ENTERED
NOV 1 2 2010

SERIAL NUMBER CHECKLIST

JOB NO: 12518 **CUSTOMER:** Husky Oil Operations

DATE: Oct 7/10 **COMPLETED BY:** Vasseet Jawa

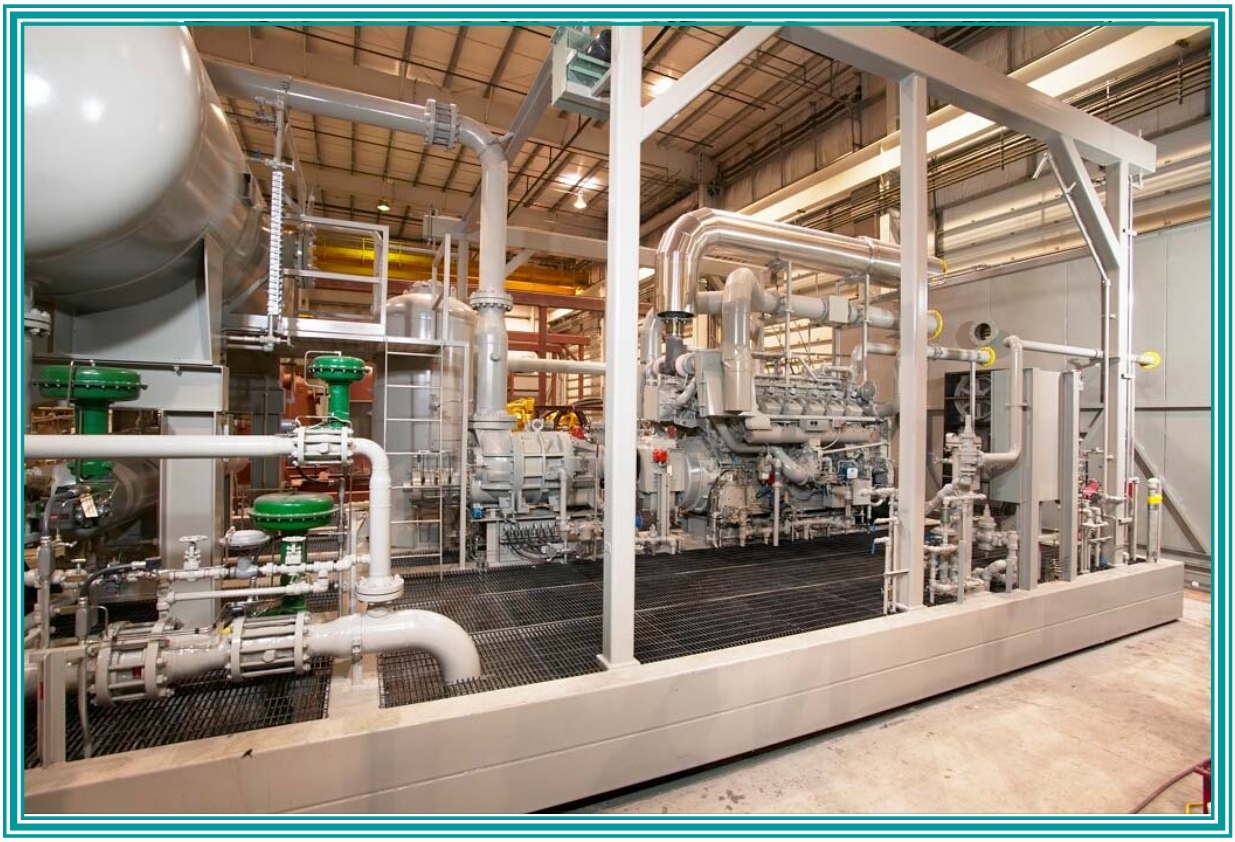
1340 HP

ITEM	MANUFACTURER	SERIAL #	CRN#	A #	
Inlet Filter FR-0100A	Solberg	No Information	—		
Inlet Filter FR-0100B	Solberg	No Information	—		
Oil Separator V-0100	Enerflex	12518236	V2200.213	6000026	
Fuel Gas Scrubber	~~Enerflex~~ TDS	8039940 1H	L1488.213		
Blowcase	NA	NA	NA	NA	
Air Cooler	Air-X-Changers 156EH	104079.31 104079.1.12	V1683.213 —	598893 —	
Oil Cooler	GEA	M180CN1751003B M180CN1751003 7	— —		
			Model	Arrangement	
Compressor	Ariel	10373	RG357M	NA	
Compressor Engine	Caterpillar	WPT01509	G3516LE	273-3063	
Oil Cooler Pump	Tuthill Brooks & Brooks Sandpiper	0607	4105V-L-7		
Engine Pre-lube Pump	---	173988	G1FB1ABTXNSX00		
Engine Oil Transfer Pump	Yamada	535763	NDP-25BAN		
Glycol Transfer Pump	Yamada	535759	NDP-25BAN		
Control Panel	Allen Bradley	12518-601	Compactlogix	NA	
PSV-0100 Relief Valve	Mercer Valve Co. Ltd.	592027	G8841.5C	2068 | 300 4471	KPA SCFM
PSV-0101 Relief Valve	—	—	—	~~2275~~ 	KPA SCFM
PSV- Relief Valve	—	—	—	— —	KPA SCFM

ENERFLEX

STANDARD COMPRESSOR PACKAGE

400 HP through to 1500 HP



OPERATION & MAINTENANCE MANUAL INSERT

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1.0 MANUAL OVERVIEW

INTRODUCTION

IT IS IMPERATIVE THAT ONLY TRAINED PERSONNEL, WHO ARE FAMILIAR WITH THE SYSTEM, ARE ALLOWED TO CONTROL AND SERVICE THIS PACKAGE.

IF IN DOUBT OF ANY OPERATING PARAMETER OR FUNCTION OF THIS UNIT, OR ANY QUESTIONS CONCERNING THIS MANUAL, IMMEDIATELY CONTACT ***ENERFLEX LTD.***.

This compression package was designed and manufactured by ***Enerflex Ltd.*** in Calgary, Alberta, Canada.

All piping, vessels, electrical components and controls are built to the applicable codes and standards.

A copy of this manual should always be accessible for reference to the operator, please refer to the appropriate section for a description of each system.

If your unit has any custom engineered features, refer to Appendix IV for special instructions.

USE OF THIS MANUAL

The descriptions contained within this manual will include generic information that is common to **400 through to 1500 HP TES standard compression packages**. References to the Process and Instrumentation Drawings and the Instrumentation Bill of Materials will be necessary to establish those items that are included with this package. For general overviews of the system operation and design, refer to the appropriate section of this manual.

PROCESS AND OPERATING DESCRIPTION

Operating techniques that are discussed in this manual are basic instructions. It is the Field Operators responsibility to gain the skills and knowledge particular to each package.

PRE-START UP CHECKLIST

Used to identify a list of items, procedures and set points that require verification prior to start up.

INITIAL START UP

The system must be checked and verified to be safe and operating within normal parameters by a qualified ***Enerflex Ltd.*** service representative, otherwise the product warranty becomes void. Please contact ***Enerflex Services*** to schedule this service.

SYSTEM MAINTENANCE

CAUTION

Under extreme operating conditions such as high or low operating temperatures or high S.G. gas, the routine maintenance schedule may have to be increased.

If the result of the oil sampling indicates a trend that the oil is being contaminated or is breaking down, the frequency of the oil sampling and analysis schedule ***must*** be increased.

The maintenance schedule that is set out in this manual is a general description and may be subject to variation depending on the service of the particular unit. Maintaining performance records and conducting routine compressor and engine oil analysis are critical to ensure proper operation.

.

2.0 WARRANTY AND LIABILITY (NEW COMPONENTS ONLY)

Enerflex Ltd. warrants only to the original purchaser that the equipment delivered hereunder shall conform to the design and specification given in connection with the sale of the equipment for 12 months from the date of commissioning, by an authorized Enerflex Ltd. representative, or 18 months from the date that the package fabrication is completed, whichever is earliest. This warranty does not cover equipment and accessories furnished by third parties which are warranted only to the extent of the third parties warranty to Enerflex Ltd..

The original purchaser's exclusive remedy under this warranty is the repair or replacement of any part or parts of the equipment which in Enerflex Ltd.'s judgment did not conform to the said plans and specifications when shipped. This warranty shall be void unless said nonconformance is identified within the warranty period and Enerflex Ltd. is notified in writing within 30 days of identification. The non-conforming part must be delivered to the Enerflex Ltd. factory or nearest branch with all transportation charges prepaid. Warrantable repairs shall be made at the Enerflex Ltd. factory or branch without charge during normal business hours. No allowances will be granted for repairs or alterations made by the original purchaser without written consent by Enerflex Ltd.. In lieu of the foregoing remedy, Enerflex Ltd. may, at its option, redesign, redevelop and/or refund the full purchase price thereof.

In the event that Enerflex Ltd., in accordance with the warranty and liability provisions contained herein, shall be required to send an authorized representative to any location, other than the factory or branch of Enerflex Ltd., to observe, discover, assist, test, replace or repair the equipment herein, Enerflex Ltd. shall be entitled to charge to the original purchaser the travel expenses, subsistence and overtime premium's for the aforesaid authorized representative.

In no event shall Enerflex Ltd. be liable for any special, consequential, punitive, incidental or indirect damages, including without limitation; loss of use or any damages to any installation, operation, or service into which the equipment or parts thereof may be put, or for interest, work stoppage, impairment of other goods, loss by reason of shutdown or non operation, increased operation expenses, cost of replacement power, equipment or service interruption, whether or not such loss or damage is based on contract, warranty, negligence, indemnity, specific liability, or otherwise.

Except for Enerflex Ltd.'s liability regarding any performance guarantees specifically given in connection with the sale of the equipment, Enerflex Ltd. liability arising out of the manufacture, sale or use of the equipment shall under no circumstances exceed the cost of repairing or replacing defective parts as indicated herein and shall be limited to the duration of this warranty.

The warranty and Enerflex Ltd.'s obligation hereunder is expressly in lieu of all other warranties, including but not limited to the implied warranties of merchantability, description and fitness for a particular purpose. All claims which exceed the aforementioned obligations are disallowed by Enerflex Ltd. and excluded from this warranty. The purchaser waives the benefit of any sale of Goods Act or similar legislation.

In order to keep this warranty in effect, the original purchaser must have the equipment maintained and serviced properly in accordance with Enerflex Ltd.'s instruction upon purchase.

It is expressly agreed and understood that this warranty will not cover any defect, damage or deterioration due to normal use, wear and tear, exposure or any damage or defects due to misuse, abuse, alteration, negligence, accident, flood, fire, acts of God or further damage or defects due to the repair of the equipment by someone other than an authorized representative of Enerflex Ltd..

It is further understood and agreed that this warranty will not be applicable to any equipment operated by the original purchaser, which in the opinion of Enerflex Ltd., constitutes or constituted unusual or hazardous operating conditions.

Enerflex Ltd. has no liability in respect to mechanical or acoustical related vibration except where the equipment was manufactured in accordance with an independent mechanical and acoustical study purchased by or on behalf of the customer. Where vibration/pulsation occurs in the absence of a formal study, Enerflex Ltd. will supply at no charge to the customer, FOB the Enerflex Ltd.'s nearest branch, one set of sized orifice plates engineered in accordance with standard industry practice. All costs associated with the installation of the orifice plates would be to the customer. Reciprocating compressor valve failures due to operation outside of the valves design parameters will not be considered for warranty.

3.0 SAFETY GUIDELINES

Safety is common sense. There are standard safety rules but each situation has its own particularities, which cannot always be covered by rules. Therefore, your experience and common sense will be your best guide to safety. Lack of attention to safety can result in: accidents, personal injury, reduction in efficiency and worse of all - **LOSS OF LIFE**. Watch for safety hazards and correct deficiencies promptly.

This compressor package has been designed and built to the highest safety standards possible, however, it must be realized that the safest machines are only as safe as the operator running it. With this in mind, please consider the following.

ALWAYS CONSIDER YOUR POSSIBLE PATH OF ESCAPE IF A FIRE OR EXPLOSION DOES TAKE PLACE. IN THE EVENT THAT PERSONNEL MAY NEED TO ESCAPE, KEEP THE AREA AROUND THE COMPRESSOR AS FREE AS POSSIBLE FROM MACHINERY, DEBRIS, FLUIDS AND PRODUCTION EQUIPMENT.

OBSERVE NON SMOKING RULE WHILE ON UNIT OR IN IMMEDIATE FACILITY OF UNIT

3.1 DANGER

3.1.1 UNIT MODIFICATIONS AND OPERATION

ALL MODIFICATIONS TO THE UNIT HAVE TO BE APPROVED IN WRITING BY ENERFLEX LTD..

1. Consult ***Enerflex Ltd.*** prior to modifying the compressor package system. Improper modifications can invalidate vessel and piping codes and can pose potential hazards to personnel and equipment.
2. Do not tamper, modify or bypass package safety and shutdown equipment. This compressor package has been equipped with safety equipment, which will protect both equipment and personnel.
3. Do not exceed maximum allowable pressures and temperatures. Be sure all maximum allowable pressures and temperatures are not exceeded when starting, running, stopping or bypassing the compressor package. Serious equipment damage and personnel injury could result should maximum allowable pressures and temperatures be exceeded.

3.1.2 AIR IN SYSTEM

AIR ENTERING SYSTEM

HAZARD: Possibility of explosion

CAUSE: 1. Air entering system while shutdown
2. Unit draws a vacuum

PREVENTION:

1. Purge system with inert gas (e.g. nitrogen) prior to Startup
2. A compressor operator must always keep in mind that his machine is handling a highly flammable substance (natural gas); and as long as the natural gas is not allowed to mix with air, it is relatively incombustible. Any gas (air and natural gas) flows from a high-pressure area to a low pressure are. Therefore, anytime the pressure in the gas system (e.g. main piping, bypass/vent piping, scrubbers) is lower than atmospheric pressure, the compressor is pulling a vacuum and air will try to enter. Be sure all possible points of entry are closed.

BREAK IN PRESSURE LINE

HAZARD: Possible Fire/Explosion
CAUSE: Unit vibrating

PREVENTION:

- If there is excessive vibration in the gas compressor package, **DO NOT** dismiss it as normal operation. Assess the severity of the problem and repair if necessary or contact ***Enerflex Services***. Shut unit down until the cause of the vibration has been repaired.

3.1.3 HOT WORK

TRAPPED COMBUSTIBLE LIQUIDS AND GASES

HAZARD: Possible Fire/explosion
CAUSE: 1. Enclosed area
2. Spillage

DEFINITIONS:

Hot work: Cutting, welding, burning, air gouging, riveting, drilling, grinding and chipping,
The use of non-classified electrical equipment
Any work done on an combustion engine
Any other work where flame is used or sparks are produce.

Test: Any test performed to determine if any combustible/flammable substances are present in the atmosphere/tanks/under skid/enclosed areas that may cause an explosion. Testing is to be done by visual inspection and sampling.

PREVENTION:

To ensure that no combustible liquids or gases are present in and around the unit follow the information shown below.

1. Underneath skid:
   a) Units come complete with checker plated flooring. The use of this solid flooring can trap combustible gases and liquids beneath the floor creating a potential explosion hazard AS PER SECTION 136 OH&S
   b) Unit should be jacked up
   c) All sections of the underside of the skid are to be tested.
   d) Ground underneath skid is to be examined for any spillage of combustible liquids. Leave unit jacked up and ensure area is made safe, this eliminates the possibility of a ***"contained' explosion***.
   e) Underside of skid is to be purged with inert gas.
2. Surrounding area around skid:
   - Ground around skid is to be examined for any spillage of combustible liquids. If in doubt jack unit up and ensure area is made safe.
3. On Skid (tanks and enclosed areas):
   a) All sections containing explosive gases are to be purged with an inert gas or filled with clean water and tested.
   b) All sections containing explosive liquids are to be flushed out with clean water and tested.

EMPLOYER RESPONSIBILITY:

Despite anything in this part, an employer must ensure that hot work is not performed.

1. In a location where flammable substance is or may be
   a) In the atmosphere or
   b) Stored, handled, processed or used;
2. On or in an installation or item of equipment that contains or may contain a flammable substance or its residue; or
3. On a vessel that contains residue that may release flammable vapors or gases when exposed to heat until
   a) Tests have been made that indicated the atmosphere is below the point at which it contains a mixture, with air and under atmospheric conditions, of a flammable substance exceeding 20% of that substance's lower explosive limit for gas or vapors, or the minimum ignitable concentration for dust; and
   b) Procedures have been implemented to ensure continuous safe performance of the hot work.

When tests are required during hot work, the employer must ensure that the tests are made at regular intervals appropriate to the nature of the hazard association with the work being performed.

3.1.4 CLOTHING

LOOSE FITTING CLOTH

HAZARD: Personal Injury

CAUSE: Clothing caught in machinery

PREVENTION:

- When around machinery, loose clothing, neckties, rings wristwatches, bracelets, hand rags, etc. should not be worn.

3.1.5 EXHAUST FUMES

EXHAUST FUMES

HAZARD: Asphyxiation

CAUSE: Improper Ventilation

PREVENTION:

- The exhaust products of an internal combustion engine are toxic and may cause injury or death if inhaled. All engine installations, especially those within a closed shelter or building, must be equipped and maintained with an exhaust discharge pipe directing exhaust gases to the outside air. A closed building or shelter must be adequately ventilated. A means of providing fresh air into a closed building or shelter is necessary.

3.2 WARNING

ALLOW COMPRESSOR PACKAGE TO COOL PRIOR TO SERVICING

HAZARD: Burn

CAUSE: Hot equipment and liquids

PREVENTION:

1. Always allow compressor package to cool before servicing.
2. Wait until engine and coolant have cooled down before removing radiator or surge tank caps. Always replace weak hoses, lines and fittings.

SPECIALTY GASES.

This compressor is designed to be operated with and compress sweet natural gas containing no hydrogen sulfide (H_2S), minimal amounts of nitrogen (N_2) and carbon dioxide (CO_2) and absolutely no air.

3.3 CAUTION

1. Keep the compressor package clean.
2. Replace damaged fan blades promptly. If a fan blade or fan jackshaft is bent or damaged in any way, it should be replace. DO NOT attempt to repair or use the damaged parts. Fan assemblies must remain in proper balance. An unbalanced fan can fly apart during use and can create an extremely dangerous condition.
3. Safety equipment. Hearing protection, safety glasses, hard hats, safety shoes or boots and fire extinguishers are recommend and are required by some local, provincial or federal regulations and by some insurance carriers.

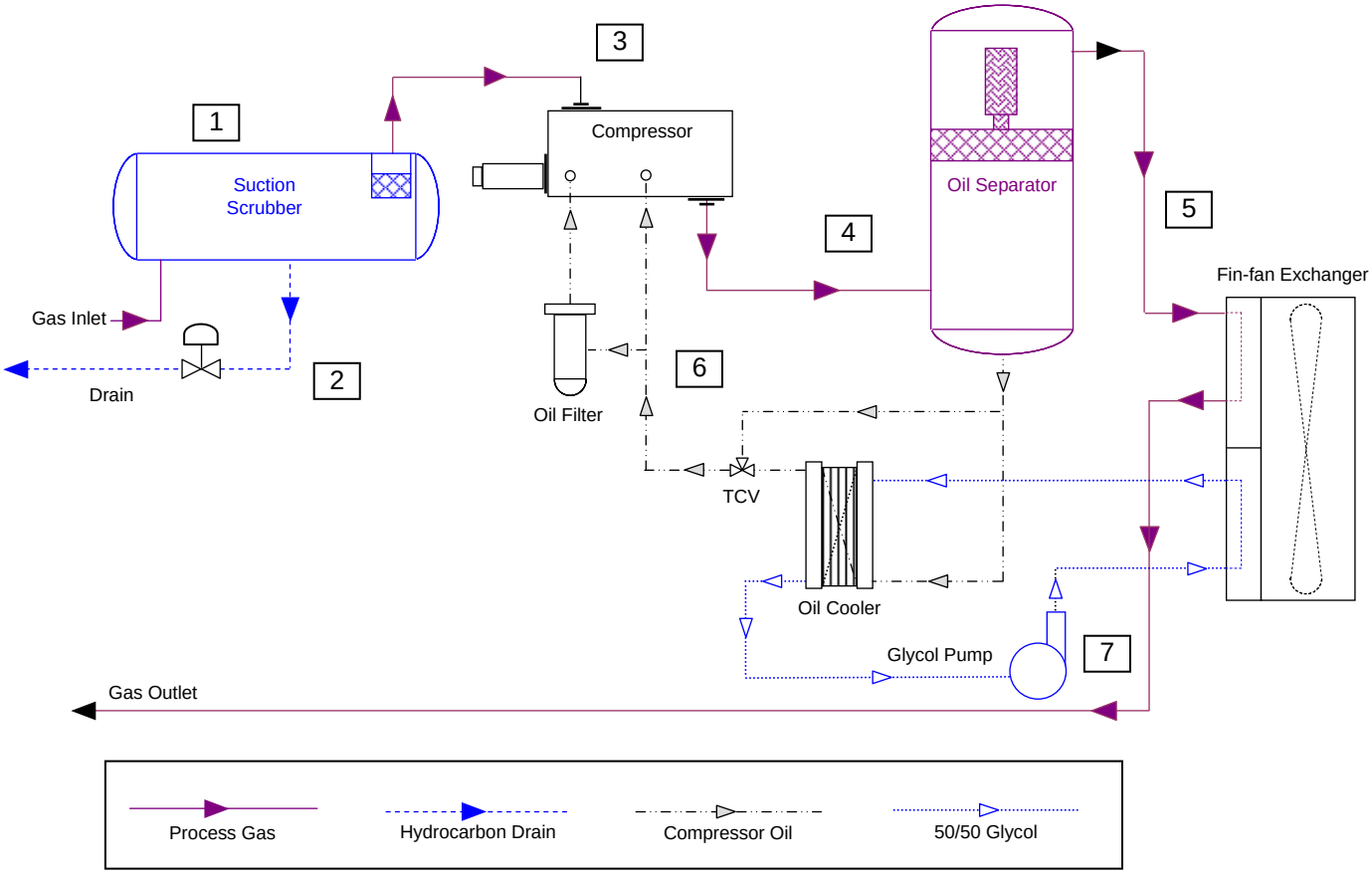
ADDITIONAL CAUTIONS, WARNINGS AND DANGERS CAN BE FOUND THROUGHOUT THIS MANUAL.

END USER AND OPERATORS MUST REFER TO THE RESPECTIVE OPERATION AND MAINTENANCE MANUAL OF THE INDIVIDUAL COMPONENTS SUPPLIED. INSTRUCTIONS IN THIS MANUAL DO NOT SUPERCEDE OR REPLACE OTHER MANUFACTURED GUIDELINES.

4.0 PROCESS DESCRIPTION

4.1 PROCESS SUMMARY

1. Inlet gas is fed through the suction scrubber to remove any free liquids or particulate.
2. Liquids are drained from the vessel to skid edge (blowcase option: liquid drains into blowcase) and the gas is routed to the compressor.
3. Compressed gas is mixed with lube oil during the compression cycle to meet the compressor lubrication requirements and absorb the heat of compression.
4. After compression, the oil/gas mixture is directed to the oil separator where the oil is removed from the gas stream and accumulated in the lower portion of the vessel.
5. Gas is directed to the fin-fan exchanger, where it is cooled before taken off skid to field piping.
6. Oil circulates within a closed-loop system. From the oil separator, oil enters the oil/glycol cooler, and then passes through the filter before returning to the compressor. Temperature of the lube oil returning to the compressor is kept constant by the thermostatic valve.
7. An engine driven pump circulates the glycol to the fin-fan exchanger, where additional heat of compression is removed *(See 4.1 Figure 1)*.



4.1 Figure 1

4.2 SUCTION SCRUBBER

Liquids and condensates in gas stream damage compressor if not removed.

4.2.1 DESCRIPTION

A skid mounted ASME designed vessel for removing inlet liquids and particulate *(See 4.2 Figure 1).*

1. Inlet gas enters vessel and undergoes a change in direction and velocity. Majority of liquid and particulates separate from the gas due to centrifugal force and gravity.
2. Separated liquid falls to bottom of the vessel and automatically drains to skid edge. (**NOTE:** End user is responsible for disposing of liquids.)

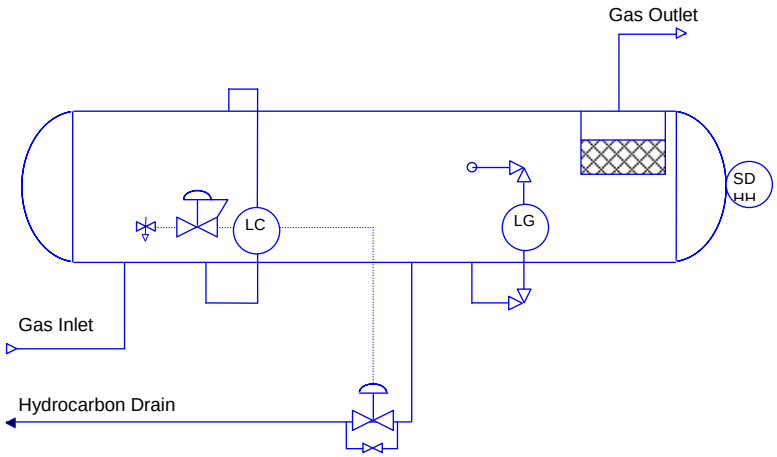
ATTENTION: If the unit comes equipped with a blow-case (option), the liquid in the suction scrubber automatically drains into the blow-case. This is a different drain system than described in this section.

3. Gas passes through a stainless steel mesh pad where the remaining fluid mist is separated from the gas.

Standard design includes

a) High-level shutdown.
b) Level gauge.
c) Level controller.
d) Level control valve.

NOTE: Refer to P&I drawings & project BOM in this manual for vessel specifications.



4.2 Figure 1

4.3 BLOW-CASE (Optional)

4.3.1 DESCRIPTION

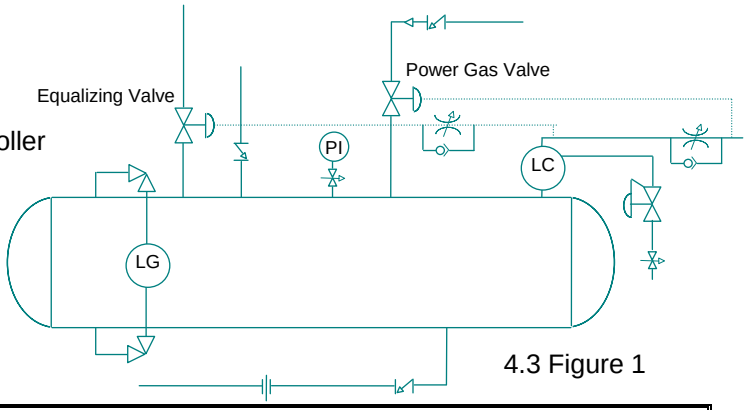
A skid mounted ASME designed vessel for collecting liquids from the suction scrubber, and discharging them into the gas outlet line on a cyclic basis. Compressor discharge gas, prior to the after-cooler, is used to pressurize the blow-case and direct the liquids into the discharge line. The ability to pressurize the blow-case above discharge line pressure is due to the pressure drop (pressure differential) across the after-cooler, piping and associated valves. The higher the differential pressure the faster the liquid is forced into the outlet.

NOTE: End user responsible for discharge line tie-in and disposing of liquids.

ATTENTION:	At low compressor loads (low ΔP) the blow-case drain and fill cycle will take longer to occur. If high liquid removal is required, because of customer piping configurations, more ΔP may have to be created by throttling the discharge upstream of the liquid injection point.

Standard design includes

a) Level indicator
b) Pressure indicator
c) Dual set-point level controller
   i. Controls the drain and fill sequence of the blow-case



4.3 Figure 1

CAUTION	It is imperative that the Equalizing Valve is never open while the Power Gas Valve is. *(See 4.3 Figure 1)*

4.3.2 BLOW-CASE DRAINING SEQUENCE

1. Maximum capacity of blow-case achieved.
2. Blow-case level controller sends pneumatic signal to control valves.
3. Pneumatic signal activates the drain sequence.
   a) Equalizing valve to suction scrubber closes.
   b) High-pressure gas valve opens (gas comes from upstream of after-cooler).
   c) Check valve from suction scrubber to blow-case closes.
   d) Blow-case pressurizes to compressor discharge pressure and liquid is forced out the drain line through the check valve into customer supplied drain system.
   e) Blow-case minimum liquid level is achieved.
4. Level controller reverses the pneumatic signal returning equipment to fill sequence.

4.3.3 BLOW-CASE FILLING SEQUENCE

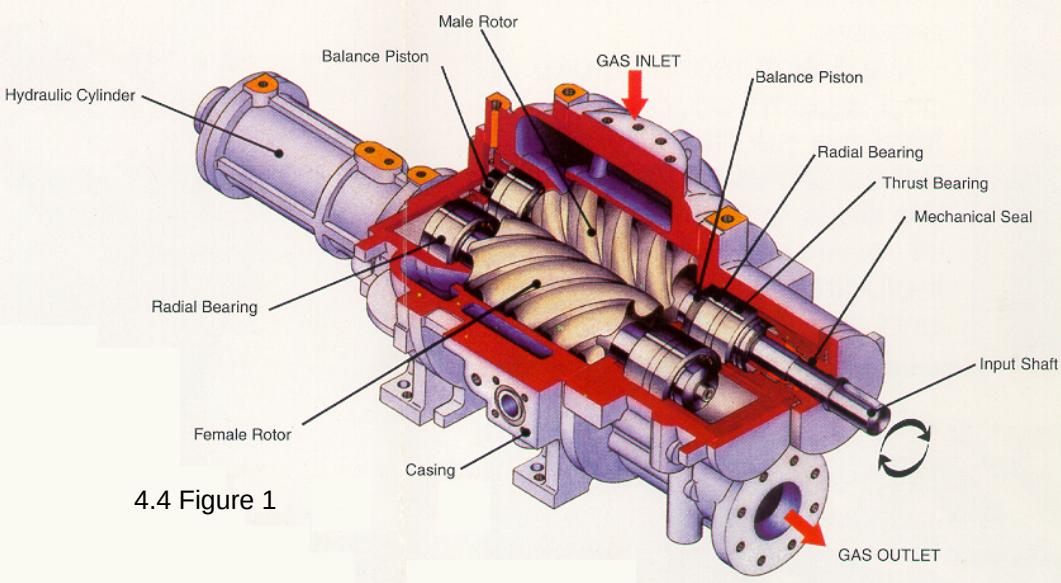
1. Minimum capacity of blow-case achieved.
2. Blow-case level controller vents pneumatic signal to control valves.
   a) High-pressure gas valve closes (gas comes from upstream of after-cooler).
   b) Equalizing valve to suction scrubber opens.
3. Liquid from suction scrubber drains (via gravity) into blow-case through a check valve.

NOTE: Refer to P&I drawings & project BOM in this manual for vessel specifications**.**

4.4 NATURAL GAS COMPRESSION

The compressor on this package is a positive displacement, oil flooded rotary screw. The screw compressor consists of two rotating parts, the male rotor (lobe) and female rotor (flute). The engine is coupled to and drives the male rotor, which in turn drives the female rotor. A screw compressor cutaway is included for component reference. *(See 4.4 Figure 1)*

⚠	It is imperative to the operation of the compressor that all performance criteria be constantly monitored. These would include all system pressures, temperatures, levels and vibrations. The unit is provided with built in shutdown switches and monitors. These devices must be kept in proper working order at all times to ensure mechanical protection of the compressor



4.4 Figure 1

4.4.1 COMPRESSOR MODELS (STANDARD PACKAGES)

ATTENTION:	Your standard compression package comes equipped with ***one*** of the following screw compressors. *(See 4.4 Table 1)*

NOTE: Refer to P&I drawings & project BOM in this manual for compressor specifications.

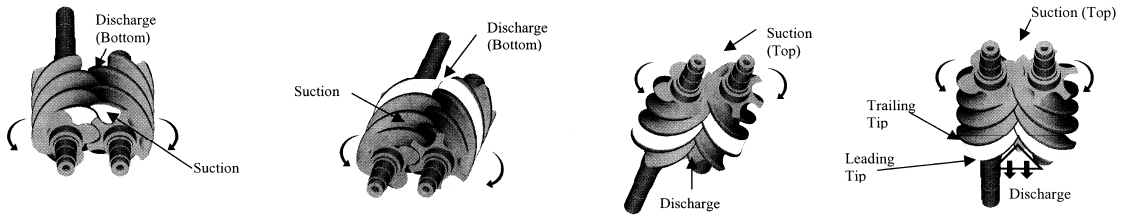
Enerflex Standard Compression Packages									
Nominal HP Rating	**Engine**	**Compressor Models** (Compressors Manufacturer – Frick)							
400 HP	Waukesha F18 or Caterpillar G3408	SGC							
		2313	2317	2321	2824	2813	2817	2821	-
		TDS							
		233S	233L	233XL	283S	283L	283SX	-	-
530 HP	Waukesha H24	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
600 HP	Caterpillar G3412	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
700 HP	GE Jenbacher J312	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
800 HP	Caterpillar G3512	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
900 HP	GE Jenbacher J316	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
1000HP	Caterpillar G3512	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
1200 HP	Caterpillar G3516	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U
1500 HP	Waukesha 5794 or Waukesha 7042	SGC							
		2813	2817	2821	2824	3511	3515	3519	3524
		TDS							
		283S	283L	283SX	-	355S	355L	355XL	355U

4.4 Table 1

4.4.2 COMPRESSION PROCESS

Gas compression in a screw compressor is accomplished by trapping the gas in a pocket between the two rotors. The compressed gas is sealed by an oil film between tight clearances.

1. Rotors turn in an outward direction causing the male and female rotor to un-mesh at the suction port and create a pocket.
2. Gas fills the pocket until the maximum inter-lobe capacity is reached, at which point the pocket rotates past the suction port and traps the gas.
3. Continued rotor rotation reduces pocket size (volume), and increases gas pressure. During compression, the gas is closed off from the suction and discharge port.
4. Compression ends when the pocket containing the trapped gas uncovers the discharge port and releases the compressed gas to the discharge line.



4.4 Figure 2

4.4.3 CAPACITY CONTROL

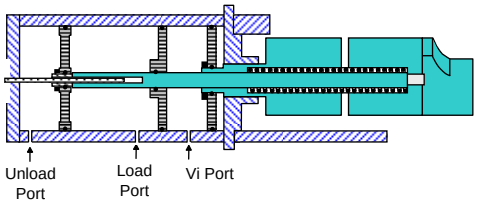
The compressor comes equipped with a step-less internal slide valve operated hydraulically with high-pressure oil. The slide valve can be used to adjust the compressor capacity from 10% to 100% of the maximum machine displacement.

Slide Valve Loading and Unloading

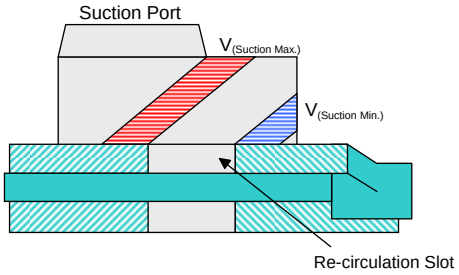
The capacity of the compressor is automatically adjusted through the package control system, which monitors the outlet or inlet pressure.

1. High-pressure oil is directed to load or unload port with a 4-way directional control valve to adjust the slide valve and match the compressor capacity to required site performance (See 4.4 Figure 2).
2. When loading the compressor the slide valve moves away from the discharge port and closes off an internal pocket on the bottom of the machine. This internal pocket acts as a re-circulation slot that controls the amount of gas being discharged from the machine (See 4.4 Figure 3).

ATTENTION:	Compressor capacity is directly related to compressor suction pressure. Without changing slide valve position and increasing suction pressure, the mass flow of gas through the compressor increases.



4.4 Figure 2



4.4 Figure 3

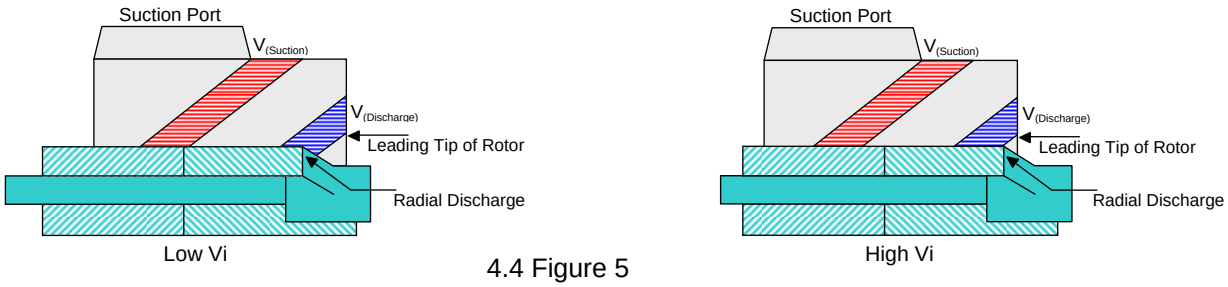
4.4.4 INTERNAL COMPRESSION RATIO (VI)

Frick SGC TDS model screw compressors are equipped with a (field adjustable by ***Enerflex Services***) fixed internal compression ratio. The compressors are shipped with the most efficient internal compression ratio to suit the original compression package operating parameters. It may need adjustment in the field if actual operating conditions are different than first specified. The Vi controls the internal compression ratio by varying the duration of the compression cycle. *(See 4.4 Figure 4)*

ATTENTION:	When choosing a Vi setting, it is always more economical to under-compress than over-compress. See Appendix I for Vi selection and procedure for adjusting the appropriate compressor model.

Vi Setting

The Vi either is fixed with mechanical spacing ring or is variable with automated PLC control. If fixed, the Vi needs to be determined and then a Vi-ring constructed and installed in the compressor by a ***Enerflex Services*** representative. *(See 11.1 Vi Selection)*



4.4 Figure 5

4.5 COMPRESSOR OIL

For proper operation, the screw compressor requires large amounts of continuous lubrication to the rotating parts.

CAUTION	Do not start or operate the compressor with cold oil. Oil within the ENTIRE oil circuit must be at least **room temperature** before the package may be started. Failure to provide warm oil can cause reduced oil flow and can damage or destroy the compressor. Refer to P&I drawings for minimum system ambient temperature.

ATTENTION:	The oil circuit is enclosed within the building for oil temperature considerations during cold weather starting. The unit is equipped with a catalytic heater that is powered from the fuel gas supply. Refer to P&I drawings for further details regarding lube-oil configuration.

4.5.1 PURPOSE

1. Lubricate internal components:
   a) Bearings.
   b) Rotors.
   c) Shaft seal.
2. Seal internal clearances:
   a) Between rotors.
   b) Between rotors and casing.
3. Absorb and remove the heat of compression.

4.5.2 COMPRESSOR OIL INJECTION POINTS

All oil injected into compressor will migrate into rotor area and be discharged from compressor with compressed gas.

Oil header and Main oil Injection

1. Header Oil injected into the bearings and seal area is filtered utilizing a **5-micron** rated filter. This is standard on both Frick and Ariel compression packages.
2. Oil supplying the main oil injection port is not filtered. This oil passes through a globe valve, used to balance the oil flow, and an inline **(fine mesh)** strainer.

NOTE: 10-micron filters are available for packages with Frick compressors.

Frick SGC or TDS Compressors

1. Oil Header
   a) Journal roller bearings, thrust roller bearings and shaft seal.
   b) Suction end bearings to balance piston. **(Frick 355mm Only)**
2. Main oil injection to rotor injection port.

4.6 OIL SYSTEM & COMPONENTS

4.6.1 SUMMARY

Lubrication of the compressor is provided by a closed loop oil system. All oil supplied to compressor is mixed with compressed gas. Oil/gas mixture is carried out of the compressor to the oil separator where oil is removed from the gas stream and accumulated in the lower portion of vessel. Oil is then cooled and filtered before returning to the oil-header of the compressor.

4.6.2 OIL AND GAS SEPARATION

Package comes complete with a skid mounted ASME design Oil Separator. *(See 4.6 Figure 1)* The oil separator removes the lube oil from the compressed gas with a minimum amount of pressure drop. The oil separator design, given normal separation levels, will result in a reduction of the oil content in the discharge gas to 10 PPM (aerosol) or better. The lower portion of the oil separator acts as the oil reservoir for the lubrication circuit.

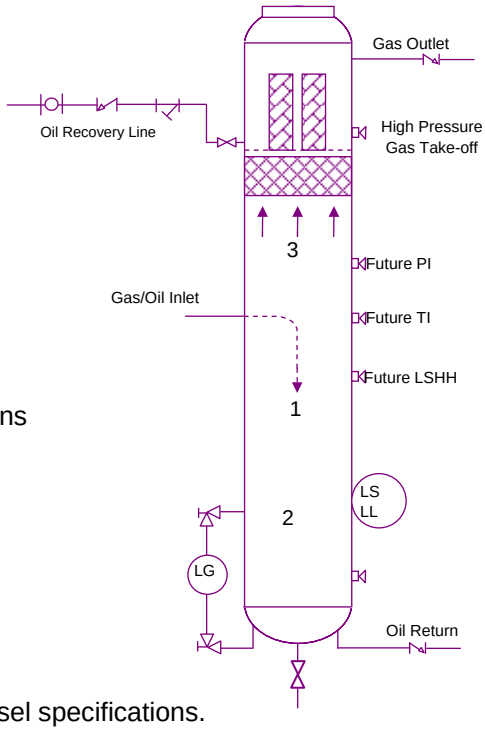
CAUTION	Heavy wet gases or gases with warm inlet temperatures can be considered **high dew point gases** and will damage the compressor if proper precautions are not taken. **High dew point gas** can condense in the compression cycle and rapidly contaminate the compressor oil. Please contact ***Enerflex Ltd.*** if **high dew points** are a concern. The compressor warranty is void if failure occurs due to oil contamination. A high level shutdown can be installed in the oil separator to minimize this damage, but it is best to avoid free liquid in the discharge gas.

Oil Separator

1. Oil/gas mixture enters the vessel and undergoes a change in direction and velocity. The majority of the oil is separated from the gas due to centrifugal force and gravity.
2. Oil collected in the bottom of the oil separator has sufficient retention time for gas bubbles to escape before re-introducing the oil back into the circuit.
3. Oil/gas haze is filtered through a stainless steel mesh pad where more lube oil is recovered.
4. Oil droplets are formed when the oil/gas mist passes through coalescing filter elements. A recovery line returns this oil to the compressor suction port.
5. Oil recovery line contains a globe valve and sight glass for controlling the oil return rate.

Standard design includes

a) Level gauge.
b) Low level shutdown.



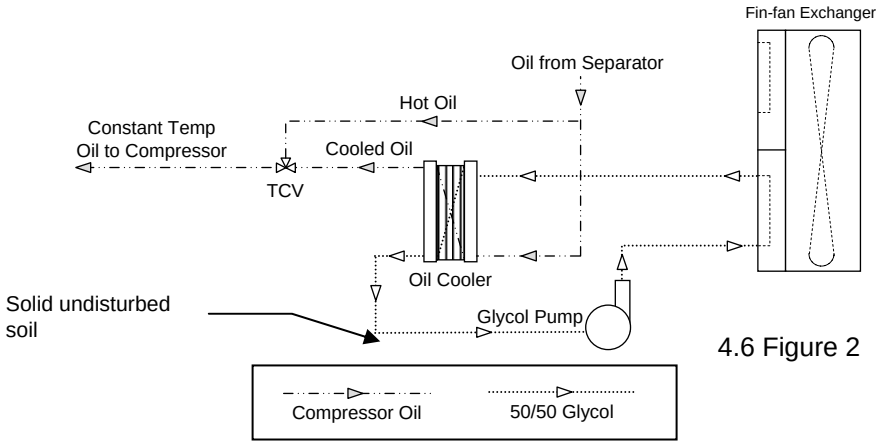
NOTE: Refer to P&I drawings and project BOM in this manual for vessel specifications.

4.6 Figure 1

CAUTION Needle valve on the oil recovery line should ONLY be open enough to keep the coalescing section of the secondary oil separator free from accumulated lube oil.

4.6.3 OIL COOLER

Gas compression package is supplied with a plate and frame type oil cooler that removes heat of compression from the lubrication oil. Oil cooler is mounted inside the building and utilizes a closed-loop circuit containing a 50/50 glycol media for indirect heat transfer. Glycol is circulated through the system by an engine driven pump, and heat transferred to the glycol is removed as it passes through a fin-fan exchanger *(See 4.6 Figure 2).*



4.6 Figure 2

4.6.4 OIL CIRCUIT TEMPERATURE CONTROL

Compressor oil temperature is controlled by a 3-way thermostatic valve. The thermostat maintains a constant oil supply temperature by mixing hot bypass oil with cool oil exiting the oil cooler. Oil supply is protected with a high temperature shutdown (See 4.6 Figure 2).

4.6.5 OIL CIRCULATION

CAUTION	It is imperative that proper oil flow to the compressor is always maintained.

Differential pressure between suction and discharge drives the compressor oil circuit. Two differential pressure measurements are monitored to ensure proper oil flow to compressor.

Discharge pressure over main oil header

Measures difference between high-pressure side (oil separator) and low-pressure side (main oil header). Differential pressure **MUST be less than 30 psi** at all times.

ATTENTION:	A shutdown on this fault will indicate that the oil filter is dirty and requires replacing.

Oil header pressure over main oil injection

Pressure difference between oil going into the rotor area and oil going to compressor bearings is monitored. Main oil header pressure **MUST be 15 psi greater** than the main oil injection to ensure proper oil flow to the bearings and shaft seal.

4.7 GAS AFTER-COOLING

After exiting the coalescing section of the oil separator, the process gas passes through the after-cooler section of the fin-fan cooler where it is cooled to 120° F by ambient air. The gas after-cooler section comes equipped with automatic louvers for controlling the gas outlet temperature. The cooler fan is belt driven from the engine crankshaft pulley. The gas leaves the cooler and is discharged to skid edge through the discharge line running on or below the skid deck.

4.8 AUXILIARY SYSTEMS

4.8.1 COOLING

1. ***Engine jacket water*** cooling is provided by a closed-loop water/glycol circuit contained within the building. The engine jacket water cooling utilizes the engine's main water pumps to circulate the coolant between the engine and the fin-fan exchanger. The temperature is controlled by a 3-way thermostatic valve within the engine.
2. ***Engine turbo/after-cooler*** cooling is also provided by a closed-loop water/glycol circuit contained within the building. The engine turbo/after-cooler circuit and the compressor oil cooling circuit share a common cooler section within the fin-fan exchanger. The circuit uses an auxiliary engine mounted pump to circulate the coolant between the engine turbo/after-cooler and the fin-fan exchanger.
3. ***Compressor oil cooling*** is provided by a closed-loop water/glycol circuit contained within the building. The compressor oil cooling circuit and the engine turbo/after-cooler circuit share a common cooler section within the fin-fan exchanger. The coolant is circulated between the compressor oil cooler and the fin-fan exchanger by an externally mounted centrifugal pump. The pump is belt driven from the engine crankshaft pulley and supplied with a discharge throttling valve to balance the glycol flow between the two circuits.

Standard design includes

a) Two pressurized coolant make-up/expansion tanks.
b) High jacket water temperature shutdown.
c) High manifold temperature shutdown.
d) Low level shutdowns. (2)

NOTE: Refer to P&I drawings & project BOM in this manual for tank specifications**.**

4.8.2 FUEL AND START GAS

Both fuel and start gas are supplied from the process. The gas supply is drawn from the cooled discharge stream. The building heaters also run on this supply.

CAUTION	Do not operate fuel and instrument gas from a **sour gas** supply. A separate sweet fuel or instrument supply MUST be installed.

ATTENTION:	High-pressure fuel gas take off is a 4" flanged pipe to aid in liquid knockout.

Standard design includes

a) Fuel filter.
b) Building heater(s).
c) Fuel shut-off valve.
d) Low pressure starter.
e) Primary and secondary regulators..

NOTE: Refer to P&I drawings & project BOM in this manual for component specifications.

5.0 CONTROLS

5.1 PANEL CONFIGURATION

5.1.1 CONTROL PANEL POWER REQUIREMENTS

Control panel and electronic ignition on the engine require a 24 VDC power supply. *(Customer Supplied)* Please contact ***Enerflex Ltd.*** if engine-driven power generation and battery pack are required. A shutdown input is provided for this purpose.

5.1.2 GAS DETECTION

Gas detection is provided ***by others*** as required by site area classifications, operating procedures and local authorities. Area classification **must** be determined by End user/Employer, not by the equipment packager.

5.1.3 SHUTDOWN/LOGIC FUNCTIONS

Shutdown functions consist of sensors and indicators. Sensor measures condition of a point in the process and the control panel will indicate the condition of that point. TES PLC system is a programmable shutdown and monitoring system with the ability to perform a number of logic functions for control of the compressor unit. Refer to panel *Operations Manual* for a detailed function/operation description. Panel is suitable for Class I, Div II, Group D areas**.**

5.1.4 INPUTS

The control system provides a number of discrete and analog inputs for pressure, temperature, level and vibration alarms and shutdowns. The system is expandable for extra inputs.

ATTENTION:	Optional remote shutdown is provided; a dry set of contacts is required from an external source.

5.1.5 OUTPUTS

The control system provides a number of discrete and analog outputs for pressure, temperature, level and vibration alarms and shutdowns. The system can be expanded to extra outputs.

5.1.6 SHUTDOWNS

The control system on this package is equipped with multiple shutdowns to protect the equipment from damage. The shutdowns are separated into three categories:

1. **Class "A"**: Shutdowns MUST be clear prior to any output function being enabled. There is no bypass time delay provided on class "A" shutdowns.
2. **Class "B"**: Shutdowns will be bypassed for a pre-set time period. Shutdowns will become active when time period has lapsed and all class "B" conditions are satisfied.
3. **Class "C"**: Shutdowns will be bypassed until they have cleared. Therefore a class "C" shutdown must clear/reset once prior to being active.

ATTENTION:	Class "B" shutdowns allow for start up with ample time to stabilize the system. The driver can be started without the class "C" shutdowns cleared.

5.2 GENERIC SHUTDOWN SUMMARY

(See Process & Instrument Drawing for applicable shutdowns/alarms)

Equipment	Shutdown/Alarm	400 – 600 HP	800 – 1500 hp	Delay (sec)
Control Panel	ESD	A	A	0.5
Control Panel	Remote ESD	A	A	Optional
Unit	Fire Detection	A	A	Optional
Unit	Gas Detection	A	A	Optional
LEVEL				
Compressor	High oil level	B	B	20.0
Compressor	Low oil level	A	A	20.0
Engine	Low oil level	A	A	20.0
Engine	Low liquid J.W. level	A	A	20.0
Engine	Low liquid T.W. level	A	A	20.0
Suction Scrubber	High liquid level	A	A	20.0
Fuel Filter	High liquid level	A	A	20.0
MISC				
Compressor	High slide valve position	D	D	0.5
Compressor	Slide valve potentiometer out of range	A	A	2.0
Compressor	MMI shutdown	A	A	0.5
Engine	Below minimum RPM	B	B	2.0
Engine	Maximum RPM exceeded	A	A	2.0
Engine	Pre-lube pump failure	A	A	0.5
Engine	Crank failure	A	A	0.5
PRESSURE				
Compressor	High suction pressure	B	B	2.0
Compressor	Low suction pressure	B	B	2.0
Compressor	Suction pressure out of range	A	A	2.0
Compressor	Low oil to injection oil differential pressure	B	B	10.0
Compressor	Oil injection pressure out of range	A	A	2.0
Compressor	High discharge pressure	A	A	2.0
Compressor	Discharge pressure out of range	A	A	2.0
Compressor	Discharge to oil differential	B	B	10.0
Compressor	Oil pressure out of range	A	A	2.0
Engine	Low oil pressure	B	B	2.0
Engine	Oil pressure out of range	A	A	2.0
Engine	High manifold pressure	A	A	2.0
Engine	Manifold pressure out of range	A	A	2.0
Gearbox	Low oil pressure	-	A	2.0
TEMPERATURE				
Compressor	High discharge gas temperature	A	A	5.0
Compressor	Discharge gas temperature out of range	A	A	2.0
Compressor	High lube oil temperature	B	B	5.0
Compressor	Lube oil temperature out of range	A	A	2.0
Engine	High jacket water temperature	B	B	5.0
Engine	Jacket water temperature out of range	A	A	2.0
Engine	High manifold temperature	B	B	5.0
Engine	Manifold temperature out of range	A	A	2.0
Gearbox	High oil temperature	-	A	2.0
VIBRATION				
Compressor	High vibration	A	A	1.0
Air-cooler	High vibration	A	A	1.0
Engine	High vibration	A	A	1.0
Gearbox	High vibration	-	A	1.0

5.3 START PERMISSIVE CONTROL

CAUTION To prevent driver overload on start up, ensure the compressor is at minimum load. (Less than 10%).

5.3.1 PERFORM THE FOLLOWING:

1. Clear all “A” class shutdowns.
2. Fully unload compressor.
   a) Capacity control in Manual Mode.
3. Initiate control panel start sequence.
   a) Driver pre-lube activation.
4. Driver crank/start sequence.
   a) Driver crank/start will be initiated
   b) Fuel valve and ignition system are activated automatically when driver RPM reaches minimum speed.

5.4 SYSTEM PROTECTION

The control system will monitor the operating conditions to ensure system performance is within safe and normal operating limits. Remote status relay provides the "System Running" signal to the remote control station *(if required).*

NOTE: Set-points may vary due to design conditions.
Refer to P&I drawings for your specific unit to confirm the protection system set-points.

5.4.1 COMPRESSOR PROTECTION

1. Suction pressure is limited between 5 and 100 psig by a pressure transmitter. The inlet Pressure Safety Valve is sized for fire and settings are shown in 5.4 Table 1 below.
2. Discharge pressure is limited by a pressure transmitter at the compressor. The discharge Pressure Safety Valve is sized for maximum compressor flow and settings are shown in 5.4 Table 1 below.

Frick TDS compressors

1. Oil header pressure must be within 30 psig of the system discharge pressure. This ensures that the oil system is functioning properly, all valves are open and the oil filter is not plugged.
2. Pressure at the main oil header must be at least 15 psig greater than the oil injection pressure. This will ensure adequate oil flow to bearings and shaft seal for safe operation.

Package Power Rating	Suction Pressure Range (psig)	Discharge Pressure Limit (psig)	Inlet PSV setting (psig)	Discharge PSV setting (psig)
400 HP	5 to 100	340	245	375
530 HP	5 to 100	315	245	350
600 HP	5 to 100	315	245	350
800 HP	5 to 100	315	245	350
1000 HP	5 to 100	315	245	350
1200 HP	5 to 100	315	245	350
1340 HP	5 to 100	315	245	350
1500 HP	5 to 100	315	245	350

5.4 Table 1

5.5 WARM UP PERIOD

The start up sequence includes a warm up period for the engine.

1. Start the engine with the capacity of the compressor completely unloaded.
2. Allow the engine to warm to operating temperature before loading the system.

ATTENTION:	The engine manufacturer has specified the low idle speed for this particular model. The idle should only be increased when the jacket water temperature has reached a minimum of 125° F (52° C).

5.6 PNEUMATIC

All pneumatic devices are supplied with instrument gas. This gas supply MUST be sweet process gas, fuel gas or compressed air.

CAUTION	DO NOT USE SOUR GAS.

6.0 PRE-START UP CHECK LIST

6.1 PRESSURE TESTING AND PURGING

When all the appropriate lines have been connected to the unit, it should be pneumatically leak tested with air or nitrogen.

- The unit has been thoroughly pressure tested prior to shipment. Leaks can occur due to transit and other items that may cause piping strain. It is essential that a leak test at site be performed.

TO AVOID AN EXPLOSION, ALL THE AIR MUST BE PURGED FROM THE SYSTEM USING AN INERT OR PROCESS GAS PRIOR TO START UP

A positive pressure is to be maintained on the complete system at all time while starting, idling and running.

6.2 ALIGNMENT

The compressor drive shaft coupling and belt drive system have been aligned prior to shipment. The alignment may shift due to:

1. Loading, unloading and transit.
2. Settling of the main skid base on its support.

Therefore, the following MUST be completed prior to commissioning:

1. A final compressor alignment.
2. A final alignment and examination of all belts.
   a) An idler located under belt guard will adjust the belt tension on the fin-fan cooler.
   b) Belts should be checked for excess vibration, noise and slippage.

UNIT MAY be equipped with a jackshaft and/or belt driven auxiliary glycol pump, if this is the case:

1. The belts on both ends of the jackshaft must be periodically checked for tension and/or wear.
2. The belt driving the glycol pump is adjusted by shifting the pump body.

THE ENGINE MUST BE SHUT OFF TO TIGHTEN THE BELTS. UNDER NO CIRCUMSTANCE IS THE SYSTEM TO BE OPERATED WITHOUT THE BELT GUARDS INSTALLED AND SECURED.

ATTENTION: A hot alignment should be completed on the compressor and belt drive systems after 500 hours run-time. Recheck all hold bolts at this time.

6.3 OIL FILTER(S)

The oil filter(s) have been installed in the housing prior to shipping.

ATTENTION: The oil filter(s) should be changed when the pressure differential exceeds 7 psi (50 kPa) with the compressor oil at operating temperature.

6.4 OIL FLUSH

Prior to shipping, an oil flush was completed to remove all fabrication debris between the filter and compressor.

CAUTION	If there is reason to suspect that debris have contaminated the compressor oil or associated piping, an oil flush MUST be performed prior to restarting. Consult ***Enerflex Services*** for the proper oil flush procedure.

6.5 GLYCOL

Glycol loop has been filed with 50/50 water/glycol coolant prior to shipping. There is a high possibility that air will be trapped in the system; therefore, the cooling system MUST be purged of air before commissioning.

1. Open all appropriate valves in the glycol loop.
2. Pump glycol into the system until a level is established in the expansion/surge tank.
   - Charge the system from a low point and bleed air from any possible high spots.
3. Ensure the engine and cooler high points are void of trapped air.

ATTENTION:	Listen for pump cavitation and watch for glycol flow during the first run test.

6.6 COMPRESSOR LUBRICATION OIL

Following an oil flush, utilizing the same type of lubricant used for normal operation:

1. Charge the system to the proper operating level.
2. Use the catalytic heater to warm the oil, building and equipment.
3. Open all appropriate valves.

CAUTION	Cold oil will have a high viscosity resulting in a low oil flow condition that will damage the compressor. Warm compressor oil to 60° F before starting unit.

ATTENTION:	Do not overfill the oil separator. High levels impede oil/gas separation, cause foaming of the oil and result in excessive oil carry over.

NOTE: Refer to P&I drawings for you specific unit to confirm the proper fluid quantities.

6.7 CONTROL SYSTEM

The control system logic and wiring must be checked before commissioning.

1. Ensure ALL ELECTRICAL SEALS have been poured.
2. Preset and test all safety systems for proper functioning.
   a) This includes a complete point-to-point function test of the panel, end devices and associated wiring.

IF IT HAS BEEN DETERMINED THAT FIRE AND/OR GAS DETECTION IS REQUIRED, THEN FIRE AND/OR GAS MONITORING SYSTEMS *(CUSTOMER SUPPLIED)* MUST BE ACTIVE AND OPERATIONAL BEFORE PROCEEDING TO COMMISSION THE UNIT.

6.8 FINAL CHECK

VISUALLY INSPECT UNIT BEFORE STARTING. PRIOR TO STARTING, WALK AROUND THE COMPRESSOR PACKAGE AND VISUALLY INSPECT THE UNIT FOR LOOSE OR BROKEN COMPONENTS, TOOLS, OPEN VALVES, MISSING EQUIPMENT ETC.

7.0 INITIAL STARTING

Initial start up and running operation is based on all pre-commissioning procedures being completed.

7.1 PRE-START UP

1. Check compressor oil, engine oil and glycol for proper levels.
2. Lubricate all bearings.
3. Warm compressor oil and equipment to room temperature.
4. Check that all valves are in the correct position.
5. Check that all level and pressure controls are at the proper settings.
6. Pre-lube engine and compressor *(if applicable for your specific unit).*
7. Clear area and equipment of loose items.

7.2 START UP

1. Unload the compressor.
2. Reset the control panel.
3. Reset the fuel shut-off valve.
   a) Valve will automatically close on unit shutdown. It must be manually opened.
   b) Ignition system is automatically activated when engine reaches minimum RPM.
4. Allowed engine to idle until the jacket water temperature reaches 125° F, typically about 10 minutes. During warm up the compressor must be unloaded with the bypass valve open and adjusted to maintain operation.
5. Close the bypass valve and manually load compressor to 50% capacity.
6. Operate the compressor at this capacity and check the following items:
   a) Compressor oil supply pressure and temperature.
   b) Oil filter pressure differential.
   c) Compressor oil level.
   d) Compressor shaft seal for leakage.
   e) Engine oil pressure and temperature.
   f) Engine jacket water level and temperature.
   g) Turbo water level and temperature.
   h) Suction pressure.
   i) Discharge pressure and temperature.
   j) Check engine, compressor, and fan for noise and vibration.
7. Load compressor and engine until discharge pressure is at desired operating pressure.
8. Monitor operation, check suction scrubber level control system and adjust oil separator return system.
9. Monitor operation until all systems are stable.

ATTENTION:	The unit can now be shut down and restarted as required.

7.3 RESTART ON SHUTDOWN

In the event of a compressor shutdown the cause must be corrected prior to a restart. The compressor can then be restarted and slowly loaded.

⚠	DO NOT RESTART A COMPRESSOR AFTER A FAULT SHUTDOWN WITHOUT FIRST DETERMINING THE CAUSE OF THE SHUTDOWN.
CAUTION	After a shutdown the hydraulic oil used to automatically load/unload the compressor must be displaced to reach a fully unloaded position. This is achieved by the slide valve spring. The process will occur automatically, but it can take up to 20 minutes

8.0 SYSTEM MAINTENANCE

Unit is designed to operate automatically with built in safety controls to protect equipment in case of malfunction. It requires only routine inspection. However, maintenance of an adequate log will indicate small changes in performance and provide early warning of possible malfunction. A sample weekly log sheet is enclosed. For packages with multiple compressors, a log for each compression system and each compressor should be maintained.

8.1 BASIC PREVENTIVE MAINTENANCE RECOMMENDATIONS

ATTENTION:	Analyze daily records to determine if performance is varying from within design limits. ***Make corrections as soon as possible***.

	Safety controls, relief valves and rotating equipment should be checked annually by qualified personnel. 1. Take precautions to avoid damage caused by liquid expansion in lines isolated by positive shut-off valves. 2. Ensure that all valves are in there normal operating position. 3. Never close valves on pressure operated safety controls or "shunt out" electrical control circuits.
CAUTION	Use manufacturer's recommended fluids and lubricants. Perform monthly oil analysis. ***Increase frequency under extreme conditions.***

MAINTENANCE (Screw Compressor)	HOURS OF OPERATION (MAXIMUM)								
	500	1000	5000	10000	15000	20000	25000	30000	
Change Oil			✓					✓	EVERY 30000 HOURS THEREAFTER OR AS PER OIL ANALYSIS
Change Filter	✓		✓	✓	✓	✓	✓	✓	EVERY 5000 HOURS THEREAFTER OR AS PER OIL ANALYSIS
Clean Liquid Strainers	✓		✓	✓		✓		✓	EVERY 10000 HOURS THEREAFTER OR AS PER OIL ANALYSIS
Change Coalescing Elements								✓	EVERY 30000 HOURS THEREAFTER OR AS PER OIL ANALYSIS
Check & Clean Suction Screen	✓	✓	✓	✓		✓		✓	EVERY 10000 HOURS THEREAFTER OR AS PER OIL ANALYSIS
Check Alignment	✓		✓	✓		✓		✓	EVERY 10000 HOURS THEREAFTER
Check Coupling	✓		✓	✓		✓		✓	EVERY 10000 HOURS THEREAFTER
Check Temperature Pressure Calibration	✓	✓	✓	✓		✓		✓	EVERY 10000 HOURS THEREAFTER
Check & Calibrate All Shutdowns	**EVERY 6 MONTHS**								
Oil Analysis	**MONTHLY** (See Section 8.3)								
Replace Shaft Seal					■		●	◆	
Inspect Compressor					■		●	◆	
15000 Hours:	■ GAS PROCESSING – HIGH OPERATION PRESSURES								
25000 Hours:	● HIGH VOLUME DUTY								
30000 Hours:	◆ LOW BOOSTER DUTY								

8.2 JACKSHAFT MAINTENANCE

Regular inspections of the jackshaft are necessary to ensure its reliable operation. During each inspection, the jackshaft should be:

- Clean and free of contaminants such as dirt, dust, etc.
- Round and axially straight
- Free of burrs and nicks
- Show little or no sign of corrosion and/or pitting

The jackshaft bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of the grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates, and the severity of the operating conditions. When lubricating the bearings, a high grade ball or roller bearing grease should be used.

CAUTION Over greasing bearings is known to increase frictional losses and raise bearing temperatures. This will lead to excessive bearing heating and premature failure.

Recommended lubrication intervals are shown in the table below. It is important to realize that the recommended intervals are based on average use.

Hours Run per Day	Suggested Lubrication Period in Weeks		
	500 - 750 RPM	751 - 1000 RPM	1001 - 1500 RPM
8	10	7	5
16	5	4	2
24	3	2	1

8.3 OIL ANALYSIS/SAMPLING

It is TES recommendation to perform monthly oil sampling. It is to the customer's discretion to increase the time period between oil sampling if contamination of oil is unlikely and to decrease the time period between oil sampling if oil contamination is likely or evident.

An oil sample must be taken when there is reason to believe the oil is contaminated anytime during operation. For example anytime there is an upset in the plant, possibilities of liquid carry over into the compressor or condensation within the compressor, compressor piping and oil separator, ect.

9.0 WEEKLY OPERATING RECORD

COMPRESSOR WEEKLY OPERATING REPORT								
Company:				**Week of**				**20 ———**
Location:				**Unit #:**				
Item	**Units**	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
Compressor Suction Pressure								
Compressor Suction Temperature								
Compressor Discharge Pressure								
Compressor Discharge Temperature								
Compressor Oil Pressure								
Balance Line Pressure **(Ariel Comp. Only)**								
Compresor Oil Filter Differential Pressure								
Ambient Temperature								
Compressor Oil Temperature		In						
		Out						
Engine Oil Temperature		In						
		Out						
Engine Jacket Water Temperature		In						
		Out						
Engine Turbo Water Temperature **(200 & 325 HP Only)**		In						
		Out						
Engine Oil Pressure								
Fuel Gas Pressure								
Oil Separator Element Differential Pressure								
Compressor Shaft Seal Leakage	Drops/Min							
Compressor Slide Valve Position	%							
Compressor Volume Ratio	Vi							
Engine Manifold Press.	in. Hg.							
Engine Governor Oil Level	☑							
Engine RPM								
Operating Hours	Compressor							
	Engine							
Accumulated Hours	Compressor							
	Engine							
Fluids Added **(Engine oil, Comp. oil, Glycol)**								

COMMENTS: _____

10.0 TROUBLESHOOTING

10.1 SCREW COMPRESSOR SYSTEM

Troubleshooting the compressor is limited to identifying the probable cause. If a mechanical problem is suspected, contact ***Enerflex Services.***

SYMPTOM	PROBABLE CAUSES	CORRECTIONS
Compressor high discharge pressure.	Discharge pressure control valve.	Check PDCV for correct set point and operation. (if equipped)
	Blockage in the discharge line.	Check all valves.
	Restricted coalescing elements.	Inspect and replace coalescing elements. Investigate problem.
	Compressor bypass in operational.	Check auto bypass valve. (if equipped)
	Compressor is not unloading.	Check hydraulic system.
Compressor high discharge temperature.	Oil temperature too high.	Check compressor oil circuit.
	Discharge pressure too high.	Troubleshoot high discharge pressure.
	Insufficient oil injection.	Increase oil injection valve setting.
	Incorrect compressor Vi setting.	Contact ***Enerflex Services***.
Compressor high oil temperature.	Dirty oil cooler.	Clean oil cooler.
	Fin-fan exchanger dirty or louvers closed.	Clean and check louver and control system for correct operation.
	Insufficient air movement.	Check fan pitch and belts.
	Insufficient glycol flow.	Inspect coolant level. Inspect glycol pump.
	Glycol system air locked.	Purge air from highest point in system.
	Oil temperature control valve stuck.	Repair or replace element.
	Incorrect Vi setting.	Check and correct for proper Vi setting.
	Too high discharge pressure.	Correct system problems.
Compressor low oil temperature.	Oil temperature control valve stuck.	Repair or replace element.
Compressor low oil injection differential pressure.	Dirty oil filters.	Replace oil filters.
	Restriction in compressor oil circuit.	Inspect oil cooler, piping, valves and oil contamination.
	Compressor oil temperature too low.	Warm up building, compressor oil and equipment.
	Low compressor differential pressure.	Lower suction pressure. Install discharge PDCV to raise discharge pressure.
Compressor low suction pressure.	Low suction pressure.	Increase suction pressure.
	Incorrect suction set point.	Check low suction shutdown set point.
	Suction control valve too slow or stuck.	Check suction control valve for operation and restriction.
	Compressor is loaded too much.	Check capacity set point or unload compressor.
	Compressor is not unloading.	Check hydraulic system.
Compressor oil high differential pressure.	Dirty oil filters.	Change oil filters.
	Restriction in compressor oil circuit.	Inspect oil cooler, piping, valves and oil contamination.
	Compressor oil temperature too low.	Warm up building, compressor oil and equipment.
	Compressor oil injection flow too high.	Pinch oil injection valve.

SYMPTOM	PROBABLE CAUSES	CORRECTIONS
Compressor shaft seal leaking.	Excess of 10 drips/minute.	Contact ***Enerflex Services***.
	Compressor oil contamination/dilution.	
	Shaft seal stuck.	
	Lack of lubrication.	
	Compressor internal failure.	
Excessive noise and vibration.	Insufficient oil injection.	Adjust main oil injection valve for correct discharge temperature.
	Coupling loose on compressor shaft	Tighten coupling. Replace if damaged.
	Engine to compressor misalignment	Realign engine and compressor.
	Liquid slug in suction line	Check suction scrubber for high level. Correct system problem.
	Engine misfiring or running rough	Contact ***Enerflex Services***.
	Compressor wear or bearing damage	
	Excessive compressor rotor endplay	
Compressor does not load/unload.	4-way hydraulic control valve/solenoid failure.	Repair or replace valve/solenoids
	Solenoid spool stuck.	Mechanically actuate with 3/16" rod against armature pin.
	Slide valve potentiometer	Check for correct resistance or faulty wiring.
	Oil too cold.	Warm up compressor oil, building and equipment.
	Closed valves.	Open hydraulic service valves.
	Panel/electrical failures.	Check panel outputs and end devices for power supply.
	Slide stop indicator rod stuck.	Contact ***Enerflex Services***.
	Unload piston stuck.	
	Slipper seals worn out or damaged.	
Low jacket water level.	Air in the glycol system.	Purge air from highest point and top up glycol.
	Leaks in glycol system.	Identify leaks and repair.
Low turbo water level.	Air in the glycol system.	Purge air from highest point and top up glycol.
	Leaks in glycol system.	Identify leaks and repair.
Suction scrubber high level.	Dump system not working.	Check and/or replace automatic dump valve.
	Level controller malfunction.	Check sensitivity, presents of float or replace defective switch.
	Free liquid in inlet gas.	Source options for removing liquids.

10.2 OIL SEPARATOR SYSTEM

SYMPTOM	PROBABLE CAUSES	CORRECTIONS
Compressor oil loss.	Maintaining too high an oil level.	Lower oil level.
	Contaminated oil.	Replace oil charge
	Damaged/not seated coalescing elements.	Inspect, tighten down or replace. Check gaskets or O-rings.
	Oil return valve closed.	Open return valve
	Oil return line plugged.	Clean strainer and needle valve.
	Oil foaming.	Check oil contamination.
Increase in oil level during initial start up.	Normal behavior.	Oil is aerated.
		Retention time for gas bubble dispersion.
		Oil volume increases when temperature rises.
Increase of oil level, while running	Excessive foaming.	Check compatibility of gas with compressor oil.
	Condensing of liquids in the oil separator.	Check for correct discharge temperature and pressure and compare to gas dew points.
		Check compatibility of gas with compressor oil.
	Liquid carry over.	Troubleshoot for high suction scrubber level.
Rapid loss - no oil showing in the return sight glass.	Suction check valve did not close on shutdown.	Repair or replace check valve.
	Coalescing elements loose/not seated.	Check gaskets or o-rings.

10.3 FULL TIME OIL PUMP SYSTEM (IF APPLICABLE)

SYMPTOM	PROBABLE CAUSES	CORRECTIONS
Main filter pressure drop is too high	Dirty oil filters.	Replace oil filters.
	Compressor oil is too cold.	Warm up building, compressor oil and equipment.
	Isolation valves are partially closed.	Open valves fully.
Noise and vibration	Pump strainer plugged.	Clean strainer.
	Pump is worn out.	Repair or replace pump.
Oil pressure drops as the Discharge pressure increases	Normal behavior.	Set main oil injection and oil pressure for max. head pressure.
Oil pressure rapidly drops off when compressor starts.	Main oil injection valve too wide open.	Set valve for ½ turn open.
	Oil pressure regulator improperly adjusted.	Adjust regulator.
Pump will not produce enough oil pressure to start compressor	Oil filters are plugged.	Check PSID across filters.
	Strainer is plugged.	Clean strainer.
	Main oil injection valve open too wide.	Set valve for ½ turn open.
	Pump regulator set too low or stuck open.	Readjust or repair regulator.

11.0 APPENDIX I

11.1 COMPRESSOR Vi

11.1.1 FIXED VI CONTROL

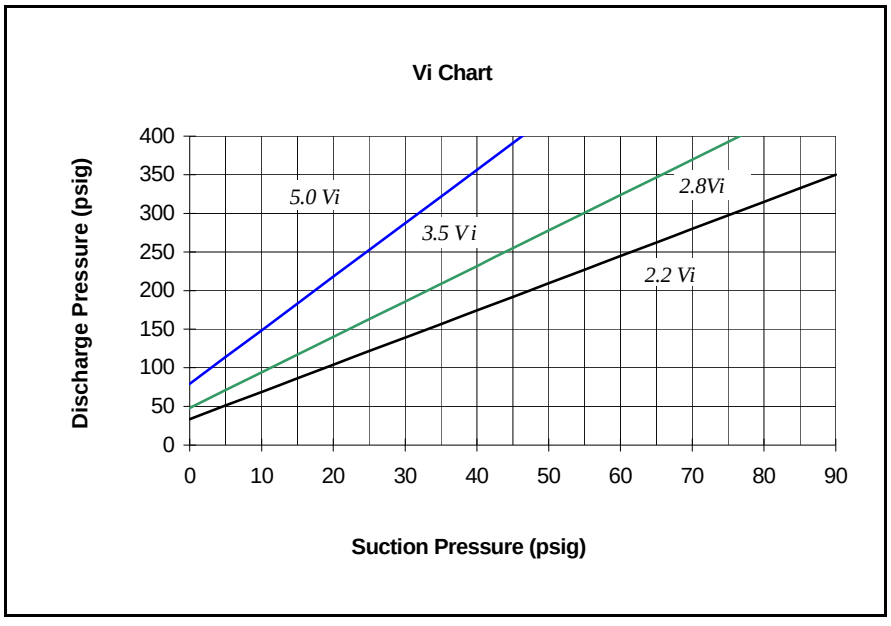
The TDS and SGC model screw compressors typically have (4) fixed Vi settings, 2.2, 2.8, 3.5 and 5.0. Unless otherwise indicated on the compressor tag, all ***Enerflex Ltd.*** compressor packages will ship with a 2.2 Vi setting (*no Vi-ring installed).* A steel Vi-ring must be machined and installed for settings other that 2.2 *(See 11.1 Figure 2)*. This procedure requires dismantling the compressor slide valve assembly.

⚠	Only qualified personnel are to perform the Vi-ring installation. Improper dismantling of the slide valve assembly can cause serious injury.

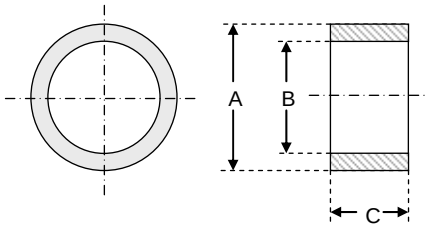
ATTENTION:	Improper Vi setting can result in low flow, high temperatures, wasted horsepower and possible vibration concerns. When choosing a Vi setting, it is always more economical to under-compress than over-compress.

With a fixed Vi, the Vi position can be determined by the following

1. Determine Vi setting corresponding with site conditions. *(See 11.1 Figure 1)*
2. Inspect Vi indicator rod to verify compressor Vi setting.
3. Vi indicator rod is approximately:
   a) 3/4" length in a 2.2 Vi.
   b) 9/16" length in a 2.8 Vi.
   c) 3/8" length in a 3.5 Vi.
   d) Flush with nut in a 5.0 Vi.
4. Contact ***Enerflex Services*** to perform Vi adjustment.



11.1 Figure 1



11.1 Figure 2

11.1.2 VARIABLE VI CONTROL

Compressor Vi setting can also be control by the PLC with hydraulic directional control valve. In this application, the compressor Vi position is communicated back to the PLC via a potentiometer or transmitter and continually adjusted and optimized by the PLC based on process conditions.

11.2 BALANCE PISTON PRESSURE REGULATION (FRICK 355 mm ONLY)

All Frick 355 mm compressors with high capacity, tandem, angular contact thrust bearings on high stage and booster type duties require a special oil piping arrangement to the balance piston. (SB-2 port) *(See 11.2 Figure 1)*

ATTENTION:	The additional piping arrangement insures adequate thrust bearing life.

The additions are arranged in parallel and listed below.

11.2.1 PRESSURE REGULATING VALVE:

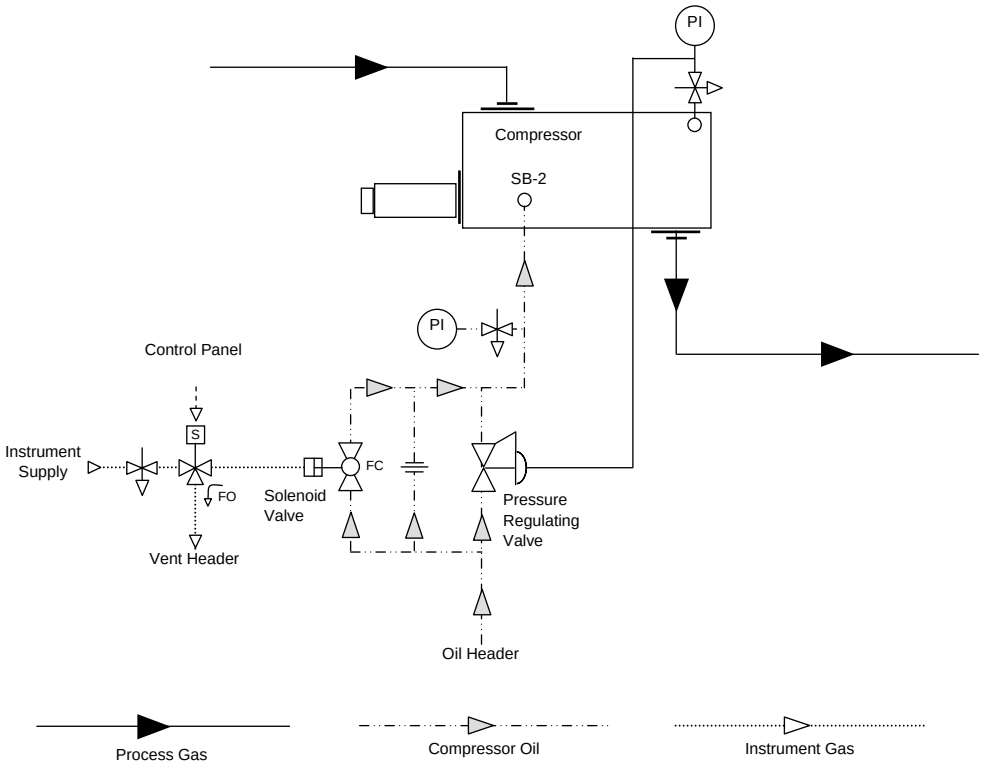
The compressor thrust balance is determined by the system discharge pressure. The proper setting for the pressure regulating valve is 50 psig below discharge pressure.

11.2.2 SOLENOID VALVE:

Signals from the control panel operate the solenoid valve. Energizing, or opening, the solenoid valve pressurizes the balance piston with full oil pressure from the oil header, bypassing the pressure regulating valve. The solenoid valve should open when the slide valve position is **70% or greater** and close when the slide valve position is **65% or less**.

11.2.3 ORIFICE:

The orifice insures oil supply to the inlet end bearings during upset conditions such as start up.



11.2 Figure 1

12.0 APPENDIX II

12.1 All UNITS

12.1.1 TOROMONT PROCESS SYSTEMS RESPONSIBILITY

Enerflex Ltd. is responsible for providing equipment that is mechanically sound and in good operating conditions to each rental equipment end user.

12.1.2 END USER RESPONSIBILITIES

If this is a rental unit consult Lease/rental contract for additional end user responsibilities.

The end user is responsible for the maintenance of, but not limited to the following:

1. All normal lubrication requirements
2. All belts, hoses, etc.
3. All ignition, carburetor and tune-up requirements
4. All alignment subsequent to start up
5. All packing, compressor piston rings, valves and mechanical seals
6. All compressor cylinders or rotors and housing
7. All cooler maintenance
8. Control panel, controls and instruments
9. All accessories, e.g.: Heaters, check valves, etc.
10. Building

In addition, the end used shall be responsible for any costs incurred due to any of the following:

1. Damage in transportation
2. Improper operation
3. Improper maintenance
4. Improper storage
5. Site conditions
6. Improper fuel gas (if not specifically authorized by ***Enerflex Ltd.***)
7. Poor gas quality
8. Improper mounting of skid
9. All others as per rental agreement

12.1.3 OPERATORS RESPONSIBILITIES

The Field Operator shall be responsible for the following:

1. Daily maintenance included maintaining proper fluid levels
2. Routine checks of compressor operations including temperatures and pressures.
3. Prompt reporting of nay problems to ***Enerflex Services***.
4. Reasonable access to location.
5. A key to any locked gate must be furnished to ***Enerflex Services***.
6. Completion of daily operating records.
   a) Forward copy to ***Enerflex Services***.
7. Oil sampling as requested by ***Enerflex Services***.

12.2 FIELD PRE-SHIPMENT PREPARATION

1. All bills of lading will include the legal land description (LSD) where the unit had been operating. This description is required if it becomes necessary to dispose of waste petroleum products (eg. Condensates that were missed during the field cleanup).
2. Identify the type of service the equipment was in (eg. Sour, sweet, propane, CO2 etc.).
3. Specific notes:
   a) Glycol coolants may remain in the main and auxiliary systems, including oil cooler and inter cooler housing, provided there are no visible external leaks. ***On Enerflex Ltd. leasing units only.*** **All other units must be drained.**
   b) Engine/compressor crankcases and on skid oil storage/make up tank DO NOT require draining. ***On Enerflex Ltd. leasing units only.*** **All other units must be drained.**
4. Drain requirements:
   a) Vacuum pump waste oil from on skid waste oil storage tanks
   b) Vacuum pump waste products from on skid compressor packing vent/drain tanks.
   c) Drain all liquids from inlet separators/coalescing filters.
   d) Drain all fluids from inter-stage/final discharge separators.
   e) Drain oil bath air cleaners
   f) Purge the process system, including gas cooler sections using an inert gas (eg. Nitrogen).
5. All open flanges **with the exception of the PSV vent header** to be hard flanged complete with gasket. All NPT screwed connections to be capped or plugged. The PSV vent header is to be sealed with plastic wrap to allow for the relief of pressure should a buildup occur
6. Engine intake and exhaust openings to be sealed off with plastic.

12.3 MOUNTING SKID (Responsibility of End User)

ATTENTION:	Installation of this skidded compressor package is entirely the responsibility of the owner. This guideline does not warrant vibration issues relating to poor pile to skid connections, or insufficient pile design.

12.3.1 GENERAL:

To determine the type of skid mounting that is required the following steps should be taken:

1. A civil engineer should be consulted in the preparation of any foundation or pad design for the unit.
2. It is always recommended to perform a geo-technical investigation of the sub-surface conditions of the installation site.

12.3.2 PILES:

1. It is the end users responsibility to place the piles as recommended by a Civil Engineer and to determine the pile diameter and depth based on the soil conditions.
2. It is important to support the skid primarily down the center members and under the rotating equipment, as well as the perimeter.
3. Skid must be shimmed level and provide good contact with pile cap
4. Skid deflection can cause alignment problems, pipe strain and vibration. Once equipment has been placed on pile caps, equipment must be checked for alignment and pipe strain. Align if required.
5. As a minimum 3 sides of pile cap should be welded to the skid member.
6. Reference P&ID and general arrangement drawings for weights and location of the major equipment.

12.3.3 TIMBERS

It is not recommend placing the skids on timbers due to the irregularities in both the skid base and the timbers.

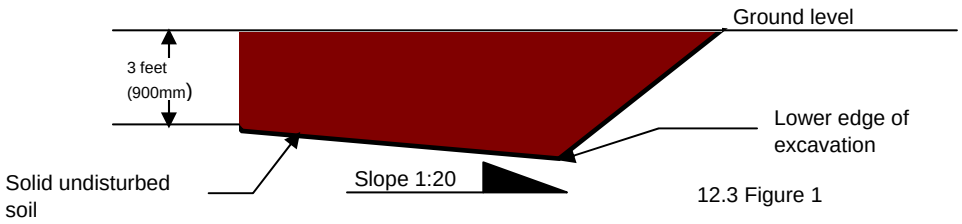
12.3.4 GRAVEL PAD

Excavation

a) The gravel pad is to be excavation to the Horizontal limits of the skid and depth as shown in 13.3 figure 1. If water or frozen soil is exposed, remove those areas as well until firm undisturbed or compacted soil is exposed.

b) Bottom of excavation is to be proof rolled in two directions prior to placement of gravel fill. Should this process reveal any soft areas, they will have to be:
   i. Removed
   ii. Exposed soil loosened (at least 6" (150 mm) deep)
   iii. Compact loosened area
   iv. Back fill with gravel.

c) The finished excavation should be crowned along centerline of the skid and sloped downward to a ratio of 1:20 to the edge of the excavation.



12.3 Figure 1

ATTENTION:	The excavation should be protected from rain, snow & ingress of free water.

Gravel Fill and Finish

a) Gravel (maximum ¾ inch(19 mm)) fill used is to be clean and well graded, unfrozen, non-frost susceptible material. The Gravel fill is to be sampled & tested to environmental conditions prior to placement.

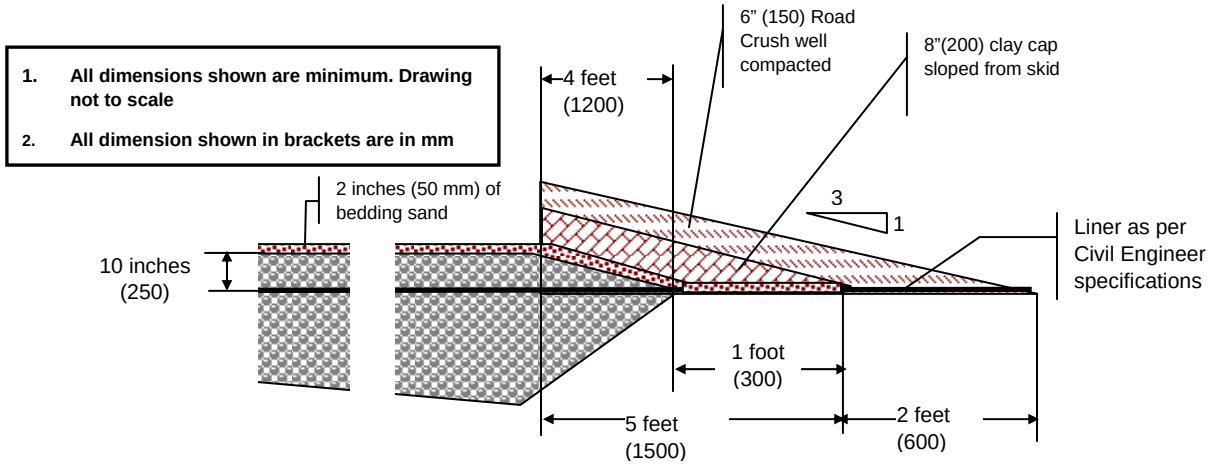
b) The excavated area is to be filled with sections of 6 inches (150 mm) gravel fill and compacted to a uniform dry density of no less than 100% standard Proctor maximum dry density.

c) Compaction is to be done by a self-propelled, smooth drum, vibratory compactor. Having a drum width of not less than 56 inches (1420 mm) wide & a gross weight not less than 11,500 lbs (5,200 kg).

d) Provide clay cap & finish gravelling as detailed.

e) The pad should be level and even, to ensure proper operation of the unit.
   i. Place unit on pad
   ii. Remove unit from pad and evaluate imprint
   iii. Fill in low spots with sand and compact
   iv. Slide compressor to final location

ATTENTION: Unnecessary prolonged exposure of the foundation to the elements is to be avoided and ponding should not be allowed.



12.3 Figure 2

13.0 APPENDIX III

13.1 SPECIAL INSTRUCTIONS