BLACKMER HDS COMPRESSORS

Installation, Operation, and Maintenance Instructions

960479
INSTRUCTIONS CB9A-050

Section	901
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Reciprocating Gas Compressors for Sour Gas Service
Single-Stage: HDS162C, HDS362C, HDS602C
Two-Stage: HDS172C, HDS372C, HDS612C
Discontinued: HDS602B, HDS612B

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This is a SAFETY ALERT SYMBOL.
When you see this symbol on the product, or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER
Warns of hazards that WILL cause serious personal injury, death or major property damage.

WARNING
Warns of hazards that CAN cause serious personal injury, death or major property damage.

CAUTION
Warns of hazards that CAN cause personal injury, or property damage.

NOTICE
Indicates special instructions which are very important and must be followed.

NOTICE

Blackmer compressors **MUST** only be installed in systems which have been designed by qualified engineering personnel. The system MUST conform to all applicable local and national regulations and safety standards.

These instructions are intended to assist in the installation and operation of Blackmer compressors and **MUST** be kept with the compressor.

Blackmer compressor service and maintenance shall be performed by qualified technicians ONLY. Service and maintenance shall conform to all applicable local and national regulations and safety standards.

Thoroughly review this manual, all instructions and hazard warnings, **BEFORE** performing any work on the compressor.

Maintain **ALL** system and compressor operation and hazard warning decals.

For handling liquefied petroleum gas, NFPA Pamphlet 58 should be consulted.

SAFETY DATA

The HDS compressor series are designed for use in Sour Gas Applications.

Persons maintaining, repairing, or working near the compressor or surrounding area must have adequate safety training and protection.

DANGER



H_2S atmospheres can cause serious personal injury or death.

H_2S atmospheres can cause serious personal injury or death.

DANGER



Flammable gas can cause death, serious personal injury or property damage

Flammable gas and/or liquid can form explosive mixtures with air causing property damage, serious personal injury or death

WARNING



Hazardous machinery can cause serious personal injury.

Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death

WARNING



Hazardous or toxic fluids can cause serious injury.

If handling hazardous or toxic fluids, system must be flushed and decontaminated, inside and out, prior to performing service or maintenance

WARNING



Hazardous gases can cause property damage, personal injury or death

Explosive gas can cause property damage, personal injury, or death.

WARNING



Hazardous pressure can cause serious personal injury or property damage

Failure to relieve system pressure prior to performing compressor service or maintenance can cause serious personal injury or property damage.

WARNING



Hazardous voltage. Can shock, burn or cause death.

Failure to disconnect and lockout electrical power before attempting maintenance can cause shock, burns or death

WARNING



Hazardous pressure can cause serious personal injury or property damage

Disconnecting fluid or pressure containment components during compressor operation can cause serious personal injury, death or major property damage

CAUTION



Extreme Heat can cause personal injury or property damage

Extreme heat can cause personal injury or property damage

GENERAL INFORMATION

Table 1 - COMPRESSOR DATA			
Single-Stage, Double-Seal Models	**HDS162C**	**HDS362C**	**HDS602C / HDS602B**
Displacement @ 350 rpm - CFM (m^3/hr) @ 825 rpm* - CFM (m^3/hr)	 7.16 (12.2) 16.9 (28.7)	 15.3 (26.0) 36.0 (61.2)	 27.2 (46.3) 64.2 (109.0)
Max. BHP (kw)	10 (7.5)	15 (11)	40 (30)
MAWP - psia (Bar)	350 (24.1)		
Maximum Discharge Temperature	350°F (176°C)		
Maximum H2S Concentration	8%		
Rotation Direction	Bi-Directional		
Two-Stage, Double-Seal Models	**HDS172C**	**HDS372C**	**HDS612C / HDS612B**
Displacement @ 350 rpm - CFM (m^3/hr) @ 825 rpm* - CFM (m^3/hr)	 3.57 (6.07) 8.42 (14.3)	 10.2 (17.3) 24.1 (40.8)	 22.9 (38.9) 53.7 (91.2)
Max. BHP (kw)	10 (7.5)	15 (11)	40 (30)
MAWP - psia (Bar)	615 (42.4)	615 (42.4)	415 (28.6)
Maximum Discharge Temperature	350°F (176°C)		
Maximum H2S Concentration	8%		
Rotation Direction	Bi-Directional		

* NOTE: Reduce maximum speeds by 9% for continuous duty operation.

The models listed above are single or two-stage, vertical, air-cooled reciprocating style compressors with single acting cylinders. All models are of ductile iron construction with stainless steel fasteners (those in contact with the gas stream) and non-hardened steel parts.

MODEL: HDS _____ ID#: _____ SERIAL NO: _____

Before proceeding:

1. Note the nameplate data in the space provided above.
2. Obtain the appropriate parts lists for the model in question.
3. These compressors are used on a wide variety of gasses. **Before doing any work on the compressor, be certain of the identification of the gas and the precautions to be followed when around that gas.**

Manuals and Parts Lists for Blackmer products may be obtained from
Blackmer's website (www.blackmer.com) or be contacting Blackmer's Customer Service.

NAMEPLATE DATA

A nameplate is attached to the side of all Blackmer compressors showing the Model No., I.D. No., and Serial No. These numbers should be available when information or parts are needed for a particular unit.



The basic size and type of the compressor is indicated by "Model No." A suffix letter is used to indicate the version.

GENERAL INFORMATION

Serial Number *: 6 digits and a suffix letter indicating the year of manufacture.

Suffix	P	Q	R	S	T	U	V	W	X	Y	Z
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004

* Starting in 2005, the suffix letter is no longer used; the year & month of construction is indicated on the nameplate.

Table 2 - Year of Manufacture

An 11 character "I.D. No." identifies the construction of the compressor.

Table 3 - ID NUMBER KEY

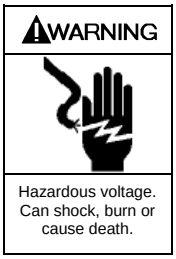
P	B	B	F	M	1	T	A	4	C	A

VALVES	Code	Fields
TNT-12 steel	BE	1 & 2
TNT-12 steel w/ Unloaders	BF	
Ductile Iron / PEEK	PB	
DI/PEEK w/ Unloaders	PC	
TNT-12 DI/PEEK	PE	
TNT-12 DI/PEEK w/ Unloaders	PF	
Stainless Steel	SB	
SS w/ Unloaders	SC	
O-RINGS		Field 3
Buna-N	B	
Neoprene	N	
PTFE	T	
Fluorocarbon (FKM)	V	
Ethylene-Propylene	E	
GASKETS		Field 4
Aluminum	A	
Iron	F	
Copper	C	
PISTON RINGS		Field 5
Glass & Moly Filled PTFE	M	
Poly Filled PTFE	A	
SEAL (PACKING) ORIENTATION		Field 6
All Lips up	1	
Top Lips Down, Bottom Up Tube to Stage 1 outlet	2	
Top Lips Up, Bottom Down	3	
Top Lips Down, Bottom Up Tube to Stage 2 outlet	4	
Up, Down, Up	5	
Down, Down, Up	6	
Down, Up, Up	7	
SEAL MATERIAL		Field 7
PTFE	T	
CYLINDER & HEAD		Field 8
Ductile Iron	A	
TNT-12 DI Cylinder	B	
TNT-12 DI Cyl. & Head	C	
PISTON RODS		Field 9
Chrome Plated Steel	1	
CrO_2 Coated Steel	3	
Black Surface Steel	4	
CRANKSHAFT & OIL FILTER		Field 10
Standard	A	
Spin-on Oil Filter	C	
OTHER	A	Field 11

Notes: A 'Z' in any field indicates a non-standard option. No model is available with all shown options.

NOTICE:

Blackmer compressors must only be installed in systems designed by qualified engineering personnel. System design must conform with all applicable regulations and codes and provide warning of all system hazards.



- **Install, ground and wire to local and National Electrical Code requirements.**
- **Install an all-leg disconnect switch near the unit motor.**
- **Disconnect and lockout electrical power before installation or service**
- **Electrical supply MUST match motor nameplate specifications.**
- **Motors equipped with thermal protection automatically disconnect motor electrical circuit when overload exists. Motor can start unexpectedly and without warning.**

LOCATION AND PIPING

Compressor life and performance can be significantly reduced when installed in an improperly designed system. Before starting layout and installation of the piping system, consider the following:

1. All piping must be leak free to a pressure of 1.5 times the maximum system pressure.

   NOTICE: If the system is to be hydro-statically tested, the compressor MUST be isolated. Liquid entering the compressor will cause damage and void the warranty.

2. A strainer should be installed in the inlet line to protect the compressor from foreign matter. A #30 mesh screen or finer is recommended. Strainers **must** be cleaned every 180 days, or more frequently if the system requires.
3. Expansion joints, placed within 36" (0.9 m) of the compressor, will compensate for expansion and contraction of the pipes. Contact the flexible connector/hose manufacturer for required maintenance/care and design assistance in their use.
4. Piping **must** be adequately supported to ensure that no piping loads are placed upon the compressor.
5. Both suction and discharge piping should slope down from the compressor. The compressor should not be placed at a low point in the piping system.



Discharge piping surface temperatures may be hot during operation (over 158°F, 70°C). Temperatures should be monitored and adequate warnings posted

MOUNTING THE COMPRESSOR UNIT

Stationary Compressors

A solid foundation reduces noise and vibration, and will improve compressor performance. On permanent installations, it is recommended the compressor be secured by anchor bolts as shown. This arrangement allows for slight shifting of position to accommodate alignment with the mounting holes in the base plate.

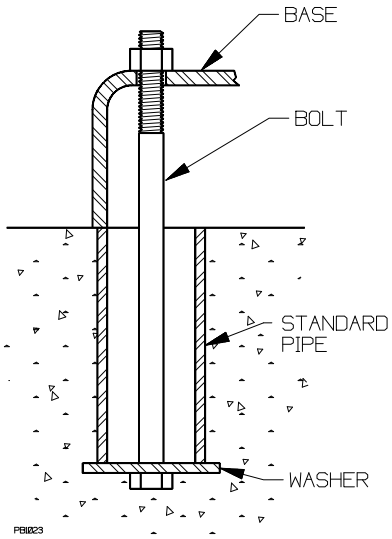


Figure 2 - Anchor Bolt

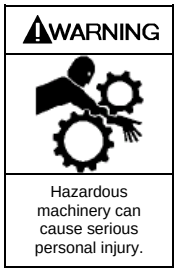
Set the anchor bolts in concrete for new foundations. When compressors are to be located on existing concrete floors, holes should be drilled into the concrete to hold the anchor bolts.

To keep vibration at a minimum, in addition to a solid concrete foundation, it is important that the concrete be located on a stable soil foundation. The base must have complete contact along its entire length with the foundation. Visible separations will result in vibrations which are magnified in the upper part of the unit.

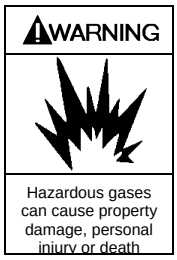
Check compressor mounting bolts and baseplate anchor bolts regularly.

INSTALLATION

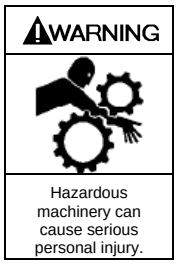
COMPRESSOR DRIVE SYSTEMS



Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death



Flywheel guard contact with moving parts may be a source of ignition in explosive atmospheres causing severe personal injury or death



Operation without guards in place can cause serious personal injury, major property damage or death.

COMPRESSOR FLYWHEEL

Blackmer compressors are fitted with flywheels which MUST be used regardless of the type of drive system employed.

Flywheels must be properly installed and aligned:

1. Ensure that the mating surface between the hub and flywheel are clean and dry – do not use a lubricant.
2. Install the hub and key on clean compressor shaft, flange end first.
3. Tighten the hub setscrew just enough to prevent it from sliding on the shaft – do not overtighten.
4. Place the flywheel on the hub and loosely thread the capscrews with lockwashers into the assembly. Do not use lubricant on the capscrews.
5. Tighten all capscrews evenly and progressively in rotation to the torque value in Table 4. There must be a gap between the hub flange and the flywheel with installation is complete. **Do not over-torque. Do not attempt to close gap between hub flange and flywheel.**

Hub Size	Capscrew Size	Torque ft-lbs. (Nm)
SF	3/8 – 16	30 (40.7)
E	1/2 - 13	60 (81)
F	9/16 – 12	75 (101)

Table 4 – Flywheel Hub Torque Values

6. Ensure that the radial and axial runout values at the rim do not exceed the following values:
   Radial O.D. Runout: 0.016 in. (0.4046 mm)
   Axial Rim Runout: 0.021 in. (0.5334 mm)
7. Ensure that the compressor flywheel guard is properly installed before operation. The guard must not contact moving parts.

V-BELT DRIVES

Most Blackmer compressors are driven via V-belts which must be properly aligned and tensioned.

1. Lay a straight edge along the face of the motor sheave and compressor flywheel.
2. Adjust either as needed to provide alignment.
3. Tighten the V-belts such that they are taut, but not overly tight. Moderate thumb pressure should deflect each belt about 1/4 – 3/8 in. (6 – 10 mm). Consult your V-belt supplier for specific values.
4. Check the belt tension after 24 - 48 hours run-in. Recheck periodically; tighten the belts as required.

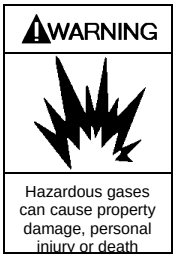
Caution should be used to avoid overtightening belts, which can shorten bearing and belt life. Belts should be inspected periodically for signs of excessive wear and replaced if necessary.

MAXIMIZING COMPRESSOR LIFE

Life of critical compressor components such as piston rings, valves and packing will vary considerably with each application, installation, and operating procedures. Premature failure of wear parts can often be attributed to one of the following causes:

1. **Excessive Temperatures**
   Primary causes are:
   - Operating at pressures other than those originally specified.
   - Handling a different gas than originally specified.
   - Clogged strainer or filter elements.
   - Line sizes too small, or other flow restrictions.
   - Excessive ambient temperature or suction gas temperature.
   - Valve problems. (See Foreign Material.)
   - Badly worn piston rings. (See Foreign Material.)

   Lower operating temperatures will increase valve and piston ring life significantly.



Extreme temperatures caused by abnormally high discharge pressure or valve problems can be a source of ignition in explosive atmospheres causing severe personal injury or death.

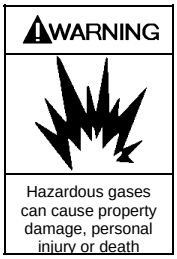
2. **Foreign Material**
   Solid particles in the gas stream will:
   - Rapidly wear the piston rings and score the cylinder wall.
   - Destroy the rod packing causing excessive leakage and score the piston rods.
   - Lodge in the valves causing loss of capacity and broken valve plates and springs.

   Liquid in the gas stream will:
   - Cause broken valve plates and springs.
   - Destroy the compressor if present in sufficient quantity.

   On new installations, it is suggested that the valves and piston rings be inspected after the first few hundred hours of operation. This will give an early indication of any abnormal problems and allow for corrective action to be taken before a costly failure results. Although piston ring life will vary from application to application, wear will be fairly consistent on subsequent sets of rings.

SEAL (PACKING) ARRANGEMENTS

Double Seals provide a wide range of leakage control/containment options. Before starting work on the compressor, note the seal orientation indicated by the 6th digit of the Compressor ID # shown on the compressor's nameplate. Also note any tubing connections in the seal area. 1/4" NPT ports are provided between each pair of seals to allow proper venting or pressurization of the seal areas (double and triple seal models only). For more information, see CB-037 "Compressor Distance Piece Options".



Improper seal installation could release explosive gas to the atmosphere creating an explosion hazard, possibly causing severe personal injury or death.

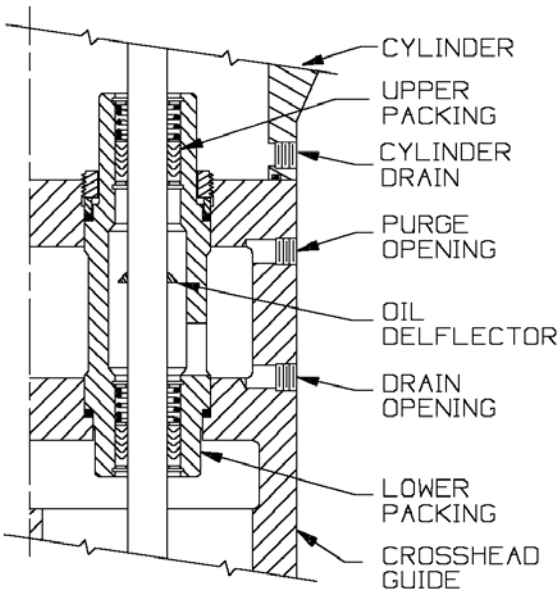


Fig. 3 - TYPICAL SEAL AREA CONSTRUCTION

Table 5 - SEAL ARRANGEMENTS - ALL DOUBLE SEAL COMPRESSORS

Type	1		2		4	3
Inlet Pressure	Atmospheric Pressure or above		Vacuum to 25 psia		Under 5 psia	
Service	General Gas Transfer	Toxic, Flammable or otherwise Hazardous Gases		General Gas Transfer		Special
Upper Distance Piece Connections	Plugged	Purge with Inert gas below suction pressure and above atmospheric pressure, or Vent to a safe location	Pressurize or Purge with an Inert gas above suction pressure and above atmospheric pressure	Connect to: 1st-Stage Discharge	Tube to: 2nd-Stage Discharge	
Lower	Install drain valve. Drain accumulated condensate or oil weekly.					
Ref. Notes:	a	b		a		c

NOTES:
a. Standard Configuration - use when no purge gas is available, or when mixing of the purge gas with the product stream is not desirable.
b. Use when no external product leakage is desirable.
Note: Mixing of inert pressurization gas and the product stream is likely to occur.
c. Consult Factory.

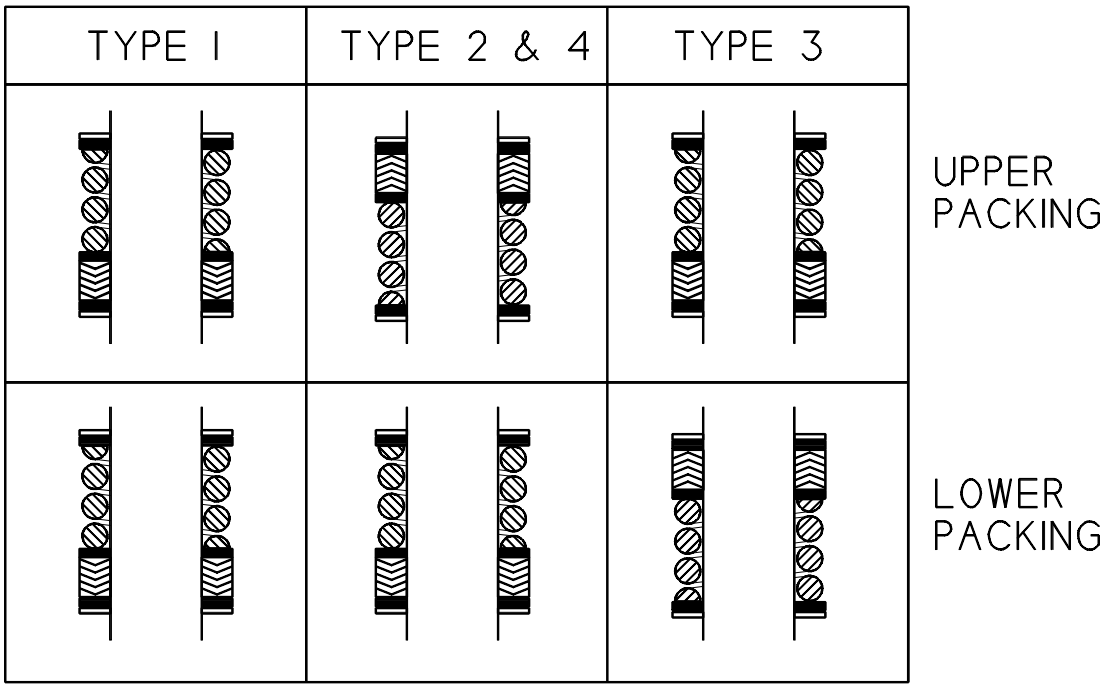


Fig. 4 - SEAL ORIENTATION - ALL DOUBLE SEAL COMPRESSORS

RELIEF VALVES

A relief valve of a type, material and pressure rating suitable to the installation, MUST be installed. The relief valve shall be installed in the discharge line between the compressor head and the first block valve.



Compressor operating against closed valve can cause system component failure, personal injury or property damage.

Since all systems differ in design, care must be taken to ensure the relief valve is installed to safely vent away from sources of ignition and personnel. This can be accomplished by either orientation or a pipe away, consult the Relief Valve manufacture for assistance.

Should the Relief Valve actuate, the cause MUST be determined and corrected before continuing operations. See the 'Troubleshooting' section.

Blackmer offers various relief valves for gas and application compatibility.

LIQUID TRAPS

Compressors handling gasses containing condensates or other liquids MUST be protected from entry of the liquid. Liquid can also enter the compressor from the discharge piping, particularly if the piping slopes down toward the compressor. To prevent liquid from entering the compressor and causing major damage, it is necessary to carefully consider the system design and have strict procedures for operation.

NOTICE: Liquid in the compressor cylinder can cause destruction of the compressor.

A liquid trap may be required at the 2nd stage inlet as well as at the compressor suction. If used, a 2nd stage inlet liquid trap would be located after the intercooler.

TEMPERATURE SWITCHES

Excessive discharge temperature is a leading cause of premature component failure and is often an early warning sign of impending problems.

Temperature switches should be installed with a thermowell as close to the compressor discharge as possible. The switch should be set to actuate at a temperature just above the maximum operating temperature of the compressor.

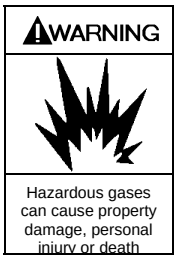
ATEX compliant compressors **must** have a temperature switch installed.

LOW OIL PRESSURE SWITCHES

Loss of crankcase oil pressure is a rare occurrence, but can result in costly damage. An optional low oil pressure switch set at about 15 psig (1 bar-g) may be installed to shut down the compressor in the event of a lubrication failure. A 10 second delay timer should be used to lock the low oil pressure switch out during compressor startup.

PRESSURE SWITCHES

Pressure switches may be installed in the suction, interstage or discharge gas stream as protective devices, for compressor control, or for other uses varying with each application and system design.



Liquid trap level switches, temperature switches, pressure switches or other electrical devices must be properly specified for applications using explosive gases.

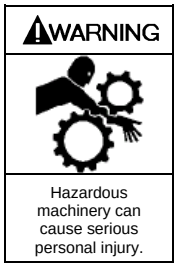
PRESSURE GAUGES

Install pressure gauges in the discharge and inlet lines to verify actual suction and discharge pressures.

INTERSTAGE PIPING / COOLING

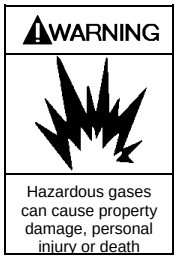
2-Stage Models: Generally, an interstage cooler should be used between the 1st stage discharge and the 2nd stage. Cooling must be sufficient to prevent excessive temperatures in the 2nd stage; typically 100 – 125°F (38 – 52 C°). If interstage cooling is sufficient to cause condensation, the resultant liquid must be removed prior to entering the 2nd stage (see LIQUID TRAPS).

PRE-STARTUP CHECK LIST



Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death

1. After the compressor is installed in the system, a complete leak test MUST be performed on both the compressor and the piping.



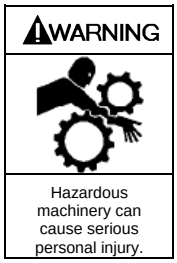
Failure to properly leak test the compressor installation may result in leakage of explosive gas to the atmosphere creating an explosion hazard, possibly causing severe personal injury or death.

2. Re-check the system piping and the piping supports to ensure that no piping loads are being placed on the compressor.

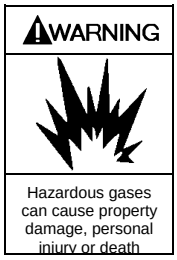


Discharge piping surface temperatures may be hot during operation (over 158°F, 70°C). Temperatures should be monitored and adequate warnings posted.

3. If V-belt driven, check the alignment of the motor and the compressor sheaves. The faces of the sheaves must be parallel.
4. Ensure that pressure gauges are installed on both inlet and discharge of the compressor.
5. Blackmer compressors are shipped from the factory without oil in the crankcase. Fill with a high quality non-detergent oil of the proper viscosity via the compressor nameplate opening.. See "Crankcase Lubrication" in this manual.
6. Check the electrical connections for proper wiring, grounding, etc.
7. With the power disconnected, remove the compressor nameplate. Squirt oil onto each crosshead while rotating the compressor by hand to verify smooth operation.
8. Ensure that all guarding is properly installed.



Operation without guards in place can cause serious personal injury, major property damage or death.



Flywheel guard contact with moving parts may be a source of ignition in explosive atmospheres causing severe personal injury or death

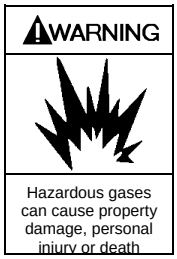
STARTUP PROCEDURE

NOTICE:

Consult the 'Troubleshooting' section of this manual if difficulties during startup are experienced.

1. Start the compressor. Oil pressure should register 25 psig (1.7 bar-g) within 10 seconds.

   If proper oil pressure is not present, stop the compressor and correct the problem.



Operation of the compressor with low or no oil may result in extreme temperature in the crankcase. This could be an ignition source in the presence of explosive gas and could lead to severe personal injury or death.

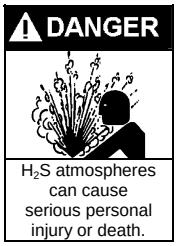
   Operating the compressor with low oil pressure will cause severe damage to the unit. See "Setting the Oil Pressure" in this manual.

   The oil pump on these models will operate in either direction of crankshaft rotation.

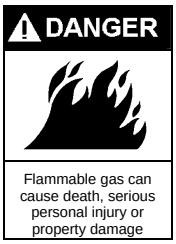
2. Verify that the suction and discharge pressures are within the expected ranges.

   Operating limits listed in the "Compressor Data" section must not be exceeded.

3. Check for leakage from the piping and equipment, and repair as necessary.
4. If the seals (packing) have just been replaced, or if the compressor has been out of service for over 6 months, the lower seal MUST be manually lubricated during the first 60 minutes of operation. See "Seal (Packing) Replacement" section. New compressors have had the packing broken in at the factory.
5. On newly rebuilt units, the valve hold down screws, valve cover plate bolts and cylinder head bolts MUST have their torque checked after 60 minutes running time. Also re-tighten all hold down bolts, flywheel bolts, etc. after 60 minutes running time. See the "Bolt Torque." table.



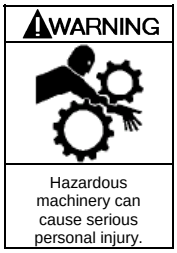
H_2S atmospheres can cause serious personal injury or death.



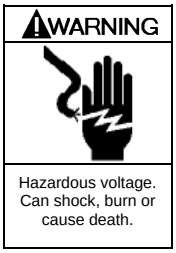
Flammable gas and/or liquid can form explosive mixtures with air causing property damage, serious personal injury or death



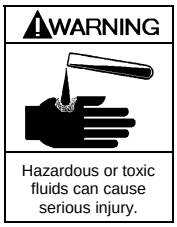
Failure to relieve system pressure prior to performing compressor service or maintenance can cause serious personal injury or property damage.



Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death



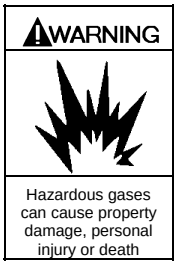
Failure to disconnect and lockout electrical power before attempting maintenance can cause shock, burns or death



If handling hazardous or toxic fluids, system must be flushed and decontaminated, inside and out, prior to performing service or maintenance



Disconnecting fluid or pressure containment components during compressor operation can cause serious personal injury, death or major property damage



Explosive gas can cause property damage, personal injury, or death.



Extreme heat can cause personal injury or property damage

BOLT TORQUES

Proper bolt torques to use when reassembling the compressor.

Table 6 - BOLT TORQUES FOR BLACKMER COMPRESSORS FT-LBS (Nm)

Size	Con. Rod Bolt	Bearing Carrier	Bearing Cover Plate	Crank-case Inspec. Plate	Oil Pump Cover	Cross Head Guide	Cylinder	Head	Piston & Nut	Valve Assy. Nut	Valve Cover Plate	Valve Hold Down Screw	Valve Cap	Packing Box Hold Down Ring
160 170	30 (40.7)	30 (40.7)	30 (40.7)	7 (9.5)	12 (16.3)	25 (33.9)	25 (33.9)	20 (27.1)	40 (54)	--	--	120 (163)	80 (108)	75 (102)
360 370	35 (47.5)	30 (40.7)	30 (40.7)	7 (9.5)	12 (16.3)	35 (47.5)	35 (47.5)	40 (54)	40 (54)	10 (13.6)	35 (47.5)	120 (163)	80 (108)	75 (102)
600 610	45 (61)	30 (40.7)	40 (54)	7 (9.5)	12 (16.3)	40 (54)	40 (54)	40 (54)	60 (81)	10 (13.6)	35 (47.5)	120 (163)	80 (108)	75 (102)

MAINTENANCE

NOTICE:

Blackmer compressor service and maintenance shall be performed by qualified technicians only. Service and maintenance shall conform to all applicable local and national regulations and safety standards.

Table 7 – SERVICE SCHEDULE

	Daily	Weekly	Monthly	6 Months	Yearly
Overall Visual Check	X				
Check Crankcase Oil Pressure	X				
Check Suction Pressure	X				
Check Discharge Pressure	X				
Drain Distance Piece		X			
Drain Liquid From Accumulation Points		X			
Clean Compressor Cooling Fins		X			
Clean Compressor Air-Cooled Intercooler Fins		X			
Check Crankcase Oil Level *			X*		
Check Mounting and Anchor Bolts			X		
Check V-Belt Tension			X		
Change Oil and External Oil Filter *				X*	
Check Inlet Filter/Strainer Element				X	
Inspect Valves				X	
Lubricate Motor Bearings per Manufacturer's Suggestions				X	
Inspect Motor Starter Contact Points					X
* Change oil every 1,000 hours of operation, or every 6 months which ever occurs first. If the oil becomes dirty or diluted, change oil and external filter as often as needed to maintain clean oil.					

Table 8 - TOOL LIST

Description	**Used For:**
Blackmer Packing Installation Tool 790536 for 160, 340, & 360 series 790538 for 600 series compressors	Rod-packing protection during installation.
Blackmer Torque Wrench Adaptors 798002 for HDS162 Compressors 798004 for HDS362 Compressors 798005 for HDS602 Compressors 798002 & 798001 for HDS172 Compressor 798005 & 798009 for HDS372 Compressor 798006 & 798008 for HDS612 Compressor 798001 for HDS172 Compressors 798010 for HDS162, 362 and 372 Compressors 798011 for HDS602 and 612 Compressors	 Piston Piston Piston Piston Piston Piston Piston Nut Piston Nut Piston Nut
Blackmer Wrench 790535	Valve Hold-down screw
3" Adjustable Spanner with 1/4" pins (like Blackmer PN 790316)	Piston Nut, Piston, Packing Box Hold-down Ring
9/16, 5/8 or 3/4" End Wrench	Cylinder and Crosshead Guide
1-1/16" Wrench or Socket	Valve Caps
3/16" Allen Wrench	Oil Pump Cover
7/16", 1/2", 9/16", 3/4", 5/8", 3/4", 7/8" & 1-3/8" Sockets	Various
Internal Snap Ring Pliers	Seal Replacement
Feeler gauges or Depth Micrometer	Piston Clearance
Screwdriver, Flat Blade	Nameplate screws, Packing Installation
Pliers	
Rubber Mallet	
Arbor Press	Wrist Pin Removal
Bearing Puller	Crankshaft Bearings
Torque Wrench	Various
Hoist (useful)	Cylinder, Crosshead Guide and Crankcase

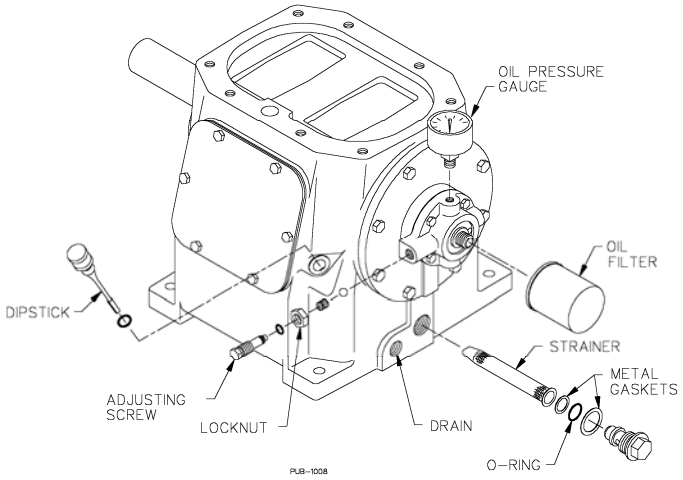


Figure 7 - Compressor Lubrication System

CRANKCASE LUBRICATION

Change the crankcase oil every 1,000 hours or 180 days, whichever is shorter. Under severe dusty, sandy or wet operating conditions, the oil should be changed every 500 hours or every 90 days.

If the crankcase oil becomes contaminated or diluted due to gas leakage past the packing seals, the oil must be changed more frequently. In such cases, change the packing seals as soon as possible.

Non-detergent oils are recommended. Detergent oils can be used providing the gas being handled does not react with the detergent in the oil. If using a detergent oil, be sure there is not a compatibility problem. Ammonia, amine and imine gases are known to react with many of the detergents in oil.

The oil used, detergent or non-detergent, should be of high quality such as API grade SJ, SL, SM, SN or similar.

API grade SA, SB, SC or similar oils should never be used. Recycled oils should never be used.

Synthetic oils are acceptable; use the same guidelines as mineral based lubricants. Consult factory for special lubricating requirements.

Before changing the oil, bring the compressor up to normal operating temperature. Remove the crankcase drain plug and drain the oil into an adequately sized container. Remove the oil pickup screen and clean in a suitable solvent. When reinstalling the pickup screen, inspect the metal gasket and the O-ring for damage, replacing as necessary. If equipped, replace the external oil filter. See Figure 7.

Refill the crankcase via the dipstick or nameplate opening. **DO NOT OVERFILL THE CRANKCASE!**

The oil pump on these models will operate in either direction of crankshaft rotation.

Sizes	Quarts	Liters
160 / 170 360 / 370 600 / 610	2 3 7	1.89 2.84 6.62

Table 9 - Oil Capacity

Mineral Based Oil - API Grade SN, SM, SL, SJ

ISO Grade	SAE	Ambient Temperature	Product
100	30	80°F (27°C) and above	Mobil® Rarus 427 or equivalent
46	20	32 to 80°F (0 to 27°C)	
32	10	0 to 32°F (-18 to 0°C)	
22 - 15	5 - 0	Below 0°F (-18°C)	

Synthetic Oil

ISO Grade	SAE	Ambient Temperature	Product
68	20+	Full Range	Mobil® Rarus SHC 1026 or equivalent

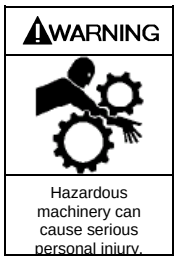
Table 10 - Oil Viscosity

SETTING THE OIL PRESSURE (see Figure 7)

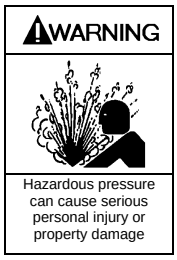
1. The oil pressure should be about 25 psig (1.73 Barg).
2. Loosen the locknut.
3. Increase the pressure setting by turning the adjusting screw inward, CLOCKWISE.

   Decrease the pressure setting by turning the adjusting screw outward, COUNTER-CLOCKWISE.
4. Retighten the locknut.

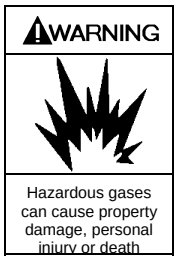
COMPRESSOR DISASSEMBLY



Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death



Failure to relieve system pressure prior to performing compressor service or maintenance can cause serious personal injury or property damage.



Venting pressure from the compressor piping could release explosive gas to the atmosphere creating an explosion hazard, possibly causing severe personal injury or death.

NOTICE:

Before starting work on the compressor, make sure all pressure is bled off on both the suction and discharge.

1. Remove the flange bolts connecting the intercooler to the cylinder head.
2. Disconnect the return tube and fitting (Two-stage models)
3. Remove the center head capscrews from the cylinder head. Remove the outer cylinder head capscrews.
4. The cylinder head assembly and cylinder head O-rings can now be removed from the cylinder. The suction and discharge valve assemblies will come off with the cylinder head. For valve disassembly instructions refer to "Valve Replacement."
5. Removal of the piston requires a 3" adjustable spanner wrench with 1/4" pins (such as Blackmer PN 790316)
   a. Rotate the flywheel by hand to bring a piston to top dead center of the cylinder.
   b. Remove the piston nut by rotating the nut counterclockwise. (Note the nylon locking insert in the piston nut. This insert must be replaced during reassembly.)
   c. To remove the piston from the cylinder, rotate it counterclockwise with the use of the adjustable spanner wrench. For removal and replacement of the piston rings, refer to "Piston Ring Replacement."
   d. Remove the thrust washer and shims. Keep the shims & piston together.
   e. Repeat these steps for the other piston.
6. Remove the cylinder capscrews.
7. The cylinder and cylinder O-rings can then be lifted from the crosshead guide (or distance piece).
8. For disassembly of the packing boxes, refer to "Seal (Packing) Replacement".

   Double-Seal Models
   a. Using an adjustable spanner wrench, remove the packing box hold-down rings. (Replace the nylon locking inserts in the hold-down rings during reassembly.)
   b. The spacer rings, upper packing box O-rings, packing boxes and lower packing box O-rings can then be removed from the piston rods.
9. Remove the crosshead guide capscrews, and lift the crosshead guide and gasket off.
10. To remove the connecting rod assemblies (with the crossheads attached) it may be necessary to drain the oil from the crankcase. **NOTE:** The piston rod is permanently attached to the crosshead to form a single assembly. Do not attempt disassembly.
    a. Remove the crankcase inspection plate.
    b. Remove the locknuts from the connecting rod bolts. This will release the connecting rod cap (the lower half of the connecting rod) and the two halves of the bearing insert. **NOTE:** The connecting rod and the connecting rod cap are marked with a dot on one side so that they can be matched properly when reassembling.
    c. Lift the crosshead assembly and connecting rod off the crankcase.

       NOTE: The connecting rod parts are not interchangeable and must be reassembled with the same upper and lower halves. To avoid confusion, work on one connecting rod at a time, or mark the individual halves with corresponding numbers.
    d. Remove the other connecting rod and crosshead assembly in the same manner.
11. Rest the crosshead assembly on a bench. Carefully drive the wrist pin and wrist pin plugs out of the crosshead and connecting rod using a suitable pin driver or an arbor press. Removal of the pin releases the crosshead assembly from the connecting rod.
12. If necessary, replace the wrist pin needle bearings or bushings after the crossheads are removed.

    HDS602C, HDS612C: Two needle bearings separated by a spacer are used. When properly installed, the needle bearings should protrude 0.075" (1.9 mm) on each side of the conrod.

    HDS602B, HDS612B: Connecting Rods with new brass bushings (instead of needle bearings) **must** be honed to the proper size after installation.

    1.2511" to 1.2514" (31.778 mm to 31.786 mm).
13. To replace the crankshaft bearings, the crankcase must be disassembled, and the crankshaft removed. Refer to "Bearing Replacement" for disassembly instructions.

COMPRESSOR ASSEMBLY

Compressor assembly is generally the opposite of compressor disassembly. Before reassembling, clean each part thoroughly. Check all machined surfaces for burrs or roughness, and file lightly if necessary. **Replace any O-rings or gaskets that are removed or disturbed during service.**

1. CRANKCASE ASSEMBLY

After replacing the crankshaft, bearing carrier, and bearing cover plate (see "Bearing Replacement"), the connecting rod and crosshead can be installed.

a. To attach the connecting rod to the crosshead assembly, first coat the wrist pin, the wrist pin bore in the crosshead assembly, and the wrist pin bearing in the connecting rod with grease.

b. Start the wrist pin in the bore of the crosshead assembly until the pin begins to project through to the inside of the crosshead assembly. (Use an arbor press if available.)

c. Slide the connecting rod up inside of the crosshead assembly and align the bearing with the wrist pin.

d. Install the wrist pin through the connecting rod until it is centered in the crosshead assembly. NOTE: The wrist pin should be snug in the crosshead assembly. The connecting rod should rotate freely on the wrist pin, but should not be loose.

e. Dip the wrist pin plugs in grease and press them in place.

f. Place the bearing halves into each half of the connecting rod, aligning the bearing tangs with the slots in the connecting rod. Coat the bearing with grease.

g. Set the top of the connecting rod over the crankshaft journal. Replace the connecting rod cap, remembering that the dots on the connecting rod and cap must be on the same side.

h. Start the nuts on the connecting rod bolts and torque per the Bolt Torque Table.

i. Follow this same procedure for the opposite connecting rod.

2. CROSSHEAD GUIDE

a. Place the crosshead guide gasket on top of the crankcase.

b. Lubricate the inside bore of the crosshead guide with light oil.

c. Set the crosshead guide over the piston rods and the crossheads, and slowly lower it against the crankcase. Make certain that the crosshead assemblies are started straight in the bores of the crosshead guide to prevent binding when lowering the crosshead guide into position.

d. Install the crosshead guide capscrews loosely.

3. Fill the crankcase with oil. See "Lubrication" for proper amount. Squirt oil into the crankshaft, roller bearings, crankshaft journals, and crosshead assemblies so they will have lubrication at start up.

4. Attach the inspection plate and the inspection plate gasket to the crankcase.

5. PACKING BOX ASSEMBLIES

Refer to the section 'SEAL REPLACEMENT' for packing box assembly. Before installing the packing boxes into the crosshead guide, inspect the piston rods for scoring or roughness. Remove any burrs or sharp edges. Lubricate the piston rods, packing and packing box O-rings with light oil. **Do not damage the packing when starting it over the rod. The packing installation tool MUST be used to avoid damaging the packing when starting it over the rod.** (see 'Tool List' table)**.**

a. Insert the lower packing box O-ring into the crosshead guide.

b. Start the packing box assembly, short end down, over the piston rod.

c. After the lower set of packing is started over the piston rod, make sure the oil deflector ring (if fitted) is properly aligned (with the flat side down) over the piston rod. Use the hole in the side of the packing box to center the deflector ring. Once the deflector ring is over the rod, the packing box can be fully inserted.

d. Install the upper packing box O-ring on the end of the packing box.

e. Place packing box spacer ring over the O-ring.

f. Install the packing box retainer ring with new nylon locking inserts, and tighten.

g. Repeat above steps for the other packing box.

6. Rotate the crankshaft by hand a few times, then uniformly tighten the crosshead guide capscrews (and upper distance piece capscrews on triple-seal models) per the Bolt Torque Table.

7. New packing must be broken in. Refer to the end of "Seal Replacement".

8. CYLINDER ASSEMBLY

a. Install new O-rings in the bottom of the cylinder. A small amount of grease may be used to hold the O-rings in place during assembly.

b. Set the cylinder over the piston rods and against the crosshead guide.

c. Loosely install the cylinder capscrews.

9. Rotate the flywheel by hand to ensure the compressor turns freely.

10. PISTONS

a. If necessary, replace the piston rings and piston ring expanders (see "Piston Ring Replacement").

b. Rotate the flywheel by hand to bring one piston rod to top dead center of the cylinder assembly.

c. Set one (1) thrust washer and one (1) shim down against the shoulder of the piston rod.

d. Squeeze the piston rings inward, with light pressure, while threading the piston clockwise onto the rod. Tighten with the 3" adjustable spanner wrench.

e. Repeat steps a - d for the second piston.

f. Rotate the compressor by hand a number of times to verify that the pistons are centered in the cylinder bores. The pistons must not touch the cylinder walls. If necessary, adjust the cylinder.

g. Tighten the cylinder capscrews per the Bolt Torque Table in an alternating pattern.

h. The proper number of shims must be installed under the piston. To check, rotate the flywheel by hand to bring a piston to the top.

   i. Measure the distance from the top of the piston to the top of the cylinder.

   ii. If necessary, remove the piston and add or subtract shims accordingly.

   iii. Repeat steps i. – ii. for the second piston.

HDS162 / HDS172	.015" - .030" (.381 - .762 mm)
HDS362 / HDS372	.025" - .040" (.635 - 1.016 mm)
HDS602 / HDS612	.030" - .045" (.762 - 1.143 mm)

i. Replace the nylon locking inserts in the piston retainer nuts.

j. Thread the piston nuts onto the piston rods and tighten with the spanner wrench.

11. CYLINDER HEAD ASSEMBLY

If the valve assemblies have been removed from the cylinder head, it is easiest to reinstall them before attaching the cylinder head to the cylinder assembly. Refer to "Valve Replacement" for instructions.

a. Place the cylinder head O-rings in the grooves located on top of the cylinder.

b. Place cylinder head assembly on the cylinder.

c. Hand tighten the outer capscrews and center capscrews into the cylinder head.

   Note: Gaskets are used on the HDS160 series center capscrews.

d. Uniformly torque the cylinder head capscrews according to the Bolt Torque Table.

12. Rotate the compressor by hand to verify that it turns freely. Make sure the pistons are not hitting against the bottom of the cylinder head assembly.

13. Two Stage Models: Install the intercooler and torque the intercooler flange capscrews to 20 ft-lbs. (27 Nm).

14. Attach the return tube and fittings to the cylinder and cylinder head. (Two-stage models)

15. Refer to the "Pre-Startup Check List", and "Startup Procedure".

16. After the compressor has been run for a sufficient enough time to reach operating temperature, allow to cool and retighten the valve hold down screws.

VALVE REPLACEMENT

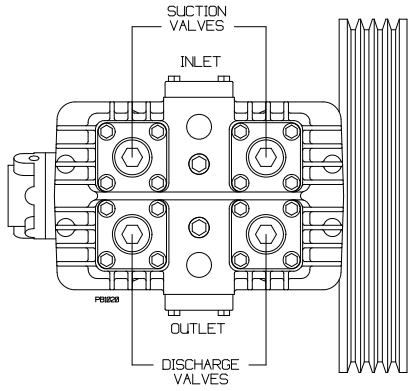


Fig. 8 – Valve Locations, Single-Stage Models

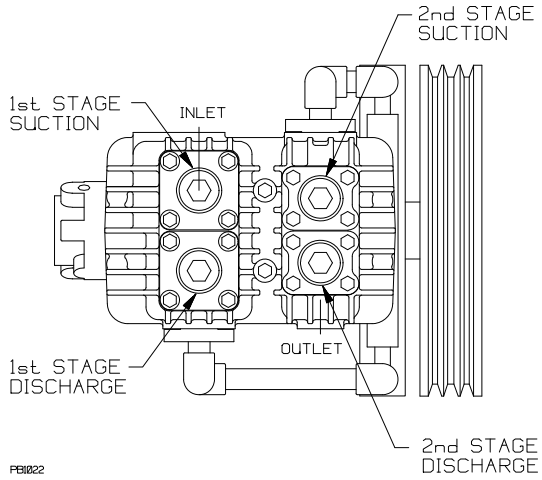


Fig. 8 – Valve Locations, Two-Stage Models

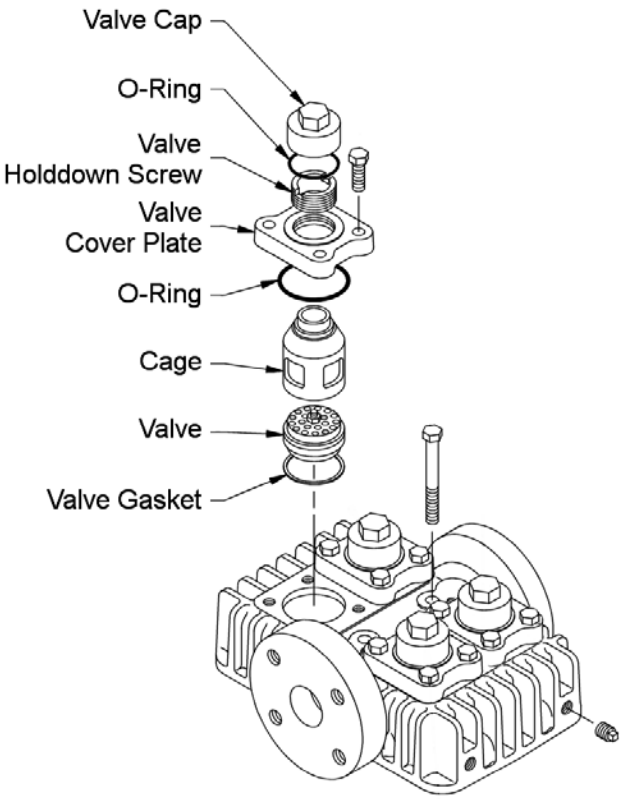


Fig. 9 – Typical Head Assembly

When replacing the valves, it is important to install the suction and discharge valves in the correct location in the cylinder head.

NOTE: The valves may be removed without removing the cylinder head from the cylinder. Be sure to remove and replace the valve gaskets.

WARNING



Hazardous pressure can cause serious personal injury or property damage

Failure to install compressor valves properly can lead to component failure, personal injury or property damage.

WARNING



Hazardous gases can cause property damage, personal injury or death

Failure to install compressor valves properly can result in leakage of explosive gas creating an explosion hazard, possibly causing severe personal injury or death.

WARNING



Hazardous gases can cause property damage, personal injury or death

Failure to install compressor valves properly can result in extreme discharge temperatures. This could be an ignition source in the presence of explosive gas possibly causing severe personal injury or death.

1. Remove the valve cap and O-ring from each valve.
2. **Remove** the valve hold down screw with a spanner wrench (such as Blackmer PN 790535).

3. VALVE REMOVAL AND DISASSEMBLY

160, 170 Series Models:

a. Remove the valve cage.
b. Remove the valve assembly and valve gasket.
c. Inspect the valve for wear or breakage.
d. Valve Repair
   i. Unscrew the valve halves and remove the spring and plate.
   ii. Inspect and replace worn components.
   iii. Reassemble valves as shown below and tighten the valve halves together.

360, 370, 600 and 610 Series Models:
Remove the valve cover plate capscrews then lift off the cover plate and O-ring.

a. Remove the valve cage.
b. Remove the valve assembly and valve gasket.
c. Inspect the valve for wear or breakage.
d. Valve Repair
   i. Remove the hex nut, separate the valve halves and remove the springs and plate.
   ii. Inspect and replace worn components.
   iii. Reassemble valves as shown in the drawing and tighten the valve assembly nut according to the Bolt Torque Table.

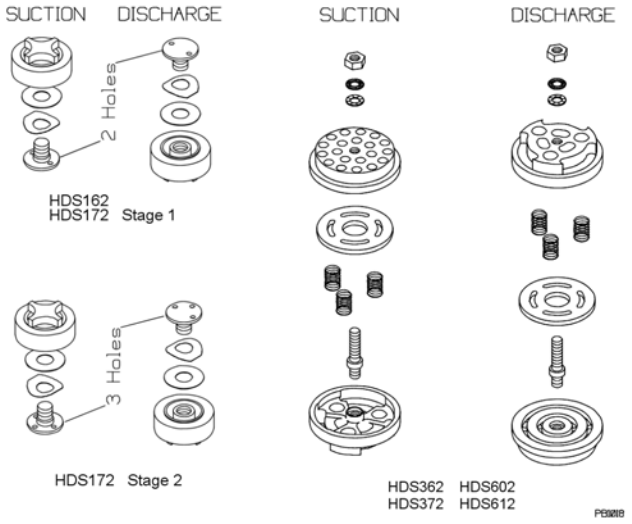


Fig. 10 – Typical Valve Assemblies
(1st Stage HDS612 Valves have 6 springs)

4. To reinstall valves:
   a. Install a new valve gasket into the cylinder head (remove any old gaskets).
   b. Install the valve assembly in the cylinder head. Make sure the valve's orientation and location are correct.
   c. Center the valve cage on the valve assembly.
   d. 360, 370, 600 and 610 Series Models:
   Make sure the valve hold down screw is removed from the cover plate, then install the valve cover plate with a new O-ring. Tighten the cover plate capscrews according to the Bolt Torque Table.
   e. Install the hold down screw and tighten according to the Bolt Torque Table.
   f. Install the valve cap and O-ring. (A little oil or grease on the O-ring will help hold it in place during installation.)
5. After replacing the valves, rotate the flywheel by hand to check for interference between the pistons and the valves.
6. After 60 minutes of running time, remove the valve cap and retorque the hold down screw. Replace the valve cap and O-ring.

PISTON RING REPLACEMENT

PISTON RING REPLACEMENT

1. Follow steps 1 through 3 of "Compressor Disassembly."
2. Remove the piston rings and the piston ring expanders from the pistons.
3. To replace the piston rings:
   a. Place an expander in the top groove of the piston. Place an expander in the second groove with its break 180 degrees from the break in the top expander. Place the third expander in the bottom groove with its break in the same position as the top expander.
   b. Place piston rings in all three grooves of the piston. Make sure the breaks in the piston rings are directly opposite the breaks in the corresponding expanders.
4. Reassemble the compressor per steps 10 through 14 of "Compressor Assembly."

1. Follow the steps in "Compressor Disassembly" to remove the packing boxes.
2. Remove the retainer ring from the packing being serviced. Disassemble the packing box and discard the old packing sets and packing springs.
3. Packing Box reassembly Notes:
   a. Clean the packing box in a suitable solvent. Inspect the bore for wear, roughness, or corrosion.
   b. See "Seal Arrangements" (Fig. 4) for the proper location and orientation of the packing components. The 6th digit of the Compressor ID# identifies the packing orientation.
   c. To ease installation on the second retainer ring, use a screwdriver handle and press on the last washer to compress the seal spring slightly.

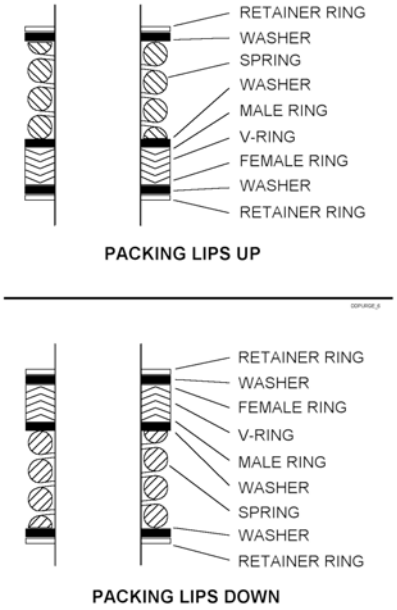


Fig. 11 – Seal Component Orientation

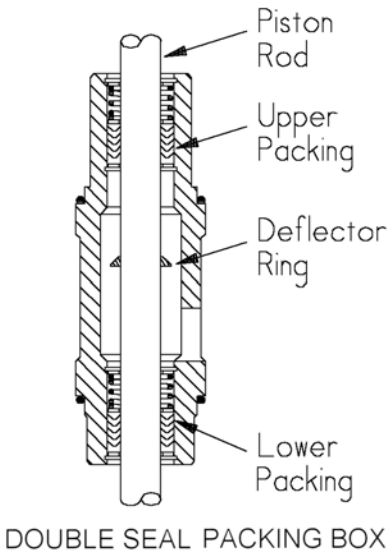


Fig. 12 - Packing Box Assembly
(all models except HDS602C & HDS612C)

4. Models HDS162C, HDS172C, HDS362C, HDS372C: Packing boxes contain two sets of packing. See Fig. 12.
   a. Install the first retainer ring (start with the inner ring), then install the packing rings, spring, washers, and the second retainer ring.
   b. Insert the oil deflector ring through the top of the packing box, flat side down, into the cavity between the upper and lower packing. NOTE: The oil deflector ring will be positioned between the two sets of packing. Install the second set of packing per step b.
   c. Proceed to Step 6 'Packing Break-in'.

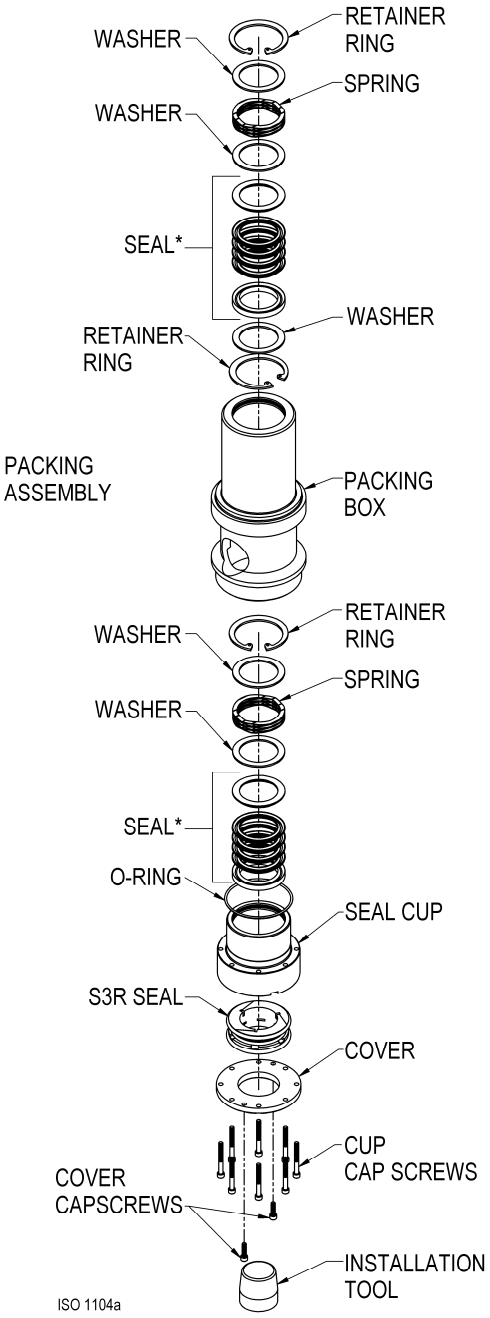


Fig. 13a – Packing Box Assembly
(models HDS602C, HDS612C)

5. Models: HDS602C and HDS612C: Packing boxes contain the upper packing set and a seal cup fastened to the bottom. The seal cup contains the lower packing set and the S3R seal. See Fig. 13a.
   a. **Upper Packing:** Install the lower retainer ring and washer. Lightly oil the packing rings, then install the packing rings, spring, washers and upper retainer ring.

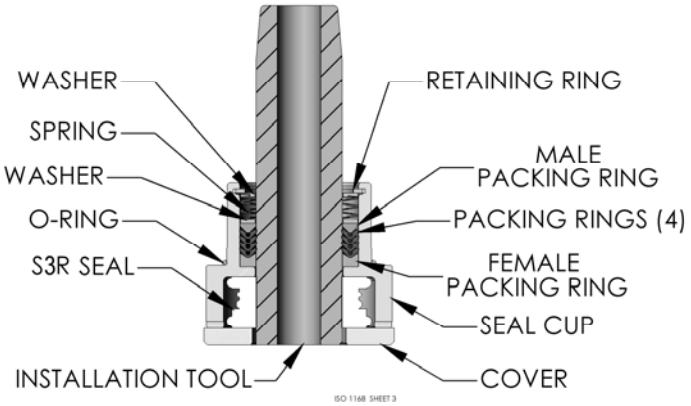


Figure 13b – Seal Cup Assembly

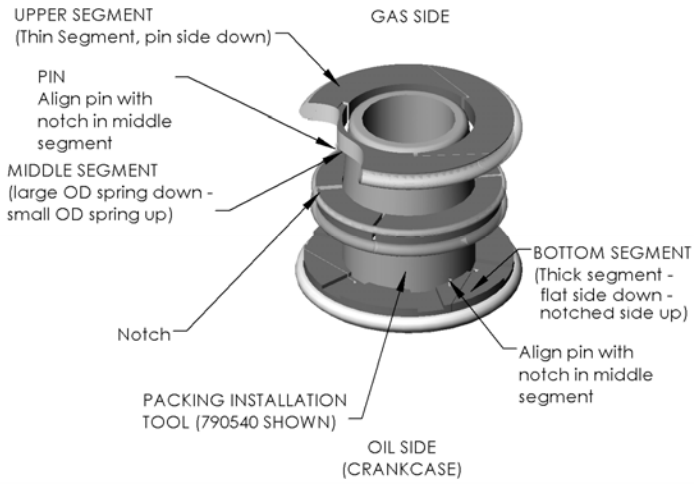


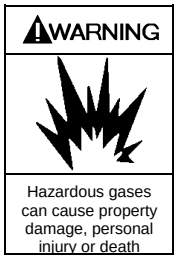
Figure 13c - S3R Oil Seal Installation

   b. **S3R Seal Cup**
   Disassembly
   - Remove the seal cup from the packing box by removing the eight socket head capscrews.
   - Remove the retainer ring, spring, packing and washers.
   - Remove the remaining two socket head capscrews to remove the seal cup cover and S3R seal.

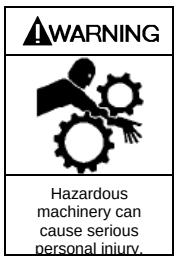
   Assembly
   - Clean the seal cup in a suitable solvent. Inspect the bore for wear, roughness, or corrosion.
   - Refer to Figs. 13a & 13b. Lightly oil the packing rings, then install the packing rings, washers, spring and retainer ring.
   - To install the S3R seal in the seal cup refer to Figures 13b & 13c . Place the S3R seal on the packing installation tool with the upper segment toward the tapered end of the installation tool. Insert the installation tool, with the S3R seal, into the seal cup, with the tapered end toward the packing rings. Place seal cup cover on seal cup and secure with the two short capscrews
   - Install the O-ring on the seal cup. Secure the seal cup to the packing box with eight capscrews.

6. **Packing Break-in**
   The lower packing must be manually lubricated with oil several times during the first 60 minutes of compressor operation. This will prevent overheating of the piston rods and potential damage to the packing material. If possible, perform the packing break-in at a lower speed – 400-500 rpm.
   To lubricate the packing:
   a. Remove the inspection plate from the crosshead guide.
   b. Run the compressor for 5 minutes then **stop** the compressor for 5 minutes to allow adequate cooling of the piston rods.
   c. Lubricate the piston rods each time the compressor is **stopped**. A small oil can should be used for lubrication

7. Proceed per the "Compressor Assembly" section.



Improper seal installation could release explosive gas to the atmosphere creating an explosion hazard, possibly causing severe personal injury or death.



Do not insert objects or fingers in inspection cavity.
Can cause severe personal injury

BEARING REPLACEMENT

NOTICE:

When replacing the bearings, the entire bearing assembly, including the bearing cup and the bearing cone, must be replaced and the crankshaft endplay must be readjusted.

1. Follow the "Compressor Disassembly" section.
2. Remove the Oil Pump per the section "Oil Pump Replacement."
3. Remove the flywheel.
4. Remove the bearing carrier and gasket from the outboard end of the crankcase. The outboard bearing cup will come off with the bearing carrier and will need to be removed with a bearing removal tool.
5. Remove the key from the crankshaft and slide the crankshaft through the outboard end of the crankcase. The bearing cones can then be removed with a bearing puller.
6. Remove the bearing cover plate from the inboard end of the crankcase. The inboard bearing cup is pressed into the crankcase and can be removed with the use of a bearing removal tool.

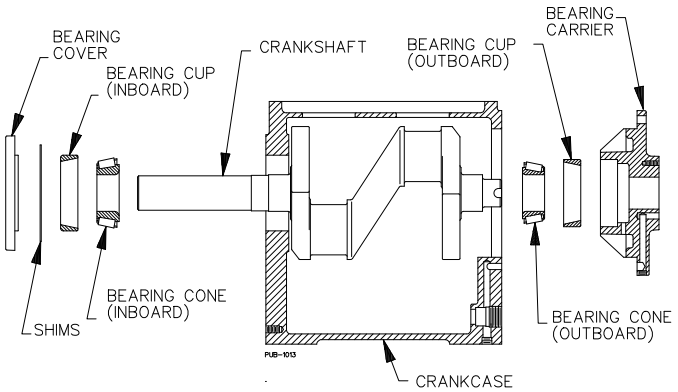


Figure 14 - Bearing Locations

7. To install the bearings:
   a. Grease the outer edges of the bearing cups.
   b. Referring to Figure 14 for the proper orientation, carefully press the inboard bearing cup into the crankcase until it is flush with the outer surface of the crankcase.
   c. Note the proper orientation and carefully press the outboard bearing cup into the bearing carrier assembly.
   d. Press a bearing cone onto each end of the crankshaft with the tapered end outward. The bearing race should rest against the shoulder on the crankshaft.
   e. Lubricate the bearings with grease.
8. Install the crankshaft through the outboard end of the crankcase.
9. With the oil pump assembly **removed**, install the bearing carrier and new gasket. The bolt hole positions ensure proper orientation. Tighten the bolts evenly per Table 8 - Bolt Torque."
10. If the bearings have not been replaced, reinstall the inboard bearing cover plate using the existing shim set. If the bearings have been replaced, use a **thicker** set of shims.
11. Rotate the crankshaft by hand to verify free movement of the shaft.
    a. If the crankshaft has an excessive amount of end play, too many shims have been used. Lateral crankshaft movement (end play) between the bearings should be:

End Play at Room Temperature
0.0015 to 0.0030" (0.038 to 0.076 mm)

    If necessary, remove shims until the end play is within tolerance.
    b. If the crankshaft binds, or will not turn, not enough shims have been used pushing the bearing cup too tight against the bearing cone. Remove the crankshaft from the crankcase and drive the inboard bearing cup out toward the inboard side of the crankcase. Reinstall the crankshaft and the bearing cover plate using additional shims as required.
12. Install the oil pump per the "Oil Pump Replacement" section of this manual.
13. Reassemble the compressor according to the "Compressor Assembly" section.

OIL PUMP REPLACEMENT

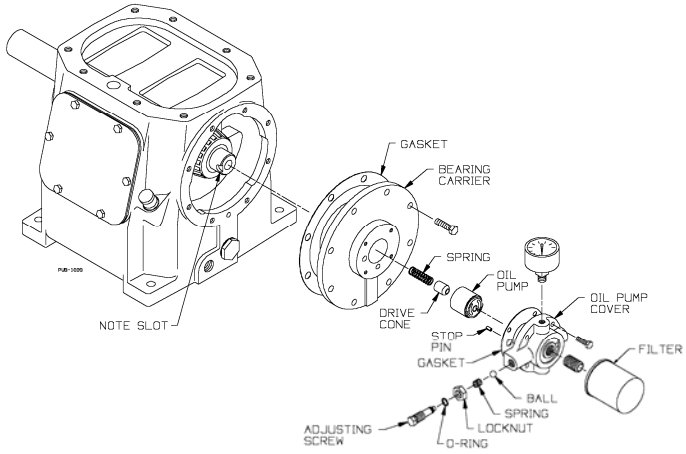


Figure 15 – Oil Pump

1. Remove the oil pump cover bolts and oil pump cover.
2. Remove the oil pump assembly, drive cone and spring.
3. Clean and inspect parts for wear or damage, replace as necessary.
4. Place the spring and the drive cone in the end of the crankshaft.
5. Note the slot in the end of the crankshaft and the drive tab on the back of the oil pump assembly. Install the oil pump assembly into the bearing carrier with the tab and slot aligned.
6. Note the groove around outer edge of the oil pump assembly and the stop pin in the oil pump cover. Position the oil pump cover and new gasket with the pin in the oil pump groove, rotating the oil pump as needed. The bolt hole positions ensure proper orientation of the oil pump cover.
7. BY HAND, tighten the oil pump cover bolts while the pump cover is held flush with the bearing carrier.

   NOTICE: If by hand tightening, the oil pump cover cannot be drawn flush with the bearing carrier, the drive tab or the stop pin are improperly aligned. DO NOT WRENCH TIGHTEN OR THE OIL PUMP WILL BE DAMAGED.
8. Once the oil pump cover is secured by hand, the bolts may be evenly tightened per Table 8 - "Bolt Torque."

EXTENDED STORAGE PROCEDURES

If a compressor is not to be put into service for some time, or if a compressor is to be taken out of service for an extended period, care must be taken to protect the compressor. The following steps must be taken for both bare compressors and those already piped into a system.

If proper storage procedures are not followed, damage to the compressor may occur. Complete compressor disassembly and replacement of rod packing, bearings and other parts may be required.

1. Keep a written record storage procedures performed – preferably on the unit itself.
2. Fill the crankcase with rust inhibiting oil. (New compressors leave the factory without oil.) Squirt oil on the piston rods and crossheads through the nameplate opening. Loosen the V-belts to relieve the load on the bearings. Rotate the compressor by hand a few times to distribute the oil.
3. Plug all openings and purge the compressor with an inert gas such as nitrogen or **dry** air at about 50 psig (3.5 bar-g). This may be done at the factory if requested. Leave the compressor pressurized to prevent air or moisture from entering the unit.

   Check the unit monthly and add additional purge gas as needed.

   NOTICE: Tag the unit with a warning that it is pressurized.
4. If a purge gas is not available, fog oil into the compressor suction while rotating the unit. Then plug all openings to keep out moisture, insects, etc.
5. **Turn the flywheel by hand a few revolutions once a month to distribute the oil.**
6. Store the unit under a plastic wrap on its wooden shipping base up off the ground. If the unit was boxed for export shipment, leave it in its box. An indoor or covered storage area is preferable.
7. **Placing the Compressor back in service.**
   When the compressor is to be put in service, vent the remaining purge gas and change the crankcase oil. Follow the "Pre-Startup Checklist" and "Startup Procedure" sections in this manual.

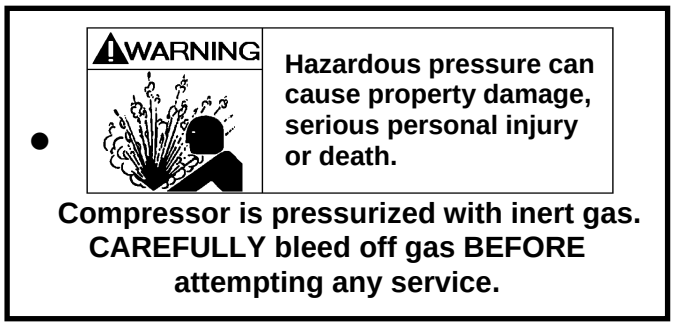


Figure 16 – Pressurized Compressor Tag

PROBLEM	STEP	PROBABLE CAUSE	WHAT TO CHECK	IF PROBLEM STILL EXISTS GO TO STEP ...
Low Transfer Rate	1	Worn or Broken Piston Rings	Check condition of rings by restricting discharge line. If pressure increases slowly, rings are probably faulty.	2
	2	Plugged Strainer	Clean screen as necessary.	3
	3	Compressor Valve Faulty	Remove and inspect for broken or worn springs, discs, or bodies.	4
	4	Compressor Drive Slipping	Tighten belts, check for sheared keys, loose keys or loose flywheel.	5
	5	Piping Improperly Designed or Installed	Use proper pipe sizes.	6
Knocks or Other Noises	6	Loose Valves	Tighten valve hold-down screws.	7
	7	Worn Internal Parts	Inspect through inspection plates and repair as necessary.	3
No Oil Pressure	8	Oil Pump Relief Valve Not Properly Set.	Set oil pump relief valve.	9
	9	Oil Pump Not Working	Check the Oil Pump drive tab or stop pin for damage.	10
	10	Low Oil Level	Check and fill as necessary	11
	11	Dirty Oil Inlet Strainer	Clean Oil Inlet Strainer	
Gas Leaking from Crankcase Breather	12	Faulty/Worn Packing	Replace Packing.	13
	13	Piston Rod Scored	Replace crosshead assemblies and packing.	14
	14	Improper Seal Arrangement	See "Seal Arrangements."	---
Relief Valve Actuates	15	Valve Closed Downstream of the Compressor	Open Valve	16
	16	Line Blockage Downstream of the Compressor	Locate Blockage and Correct	---
Shake or Vibration	17	Loose/Broken Mounting or Anchor Bolts	See “Mounting the Compressor Unit“	18
	18	Improper Mounting	Ensure base is supported full length. See "Mounting the Compressor."	19
	19	Improperly Aligned V-belt Sheaves	See "V-Belt Drives"	20
	20	Improperly Installed Flywheel	See "Compressor Flywheel"	21
	21	Nonfunctioning Valves	Replace or repair valves.	---

ADDITIONAL NOTES FOR INTERSTAGE PRESSURE (Two-Stage Compressors):

Interstage pressure is an important indicator of the proper operation or condition of a two-stage compressor.

* Low interstage pressure may indicate problems with the first stage valve or piston rings.
* High interstage pressure may indicate problems with the second stage valves or piston rings.

Low compression ratios can cause high interstage pressures. Two-stage compressors are not normally recommended for operation below 5 compression ratios.

Consult factory for further information.

ATEX Declarations
Compressors

Blackmer, A Dover Company,
1809 Century Avenue S.W., Grand Rapids, Michigan 49503-1530, United States of America

DECLARATION OF CONFORMITY

As defined by the ATEX directive 94/9/EC

Herewith we declare that all Blackmer LB and HD compressor product lines to which this declaration relates are in conformity with the provisions of the ATEX Directive 94/9/EC as of 01 July 2003. This equipment is a reciprocating compressor for liquefied gas transfer or gas compression applications. This device is not intended to act as a safety accessory.

Applied Harmonized Standards:
EN1127-1, EN13463-1

Date: 29 February 2012
Thomas Madden.
Vice President and General Manager

DECLARATION OF CONFORMITY

As defined by the Machinery Directive 2006/42/EC

Herewith we declare that all Blackmer LB and HD compressor product lines to which this declaration relates are in conformity with the provisions of the Machinery Directive, 2006/42/EC Annex IIA as of 17 May 2006. The above equipment is a reciprocating compressor designed for liquefied gas transfer or gas compression applications. This device is not intended to act as a safety accessory.

This component must not be operated until the machine into which it is incorporated has been declared in conformity with the provision of the directive.

Applied Harmonized Standards:
EN1012-1, EN292

Date: 29 February 2012
Thomas Madden.
Vice President and General Manager

ATEX/ Machinery Directive Notifications:

Maximum Surface Temperature: An ATEX compliant temperature switch **must** be installed if the compressor is used in an ATEX zone. It is the end users responsibility to ensure the compressor does not exceed the temperature limits for the relevant ATEX zone. Closed inlet or outlet valves can result in excess compressor surface temperature conditions.

Intended Use: Blackmer compressors are intended for use in liquefied gas transfer or gas compression applications. The compressor must be operated in systems, with gasses and at conditions for which it is specifically designed and sized.

Possible Misuse Warning: The compressor must only be installed in systems designed for its intended use.

Mechanical Ignition Sources: Guards, intended to protect from personal injury from rotating components, must be fabricated from ATEX compliant materials to prevent a potential ignition source. The compressor and its drive system must be properly grounded to prevent electrostatic discharge. The compressor has internal parts that rub together. These parts require proper viscosity lubricant to lubricate the rubbing surfaces. Compressor must be properly maintained and lubricated, see IOM (Installation, Operation, & Maintenance Instructions) for service information.

Sound Measurements: Sound Levels for gas compression equipment vary greatly, depending on operating conditions, piping system design, foundation design, etc. You can expect the following sound levels when operating a Blackmer compressor at its' maximum rated speed and discharge pressure. Sound levels are measured at 1 meter from the compressor and 1.6 meters from the foundation per European Machinery Directive 2006/42/EC. Maximum Noise Level: 85 dba

Equipment Marking: All compressor models are classified Group II category 2, Gas Group IIB and have a temperature limit of 176 C. Compressors are marked "Ex II 2 G IIB 176 C MAX "

Compressor Models Covered: LB, HD

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