

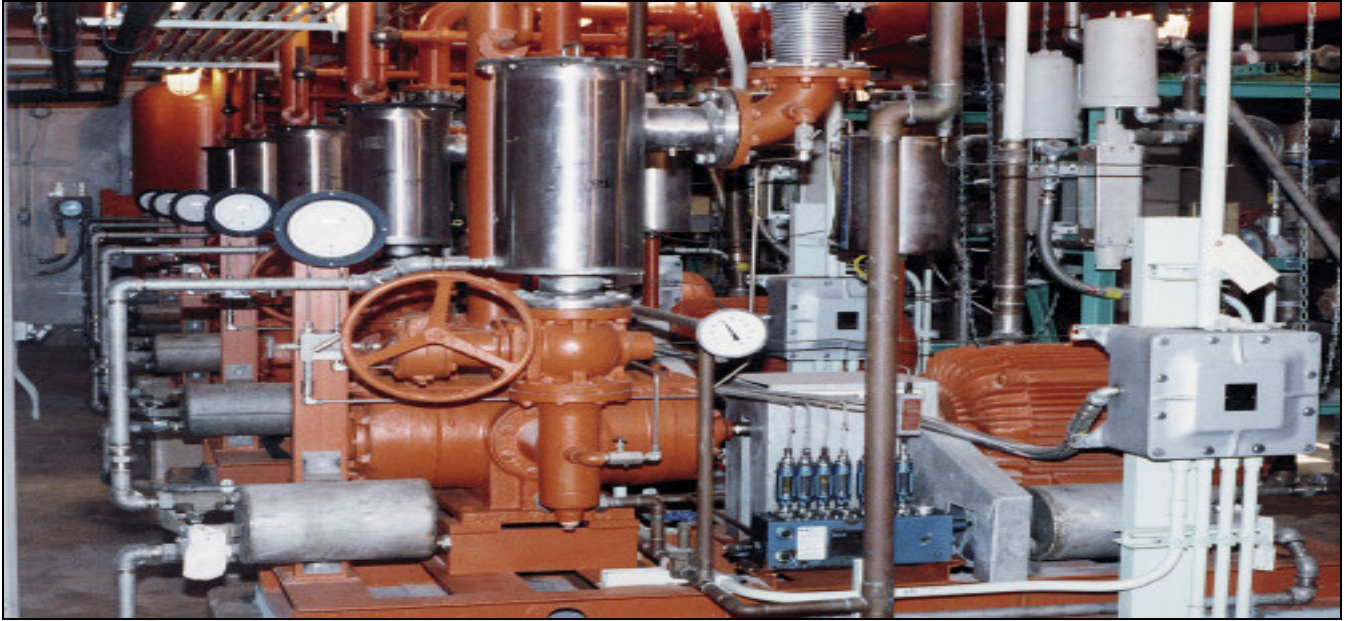


**PACKAGING GUIDELINES FOR  
RO-FLO® COMPRESSORS AND VACUUM PUMPS**

**MAY 2018**

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## SAFETY INFORMATION



### CAUTION

RO-FLO COMPRESSORS AND VACUUM PUMPS MUST BE OPERATED BY PROFESSIONALS TRAINED IN THE USE OF GAS COMPRESSION EQUIPMENT.

PLEASE CONTACT YOUR SYSTEM INTEGRATOR / PACKAGER FOR TRAINING IN THE USE AND MAINTENANCE OF RO-FLO COMPRESSORS AND VACUUM PUMPS AS APPLIED IN YOUR SYSTEM.



### CAUTION

READ AND UNDERSTAND THE OPERATOR'S MANUAL BEFORE USING THIS COMPRESSOR. IT IS ESSENTIAL TO REFER TO THE PACKAGER'S OPERATING MANUAL FOR COMPLETE OPERATING INSTRUCTIONS.

FAILURE TO FOLLOW OPERATING INSTRUCTIONS MAY RESULT IN SERIOUS INJURY OR DEATH.

Read this document carefully before installing and starting your compressor.

The following instructions have been prepared to assist in installation, operation, and maintenance of your Ro-Flo® sliding vane compressor. Following these instructions and those provided for the compressor package will ensure a long operational life for your equipment.

The entire manual should be reviewed before attempting to install, operate, service, or repair the compressor.

Ro-Flo® sliding vane compressors are positive displacement style compressors, which are designed to compress gas. The compressor must not be subjected to liquids in the inlet gas stream. Ro-Flo Compressors, LLC is not responsible for the system design to prevent liquid in the gas stream, and as such Ro-Flo Compressors, LLC cannot warrant equipment damaged by improperly protected or operated equipment.



### CAUTION

PERSONAL PROTECTIVE EQUIPMENT (PPE) SHOULD BE USED TO AVOID HEALTH HAZARDS (EXCESSIVE SOUND LEVEL EXPOSURE) DUE TO HIGH NOISE LEVEL DURING NORMAL OPERATION.

IT IS RECOMMENDED THAT THE CUSTOMER ESTABLISH AN EHS PLAN TO AVOID AN EXPOSURE RISK IN EXCESS OF PERMISSIBLE EXPOSURE LIMIT (PEL) AS DEFINED BY THE OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION (OSHA) OR OTHER REGULATING BODY.



### CAUTION

THE INFORMATION CONTAINED WITHIN IS INTENDED TO ASSIST OPERATING PERSONNEL BY PROVIDING INFORMATION ON THE GENERAL CHARACTERISTICS OF EQUIPMENT OF THIS TYPE. IT DOES NOT RELIEVE THE USER OF RESPONSIBILITY TO USE SOUND ENGINEERING PRACTICES IN THE INSTALLATION, APPLICATION, AND MAINTENANCE OF PARTICULAR EQUIPMENT PURCHASES.

## GENERAL INTENT

These standards are presented as our guidelines and recommendations to PACKAGERS for use when designing and installing Ro-Flo® compressors on a packaged unit.

Ro-Flo® sliding vane compressors are normally installed on a structural steel skid with major components, accessories, on-skid piping, controls, and alignment completed by a PACKAGER. Skid mounting is by far the most common arrangement used. The unit is shipped to the site as a complete package ready for installation per the PACKAGER's instructions. Proper installation is important to the successful operation of the unit.

A PACKAGER is defined as any Ro-Flo Compressors authorized party incorporating a Ro-Flo® compressor into the manufacture or assembly for an END USE CUSTOMER.

This STANDARD is not intended to be an engineering data book. It is a guide and does not supersede customer specifications that meet or exceed its intent. Ro-Flo Compressors, LLC recognizes that there are many technically acceptable ways to package compressors.

This STANDARD has been devised as a unit and is not intended to be split up and distributed in sections. All departments in the PACKAGER's organization need to be aware of the entire contents.

The wide range of possible uses of Ro-Flo® compressors will periodically make certain deviations from these STANDARDS necessary. It is the PACKAGER's responsibility to insure these deviations are acceptable to Ro-Flo Compressors, LLC.

### PACKAGER DESIGN REVIEW - GRATUITOUS ADVICE

On the occasion of a new PACKAGER relationship, or a new design of a compressor skid, or in the normal course of business, it is the practice of Ro-Flo Compressors to offer to review the PACKAGER's design at no charge to the PACKAGER, and offer advice on overall package design. On these occasions, this advice is given as Gratuitous Advice.

**Gratuitous Advice: If Ro-Flo Compressors furnishes the PACKAGER with advice or assistance concerning the products, systems, or work which is not required pursuant to the purchase agreement, the furnishing of such advice or assistance will not subject Ro-Flo Compressors to any liability, whether in contract, tort, warranty, indemnity, negligence, strict liability, or otherwise.**



## PACKAGER RESPONSIBILITIES

The PACKAGER must maintain engineering, sales, and service personnel properly trained by Ro-Flo Compressors to effectively sell, design, manufacture, maintain, and repair Ro-Flo® compressors.

In addition to the above items, it is the PACKAGER's responsibility to:

### UNDERSTAND THE COMPRESSOR DESIGN LIMITATIONS

It is the PACKAGER's responsibility to ensure that free liquids in the gas stream are removed to prevent damage to the compressor and ensure long operational life.



#### WARNING

Free liquids are the #1 cause of compressor problems & failure.

System pressures and temperatures should not exceed maximum allowable compressor limits. Drivers should be selected so the delivered power does not exceed the compressor shaft horsepower limitations. Design conditions must be provided with the compressor purchase order.

The PACKAGER should maintain and use the most current version of the Ro-Flo Performance software and/or seek assistance from Ro-Flo Compressors for selecting compressors and compressor options or evaluating field operating conditions.

**Note:** *Although the Ro-Flo Performance software is a comprehensive tool for Ro-Flo® compressors, the PACKAGER is encouraged to use more advanced thermodynamic gas property analysis programs for flash analysis and thermodynamic property calculation.*

When reconfiguring older components or legacy equipment, be aware that they may have different design limits than equipment of today's current design. Always get serial numbers and check with Ro-Flo Compressors for correct operating limits.

### UNDERSTAND THE CUSTOMER SPECIFICATIONS

The PACKAGER is responsible for ensuring that the package meets all laws and statutes of where the equipment will be manufactured, installed, and operated.

The compressor must be selected for the specific operating characteristics of the process. Actual gas flows, pressures, and temperatures are required so that the optimum operating speed, drive power, and lubrication characteristics can be selected. The PACKAGER must provide or verify that Ro-Flo Compressors, LLC has the correct design conditions. Ro-Flo Compressors, LLC rating plates are stamped with rated performance information. Failure to provide correct design conditions could void the compressor warranty.

The PACKAGER should understand the END USE CUSTOMER's specifications and make exceptions where necessary. The PACKAGER

should work with the END USE CUSTOMER to define present and future conditions with regard to:

- A. Design point conditions and any possible alternate conditions.
- B. Gas composition, so any special gas components may be identified and addressed properly. Special attention should be given to corrosive characteristics and gas dew point.
- C. Site conditions, including site elevation, ambient temperatures, dust, humidity, rainfall, wind velocity, soil conditions, and seismic conditions, seasonal changes in all conditions, and the impact of these conditions on the package design.
- D. Duty cycle of the compressor operation and its impact on selection and design of the compressor package and its components.
- E. Available sources for cooling medium.

### PACKAGING QUALITY

A compressor package's reputation is shared by the PACKAGER, Ro-Flo Compressors, and the driver manufacturer, but not always in equal proportions. A successful package blends precision component selection, design, fabrication, sales, and service. It is Ro-Flo Compressors intent to lead the industry in performance and reputation. Ro-Flo Compressors and PACKAGER's must work together to meet this expectation. This document is intended as a minimum requirement for packaging quality. However, the PACKAGER is encouraged to exceed this standard in providing only the finest packages for the END USE CUSTOMER.

### PROVIDING THE CUSTOMER WITH NECESSARY INFORMATION

Provide the END USE CUSTOMER with performance data sheets for the intended operating conditions from the Ro-Flo Performance software, the Ro-Flo Installation, Operation, and Maintenance Manual, and adequate instructions so the compressor system can be operated properly and safely.

### PROVIDE PROPER STORAGE

The PACKAGER must provide clean, dry storage for all compressors and parts held in inventory.

New Ro-Flo® compressors are shipped with a vapor-phase corrosion inhibitor (VpCI). This is suitable for storage of equipment for 1 year if all shipping covers are left intact. If the shipping covers are removed, new VpCI or other means of preservation need to be applied.

During compressor package construction it is common to remove the compressor shipping covers for installation of piping, etc. Care must be taken to prevent debris from entering the system. In addition, the compressor package must be suitably preserved to prevent compressor corrosion.

When applicable, the factory recommended procedures for long-term storage must be followed. Long term storage procedures are available in the Ro-Flo Installation, Operation, and Maintenance Manual.



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## ITEMS PROVIDED BY RO-FLO COMPRESSORS

The following information is available from Ro-Flo Compressors:

1. Ro-Flo Packaging Guidelines
2. Ro-Flo Installation, Operation, and Maintenance Manual
3. Ro-Flo Parts Book
4. Ro-Flo® General Arrangement Drawings
5. Compressor Performance Data Sheet(s), either generated by the PACKAGER or Ro-Flo Compressors. The Performance Data Sheet includes the following information:
  - a. Required operating power and speed
  - b. Recommended coolant flow rate
  - c. Recommended lubrication rate and viscosity

The following services are also available from Ro-Flo Compressors.

- Witnessed Hydrostatic Test
- Witnessed Pneumatic Leak Test
- Helium Leak Test
- Material Certificates
- Certificate of Conformance
- Rotor Balancing
- Mechanical and Performance Tests

Please contact your sales representative for more information.

## SKID DESIGN AND COMPRESSOR MOUNTING

Package design is the responsibility of the PACKAGER.

Package design and fabrication should be conducted within the following guidelines. This guideline does not replace good engineering practice, other engineering specifications (such as ASME, API, etc.), or local regulations or standards. If a conflict does arise this should be reviewed with Ro-Flo Compressors to provide guidance.

Equipment should be arranged on the skid to provide easy access to the compressor and other components for maintenance and inspection. The PACKAGER is referred to the compressor General Arrangement drawings for recommended service access for Ro-Flo® compressors. The skid should also be arranged to provide proper access for lifting devices for servicing compressor components or other components of the compressor system.

### COMPRESSOR WEIGHTS AND CENTER OF MASS

Please refer to the general arrangement drawings for your specific compressor model for weight and center of mass information. The general arrangement drawings and 3D CAD models are available from Ro-Flo Compressors, LLC upon request.

### SKID MOUNTING

The skid should be rigid enough to prevent twisting due to the torque between the driver and the compressor. The skid should be stiff enough to assure reasonable retention of alignment between the driver and the compressor when the package is being moved. Final alignment of the compressor and driver is required upon package installation. The suggested procedures for alignment are described in the Ro-Flo Installation, Operation, and Maintenance Manual.

The skid should provide sufficient mass to absorb vibration transmitted by the compressor and motor. Ro-Flo® rotary sliding vane compressors produce relatively low vibration levels (as compared to other compressors).

It is recommended that the compressor skid be grouted in location to absorb vibration and transmit compressor forces.

### COMPRESSOR MOUNTING

The PACKAGER is responsible for designing compressor hold down bolting. Properly designed bolting should consider the following aspects of the design:

- Bolt length
- Bolt grade
- Skid construction
- All loads acting on the compressor (including gas forces)

In general, it is recommended that AISI 4140 studs be used to secure the compressor to the skid. These typically extend through full frame members.

## COMPRESSOR OPERATING LIMITS

The maximum allowable working temperature (MAWT) for all Ro-Flo® compressor models is 350 °F (176 °C).

The maximum allowable working pressure (MAWP) for Ro-Flo® compressors are listed in **TABLE 1**. The user should refer to documentation provided by the PACKAGER as the compressor may not be the lowest MAWP component in the system. Application conditions may limit the discharge pressure to a value less than the MAWP.

**TABLE 1 - Compressor Maximum Allowable Working Pressure (MAWP)**

80 PSIG DISCHARGE		150 PSIG DISCHARGE	
MODEL	MAWP (psig)	MODEL	MAWP (psig)
2CC	80	206	150
4CC	80	207	150
5CC	80	208B	150
7D	80	210M	150
8D, SD8D	80	211M	150
8DE, SD8DE	80	212M	150
10G	80	217M	150
11S	80	219M	150
11L	80		
12S	80	200 PSIG DISCHARGE	
12L	80	HP6, HP7, HP8	200
17S	80	HP10	200
17L	80	HP11	200
19S, SD19S	80	HP12	200
19L, SD19L	80		
19LE, SD19LE	80		

## COMPRESSOR SYSTEM SOUND CONTROL

The compressor PACKAGER should consider sound control in the design of the compression system. Ro-Flo® compressor and vacuum pump expected sound characteristics are available in "Appendix I - Expected Sound Pressure Levels".

## COMPRESSOR DRIVE

Ro-Flo® compressors are suitable for use with electric motor or engine drives. Ro-Flo® compressors may be either direct coupled or belt driven. An application review is required to determine if it is possible to use a belt drive (due to belt pull loads on the compressor).

### DRIVE SELECTION

The compressor drive should be selected taking into consideration any losses associated with power transmission (belt drive systems, gear boxes, etc.).

The PACKAGER is responsible for ensuring the driver is capable of developing sufficient torque to overcome compressor starting requirements. It is recommended that the drive produce a minimum torque of 108% of the required operating torque of the compressor, when started against full discharge pressure.

A variable speed driver will allow for utilization of the Ro-Flo® compressors turn down capability to control flow rate. Compressor operating speed ranges are shown in **TABLE 2**. It should be noted that these are minimum and maximum operating speeds, however, the compressor speed may be further limited by the application conditions.

Variable speed controllers should be equipped with stops to prevent operation above or below the corresponding maximum and minimum operating speeds of the compressor.

Ro-Flo® compressors are constant torque machines throughout their operating speed range for a given set of operating conditions.

### Engine Drives

For direct-coupled engine drive arrangements, a torsional vibration analysis is required for selection of flywheel and coupling. Please contact Ro-Flo Engineering for rotor mass moment of inertia and stiffness information.

### Electric Motor Drives

It is generally recommended that if single speed electric motors are used, that a "soft start" system be used. For variable speed drives, it is recommended that the motor be an inverter duty motor, as these typically are capable of providing constant torque throughout a specified speed range.

If the compressor will have start/stop operation (typically controlled by a pressure switch), the PACKAGER must review the application with the motor vendor to determine the acceptable number of start/stops per hour.

**TABLE 2 - Compressor Operating Speed Range.**

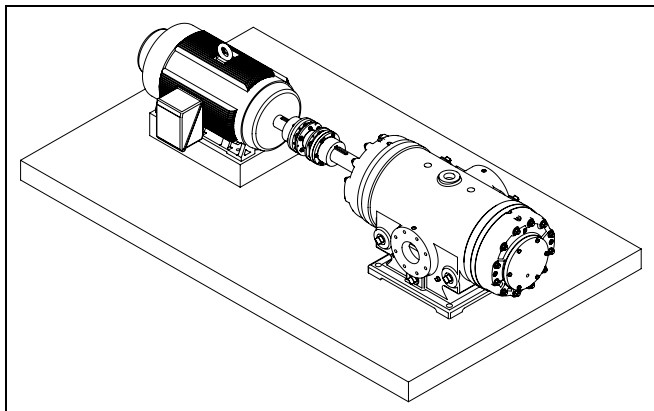
MODEL	MINIMUM SPEED (RPM)	MAXIMUM SPEED (RPM)
<b>2CC, 4CC, 5CC</b>	865	2200
<b>7D</b>	690	1465
<b>8D, 8DE</b>	600	1465
<b>SD8D, SD8DE</b>	600	1465
<b>10G</b>	450	1300
<b>11S, 11L</b>	400	1000
<b>12S, 12L</b>	380	920
<b>17S, 17L</b>	310	760
<b>19S, 19L, 19LE</b>	275	640
<b>SD19S, SD19L, SD19LE</b>	275	640
<b>206, 207, 208B</b>	600	1465
<b>HP6, HP7, HP8</b>	600	1465
<b>210M, HP10</b>	450	1300
<b>211M, HP11</b>	400	1000
<b>212M HP12</b>	380	920
<b>217M</b>	310	760
<b>219M</b>	275	640

## DRIVE ARRANGEMENTS

There are numerous methods to provide power to Ro-Flo® compressors. This section will cover some of the more common drive arrangements.

### Direct Drive

The most common configuration is to have the driver directly coupled to the compressor.

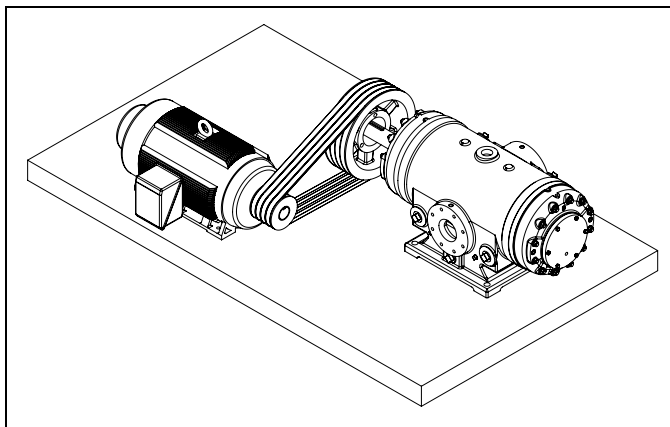


**FIGURE 1** - Compressor directly coupled to electric motor.

### Belt Drive

Belt drive design must be determined by the compressor operating conditions and belt manufacturer. The belt manufacturer will define tension levels and belt operating limits. The loads predicted by the belt drive manufacturer should be reviewed with the Ro-Flo Performance software to determine if a jackshaft arrangement is required.

Cog (toothed) drive belts typically generate lower belt pull forces, which reduce the side loads on compressor bearings and rotor.

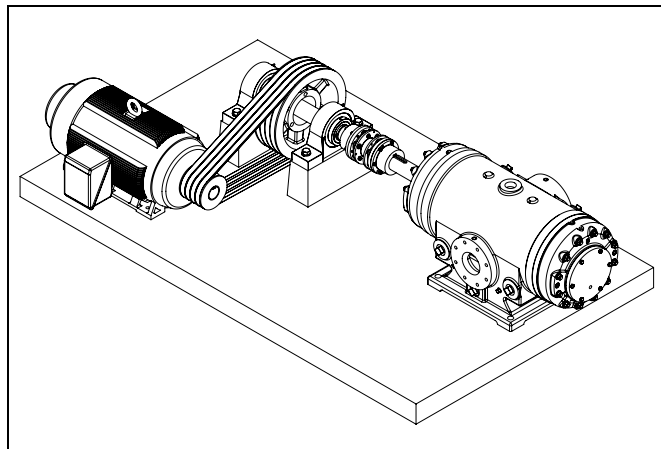


**FIGURE 2** - V-belt drive with sheave mounted directly on compressor shaft.

### Belt Drive with Jackshaft

**FIGURE 3** illustrates a typical jackshaft arrangement, which eliminates excessive belt load on the compressor. Alignment between compressor

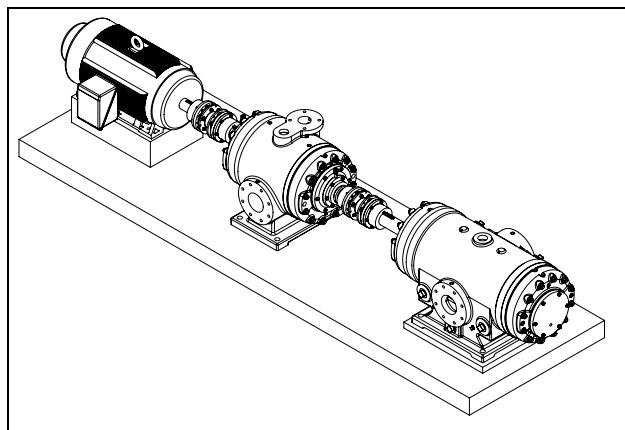
and jackshaft is checked in the same manner as with direct drive units.



**FIGURE 3** - Typical arrangement for belt drives with pedestal bearings and a jackshaft.

### Two (2) Stage Compressor Train

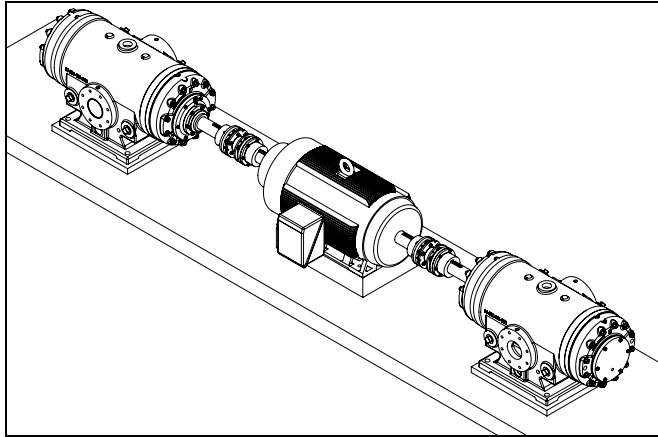
**FIGURE 4** shows a typical 2 stage compressor train driven by one electric motor.



**FIGURE 4** - Typical 2 stage compressor train drive arrangement.

## Tandem Drive

Tandem units (2 compressors driven by a double shaft extension motor) should have torque controlling couplings (dry powder, friction disc., etc) to avoid excessive starting torque on the compressor shaft when one compressor is uncoupled.



**FIGURE 5** - Tandem drive arrangement, with an electric motor between two Low Pressure model compressors.

## GUARDS

The PACKAGER shall provide adequate coupling / belt guards that are in compliance with local regulations.

## COUPLINGS

All direct coupled units (engine or electric motor) should use a torsionally rigid coupling. Spacer couplings should be used to allow easy access to the compressor for maintenance. For recommended allowance for maintenance, please refer to the compressor General Arrangement drawings available on the Ro-Flo Compressors web-site:

[www.roflocompressors.com](http://www.roflocompressors.com).

All Ro-Flo® compressors have a straight shaft with a keyway. Compressor shaft dimensions can be found in **TABLE 3**.

**TABLE 3** - Compressor shaft dimensions.

MODEL	SHAFT DIAMETER @ COUPLING		NOMINAL SQUARE KEYWAY DIMENSION
	inch		inch
2CC, 4CC, 5CC	1.250	+0.000 -0.001	0.25
7D	1.625	+0.000 -0.001	0.375
8D, 8DE	1.625	+0.000 -0.001	0.375
SD8D, SD8DE	1.875	+0.000 -0.001	0.500
10G	2.625	+0.000 -0.001	0.625
11S, 11L	3.000	+0.000 -0.001	0.750
12S, 12L	3.000	+0.000 -0.001	0.750
17S, 17L	3.500	+0.000 -0.001	0.875
19S, 19L, 19LE	3.500	+0.000 -0.001	0.875
SD19S, SD19L, SD19LE	4.000	+0.000 -0.001	1.000
206, 207, 208B	1.625	+0.000 -0.001	0.375
HP6, HP7, HP8	1.875	+0.000 -0.001	0.500
210M, HP10	2.625	+0.000 -0.001	0.625
211M, 212M, HP11, HP12	3.000	+0.000 -0.001	0.750
217M, 219M	3.500	+0.000 -0.001	0.875

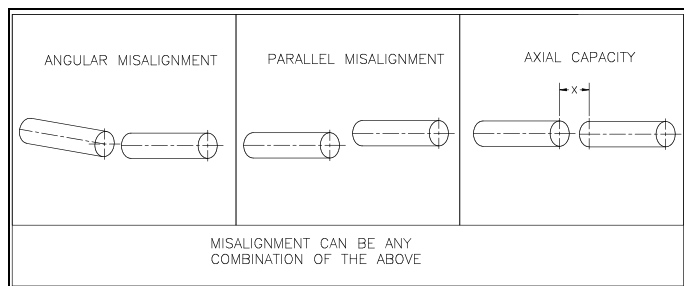
## COMPRESSOR ALIGNMENT

For direct-coupled drive arrangements, angular, parallel, and axial alignment between the compressor and driver must be maintained. The package design should allow for ease of alignment adjustment in the field. This is normally accomplished with shims and jackscrews on the mounting feet of the driver. Refer to "Compressor Alignment" on page 14 for alignment tolerances.

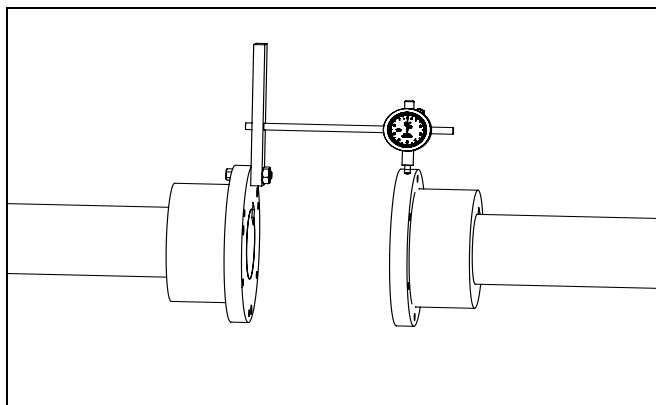
Realignment should be completed upon compressor package installation and following compressor package transportation. Failure to assure proper shaft alignment on coupling drive units will result in excessive noise, coupling wear, and/or bearing damage. Improper shaft alignment for belt driven units may result in belt slippage and/or unequal belt wear, which may result in shortened belt life.

Refer to **FIGURE 6**, **FIGURE 7**, and **FIGURE 8** illustrating angular and parallel misalignment and the dial indicator method for checking these. It is important to rotate both shafts simultaneously to avoid errors due to surface imperfections of the coupling hubs. Note that each shaft revolution the coupling will flex for the combined parallel and angular misalignment. The sum of these may be considered as the overall shaft misalignment.

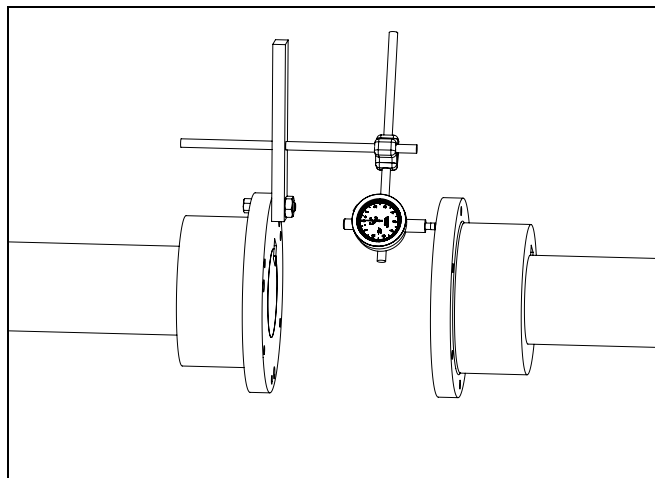
Parallel and angular alignment of the compressor and driver should be within 0.006 inch or the coupling limits, whichever is less.



**FIGURE 6** - Angular misalignment, parallel misalignment, and axial capacity illustrated.



**FIGURE 7** - Checking parallel alignment with dial indicator on coupling flange.



**FIGURE 8** - Checking angular alignment with dial indicator on coupling face.



## PIPING SYSTEMS AND VESSELS

A properly designed piping system is critical to successful compressor operation. The following features described in this section have been successfully employed in Ro-Flo® compressor system designs. The following items are illustrated in **FIGURE 10**, "Appendix III - Example Single Stage P&ID" on page 32, and "Appendix VI - Example Two Stage P&ID" on page 38.

It is the PACKAGER's responsibility to insure compliance with all state and local codes applicable to the particular installation.

### EQUIPMENT GROUNDING

All equipment and the piping system should be grounded to prevent electrostatic charge accumulation.

### INLET FILTERS

Inlet filters are required where gas streams contain particulate matter or debris. The filter should be designed to remove at least 90% of all dirt particles (10 microns or larger) from the inlet gas stream. Pressure drop through a filter will increase due to contamination and should be accounted for during equipment selection.

### SEPARATOR VESSELS / DRIP LEGS

Properly sized separators (scrubbers) must be installed prior to each stage of compression. It is the responsibility of the PACKAGER to size and select these items.



#### WARNING

Liquid ingestion in the compressor can result in catastrophic failure.

Ro-Flo® compressors can tolerate mist or small droplets of liquid, however, the best operating life will occur if all free liquids are removed from the gas stream. Large quantities of liquid (commonly referred to as a liquid slug) may result in catastrophic failure.

Inlet separators should be located as close to the compressor inlet as feasible to minimize potential liquid formation between the separator vessel and compressor.

Depending on the discharge piping configuration it may be desirable to have a separator vessel near the compressor discharge to remove liquids that may form in the discharge piping due to the cooling of the process gas. Depending on piping configuration and gas velocities, these free liquids may flow back into the compressor.

The separator vessels and drip legs should be equipped with automatic drain valves. It may be necessary to have drain pumps to remove accumulated liquid depending on the pressure differentials between the process and drain system. It is also necessary to have level switches for high level alarm and high-high shutdown.

## PROCESS PIPING

Extreme care must be taken during piping and fabrication to insure that contaminants such as grinding dust, weld slag, and rain do not get into the compressor or process control valves. Suction pipe internals must be cleaned. A 16-mesh start-up screen (witch's hat) should be installed near the compressor suction flange. The screen can be removed when debris stops accumulating.

All mating flanges on compressor inlet and discharge must be flat-faced design with full-face gaskets. **RAISED FACE OR RING JOINT FLANGES SHOULD NEVER BE USED ON THESE CONNECTIONS.**

The process piping should be straightforward in its arrangement and when possible sized equal to or larger than the flange connection sizes on the compressor.

When possible piping should be designed / fabricated with a slight slope to drain liquids away from the compressor (especially during shutdown). Provision must be made to drain accumulated liquids from any possible collection points prior to start-up. Drains and drip legs for oil and liquid accumulation are recommended as shown in **FIGURE 9**, on both the suction and discharge piping.

For applications with low gas flow rates, consideration should be given to placement of drains, drip legs, & separator vessels, as the gas velocity may be insufficient to carry liquids away from the compressor.



#### CAUTION

Consideration for liquid drains from the piping should take into account not only during operation, but also shut down conditions where process piping has an opportunity to cool, thereby, allowing additional condensate to form.

Piping connected to the compressor should be adequately supported and aligned such that minimal stress is transmitted to the compressor/piping connection. Piping stress analysis shall consider thermal loads, gas loading forces, and piping system weight. See **TABLE 4** for allowable flange loading for Ro-Flo® compressors/vacuum pumps. Additionally, the piping must have an adequate number of elbows, tee's and spool pieces to permit their removal for accessibility to the compressor for service. Stud lengths should be selected so that a minimum of one full thread is exposed on the stud when the nut is properly torqued.

The locations for gas temperature and pressure instrumentation connections, both inlet and discharge, should be as close as possible to the compressor flanges. The discharge temperature indicator gauges and switches will be most effective if they are placed either in the compressor inspection openings or in the piping immediately downstream of the compressor.

For installations in cold climates it may be necessary to insulate piping to maintain proper process gas temperatures to ensure the process gas remains in vapor phase until liquids can be properly managed.

**TABLE 4 - Loading Limits on Ro-Flo® Suction and Discharge Flanges**

MODEL	SUCTION FLANGE DIA.	DISCHARGE FLANGE DIA.	SUCTION FLANGE		DISCHARGE FLANGE	
	(in)	(in)	Fx,y,z	Mx,y,z	Fx,y,z	Mx,y,z
	(in)	(in)	(lbs)	(ft-lbs)	(lbs)	(ft-lbs)
2CC	2	1.5	100	1190	75	970
4CC	2	1.5	100	1190	75	970
5CC	2	1.5	100	1190	75	970
7D	3	3	150	1500	150	1500
8D, SD8D	4	3	200	1670	150	1500
8DE, SD8DE	4	3	200	1670	150	1500
10G	5	4	250	1670	200	1670
11S	6	5	300	1670	250	1670
11L	6	5	300	1670	250	1670
12S	8	6	400	1670	300	1670
12L	8	6	400	1670	300	1670
17S	8	6	400	1670	300	1670
17L	8	6	400	1670	300	1670
19S, SD19S	10	8	500	1670	400	1670
19L, SD19L	10	8	500	1670	400	1670
19LE, SD19LE	10	8	500	1670	400	1670
206, HP6	3	2*	150	1500	80	970
207, HP7	3	2*	150	1500	80	970
208B, HP8	3	2*	150	1500	80	970
210M, HP10	4	2.5*	200	1670	100	1375
211M, HP11	5	3*	250	1670	120	1500
212M, HP12	6	4*	300	1670	160	1670
217M	6	4*	300	1670	160	1670
219M	8	4*	400	1670	160	1670

\* Vertical Orientation (top Discharge)

allowable working pressure of the compressor. Normal engineering practice (ASME Code) requires the valve to be set at 7 PSI or 10% above the operating pressure, whichever is greater. The safety relief valve should NOT be used as a process control device and is meant for emergency situations only.

## GAS COOLERS

There are many acceptable styles of gas coolers (vertical or horizontal, gas-to-air, gas-to-water, etc.) for compression applications, however, all designs should allow for drainage of liquids formed in the cooler.

Two-stage Ro-Flo® systems generally require intercooling (between the first and second stage) to insure a second-stage gas discharge temperature of 350 °F or less.

Separators should be provided after any gas cooler.

## GAS RECYCLE (BYPASS) LOOP

If a recycle (bypass) loop is required, the gas should be cooled prior to return to suction. This will prevent overheating of the compressor due to recirculation of hot gas. The gas bypass loop must enter the gas piping upstream of the inlet separator to remove any free liquids.

When sizing coolers for bypass conditions, assume 100% bypass condition (100% of volume being returned to suction).

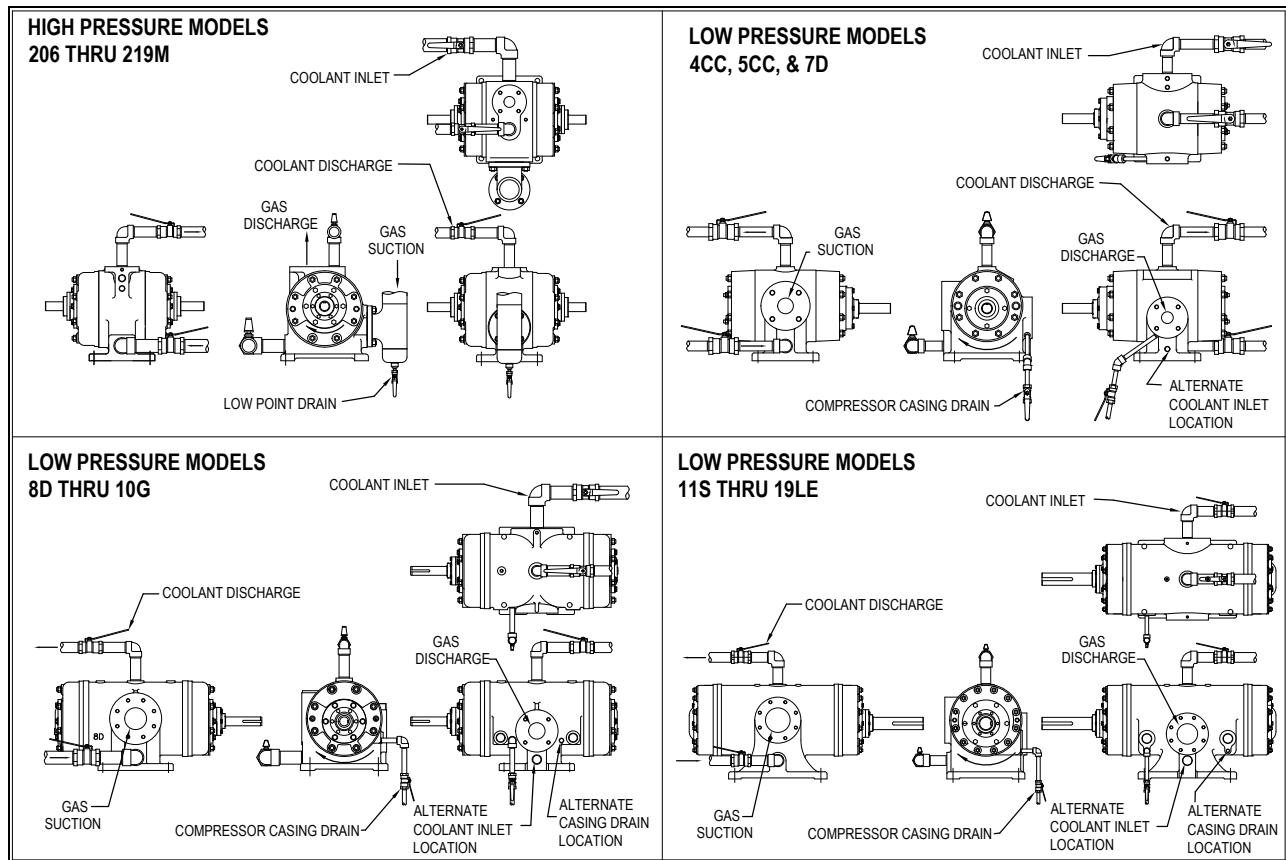
## DISCHARGE CHECK VALVE

A process gas check valve is required after each compressor. This discharge check valve should be mounted as close as possible to the compressor discharge outlet to prevent reverse flow (and potentially reverse rotation) when the compressor is shut down.

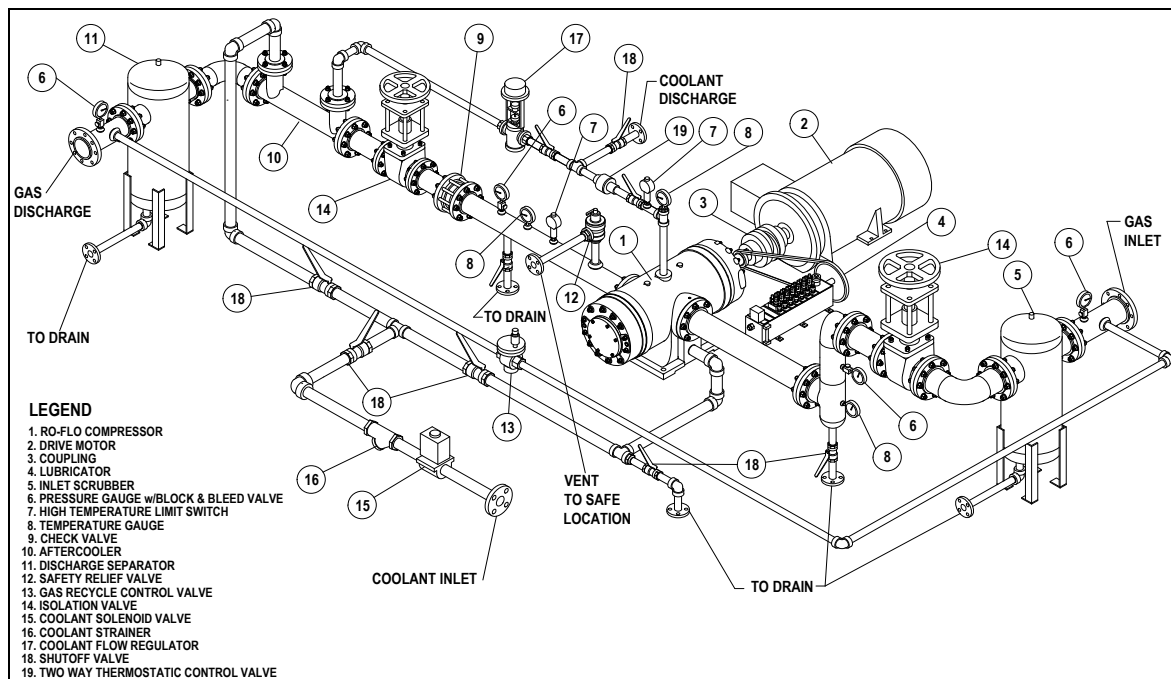
The discharge check valve is to be installed in the discharge line as close to compressor discharge flange as possible, but after all protection devices such as the safety valve and temperature/pressure sensors.

## PRESSURE SAFETY RELIEF VALVE

A gas pressure safety relief valve is required on the discharge side of the compressor before any other valve, set to operate at not more than the



**FIGURE 9 - Ro-Flo® cylinder drain locations and arrangements.** (Note: All pipe & valve positions shown for clarity only, customer configuration may differ per application.)



**FIGURE 10 - Typical piping arrangement - open loop cooling system shown.** (Note: All pipe & valve positions shown for clarity only, customer configuration may differ per application.)

## LUBRICATION

Proper lubrication is required for successful compressor operation and component life.

The PACKAGER shall select a block-type lubricator to insure that proper flow will be provided to all points on the compressor under all operating conditions, including the initial compressor break-in period. The break-in lube rate should be double the normal lube rate for the first 300 hours of operation. Ideally, lubrication should be injected approximately 3 (or more) times per minute. The lubrication cycle rate should not be more than 1 minute between injection cycles.

Oil lubrication tubing should be adequately sized and supported.

In cold climates, heaters and thermostats within the lubricator reservoir may be necessary to ensure proper oil viscosity. Use multi-viscosity or low viscosity grade oil in cold locations (below 32 °F.). Lubricator must be weather proof for outdoor locations.

Refer to the compressor General Arrangement drawings for identification of all lubrication points on the compressor.

The lubrication system must have provisions to shutdown the compressor when a no-flow condition exists.

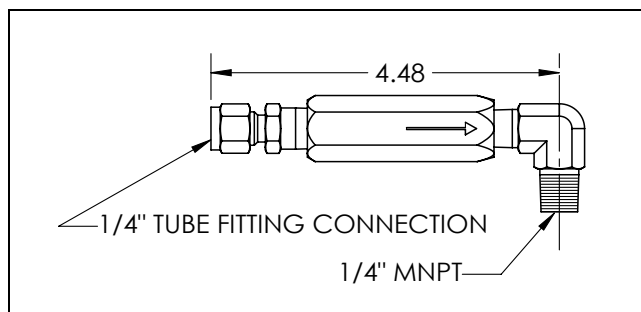
Lubrication tubing must be clean and free of any debris.

Lubrication rates vary directly with compressor speed. If a fixed speed lubricator is used (example: separate motor), the lubrication rate should be set for the highest compressor operating speed.

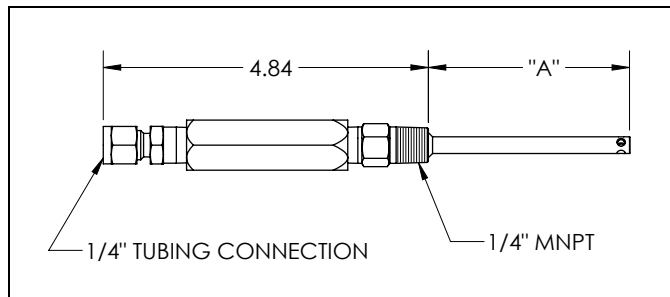
The lubrication system must be primed at the check valves on the compressor, prior starting the compressor. Pre-lube is not required prior to starting the compressor.

### LUBRICATION SETUP

Ro-Flo Compressors recommends check valves at all lubrication points. Ro-Flo Compressors offers the following lubrication components.



**FIGURE 11** - Angled Double Check Valve for compressor lube points.



**FIGURE 12** - Inlet Lubrication Quill.

**TABLE 5** - Compressor Lubrication Accessories

MODEL	NUMBER OF LUBE POINTS	INLET LUBRICATION QUILL		LUBRICATOR DRIVE SHEAVE	
		Quill Length (inches) ("A" Dim.)	Part Number	Pitch Diameter (inches)	Part Number
2CC, 4CC 5CC	5	3	16-630-888-034	3	16-132-506-501
7D	7	4	16-630-888-035	3	16-132-506-502
8D, SD8D 8DE, SD8DE	7	5	16-630-888-038	3	16-132-506-502
10G	7	5	16-630-888-038	4	16-132-492-503
11S, 11L	8	N/A	N/A	5	16-132-534-501
12S, 12L	9	6	16-630-888-036	5	16-132-534-501
17S, 17L	9	6	16-630-888-036	5	16-132-399-501
19S, SD19S, 19L, SD19L, SD19LE, 19LE	10	8	(2 required) 16-630-888-037	5	16-132-399-501
206, HP6 207, HP7 208B, HP8	7	3	16-630-888-034	3	16-132-506-502
210M, HP10	7	4	16-630-888-035	4	16-132-492-503
211M, HP11, 212M, HP12	7	5	16-630-888-038	5	16-132-534-501
217M, 219M	7	6	16-630-888-036	5	16-132-399-501

\* For detailed information on lubrication point locations refer **TABLE 6** and **FIGURE 13**.

**TABLE 6** - Oil injection points and approximate lubrication rates. The lubrication rates listed in this table are for compressors operating on air at maximum operating speed.

Model	Lubrication Injection Points	Quantity Of Lube Points	Pints Per Hr Total	Approximate Drops/Min Per Lube Point*
2CC 4CC 5CC	1-2-7-14-15	5	.09	5
7D	1-2-3-4-7-14-15	7	.15	6
8D, 8DE, SD8D, SD8DE	1-2-5-6-7-14-15	7	.19	7
10G	1-2-11-12-7-14-15	7	.29	10
11S	1-2-3-4-5-6-28-29	8	.28	9
11L	1-2-3-4-5-6-28-29	8	.35	11
12S	1-2-3-4-5-6-7-28-29	9	.36	10
12L	1-2-3-4-5-6-7-28-29	9	.36	10
17S	1-2-3-4-5-6-7-28-29	9	.37	10
17L	1-2-3-4-5-6-7-28-29	9	.45	12
19S, SD19S	1-2-8-9-10-11-12-13-28-29	10	.42	10
19L, 19LE, SD19L, SD19LE	1-2-8-9-10-11-12-13-28-29	10	.50	12
206, 207, 208B, HP6, HP7, HP8	17-18-19-20-30-31-32	7	.15	5
210M, HP10	17-18-19-20-22-30-31	7	.17	6
211M, HP11	17-18-19-20-22-24-25	7	.24	9
212M, HP12	17-18-19-20-22-24-25	7	.24	9
217M	17-18-19-20-22-24-25	7	.29	10
219M	17-18-19-20-22-24-25	7	.29	10

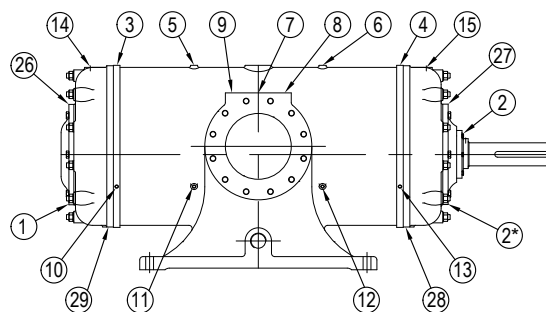
\*Assumes 14,000 drops per pint. Lubricator manufacturers use different standard drops per pint which will affect the above drops/min lubrication rate. See lubricator manufacturer's manual for more information.

**TABLE 7** - Lubrication Rate Multiplier

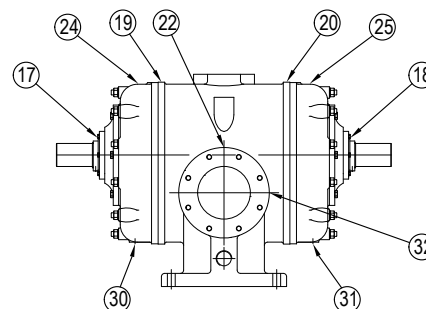
Gas/Vapor Handled	Multiplier
For air and dry inert gases	1.0
Water vapor, wet non-corrosive gases and vapors	1.1
Condenser service	1.2
Refrigeration, sweet natural gas, methane, ethane, propane, butane	1.5
Sour natural gas, sludge gas, heavy hydrocarbons (pentane & heavier)	2.0
Vapor recovery, solvents, acids, ketones	4.0
Gasoline vapors	4.0

### COMPRESSOR LUBRICATION INJECTION POINTS (INLET SIDE SHOWN)

#### LOW PRESSURE MODEL



#### HIGH PRESSURE MODEL



**FIGURE 13** - Compressor lubrication injection points, inlet side shown. For more specific locations see the compressor general arrangement drawings available on the Ro-Flo Compressors web-site.

## COMPRESSOR LUBE RATE CALCULATION

### Normal Lube Rate

The following formula can be used to calculate the correct lubrication rate for your compressor application:

$$\text{Lube Rate} = \text{Pints per hour} \times \frac{\text{Operating Speed}}{\text{Compressor Max Speed}} \times \text{Gas Multiplier}$$

Pints per Hour from **TABLE 6**

Gas Multiplier from **TABLE 7**

Compressor Max Speed from TABLE 2 on page 11

### Break-in Lube Rate

The break-in lubrication rate is double the normal operating lubrication rate for the first 300 hours of operation when the compressor is new or after a major overhaul.

$$\text{Break in Lube Rate} = 2 \times \text{Lube Rate}$$

### Compressor Lube Rate Calculation Example

Below is an example calculation for the calculation of the compressor lube rate. The operating parameters for this lube rate calculation are:

- Ro-Flo model 10G
- Operating Speed 950 RPM
- Vapor recovery Service

With the information above we can determine the following:

- From **TABLE 6**, the base lube rate for a Ro-Flo® model 10G is 0.29 pints/hour.
- From **TABLE 7**, the gas multiplier is 2.0.
- From TABLE 2 on page 11 maximum compressor operating speed is 1300 RPM.

Using the above equation we obtain:

$$\text{Lube Rate} = 0.29 \text{ pints / hr} \times \frac{950 \text{ RPM}}{1300 \text{ RPM}} \times 2.0$$

$$\text{Lube Rate} = 0.42 \text{ pints / hr}$$

The above lube rate is the recommended lube rate for the compressor running with the stated operating conditions. All operating conditions should be considered when setting the lubrication rate.

The break-in lube rate is double the normal lube rate:

$$\text{Break in Lube Rate} = 0.84 \text{ pints / hr}$$



## OIL SYSTEM FOR DOUBLE BELLOWS TYPE & CARTRIDGE SHAFT SEALS

The double bellows shaft seal oil system is designed to keep the seal parts submerged in oil and to maintain the pressure on this oil. If leakage occurs at the outer seal, it will be towards the atmosphere and air will not be drawn into the system. If leakage occurs at the inner seal, it will be into the compressor.

The double bellows seal consists of two carbon rings that rotate and seal against two highly polished stationary rings. The seal is filled with oil by a reservoir mounted above the seal cage. The seal is both lubricated and cooled by thermal circulation of the oil and rotation of the seal.

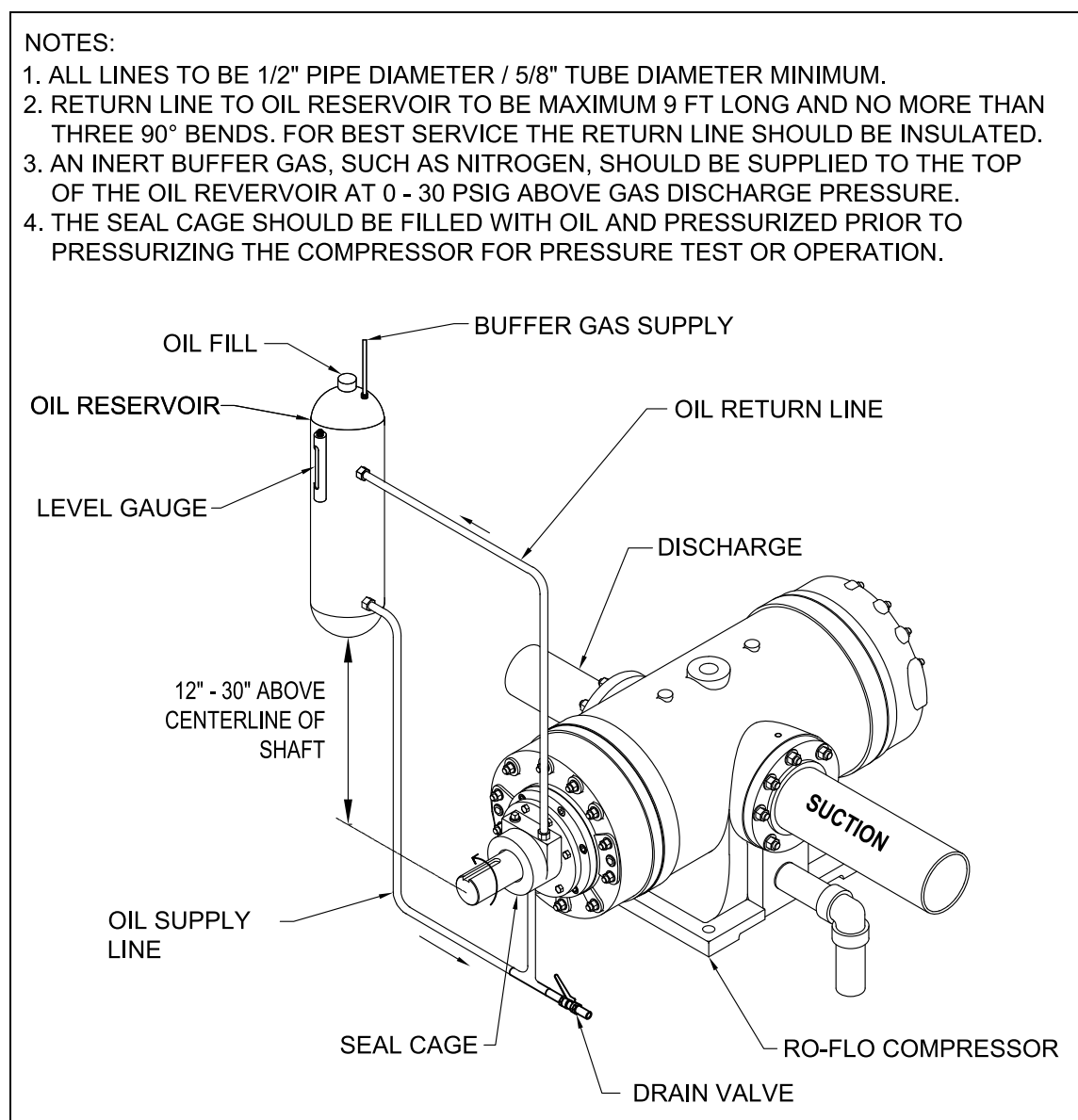
The oil reservoir should be designed to contain 1 gallon of oil per inch of shaft diameter. The reservoir must be connected as shown in **FIGURE 14**. The lower connection on the oil reservoir should be connected to the bottom of the seal cage.

The upper connection of the oil reservoir should be connected to the top of the seal cage. For low pressure models use the connection nearest the compressor suction flange. For high pressure models use the connection nearest the compressor discharge flange.

Use a minimum pipe diameter of 1/2 inch or minimum tubing diameter of 5/8 inch. Locate oil reservoir so piping is as straight as possible to minimize restriction to convective oil flow. Use large radius bends.

NOTE: Be sure to maintain oil level in reservoir above upper pipe connection to provide proper oil circulation. Oil level will drop slightly during initial start-up.

Refer to "Appendix IV - Example Single Stage Double Bellows & Double Opposed Cartridge Seal Support System P&ID" on page 34 and "Appendix VII - Example Two Stage Double Bellows & DOUBLE OPPOSED CARTRIDGE Support System P&ID" on page 40.



**FIGURE 14** - Typical piping arrangement for double bellows seal.

## COMPRESSOR COOLING SYSTEM

The compressor cooling system's function is to control thermal expansion to maintain internal compressor clearances. This system is not designed to control gas discharge temperatures.

Cooling system piping must be designed / installed in such a manner that air can be vented prior to system start-up.

The optimal coolant discharge temperature for the compressor is  $105 \pm 5$  °F ( $40.5 \pm 2.7$  °C). Coolant discharge temperatures below 100 °F (37.8 °C) should be avoided as there is risk of internal loss of clearance. For closed loop cooling systems in hot ambient conditions, it may not be possible to maintain the ideal coolant discharge temperature. For hot ambient conditions it is acceptable to have coolant discharge temperatures up to 165 °F (73.9 °C). Coolant discharge temperature shutdown should not exceed 190 °F (87.8 °C).



### CAUTION

Head gasket failure may occur with coolant discharge temperatures above 190 °F (87.8 °C).

Coolant temperatures above 165 °F (73.9 °C) will increase internal clearances, which will reduce compressor efficiency (resulting in increased recirculation of process gas and higher gas discharge temperature).



### CAUTION

Coolant flow must be stopped when the compressor is shutdown to prevent rotor/cylinder contact.

Circulation of coolant during shutdown periods can cause loss of internal clearances, which may result in rotor/cylinder contact.



### CAUTION

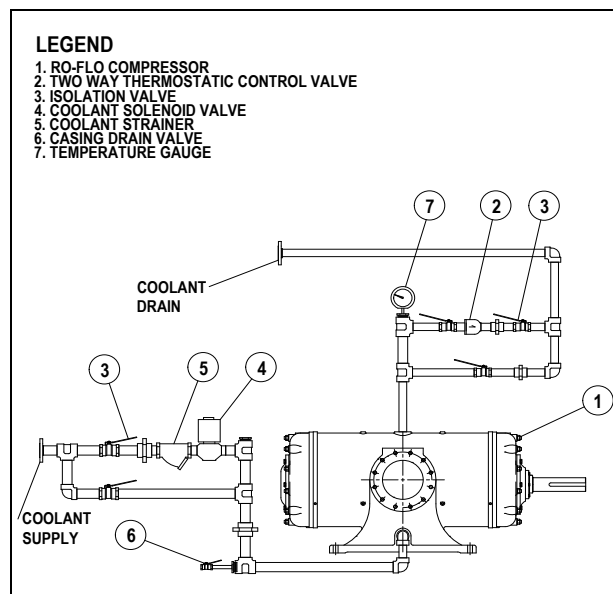
Water jacket pressure must not exceed 50 psig (3.45 barg)

### OPEN LOOP COOLING

Open loop cooling typically uses a two-way flow regulator installed near the compressor cooling water discharge as shown in **FIGURE 15**. The two-way thermostatic control valve should have a weep hole to allow a minimum amount of coolant flow so the temperature sensing element is exposed to hot coolant. The compressor cooling system must be filled with coolant and purged of air prior to start-up.

Solenoid valves should be used to start and stop coolant flow when the compressor is started and stopped. Good piping practice typically includes a manual bypass system around the solenoid valve and the two-way flow regulator.

In climates where freezing temperatures may occur, systems should have automatic jacket water drain valves to drain water out of the compressor jacket when the unit stops to prevent damage to the compressor.



**FIGURE 15** - Typical open loop cooling system.

### CLOSED LOOP COOLING

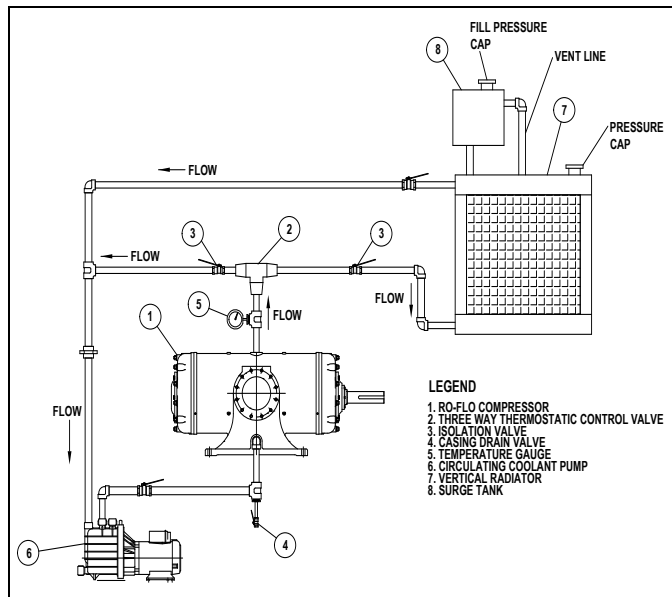
In outdoor closed loop cooling systems, a mixture of 60% glycol and 40% water gives maximum protection (freezes at -70 °F (-56.6 °C), boils at 280 °F (137.7 °C)).

Closed loop glycol/water (**FIGURE 16**) radiator cooling systems may be designed for the approximate flow rates calculated in "Coolant Flow Requirement". Higher compressor casing temperatures will result in higher gas discharge temperatures.

A three-way coolant flow regulator, as shown in **FIGURE 16**, is required to maintain compressor coolant outlet temperature above 100 °F (37.8 °C).

On closed loop cooling systems, a 3-way flow regulator should be used; 2-way regulators are unacceptable because they can stall (dead end) the water pump.

Examples of closed looping cooling systems can be found in "Appendix III - Example Single Stage P&ID" on page 32 and "Appendix VI - Example Two Stage P&ID" on page 38.



**FIGURE 16** - Typical closed loop cooling system.

### COOLANT FLOW REQUIREMENT

Compressor applications should have coolant piping capable of the flow rate (gallons per minute (GPM)) calculated by the following equation:

$$GPM = \frac{\text{Motor Horsepower}}{10}$$

Vacuum pump applications should have coolant piping capable of the flow rate (gallons per minute (GPM)) calculated by the following equation:

$$GPM = \frac{\text{Motor Horsepower}}{5}$$

The above estimated flow rates are based on a design coolant temperature rise of 15 °F (8.3 °C). This flow rate will maintain 105 °F (40.5 °C) coolant discharge temperature with 90 °F (32.2 °C) incoming coolant.

### COOLING WATER CONTAMINANTS

The total water hardness (TDS) of the cooling water should not exceed 300 ppm (mg/l). Deposits will build up over time and will require periodic acid cleaning of the compressor water jacket.

Water containing suspended solids should not be used since the solids will rapidly settle out in the compressor water jacket.

### COOLING WATER PRESSURE DROP

A pressure drop of 5 PSI (35 kPa) may be assumed through the compressor casing. The pressure drop through the water temperature regulating valve and inlet solenoid valve should be considered during system design.

**TABLE 8** - Compressor coolant jacket capacities.

MODEL	APPROXIMATE VOLUME	MODEL	APPROXIMATE VOLUME
	Gallons (Liters)		Gallons (Liters)
2CC	0.8 (3)	206, HP6	2.8 (10.6)
4CC	1.0 (3.8)	207, HP7	2.8 (10.6)
5CC	1.3 (4.9)	208B, HP8	2.8 (10.6)
7D	3.0 (11.4)	210M, HP10	6.0 (23)
8D, SD8D	5.5 (21)	211M, HP11	9.0 (34)
8DE, SD8DE	5.5 (21)	212M, HP12	10.5 (40)
10G	8.0 (30)	217M	13.0 (49)
11S	10.0 (38)	219M	16.3 (62)
11L	10.5 (40)		
12S	12.5 (47)		
12L	13.8 (52)		
17S	20.0 (76)		
17L	24.5 (93)		
19S, SD19S	27.0 (102)		
19L, SD19L	30.0 (114)		
19LE, SD19LE	30.0 (114)		

### COOLING OF TWO STAGE SYSTEMS

Two stage compressor systems should have the coolant supply connected in parallel to each compressor. Each compressor should have a thermostatic valve to control the coolant discharge temperature independently. The compressor cooling circuit should not be connected in series as this may cause excessive heat build up within the compressor and may cause damage to the sealing elements and/or premature cylinder bore wear/blade failure. Refer to the example in "Appendix VI - Example Two Stage P&ID" on page 38.

# INSTRUMENTATION AND CONTROL SYSTEM

## SHUTDOWNS - MINIMUM RECOMMENDATIONS

The following shutdowns are strongly recommended by Ro-Flo Compressors as a minimum. The compressor application, package design, and operation may dictate the necessity for additional shutdowns. Failure to incorporate these shutdowns into the control system will put the safety of the operators and equipment at risk.



### WARNING

#### Do not tamper with or disable shutdown devices.

Tampering with or disabling shutdown devices may result in serious injury or death.

A general recommendation is to set shutdown trip levels 10% above (or below, as appropriate) nominal operating conditions.

1. High gas discharge pressure.
2. High gas discharge temperature – must not be allowed to exceed 350 °F (176.6 °C).
3. High coolant discharge temperature - must not exceed 190 °F (87.7 °C)
4. Low jacket cooling water outlet temperature – must not be allowed to drop below 100 °F (37.8 °C) or insufficient internal clearances could result in failure.
5. Low lubricator oil flow and/or low lubricator supply tank levels.
6. High liquid level in suction separator (scrubber) and interstage (if applicable).
7. For units equipped with a double bellows seal or cartridge seal, low barrier fluid level and low barrier fluid pressure.

## ALARMS

Including alarms as part of the control system is good practice. A general recommendation would be to set alarm levels between shutdown levels and nominal operating conditions so that operators are alerted to conditions that deviate from nominal. The necessity for alarms is ultimately up to the packager and end user, however, the following should be considered:

1. Safety of operators and equipment.
2. Maintenance. For example, adding oil to the lubrication system.
3. How critical is the equipment to the overall process?
4. How remote is the installation?
5. How much response time do operators have to address alarms? Can corrective action be applied in a timely manner to avoid equipment shutdown and/or damage?

## LOCAL INDICATORS / GAUGES - MINIMUM RECOMMENDATIONS

1. Compressor suction/discharge gas pressure (each stage).
2. Compressor discharge gas temperature (each stage).
3. Compressor run time – hour meter
4. Compressor cooling water outlet temperature (each stage)
5. Separator (scrubber) level.
6. Coolant pressure.

## INSTALLATION OF LOCAL INDICATORS / GAUGES

Below are some good practices for installing instrumentation on a Ro-Flo® package.

The compressor discharge and coolant outlet temperature instrumentation shall be located as close as possible to the compressor as possible. This will help provide accurate temperature measurements of the compressor conditions.

Process gas instrumentation is preferably located near the top of horizontal pipe runs to avoid any condensation that may be present at the bottom of the pipe. Condensation may corrupt instrumentation measurements if allowed to contact the instrument.

The compressor discharge instrumentation is preferably located between the compressor and gas discharge check valve. This will help ensure accurate measurements of the compressor gas discharge conditions.

## DRIVERS

Variable speed controllers should be equipped with limits to prevent operation above or below the corresponding maximum and minimum operating speeds of the compressor.

The driver manufacturer should be consulted for their recommendation of the number of allowable starts per hour.

## LUBRICATION

Lubrication is critical to the equipment health and Ro-Flo Compressors strongly recommends that instrumentation is included that ensures satisfactory operation of the lubrication system. The preferred method for accomplishing this is to monitor oil flow (e.g. no-flow switch). For lubrication systems with divider blocks, one (1) flow sensor is typically sufficient. Lubrication systems with pump-to-point would ideally provide flow sensors on each pump-to-point line. Ro-Flo Compressors recognizes the fact that this can result in many flow sensors, however, monitoring only 1 or 2 pumps will still allow the compressor to run after multiple pump failures.

## COMPRESSOR COOLING JACKET

The packager should consider a sight glass flow indicator in the compressor jacket cooling system. A switch monitoring coolant pressure in the jacket cooling system may also need to be considered for loss of coolant and/or process contamination.

## SEPARATORS (SCRUBBERS)

The separators (scrubbers) are critical pieces of equipment for the compressor and potentially other downstream equipment. The PACKAGER needs to consider how liquids are removed from the separator. If the separator is operating near ambient pressures and/or sub-ambient pressures, a pump will likely be required to remove liquids during compressor operation (see P&ID example). If applicable, monitoring differential pressure across the separator vessel provides the ability to assess filter element condition. Additionally, some applications may require positive inlet pressures (no vacuum pressure) to ensure that no air/oxygen is drawn into the process. In these instances, a separator differential pressure switch or compressor inlet vacuum pressure switch may be required.



### CAUTION

Caution should be taken to prevent pressure overshoots or deep vacuum conditions being developed during starts, stops, and other transient conditions.

## HEAT EXCHANGERS

Monitoring temperature downstream of heat exchangers will allow the user to determine if the heat exchanger is operating correctly or needs service.

## AIR QUALITY MONITORING/GAS DETECTOR

Often it is advisable for systems to have air quality monitoring/gas detectors to protect operators. For units in enclosed environments this is often critical to ensure operator safety. Use of these systems should be reviewed with respect to applicable local, national, and international codes.

## OXYGEN (O<sub>2</sub>) SENSOR

When dealing with explosive or flammable gases, or when dealing with process gas streams that are sensitive to oxygen in the gas stream, an oxygen (O<sub>2</sub>) sensor may be advisable. Oxygen sensors are most often employed when gas inlet pressures are near or below ambient pressures.

## DRY-OUT CYCLE

For those units dealing with gases near their dew point, a dry-out cycle should be considered. This will help to prevent accumulation of liquids in the compressor due to process gas cooling. In oil & gas applications, these dry-out cycles are often run with fuel gas or nitrogen (N<sub>2</sub>), as these are clean-dry gases. If a dry-out cycle will be used, operating conditions should be reviewed to ensure that the compressor remains within acceptable operating limits.

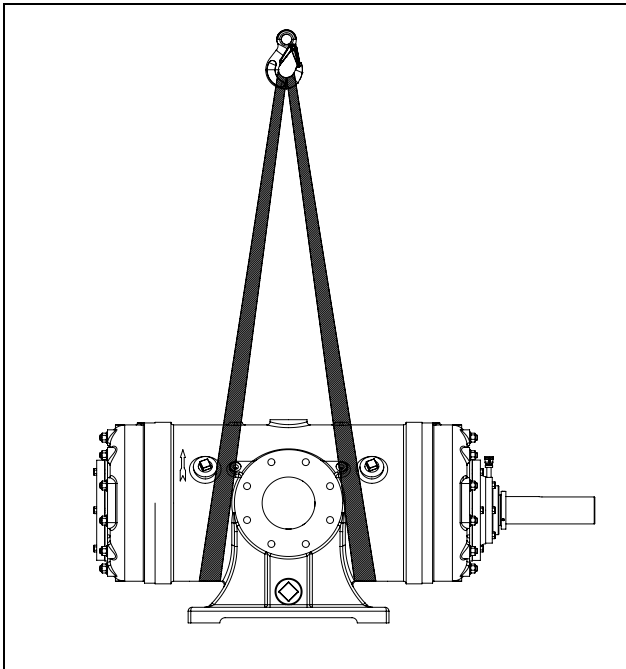
## CONTROL STRATEGY

The control strategy of the system should be developed to safely control the compressor and auxiliary systems during both normal operation and transient conditions. Examples of transient conditions to evaluate are compressor start-up & shut-down events. Consideration should be given to such aspects as valve timing / responsiveness and the inertia of the gases, inertia of mechanical components, etc.

## ASSEMBLY AND SHOP TESTING

Several items need attention during assembly and shop testing:

When lifting the compressor, always sling the unit from underneath the ends of the cylinder as shown in **FIGURE 17**. Do not use the eye-bolt holes located on top of the cylinder heads for lifting the assembled compressor. Do not lift the compressor by slinging around the compressor shaft.



**FIGURE 17** - Method of proper slinging for lifting the compressor.

During skid fabrication and shop testing care must be taken to insure dirt & debris does not enter the machinery.

When testing the compressor in the shop, the operating conditions of the test need to be evaluated using the Ro-Flo Performance software, taking into consideration the test process gas, which is often air. Operating on air generates different loads and temperatures than the actual process gas being used in the field. Often operating conditions need to be modified to prevent equipment overload or excessive temperatures from being generated. Fabrication shops do not always have the same power sources available as the final installation site. In these instances, it may be necessary to reduce compressor load by reducing discharge pressure and/or suction throttling.

If the compressor is equipped with a double bellows seal, it should be pressurized prior to gas leaking testing of the piping system or operating the compressor. Please see "Oil System for Double Bellows Type & Cartridge Shaft Seals" on page 21 for more information.



## START-UP, SERVICE, AND PARTS

1. The PACKAGER is responsible for providing competently trained field start-up service and/or warranty investigations as required. Ro-Flo Compressors, LLC can provide field service for start-up and/or training.
2. The PACKAGER must provide the compressor unit operator with Ro-Flo Installation, Operation, and Maintenance Manual and lubrication information.
3. The PACKAGER shall insure that the Ro-Flo Installation, Operation, and Maintenance Manual is correct for the model and serial numbers provided.
4. The PACKAGER shall record the serial and model number for each unit shipped.
5. The END USE CUSTOMER should retain a copy of the Ro-Flo Installation, Operation, and Maintenance Manual for each installed unit.

## APPENDIX I - EXPECTED SOUND PRESSURE LEVELS

The expected sound pressure levels shown in **TABLE 9** and **TABLE 10** are provided as a general reference. Actual sound characteristics will vary by application due to changes in gas properties, gas pressures, gas temperatures, operating speeds, piping arrangements, and other factors of the skid design.

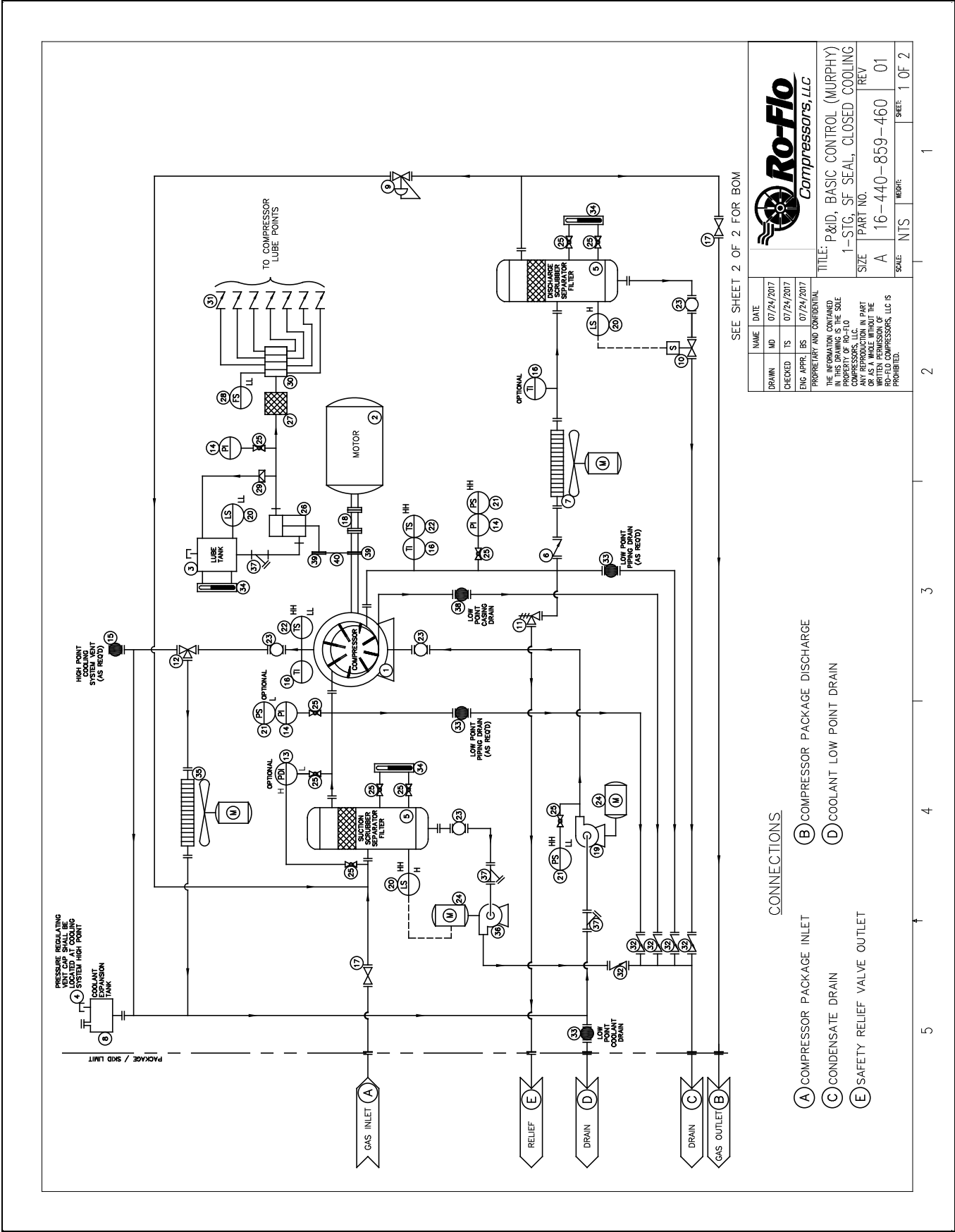
**TABLE 9** - Expected Sound Characteristics of Ro-Flo® Sliding Vane Compressors.

EXPECTED SOUND PRESSURE LEVELS (dB)														
Model	Speed (RPM)	Disch Press (PSIG)	dBA @ 3'	OCTAVE CENTER FREQUENCIES (Hz)										dBC @ 3'
				31.5	63	125	250	500	1000	2000	4000	8000	16000	
2CC	1160	50	75	61	62	66	73	70	69	62	60	59	55	77
	1740	50	78	63	64	69	76	72	72	71	68	64	60	80
4CC	1160	50	75	61	62	66	73	70	69	62	60	59	55	77
	1740	50	78	63	64	69	76	72	72	71	68	64	60	80
5CC	1160	50	75	61	62	66	73	70	69	62	60	59	55	77
	1740	50	78	63	64	69	76	72	72	71	68	64	60	80
7D	865	50	76	66	72	74	72	69	67	63	61	66	63	79
	1160	50	80	66	71	76	78	72	71	67	69	74	70	83
8D, SD8D	865	50	86	78	69	77	83	79	82	74	70	62	63	88
	1160	50	89	77	73	85	86	81	75	77	85	86	83	92
8DE, SD8DE	1160	50	90	76	74	81	87	80	77	78	86	79	82	92
10G	865	50	89	78	85	87	86	81	78	72	80	72	61	90
	1160	50	90	69	73	85	89	84	80	77	74	84	66	93
11S	865	50	90	70	72	86	88	85	81	73	76	83	59	92
11L	865	50	91	72	76	88	84	83	78	76	77	86	60	93
12S	865	50	91	69	67	78	80	81	80	84	86	83	67	94
12L	865	50	94	71	74	86	91	83	80	78	80	89	70	97
17S	690	50	95	72	72	88	90	89	83	83	89	84	73	98
17L	690	50	96	70	73	82	90	90	81	87	90	94	90	99
19S, SD19S	575	50	94	67	81	85	84	91	86	91	86	90	77	100
19L, SD19L	575	50	95	69	78	87	89	86	88	89	93	91	90	101
19LE, SD19LE	575	50	95	69	78	87	89	86	88	89	93	91	90	101
206, HP6	1160	40	85	59	62	71	84	76	73	70	78	80	70	87
207, HP7	1160	40	85	59	62	71	84	76	73	70	78	80	70	87
208B, HP8	1160	40	85	59	62	71	84	76	73	70	78	80	70	87
210M, HP10	1160	40	84	65	76	81	80	75	76	75	73	70	66	86
211M, HP11	865	40	85	63	75	80	82	74	77	76	71	73	69	87
212M, HP12	865	40	86	65	77	82	81	75	78	82	73	75	70	88
217M	690	40	87	66	76	80	84	72	79	85	82	84	73	89
219M	575	40	87	62	78	77	81	78	80	85	84	86	64	90

**TABLE 10** - Expected Sound Characteristics of Ro-Flo® Sliding Vane Vacuum Pumps.

EXPECTED SOUND PRESSURE LEVELS (dB)														
Model	Speed (RPM)	Suction Press (Inches HgV)	dBA @ 3'	OCTAVE CENTER FREQUENCIES (Hz)										dBC @ 3'
				31.5	63	125	250	500	1000	2000	4000	8000	16000	
2CC	1160	25	75	61	60	66	72	69	70	66	61	59	52	76
	1740	25	76	62	61	68	73	74	70	69	63	60	55	57
4CC	1160	25	75	61	60	66	72	69	70	66	61	59	52	76
	1740	25	76	62	61	68	73	74	70	69	63	60	55	57
5CC	1160	25	75	61	60	66	72	69	70	66	61	59	52	76
	1740	25	76	62	61	68	73	74	70	69	63	60	55	57
7D	865	25	80	66	65	69	74	77	71	71	62	59	64	82
	1160	25	82	63	70	68	72	78	76	73	64	65	59	84
8D, SD8D	865	25	85	64	73	72	76	79	74	75	66	61	56	87
	1160	25	86	62	71	74	77	82	78	77	72	72	62	88
8DE, SD8DE	1160	25	86	62	71	74	77	82	78	77	72	72	62	88
10G	865	25	87	69	72	75	80	81	80	80	75	76	56	89
	1160	25	88	68	73	76	81	83	81	82	78	78	61	90
11S	865	25	88	72	71	76	82	81	84	81	77	80	57	89
11L	865	25	88	71	73	77	83	82	79	80	79	81	60	90
12S	865	25	88	71	72	76	82	80	77	79	80	70	63	89
12L	865	25	88	73	69	78	84	79	82	78	80	63	64	90
17S	690	25	88	74	74	81	84	81	81	81	79	69	60	90
17L	690	25	89	74	75	82	84	80	83	82	78	67	62	92
19S, SD19S	575	25	90	71	74	84	83	84	82	80	79	70	60	92
19L, SD19L	575	25	91	73	77	85	82	83	83	81	78	73	65	93
19LE, SD19LE	575	25	91	73	77	85	82	83	83	81	78	73	65	93

APPENDIX II - EXAMPLE SINGLE STAGE BASIC P&ID




BILL OF MATERIALS

ITEM #	QTY	DESCRIPTION	ITEM #	QTY	DESCRIPTION
1	1	COMPRESSOR	25	10	INSTRUMENT ISOLATION VALVE
2	1	COMPRESSOR DRIVE MOTOR	26	1	PISTON / PLUNGER LUBE OIL PUMP (ADJUSTABLE FLOW)
3	1	LUBE OIL TANK	27	1	LUBE OIL FILTER
4	1	PRESSURE REGULATING VENT CAP	28	1	DIVIDER BLOCK PROX SWITCH (FLOW SWITCH)
5	2	SEPARATOR/SCRUBBER/FILTER	29	1	RUPTURE DISC
6	1	CHECK VALVE (PROCESS GAS)	30	1	LUBE OIL DIVIDER BLOCK ASSEMBLY
7	1	HEAT EXCHANGER	31	—	LUBE POINT CHECK VALVES (QTY. VARIES WITH COMPRESSOR)
8	1	JACKET COOLING EXPANSION TANK	32	—	CHECK VALVE (QTY. DEPENDENT UPON LAYOUT)
9	1	RECYCLE PRESSURE REGULATING VALVE	33	—	PIPING LOW POINT DRAIN BALL VALVE (QTY. DEPENDENT UPON LAYOUT)
10	1	LEVEL CONTROL SOLENOID VALVE	34	3	LEVEL INDICATOR
11	1	PRESSURE SAFETY VALVE	35	1	JACKET COOLING HEAT EXCHANGER
12	1	THERMOSTATIC VALVE, 3-WAY DIVERTING MODE	36	1	LEVEL CONTROL PUMP
13	1	DIFFERENTIAL PRESSURE GAUGE	37	3	PUMP STRAINER
14	3	PRESSURE GAUGE	38	1	COMPRESSOR CASING DRAIN BALL VALVE (PROCESS)
15	—	COOLING SYSTEM HIGH POINT VENT (QTY DEPENDENT UPON LAYOUT)	39	2	SHEAVE (PULLEY)
16	3	TEMPERATURE INDICATOR	40	1	BELT
17	2	PACKAGE ISOLATION VALVE			
18	1	COUPLING ASSEMBLY			
19	1	JACKET COOLANT PUMP			
20	3	LEVEL SWITCH			
21	3	PRESSURE SWITCH			
22	2	TEMPERATURE SWITCH			
23	4	ISOLATION BALL VALVE			
24	2	PUMP MOTOR			

NAME	DATE
DRAWN MD	07/24/2017
CHECKED TS	07/24/2017
ENG APPR BS	07/24/2017

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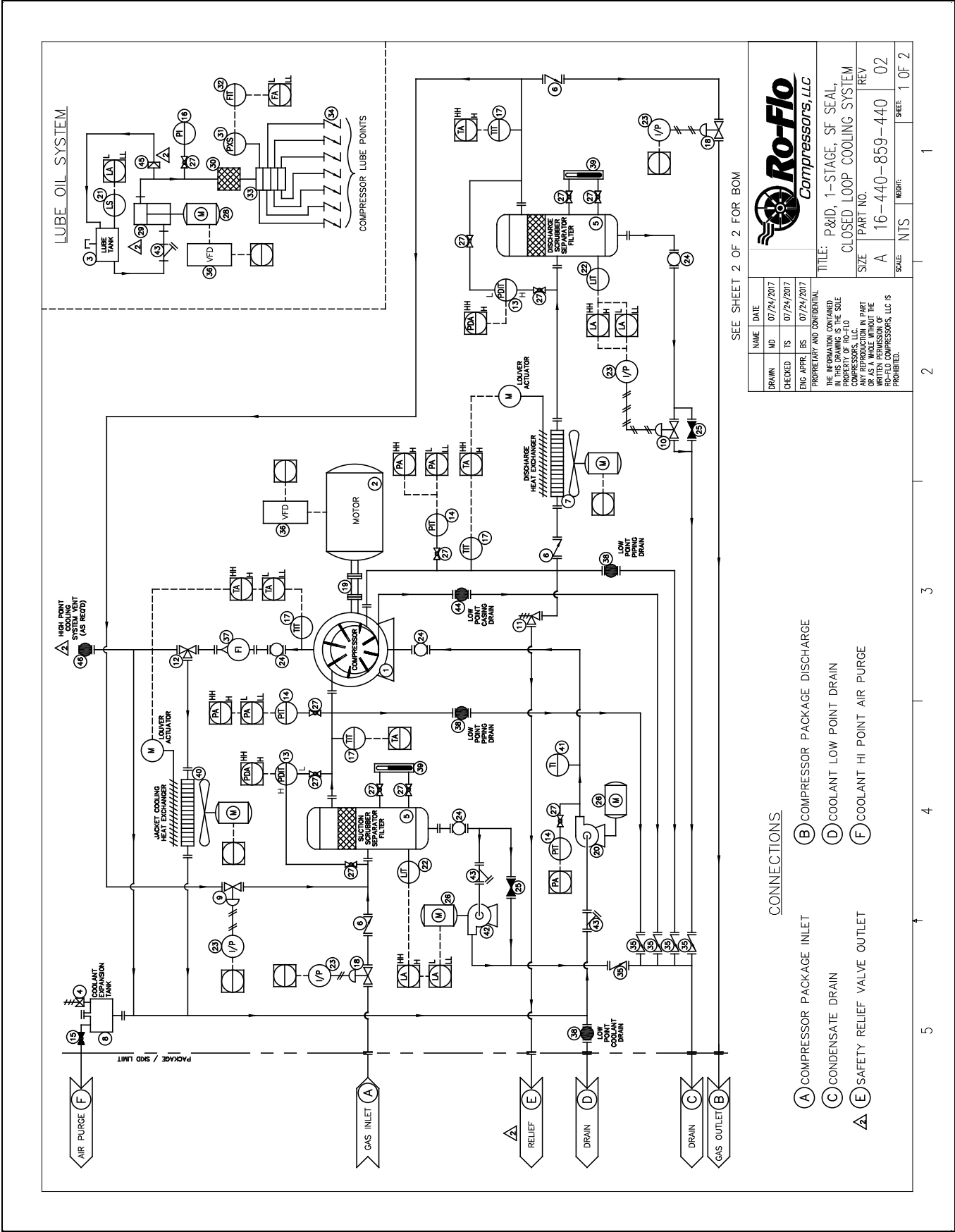
TITLE: P&ID, BASIC CONTROL (MURPHY)

1-STG, SF SEAL, CLOSED COOLING

SIZE	PART NO.	REV
A	16-440-859-460	01


SCALE: NTS    MEAS:    SHEET: 2 OF 2

APPENDIX III - EXAMPLE SINGLE STAGE P&ID



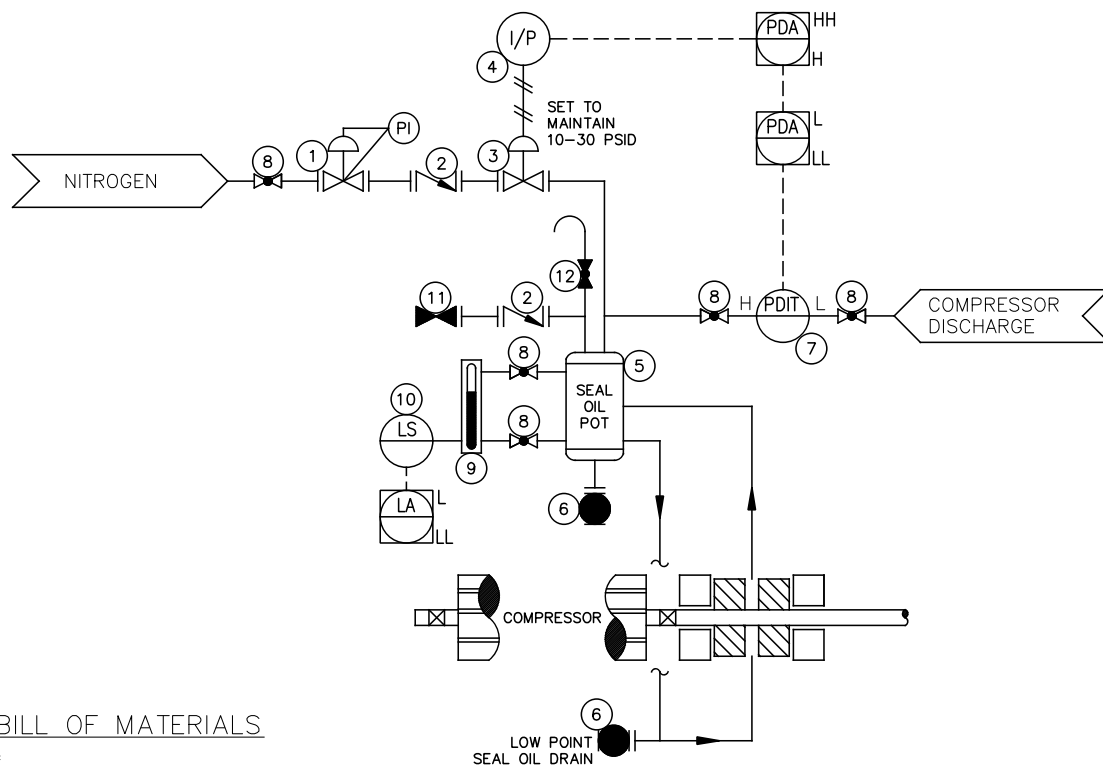
BILL OF MATERIALS

ITEM #	QTY	DESCRIPTION	ITEM #	QTY	DESCRIPTION
1	1	COMPRESSOR	25	2	BY-PASS VALVE
2	1	COMPRESSOR DRIVE MOTOR	26	2	PUMP MOTOR
3	1	LUBE OIL TANK	27	12	INSTRUMENT ISOLATION VALVE
4	1	COOLANT PRESSURE RELIEF/REGULATOR	28	1	LUBE OIL PUMP MOTOR
5	2	SEPARATOR/SCRUBBER/FILTER	29	1	PISTON/PLUNGER LUBE OIL PUMP (ADJUSTABLE FLOW) $\Delta$
6	3	CHECK VALVE (PROCESS GAS)	30	1	LUBE OIL FILTER
7	1	HEAT EXCHANGER	31	1	DIVIDER BLOCK PROX SWITCH
8	1	JACKET COOLING EXPANSION TANK	32	1	FLOW INDICATING TRANSMITTER/LOW OIL FLOW SWITCH
9	1	RECYCLE CONTROL VALVE	33	1	LUBE OIL DIVIDER BLOCK ASSEMBLY
10	1	LEVEL CONTROL VALVE	34	—	LUBE POINT CHECK VALVES (QTY. VARIES WITH COMPRESSOR)
11	1	PRESSURE SAFETY VALVE	35	—	CHECK VALVE (QTY. DEPENDENT UPON SYSTEM)
12	1	THERMOSTATIC VALVE, 3-WAY DIVERTING MODE	36	2	DRIVE CONTROL
13	2	DIFF. PRESS. INDICATING TRANSMITTER	37	1	OUTLET COOLANT FLOW INDICATOR
14	3	PRESSURE INDICATING TRANSMITTER	38	—	PIPING LOW POINT DRAIN BALL VALVE (QTY DEPENDENT UPON SYSTEM)
15	—	BLEED VALVE (QTY. DEPENDENT UPON SYSTEM)	39	2	LEVEL INDICATOR
16	1	PRESSURE INDICATOR	40	1	JACKET COOLING HEAT EXCHANGER
17	4	TEMPERATURE INDICATING TRANSMITTER	41	1	TEMPERATURE INDICATOR
18	2	ISOLATION/CONTROL VALVE	42	1	LEVEL CONTROL PUMP
19	1	COUPLING ASSEMBLY	43	3	PUMP STRAINER
20	1	JACKET COOLANT PUMP	44	1	COMPRESSOR CASING DRAIN BALL VALVE (PROCESS)
21	1	LOW OIL LEVEL SWITCH	45	1	PRESSURE RELIEF (RUPTURE DISC) $\Delta$
22	2	LEVEL INDICATING TRANSMITTER	46	—	COOLING SYSTEM HIGH POINT VENT (QTY DEPENDENT UPON LAYOUT) $\Delta$
23	4	CURRENT TO PNEUMATIC CONVERTER			
24	4	ISOLATION BALL VALVE			

NAME		DATE	
DRAWN	MD	07/24/2017	
CHECKED	TS	07/24/2017	
ENG APPR	BS	07/24/2017	
			
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TITLE:		P&ID, 1-STAGE, SF SEAL, CLOSED LOOP COOLING SYSTEM	
SIZE	PART NO.	REV	
A	16-440-859-440	02	
SCALE:	NTS	MECH:	SHEET 2 OF 2

5 4 3 2 1

## APPENDIX IV - EXAMPLE SINGLE STAGE DOUBLE BELLOWS & DOUBLE OPPOSED CARTRIDGE SEAL SUPPORT SYSTEM P&ID




### BILL OF MATERIALS

ITEM #	QTY	DESCRIPTION
1	1	PRESSURE REGULATOR
2	2	CHECK VALVE
3	1	DIFFERENTIAL PRESSURE CONTROL VALVE
4	1	CURRENT TO PNEUMATIC CONVERTER
5	1	SEAL POT
6	2	BALL VALVE
7	1	DIFFERENTIAL PRESSURE INDICATING TRANSMITTER
8	5	GAS / INSTRUMENT ISOLATION VALVE
9	1	LEVEL INDICATOR
10	1	LOW LEVEL SWITCH
11	1	BARRIER FLUID FILL VALVE
12	1	BLEED VALVE (FOR FILLING PURPOSES)

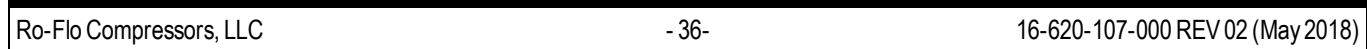
### NOTES:

1. MINIMIZE PIPING LINE LOSSES
2. BARRIER FLUID LINES TO AND FROM SEAL SHALL HAVE A MINIMUM PIPE DIAMETER OF 1/2" OR MINIMUM TUBE DIAMETER OF 5/8"
3. USE LARGE RADIUS BENDS
4. USE CORRECT TANGENTIAL OUTLET PORT ON SEAL HOUSING (SEE RO-FLO PACKAGING GUIDELINES).
5. 1/4" PER FOOT MINIMUM UPWARD SLOPE ON BARRIER FLUID HORIZONTAL LINES BETWEEN THE SEAL HOUSING BARRIER FLUID OUT CONNECTION AND SEAL POT.
6. SEAL POT SHALL BE LOCATED A MAXIMUM OF 3 FEET HORIZONTALLY FROM THE COMPRESSOR SHAFT CENTERLINE.
7. THE BOTTOM OF THE SEAL POT SHALL BE LOCATED 12"-30" ABOVE THE COMPRESSOR SHAFT CENTERLINE.

NAME	DATE
DRAWN MD	04/29/2016
CHECKED TF	04/29/2016
ENG APPR BS	04/29/2016
PROPRIETARY AND CONFIDENTIAL	
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TITLE: P&ID, DOUBLE BELLOWS SEAL SUPPORT SYSTEM, 1-STAGE	
SIZE A	PART NO. 16-440-859-455
SCALE: NTS	WEIGHT: SHEET 1 OF 1



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BILL OF MATERIALS							
ITEM #	QTY	DESCRIPTION	ITEM #	QTY	DESCRIPTION		
1	1	1ST STAGE COMPRESSOR	25	1	PISTON/PLUNGER LUBE OIL PUMP (ADJUSTABLE FLOW)		
2	1	2ND STAGE COMPRESSOR	26	1	LUBE OIL FILTER		
3	1	COMPRESSOR DRIVE MOTOR	27	1	DIVIDER BLOCK PROX SWITCH (FLOW SWITCH)		
4	1	LUBE OIL TANK	28	1	MASTER LUBE OIL DIVIDER BLOCK ASSEMBLY		
5	1	PRESSURE REGULATING VENT CAP	29	2	SLAVE LUBE OIL DIVIDER BLOCK ASSEMBLY		
6	3	SEPARATOR/SCRUBBER/FILTER	30	—	LUBE POINT CHECK VALVES (QTY. VARIES WITH COMPRESSOR)		
7	2	CHECK VALVE (PROCESS GAS)	31	—	CHECK VALVE (QTY. DEPENDENT UPON LAYOUT)		
8	2	HEAT EXCHANGER	32	4	LEVEL INDICATOR		
9	1	JACKET COOLING EXPANSION TANK	33	1	JACKET COOLING HEAT EXCHANGER		
10	1	RECYCLE PRESSURE REGULATING VALVE	34	1	LEVEL CONTROL PUMP		
11	2	LEVEL CONTROL SOLENOID VALVE	35	3	PUMP STRAINER		
12	2	PRESSURE SAFETY VALVE	36	1	PRESSURE RELIEF (RUPTURE DISC)		
13	2	THERMOSTATIC VALVE, 3-WAY DIVERTING MODE	37	2	SHEAVE (PULLEY)		
14	3	DIFFERENTIAL PRESSURE GAUGE	38	1	BELT		
15	5	PRESSURE GAUGE	39	4	TEMPERATURE SWITCH		
16	—	COOLING SYSTEM HIGH POINT VENT (QTY. DEPENDENT UPON LAYOUT)	40	2	COMPRESSOR CASING DRAIN BALL VALVE (PROCESS)		
17	4	PRESSURE SWITCH	41	—	PIPING LOW POINT DRAIN BALL VALVE (QTY DEPENDENT UPON LAYOUT)		
18	4	TEMPERATURE INDICATOR	42	1	PRESSURE RELIEF VALVE		
19	2	ISOLATION/CONTROL VALVE	43	2	ISOLATION/FLOW ADJUSTMENT VALVE		
20	2	COUPLING ASSEMBLY	44	1	DIFFERENTIAL PRESSURE SWITCH		
21	1	JACKET COOLANT PUMP	45	17	INSTRUMENT ISOLATION VALVE		
22	4	LEVEL SWITCH					
23	5	ISOLATION BALL VALVE					
24	2	PUMP MOTOR					

NAME

DATE

DRAWN

MD

07/24/2017

CHECKED

TS

07/24/2017


ENG APPR.

BS

07/24/2017

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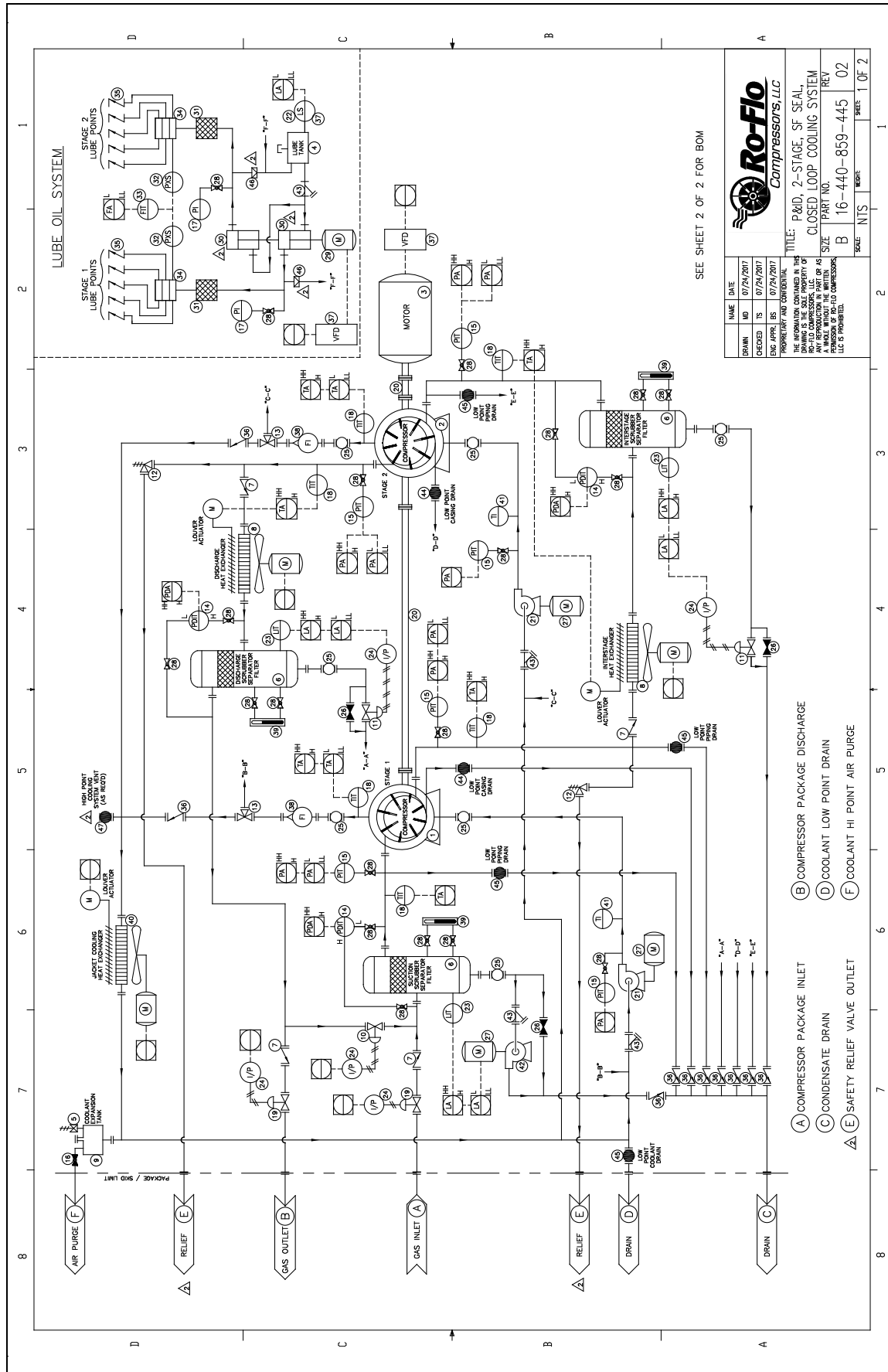
Ro-Flo  
Compressors, LLC

TITLE: P&ID, BASIC CONTROL (MURPHY)  
2-STG. SF SEAL, CLOSED COOLING


SIZE PART NO. REV  
B 16-440-859-465 01

SCALE NTS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

# APPENDIX VI - EXAMPLE TWO STAGE P&ID



BILL OF MATERIALS									
ITEM #	QTY	DESCRIPTION	ITEM #	QTY	DESCRIPTION	ITEM #	QTY	DESCRIPTION	ITEM #
1	1	1ST STAGE COMPRESSOR	25	7	ISOLATION BALL VALVE	25	7	ISOLATION BALL VALVE	25
2	1	2ND STAGE COMPRESSOR	26	3	BY-PASS VALVE	26	3	BY-PASS VALVE	26
3	1	COMPRESSOR DRIVE MOTOR	27	3	PUMP MOTOR	27	3	PUMP MOTOR	27
4	1	LUBE OIL TANK	28	20	INSTRUMENT ISOLATION VALVE	28	20	INSTRUMENT ISOLATION VALVE	28
5	1	COOLANT PRESSURE RELIEF/REGULATOR	29	1	LUBE OIL PUMP MOTOR	29	1	LUBE OIL PUMP MOTOR	29
6	3	SEPARATOR/SCRUBBER/FILTER	30	2	PISTON/PLUNGER LUBE OIL PUMP (ADJUSTABLE FLOW) Δ	30	2	PISTON/PLUNGER LUBE OIL PUMP (ADJUSTABLE FLOW) Δ	30
7	4	CHECK VALVE (PROCESS GAS)	31	2	LUBE OIL FILTER	31	2	LUBE OIL FILTER	31
8	2	HEAT EXCHANGER	32	2	DIVIDER BLOCK PROX SWITCH	32	2	DIVIDER BLOCK PROX SWITCH	32
9	1	JACKET COOLING EXPANSION TANK	33	1	FLOW INDICATING TRANSMITTER/LOW OIL FLOW SWITCH	33	1	FLOW INDICATING TRANSMITTER/LOW OIL FLOW SWITCH	33
10	1	RECYCLE CONTROL VALVE	34	2	LUBE OIL DIVIDER BLOCK ASSEMBLY	34	2	LUBE OIL DIVIDER BLOCK ASSEMBLY	34
11	2	LEVEL CONTROL VALVE	35	—	LUBE POINT CHECK VALVES (QTY. VARIES WITH COMPRESSOR)	35	—	LUBE POINT CHECK VALVES (QTY. VARIES WITH COMPRESSOR)	35
12	2	PRESSURE SAFETY VALVE	36	—	CHECK VALVE (QTY. DEPENDENT UPON SYSTEM)	36	—	CHECK VALVE (QTY. DEPENDENT UPON SYSTEM)	36
13	2	THERMOSTATIC VALVE, 3-WAY DIVERTING MODE	37	2	DRIVE CONTROL	37	2	DRIVE CONTROL	37
14	3	DIFF. PRESS. INDICATING TRANSMITTER	38	2	OUTLET COOLANT FLOW INDICATOR	38	2	OUTLET COOLANT FLOW INDICATOR	38
15	6	PRESSURE INDICATING TRANSMITTER	39	3	LEVEL INDICATOR	39	3	LEVEL INDICATOR	39
16	—	BLEED VALVE (QTY. DEPENDENT UPON SYSTEM)	40	1	JACKET COOLING HEAT EXCHANGER	40	1	JACKET COOLING HEAT EXCHANGER	40
17	2	PRESSURE INDICATOR	41	2	TEMPERATURE INDICATOR	41	2	TEMPERATURE INDICATOR	41
18	6	TEMPERATURE INDICATING TRANSMITTER	42	1	LEVEL CONTROL PUMP	42	1	LEVEL CONTROL PUMP	42
19	2	ISOLATION/CONTROL VALVE	43	4	PUMP STRAINER	43	4	PUMP STRAINER	43
20	2	COUPLING ASSEMBLY	44	2	COMPRESSOR CASING DRAIN BALL VALVE (PROCESS)	44	2	COMPRESSOR CASING DRAIN BALL VALVE (PROCESS)	44
21	2	JACKET COOLANT PUMP	45	—	PIPING LOW POINT DRAIN BALL VALVE (QTY DEPENDENT UPON SYSTEM)	45	—	PIPING LOW POINT DRAIN BALL VALVE (QTY DEPENDENT UPON SYSTEM)	45
22	1	LOW OIL LEVEL SWITCH	46	2	PRESSURE RELIEF (RUPTURE DISC) Δ	46	2	PRESSURE RELIEF (RUPTURE DISC) Δ	46
23	3	LEVEL INDICATING TRANSMITTER	47	—	COOLING SYSTEM HIGH POINT VENT (QTY DEPENDENT UPON LAYOUT) Δ	47	—	COOLING SYSTEM HIGH POINT VENT (QTY DEPENDENT UPON LAYOUT) Δ	47
24	5	CURRENT TO PNEUMATIC CONVERTER							



**Ro-Flo**  
Compressors, LLC

NAME	DATE
DRAWN: MD	07/24/2017
CHECKED: TS	07/24/2017
ENG APPR: BS	07/24/2017

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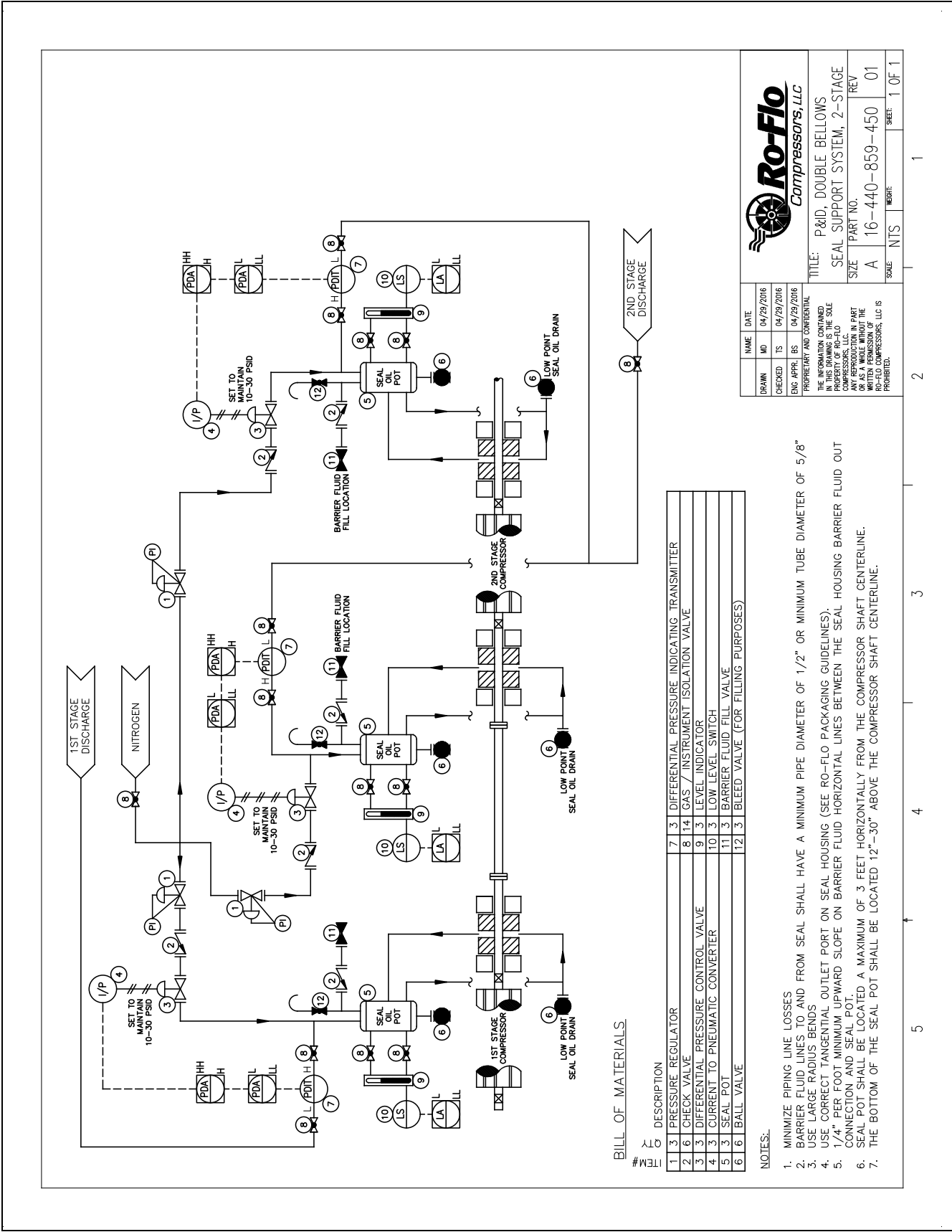
TITLE: P&ID, 2-STAGE, SF SEAL, CLOSED LOOP COOLING SYSTEM

SIZE: 16" PART NO. 16-440-859-445

REV: 02

SCALE: NTS 1" = 1' MORE 2 OF 2

APPENDIX VII - EXAMPLE TWO STAGE DOUBLE BELLOWS & DOUBLE OPPOSED CARTRIDGE SUPPORT SYSTEM P&ID



NAME	DATE
DRAWN	MD 04/29/2016
CHECKED	TS 04/29/2016
ENG APPR	BS 04/29/2016
PROPRIETARY AND CONFIDENTIAL	
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Ro-Flo Compressors, LLC	
TITLE: P&ID, DOUBLE BELLOWS SEAL SUPPORT SYSTEM, 2-STAGE	
SIZE	PART NO.
A	16-440-859-450
SCALE	REV
1	01
NTS	SHEET
1	1 OF 1

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## CONTACT RO-FLO COMPRESSORS

The people at Ro-Flo Compressors know that communication is key in providing a world class product. For that reason we have provided the following methods of contacting our team:

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