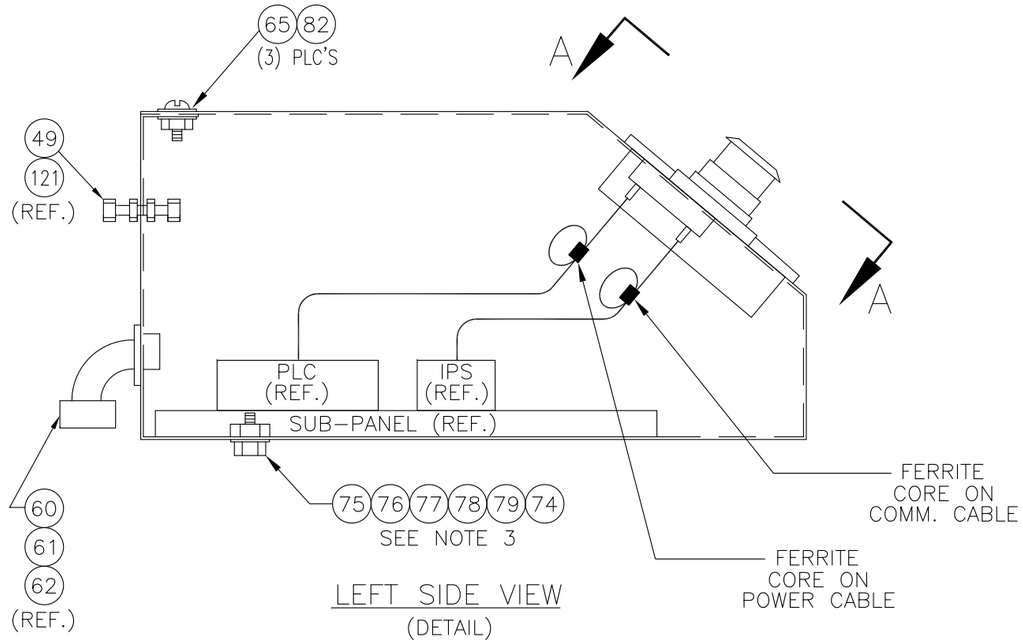
DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONAL ± ANGULARMACH ± 0'-30' BEND ± 2' | TWO PLACE DECIMAL ± THREE PLACE DECIMAL ± FINISHED SURFACE RMS BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

SYSTEM ELECTRICAL INTERFACE MODEL L1410 COLDBOX WITH RS COMPRESSOR

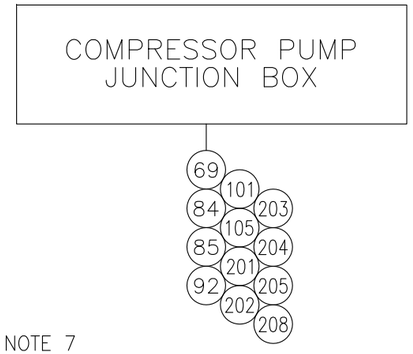
SIZE B | DWG. NO. 8016097 | REV. 0
CAD FILE NO. 8016097 | SCALE NONE | SHEET 1 OF 1



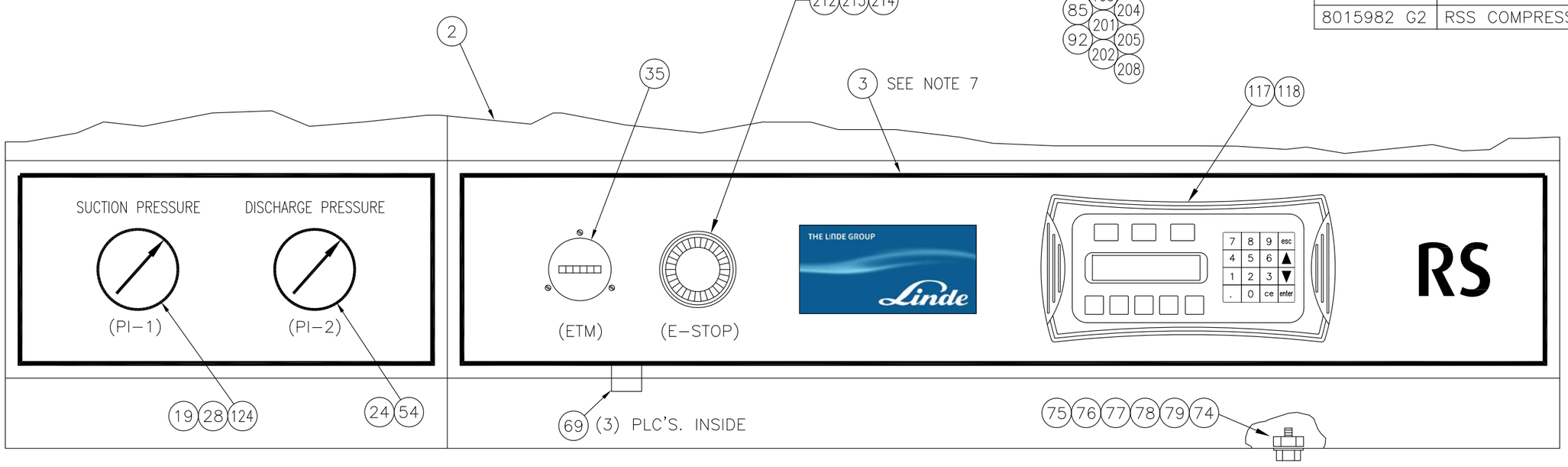
LEFT SIDE VIEW
(DETAIL)

NOTES:

1. TS-1 SUPPLIED WITH COMPRESSOR (FROM MANUFACTURER).
2. USE EPOXY (ITEM 90) TO SEAL PIPE THREADS.
3. DRILL & TAP 1/4-20 HOLE IN PANEL SUPPORT FRAME FOR ITEM 80. CONNECT TO ITEM 75 WITH ITEM 74.
4. TWO FERRITE CORES ARE FURNISHED WITH ITEM 117 (PANEL).
5. CABLE FOR ETHERNET MODULE PROVIDED WITH THE COMMUNICATION HARDWARE.
6. WIRING DIAGRAM DWG 8015728 AND ELECTRICAL SCHEMATIC DWG 8015729 TO BE REFERENCED FOR ASSEMBLIES BUILT BEFORE JULY 2009.
   WIRING DIAGRAM DWG 8015906 AND ELECTRICAL SCHEMATIC DWG 8015905 TO BE REFERENCED FOR ASSEMBLIES BUILT AFTER JULY 2009.
7. REFER TO GROUP DESIGNATION TABLE FOR CORRECT DECAL PART NUMBER. APPLY DECALS APPROXIMATELY AS SHOWN.
8. ITEM 1, 0826033, TO BE INSTALLED IN COMPRESSOR MOTOR TERMINAL BOX, POSITION F5 (SEE 8015906).



GROUP	DESIGNATION	DECAL
8015982	RS COMPRESSOR	8015977
8015982 G1	RSX COMPRESSOR	8015978
8015982 G2	RSS COMPRESSOR	8015979



VIEW "A-A"

NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
1	REVISED PER RFC #14-984	FM	FM	JF	NC	Apr 29, 14
0	RELEASED PER DEO #10454	FM	FM		JF	Apr 03, 12

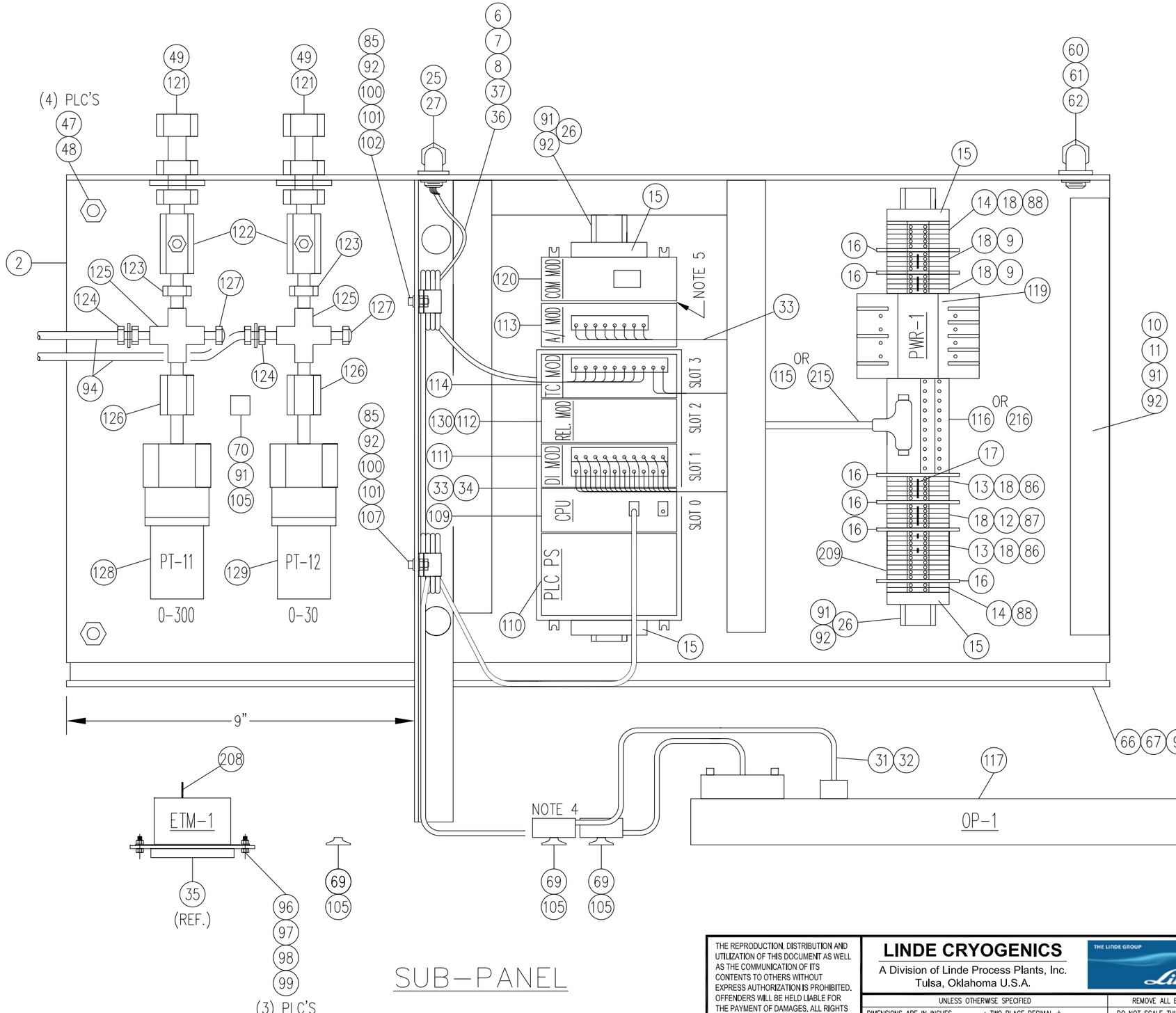
NEXT ASSEMBLY	USED ON

LINDE CRYOGENICS
A Division of Linde Process Plants, Inc.
Tulsa, Oklahoma U.S.A.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES. TWO PLACE DECIMAL ±
TOLERANCES: THREE PLACE DECIMAL ±
FRACTIONAL ± FINISHED SURFACE RMS
ANGULARMACH ± 0'-30' BEND ± 2' BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

CONTROL CABINET ASSEMBLY "CE"- RSS/RS/RSX COMPRESSOR DAQ CONTROLLED

SIZE B | DWG. NO. 8015982 | REV. 1
CAD FILE NO. 8015982/982s1 | SCALE NONE | SHEET 1 OF 2



T/C MODULE ITEM 114
JUMPER CONFIG.

0 — 1 } 4 CHANNELS

2 — 3 — 4 — 5 } T/C TYPE "T"

6 — 7 } UNITS IN "C"

A/I MODULE
JUMPER CONFIG.

JMP1 = ON
JMP2 = OFF

ETHERNET MODULE
SWITCH CONFIGURATION

DIP SWITCH BLOCK

OFF ● ● ● ● ● ● ● ● ●
ON ●
9 8 7 6 5 4 3 2 1 0

SEE SHEET 1 FOR REVISIONS

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THREE PLACE DECIMAL ±
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:

REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

CONTROL CABINET ASSEMBLY "CE" – RSS/RS/RSX COMPRESSOR DAQ CONTROLLED

SIZE	DWG. NO.	REV.
B	8015982	1
CAD FILE NO. 8015982/982s2	SCALE NONE	SHEET 2 OF 2

Item Production BOM

Linde Cryogenics

No.	Description	Revision	Drawing Number	Drawing Size
8015982	CABINET,PLC CONTROL "CE" RS	1	8015982	B

No.	Position ID	Description	Unit of Measure Co	Quantity	Type
0826033	0001	FUSE,3A 250V BUSS AGC-3	EA	1	Item
8015668	0002	PANEL,CONTROL RS/RSS/RSX COMP	EA	1	Item
8015977	0003	DECAL,CONTROL PANEL RS	EA	1	Item
3545467	0005	THERMOCOUPLE,TYP T RSS/RS/RSX	EA	1	Production BOM
0519990	0006	CLAMP,HOSE SS IDEAL 6464	EA	0	Item
0519860	0007	CLAMP,HOSE .25"-.625" SS	EA	0	Item
B0070348	0008	TUBE,SHRINK 0.1875"OD BLK	FT	1	Item
205161	0009	BLOCK,TERMINAL BLUE 25A, 600V	EA	8	Item
0818042	0010	COVER,WIREWAY 1" PANDUIT C1LG6	FT	4	Item
205097	0011	WIREWAY,1"WX2"H PANDUIT "CE"	FT	4	Item
205920	0012	BLOCK,TERM GRAY 20A 600V CE	EA	5	Item
205921	0013	BLOCK,TERM BLK 20A 600V CE	EA	15	Item
205084	0014	BLOCK,TERM,GND,GRN/YEL 10AWG	EA	7	Item
204748	0015	BRACKET,END 35MM DIN RAIL	EA	4	Item
204750	0016	SEPARATOR,TERM BLOCK 100/PKG	EA	7	Item
205922	0017	JUMP,TERM BLOCK MULTIPOLE	EA	1	Item
205118	0018	MARKER,TERM 5MM 0-100	ST	2	Item
204771	0019	GAUGE,CMPD 30-0-30 2.5"	EA	1	Item
204772	0024	GAUGE,CMPD 30-0-300 2.5"	EA	1	Item
205085	0025	CONN,STR RLF, 90DEG 0.5"	EA	1	Item
0828060	0026	USE 206647	FT	2	Item
0806068	0027	NUT,LOCK .5" THOMASBETT 141	EA	1	Item
0541083	0028	GAUGE,PROTECTOR .25FPT SS	EA	1	Item
B0818065	0031	CABLE,3/C #20AWG 600V SHLD	FT	6	Item
B0070358	0032	TUBE,SHRINK 0.375"OD BLK 4'LG	FT	1	Item
B0824065	0033	TUBE,SHRINK 0.25"OD	FT	2	Item
204784	0034	CABLE,1P #24AWG T+S 300V CE	FT	4	Item
203134	0035	METER,TIME 115VAC 50/60HZ	EA	1	Item
204974	0036	WIRE,T/C TYPE T, 24AWG	FT	25	Item
0827050	0037	HARNESS,CABLE SPIROBAND IBOCO	FT	5	Item
B0520646	0047	NUT,HEX 3/8-16 SS	EA	4	Item
B0521622	0048	WASH,LOCK .375" SS	EA	4	Item
B0521643	0049	WASH,LOCK .4375" SS	EA	2	Item
0518067	0054	CONN, 0.125"OD X 0.25FPT	EA	1	Item
0829445	0060	CONN,COND 90D 0.75" LIQTITE	EA	1	Item
0829464	0061	COND,FLEX .75" LIQTITE	FT	3	Item
203505	0062	CONN,COND 45D 0.75" LIQTITE	EA	1	Item
B0523014	0065	SCREW,PAN #10-32X.5" SS	EA	3	Item
205096	0066	WIREWAY,.5"WX1"H PANDUIT "CE"	FT	2	Item
204573	0067	COVER,WIREWAY .5" PANDUIT	FT	2	Item
0826056	0069	BASE,MTG FOR TY-WRAP	EA	5	Item
204618	0070	TY-RAP,MTG PLATE THOMAS&BETT	EA	1	Item
205159	0074	WIRE,#14AWG 600V GRN+YELL CE	FT	2	Item
204576	0075	BOLT,HEX 1/4-20UNCX.75" CU	EA	1	Item
204577	0076	WASH,LOCK .25" BR SPLIT	EA	2	Item

Item Production BOM

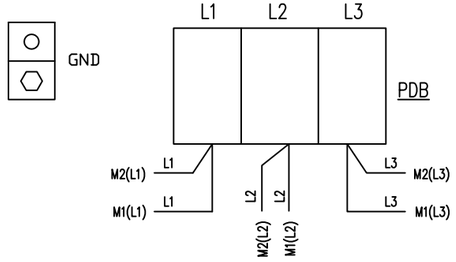
Linde Cryogenics

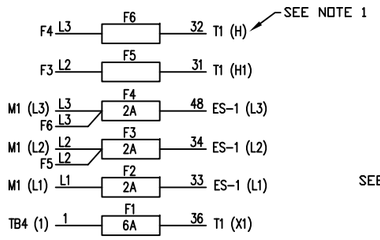
No.	Description	Revision	Drawing Number	Drawing Size		
B0520608	0077	NUT,HEX 1/4-20 BR	EA		1	Item
B0521608	0078	WASH,.25" BR	EA		1	Item
300349	0079	RING,TERM #12/10AWG .25"HOLE	EA		2	Item
204578	0080	POST,GROUNDING,1/4-20X1"	EA		1	Item
B0523639	0082	WASH,FL #10 SS	EA		3	Item
204738	0084	SCREW,PAN #6-32X1" SS	EA		2	Item
B0521641	0085	WASH,LOCK #6 SS	EA		6	Item
204780	0086	WIRE,#18AWG 600V BLK CE PVC	FT		120	Item
204781	0087	WIRE,#18AWG 600V WHT CE PVC	FT		20	Item
205186	0088	WIRE,#22AWG 300V GREEN+YELLOW	FT		6	Item
B0579391	0090	EPOXY,2 GRAM KIT LOCTITE	EA		5	Item
B0529910	0091	SCREW,PAN #6-32X.375" SS	EA		30	Item
B0523552	0092	WASH,FL #6 SS	EA		36	Item
35421316P66	0094	TUBE,SMLS 0.125"OD X.035W 304L	FT		6	Item
B0529058	0096	SCREW,PAN #4-40X.5" SS	EA		3	Item
B0523635	0097	WASH,FL #4 SS	EA		3	Item
B0521639	0098	WASH,LOCK #4 SS	EA		3	Item
B0520638	0099	NUT,HEX #4-40 SS	EA		3	Item
B0529940	0100	SCREW,PAN #6-32X.75" SS	EA		2	Item
B0520640	0101	NUT,HEX #6-32 SS	EA		6	Item
0806037	0102	CLIP,TUBE 5/8-#10 ADEL	EA		1	Item
0825054	0105	TY-RAP,CABLE 3.62"LG WHT NYLON	EA		50	Item
0806036	0107	CLIP,TUBE 3/4-#12 ADEL	EA		1	Item
204967	0109	CPU,30.4K WORDS W/16-LOOPS	EA		1	Item
204979	0110	BASE,PLC205 6 SLOT 110V	EA		1	Item
204958	0111	MODULE,INPUT 16PT 110VAC	EA		1	Item
204959	0112	MODULE,RELAY OUT 4PT	EA		1	Item
205042	0113	MODULE, A. 4 CH. 4-20 MA	EA		1	Item
204960	0114	MODULE,T/C 4 CH.	EA		1	Item
205789	0115	CABLE,ZIPLINK 1.6 FT LONG	EA		0	Item
205790	0116	CONNECTOR,MODULE TO ZIPLINK	EA		0	Item
204963	0117	PANEL,OPERATOR CONTROL	EA		1	Item
204964	0118	CABLE,COMM. PANEL TO PLC	EA		1	Item
204657	0119	SUPPLY,POWER 24VDC 2.1A	EA		1	Item
204980	0120	MODULE,PLC205 ETHERNET 10 BASE	EA		1	Item
205043	0121	CONN,TUBE BULKHEAD 0.25" OD	EA		2	Item
0513474	0122	VALVE,VARIDAMP .25IPS	EA		2	Item
0510915	0123	NIPPLE,HEX BR .25NPT X 1.375"	EA		2	Item
0518069	0124	CONN, 0.125"OD X 0.25MPT	EA		3	Item
205044	0125	CROSS,PIPE CONN. .25"FT BRASS	EA		2	Item
203238	0126	ADAP,0.5FPTx0.25MPT BR	EA		2	Item
0511019	0127	PLUG,HEX .25NPT BR CAJON B-4-P	EA		2	Item
205030	0128	TRANSMITTER,PRESS 0-300 PSI	EA		1	Item
205029	0129	TRANSMITTER,PRESS 0-30 PSI ABS	EA		1	Item
3545468	0130	SUPPRESSOR,SURGE PER SPEC	EA		1	Item
0822013	0201	VARISTOR,METAL OXIDE (MOV) GE	EA		2	Item
B0071332	0202	TUBE,SHRINK 0.0625"OD BLK	FT		1	Item
0812085	0203	DISCON,FEM SO T&B RB14-25OF	EA		2	Item
205275	0204	DISCONNECT,FEMALE NYLON FULL	EA		20	Item

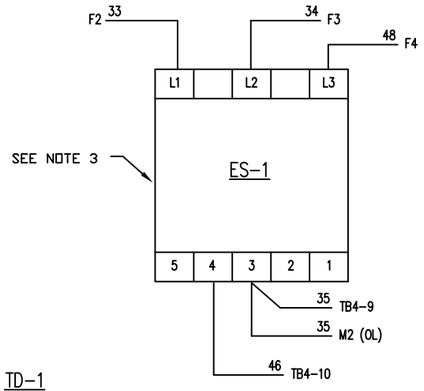
Item Production BOM

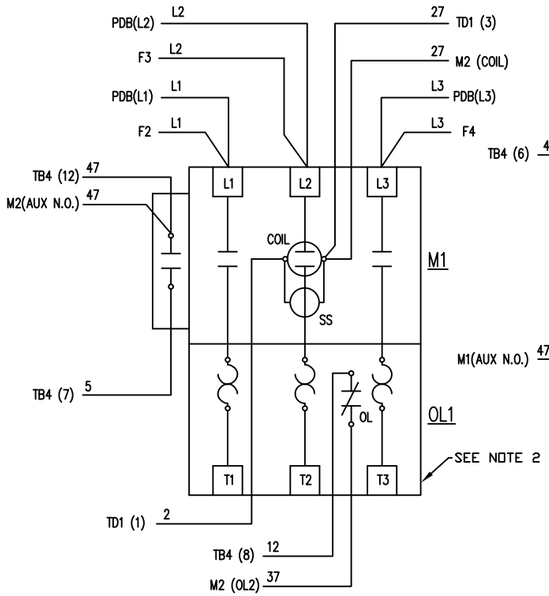
Linde Cryogenics

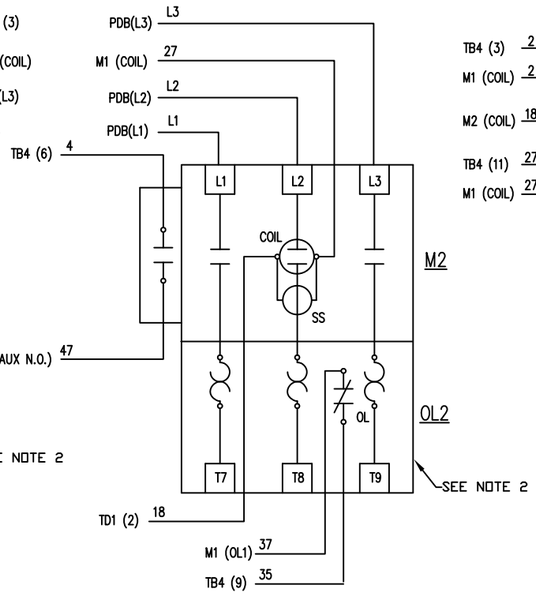
No.	Description	Revision	Drawing Number	Drawing Size		
0829020	0205	DISCON,ADAP M/F T&B F250TA	EA		3	Item
0822002	0208	DISCON,FEM INSUL 90D FLAG T&B	EA		8	Item
204754	0209	FERRULE,2WIRE 1.5X8 16AWG SHT	EA		50	Item
300539	0212	PUSHBUTTON,ILLUM RED 1NC	EA		1	Item
204929	0213	RING,PROTECTIVE ALLEN-BRADLEY	EA		1	Item
205093	0214	RING,YELLOW IEC, EMERGENCY	EA		1	Item
205789	0215	CABLE,ZIPLINK 1.6 FT LONG	EA		1	Item
205790	0216	CONNECTOR,MODULE TO ZIPLINK	EA		1	Item

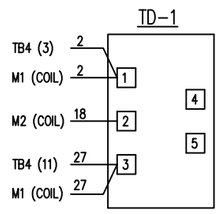


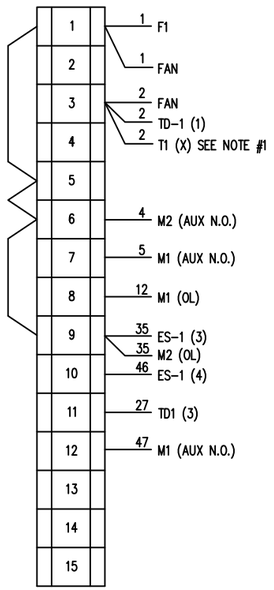


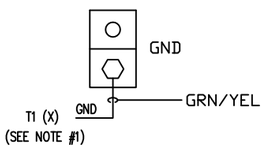


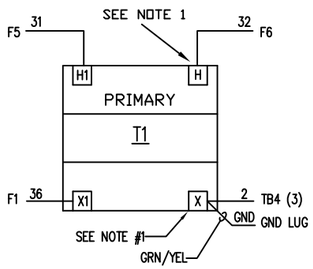


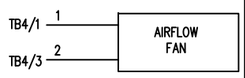


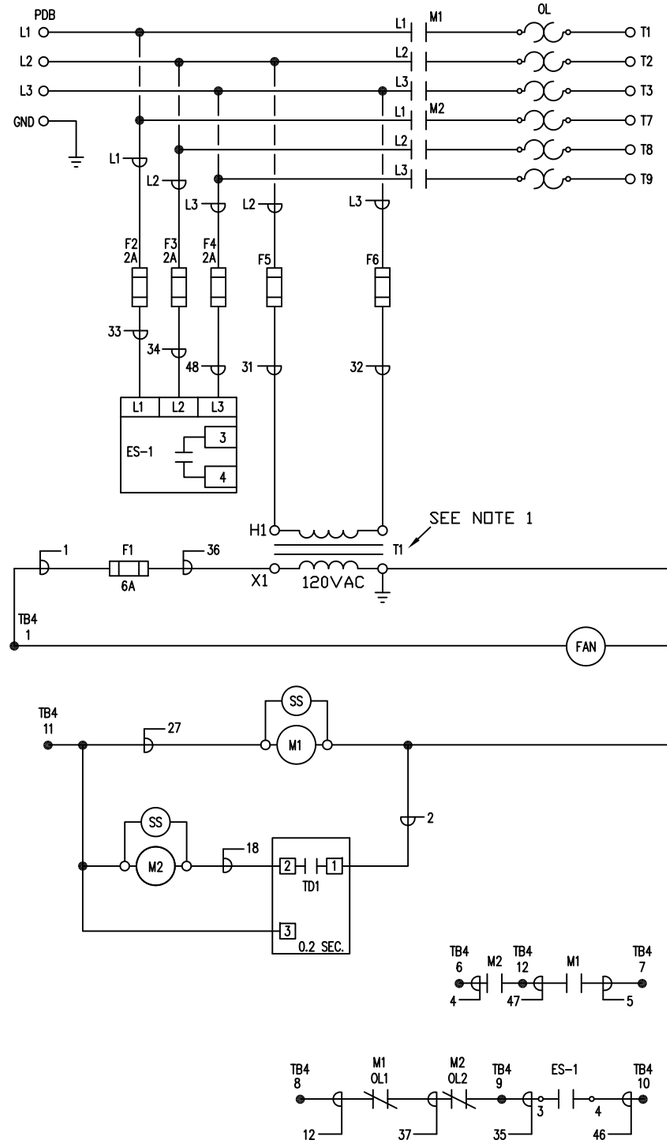












NO.	REVISION/ISSUE	BY	CHK.	REVIEW	APPR.	DATE
0	RELEASED PER DEO #10408	FM	FM	MAK	CML	Nov 23, 09

NEXT ASSEMBLY | USED ON

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Tulsa, Oklahoma U.S.A.

Linde Engineering — Linde

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THREE PLACE DECIMAL ± .005
FINISHED SURFACE RMS
BREAK CORNERS IN: OUT:
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

WIRING DIAGRAM/SCHEMATIC STARTER PANEL, RS SERIES COMPRESSOR PART WIND STARTING, CE MARKED

SIZE B | DWG. NO. 8015909 | REV. 0
CAD FILE NO. 8015909/909s1 | SCALE NONE | SHEET 1 OF 2

TABLE 1

STARTER PANEL COMPONENT SETTINGS						
PURCHASING PART NO. 3545 495	MOTOR VOLTAGE & FREQUENCY	ASSEMBLY 8015 908 GROUP #	3 PHASE MONITOR VOLT SETTING	OVERLOAD RELAY SETTING (AMPS)	TRANSFORMER PRIMARY CONNECTIONS	TRANSFORMER SECONDARY CONNECTIONS
P2	500/50	G1	500	58	H1 H5	X1 X4
P4	500/50	G2	500	70	H1 H5	X1 X4
P8	400/50	G5	380	73	H1 H3	X1 X3
P9	346/50	G5	355	84	H1 H3	X1 X4
P11	400/50	G6	380	88	H1 H3	X1 X3
P12	346/50	G6	355	101	H1 H3	X1 X4
P15	220/50	G7	220	132	H1 H2	X1 X4
P16	200/50	G7	200	145	H1 H2	X1 X4
P18	220/50	G7	220	159	H1 H2	X1 X4
P19	200/50	G7	200	175	H1 H2	X1 X4
P40	500/50	G17	500	30	H1 H5	X1 X4
P43	400/50	G19	400	38	H1 H3	X1 X3
P44	346/50	G19	355	44	H1 H2	X1 X4
P47	220/50	G20	220	68	H1 H2	X1 X4
P48	200/50	G20	200	75	H1 H2	X1 X4

NOTES:

1. WIRE #31 IS ALWAYS ON TERMINAL H1, AND WIRE #36 IS ALWAYS ON TERMINAL X1. CONNECT REMAINING PRIMARY AND SECONDARY WIRES (#32 & #2) PER TABLE 1.
2. ADJUST OVERLOAD RELAY DIALS PER TABLE 1.
3. ADJUST 3 PHASE MONITOR LINE VOLTAGE SETTING PER TABLE 1.
   SET ES-1 "UNBALANCE" DIAL TO 5%.
   SET ES-1 "TRIP DELAY" DIAL TO 5 SECONDS.
   SET ES-1 "AUTO RESTART DELAY" DIAL TO 10 SECONDS.
   SET ES-1 "SELECTOR" DIAL TO "AUTO RESTART".
4. ALL WIRING TO BE SPECIFIED AND SUPPLIED BY PANEL VENDOR.
5. TWO SPARE FUSES OF EACH TYPE SHALL BE PLACED IN A BAG AND SECURED TO THE INSIDE OF EACH ENCLOSURE.

SEE SHEET 1 FOR REVISIONS

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Linde Engineering Linde

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DO NOT SCALE THIS DRAWING
THIRD ANGLE PROJECTION

WIRING DIAGRAM/SCHEMATIC
STARTER PANEL, RS SERIES COMPRESSOR
PART WIND STARTING, CE MARKED

SIZE B | DWG. NO. 8015909 | REV. 0
CAD FILE NO. 8015909/909s2 | SCALE NONE | SHEET 2 OF 2

BILL OF MATERIAL FOR PART NUMBER: 8015436

KIT, ADSORBER MAINTENANCE - RS SERIES COMPRESSOR

Item	Part Number	Description	Quantity
0001	3544022P3	CARBON, PELLETS, NORIT RB-3	12.0000
0002	0580319	ORING, 920 BUNA N674-70 PARKER	4.0000
0003	A35421040	SPEC, CARBON REPACKING PROCEDURE	1.0000
0004	3544022P2	CARBON, SAMPLE PACK, NORIT RB-3	1.0000
0006	A3545293	SPEC, MSDS ACTIVATED CARBON	1.0000

Title: **SPECIFICATION FOR CARBON REPACKING PROCEDURE RS COMPRESSOR ADSORBER (FLANGED AND NON-FLANGED)**

SPECIFICATION

FOR

CARBON REPACKING PROCEDURE

RS COMPRESSOR ADSORBER

(FLANGED AND NON-FLANGED)

5	NC Nov 24, '10	JPB Nov 24, '10	Revised per RFC #10-874
4	GC 5/28/04	GC 5/28/04	Revised for CE notes; RFC #04-754
2	SG 6/8/01		REVISED PER RFC #01-135
A	S.Ryan 5/1/92	KW 5/11/92	REVISED PER DEO #4972, S/N 104+
REV LTR	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE

Linde Cryogenics
A Division of Linde Process Plants, Inc.

SPECIFICATION

INITIAL APPROVALS	PREPARED	DATE	Approved	DATE	Number:	Rev.
	S. Ryan	5/1/92	KW	5/11/92	**A 3542 1040**	5

1.0 SCOPE

This specification defines the procedure for replacing the carbon in an RS series compressor adsorber.

The recommended replacement interval is 8000 hours.

2.0 MATERIALS REQUIRED FOR FLANGED ADSORBER

- Kit P/L 8015176G1 Adsorber Maintenance Kit - RS Flanged
- Two (2) 1 1/8” wrenches
- Light solvent/cleaner
- Vacuum pump capable of achieving a blank off pressure of less than 25 microns.

3.0 PROCEDURE FOR ADSORBERS WITH TOP FLANGE

1. Turn off compressor and switch off all electrical power supplies.
2.  **Depressurize the compressor using the evacuation fitting located downstream of the adsorber.**
3. Verify that the adsorber is depressurized by opening valve V215 located on the side of the adsorber. Leave V215 open.
4. In order to remove the top flange, the compression fitting located between the pressure regulator (V202) and the top flange must be disconnected. Refer to the appropriate compression fitting instruction procedure located in the appendix of the operator’s manual in order to correctly disassemble and reassemble this fitting.
5. Remove the eight (8) hex head bolts, nuts, and washers with two (2) 1 1/8” wrenches.
6. Remove the flange from the adsorber. Be careful not to damage the sealing surfaces located on the flange or adsorber. Cover the surfaces with tape if necessary.
7. Remove the carbon using a shop-type vacuum cleaner. Discard the used carbon
8. Under normal operating conditions, the felt disc at the bottom of the adsorber does not require replacement. The disc should be completely free of oil and undamaged. Carefully vacuum any carbon dust particles from the felt. Contact LC field service if it is necessary to replace the felt.

9. Clean the interior of the adsorber body using a clean cloth moistened with a suitable cleaner/solvent.
10. Install fresh, processed carbon into the adsorber body. Tap the side of the adsorber with a plastic mallet when filling in order to ensure proper settling. Slightly overfill the vessel so the carbon will be compressed when the flange is installed.
11. Remove and discard the O-ring in the flange; clean the groove and sealing surfaces of the flange and adsorber body; and reinstall the new O-ring and existing flange. Use care so as not to allow any carbon particles to foul the O-ring sealing surfaces. Torque the ¾" bolts to 67.8 N·m (50 ft·lbf).
12. Remake the compression fitting on the gas inlet line.
13. Close the angle valve (V215) on the adsorber.
14. Connect a vacuum pump to the evacuation fitting located downstream of the adsorber and evacuate the adsorber to a level of ≤100 microns. Heat the adsorber to a maximum of 93°C (200°F), if a heating blanket is available. Evacuate the adsorber overnight, approximately 12 hours, to a level of <100 microns.
15. Charge the entire system to 14.5 bar (210 psig) with pure helium through the purge port upstream of the pressure regulator (V202).
16. The system is now ready for normal operation.
17. Note the maintenance performed in the compressor operator's logbook.

4.0 MATERIALS REQUIRED FOR NON-FLANGED (PIPE PLUG) ADSORBER

- Kit P/L 8015436 Adsorber Maintenance Kit
- One (1) 1-7/8" wrench
- Light solvent/cleaner
- Vacuum pump capable of achieving a blank off pressure of less than 25 microns.

5.0 PROCEDURE FOR ADSORBERS WITH PIPE PLUG

1. Turn off compressor and switch off all electrical power supplies.

2.  **Depressurize the compressor using the evacuation fitting located downstream of the adsorber.**

3. Using a 1-7/8” wrench, remove the top plug from the adsorber. Carefully mask the sealing surface of the boss on the adsorber with heavy tape.

4. Remove the lower plug from the adsorber. Carefully mask the sealing surface of the mating boss.

5. Using a shop-type vacuum cleaner outfitted with a reduced nozzle, remove the used carbon utilizing both the top and bottom ports. Take care not to damage the wire cloth located just beneath the bottom port. Discard the used charcoal.

6. Remove the tape from the lower port and clean sealing surface and threads with a light solvent.

7. Remove and discard the used O-ring from the bottom plug. Install a new O-ring on the plug and reinstall the plug into the adsorber. Seat the plug firmly, but do not overtighten.

8. Install fresh, processed carbon through the top port. Tap the side of the adsorber with a plastic mallet when filling in order to ensure proper settling. Fill adsorber to within 178mm (7 inches) of top of fill port. Always keep the cans closed when they are not being used to prevent the carbon from adsorbing moisture.

9. Remove the tape from the upper port and clean the sealing surface and threads with light solvent.

10. Remove and discard the used O-ring from the top plug. Install a new O-ring on the plug and reinstall the plug into the adsorber. Seat the plug firmly, but do not overtighten.

11. Connect a vacuum pump to the evacuation fitting located downstream of the adsorber and evacuate the adsorber to a level of $\leq$100 microns. Heat the adsorber to a maximum of 93^{o}C (200°F), if a heating blanket is available. Evacuate the adsorber overnight, approximately 12 hours, to a level of $<$100 microns.

12. Charge the entire system to 14.5 bar (210 psig) with pure helium through the charging port upstream of the pressure regulator (V202).

13. The system is now ready for normal operation.

14. Note, in the compressor operator’s logbook, that the maintenance has been performed.

HARTFORD® COMPRESSORS

WEST HARTFORD, CT 06110, U.S.A.

EDS- Y-1110-0002-01

SHEET 1 OF 3

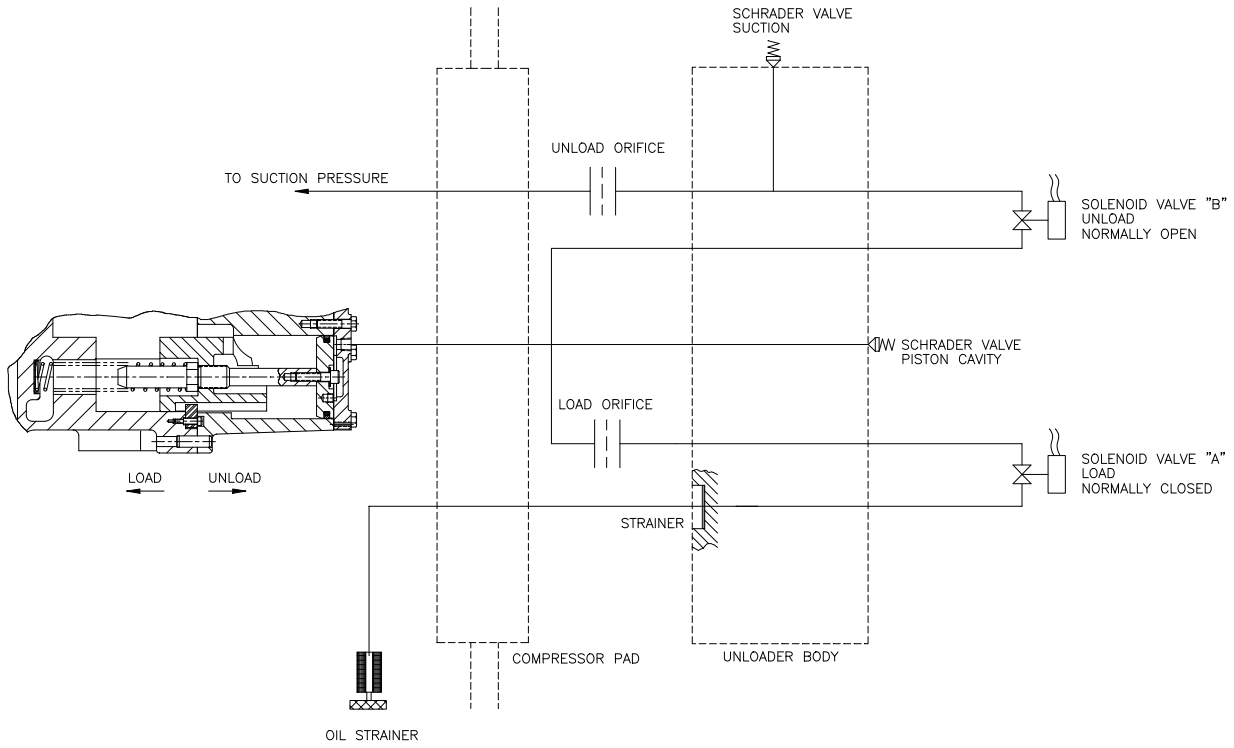
ISSUED 12/9/1999

ENGINEERING DATA SHEET

PREPARED BY: SVC | APPROVED BY:

SUBJECT: UNLOADER PAD SCHEMATIC, OPERATION AND TROUBLESHOOTING

1.) Schematic:



2.) Operation:

Position	"Load" Solenoid A Normally Closed	"Unload" Solenoid B Normally Open
UNLOAD	OFF	OFF
HOLD	OFF	ON
LOAD	ON	ON

OFF = Solenoid is de-energized
ON = Solenoid is energized

Rev: 4/03/01

Pictures from C:\DRAW\UNLOADER SCHEMATIC

ENGINEERING DATA SHEET

PREPARED BY: SVC | APPROVED BY:

SUBJECT: UNLOADER PAD SCHEMATIC, OPERATION AND TROUBLESHOOTING

UNLOAD: When both solenoids are de-energized, the compressor is in the "UNLOAD" position. In operation, this makes a differential pressure of suction to discharge across the piston, which overcomes the pressure differential across the slide-valve. The slide-valve is spring loaded so that when the compressor is off, with no pressure differentials, the slide-valve can move to the fully unloaded position.

HOLD: When the compressor is put in the "HOLD" position, both solenoids are closed and the piston cavity is isolated.

In any part load condition, the piston cavity pressure rebalances so that the force created by the pressure differential of suction to discharge pressure, across the slide-valve, equals the force created by the pressure differential of cavity pressure to discharge pressure, across the piston.

LOAD: When the compressor is put in the "LOAD" position, the pressure across the piston is equalized and the pressure differential across the slide-valve causes the machine to move in the load direction.

Note: There is no direct indication of slide-valve movement, however, when the slide-valve moves, there are several indirect effects. With increasing load, current draw will increase and suction pressure will decrease. Also the pitch of the compressor will change with load.

In the full load condition, the slide valve is positively stopped against the slide-stop. This does not allow the slight movement necessary to rebalance the piston cavity pressure. Thus, there is normally a significant time delay for the compressor to start unloading from the fully loaded position as the piston cavity bleeds down to the balance pressure.

TYPICAL LOADING TIME

MODEL	Unload (s)	Load (s)
1111NHF6X6K	22	16
1113NHF6X6K	28	16
1117NHF6X6K	31	18
1210NHF6X6K	28	22
1212NHF6X6K	35	25
1215NHF6X6K	45	31
1218NHF6X6K	49	36
1210NHF6W4K	35	40
1212NHF6W4K	40	53
1215NHF6W4K	45	54
1218NHF6W4K	49	55

ENGINEERING DATA SHEET

PREPARED BY: SVC | APPROVED BY:

SUBJECT: UNLOADER PAD SCHEMATIC, OPERATION AND TROUBLESHOOTING

3.) Reading Compressor Pressures: There are two schrader valves on the unloader pad which allow various pressures to be measured inside of the compressor for start-up and trouble-shooting purposes.

Suction Schrader Valve:

- Suction pressure can be read from the suction schrader valve while the compressor is in the "HOLD" position. This is useful for measuring the suction pressure after the suction filter.

Piston Cavity Schrader Valve:

- Discharge pressure is read downstream the oil strainers when the unloader solenoids are in the "LOAD" position. This is best read when the compressor is fully loaded.
- Suction pressure is read when the unloader solenoids are in the "UNLOAD" position. This is best read when the compressor is fully unloaded.
- An intermediate pressure is read when the unloader is in the "HOLD" position when the compressor is not at full load. This value is approximately (Pdisch*0.3 + Psuct*0.7).

4.) Troubleshooting: In all cases, the first step is to ensure that the solenoids are actually being energized and in the proper sequence.

Compressor won't load:

- Read pressure at the suction schrader valve. Excessive pressure drop across the filter can give the appearance of the compressor not loading by reducing mass-flow and capacity.
- Read pressure at the piston cavity in the "LOAD" position. If the cavity pressure reads at or near suction pressure, then the problem is most likely a clogged strainer or orifice on the pad. Disassemble and check the pad for signs of dirt or debris.

Compressor won't hold:

- Read the pressure of the piston cavity with the compressor in the "HOLD" position. If this equals or approaches suction pressure, then there is a leak on the gasket or unload solenoid valve. If this reads discharge pressure, then the leak may be on the gasket, solenoid valve, or internal to the compressor.

Compressor won't unload:

- Read the pressure of the piston cavity with the compressor in the "UNLOAD" position. If this reads discharge pressure, there may be a leak between the piston cavity and the gasket, solenoid valve or internal to the compressor.

Slide valve is "stuck":

- If the cavity pressure reads normally, and no movement can be detected, then the valve may be "stuck". This can be checked by pumping the system down removing the pad, and pressurizing the piston cavity with dry air or nitrogen. Note that there is no fitting to connect to, but a small amount of pressure supplied to the piston cavity port should be enough to move the valve. A metallic "clink" can be heard when the valve is forced to the fully loaded position, and when the spring returns the valve to the fully unloaded position.

HARTFORD® COMPRESSORS

WEST HARTFORD, CT 06110, U.S.A.

ENGINEERING DATA SHEET

EDS- Y-1100-0014-05

SHEET 1 of 4

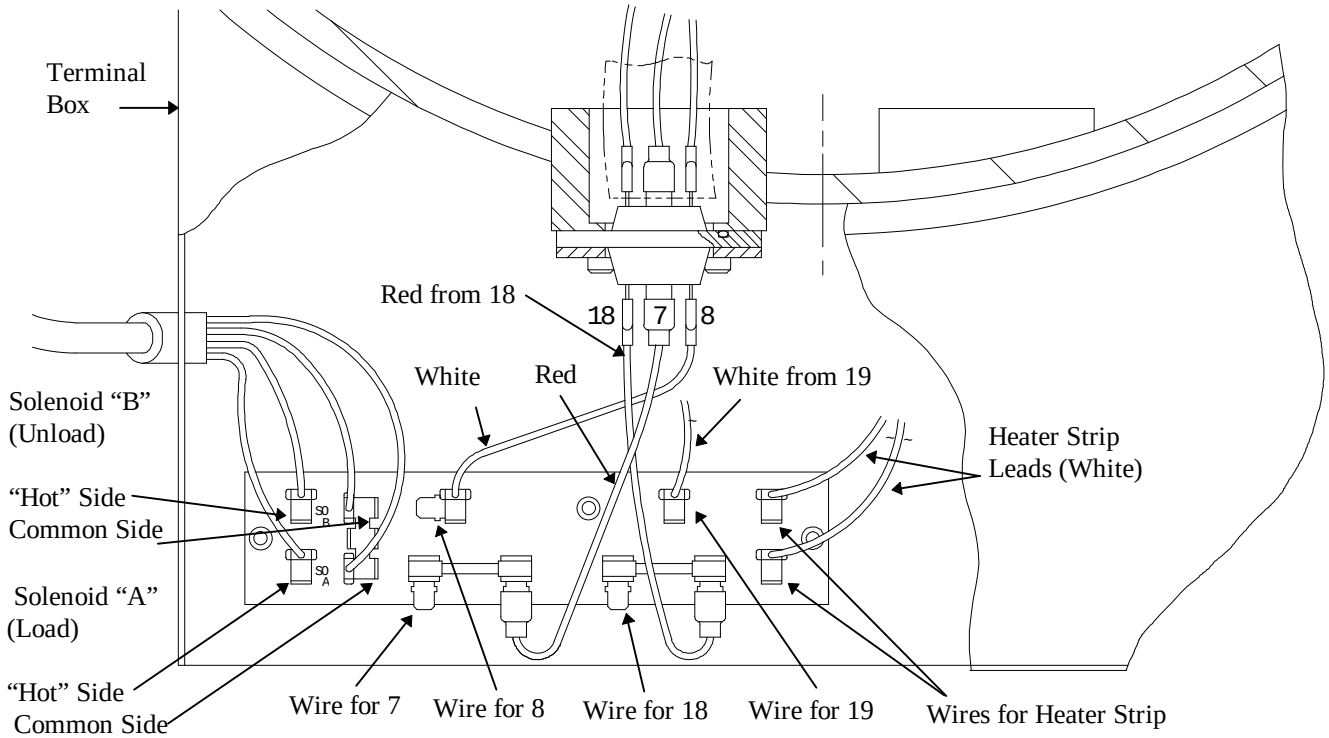
ISSUED Jan. 4, 1983,
Rev 1/12/95

PREPARED BY: R. Angers | APPROVED BY:

SUBJECT: Recent Electrical Changes to Vertical Screw Compressors

A new oil level sensor has been added to 127mm OEM and RMF compressors with serial number 95J and later. Compressors built before 95J and all 102mm compressors still have the old style internal float switch.

a.) For the old style internal float switch, the wiring should be done as shown:



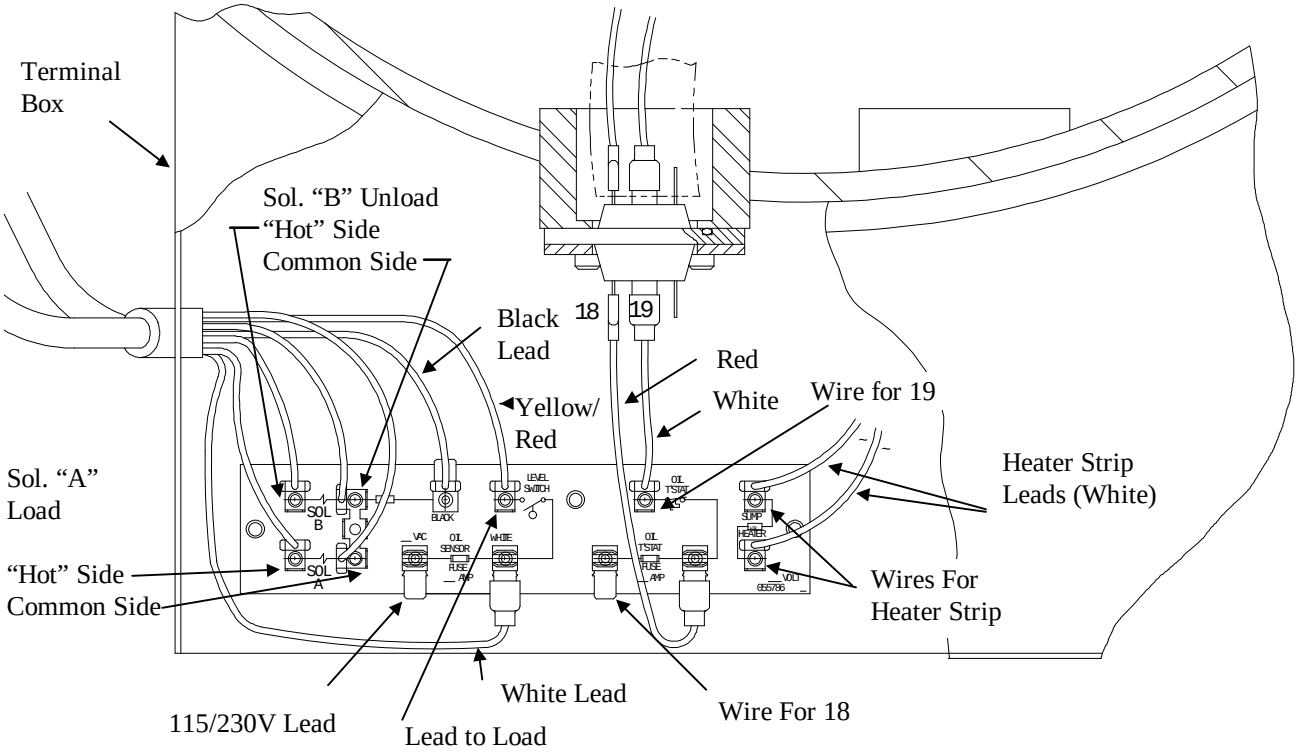
The old style float switch, which is internal, utilizes terminals 7 and 8 in the four post feed through. The fuse block terminal board shown will only work with the internal oil float switch. The part number for the fuse block terminal board is 053955A1 and 053955A2 for 115V and 230V control voltages respectively. The fuse part number for the float switch with a control voltage of 115V is FUS219. Similarly the fuse part number for the float switch with a control voltage of 230V is FUS216.

ENGINEERING DATA SHEET

PREPARED BY: R. Angers | APPROVED BY:

SUBJECT: Recent Electrical Changes to Vertical Screw Compressors

b.) The new style external oil level sensor requires new wiring and the fuse block terminal has been modified as shown:



The new oil level sensor does not utilize terminals 7 and 8 of the four post feed through. For a control voltage of 115V, the terminal plate part number is 055786A1 and the new fuse is FUS220. For a control voltage of 230V, the terminal plate part number is 055786A2 and the new fuse is FUS219.

ENGINEERING DATA SHEET

PREPARED BY: R. Angers | APPROVED BY:

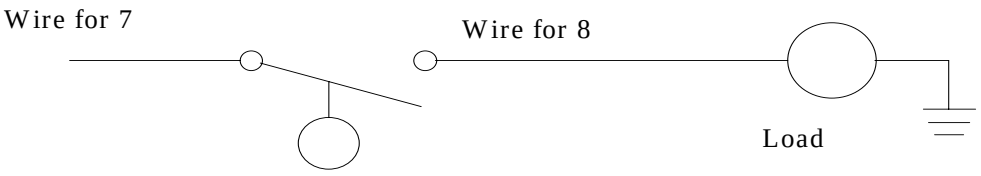
SUBJECT: Recent Electrical Changes to Vertical Screw Compressors

c.) The new oil level sensor is an electronic optical sensor switch. The oil level sensor requires a new terminal and fuse plate (shown on previous pages) and a different size fuse (mentioned earlier). The new sensor has three leads, as opposed to the float switch which had two. The third lead utilizes the common side on the unloaders through a resistor.

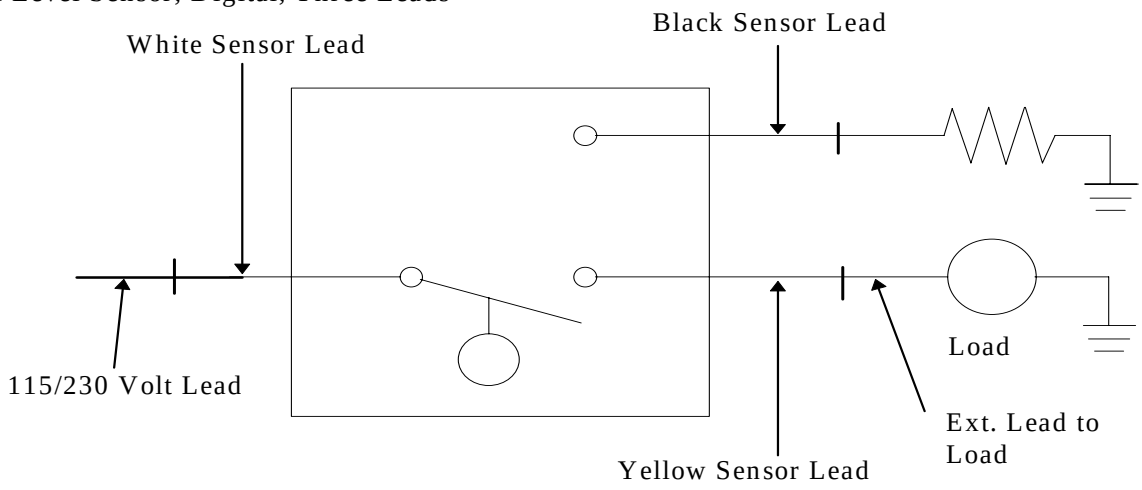
The inductance rating for the sensor is 36VA for the 115 volt or 230 volt sensor. The 115 volt sensor has white, black, and yellow leads and the part number is 055782A2. The 230 volt sensor has white, black, and red leads and the part number is 055782A1.

The following schematic shows the differences between the new sensor and the old style float switch.

Oil Float Switch, Analog, Two Leads



Oil Level Sensor, Digital, Three Leads



ENGINEERING DATA SHEET

PREPARED BY: R. Angers	APPROVED BY:	

SUBJECT: Recent Electrical Changes to Vertical Screw Compressors

d.) Troubleshooting the oil level sensor. Two possible methods of failure exist, power applied with LOW oil level and no power with HIGH oil level.

The first failure mode, power applied with LOW oil level, can be caused by: internal sensor LED failure, overload of three to five amps, or deposits on the internal prism face blocking the light return. The LED failure is the result temperature and current flow. If the discharge temperature is within the acceptable limits, the LED will not fail due to excessive temperatures. The fuse on the white line of the sensor should protect against high current flows. If the fused glass prism is damaged or coated on the internal face, the fused glass prism should be replaced.

The second failure mode, NO power applied with HIGH oil level, can be caused by a short circuit across the electrical load or light detector “dark current” leakage due to extremely high temperatures. The fuse will protect against the short circuit and the excessive temperatures should not occur during normal operation.

To check the sensor, measure the voltage between the yellow lead and the common side of the unloader, at the triple 1/4” quick connect on the fuse and terminal plate. If there is a sufficient oil level, the voltage between the yellow lead and the common side should be 115V or 230V, depending on the control voltage. If the oil level is inadequate, the voltage should be approximately zero.

If problems persist, check the incoming voltage to insure that it is within the allowable limits for the control voltage. The voltage between the white lead and the common side of the unloaders should be the line voltage. Check all connections for continuity and check the fuses. Verify the resistance values for the resistors where the values are 24.3k Ω for 115V control voltage and 47k Ω for 230V control voltage.

Hartford Compressors Inc.
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West Hartford, CT 06110 USA
*Phone: 860-249-8671 * Fax: 860-548-1705*
E-mail:webmaster@hartfordcompressors.com

SERVICE BULLETIN :
Operation And Installation Of The Optical Oil Level Sensor

Applications: "J" & "K" MSC's with serial Numbers after "95J".

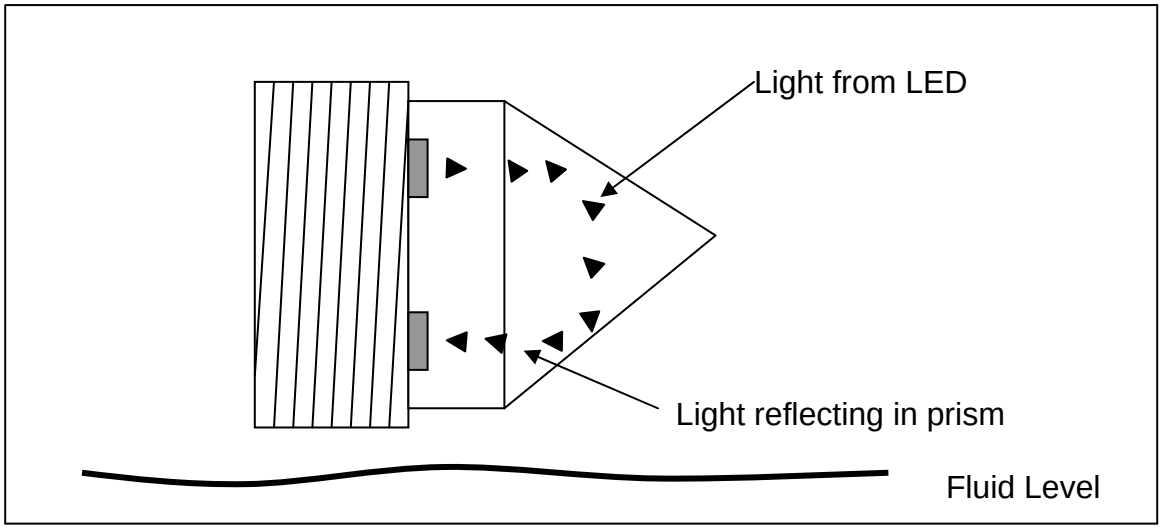


Figure 1.

OIL BELOW SENSING PRISM

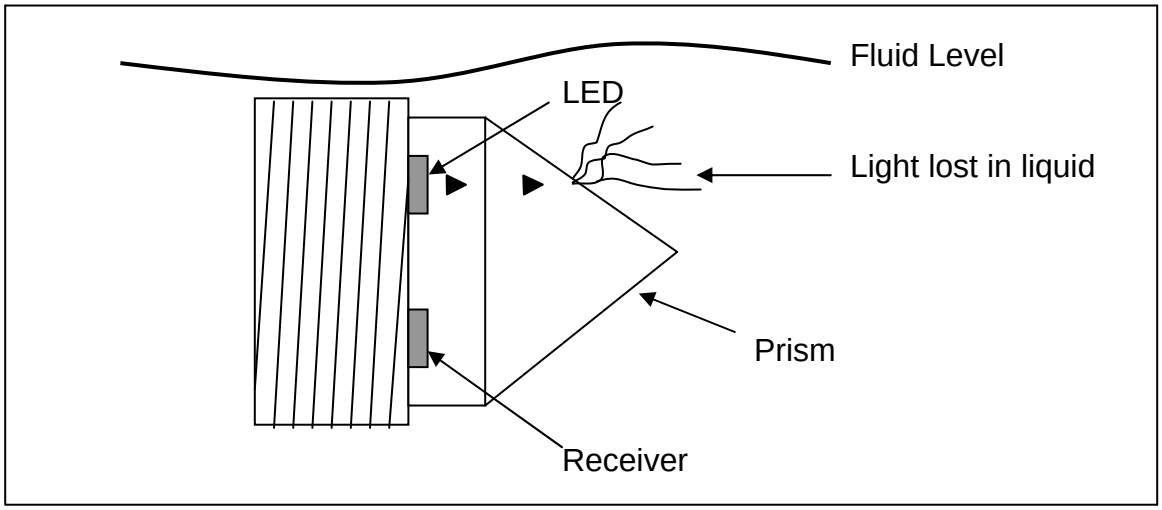


Figure 2.

OIL COVERING SENSING PRISM

PART INFORMATION:

Two sensors are available, one for 115 VAC and one for 230 VAC.

CONTROL VOLTAGE	HCI PART #	WIRE COLORS
115 VAC	055820A1	White, Yellow, Black
230 VAC	055820A2	White, Red, Black

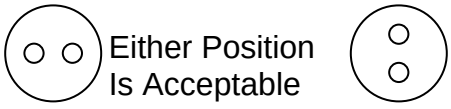
OPERATION

- The optical oil level sensor is mounted in the compressor body at the lowest point location at which the compressor can safely be operated.
- When the oil level drops below the level of the sensor, the sensor sends an electrical signal to the compressor control circuit, shutting down the compressor.
- On some packages containing multiple compressors, the control circuit will initiate a signal to feed oil to the compressor from the oil equalization circuit.
- When the oil is below the level of the sensor (See Fig. 1.) light from the LED reflects off the prism and is picked up by the receiver. This signal shuts the compressor off.
- When the oil level is above the prism, (See Fig. 2.) light from the LED is lost in the liquid. Interrupting the beam to the receiver signals the control circuit that oil is detected, allowing the compressor to run.
- It is important for the prism to be extremely clean or the receiver may get an erroneous signal. Dust or dirt on the prism can give a false reading indicating there is a liquid covering the prism. If the prism is cracked, the same problem will occur.

NOTE: The sensor will detect any fluid. If water or liquid refrigerant is present, the sensor will act the same as though oil was covering the prism

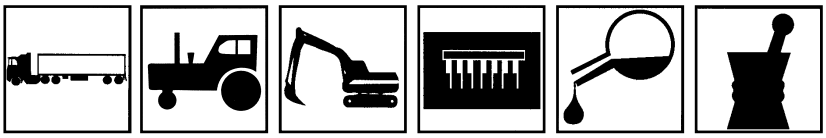
INSTALLATION INSTRUCTIONS

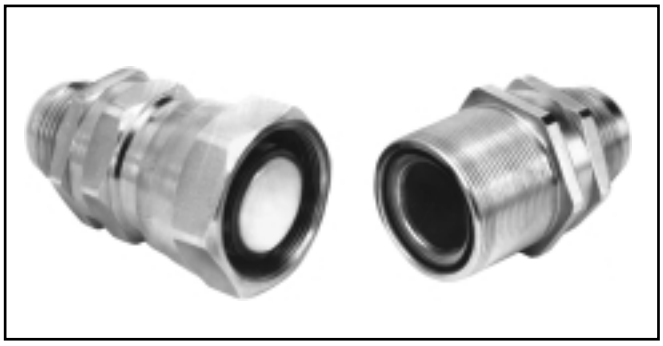
- When replacing the oil sensor, it is important that you use extreme caution when tightening the replacement sensor. Whenever possible, use a box end wrench to tighten the replacement sensor.
- The wrench must be as low (near the thread end on the sensor) as possible. If the sensor is tightened from the upper end, it is possible to distort the housing and crack the prism. Over torquing the sensor can also crack the prism.
- When installing the electronic section into the prism section, there is no specific alignment required. The sensor will function in any position.

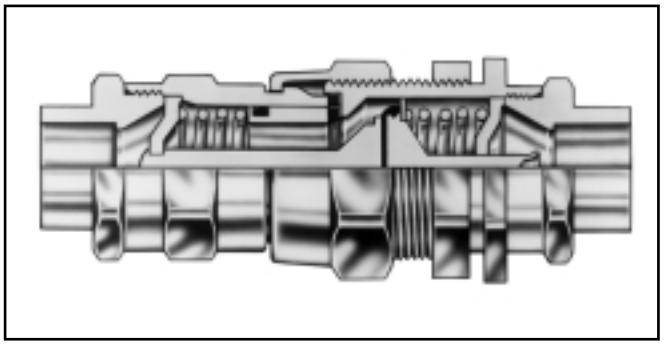


Refer to oil sensor replacement kit for additional instructions.

5400 Series/Low Air Inclusion Refrigerant





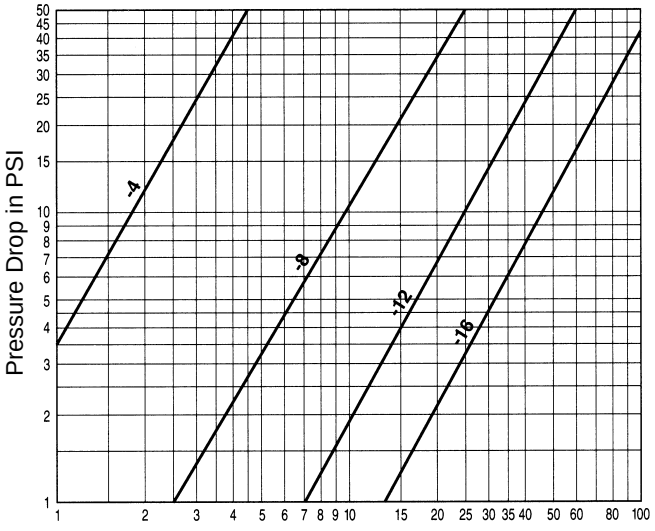


The 5400 Series is designed for air conditioning, refrigerant, gaseous and fluid transfer applications.

- Brazed or threaded end connections for versatility of installation on tubing or hose.
- Tubular valve construction for low fluid loss and air inclusion.
- Thread together design allows connection and disconnection against pressure.
- Lock washer and jam nut standard for optional bulkhead mounting.
- Standard seal material – Neoprene.
- Standard adapter material – Steel or Brass.
- Standard body material – Zinc plated steel.
- Safety sleeve lock available, contact Eaton Aeroquip for details.

Flow Data

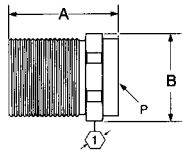
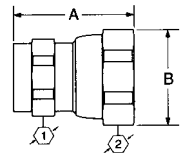
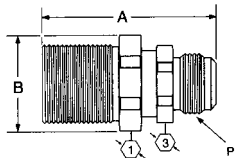
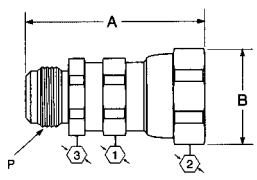
Pressure Drop Versus Flow Graphic



Gallons Per Minute Flow
(Test Fluid MIL-H-5606 Hydraulic Oil At 100° F)

Physical Characteristics

Coupling Dash Size	Maxium Operating Pressure (psi connected)	Minimum Burst Pressure (psi connected)	Maximum Operating Pressure (psi disconnected)		Vacuum (in./Hg.)	Rated Flow (gpm)	Air Inclusion (cc max.)	Fluid Loss (cc max.)
			Male Half	Female Half				
–4	3000	9000	2500	500	28	2	.10	.05
–8	1750	5200	1750	400	28	14	.10	.10
–12	700	2100	800	400	28	35	.30	.10
–16	700	2100	700	300	28	75	.50	.20

5400 Series	Coupling Size	Thread Size (P)	Tube O.D. Size	Dimensional Data A	B	①	②	③	Part Number Neoprene	Line Ref.
Male Half No Adapter 	–4			1.08	.83	.75			5400–S2–4	1
	–8			1.37	1.25	1.13			5400–S2–8	2
	–12			1.74	1.83	1.63			5400–S2–12	3
	–16			1.83	2.10	1.88			5400–S2–16	4
										5
										6
										7
										8
Female Half No adapter 	–4			1.13	.83	.63	.75		5400–S5–4	9
	–8			1.63	1.31	1.00	1.19		5400–S5–8	10
	–12			2.15	1.80	1.38	1.63		5400–S5–12	11
	–16			2.37	2.24	1.75	2.00		5400–S5–16	12
										13
										14
										15
										16
Male Half SAE 37° (JIC) 	–4	7/16-20		1.88	.83	.75		.63	5410–S17–4–4	17
	–4	9/16-18		1.89	.83	.75		.63	5410–S17–6–4	18
	–8	9/16-18		2.18	1.25	1.13		1.00	5410–S17–6–8	19
	–8	3/4-16		2.28	1.25	1.13		1.00	5410–S17–8–8	20
	–12	7/8-14		2.75	1.83	1.63		1.38	5410–S17–10–12	21
	–12	1 1/16-12		2.86	1.83	1.63		1.38	5410–S17–12–12	22
	–16	1 5/16-12		2.99	2.10	1.88		1.75	5410–S17–16–16	23
										24
Female Half SAE 37° (JIC) 	–4	7/16-20		1.93	.83	.63	.75	.63	5410–S14–4–4	25
	–4	9/16-18		1.94	.83	.63	.75	.63	5410–S14–6–4	26
	–8	9/16-18		2.43	1.31	1.00	1.19	1.00	5410–S14–6–8	27
	–8	3/4-16		2.53	1.31	1.00	1.19	1.00	5410–S14–8–8	28
	–12	7/8-14		3.16	1.80	1.38	1.63	1.38	5410–S14–10–12	29
	–12	1 1/16-12		3.27	1.80	1.38	1.63	1.38	5410–S14–12–12	30
	–16	1 5/16-12		3.53	2.24	1.75	2.00	1.75	5410–S14–16–16	31
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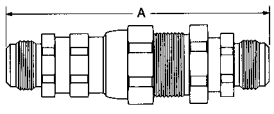
Complete Coupling SAE 37° (JIC) 	–4	7/16-20		3.54					5410–4–4	33
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	–12	7/8-14		5.33					5410–10–12	37
	–12	1 1/16-12		5.54					5410–12–12	38
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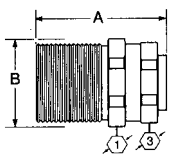
										40
Male Half Braze Tubing Adapter 	–4		1/4	1.52	.83	.75		.63	5401–S17–4–4	41
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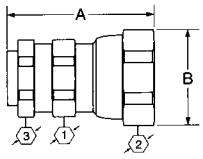
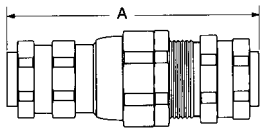
	–8		3/8	1.75	1.31	1.13		1.00	5401–S17–6–8	43
	–8		1/2	1.75	1.31	1.13		1.00	5401–S17–8–8	44
	–12		5/8	2.47	1.80	1.63		1.38	5401–S17–10–12	45
	–12		3/4	2.47	1.80	1.63		1.38	5401–S17–12–12	46
	–16		1	2.80	2.24	1.88		1.75	5401–S17–16–16	47
										48

5400 Series

Female Half
Braze Tubing Adapter



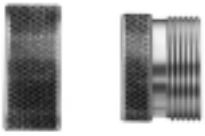
Complete Coupling
Braze Tubing Adapter



Coupling Size	Thread Size (P)	Tube O.D. Size	Dimensional Data A	B	1	2	3	Part Number Neoprene	Line Ref·
–4		1/4	1.57	.83	.63	.75	.63	5401–S14–4–4	1
–4		3/8	1.57	.83	.63	.75	.63	5401–S14–6–4	2
–8		3/8	2.00	1.31	1.00	1.19	1.00	5401–S14–6–8	3
–8		1/2	2.00	1.31	1.00	1.19	1.00	5401–S14–8–8	4
–12		5/8	2.88	1.80	1.38	1.63	1.38	5401–S14–10–12	5
–12		3/4	2.88	1.80	1.38	1.63	1.38	5401–S14–12–12	6
–16		1	3.34	2.24	1.75	2.00	1.75	5401–S14–16–16	7
									8
–4		1/4	2.82					5401–4–4	9
–4		3/8	2.82					5401–6–4	10
–8		3/8	3.37					5401–6–8	11
–8		1/2	3.37					5401–8–8	12
–12		5/8	4.76					5401–10–12	13
–12		3/4	4.76					5401–12–12	14
–16		1	5.52					5401–16–16	15
									16

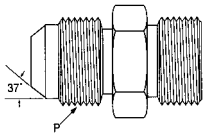
Accessories

Dust Cap Dust Plug



			Dust Cap with Gasket	Dust Plug with Gasket	
					17
–4			5400–S6–4	5400–S8–4	18
–8			5400–S6–8	5400–S8–8	19
–12			5400–S6–12	5400–S8–12	20
–16			5400–S6–16	5400–S8–16	21
					22
					23
					24
					25

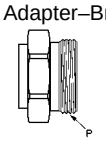
Adapter
SAE 37° (JIC)



O-Ring Required

			O-Ring	Brass	Steel	
						26
–4	7/16-20	1/4	22546–12	202220–4–4B	202220–4–4S	27
–4	9/16-18	3/8	22546–12	202220–6–4B	202220–6–4S	28
–8	9/16-18	3/8	22546–17	202220–6–8B	202220–6–8S	29
–8	3/4-16	1/2	22546–17	202220–8–8B	202220–8–8S	30
–12	7/8-14	5/8	22546–23	202220–10–12B	202220–10–12S	31
–12	1 1/16-12	3/4	22546–23	202220–12–12B	202220–12–12S	32
–16	1 5/16-12	1	22546–28	202220–16–16B	202220–16–16S	33

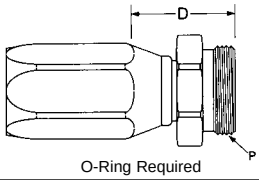
Adapter–Braze



O-Ring Required

				Brass		
						34
–4	1/2-20	1/4	22546–12	202208–4–4B		35
–8	7/8-20	1/2	22546–17	202208–8–8B		36
–12	1 1/4-18	5/8	22546–23	202208–10–12B		37
–16	1 19/32-20	7/8	22546–28	202208–14–16B		38

Hose Fitting
SAE 100R5†

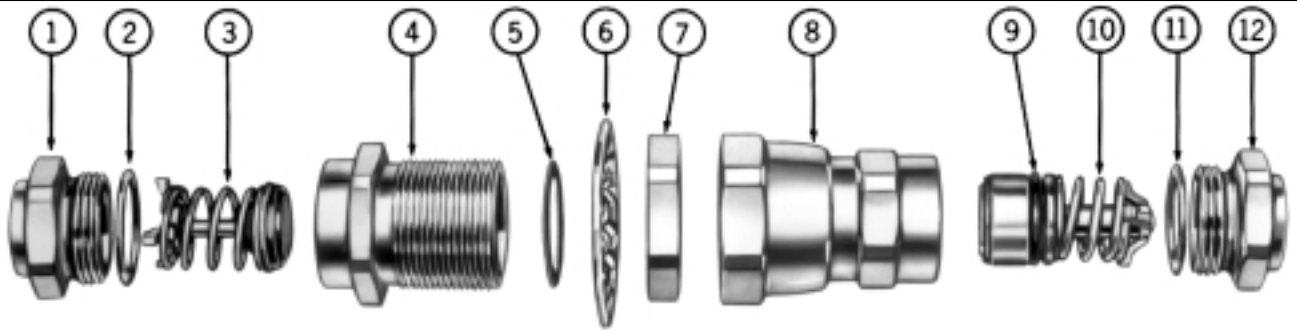


O-Ring Required

		Hose Size	D			
						39
–4	1/2-20	–4	.92	22546–12	487–4–4S	40
–4	1/2-20	–6	.96	22546–12	487–4–6S	41
–8	7/8-20	–6	.96	22546–17	487–8–6S	42
–8	7/8-20	–8	1.06	22546–17	487–8–8S	43
–12	1 1/4-18	–10	1.07	22546–23	487–12–10S	44
–16	1 19/32-20	–16	1.01	22546–28	487–16–16S	45

†*Additional dash styles available.*

Assembly Instructions/Component Part Numbers



Typical Male Coupling Half (S2)

Typical Female Coupling Half (S5)

Assembly Instructions

Steps:

1. After tubing or hose has been connected to adapters ① and ⑫, install O-Rings ② and ⑪† on adapters. Be sure O-Rings are not twisted.
2. Oil O-Rings ② and ⑪ liberally with system fluid to prevent them from scuffing and tearing when coupling body is threaded on adapter.
3. S2 Half—Lubricate poppet face with system fluid. Insert poppet valve assembly ③ into body ④. Tighten body ④ on adapter ①. After body and adapter make metal-to-metal contact, tighten by rotating body ④ 1/8" with respect to adapter ① or torque per table value.

   S5 Half—Oil O-Ring ⑨† liberally with system fluid. Insert valve and sleeve assembly ⑩ into body ⑧. Tighten body ⑧ on adapter ⑫. After body and adapter make metal-to-metal contact, tighten by rotating body ⑧ 1/8" with respect to adapter ⑫ or torque per table value.
4. Coupling Connection—Lubricate gasket seal ⑤ on 5400-S2 half with system fluid. Thread union nut ⑧ on 5400-S2 half. Tighten union nut to torque values shown in Table. Be sure S2 and S5 bodies do not rotate during connection.

Bulkhead Mounting––S2 Half

Install lock washer ⑥ on S2 half. Insert S2 half through bulkhead, and tighten jam nut ⑦ so that lock washer teeth are fully compressed.

NOTE: Lock washer ⑥ must be between hex of S2 half and bulkhead.

Maximum Bulkhead Thickness

Coupling Size	Lock Washer Installed	Lock Washer Not Used
–4	.206	.256
–8	.136	.203
–12	.232	.292
–16	.101	.161

Torque Values

Recommended torque values in ft. lbs., are listed below.

Dash Size	Adapter to Body		S2 Half to S5 Half
	Braze Type or Aluminum	Non-braze Type Steel or Brass	
–4	6–8	12–15	10–12
–8	15–20	35–45	35–37
–12	35–40	45–55	45–47
–16	50–60	55–65	65–67

†***IMPORTANT**: Generous lubrication is required for all gaskets and O-Rings. Use refrigeration oil only when used in refrigerant system.*

Component Part Numbers

Item No.	Dash Size→	–4	–8	–12	–16	Line Ref.
	O.D. Tube Size→	1/4"–3/8"	1/4"–5/8"	5/8"–7/8"	7/8"–1 3/8"	
	Typical Male Half					**1**
1	Tubing Adapter	202208–*–4	202208–*–8	202208–*–12	202208–*–16	**2**
2	O-Ring	22546–12	22546–17	22546–23	22546–28	**3**
3	Poppet Valve Assembly	5400–S20–4	5400–S20–8	5400–S20–12	5400–S20–16	**4**
4	Body	5400–17–4	5400–17–8	5400–17–12	5400–17–16	**5**
5	Gasket Seal	22008–4	22008–8	22008–12	22008–16	**6**
6	Lock Washer	5400–54–4S	5400–54–8S	5400–54–12S	5400–54–16S	**7**
7	Jam Nut	5400–53–4S	5400–53–8S	5400–53–12S	5400–53–16S	**8**
	Typical Female Half					**9**
8	Union Nut and Body Assembly	5400–S16–4	5400–S16–8	5400–S16–12	5400–S16–16	**10**
9	O-Ring	22546–10	22546–112	22546–116	22546–214	**11**
10	Valve and Sleeve Assembly	5400–S19–4	5400–S19–8	5400–S19–12	5400–S19–16	**12**
11	O-Ring	22546–12	22546–17	22546–23	22546–28	**13**
12	Tubing Adapter	202208–*–4	202208–*–8	202208–*–12	202208–*–16	**14**

**Specify O.D. Tubing size of adapter required in 16th of an inch. Example: –4 coupling with 3/8" O.D. tubing is 6/16 or –6. Part number is then 202208–6–4.*

Linde Cryogenics
Aeroquip Part Numbers

LC P/N	Description	LC P/N	Description
Tubing Adapter - Stainless Steel		Tubing Adapter - Brass	
3762029P4	Adapter, 0.1875" OD SS (#4 Aeroquip)	3762029P8	Adapter, 0.1875" OD Brass (#4 Aeroquip)
3762029P1	Adapter, 0.25" OD SS (#4 Aeroquip)	0510177	Adapter, 0.25" OD Brass (#4 Aeroquip)
3762029P3	Adapter, 0.375" OD SS (#4 Aeroquip)	0513114	Adapter, 0.375" OD Brass (#4 Aeroquip)
3762029P2	Adapter, 0.5" OD SS (#4 Aeroquip)	3762029P6	Adapter, 0.5" OD Brass (#4 Aeroquip)
3825037	Adapter, 0.375" OD SS (#8 Aeroquip)	202497	Adapter, 0.25" OD Brass (#8 Aeroquip)
3592318	Adapter, 0.5" OD SS (#8 Aeroquip)	0513121	Adapter, 0.375" OD Brass (#8 Aeroquip)
3592354	Adapter, 0.625" OD SS (#8 Aeroquip)	0510178	Adapter, 0.5" OD Brass (#8 Aeroquip)
		0510187	Adapter, 0.625" OD Brass (#8 Aeroquip)
3824126P3	Adapter, 0.5" OD SS (#12 Aeroquip)		
3824126P4	Adapter, 0.625" OD SS (#12 Aeroquip)	0513157	Adapter, 0.625" OD Brass (#12 Aeroquip)
3824126P1	Adapter, 0.75" OD SS (#12 Aeroquip)	0512147	Adapter, 0.75" OD Brass (#12 Aeroquip)
3824126P5	Adapter, 0.875" OD SS (#12 Aeroquip)	0513155	Adapter, 0.875" OD Brass (#12 Aeroquip)
3824126P2	Adapter, 1" OD SS (#12 Aeroquip)		
		204632	Adapter, 0.875" OD Brass (#16 Aeroquip)
3824962	Adapter, 1.375" OD SS (#16 Aeroquip)	0512116	Adapter, 1" OD Brass (#16 Aeroquip)
3824125	Adapter, 1.5" OD SS (#16 Aeroquip)	0513153	Adapter, 1.375" OD Brass (#16 Aeroquip)
Oring		Gasket Seal	
0580304	Oring, Buna 2-012 (#4 Aeroquip)	0580138	Gasket, 0.25" Rubber (#4 Aeroquip)
0580305	Oring, Buna 2-017 (#8 Aeroquip)	0580137	Gasket, 0.5" Rubber (#8 Aeroquip)
0581482	Oring, Buna 2-023 (#12 Aeroquip)	0580168	Gasket, 0.75" Rubber (#12 Aeroquip)
0582458	Oring, Buna 2-028 (#16 Aeroquip)	0581036	Gasket, 1" Rubber (#16 Aeroquip)
Male Coupling		Female Coupling	
0511524	Coupling, Male 0.25" Cad Plt Stl (#4 Aeroquip)	0511526	Coupling, Female 0.25" Cad Plt Stl (#4 Aeroquip)
0511525	Coupling, Male 0.5" Cad Plt Stl (#8 Aeroquip)	0511527	Coupling, Female 0.5" Cad Plt Stl (#8 Aeroquip)
0511588	Coupling, Male 0.75" Cad Plt Stl (#12 Aeroquip)	0511586	Coupling, Female 0.75" Cad Plt Stl (#12 Aeroquip)
0511585	Coupling, Male 1" Cad Plt Stl (#16 Aeroquip)	0511587	Coupling, Female 1" Cad Plt Stl (#16 Aeroquip)
Lock Washer		Jam Nut	
B0521685	Lock washer, 0.25" Cad Plt Stl (#4 Aeroquip)	B0522616	Jam Nut, 0.25" Cad Plt Stl (#4 Aeroquip)
B0521684	Lock washer, 0.5" Cad Plt Stl (#8 Aeroquip)	B0522615	Jam Nut, 0.5" Cad Plt Stl (#8 Aeroquip)
B0523642	Lock Washer, 0.75" Cad Plt Stl (#12 Aeroquip)	B0524622	Jam Nut, 0.75" Cad Plt Stl (#12 Aeroquip)
B0523667	Lock Washer, 1" Cad Plt Stl (#16 Aeroquip)	B0524639	Jam Nut, 1" Cad Plt Stl (#16 Aeroquip)
Dust Cap		Dust Plug	
0519810	Dust Cap, 0.25" Cad Plt Stl (#4 Aeroquip)	0511043	Dust Plug, 0.25" Cad Plt Stl (#4 Aeroquip)
0519809	Dust Cap, 0.5" Cad Plt Stl (#8 Aeroquip)	0511034	Dust Plug, 0.5" Cad Plt Stl (#8 Aeroquip)
0510475	Dust Cap, 0.75" Cad Plt Stl (#12 Aeroquip)	0511059	Dust Plug, 0.75" Cad Plt Stl (#12 Aeroquip)
0510487	Dust Cap, 1" Cad Plt Stl (#16 Aeroquip)	0511071	Dust Plug, 1" Cad Plt Stl (#16 Aeroquip)

II. INSTALLATION

Figure 9. Sample Control Wiring Diagram with TI Klixon Motor Protector

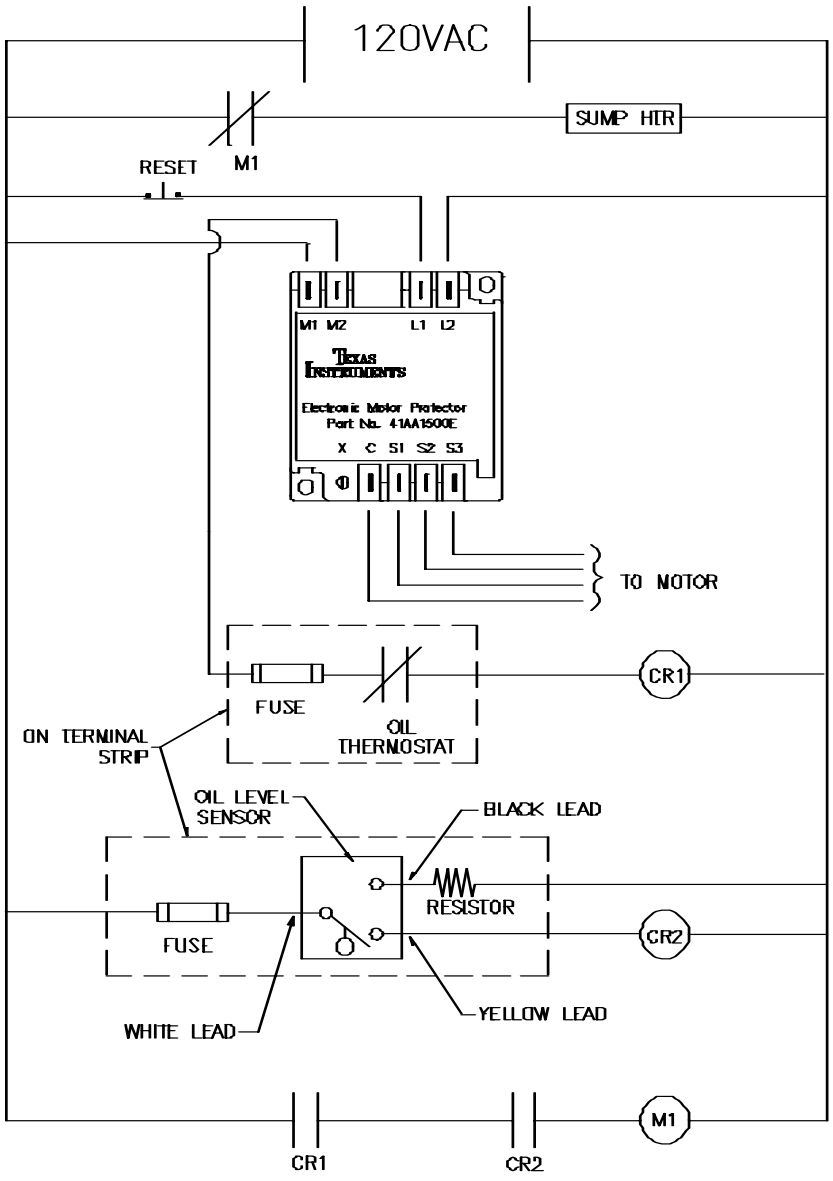


Table 8. Motor Sensor Resistances and Trip Points

SENSOR	ROOM TEMP 77°F (25°C)	OPERATING 170°F (76.7°C)	TRIP 305°F (151.7°C)
ROBERTSHAW	76 Ω	94 Ω	124 Ω
TI 41AA/2ACE	500-2500 Ω	< 5000 Ω	> 5000 Ω

b) TI 2ACE Motor Protector: The 2ACE solid state motor protection module provides current and thermal overload protection. This device monitors motor temperature via thermistor sensors installed in the motor windings. The module responds to the change in resistance when one or more of the sensors is exposed to trip temperature. The module will in turn shut off the output control relay, de-energizing the motor's pilot circuit.

To protect against current overload, the module monitors the current in each phase and reacts just like a solid state overload relay; it utilizes a trip curve based on an adjustable must hold amp setting. The current transducers are also used to protect against phase loss, current unbalance and miswire.

Calibrate the module using the 8 position DIP switch on the back of the module. The calibration is set using binary logic and can be set in 1 amp increments from 25 - 225 amps. The DIP switches are labeled 1 to 8 with 1 representing the most significant bit and 8 representing the least significant bit. The value of each switch in the on position is tabulated below. Add together the values of the on DIP switches to arrive at the MHA value.

Table 9. DIP Switch Values

DIP switch #	1	2	3	4	5	6	7	8
DIP switch amp value (on)	128	64	32	16	8	4	2	1

Ex: To get 121 amps, turn on switch 2, 3, 4, 5, and 8. This gives 64 +32 + 16 + 8 + 1 = 121.

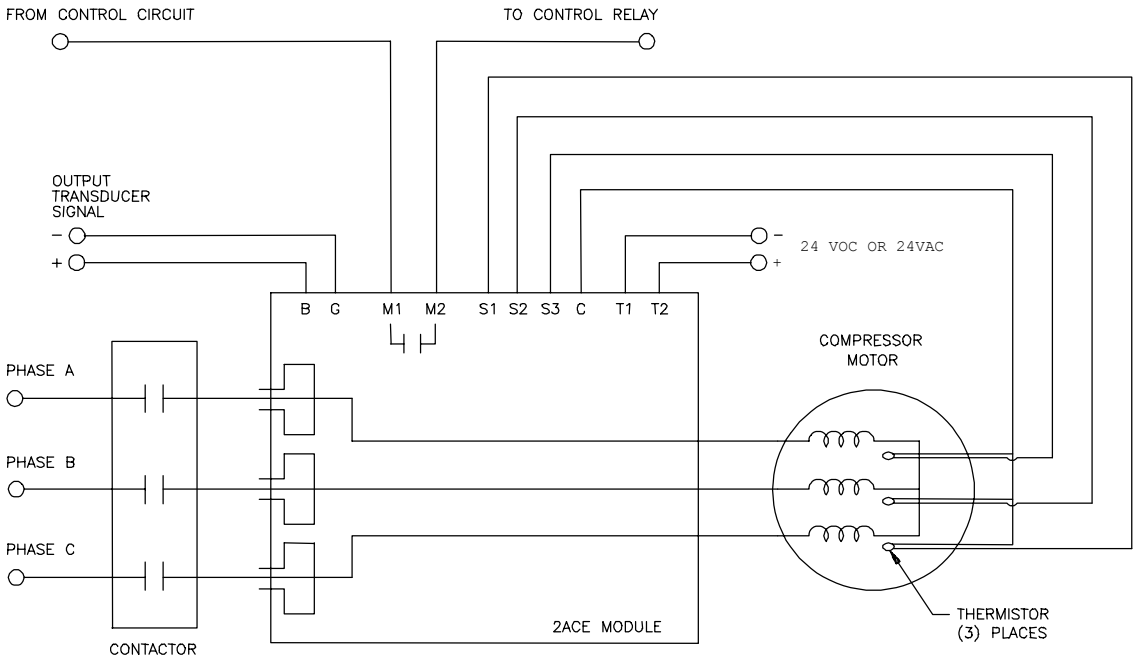
Module display codes: When the module is energized, it utilizes a seven segment display to provide operating status and fault diagnostic information. To reset the module, remove power from the T1 and T2 terminals for a minimum of two seconds.

Table 10. Display Value Definitions

DISPLAY VALUE	DEFINITION
0	Normal - no fault detected, module on, compressor on.
HA xxx	Normal - compressor off. Five digit cycling display - reads "H","A" followed by the three digit MHA setting. Ex: If calibrated at 121A, the display will repeatedly flash H, A, 1, 2, 1
1	Fault - current overload
2	Fault - loaded unbalance: >17% unbalance, current > .65*MHA
3	Fault - unloaded unbalance: > 25% unbalance, .40*MHA< current < .65*MHA
4	Fault - improper phase sequence/miswire
5	Fault - over temperature
6	Fault - out of range of MHA calibration
7	Fault - unloaded unbalance: >50% unbalance, current < .40*MHA
8	Fault - phase loss: >60% unbalance

II. INSTALLATION

Figure 10. TI 2ACE Motor Protector Wiring Diagram



c) Oil Level Sensor: The compressor is equipped with an optical level switch to protect the compressor from low oil level. See Figures 8 and 9 for wiring diagrams. A fuse is provided on the terminal board to protect the switch from fluctuations in control voltage. See Table 11 for fuse specifications.

Wire the hot lead to the white sensor lead. Wire the lead to load to the yellow/red (115/230 Volt) lead. The black lead is wired through a resistor directly to the unloader common (no other wiring is required for the black lead).

Table 11. Terminal Board Replacement Kits

CONTROL VOLTAGE	TERMINAL STRIP PART #	OIL SENSOR PART #	OIL SENSOR FUSE RATING	OIL T'STAT FUSE RATING
115 V	053888A5	055820A1	1.50 A	3.00 A
230 V	053888A6	055820A2	0.75 A	1.50 A

d) Sump Heater: The compressor's oil sump heater must be energized at least 24 hours prior to start up or sump heated to a minimum of 30°F (17°C) above ambient. Under normal operation the heater should be energized when the compressor is not running. The unit should never be left in service if the sump heater is inoperative.

e) Unloader Coils: The compressor is equipped with a 3-way solenoid valve for compressor capacity control. The two solenoid valves are wired to the compressor terminal box. The "load" coil is marked "A"; the "unload" coil is marked "B".

f) Oil Thermostat: The thermostat will open at 240°F. It is a secondary thermal protection device preventing the compressor from operating at excessive temperatures.

Installation, Operation & Troubleshooting for Texas Instruments 2ACE Motor Protection Modules

SUBJECT: Installation Operation & Troubleshooting Texas Instruments (TI) "KLIXON" 2ACE Motor Winding Protectors

APPLICATION: 110mm & 127mm Medium Screw Compressors

Hartford Compressors Inc. is presently offering the optional 2ACE module designed to protect the motor from excessive motor winding temperatures. In addition, the 2ACE module can monitor the motor current as well as the motor winding temperature. See service bulletin # SB19a for information on the TI 41AA modules.

There is presently only one 2ACE module being offered *by Hartford Compressors Inc*. for use in our compressors. Do not attempt to install a substitute with a different TI model number!

HCI Part #	Texas Instruments Part #	Thermister Type
055992A1*	2ACE-2C1	PTC (TI)

* This part number is for a module only. If ordering a module with a replacement compressor, use kit # 056169A1.

KRIWAN MOTOR SENSORS

Until April 2004, Texas Instrument sensors were used in the motors. In May 2004, we began using Kriwan sensors in the motors. Both sensors are compatible with the TI modules.

IDENTIFICATION

The last two digits of the compressor serial number identify the motor style.

i.e. Serial # DWC-A0123-16 (16) Indicates that this is a Leroy Somer motor with the new style (Kriwan) sensors.

Motors with new sensors will be identified with the numbers **16** – **17** or **18** at the end of the serial number.

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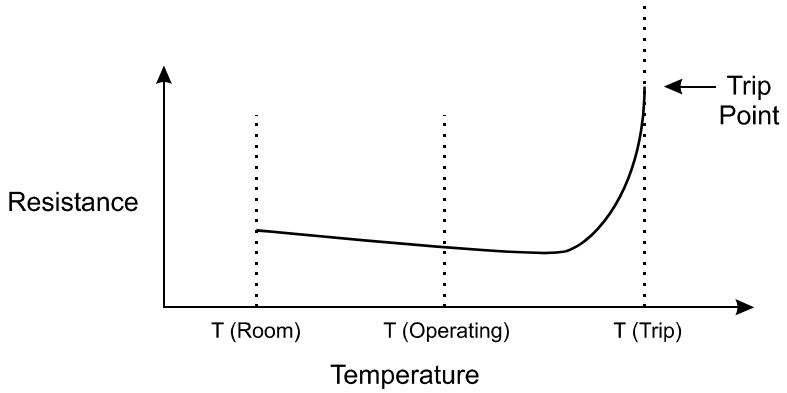
SENSOR RESISTANCE

The following table explains the characteristics of the three types of sensors.

SENSOR	ROOM TEMP 77ºF (25ºC)	OPERATING TEMP 170ºF (76.7ºC)	TRIP POINT TEMP AT MODULE 305ºF (152ºC)
Robertshaw	76 Ω	94 Ω	124 Ω
Texas Instruments	500 - 2500 Ω	< 2,500 Ω	5,000 Ω
Kriwan	10 - 100 Ω	< 100 Ω	13,500 Ω

Note: The Texas Instrument 2ACE module cannot read below 200 ohms. To compensate for this when the compressor has Kriwan sensors, 500 – 1000 ohm, 1-watt resistors must be installed in line with the sensor to the module. The TI and the Kriwan sensors will have low resistance readings until just before reaching the trip points. At that point, the resistance will increase rapidly until it reaches the trip point. As seen below the Kriwan sensor will have a lower resistance during operation than it will at room temperature.



INSTALLATION

Many operating problems can be avoided if the module is properly installed. Here are some helpful hints on installing the module.

LOCATION

- Control panel must be well ventilated
- Maximum ambient temperature is 150°F
- Install the module in the electric panel in such a way as to allow the power wires to be installed through the current transformers
- If there are two contactors used for the compressor, it is permissible to run two wires of the same phase through each current transformer

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INSTALLATION AND WIRING MODULE POWER

- Module input power to terminals **T1** & **T2**
- Input voltage must be between 20 and 28 VAC or 25 and 34 VDC
- Do not ground wires
- To protect the module components, install a ½ amp quick-blow in-line fuse from the power supply

SENSOR WIRING

- Wire sensors to **C, S1, S2** & **S3**

  Note: When wiring to Kriwan sensors, install 500 – 1000 ohm resistors in line with the sensor wires.
- The sensor wires must match the motor terminals and the module terminals
- Sensor wires must run in a separate wire conduit from the power wires
- This wire conduit should be installed separately from the main power run

Note: "C" is **NOT** a ground. Do **NOT** connect this terminal to any type of ground.

MODULE RELAY

- Terminals **M1** & **M2** tie in to a normal open (N/O) relay in the module.
- These terminals are to be wired to the compressor control circuit in such a way as to shut the compressor down if this relay opens. It is recommended that it break the circuit to the compressor contactor coil.

GENERAL

- Do not ground any wires
- No jumpers are to be used

MODULE SETUP

- Program the must hold amperage (MHA) into the module before energizing the module
- Determine the maximum amperage draw (RLA) of the compressor for the particular application
- The MHA is determined by multiplying the RLA by 1.10
- If the MHA is less than 225 amps, the module can be mounted in either the full line or the half line (for two-step start using two contactors)
- If the MHA is more than 225 amps, the module must be installed with the wires from the lead contactor only
- If wiring only one lead through the module, the module must be set at .5 X MHA

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- Once the module setting has been determined, calibrate the module using the 8-position DIP-switch panel in back of the module. The calibration is set using binary logic and can be set in 1 amp increments from 25 to 225 amps. The value of each switch in the "ON" position is tabulated below. Add the values together on the DIP-switches to arrive at the MHA value.

DIP Switch #	1	2	3	4	5	6	7	8
Amp Value	128	64	32	16	8	4	2	1

Note: The left position of the DIP-switch is the "ON" position.

- If the 2ACE module is not calibrated with a "Must Hold" setting or is set below the acceptance range, the module will display a "6"
- The module will not function properly until the "Must Hold" setting is calibrated correctly

MODULE COMMUNICATIONS

- The 2ACE module can be used to supply a control microprocessor with current information hereby eliminating the need for separate current transducers
- The module produces a proportional, load independent 0 to 5 VDC output that is linear over its full-scale range of 0 to 225 amps
- The output voltage value and the input current value are related by
  VDC Value (output) = Amperage Value (Input) / 45
- The module responds to the average AC current and incorporates full-scale signal conditioning of the transducer to produce a low ripple DC output voltage signal direct into the microprocessor without requiring a filter conditioning board
- The 2ACE module is connected the control microprocessor from terminals "B" (Positive) and "G" (Ground)

OPERATION

The 2ACE module functions in conjunction with sensors that are imbedded in the motor windings

- The sensors are positive temperature coefficient (PTC) thermistors
- Three sensors are connected for normal operation
- On newer compressors the 4th sensor is wired to the opposite terminal board as a spare
  It is designated S4
- If there is no S4 designation on the other terminal board, the spare sensor is installed inside the compressor behind the terminal board

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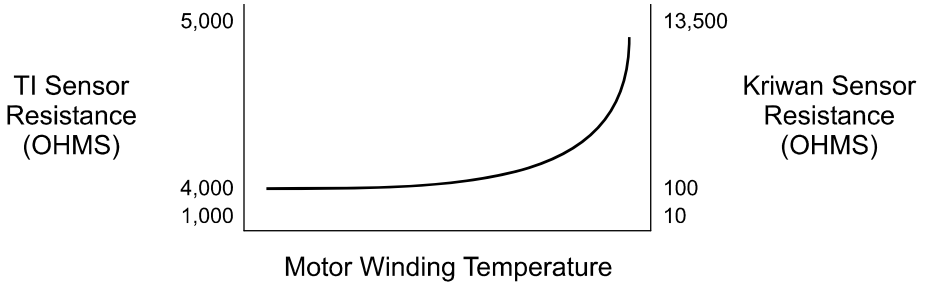
- They are preset to trip at a predetermined temperature

COMPRESSOR	TRIP POINT
MSC	302ºF (150ºC)

- The module senses the resistance of the sensors
- When the motor winding temperature reaches the set point, the module opens a set of contacts between terminals M1 and M2
- These are wired to the compressor's control circuit shutting down the compressor. In order to reset the module, the power to the module must be interrupted.
- This is normally accomplished with a normally closed (N/C) push button.
- Refer to the attached wiring diagram showing the recommended method of wiring the control.

When reading the sensor resistance, the sensor wires MUST be disconnected from the control module. Otherwise an erroneous reading will result.

- During shutdown, after the motor has cooled, the TI thermistors will read from 500 to 2500 ohms (Kriwan sensors will read 10 – 50 ohms)
- At the normal operating temperature (170°F), they will read < 5000 ohms (<13,500 ohms for Kriwan sensors)
- As the temperature approaches the set point, their resistance will increase rapidly until, at the trip point, they will read >5000 ohms (13,500 ohms for Kriwan sensors)



Note: When troubleshooting, it is important to realize that, once the compressor shuts down, the motor winding temperature will decrease rapidly and the resulting PTC resistance will also drop rapidly. For this reason, all resistance readings should be taken as soon as possible after the module trips.

- When the module has been calibrated, wired and energized, it utilizes the LED display to provide operating status and fault diagnostic information

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- Under normal circumstances, before the compressor is started, the LED display will flash different displays to show the “Must Hold” setting of the module
- For example, if the MHA setting is 123 amps, the display will flash **H**, **A**, **1**, **2**, **3**

TROUBLESHOOTING

- The 2ACE module will reset automatically if supply power is lost and regained
- For all other faults, the module will not reset automatically
- To reset the module, the power to the module must be interrupted
- As mentioned earlier, this is normally accomplished with a normally closed (N/C) push button
- Refer to the attached wiring diagram showing the recommended method of wiring the control

NORMAL CAUSES OF HIGH MOTOR WINDING TEMPERATURES

- The LED display on the module will show a numbered code when the compressor is operating.
- There are nine different codes that can be displayed in addition to the “Must Hold” display when the compressor is not operating. Each is self-explanatory.

DISPLAY	DEFINITION
0	Normal - No Fault - Module ON - Compressor ON
1	Fault - Current Overload
2	Fault - Loaded unbalance/phase loss: >17% unbalance. Current >.65% MHA
3	Fault - Unloaded unbalance/phase loss: > 25% unbalance, 65%MHA >Current > 40% MHA
4	Fault - Improper phase sequence/miswire
5	Fault - Over-temperature
6	Fault - Out of range of MHA calibration
7	Fault - Unloaded unbalance/phase loss: >50% unbalance, < 40% MHA
8	Fault - Phase loss: > 60% unbalance

- If the compressor shuts off on one of the faults read the LED display and correct the fault.
- If there is no display on the module LED display, de-energize the module for five minutes and restart. The display should come back on and function normally.
- If the motor is overloaded, the amperage will increase resulting in a rise in motor winding temperature above the normal operating temperature.
- A large voltage imbalance will cause the amperage to rise abnormally resulting in an increase in the motor winding temperature. The phase to phase voltage imbalance should not exceed 2%.

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- Normally, on air-cooled installations, the motor is indirectly cooled using liquid injection. When the package goes into a “pumpdown” mode, the liquid injection shuts off. This may allow the motor windings to approach the trip point and trip the module even though the compressor has actually shut down. The solution would be to install a separate liquid injection line with solenoid or limit the pumpdown time.

OTHER CAUSES OF MOTOR WINDING PROTECTOR MODULE TRIPS

It has been our experience that, being a solid state control, the module can be susceptible to nuisance trips. We have listed some other problems that may cause the module to trip.

- Loose wires. All wire connections must be tight. Check all connections, especially the thermistor wires.
- Check the module power supply. It must be between 20 & 28 VAC or 25 & 34 VDC.
- Check control voltage quality. Sudden spikes in the supply power can cause the module to trip.
- Stray Voltages: The sensor wires must be run in a separate conduit from the main power wires. If run in the conduit with the main power wires, the voltage from the power can cause erratic readings of the sensors.
- Defective sensor. If one of the sensors is defective, it can give a “trip” signal to the module.
- In rare instances, a sensor may appear to be operating correctly but it will open shortly after the compressor starts.
- Follow the instructions for troubleshooting a sensor that opens sporadically.
- If a sensor is determined to be defective there are two solutions to remedy the problem. See section on repairing a defective sensor.
- High Ambient temperatures. If the module is subjected to temperatures in excess of 150°F, it will trip. There may or may not be a display on the module when this happens.

LOCATING A SENSOR THAT OPENS SPORADICALLY

In rare cases, a sensor will only open when the compressor runs. It will close again when the compressor is shut down. Use the following instructions to find the defective sensor.

When running these tests; closely monitor temperatures and pressures to be sure that the compressor motor does not overheat. It is recommended that a thermometer be installed on the discharge line within 6" of the compressor. The discharge line temperature should not be allowed to go above 170°F.

1. With the compressor shut down and wired normally, install three, 1000 ohm resistors in the module between terminals C and S1, C and S2, C and S3.
2. Run the compressor normally for, between 30 and 60 minutes.
3. If the module trips, the module is bad.
4. If the module does not trip the compressor, remove the resistor between C and S1. Connect wires C and S1 between the compressor and the module
5. Run the compressor for another 30 to 60 minutes.
6. If the module trips, that sensor is bad. Replace the resistor.
7. Shut down the compressor and repeat steps 4, 5 & 6 with sensors S2 and S3.
8. Once you have determined which sensor(s) is bad, continue with the following repairs

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REPAIRING DEFECTIVE SENSORS

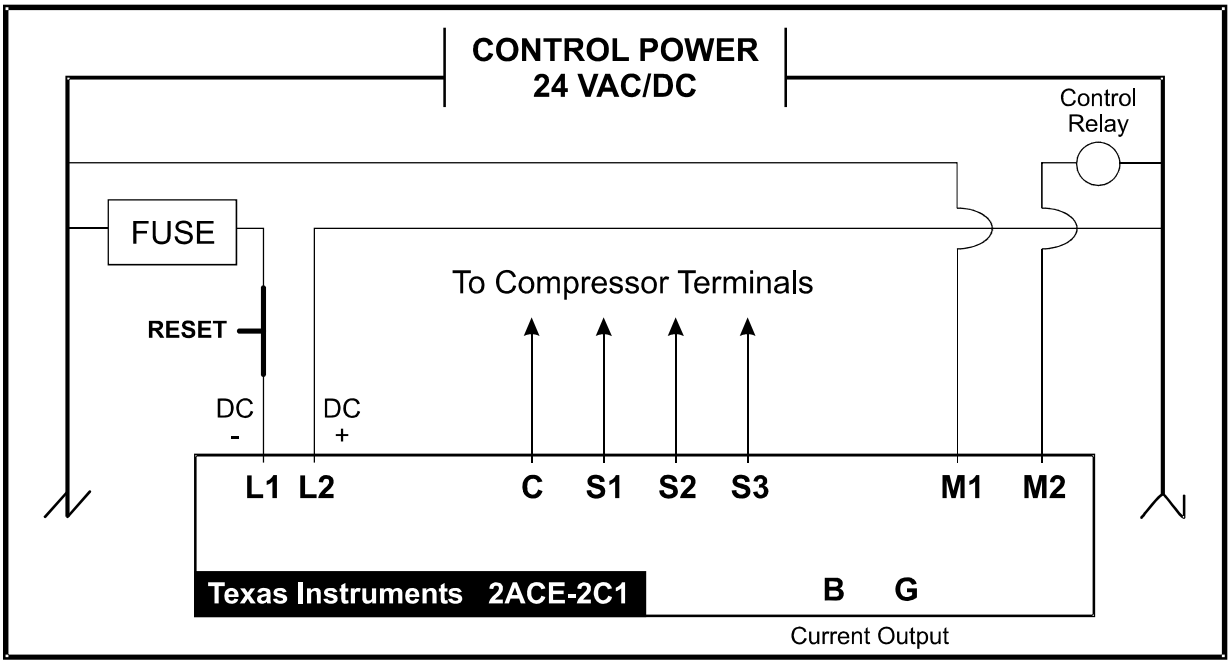
If a temperature sensor is determined to be defective there are two accepted solutions to the problem. The first is to use the spare sensor. The second is to jump out the defective sensor.

USING THE SPARE SENSOR

- On newer 127mm compressors built after 2003, there is an installed spare sensor. Between the power terminals there are two 4-post terminal boards. The right hand board has the 4 connectors for the motor sensors. The left hand board has one terminal designated S4. This is the spare sensor.
- If there is no S4 terminal designation, there may be a spare sensor tied behind the right hand board. Call HCI Application Engineering department with the compressor serial number to see if there is a spare sensor installed in the compressor.
- There is a kit available to utilize the spare sensors that are installed inside the compressor. This kit contains a terminal plate o-ring, shrink insulation, a wire tie and instructions. The instruction sheet gives detailed instructions on how to use to the spare sensor.
- If the spare sensor is used, it is recommended that a note be placed on the outside to inform future Service Technicians.

SENSOR REPLACEMENT KIT: # 055047A1

- If, after using the spare sensor, there is still a defective sensor, contact HCI Application Engineering Department for further instructions



TYPICAL WIRING DIAGRAM (2ACE)

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MODEL RS SERIES COMPRESSOR TEST DATA

CUSTOMER: **SALES ORDER #:**

DATE RECEIVED: ____________________________

TEST ENGINEER: ____________________________

SERIAL #: ____________________

DATA POINT		1st Stage Drain Valve	Load	Pressures (psig)												Temperature (F)							Flows					Motor Data							
				Suction	Discharge	Oil Cooler		Water		Aftercooler		1st Coal	2nd Coal	After Flocon	After Ads	Skid H20	Aftercooler			Oil Cooler			Skid H20	AftC H20	Oil	Pump He	Pump He	AMPS			VOLTS			P.F.	Total Power
TIME	ETM	(turns open)	%	PI-1	PI-2	In	Out	In	Out	In	Out					IN	H20 OUT	He IN	He OUT	H20 OUT	Oil IN	Oil OUT	gpm	hgpm	gpm	scfm(0)	scfm (20)	#1	#2	#3	#1	#2	#3		(KW)
Test 1 - Set coalescer drain on 1st stage to 1 turn greater than the steady state level position for each data point. Record each setpoint. Set all other coalescer drains to 1/2 turn open.																																			

NOTES:

CPI ENGINEERING SERVICES, INC.
Material Safety Data Sheet

2300 James savage Rd.
Midland, Michigan 48642
PH: (989) 496-3780
Fax: (989) 496-2313

Emergency Number: (989) 496-3780

Section 1 Product Name and Information

Product (Trade Name and Synonyms): CP-4600 Series
Chemical Name: Polyalphaolefin
Chemical Family: Synthetic hydrocarbon
Formula: Proprietary
CAS#: Proprietary

Section 2 Components and Hazard Statement

This material has no known hazards under applicable laws. The product contains no known carcinogens. No special warning labels are required under OSHA 29 CFR 1910.1200.

Section 3 Safe Handling and Storage

Handling: Do not take internally. Avoid contact with skin, eyes, and clothing. Upon contact with skin, wash exposed area with soap and water. If product enters the eyes, flush with water for 15 minutes and consult a physician. Wash contaminated clothing before reuse.

Storage: Keep container tightly sealed when not in use.

CPI Engineering Services, Inc.
Product Name: CP-4600 Series

Distributed by Linde Cryogenics
Compressor Fluid: Heli-Lube 68

Section 4 **Physical Data**

Appearance: Clear liquid, yellow to light brown tint
Boiling Point: > 300°F
Vapor Pressure: < 0.01 mmHg @ 20°C
Specific Gravity (water=1): 0.79-0.85
Volatiles, Percent by Volume: 0%
Odor: None
Solubility in Water: Insoluble
Evaporation Rate (butyl acetate=1): Nil

Section 5 **Fire and Explosion Hazards**

Flash Point (Cleveland Open Cup): 425°F
Flammable Limits: Not established
Auto ignition Temperature: No data
HMIS Ratings:

Health:	0
Flammability:	1
Reactivity:	0

NFPA Ratings in air: Not estabilished

Extinguishing Media: Dry chemical; CO_2 foam; water spray (fog)

Unusual Fire and Explosion Hazards: None

Special Fire Fighting Techniques: Toxic fumes, gases or vapors may evolve on burning. Firefighters should use NIOSH/MNSA-approved self-contained breathing apparatus. Use water to cool fire-exposed containers. Use water carefully near exposed liquid to avoid frothing and splashing of hot liquid.

Section 6 **Reactivity Data**

Stability: Stable
Hazardous Polymerization: Will not occur
Incompatible Materials: Strong oxidizers
Conditions to Avoid: Excessive heat
Hazardous Decomposition Products: Analogous compounds evolve carbon monoxide, carbon dioxide, and other unidentified chemicals when burned. See section 5.

Section 7 **Health Hazard Data**

Threshold Limit Value: 5 mg/m^3 ACGIH
Situations to Avoid: Avoid breathing oil mists.
First Aid Procedures:

Ingestion: DO NOT INDUCE VOMITING. If conscious, give 2 glasses of water and consult physician. May cause nausea and diarrhea.

Inhalation: Product is not toxic by inhalation. If oil mist is inhaled, remove to fresh air and consult physician.

Contact: Upon contact with skin, wash exposed area with soap and water.

Section 8 **Personal Protection Information**

Respiratory Protection: Use in well ventilated area
Ventilation: Local exhaust
Protective Gloves: Not required, but recommended, especially for prolonged exposure
Eye/Face Protection: Safety glasses or goggles

CPI Engineering Services, Inc.
Product Name: CP-4600 Series

Distributed by Linde Cryogenics
Compressor Fluid: Heli-Lube 68

Section 9 **Spill or Leak Procedures**

In Case of Spill: Wear suitable protective equipment, especially goggles. Stop the source of the spill. Dike the spill area. Use absorbent materials to soak up fluid (i.e. sand, sawdust and commercially available materials). Wash the spill area with large amounts of water. Properly dispose of all materials.

Section 10 **Waste Disposal Methods**

Incinerate this product and all associated wasted in a licensed facility in accordance with Federal, State, and local regulation. This material is not a hazardous waste under RCRA Regulation 40 CFR 261.

The information in this material safety data sheet should be provided to all who use, handle, store, transport or are otherwise exposed to this product. We believe the information in this document to be reliable and up to date as of the date of publication, but makes no guarantee that it is.

Date Revised: 01/07

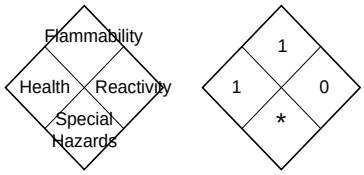
CPI Engineering Services, Inc.
Product Name: CP-4600 Series

Distributed by Linde Cryogenics
Compressor Fluid: Heli-Lube 68

Norit Activated Carbon
leading in purification

MATERIAL SAFETY DATA SHEET

NFPA HAZARD SYMBOL+



4-Extreme
3-High
2-Moderate
1-Slight
0-Insignificant
*-See Section 16 for Special Hazards

Norit MSDS No. 102
Revision Date: August 5, 2008
Revision No. 05

Norit Activated Carbons

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Norit Americas Inc. **3200 West University Avenue** **Marshall, TX 75670**

Emergency Telephone Numbers:

Chem-tel (800) 255-3924 (24 hour) Sales Office (800) 641-9245 Marshall Plant (903) 923-1000

Names used on product labels:

ELORIT®	NORIT® PK 0.25-1	NORIT® RO 0.8 (H)	NORIT® SX 1
NORIT® A SUPRA USP	NORIT® PK 1-3	NORIT® RO 2H	NORIT® SX 1G
NORIT® A SPECIAL E 153	NORIT® PK 3-5	NORIT® ROW 0.8 SUPRA	NORIT® SX 2
NORIT® AZO	NORIT® PKDA 10X30	NORIT® ROX 0.8	NORIT® SX 4
NORIT® B SUPRA USP	NORIT® PN 2	NORIT® ROY 0.8	NORIT® SX PLUS
NORIT® C EXTRA USP	NORIT® R 1 EXTRA	NORIT® RO 3515	NORIT® SX PLUS CAT
NORIT® CNR 115	NORIT® R 2030	NORIT® RO 3520	NORIT® SX SUPER E 153
NORIT® D10	NORIT® R 2030 CO_2	NORIT® RX 1 EXTRA	NORIT® SX ULTRA
NORIT® DLC PLUS	NORIT® RB 2(C)	NORIT® RX 3 EXTRA	NORIT® SX ULTRA CAT
NORIT® DLC SUPER	NORIT® RB 3	NORIT® RX 4 EXTRA	NORIT® SXRO
NORIT® DLC SUPRA	NORIT® RB 30M	NORIT® SA 4	NORIT® VETERINAIR
NORIT® E SUPRA USP	NORIT® RB 4	NORIT® SA 4 PAH	SORBONORIT® 4
NORIT® GBG	NORIT® RB 4 C	NORIT® SA 4 PAH HF	SORBONORIT® B3
NORIT® GF 40	NORIT® RB 40M	NORIT® SA 4 PAH XL	SORBONORIT® B4

Chemical Name • Activated Carbon
Product Use • Liquid and vapor applications (purification, decolorization, separation, and deodorization)

2. COMPOSITION / INFORMATION ON INGREDIENTS

IDENTITY	CAS NO.	%
Activated Carbon	7440-44-0	100

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Odorless black granules or powder. **Activated carbon (especially when wet) can deplete oxygen from air in enclosed spaces, and dangerously low levels of oxygen may result.** When workers enter a vessel containing activated carbon, follow procedures for potentially low oxygen. Workers should also take appropriate precautions when dealing with spent (used) activated carbons which may exhibit properties of adsorbed materials.

POTENTIAL HEALTH EFFECTS:

Medical conditions aggravated by exposure: None documented

Routes of Exposure:

Eyes: • Not corrosive, but like most particulate materials, may cause mild physical irritation.

Skin: • Not corrosive and not a primary skin irritant. Mild irritation is possible due to abrasive action of dust.

Ingestion: • No known deleterious effects.

Inhalation: • Possible mild irritation of respiratory tract due to drying and abrasive actions of dust.

Chronic Effects: • IARC: Not listed • NTP: Not listed • OSHA: Not regulated

For additional information, see Section 16.

4. FIRST AID MEASURES

Skin:	• Wash material off the skin with soap and water. Seek medical attention if irritation occurs.
Eyes:	• Flush with copious amounts of water. Seek medical attention if irritation occurs.
Ingestion:	• Give one or two glasses of water to drink. Seek medical attention if gastrointestinal symptoms develop.
Inhalation:	• Remove to fresh air. Seek medical attention if cough or respiratory symptoms develop.

5. FIRE FIGHTING MEASURES

Flashpoint	• Not Applicable.
Non-flammable	• 16CFR1500.44.
Not Self Heating	• UN Manual of Tests and Criteria, Test N.3.
Flammability Limits in Air	• LFL and UFL Not Applicable.

GENERAL HAZARD:
Activated carbon is difficult to ignite and tends to burn slowly (smolder) without producing smoke or flame. Toxic gases will form upon combustion.

FIRE FIGHTING INSTRUCTIONS:
If possible to do safely, move smoldering activated carbon to a non-hazardous area, preferably out of doors. Extinguish fire using water fog, fine water spray, carbon dioxide or foam. Avoid stirring up dust clouds.

FIRE FIGHTING EQUIPMENT:
Fire fighting personnel should wear full protective equipment, including self-contained breathing apparatus (SCBA) for all inside fires and large outdoor fires.

HAZARDOUS COMBUSTION PRODUCTS:
Combustion products may include smoke and oxides of carbon (for example, carbon monoxide). Materials allowed to smolder for long periods in enclosed spaces, may produce amounts of carbon monoxide which reach the lower explosive limit (carbon monoxide LEL = 12.5% in air). Under certain conditions, any airborne dust may be an explosion hazard. Used activated carbon may produce additional combustion products.

6. ACCIDENTAL RELEASE MEASURES

IF A SPILL OR LEAK OCCURS:
Clean up spills in a manner that does not disperse dust into the air. Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposure, and removal of material from eyes, skin, and clothing.

DISPOSAL METHOD:
Spent granular activated carbon may be recyclable. Dispose of virgin (unused) carbon (waste or spillage) in a facility permitted for non-hazardous wastes. Spent (used) carbon should be disposed of in accordance with applicable laws.

CONTAINER DISPOSAL:
Do not reuse empty bags. Dispose of in facility permitted for non-hazardous wastes.

7. HANDLING AND STORAGE

Storage Temperature:	• Ambient
Storage Pressure:	• Atmospheric
Handling:	• Follow good handling and housekeeping practices to minimize spills, generation of airborne dusts, and accumulation of dusts on exposed surfaces.
	• Use with adequate exhaust ventilation to draw dust away from workers' breathing zones.
	• Prevent or minimize exposures to dusts by using appropriate personal protection equipment.
	• Wash exposed skin areas thoroughly with soap and water after handling.
Storage:	• Store product in a closed dry container. Maintain good housekeeping. Store away from strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls:
- Use local exhaust ventilation to control emissions near the source.

Eye Protection:
- Safety glasses with side shields are recommended for any type of handling. Where eye contact or dusty conditions may be likely, dust tight goggles are recommended. Have eye flushing equipment available.

Skin Protection:
- Avoid skin contact with this product. Wear appropriate dust resistant clothing. Wash contaminated clothing and clean protective equipment before reuse. Wash skin thoroughly after handling.

Respiratory Protection:
- Keep dust exposure to a minimum with engineering and administrative controls. Use appropriate NIOSH/MSHA approved particulate respirators if necessary. Observe respirator use limitations specified by NIOSH/MSHA or the manufacturer.

Airborne Exposure Guidelines:

Recommended Exposure Limits 8-hr TWA	Activated Carbon
Total Dust	7.5 mg/m^3*
Respirable Fraction	2.5 mg/m^3*

*OSHA and ACGIH have not established specific exposure limits for this material. These guidelines are based on a conservatively high concentration of silica quartz (2%). Actual airborne silica concentrations may be much lower. If so, the PEL or TLV would be higher. No ceiling or short-term exposure limits have been set by OSHA or ACGIH.

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point, C:	• NA
Bulk Density - Granular Grades	• 21-25 lbs/ft^3
Bulk Density - Powder Grades	• 15-35 lbs/ft^3
Vapor Pressure	• NA
Vapor Density	• NA
Evaporation Rate	• NA
Freezing Point, C:	• NA
% Volatiles	• NA
Solubility in Water	• Insoluble
Appearance and Odor	• Black granules or powder with no odor

NA - Not applicable

10. STABILITY AND REACTIVITY DATA

Stability:
- This product is stable under the specified conditions of storage, shipment and use.

Incompatibility:
- Contact with strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in rapid combustion. Avoid contact with strong acids.

Hazardous Decomposition Products:
- Oxides of Carbon

Hazardous Polymerization:
- Does not occur.

11. TOXICOLOGICAL INFORMATION

This material is non-toxic in its original state. Used activated carbon may exhibit characteristics of the adsorbed material.

12. ECOLOGICAL INFORMATION

This material, in its original state, is not harmful to the environment. Used activated carbon may exhibit characteristics of the adsorbed material.

13. DISPOSAL CONSIDERATIONS

Activated carbon, in its original state, is not a hazardous material or hazardous waste. Follow applicable governmental regulations for waste disposal.

Used activated carbon may become classified as a hazardous waste depending upon the application. Follow applicable regulations for disposal.

Recycling (reactivation) may be a viable alternative to disposal. Contact Norit Americas Inc. for information.

14. TRANSPORT INFORMATION

DOT (Department of Transportation)

Proper Shipping Name:	• Activated carbon (Not DOT Regulated).
Hazard Class:	• Not applicable.
UN/NA Number:	• Not applicable.
Packing Group:	• Not applicable.
Freight Classification:	• STCC Code - #2899643 NMFC #040560

15. REGULATORY INFORMATION

FEDERAL REGULATIONS:

OSHA Hazard Communication Standard, 29CFR1910.1200:	• See "Particulates not otherwise regulated," in Table Z-1, of 29CFR1910.1000, "Limits For Air Contaminates".
CERCLA/SUPERFUND, 40CFR117, 302:	• Notification of spills of this material is not required.
SARA/SUPERFUND:	• Section 302 - Extremely Hazardous Substances (40CFR355): This product is not listed as an extremely hazardous substance. • Section 313 - List Of Toxic Chemicals: This product is not listed.
Toxic Substances Control Act, 40CFR710:	• Activated carbon is on the inventory list.
Resource Conservation and Recovery Act:	• Activated carbon, in its original state, does not meet the criteria of hazardous waste.

STATE REGULATIONS:

California Occupational Safety and Health:	• Not listed
Massachusetts Substance List:	• Not listed
New Jersey Right-to-Know:	• Not listed
Pennsylvania Right-to-Know:	• Not listed

16. OTHER INFORMATION

Activated carbon can be safely stored in any normal storage area, but away from sources of direct heat.

WARNING: Activated carbon (especially when wet) can deplete oxygen from the air, and dangerously low levels of oxygen may result. When workers enter a vessel containing activated carbon, procedures for potentially low oxygen areas should be followed.

Activated carbons are not listed as potential carcinogens by any agency. Activated carbon may contain crystalline silica, which has been listed as a potential carcinogen of the lungs by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP). Much of the silica is inextricably bound within the particles of activated carbon, and does not present a substantial health hazard. Because Norit Americas adheres to a very conservative position regarding all health and safety matters, we recommend and follow a practice of requiring respiratory protection whenever there is any evidence of airborne dust.

REVISION SUMMARY:

REV 05: Changed name of SA 4 PAH 510 to SA 4 PAH XL in Section 1.
REV 04: Added NORIT SA 4 PAH 510, RB 30M, RB 40M and NORIT RO 2H to Section 1.
REV 03: New format and removed some products no longer available.
REV 02: Added new products NORIT A SPECIAL E 153, NORIT GCN 612G, NORIT RB 4W, NORIT RO 0.8H, NORIT ROW 0.8 SUPRA, NORIT RO 3515, NORIT RO 3520, NORIT RX 4 EXTRA and NORIT VETERINAIR to Section 1.
REV 01: Added new products, NORIT DLC PLUS, NORIT DLC SUPER and NORIT DLC SUPER to Section 1.
REV 00: New MSDS

The information herein is given in good faith but no warranty, expressed or implied, is made.

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

*

1 Identification of Substance

Product Details

Trade Name: Helium, compressed gas

Product No: G-5

Manufacturer/Supplier:

Linde
575 Mountain Avenue
Murray Hill, NJ 07974 USA
ph: 908-464-8100

Linde Gas Puerto Rico, Inc.
Las Palmas Village
Road No. 869, Street No. 7
Catano, Puerto Rico 00962
ph: 787-754-7445

Linde Canada Limited
5860 Chedworth Way
Mississauga, Ontario L5R 0A2
ph: 905-501-1700
.

Information Department:
Linde U.S. National Operations Center: 1-800-232-4726 (for US and Puerto Rico assistance)

Emergency Information:
For U.S & Puerto Rico, CHEMTREC 24-HOUR EMERGENCY TELEPHONE NUMBER: 800-424-9300
For Canada, 24-HOUR EMERGENCY TELEPHONE NUMBER: 905-501-0802

*

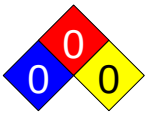
2 Hazards Identification

Hazard Description:
Helium is a colorless, odorless inert gas. Helium is a simple asphyxiant. Maintain oxygen levels above 19.5%. Contents under pressure. Use and store below 125°F.

Emergency Overview:
This product does not contain oxygen and may cause asphyxia if released in a confined area. Intentional misuse of this product can cause serious lung damage or death. Contact with rapidly venting helium gas near the point of release may cause frostbite.

CLASSIFICATION SYSTEM:

NFPA Ratings (scale 0 - 4)



Health = 0
Fire = 0
Instability = 0
Special = SA

HMIS Ratings (scale 0 - 4)

Health = 0
Fire = 0
Physical Hazard = 3

*

3 Composition/Data on Components

CAS No. Description
7440-59-7 Helium, compressed gas
IDENTIFICATION NUMBER(S):
EINECS Number: 231-168-5

*

4 First aid measures

After Inhalation:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an

(Contd. on page 2)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

uncontaminated area and, if breathing has stopped, administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

After skin contact:
None required for gas. For frostbite, immerse skin in lukewarm water. DO NOT USE HOT WATER. Obtain medical attention.

After eye contact:
None required for gas. If frostbite is suspected, flush eyes with cool water for 15 minutes and obtain immediate medical attention.

After ingestion: None expected, as helium is a gas at room temperature.

*

5 Fire fighting measures

Flammable Properties:
Nonflammable. Cylinder may rupture violently from pressure or vent rapidly when involved in a fire situation.

Suitable extinguishing agents:
None required. Use extinguishing media appropriate for the combustible material present.

Protective equipment:
Firefighters should wear approved NIOSH/MSHA full facepiece self-contained breathing apparatus (SCBA) and full turnout or Bunker gear.

Fire Fighting Instructions:
Continue to cool fire-exposed containers until well after flames are extinguished.

*

6 Accidental release measures

Person-related safety precautions:
Evacuate all personnel from the affected area. Use appropriate personal protective equipment (see Section 8). Stop the flow of gas or remove cylinder to outdoor location - ONLY if possible to do so without risk. Ventilate enclosed areas. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest Linde location.

*

7 Handling and storage

HANDLING:
Information about protection against explosions and fires:
Store in a cool, dry area away from combustibles, sunlight, incompatilbe materials, and sources of heat or ignition. Ensure adequate ventilation.

STORAGE:
Requirements to be met by storerooms and receptacles:
This product mixture is noncorrosive and may be used with all common structural materials.

(Contd. on page 3)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

Use only in well-ventilated areas in accordance with manufacturer's and Linde's instructions. Do not tip, drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Valve protection caps must remain in place unless container is secured with valve outlet piped to the use point. Use a pressure-reducing regulator when connecting cylinder to lower pressure piping or systems. Do not heat container by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the system. If user experiences any difficulty operating container valve, discontinue use and contact supplier. Do not insert any object (i.e., screwdriver) into valve cap openings as this can damage valve, causing leakage.

Protect containers from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time.

For additional recommendations, consult Compressed Gas Association's Pamphlets P-1, P-9 and P-18, and Safety Bulletins SB-2 and SB-14.

Specific applications:
Proper handling, storage and operation of regulating equipment and cylinders is required to safely fill helium balloons. DO NOT ALLOW CHILDREN or unqualified people to operate balloon filling equipment. INTENTIONAL INHALATION OF HELIUM CAN CAUSE SERIOUS LUNG DAMAGE OR DEATH. A balloon-filliing helium regulator must be attached to the valve before it is opened. Close cylinder valve after each use and when empty. Do not use in poorly ventilated areas or attempt to remove stuck or jammed protective caps. Check for leaks and do not use leaky equipment. Do not use helium unless cylinder is properly labeled. Do not attempt to transfer helium from cylinder into any other container. Do not substitute hydrogen (a highly flammable gas) for helium.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

Security:
Store container in a secured area. Limit access to authorized personnel only. Report any incidents involving thefts, misuse, or inventory shortages (missing containers or cylinders) to law enforcement and the supplier. Security shall be provided in accordance with all local, state (provincial) and federal regulations.

*

8 Exposure controls and personal protection

Engineering Controls:
Use local exhaust in combination with general ventilation systems as necessary to prevent accumulation of helium concentrations above acceptable exposure limits and to maintain oxygen levels in air above 19.5%.

Components with limit values that require monitoring at the workplace:	
Helium, compressed gas	
TLV	Simple asphyxiant

PERSONAL PROTECTIVE EQUIPMENT:

Breathing equipment:
For emergency release, use a positive pressure NIOSH-approved air-supplying respirator system (SCBA or airline/escape bottle) using a full-face mask and at a minimum Grade D air.

Hand/skin protection: Protective gloves and clothing appropriate for the job.

Eye/face protection: Safety goggles or glasses as appropriate for the job.

(Contd. on page 4)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

Other/General Protection:
Safety shoes or other footwear appropriate for the job, safety shower and emergency eyewash station.

*

9 Physical and chemical properties

GENERAL INFORMATION:	
Form:	Gas
Color:	Colorless
Odor:	Odorless
CHANGE IN CONDITION:	
Melting point/Melting range:	Not available
Boiling point/Boiling range:	-268.9°C (-452°F)
Flash point:	Not applicable
Vapor pressure:	Not available
Density:	Vapor density for hydrogen is 0.07
Solubility in / Miscibility with Water at 0°C (32°F):	0.0094 vol/vol

*

10 Stability and reactivity

Thermal decomposition / Conditions to be avoided: Stable

Materials to be avoided: None. Product is an inert gas.

Dangerous reactions: None

Dangerous products of decomposition: None

*

11 Toxicological information

ACUTE TOXICITY
Toxicological Overview: Helium is a simple asphyxiant. See "Inhalation Effects" section below.
PRIMARY IRRITANT EFFECT:

On the skin:
Not expected to cause skin irritation. Contact with rapidly expanding gas near the point of release may cause frostbite with redness, skin color change to gray or white, and blistering.

On the eye:
Not expected to cause eye irriation. Contact with rapidly expanding gas near the point of release may cause frostbite.

On inhalation:
High concentrations of helium may exclude an adequate supply of oxygen to the lungs. Effects of oxygen defeciency resulting from simple asphyxiation may include rapid breathing, diminished mental alertness, impared muscular coordination, faulty judgement, depression of all sensations, emotional instability and fatigue. As asphyxiation progresses, nausea, vomiting, prostration and loss of consciousness may result, eventually leading to convulsions, coma and death.

Intentional inhalation of helium balloon gas can cause asphyxiation, lung damage and death.

(Contd. on page 5)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

Other information (about experimental toxicology):
Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

*
12 Ecological information

Environmental impact:
Not classified as a Class I or Class II ozone depleting substance. Not toxic. Will not bioaccumulate.

13 Disposal considerations

PRODUCT:
Recommendation:
Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED, WITH ALL VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to Linde or authorized distributor for proper disposal.

*
14 Transport information

DOT regulations:

Hazard class:	2
Identification number:	UN1046
Packing group:	-
Proper shipping name (technical name):	HELIUM, COMPRESSED
Label	2.2

Land transport ADR/RID (cross-border):

ADR/RID class:	2 1A Gases
Danger code (Kemler):	20
UN-Number:	1046
Packaging group:	-
Label:	2.2
Description of goods:	1046 HELIUM, COMPRESSED

Maritime transport IMDG:

IMDG Class:	2.2
UN Number:	1046
Label	2.2

(Contd. on page 6)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

Packaging group:	-
EMS Number:	F-C,S-V
Proper shipping name:	HELIUM, COMPRESSED

Air transport ICAO-TI and IATA-DGR:

ICAO/IATA Class:	2
UN/ID Number:	1046
Label	2.2
Packaging group:	-
Proper shipping name:	HELIUM, COMPRESSED

*
15 Regulations

SARA
Section 355 (extremely hazardous substances): Substance is not listed.
Section 313 (Specific toxic chemical listings): Substance is not listed.
TSCA (Toxic Substance Control Act):
The substance is listed.

Helium, compressed gas

PROPOSITION 65:
Chemicals known to cause cancer: Substance is not listed.
Chemicals known to cause reproductive toxicity for females: Substance is not listed.
Chemicals known to cause reproductive toxicity for males: Substance is not listed.
Chemicals known to cause developmental toxicity: Substance is not listed.

CARCINOGENICITY CATEGORIES:
EPA (Environmental Protection Agency) Substance is not listed.
IARC (International Agency for Research on Cancer) Substance is not listed.
NTP (National Toxicology Program) Substance is not listed.
TLV (Threshold Limit Value established by ACGIH) Substance is not listed.
NIOSH (National Institute for Occupational Safety and Health) Substance is not listed.
OSHA (Occupational Safety & Health Administration) Substance is not listed.

Product related hazard informations:

Safety phrases: 3/7 Keep container tightly closed in a cool place.

*
16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Department Issuing MSDS: Linde Safety, Health, Environment and Quality
Contact: Refer to Linde web site for contact and product information at www.lindeus.com.

Sources:
ABBREVIATIONS AND ACRONYMS:

ADR/RID: Agreement on Dangerous Goods by Road/Regulation concerning the International Transport of Goods by Rail
CAS: Chemical Abstracts Service

(Contd. on page 7)

MATERIAL SAFETY DATA SHEET

Printing date 06/01/2009 Revision date 06/01/2009

Trade Name: Helium, compressed gas

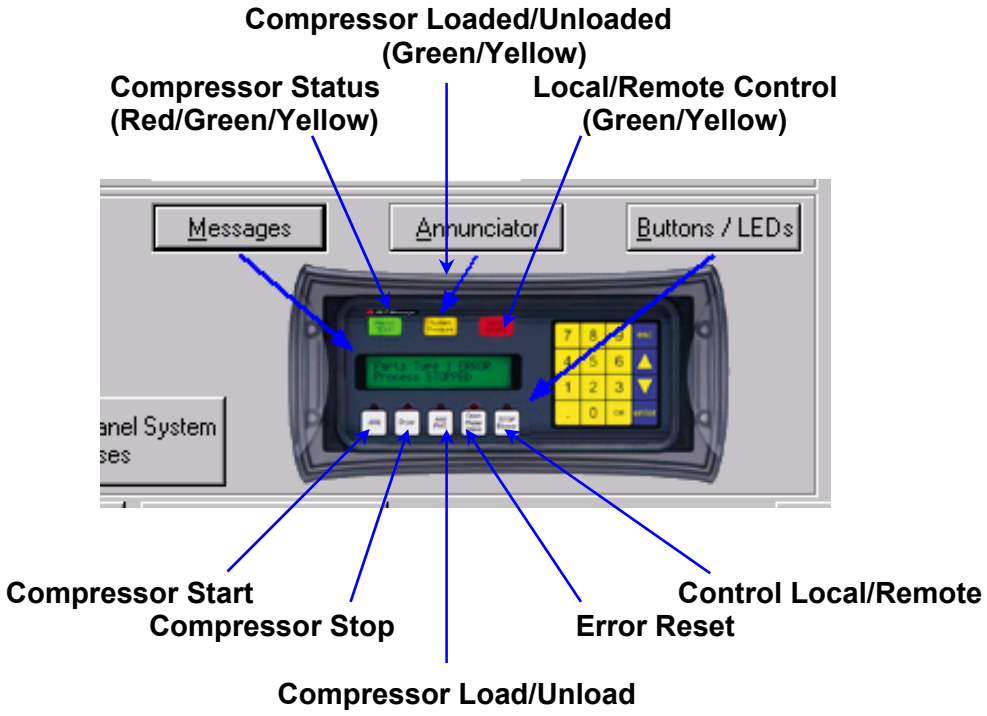
DOT: US Department of Transportation
EINECS: European Inventory of Existing Chemical Substances
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
HMIS: Health Management Information System
IATA: International Air Transport Organization
IATA-DGR: Dangerous Goods Regulations by the International Air Transport Organization
ICAO: International Civil Aviation Organization
ICAO-TI: Technical Instructions by the International Civil Aviation Organization
IMDG: International Marine Code for Dangerous Goods
NFPA: National Fire Protection Association

GENERAL DISCLAIMER
For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde LLC, Linde Merchant Products or Linde Gas North America LLC (or any of their affiliates and subsidiaries) and the purchaser.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

1.0 Compressor Operator Panel

The panel displays: Compressor status, light and message.
Error messages.
First trip message (FIFO).
Alarms on process values and broken T/C.
Reads data in English units (SI version is available).
Has password protection on setpoint entries.
NOTE: **Password is written on the back of the panel.**



1.1 Annunciators - 3 Lights At Top Left Of Panel

1.1.1 ***Compressor Status*** indicates on, off and error states.

On is Green; On means that compressor is operating.
Off is Red; Off means compressor is not operating.
Error is Yellow; Error means that safety input is tripped or the last fault hasn't been cleared/reset.

1.2.2 ***Loading Status*** indicates compressor loading status.

On is Green; On means that compressor loading solenoids are energized.
Off is Yellow light; Yellow means that compressor loading solenoids are de-energized.

1.2.3 ***Local/Remote Status*** indicates compressor control location.

Local is Green; Local means that compressor can be operated only from the local panel.
Remote is Yellow; remote means that compressor can be operated from any location.

1.2 Pushbuttons - 5 At Bottom Left Of Panel

1.2.1 ***Left to Right Pushbuttons Are***:

START
STOP
LOAD/UNLOAD Compressor
RESET Error
LOCAL/REMOTE

1.3 LED's - 5, 1- Each, Above Each Of 5 Pushbuttons

First 4-LED's, to the left of the panel, light-up momentarily when their respective buttons are pressed. The LED furthest to the right of the panel stays ON when the panel is set for LOCAL control mode; it is OFF when panel is set for REMOTE control mode.

1.4 Message Displays - 2 Lines In Middle Of Panel

1.4.1 Operator can manually scroll through message directories to trigger local messages.

1.4.2 PLC messages are triggered by PLC. A PLC Message LED located in the upper left corner of the text display panel lights-up to indicate when a displayed message was prompted by the PLC.

2.0 Messag es

2.1 Local Messages

2.1.1 System Configuration

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Enter<

-SYSTEM CONFIG.	
Set Def. (0=norm)	**0**

Press >Down<

To load the default configuration to PLC, write value of 1 to the data box. PLC will change it back to 0 when the default values are written.

Default setpoints for shutdowns:
TAHH-11 Pump He discharge high temperature 170°F
TALL-12 Pump He suction low temperature 14°F
PAHH-11 Pump He discharge high pressure 275 psig
PALL-11 Pump He discharge low pressure 150 psig

Default setpoints for alarms:
TAH-11 Pump He discharge high temperature 160°F
TAL-12 Compressor He suction low temperature 30°F
PAH-11 Pump He discharge high pressure 265 psig
PAL-11 Pump He discharge low pressure 160 psig

Default timers setpoints:
Timer 1 used to delay compressor oil level low signal. Default delay 60 sec. Entry is limited at 0-600 (0-60sec.)
Timer 2 used to delay coalescer oil presence signal. Default delay 5 min. Entry is limited at 0-15 (0-15min.)
Timer 3 used to delay compr. suction press. low signal. Default delay 90 sec. Entry is limited at 0-1200 (0-120sec.)
Timer 4 used to shutdown compressor if it does not start in the selected time. Default delay 2 sec. Entry is limited at 0-50 (0-5sec.)

-SYSTEM CONFIG.	
Disabl.Alms (0=norm)	**0**

Press >Down<

Used to disable alarms, write value of 1 to the data box. Value of 1 in data box indicates that all alarms are disabled.

-SYSTEM CONFIG.	
Set Temp.Unit (0=C)	**0**

Press>Down<

Used to change the temperature to read either Celsius (0) or Fahrenheit (1).

-SYSTEM CONFIG.	
Set Pr. Units (0=bar)	**0**

Press >Down<

Used to change the pressure to read either Bar (0) or Psig (1).

-SYSTEM CONFIG.	
Hardw.Int. (1=used)	**0**

During initial start-up select the proper setting for your Equipment. (0) if used with Ethernet enabled equipment. (1) if used with relay enabled equipment.

Press >Esc< to return to main list.

2.1.2 Discrete Inputs

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+SYSTEM CONFIG.	
DISCR.INPUTS	1=OK

Press >Enter<

-DISCR.INPUTS	1=OK
TS1,Mot.Tmp.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
TS5,Oil Tmp.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
LS1,Oil Lvl.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
LS2,CoaLvl	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
PB1, E.Stop	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
PAHH11,Dis.Pr.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
PALL12,Suc.Pr.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
M1,Comp.On	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
OL1,MotLoad	**[1]**

Press >Down<

- DISCR.INPUTS	1=OK
ES1,PowQual.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
TAHH11,DisTmp.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
TALL12,SucTmp.	**[1]**

Press >Down<

-DISCR.INPUTS	1=OK
Rem.Start	**[0]**

Press >Down<

ENTER opens the Discrete Inputs folder for viewing. The plus (+) sign changes to minus (-) sign when folder is OPEN.

1 =Switch OK, **0** =Tripped

Contents of the Discrete Inputs Folder are:

Motor Temperature High
Oil Temperature High
Oil Level Low
Coalescer Oil Level Presence
Discharge Pressure High
Suction Pressure Low
Compressor Is Operating
Motor Overload
Power Quality Bad
Compressor Discharge Temperature High
Suction Temperature Low
Remote START
Remote STOP
Remote LOAD

-DISCR.INPUTS	1=OK
Rem.Stop	**[0]**

Press >Down<

-DISCR.INPUTS	1=OK
Rem.Load	**[0]**

Press >Esc< to return to main list.

2.1.3 Temperatures Indicators

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+DISCR.INPUTS	1=OK
+TEMPER.IND.	C/F

Press >Enter<

-TEMPER.IND.	C/F
TI11,HeOut	**80.7**

Press >Down<

-TEMPER.IND.	C/F
TI12,HeIn	**34.3**

Press >Down<

-TEMPER.IND.	C/F
TI12,HeIn(Neg.C)	**14.0**

Press >Down<

-TEMPER.IND.	C/F
TI13,WatIn	**72.1**

Press >Down<

-TEMPER.IND.	C/F
TI14,Aftcolr	**114.5**

Press >Esc< to return to main list.

Units of temperature are set to Fahrenheit. The following temperatures are measured by set of four, type T thermocouples:

- He Compressor Discharge Temperature
- He Compressor Suction Temperature
- Water Compressor Inlet
- He Aftercooler Discharge Temperature

Adding of temperature channels is possible by adding a temperature module and a software change.

Units of temperatures are set by jumper on bank J7 on PLC's thermocouple module.

For Celsius: Jumpers Units-0 = Off,
Units-1 = On.
For Fahrenheit: Jumpers Units-0 = On,
Units-1 = On.

The unit jumpers shall not be changed unless appropriate changes are made to the software.

2.1.4 Pressures Indicators

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+DISCR.INPUTS.	
+TEMPER.IND.	C/F

Press >Down<

+ TEMPER.IND.	C/F
+PRESS.IND.	B/Psig

Press>Enter<

-PRESS.IND.	B/Psig
PI11, DisPre	**240.0**

Press>Down<

- PRESS.IND.	B/Psig
PI11, (NegVal)	**0.0**

There are two pressure indicators, PI11and PI12, each read positive and negative pressure. If reading negative a value will be in the (NegVal) data block, if positive then the (NegVal) data block will have a (0).

Press>Down<

- PRESS.IND.	B/Psig
PI12, SucPre	**2.0**

Press >Down<

- PRESS.IND.	B/Psig
PI12, (NegVal)	**0.0**

Press >Esc< to return to main list.

2.1.5 Temperature Alarm Setpoints

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+DISCR.INPUTS	1=OK
+TEMPER.IND.	C/F

Press >Down<

+TEMPER.IND.	C/F
+ PRESS.IND.	B/Psig

Press >Down<

+ PRESS.IND.	B/Psig
+ TEMP.ALARM SETP.	

Press >Enter<

- TEMP.ALARM SETP.	
TAH11_SP Pout	165.0

Press >Down<

- TEMP.ALARM SETP.	
TAL12_SP (NegC)	32.0

Press >Esc< to return to main list.

Two temperature alarms are configured.

He pump discharge high temperature 165^{o}F
Entry limit is set at 0-200^{o}F.
He compressor suction low temperature 32^{o}F
Entry limit is set at 0-36^{o}F.

The setpoint change is protected by password. Password is entered during the panel configuration process. The password is written on back of the unit. A change to the password requires an edit and download configuration software to the panel.

2.1.6 Temperature Shutdown Setpoints

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+DISCR.INPUTS	1=OK
+TEMPERATURES deg.C	

Press >Down<

+TEMPERATURES deg.C	
+TEMP.ALARM SETP.	

Press >Down<

+TEMP.ALARM SETP.	
+TEMP.TRIP SETP.	

Press >Enter<

-TEMP.SHTD. SETP.	
TAHH11_SP., POUT.	**170.0**

Press >Enter<

-TEMP.SHTD. SETP.	
TALL12_SP.,(neg.C)	**14.0**

Press >Esc< to return to main list.

One temperature trip is configured.

He pump discharge high temperature 170^{o}F

Entry limit is set at 0-175^{o}F.

The setpoint change is protected by password. Password is entered during the panel configuration process. The password is written on back of the unit. The change of the password requires an edit and download configuration software to the panel.
Contact the factory for advise on panel software download.

2.1.7 Pressure Alarms

+SYSTEM CONFIG.
+DISCR.INPUTS 1=OK

Press >Down<

+DISCR.INPUTS 1=OK
+TEMP.ALARM SETP

Press >Down<

+TEMP.ALARM SETP
+PRESS.ALARM SETP.

Press >Enter<

-PRESS.ALARM SETP.
PAH11, PmpDis **265.0**

Press >Enter<

-PRESS.ALARM SETP.
PAL11, PmpDis **160.0**

Press >Esc< to return to main list.

Two Pressure alarms are configured. Both of which are related to the Compressor Pump Discharge pressure PI11. One is the High pressure alarm set at 265psig the Other is the Low pressure alarm set at 160psig

2.1.8 Pressure Shutdowns

+SYSTEM CONFIG.
+DISCR.INPUTS 1=OK

Press >Down<

+DISCR.INPUTS 1=OK
+TEMP.ALARM SETP

Press >Down<

+TEMP.ALARM SETP
+PRESS.ALARM SETP.

Press >Down<

+PRESS.ALARM SETP.
+PRESS.SHTD SETP.

Press >Enter<

-PRESS.SHTD SETP.
PAHH11,PmpDis **275.0**

Press >Down<

-PRESS.SHTD SETP.
PALL11, PmpDis **150.0**

Press >Esc< to return to main list.

Two pressure shutdowns are configured. Both relating to PI1, the first of which if for the compressor pump discharge pressure to High at 275psig, the second being the compressor discharge pressure to Low at 150psig.

2.1.9 Timers Setpoints

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+SYSTEM CONFIG.	
+DISCR.INPUTS	1=OK

Press >Down<

+DISCR.INPUTS	1=OK
+TEMPER deg.C	

Press >Down<

+TEMPERATURES deg.C
+TEMP.ALARM SETP.

Press >Down<

+TEMP.ALARM SETP.
+TEMP.TRIP SETP.

Press >Down<

+TEMP. TRIP SETP.
+TIMERS SETP.

Press >Enter<

-TIMERS SETP.	
Comp. Oil Dly.	**60**

Press >Down<

-TIMERS SETP.	
Coal.Oil Dly.	**5**

Press >Down<

-TIMERS SETP.	
Comp.Suct.Dly.	**900**

Press >Down<

-TIMERS SETP.	
Comp.Run Dly.	**20**

Press >Esc< to return to main list.

Four PLC timer setpoints are changeable.

T1, compr. oil level delay. 600 for 60 Seconds
T2, Coal.Oil Dly. 5 for 5 Minutes
T3, Comp.Suct.Dly 900 for 90 Seconds
T4, Comp.Run Dly 20 for 2 Seconds

The setpoint change is protected by password. Password is entered during the panel configuration process. The password is written on back of the unit. The change of the password requires an edit and download configuration software to the panel.

2.2 PLC Messages

Line 1 (Value in V3001 displays the matching message)

1 STATUS

2 ALARM

3 FAULT

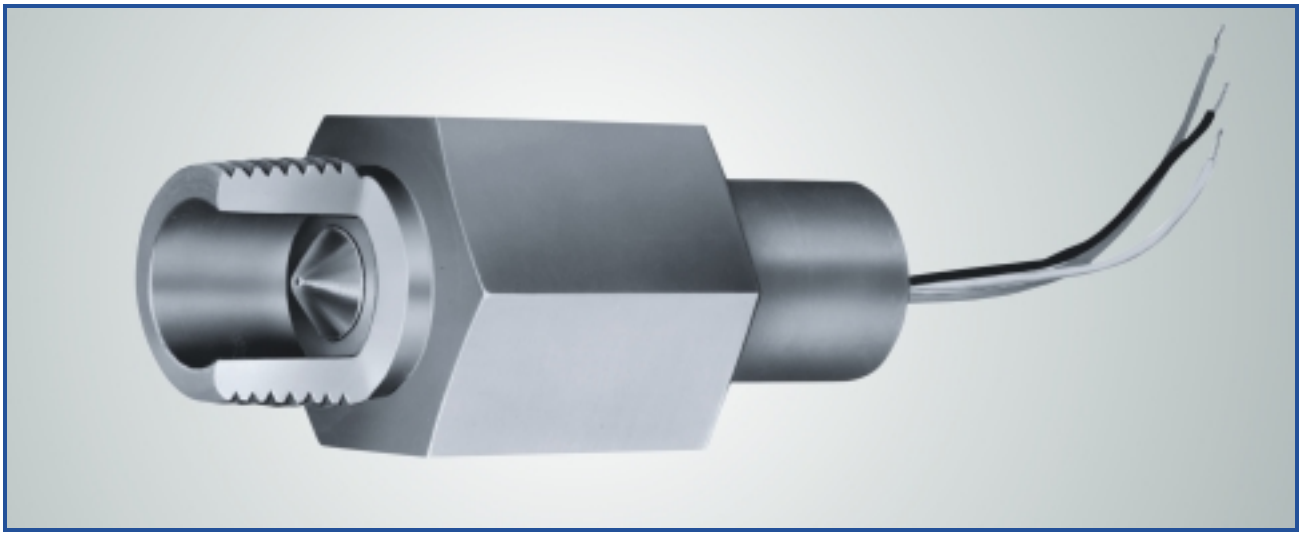
Line 2 (Value in V3002 displays the matching message)

1 TS1, Motor Hi Temp
2 TS5, Oil Hi Temp
3 LS1, Oil Low Lvl
4 LS2, Coal Oil Hi Lvl
5 PAHH11, Cmp Dis Hi Pr
6 PALL12, Cmp Suct Lo Pr
7 M, Cmp Not Started
8 OL1_2, Cmp Overloaded
9 ES1, Power Qual Bad
10 Msg. Box Empty
11 new
12 Cmp in Local Cntr
13 Cmp in Remote Cntr
14 Eng. Units (Farenh)
15 SI Units (Celsius)
16 TE-11 Fault Alarm
17 TE-12 Fault Alarm
18 TE-13 Fault Alarm
19 TE-14 Fault Alarm
20 TAH11, Pmp He Out Hi Tmp
21 TAHH11, Pmp He Out Hi Tmp
22 TAL12, Cmp He Suc Low Tmp
25 ALM, PAL12, Pmp Suc Low
26 ALM_LS2_Coal 3 Oil
27 ALM_Spare
28 ALM_Spare
29 ALM, PAH11, Pmp Dis Pr Hi
30 ALM, PAL11, Pmp Dis Pr Lo
31 Std, TALL12 Pmp Inl T Low
32 Std, PALL11 Pmp Dis P Low
33 Std, E-Stop Active

PLC has total of 33 messages.
(end)

LIQUID LEVEL SWITCH

HENRY TECHNOLOGIES

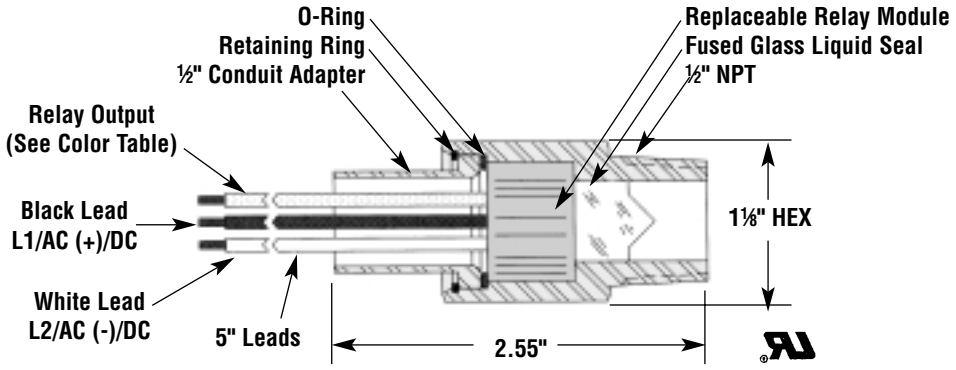


- ✔ **Switches Solid-State** for liquid sensing
- ✔ **No contact** level sensing
- ✔ **Serviceable without** loss of refrigerant
- ✔ **Works with oil, refrigerants,** or any non-hazardous non-corrosive fluid
- ✔ **Glass prism in contact** with fluid medium
- ✔ **Industry approved for Nema 4** and 4X for Water tight
- ✔ **Meets UL Standard #873 & #207** File Numbers E141577 & sa6720*

*U.S. Patent #5,278,426 & other U.S. and Foreign Patents pending

Mounting:	Horizontal Only
Switch Inductive Ratings:	36 va Pilot Duty Rated
Contacts, Power Off:	Normally Open (N.O.)
Contact Life:	Over 1 Million Cycles at Rated Electrical Load
Pressure Rating:	1200 PSI Working, 6000 Burst
Power for Operation:	3.5 ma AC, 5.5 ma DC
Minimum Load:	2 ma (without bleed resistor)

S-9400 Series
with ½" NPT Connection



Compressor Protective Devices

AC&R Components