



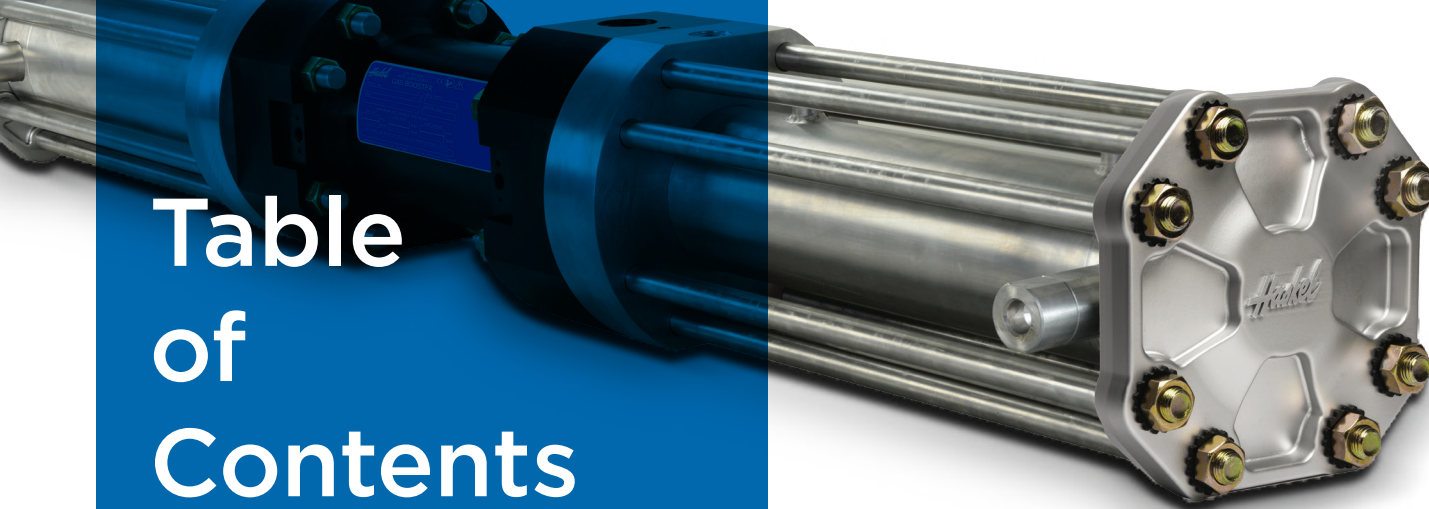
INSTALLATION | OPERATION | MAINTENANCE

# H-DRIVE<sup>®</sup> MANUAL



Proven.  
Reliable.  
Expert.  
Customer-focused.

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# 1.0 General

## 1.1 INFORMATION ABOUT THIS MANUAL

This manual is intended to enable the safe and proper handling of a Haskel H-Drive® gas booster from installation to operation and maintenance. The manual itself is considered a critical component of the H-Drive gas booster. It must be kept in the vicinity of the booster so that it is always readily available to personnel.

All personnel interacting with the booster must have read and understood the manual before performing any tasks. This manual comprises safety, handling, installation, technical data, system integration guidelines, operations, and maintenance instructions regarding the Haskel H-Drive gas booster. It provides all personnel with the essential prerequisites for safe work. Beyond the scope of the manual, all applicable local, state, and federal safety regulations and general health and safety protocols must be complied with in the gas booster's area of operation.

Additionally, the diagrams and illustrations presented in this manual represent components, systems, and functionality and are intended for general understanding.

## 1.2 ABOUT HASKEL

For 75 years and counting, Haskel has been recognized as the world's leading provider of high-pressure industrial gas and liquid handling equipment. We not only lead this industry—we pioneered it with our product innovations.

It's why the products and solutions we create perform successfully in various safety-critical environments. And it's why we are consistently selected for mission-critical applications that are fundamental to global sustainability, safety, national security, research, and exploration. Because no one handles high pressure like Haskel.

To provide our customers with the highest level of confidence in the safety of our products, we obtain international approvals such as ISO, ATEX, IECEX, ABS, API 6A and 17D, CE, NACE MR0175/ISO 15156-2003, and more.

OEMs and customers turn to us for our expertise in high-pressure applications and legendary product reliability, ensuring minimized product life-cycle costs with sector-leading run-lives and negligible routine maintenance requirements. A global sales and service network provides timely expert technical support. This is all backed by a no-hassle product warranty.

### Making life better together—We are an Ingersoll Rand Business

Our brands are evolving as our businesses continue to grow and thrive as part of Ingersoll Rand. The next step in this evolution, as of today, is to endorse our brands as Ingersoll Rand businesses. This endorsement highlights the collective strength in the Ingersoll Rand portfolio and the long legacy of these individual, gold-standard brands.

Benefiting from over 160 years of experience, which comes from serving 100,000 industrial customers across 50 countries, being 'an Ingersoll Rand business' brings unparalleled value to our customers and markets.

For more information on the Ingersoll Rand portfolio of brands, visit [irco.com/en-gb/brands](https://irco.com/en-gb/brands).

## 1.3 HASKEL'S SUSTAINABILITY COMMITMENT

Sustainability remains a growing focus worldwide, with many countries enacting green practices and net-zero emission goals. Haskel has been at the forefront of sustainability through technological innovations to help drive us toward a more sustainable future.

The **H-Drive® gas booster** is a prime example of Haskel's innovation in sustainable technology. The equipment is designed for various gas applications, many related to the clean energy market. These applications include charging large volume, high-pressure

hydrogen storage vessels needed for hydrogen vehicle refueling and constant energy supply systems.

The H-Drive design and technology take into account future developments in the hydrogen market and maintains a keen focus on user safety. The product reduces maintenance requirements with its unique self-lubricating seal design that delivers spring-loaded, non-contaminating compression. The product features help drive down the life cost of the product, an essential issue in the drive for a low-cost, sustainable energy future.

Advancements in new and clean energy have spurred rapid growth in the hydrogen market. Such growth has caused a need for **safe** and **efficient** equipment to serve this industry, two of Haskel's core strengths. Haskel's long proven track record in high-pressure hydrogen gas applications and the sealing and high-pressure containment for the H-Drive is based on this track record.

Additional technology innovations include the **Q-Drive**, an electric servo-driven gas compressor system, **hydrogen refueling stations**, and equipment for fuel cell EVs, further demonstrating that Haskel is a leader in supporting a greener global economy.

The team has also established its own sustainability goals and action points to contribute to a greener environment. Every step counts, even smaller steps like switching to biodegradable packing materials and water recycling to installing motion sensors that allow lighting in the unused areas of the facility to remain unlit when unoccupied—from the master copy room to the shop floor mezzanines.

## Haskel's Commitment to Going Green

Haskel works towards its commitment to a greener future by implementing yearly goals and environmental check-ins. Efforts are supported by the Ingersoll Rand's AHS Community, a collective group focusing on working together to implement and support sustainability measures, ecological health, and safety best practices across the globe. Ingersoll Rand's commitment to sustainability is an excellent push for Haskel facilities, with **2030 and 2050 environmental goals** focusing on improving water, air, and land quality.

In addition to their environmental goals, Haskel's USA facility has been officially certified as a Cal/VPP Star Site. This voluntary Cal/OSHA program evaluates participants every three to five years for "exemplary worksites with comprehensive, successful safety and health management systems." To participate in this program, employers must apply to OSHA and undergo a rigorous onsite evaluation by a team of safety and health professionals. Because of Haskel's efforts and constant move towards greener practices, Haskel's Burbank, California facility has been one of the few organizations to be awarded OSHA's Cal/VPP Star Certification for going above and beyond any California environmental regulations.

**Contact our team** today to learn more about Haskel's green initiatives and sustainable product offerings.

## 1.4 ABBREVIATIONS

### Units of measurement

ABBREVIATION	DESCRIPTION
ft	foot
in	inch
psi	unit of pressure, pound force per square inch
psig	PSI in relation to atmospheric pressure; gauge pressure
bar	metric unit of pressure
barg	pressure measured relative to atmospheric pressure
SCFM	standard cubic feet per minute
LPM	liters per minute
dB	decibels
BTU	British thermal unit; measure of heat
hr.	hour



ABBREVIATION	DESCRIPTION
ft-lbs	foot-pound; unit of torque
Nm	Newton-meters; unit of torque
MAWP	maximum allowable working pressure
CPM	cycles per minute
Nm <sup>3</sup> /h	normal cubic meters per hour; similar to SCFM
NI/m	normal LPM per minute
GPM	gallons per minute

## Other abbreviations

ABBREVIATION	DESCRIPTION
HPU	hydraulic power unit
OEM	original equipment manufacturer
HP	horsepower
PPE	personal protection equipment
P&ID	pipng and instrument diagram
LEL	lower explosive limit
YTS	yield tensile strength
UTS	ultimate tensile strength
ID	inside diameter
OD	outside diameter
PD	pressure drop
SF	safety factor
ATEX	Atmosphere Explosive (European Directive 2014/34/EU)
COSHH	Control of Substances Hazardous to Health
PT	pressure transducer
TT	temperature transducer
HE	heat exchanger
PRV	pressure regulating valve

## 1.5 STANDARD TERMINOLOGY

Throughout this manual, you will see the following references related to the H-Drive® gas booster. To make communications less confusing, below is a list of the standard parts and their descriptions.

- **Compression ratio:** the compression ratio is the ratio of the pressure between the inlet pressure feeding the booster and the outlet delivery pressure after compression.
- **Cycle:** a single cycle includes one forward stroke and one reverse stroke of the hydraulic rod.
- **Double-acting H-Drive models:** a double-acting H-Drive gas booster is designed to discharge gas on both strokes of the cycle. It consists of two gas inlets and two gas outlets with a single compression stage. Two-stage models will discharge pressurized gas at the end of each stroke. Double-acting models provide higher flow rates but lower compression ratios than single-acting models.
- **Two-stage H-Drive models:** a two-stage H-Drive gas booster consists of two compression stages. Gas will initially be compressed in the first gas cylinder (always the larger of the two cylinders) and then fed into the second gas cylinder through interstage pipework. After the interstage pipework, the gas will be compressed for a second time before being discharged. Two-stage models provide higher compression ratios but lower flow rates relative to a double-acting model.
- **Check valves:** each inlet and outlet of the booster is fitted with a check valve (also referred to as a 'non-return valve' to prevent the reverse flow of gas).

- **Stroke:** Stroke is the travel of the hydraulic piston in one direction.
- **Unswep volume:** The volume of gas left in the gas cylinder on completion of a stroke.

## 1.10 Contact Information

If, after reading this manual in its entirety, you have any questions or concerns that are not explicitly addressed in this manual, please reference the below for contact information.

### Haskel Americas - Technical Support

100 East Graham Place  
Burbank, CA, United States

**Tel.** 1.818.843.4000

**E-mail:** [supportam@haskel.com](mailto:supportam@haskel.com)

### Haskel Europe - Sales Inquiries

North Hylton Road  
Sunderland SR5 3JD, England, UK

**Tel:** 44-191-549-1212

**E-mail:** [saleseurope@haskel.com](mailto:saleseurope@haskel.com)

# 2.0 Warranty

Haskel manufactured products are warranted free of original defects in material and workmanship for one year from the date of invoice. This warranty does not include incorrect installation, improper maintenance, incompatible fluids, foreign materials in the driving media, pumped media, or application of pressures beyond the catalog ratings.

Products believed to be originally defective may be returned for repair and/or replacement to the authorized distributor. If upon inspection the problem is found to be originally defective material or workmanship, repair or replacement will be made at no charge for labor or materials, F.O.B. the point of repair or replacement. No consequential damages from the use of this equipment are covered under the terms of this warranty. **Permission to return under warranty should be requested before shipment and include the following:**

- The original purchase date.
- Purchase order number.
- Serial number.
- Model number.
- Other pertinent data to establish warranty claim and expedite the return or replacement to the owner.

If the Booster has been disassembled and reassembled in a facility other than the authorized Haskel repair station, the warranty is void if it has been improperly reassembled or substitute parts have been used in place of factory-manufactured parts. Any modification to any Haskel product, which has been made or may be made in the future, has been and will be made at the owner's sole risk and responsibility and without Haskel's approval or consent. Haskel disclaims any and all liability, obligation, or responsibility for the modified product and for any claims, demands, or causes of action for damage or personal injuries resulting from the modification and/or use of such a modified Haskel product. Haskel's obligation concerning its products shall be limited to replacement, and in no event shall Haskel be liable for any loss or damage, consequential or special, of whatever kind of nature, or any other expense which may arise in connection with or as a result of such products or the use or incorporation thereof in a job. This warranty is expressly made instead of all other warranties of merchantability and fitness for a particular purpose.

No express warranties and implied warranties, whether of merchantability or fitness for a particular purpose or otherwise, other than those expressly set forth above shall apply to Haskel products.

# 3.0 Safety Instructions

This section provides an overview of general aspects of safety that are critical to ensuring optimal protection of personnel and proper operation of the H-Drive® gas booster. This manual provides additional safety guidelines and instructions for specific work tasks during individual phases of the machine's installation, operation, integration, and maintenance.

The Haskel H-Drive gas boosters have been designed to minimize health and safety hazards under the Machinery Directive 2006/42/EC. However, as with all systems, precaution should always be observed regardless of the safeguards in place.

## **WARNING!**

**The H-Drive gas booster MUST be installed, operated, and maintained by suitably trained and competent personnel.** The entirety of this manual must be read and understood by the end user(s) before the installation and operation of the product.

## 3.1 EXPLANATION OF SIGNS AND SYMBOLS

Color-coded signs are used throughout this manual to highlight safety hazards and essential information. The safety instructions are always introduced by signal words that express the extent of the danger. These signs, and their unique meanings, are detailed below:

### **WARNING!**

Indicates an immediate hazard that **WILL** or **COULD** result in **SEVERE** injury, death, or significant damage to equipment if not avoided.

### **CAUTION!**

Indicates an immediate hazard that **WILL** or **COULD** result in **MINOR** injury or damage to equipment if not avoided.

### **NOTICE**

Indicates essential information that is **NOT** hazard-related.

## 3.2 INTENDED USE

Haskel gas boosters are used exclusively for the oil-free compression of processed gases. The design and specification of the comprehensive gas compression system in which the H-Drive is to be installed is the end user's responsibility. Guidelines and recommended parameters are provided in this manual.

Haskel H-Drive gas boosters may be installed in a potentially explosive environment. Further details can be found in the **Operating with Hazardous Gases** section of this manual. Safety protocols can be found in the **Operating with Hazardous Gases** section.

Adherence to the instructions and requirements within this manual also constitutes intended use. Using the gas booster for anything outside of its intended use is considered a misuse of the product, and doing so invalidates the product's warranty.

### **NOTICE!**

**Haskel cannot be held responsible for any misuse of the gas booster.**

Improper installation, operation, or maintenance of any aspect of the gas booster will invalidate the machine's warranty.

### **WARNING!**

**Using the gas booster beyond its intended use could result in serious equipment damage and severe injury or death.**

- Never exceed the limits or pressures that are indicated in this manual.
- Do not operate the booster if the system's integrity is in question.
- Always comply with this manual's installation, operation, and maintenance instructions.

## 3.3 SAFETY PRECAUTIONS

Most accidents that occur during the installation, operation, or maintenance of a machine are often the result of ignoring basic safety rules. Disregarding safety precautions is considered unsafe use or misuse of the gas booster and system.

This section lists residual risks from gas boosters even if installed correctly and operated as intended. Observe the safety instructions provided here and throughout the manual to minimize personnel and property damage risk and mitigate dangerous situations.

### 3.3.1 FIRE PREVENTION

Preventing fires in the workspace must be a continual practice for all personnel. This becomes increasingly more important when working with machines that use extreme pressures. Highly pressurized systems can cause cracks, breaches, and ruptures throughout the system, leading to highly flammable and potentially explosive situations. Fire mitigation through routine maintenance is key to preventing many issues, including fires.

 **WARNING!**

**Do not smoke near the gas booster system or around compressed gas. Also, because it's bad for health.**

 **WARNING!**

**Danger of injury due to improper fire prevention and protection.**

Fire mitigation and fire response systems must be observed regularly. In the event of a fire, serious injuries or death may occur if the fire extinguisher is not functioning correctly or is unsuited to the specific fire class.

- Check the integrity of the system before any operations.
- Routinely maintain the system to ensure all components are functioning correctly.
- Ensure fire extinguishers are readily available and suited for the potential fire class.
- Check the functionality of fire extinguishers every two years.
- In the event of use, follow the safety and operational instructions on the extinguisher.

## 3.3.2 IGNITION HAZARDS

Pressurized oil in hydraulic systems presents a considerable fire hazard, particularly in processes where ignition sources are constantly present. Atomization of the fluid dramatically increases the ease of ignition.

### **WARNING!**

**Removing all sources or potential ignition sources from the system area is required before any system operation.**

Hydraulic fluid can travel significantly because it's under pressure when a system fails. The owner/operator must remove not only apparent sources of ignition but also potential sources in the larger vicinity of the workspace.

### **EX WARNING! [EX]**

**Dangers and risks due to explosion.**

Any ignition sources, such as sparks, open flames, and hot surfaces in the workspace, can cause an explosion. Properly ground the HPU to prevent sparks from static electricity. A ground continuity test is strongly recommended before starting.

- Never open a system with flammable gas.
- Ensure the atmosphere is not potentially explosive.

### **EX WARNING! [EX]**

**Hazardous gases are highly flammable.**

Before performing maintenance, ensure the system has been purged with an inert gas according to proper procedures, found in [Purging the System](#).

- Before fault elimination procedures, flush the booster with an inert gas.
- Verify gas and hydraulic systems are depressurized after purge, prior to any maintenance.

An ignition hazard assessment has been carried out to identify potential ignition sources. The ignition sources identified have been assessed with compliance to EN 80079-36 & EN 80079-37 for construction safety applicable to non-electrical equipment for explosive atmospheres.

**Mechanical components without existing certification have been reviewed in the following areas:**

- Electrostatic discharge
- Hot surfaces
- Mechanically generated sparks
- Release of high-pressure gas or parts
- Consists of coating thickness for electrostatic discharge
- The temperature of fluid and seals for hot surfaces.
- Use of light materials for mechanically generated sparks.
- Joint separation factor of safety applied to tie rod sizing to avoid release of gas or parts during the compression process.

### **NOTICE!**

**The end user is responsible for any other hazards or forms of potential ignition during the operation.**

### 3.3.3 TUBING AND FITTINGS

From the system's design to installation and maintenance, adequately sized and rated tubing and fittings are critical for safety and ensuring the system operates properly. Each system's requirements vary, and the potential to use an incorrect tube and fitting is high. It's highly recommended to consult with a systems engineer in the design phase of your system to ensure you've selected an appropriate tube and fitting configuration for your system from the start. See the [Connections—Tubing, Pipe, and Hoses](#) section of this manual for further information.

#### **WARNING!**

**Incorrectly sized or incorrectly rated tubing and fittings used in a system could lead to severe injury and significant system damage.**

Only use tubing and fittings with appropriate pressure ratings.

- Always adhere to the installation instructions, including proper torque values.
- Always use appropriate fittings, brackets, supports, or otherwise.
- Always follow the instructions provided in this manual regarding the correct size, rating, and installation of all fittings.

### 3.3.4 HAZARDOUS GAS

Additional safety precautions must be observed when using hazardous gases in the system. Always follow all procedures correctly when handling hazardous media. Ensure that whoever designs, installs, maintains, and tests your control measures is competent and has the necessary skills, knowledge, and experience. Observe applicable hazardous media data sheets and refer to the system's warning labels to identify the risks associated with the machine. If in doubt, contact a specialist.

#### **EX WARNING! [EX]**

**Working hazardous media require additional safety precautions and procedures.**

- ATEX parameters outlined on the product identification plate must be entirely adhered to. See [Operating with Hazardous Gases](#) for additional information. Comply with all local regulations.

#### **WARNING!**

**Ensure workers are trained on any gas media in use on the worksite, the hazards associated with them, and the emergency response measures to be taken in the event of an incident.**

Refer to COSHH data sheets for handling, storage, and emergency measure instruction of hazardous gas. Ensure all hazardous gas containers are labeled correctly and clearly identifiable. Failure to do so could result in severe injury or death.

- Refer to individual safety protocols for specific eye protection and respiratory protection measures.
- Wear safety glasses, a face shield, and working gloves when handling gas containers.
- Ensure proper first aid is on-site in the case of an injury resulting from working with hazardous gases.

#### **EX WARNING! [EX]**

**If working with hazardous gas, purge the system with an inert gas before performing any maintenance or repairs on the system.**

- Failure to do so will release flammable gas into the atmosphere when the gas lines are opened. This could create an explosive atmosphere and put personnel in significant danger. Refer to [Purging the System](#) for further information.

#### **WARNING!**

**Ensure appropriate booster is selected for hazardous gas service and a preventative maintenance schedule is followed.**

Preventative maintenance is increasingly more important for safe operation in hazardous gas applications. Refer to the Service Schedule for recommended preventive maintenance guidelines. Consult the factory for applications other than those listed in the permitted media table found in the Permitted Gases section of this manual.

### 3.3.5 INERT GASES

Working with inert gases as a dispersion media comes with risks. Inert gases are odorless and colorless gases that do not burn or explode and contain very low chemical reactivity under normal conditions. However, some inert, naturally occurring gases such as helium and argon can displace enough air to reduce oxygen levels and cause injury or death if present in sufficiently high concentrations. Low oxygen levels are particularly problematic in poorly ventilated, confined spaces. Oxygen levels that are low enough can also cause a loss of consciousness and death due to asphyxiation. Thus, all personnel must be aware of potential hazards that may arise due to leakage of inert gas and take precautions. For a list of acceptable inert gases, see the [Permitted Gases](#) section of this manual.

#### **WARNING!**

**Ensure workers are trained on any gas media in use on the worksite, the hazards associated with them, and the emergency response measures to be taken in the event of an incident.**

Make sure that all gas containers are labeled correctly and clearly identifiable. Failure to do so could result in severe injury or death.

- Refer to individual safety protocols by gas media for specific eye protection and respiratory protection measures.
- Wear safety glasses, a face shield, and working gloves when handling gas containers.
- Ensure proper first aid is on-site in the case of an injury resulting from working with inert gases.

#### **EX WARNING! [EX]**

**Compressed gas may displace oxygen and cause rapid suffocation if leaked.**

Any gas in high concentrations may be considered an asphyxiant. An oxygen level detector is recommended.

### 3.3.6 MAINTENANCE

A properly maintained system is a safe system. Numerous potential dangers can be mitigated with diligent, regular system maintenance. Safety precautions are just as necessary when performing maintenance on the machine as when the machine is in operation. Specific maintenance-related precautions are indicated in the [Maintenance and Services](#) section of the manual.

#### **WARNING!**

**Regular testing is required to keep a well-maintained system. Failure to do so could result in equipment damage and severe injury to personnel.**

Failure to keep a well-maintained system could result in warranty claims being rejected or a faulty system that could cause damage, injury, or death.

- The equipment must be tested and signed off as ready for use before any operations.
- Diligent record-keeping on all testing and maintenance of the system is highly recommended.

#### **WARNING!**

**Observe all applicable instructions during the maintenance of the system or any component of the system.**

Many components have specific safety considerations that could significantly impact the safety of personnel and the integrity of the equipment.



### 3.3.7 NOISE

Working with and around any hydraulic power unit and the drive, its powering will undoubtedly be loud. Although a certain amount of noise control is required to conform to government regulations, a conscientious noise control program may also be integrated into the system's design.

#### **WARNING!**

##### **Risk of injury caused by noise.**

Noise levels generated during operation can cause severe hearing loss. Unusual noise levels may indicate a problem with the system or machine.

- Always wear PPE when working near running machines.
- Local noise regulation must be observed.
- Ear defenders must be used if the noise level exceeds 85 dB.

### 3.3.8 PRESSURIZED COMPONENTS

The stored energy associated with pressurized systems can potentially cause minor injuries to fatalities. It is critical to adhere to proper safety precautions and sound working practices to mitigate the dangers of working with pressurized components.

#### **WARNING!**

##### **There is a danger of injury due to pressurized components.**

- Ensure the pressure limits of the product are not exceeded under any circumstance.
- Ensure damaged pressurized components are replaced immediately.
- Ensure all ancillary pressurized equipment (pipework, hoses, etc.) to the H-Drive gas booster is suitably secured and supported.
- Levels of protection from over pressurization should be applied; refer to the System Integration section of this manual.

#### **WARNING!**

##### **High-pressure media can be dangerous if improperly handled.**

Always remove all gas from the system before conducting any maintenance.

- Always establish a depressurized state before carrying out any maintenance to the product.
- Never tighten connections under pressure and never slacken them as a means of letting off pressure.
- Always unscrew fittings with the vent orifice pointed away from the user in case residual pressure remains.
- Never pressurize rapidly, as gases are hazardous when pressurized in a small cavity.
- Never feel for leaks with a bare hand. Always think and look before touching pipework.
- Equipment's weight.

### 3.3.9 TEMPERATURES

Extreme low and high temperatures can affect the performance and efficiency of the H-Drive. It's essential to ensure that ambient and system surface temperatures are monitored and that the fluids used in the system are appropriate for the expected temperatures.

#### **WARNING!**

##### **Operating the system outside the temperatures specified by the system design parameters is strictly prohibited and could cause injury to the user.**

- For ambient, gas, surface, and hydraulic oil temperature ranges: see the [Temperature](#) section of this manual.

### 3.4 SAFETY SYMBOLS

It is advised to display the necessary safety signs to mitigate risks where required.



**Proper Ear Protection  
Must be Worn**



**Proper Eye Protection  
Must be Worn**



**Protective Footwear  
Must be Worn**



**High-Visibility Jackets  
Must be Worn**



**Safety Helmets Must  
be Worn**



**Appropriate Clothing  
Must be Worn**



**Antistatic Clothing  
Must be Worn**



**Antistatic Footwear  
Must be Worn**

#### 3.4.1 WARNING AND CAUTION SIGNS

The following signs are signs that all personnel should recognize. Owners are responsible for providing all applicable warning and caution signs in the workspace and areas where appropriate.



**General Warning of  
Danger**



**Warning: Flammable  
Gas**



**Warning: ATEX Area**



**Warning: Hot Surfaces**



**Warning: Loud Noises**



**Warning: Read  
Installation &  
Operations Manual**

## 3.5 SPECIAL SAFETY INSTRUCTIONS

The following symbols are used in the manual to draw attention to specific dangers:



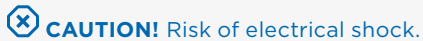
In this instance, the “EX” next to the symbol indicates instructions for the intended use of the gas booster in potentially explosive areas. If an instruction called out this way is disregarded, there is an increased danger of explosion and potentially fatal injuries.

### Safety instructions in the installation, operation, and maintenance instructions.

This manual also incorporates safety instructions into specific, individual instructional tasks. Do not disregard these safety instructions. They are pertinent to the particular action in a task.

#### Example:

1. Plug the machine in.



2. Proceed to switch the machine on.

## 3.6 RECOMMENDATIONS AND TIPS

- This symbol indicates helpful tips, recommendations, and additional information intended to aid personnel in efficiently installing, operating, and maintaining the machine. It may also provide information to inform personnel or convey general guidelines for clarity and understanding.

## 3.7 ADDITIONAL INDICATORS

Additional symbols are used in this manual to indicate instructions, references, and listings to aid in the machine’s installation, operation, and maintenance.

- References to sections of this manual or any other applicable documents.
- Listings without a specified sequence.
- Specific guidelines and recommendations.

## 3.8 RESPONSIBILITY OF THE OWNER

The owner is the person(s) that has the legal product responsibility during the installation, operation, and maintenance of the gas booster and its integrated system. The owner is the person(s) operating the gas booster or who entrusts operational usage to a third party that is ultimately responsible for the user's protection during operation.

In addition to the safety guidelines in this installation and operations manual, the owner must comply with applicable accident prevention, health and safety standards, and environmental protection regulations in all applications utilizing a Haskel H-Drive® gas booster.

- ☒ The owner must ensure that all personnel interacting with or handling the gas boosters have read and understood this manual. It's the owner's responsibility to inform personnel of the potential hazards of operating a gas booster.
- ☒ The owner must provide all personnel with the required PPE and instruct them that they are required to wear applicable PPE when working with the gas booster.
- ☒ The owner is responsible for any misuse or abuse of the gas booster.
- ☒ The owner is responsible for the proper installation, operation, maintenance, and cleaning of the gas booster.
- ☒ The owner is responsible for ensuring that the operations of the gas booster comply with all current local, state, and federal regulations in the context of health and safety as well as environmental protection.
- ☒ The owner must ensure that safety devices are integrated and that all devices function correctly.
- ☒ The owner must ensure that all connections are appropriately rated for the applicable pressure range and are correctly installed before operation.
- ☒ The owner is responsible for all additional safety considerations and applicable operational measures when employing hazardous gases in the system.
- ☒ The owner is responsible for ensuring that a qualified technician executes all repair tasks according to the maintenance section of this manual.
- ☒ The owner is responsible for the parameters set on the control system, including ensuring the correct course of action is applied when operating limits are reached.
- ☒ The owner must ensure that all warnings, instructions, and safety signs on the booster and in the workspace are always maintained and legible for all personnel.
- ☒ The owner must ensure that the gas boosters are checked for damage and are in proper operational condition before each start-up.
- ☒ The owner is responsible for the provision and operation of the hydraulic power/drive unit.
- ☒ The owner is responsible for the overall system design and componentry selection.
- ☒ The owner must ensure the system operates within specified temperature limits, including ambient and system temperature acceptable ranges.
- ☒ The owner is responsible for any hazards or forms of potential ignition introduced during the operation of the product.
- ☒ The owner is responsible for potential system damages if any other hazards or forms of possible ignition are introduced during the operation of the product that is beyond the scope of the ignition assessment parameters.

# 4.0 H-Drive Overview

The H-Drive is a technological evolution in gas compression from the experts who developed the first hydraulic-driven gas booster over 75 years ago. Engineered to safely and reliably handle the higher capacity flow and pressure needed for specific applications and extend the product scope of the Haskel air-driven gas booster product line.

## 4.1 DESCRIPTION

The Haskel H-Drive gas booster is designed to compress a wide range of gases safely, reliably, and economically. The H-Drive meets the demands of an ever-growing marketplace where higher flow applications are required.

The H-Drive dramatically improves important aspects of handling gas at high pressures or flow capacities. They are constructed of materials recognized by leading regulatory agencies as the best for the safe lifetime of continuous operation. They provide the best efficiency at the lowest maintenance cost for the pressure and flow levels versus other compressor designs. The standard hydraulic drive cylinder provides interchangeability of the three modular gas sections.

Haskel has a proven record for high-pressure gas sealing and compression. The unique seal design within the H-Drive delivers low-friction sealing for the non-contaminating compression of gas. The specially designed seals are designed for a full range of gas sealing pressures and do not require lubrication. They ensure the best possible cleanliness of gas for this product category.

Whether working with hydrogen, helium, nitrogen, argon, CNG, or other gases from alternative vehicle fueling to tube trailer supply and helium blanketing, the H-Drive sets the standard in reliability for the industry.

**A typical gas booster system is comprised of many functional components, including:**

- ▶ Haskel Gas Booster (the H-Drive)
- ▶ Hydraulic Power Unit
- ▶ Electrical System / Control System
- ▶ Gas Sequence Valve System
- ▶ Gas Storage and Dispensing

## 4.2 H-DRIVE GAS BOOSTER MODELS

There are six H-Drive gas booster models, each utilizing a common linear actuating hydraulic cylinder which drives the gas pistons during compression activity. These models can be divided in to two categories, double acting and two stage models.

MODEL	CATEGORY
HGD-63	Double Acting
HGD-90	
HGD-150	
HGT-90/63	Two Stage
HGT-150/63	
HGT-150/90	

## 4.2.1 H-DRIVE GAS BOOSTER PART NUMBER NOMENCLATURE

The following figure depicts how the part number legend is structured for the H-Drive gas booster models.

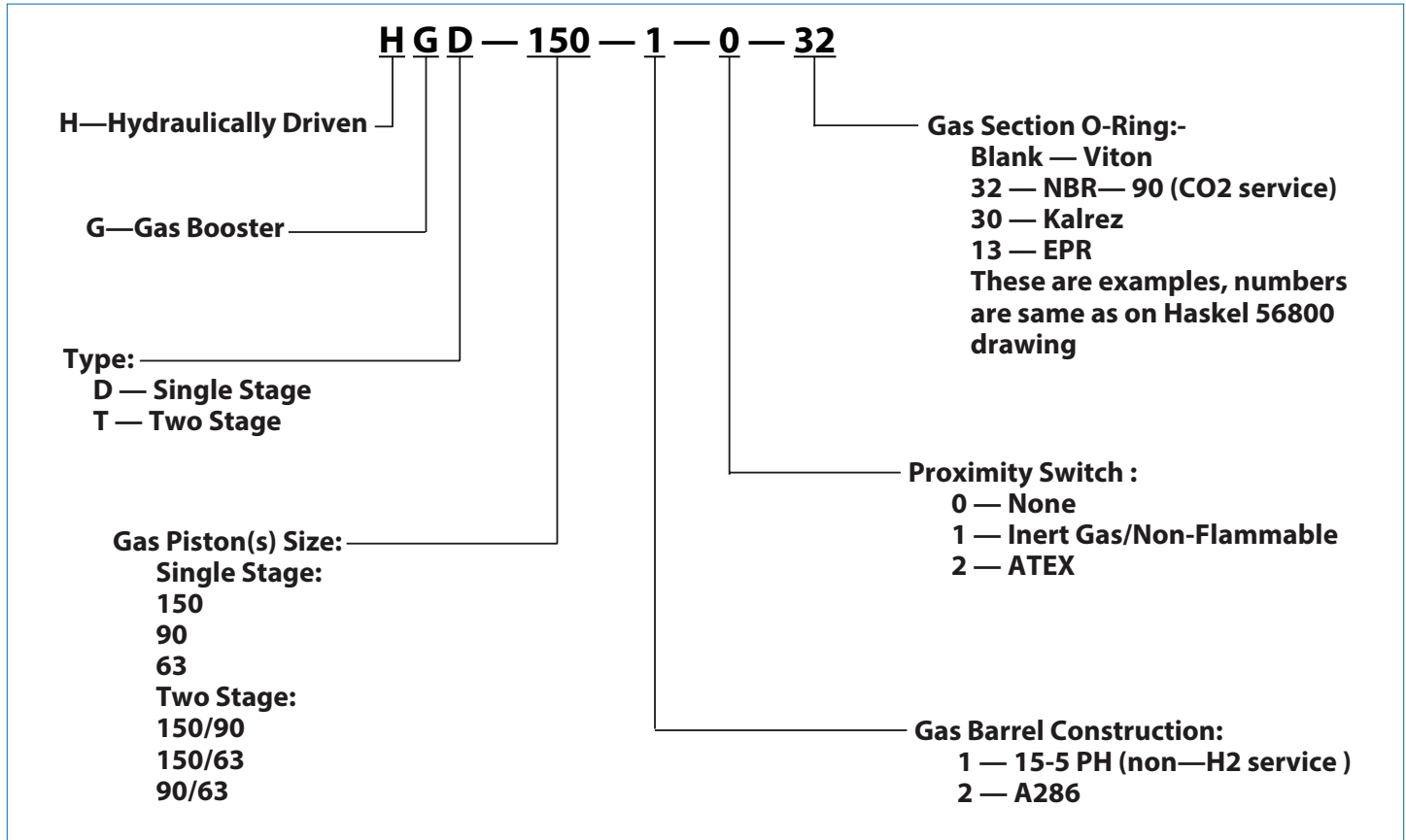


Figure 1: Part number legend for the H-Drive gas boosters.

## 4.2.2 DOUBLE-ACTING GAS BOOSTERS—HGD MODELS

A **double-acting** H-Drive consists of two gas inlets and two gas outlets with a single stage of compression. double-acting models will discharge pressurized gas at the end of each stroke. They provide higher flowrates but lower overall compression ratios relative to a two-stage model.

Haskel **HGD H-Drive models (HGD-150, HGD-90, HGD-63)**

## 4.2.3 TWO-STAGE GAS BOOSTERS—HGT MODELS

A **two-stage** H-Drive consists of two stages of compression. First, gas will be compressed in the first gas cylinder (always the larger of the two cylinders), then it will be fed into the second gas cylinder via ‘interstage pipework’ that connects both gas cylinders. There, it will be compressed for a second time before being discharged. Two-stage models provide higher overall compression ratios but lower flowrates relative to a double-acting model.

Haskel **HGT H-Drive models: HGT-150/90, HGT-150/63, HGT-90/63.**

## 4.3 H-DRIVE GAS BOOSTER COMPONENTS

Each H-Drive gas booster can be identified into two different sections: the **hydraulic cylinder** and the **gas sections**. Each of these sections has its own subsections of components.

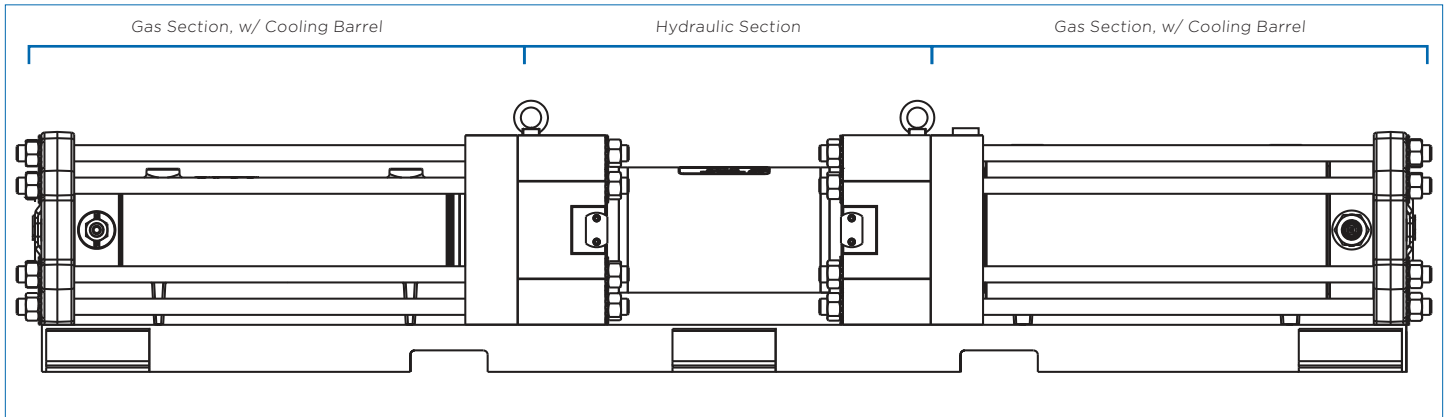


Figure 2: The sections of an H-Drive gas booster.

### 4.3.1 THE HYDRAULIC CYLINDER

The hydraulic cylinder is a double-acting, linear actuating cylinder used to apply bidirectional force in the cycling of the H-Drive gas booster through the hydraulic rod. The hydraulic rod drives the gas pistons and distributes that load to the gas section to provide a means of gas compression.

### 4.3.2 THE GAS SECTION

The gas section is key to the functioning of the H-Drive gas booster. It consists of a **gas barrel**, whereby the gas is drawn in and compressed, a **piston** to move the gas and create compression, and **check valves** to ensure gas only flows in one direction. The diameter of the gas cylinder will vary upon each model as it's size is determined by the required gas flows and pressures. The gas cylinder size is always indicated in the product part number.

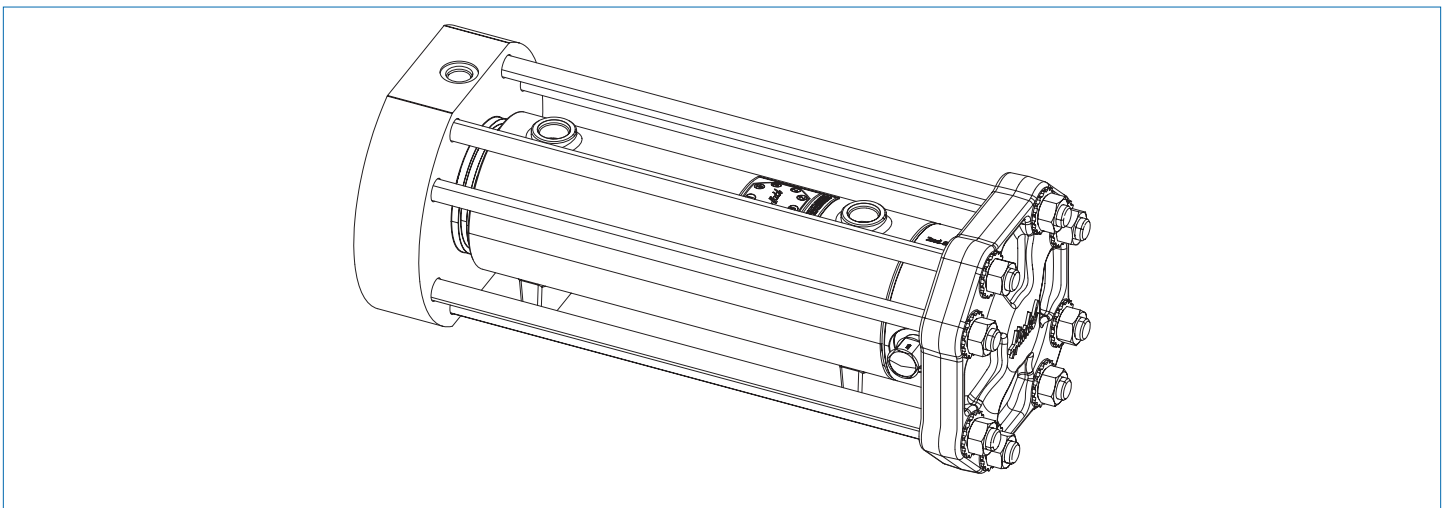


Figure 3: View of the gas section within the H-Drive gas booster. For reference only, actual model may vary. Refer to relevant model drawings.

### 4.3.2.1 GAS PISTON

The gas piston is a floating piston design. The piston stays seated against the hydraulic rod using the force of the gas pressure. The geometry and design of the piston will vary depending upon the size of the gas section. Refer to the **Drawings** section of the manual for model-specific details.

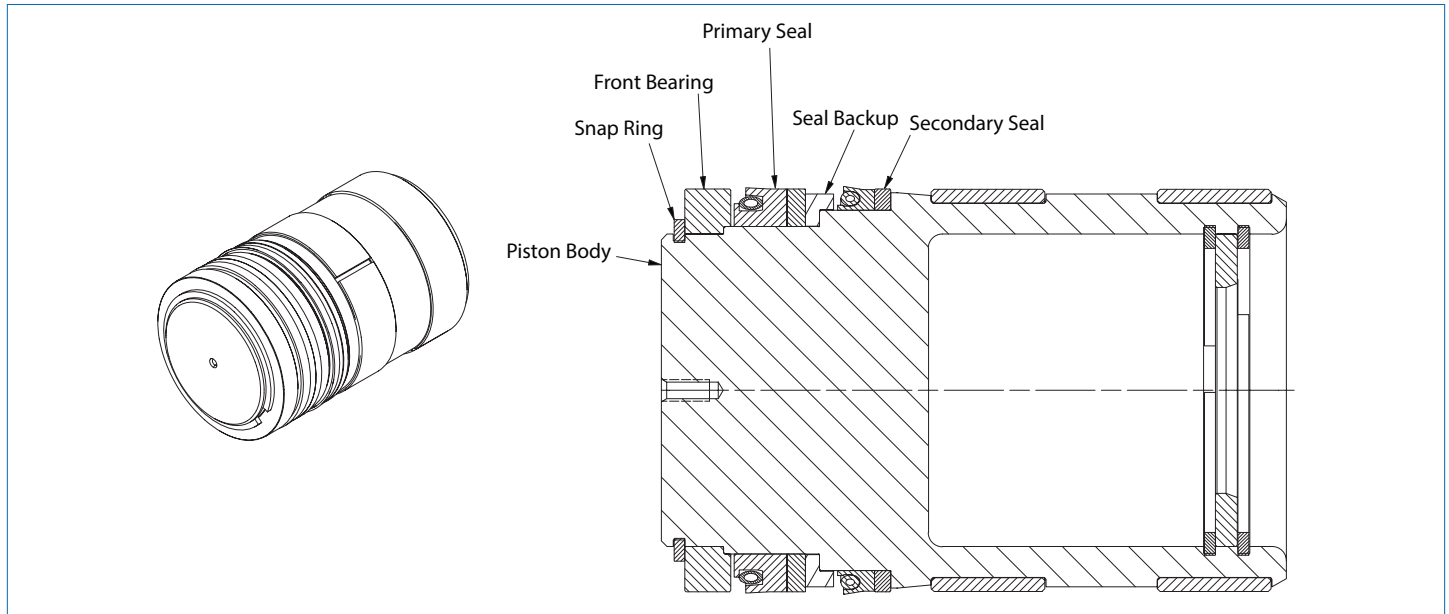


Figure 4: The piston seal package for the H-Drive gas piston.

### 4.3.2.2 CHECK VALVES

When the piston reverses direction, the inlet check valve closes, trapping the gas; the outlet check valve opens to direct the flow into the downstream system (compression stroke). The outlet check valve closes when the stroke is complete and another suction stroke begins. This prevents system gas from returning (back flowing) into the gas section.

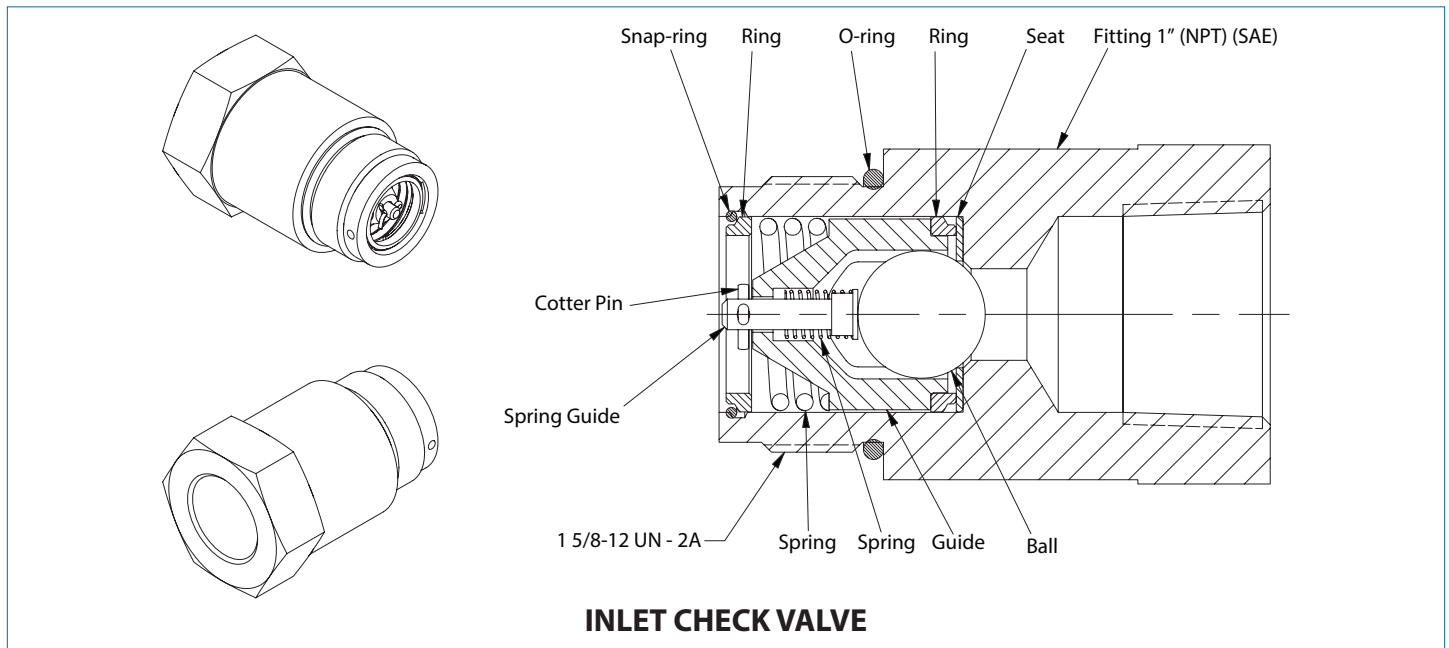
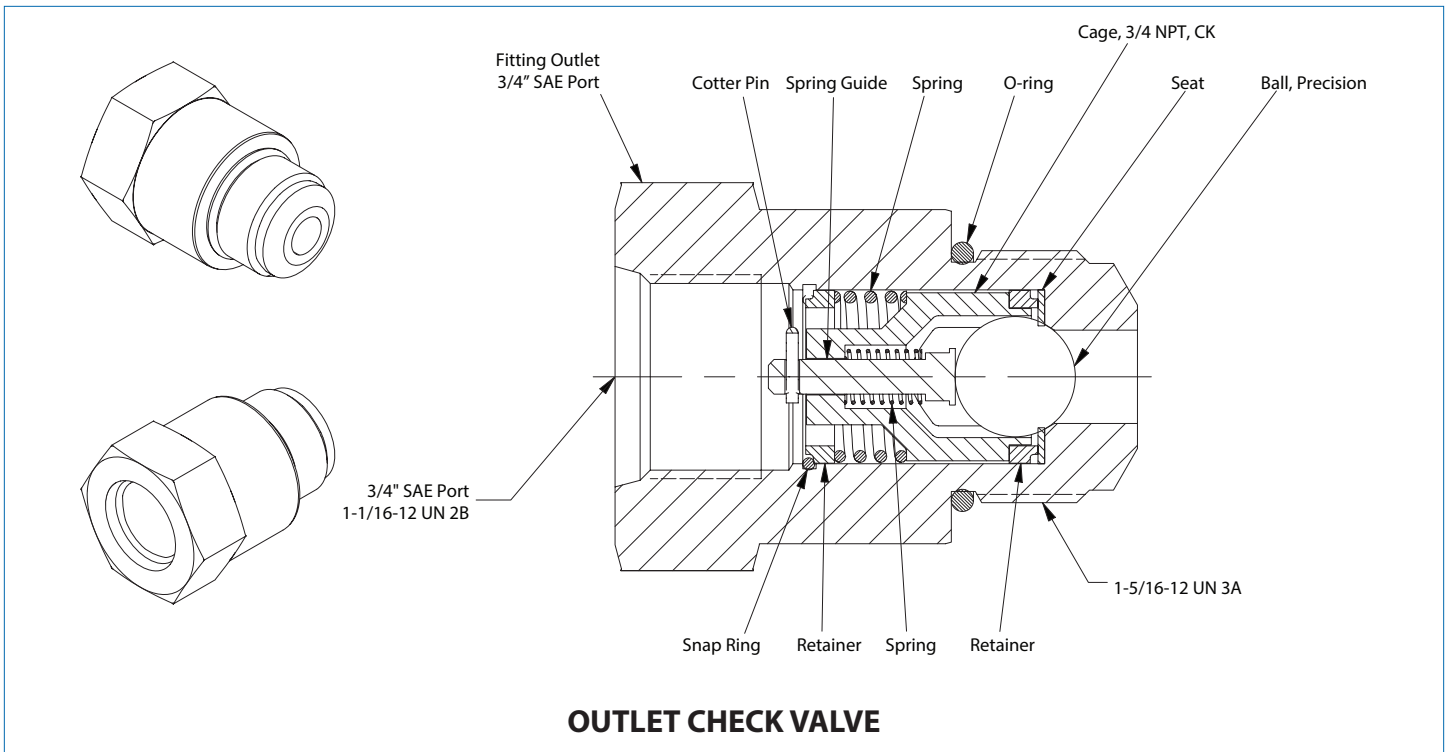


Figure 5: Inlet Check Valve.

**i** General information, please see section 7.5.3 for detailed check valve data. Connection port and design of the check valve will vary depending upon the H-drive model.



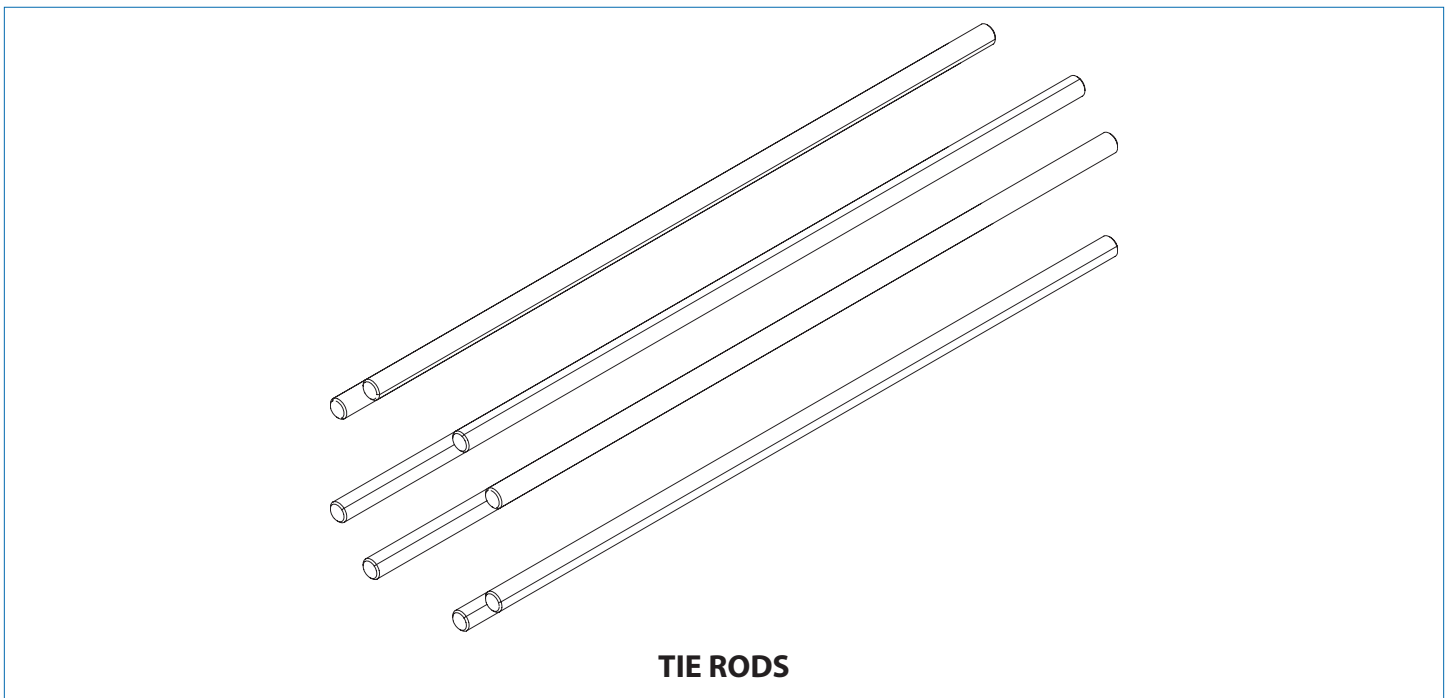


**Figure 6: Outlet Check Valve**

**i** General information, please see section 7.5.3 for detailed check valve data. Connection port and design of the check valve will vary depending upon the H-drive model.

### 4.3.2.3 TIE RODS

Tie rods are high-strength alloy steel with a zinc plate and carry tensile loads in the system. Tie rods are essential to the gas section design as they hold all subassembly and parts together.



**Figure 7: Tie Rods**

### 4.3.2.4 COOLING JACKET

Cooling jackets contain a low-pressure coolant that surrounds the gas barrels to provide a means of cooling/heat exchange. They will require an inlet supply line and return line to an external coolant circuit.

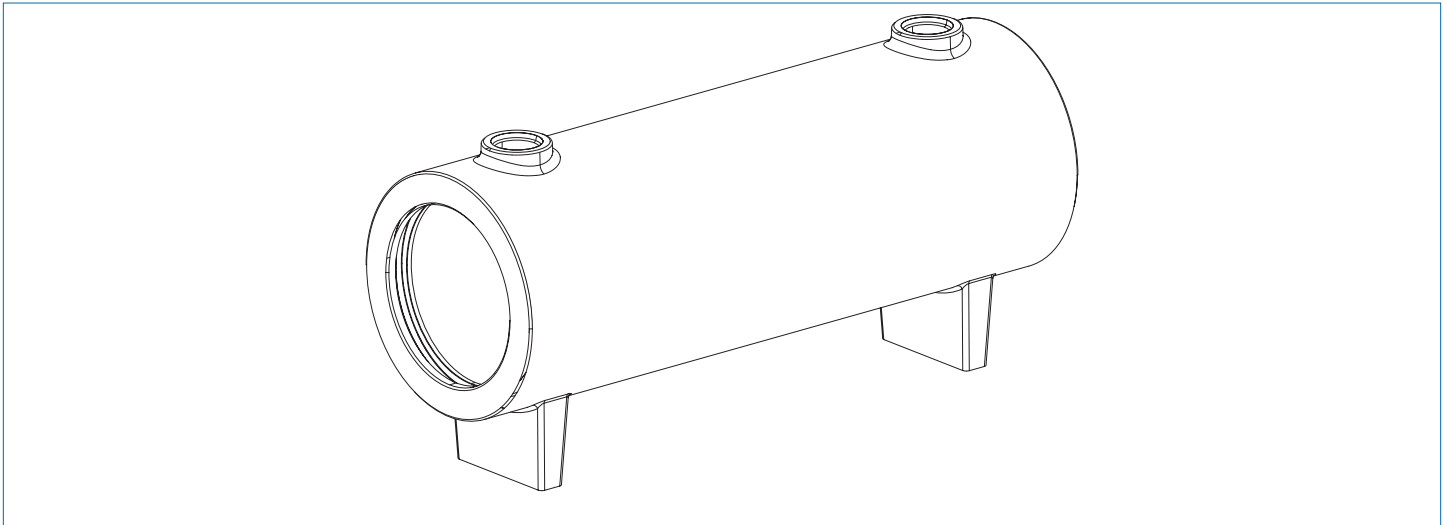


Figure 8: The cooling jacket of H-Drive gas booster.

## 4.4 H-DRIVE NAMEPLATE

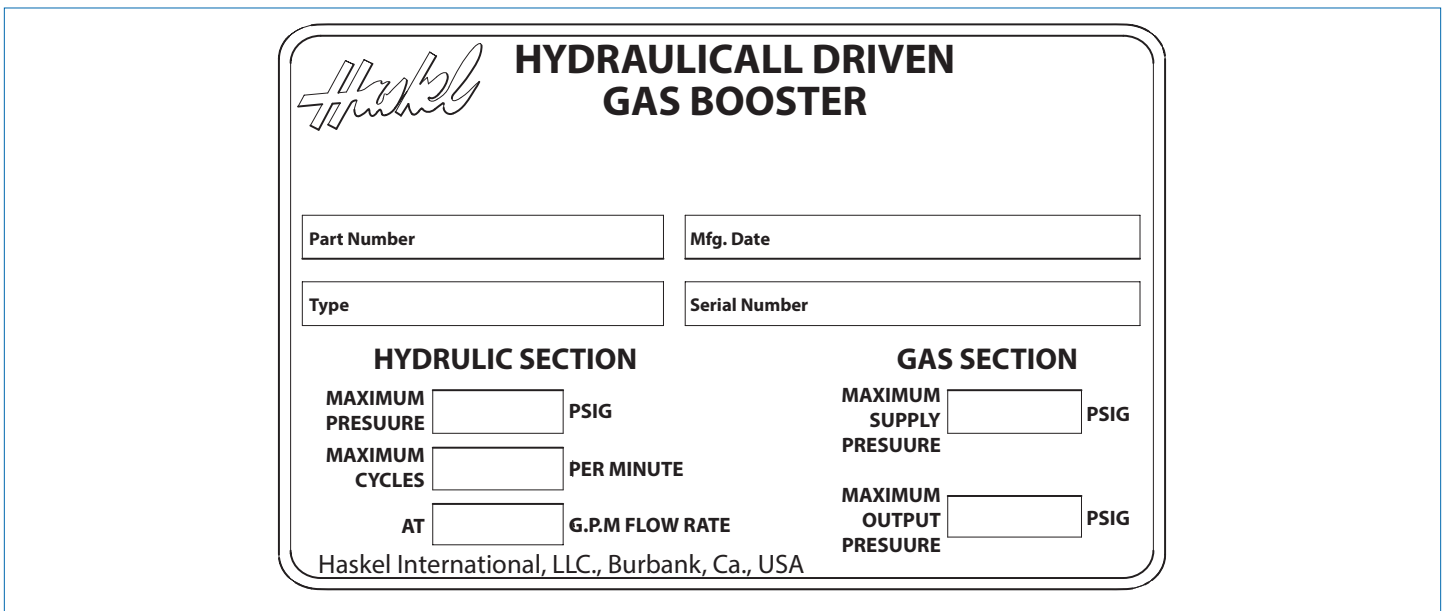


Figure 9: Example of an H-Drive gas booster nameplate.

The nameplate is centrally located on the hydraulic cylinder and provides the defined operating parameters for the specific model and the relevant information in adherence with legislative requirements.

# 5.0 Installation

The installation instructions of the H-Drive® gas booster into the integrated system should be followed step by step. This section details precautions, instructions, guidelines, and recommendations for installing the H-Drive gas booster. For any questions not addressed directly in the installation of the product, please see [Troubleshooting](#).






## **WARNING!**

**Ensure all equipment has been installed per the instructions provided in this manual.**

Failure to do so could result in severe injury.

## 5.1 SAFETY INSTRUCTIONS—BEFORE INSTALLATION

Please ensure the following safety precautions are completed before commencing installation.

-  For [System Integration](#), refer to Haskel H Drive integration design guide.
-  Review the maximum system pressure that inlet and outlet ports may encounter.
-  Ensure the system is accurately rated for the potential pressures at all connections.
-  Verify that all connected fittings, piping, tubing, gauges, and other ancillary components are properly rated at all ports.
-  Confirm the compatibility of the media with all components and piping.

## **WARNING!**

**Improper installation can cause severe injuries to personnel and significant damage to equipment.**




- Only allow the appropriate personnel to install the system and perform the initial commissioning.
- Ensure the installation area is clean and free of unnecessary items. Loose parts and tools lying around are accident hazards.
- Ensure all interface tubing/pipework are appropriately sized and torqued to the manufacturing specifications.

Follow detailed recommendations on bolt-tightening torque (see [Torque Specifications](#)).

## **WARNING!**

**The H-Drive gas boosters are designed to compress hazardous and combustible gases.**

Failure to adhere to the following installation instructions may result in the release of those gases. Ensure that the gas supply to the product can be shut off safely, at any time, if needed.

-  If the product is installed indoors, Haskel recommends that all relief valve vents or booster vents be routed to an outdoor location. This is the same recommendation for flammable and inert gases.
-  For flammable gases, Haskel recommends outdoor installations. Please consult your local regulations and route vented gases outside the predefined zones to stay within specified constraints.
-  Haskel recommends an E-stop circuit be used that can do the following actions:
  - Drop out the hydraulic HPU (stop pressure advancement)
  - Isolate the inlet and outlet gas interfaces
  - Vent pressure downstream of the isolation valves
  - Vent gas booster and interstage piping

## 5.2 PREREQUISITES FOR INSTALLATION

For proper installation, please ensure that the following criteria are met regarding the installation site and the booster itself:

- ☒ Ensure there is a suitable amount of space to install the H-Drive gas booster and maintain, including space to remove gas barrels.
- ☒ The gas booster must be installed in a clean environment free of dust.
- ☒ The installation site must be a level surface.
- ☒ The gas booster must be securely installed on an appropriate mounting plate or base.
- ☒ The gas booster must be easily accessible on all sides of the drive.
- ☒ The installation site should be well-ventilated.
- ☒ The installation must allow service access to all edges of the system skid.

## 5.3 MOUNTING PLATE REQUIREMENTS

The H-drive gas booster must be mounted on a stationary base or mounting plate. Haskel provides its standard, recommended mounting plate ([Figure 10](#)). If an equivalent base can be incorporated into a skid structure, Haskel suggests reviewing that mounting plate design before installing an H-Drive gas booster.

Refer to [Drawings and Schematics](#) for general arrangement drawings by the H-Drive model, including H-drive dimensions and locations of the hydraulic drive and gas section mounting holes.

**Critical mounting plate requirements:**

- 📢 Use [Figure 10](#) as a reference to the mounting holes.
- ☒ The mounting plate must support an **H-Drive gas booster weight of ~545 kg (~1,200 lbs)**.
- ☒ The mounting plate must support the **entire length of the H-Drive ~205 cm (80 in)**.
- ☒ The mounting plate must have a **flatness of 1 mm/meter** over the entire length of the plate.
- ☒ Hydraulic cylinder mounting holes must be straight drill holes with a **diameter of 22 mm (0.875 in)**.
- ☒ Cooling barrel mounting holes must be straight drill holes with a **diameter of 16 mm (5/8 in)**.
  - The hole size is large relative to the mounting bolt to avoid over-constraining the booster.
- ☒ Cooling barrel drain holes must be straight drill holes with a **diameter of 32 mm (1.25 in)**.
  - This is to access the drain plug through the mounting plate during maintenance.
- ☒ Allocate access to cooling barrels, drain ports, and mounting screws underneath the mounting plate mount.

### **WARNING!**

**If you elect to use your own mounting plate, the gas sections of the gas booster must be sufficiently supported.** The baseplate keeps the hydraulic and gas sections in concentricity with each other.

- Improper support of the gas sections will cause the gas sections to sag, which will initiate a cascade of system failures.

## 5.4 MOUNTING THE H-DRIVE GAS BOOSTER

### ⊗ CAUTION!

The gas booster must be installed horizontally on the mounting plate.

### ⊗ CAUTION!

The base plate must support the entire 205 cm (80 in) length of the H-Drive gas booster. Hanging gas sections without the proper support will invalidate the warranty.

### PPE required:

- Protective clothing
- Safety goggles
- Safety footwear

### Tools required:

- Power drill
- Heavy lifting strap
- Crane/forklift
- Ratchet
- Socket
- Adjustable wrench(s)
- Torque wrench

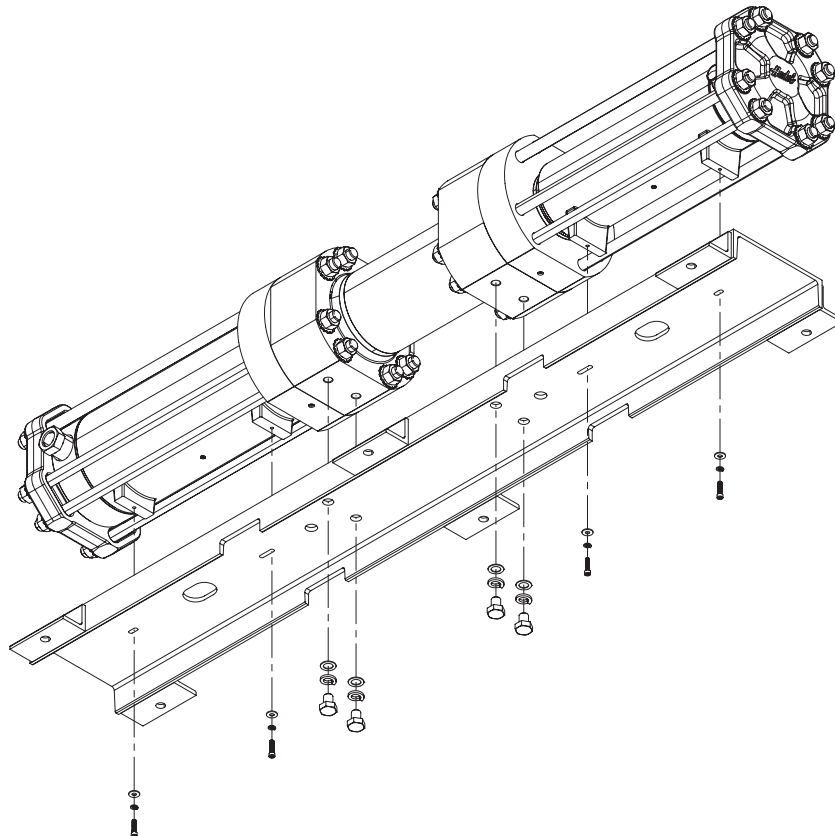



Figure 10: Mounting hole locations on the H-Drive for mounting it to the base plate.

## 5.4.1 INSTALLATION STEPS

 Place a catch tray under the mounting plate for maintenance.

1. Use grade 4 zinc plated 3/4"-16 UNF steel bolts for the hydraulic drive mounting holes with 1 flat and 1 lock washer.
2. Thread to a depth of 30 mm (1.18 in).
3. Torque to 33.83 Nm (25 ft-lbs).

 **Do not lubricate.**


4. Use 4 zinc-plated 5/16"-18 UNC soft steel or aluminum bolts for cooling barrel legs with 1 flat washer per bolt.
5. Hand tight through the baseplate holes on the mounting plate.
6. Thread to a depth of 19 mm (0.75 in) on each leg.

 **Do not torque these bolts. Full-thread engagement only (horizontal support) with minimal torque.**

### CAUTION!

The cooling barrel material is aluminum. Over-tightening the cooling barrel plug may cause damage to the threads and crack the barrel.

7. Verify all torques on the gas booster.

 Although Haskel verifies all torque values before shipping the product, mishandling the product during transportation or similar actions out of the manufacturer's control can occur. To avoid malfunction, verify the torque values before commissioning the unit for the first time.

 Refer to **Torque Specifications** for all recommended torque.

### CAUTION!

**Overtightening may cause damage to equipment.**

Cooling barrels are made of aluminum. Over-tightening the cooling barrel plug may cause damage to the threads and crack the barrel.

8. Verify that the booster is level after installation.

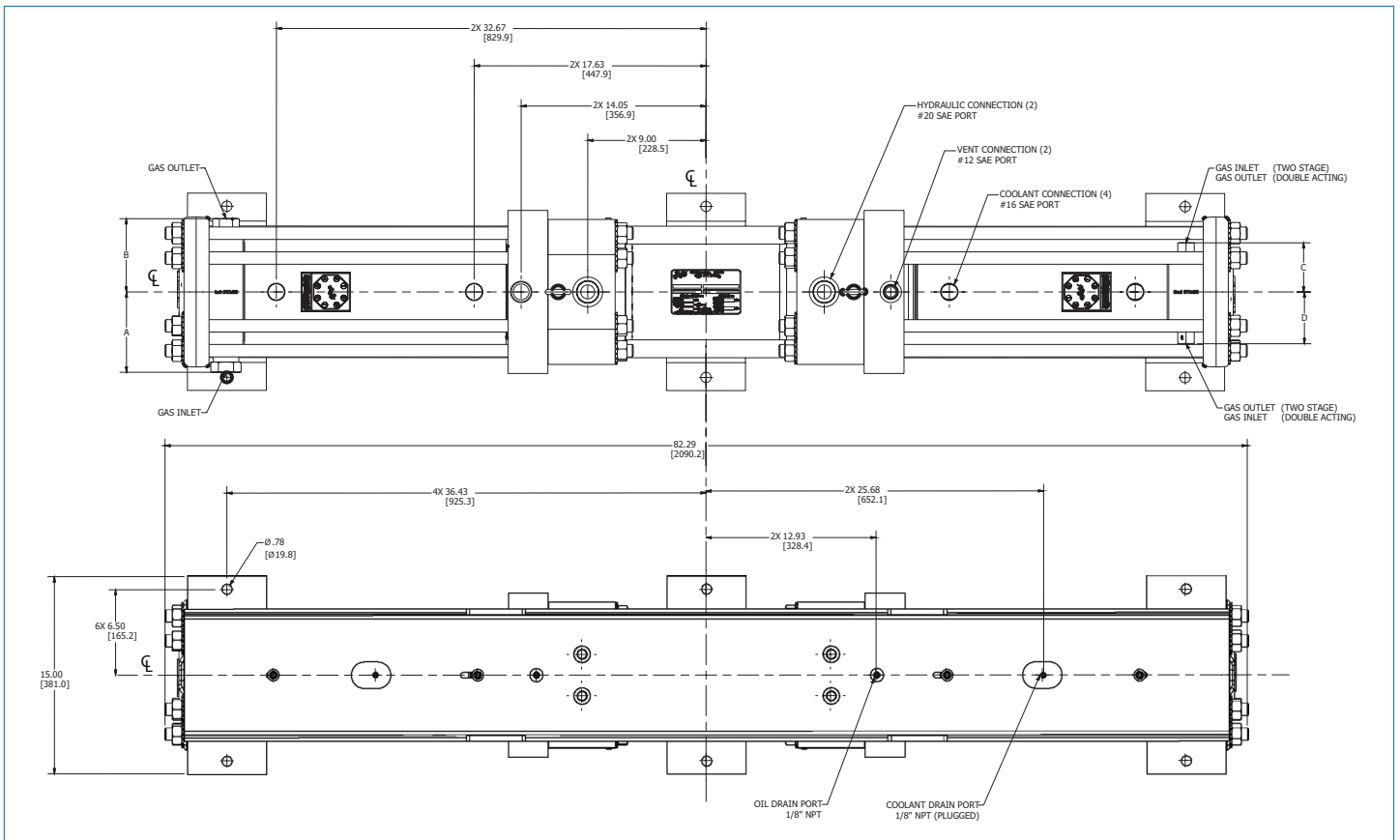
 Please see the **Troubleshooting** section of this manual if the gas booster is not level.

9. Verify that the installed gas booster is electrically grounded.

### WARNING!

**All equipment must be appropriately grounded and tested.**

All personnel and equipment entering the work area must be earthed to the same potential to mitigate static.



**Figure 11: H-Drive mounting hole and port dimensions.**

BOOSTER	DIMENSION 'A'	DIMENSION 'B'	DIMENSION 'C'	DIMENSION 'D'
H12-150	6.11 [155.2]	5.58 [141.7]	6.11 [155.2]	5.58 [141.7]
H12-90	7.53 [191.2]	8.28 [210.3]	7.53 [191.2]	8.28 [210.3]
H12-63	7.19 [182.5]	7.94 [201.7]	7.19 [182.5]	7.94 [201.7]
H12-150/63	6.11 [155.2]	5.58 [141.7]	3.74 [94.9]	3.94 [100.0]
H12-150/90	6.11 [155.2]	5.58 [141.7]	4.18 [106.1]	4.38 [111.2]
H12-90/63	4.18 [106.1]	4.38 [111.2]	3.74 [94.9]	3.94 [100.0]

**Table 1: H-Drive width dimensions**

Note: All dimensions are approximate. Dimensions shown in inches [millimeters].

## 5.4.2 TYPICAL TWO-STAGE (HGT) H-DRIVE INSTALLATION SCHEMATIC

The following illustration has been provided to demonstrate the instrumentation required to condition and monitor gas behavior throughout the compression activities to ensure adherence to the operating parameters.

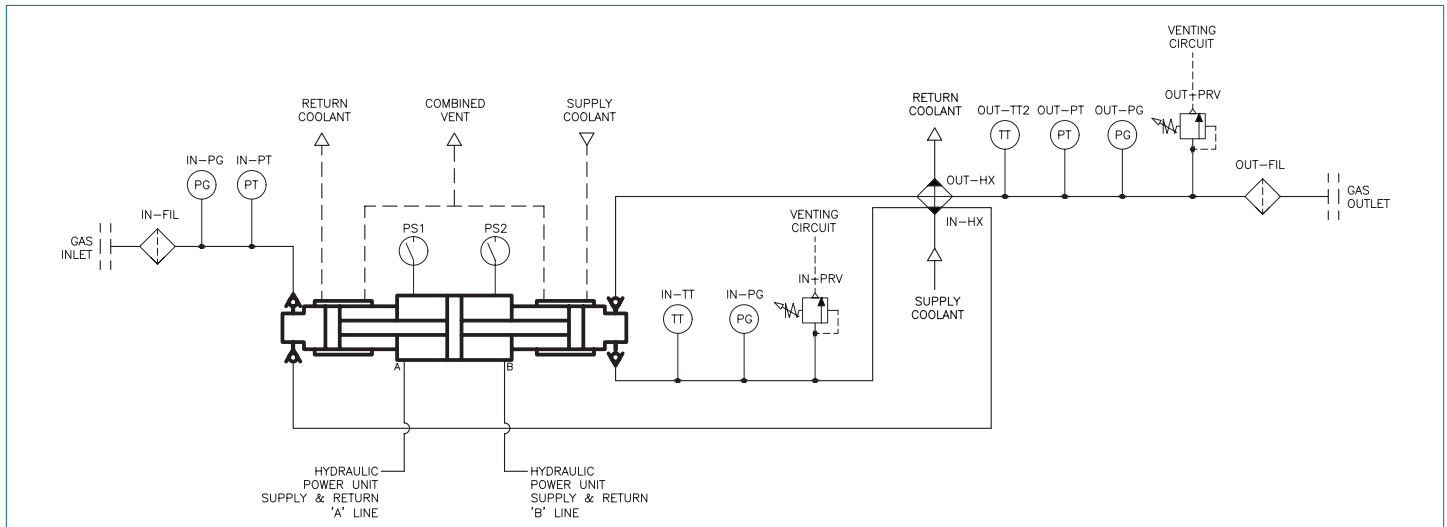


Figure 12: Two Stage Schematic

## 5.4.3 TYPICAL DOUBLE-ACTING (HGD) H-DRIVE INSTALLATION SCHEMATIC

The following illustration has been provided to demonstrate the instrumentation required to condition and monitor gas behavior throughout the compression activities to ensure adherence to the operating parameters.

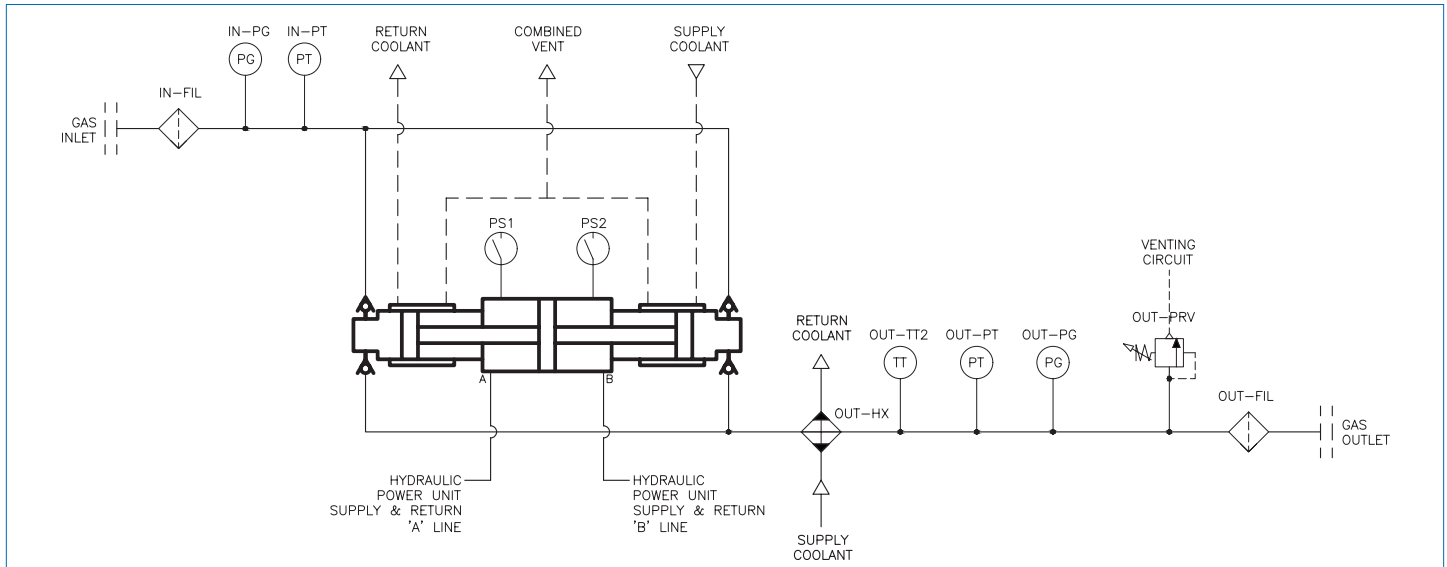


Figure 13: Double Acting Schematic

### **⚠️ WARNING!**

**The provisions of the cooling system, hydraulic power unit and venting circuit are the full responsibility of the system owner.**

It is also the responsibility of the end user to ensure the system is designed in accordance with all local legislation and directives. The guidelines below have been provided to ensure safe and efficient control of the H-Drive.



### 5.4.3 SYSTEM INTEGRATION KEY

The following describes the symbols and acronyms depicted on the typical installation schematics. Additional information about integration components such as transducers and heat exchangers can be found in the [Appendix](#) of this manual.

- **IN-FIL (inlet filter):** a single 10 micron filter is recommended on the inlet of the gas booster.
- **i** High-density filters can introduce significant pressure drops. It is essential that an appropriately sized filter be chosen to allow adequate gas flow into the booster. Flow constant (Cv) should meet or exceed that of appropriately sized tubing.
- **IN-PT (inlet gas pressure transducer):** a single pressure transducer is **required** on the inlet pipework of the system to monitor the inlet pressure to the H-Drive gas booster.
- **IN-PG (inlet gas pressure gauge):** a single analog pressure gauge is **recommended** on the inlet pipework of the system as a visual reference to the inlet pressure of the H-Drive gas booster.
- **INT-PG (interstage pressure gauge) (two-stage models only):** a single analog pressure gauge is **recommended** on the interstage pipework to monitor and provide a visual reference of the outlet pressure from the first compression stage.
- **IN-PRV (interstage pressure relief valve) (two-stage models only):** a pressure relief valve is recommended on the interstage of the H-Drive gas booster as a form of mechanical protection from overpressure.
- **INT-TT1 (interstage temperature transducer) (two-stage models only):** a temperature transducer is **required** on the interstage pipework to monitor the temperature of the gas from the first stage of compression.
- **INT-HX (interstage heat exchanger) (two-stage models only):** a heat exchanger **must** be installed within the interstage pipework to reduce the gas temperature before entering the second compression stage.
- **OUT-TT1 (A/B) (outlet temperature transducer):** a temperature transducer is **required** on the outlet pipework to monitor the temperature of the gas from the first stage of compression.
  - ✓ This must be installed **before** the interstage heat exchanger.
  - ✓ For **double-acting models**, a temperature transducer **must** be installed on the pipework of **both** outlets.
  - ✓ It is advised to install the sensor as close to the connection of the gas booster as possible.
- **OUT-HX (outlet heat exchanger):** a heat exchanger **must** be installed on the outlet pipework from the H-Drive gas booster to reduce the outlet gas temperature before it is processed downstream within the intended system.
- **OUT-PT (outlet pressure transducer):** a single pressure transducer is **required** on the outlet pipework of the system to monitor the internal pressure of the H-Drive gas booster.
- **OUT-PRV (outlet pressure relief valve):** a pressure relief valve is **recommended** on the outlet of the H-Drive gas booster as a form of mechanical protection from overpressure.
- **OUT-PG (outlet pressure gauge):** a single analog pressure gauge is **recommended** on the outlet pipework of the system as a visual reference to the outlet pressure from the H-Drive gas booster.
- **OUT-TT2 (outlet temperature transducer):** a second temperature transducer is **required** on the outlet pipework to monitor the gas temperature after the outlet heat exchanger.
- **OUT-FIL (outlet filter):** a single 10 micron filter is recommended for high purity applications on the outlet of the gas booster.
- **PS1 & PS2 (proximity switch):** the purchase of an H-Drive can be configured with or without proximity switches. It is always recommended to use Haskel-provided proximity switches for operating the hydraulic cylinder.

## 5.5 CONNECTIONS-TUBING, PIPE AND HOSES

When installing your gas booster system, the sizing of tubing, pipe, or hoses is critical. Proper sizing should also be appropriate to the specific application of intended use. Pressure drops at the inlet ports to the gas, hydraulic, or coolant connections can affect the flow performance and life of the seal sets.

- ✔ **Review the pressure rating as it relates to gas requirements per sizing guidelines.** Haskel recommends using like materials for the mating components.

### 5.5.1 GAS CONNECTIONS

For gas connections that achieve pressure levels greater than 488 barg (6,500 Psig), a cone and thread tubing system such as the medium pressure. For pressure below 448 barg (6,500 Psig), a compression style system or a two-ferrule fitting like those offered by BuTech®, Swagelok® and Parker®. The compression style method allows the largest inside diameter (ID) to minimize the pressure drop (PD) to the ports.

- i** Using the recommended tube diameters ensures the booster reaches the maximum delivery output.
- i** These inlet and outlet connections are standard. Using alternative connections will negatively impact the booster's efficiency.

Below is a guide to the minimum ID required for the H-Drive gas booster.

- ✔ The wall thickness of the tubing should be aligned with the pressure rating requirement for that leg of the circuit design.

INLET PRESSURE	8-51 bar (125 -750 psig)	51-103 bar (750-1500 psig)	103-165 bar (1,500-2,400 psig)	165-227 bar (2,400-3,300 psig)	227-289 bar (3,300-4,200 psig)	289-620 bar (4,200-9,000 psig)	620-1,304 bar (9,000-15,000 psig)
HGD-150	*0.652	*0.652	*0.652	*0.62	NR	NR	NR
HGD-90	NR	*0.652	*0.652	*0.62	*0.584	0.438	NR
HGD-63	NR	NR	*0.652	*0.62	*0.584	0.438	0.312
HGT-90/63	NR	*0.652	*0.652	*0.62	*0.584	NR	NR
HGT-150/63	*0.652	NR	NR	NR	NR	NR	NR
HGT-150/90	*0.652	*0.652	*0.652	NR	NR	NR	NR

Table 2: Recommended minimum inlet tubing ID by H-Drive model.

OUTLET PRESSURE	8-165 bar (125 -2,400 psig)	165-289 bar (2,400-4,200 psig)	289-310 bar (4,200-4,500 psig)	310-689 bar (4,500-10,000 psig)	689-1,034 bar (10,000-15,000 psig)
HGD-150	*0.652	*0.584	*0.37	NR	NR
HGD-90	NR	NR	0.438	0.438	NR
HGD-63	NR	NR	NR	0.312	0.312
HGT-90/63	NR	*0.584	0.438	0.312	0.312
HGT-150/63	NR	*0.584	0.312	0.312	0.312
HGT-150/90	NR	*0.584	0.438	0.438	NR

Table 3: Recommended minimum outlet tubing ID by H-Drive model.

#### Notes:

\*Twin ferrule compression fittings and associated tubing recommended if within pressure range  
 Wall thickness of tubing should be appropriate for pressure requirement  
 Minimum inlet tube ID should be sized according to lowest inlet pressure condition.  
 Minimum outlet tube ID should be sized according to highest outlet pressure condition.  
 NR = Consult factory for tubing recommendation

Tube OD should match the port size listed below:

MODEL NO.	INLET CHECK PORTS	OUTLET CHECK PORTS
HGD-150	1 in SAE port	3/4" SAE port
HGD-90	3/4 in MP Butech®	3/4" MP Butech®
HGD-63	3/4 MP Butech®	3/4" MP Butech®

MODEL NO.	STAGE	INLET CHECK PORTS	OUTLET CHECK PORTS
HGT-150/63	-150	1 in SAE port	3/4" SAE port
	-63	9/16 in MP Butech®	9/16 MP BuTech®
HGT-150/90	-150	1 in SAE port	3/4" SAE port
	-90	9/16 in MP Butech®	9/16" MP BuTech®
HGT-90/63	-90	9/16" MP Port	9/16" MP BuTech®
	-63	9/16" MP Port	9/16" MP BuTech®

Table 4: Gas port fittings of H-Drive gas booster model.

## Tube Reference Table

MFG	TUBE OD (in)	WALL THICKNESS (in)	TUBE ID (in)	RATING	MATERIAL	SPEC
BuTech®	1	0.065	0.870	165 bar (2,400 psig)	316/316L	ASTM A269 (SEAMLESS)
	1	0.083	0.834	213 bar (3,100 psig)		
	3/4	0.049	0.0652	165 bar (2,400 psig)		
	3/4	0.065	0.620	227 bar (3,300 psig)		
	3/4	0.083	0.584	165 bar (4,200 psig)		
	1/2	0.049	0.402	255 bar (3,700 psig)		
	1/2	0.065	0.370	351 bar (5,100 psig)		
	1/2	0.083	0.334	461 bar (6,700 psig)		
	3/8	0.049	0.277	330 bar (4,800 psig)		
	3/8	0.065	0.245	448 bar (6,500 psig)		
BuTech®	1	(M/P)	0.562	1,378 bar (20,000 psig)	316	BU-2000/ASTM A-213
	3/4	(M/P)	0.438	1,378 bar (20,000 psig)		
	9/16	(M/P)	0.312	1,378 bar (20,000 psig)		

Table 5: Tube reference table for connection guidelines.

## 5.5.2 HYDRAULIC CONNECTIONS

All H-Drive gas booster models have the same hydraulic ports. Ports sizes are listed below.

- i** These connections are typically a hose assembly for flexibility.
- ✔ Specific hoses or tubing should have a **safety factor of 3:1** to the maximum operating pressure of **241 barg (3,500 psig)**.

**Note:** Recommend use of hydraulic hose whip restraints on both hydraulic hoses. Eyelet can be utilized as an anchoring location

PORT SIZE	THREAD SIZE	O-RING SIZE
1.25 SAE/MS straight thread port	1-5/8 - 12 UN	AS568D size: 920 Buna N, 90 Durometer

- ✔ Ports conform to **SAE J1926-1/MS16142, SAE20**.

hose minimum ID	0.875 in ID
flow capacity	≤ 44.1 GPM

**Table 6:** Hydraulic port connections.

## 5.5.3 COOLANT CONNECTIONS

- ✔ All H-Drive gas booster models have the same coolant ports. Port sizes are listed below.
- ✔ Specific hoses or tubing must have a **safety factor of 3:1 to the maximum operating pressure of 10.4 barg (150 psig)**.

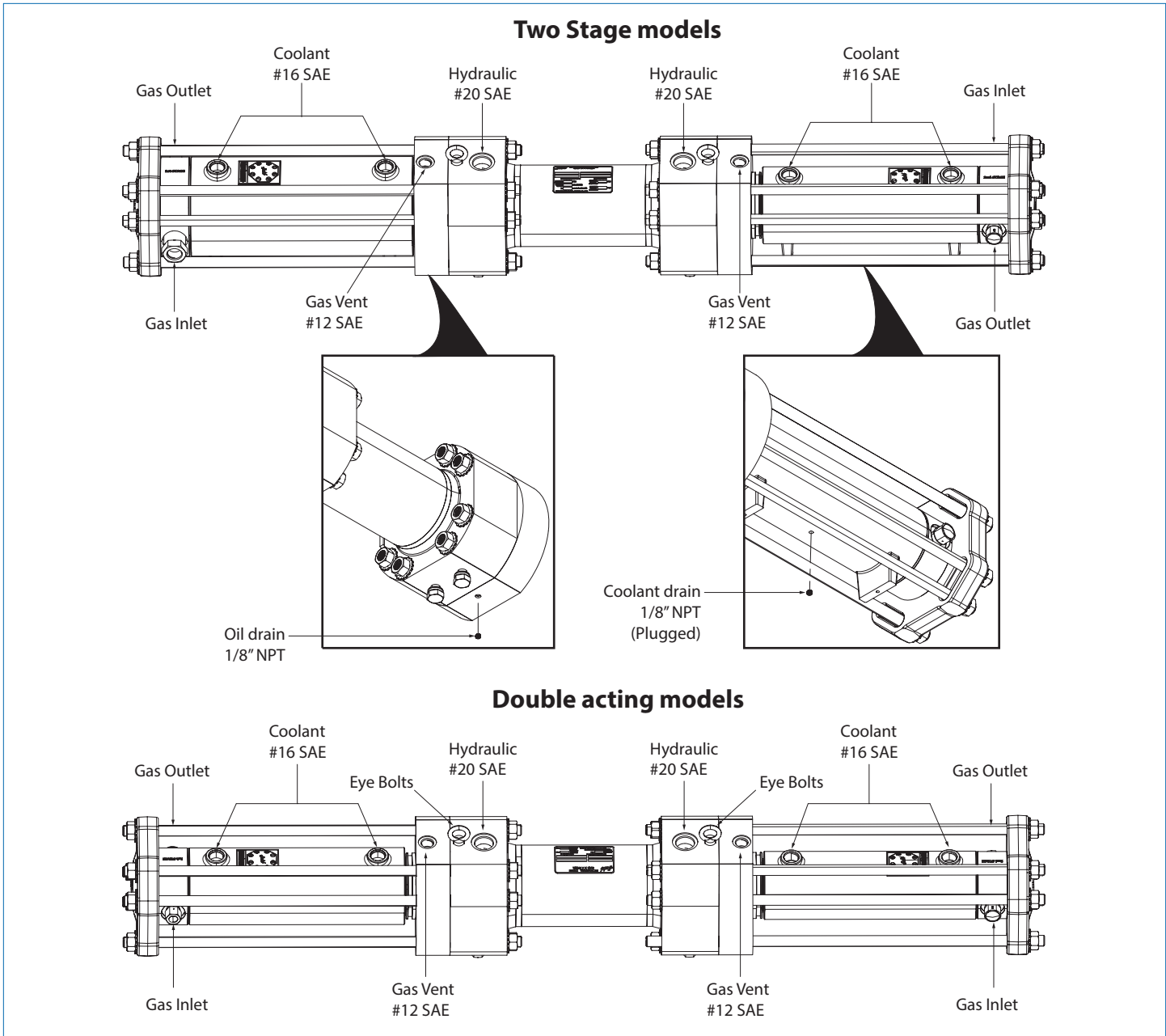
### Coolant Connections

PORT SIZE	THREAD SIZE	O-RING SIZE
1.00 SAE/MS straight thread port	1-5/16 - 12 UN	PRP size 916 Buna N, 90 Durometer

- ✔ **SAE J1926-1/MS16142, SAE16**.

hose minimum ID	0.75 in ID	
flow capacity	14 GPM	

**Table 7:** Recommended coolant port connection sizes.



**Figure 14:** Port locations for two-stage and double-acting H-Drive models.

**Notes:**  
 Gas connection ports vary per model, reference Table 3, on pg. 35  
 Eye bolts are for lifting the hydraulic cylinder only, may be used to secure hydraulic hose whip restraints.

## 5.6 INSTALLING PIPEWORK

### WARNING!

#### **Risk of equipment damage if the wrong connecting lines are used.**

Incorrectly sized piping, tubing, or threaded unions can cause malfunctions and damage the gas booster.

- Pressure rating of tubing should exceed the maximum pressure in its respective location of the gas circuit
- Tubing should be selected to minimize pressure drop to booster (reference section 5.5.1)
- Properly tighten all connections with their specified torque.

 The compressed gas network must be professionally planned, installed, and maintained.

### CAUTION!

#### **Inlet and outlet check valves have the same port and thread sizes.**

Pay attention to the “in” and “out” words engraved on the end cap ports and match them with the exact words on the check valve bodies. Swapping the check valves or putting two identical check valves on the same gas section can result in over-pressurizing the gas sections and tubing.

### PPE required:

- Protective clothing
- Safety goggles
- Safety footwear

### Tools required:

- Ratchet
- Socket
- Adjustable wrench(s)

## 5.6.1 INSTALLATION STEPS

1. Connect the hydraulic hoses using a #20 SAE Port (2).
2. Torque to a maximum of 271 N-m (200 ft-lbs).
3. Connect the cooling hoses using a #16 SAE Port.\*
4. Torque to a maximum of 68 N-m (50 ft-lbs).
5. Connect the gas lines using the correct port based on your H-Drive gas booster model. The port size will also indicate torque requirements.

\* The cooling barrels are typically connected in series, with the second stage gas section cooled first on two stage models.

## 5.7 PROXIMITY SWITCHES

### 5.7.1. EXPLOSION PROOF PROX SWITCH

Proximity switches can be provided and installed within the hydraulic cylinder to detect the position of the hydraulic piston nearing the end of a stroke and provide feedback to the control system.

APPROVALS:

ELECTRICAL CLASS CENELEC: Eex d IIC T6 ZONE 1



Ex d IIC T6 Gb, Ex tb IIIC T85°C Db, IP66  
(Ta = -40°C to + 50°C)

Ex d IIC T4/T3 Gb, Ex tb IIIC T135°C/200°C Db, IP66  
(Ta = -40°C to +100°C /150°C)

- i** OPERATING PRESSURE: 5.000 PSI
- i** OPERATING VOLTAGE: 10-30 V DC
- i** Rating: 4A @ 120VAC/3A @ 24VDC  
2A @ 240 VAC/1.25A @ 48VDC
- i** Max Sensing Distance: .072 in [1.82 mm]

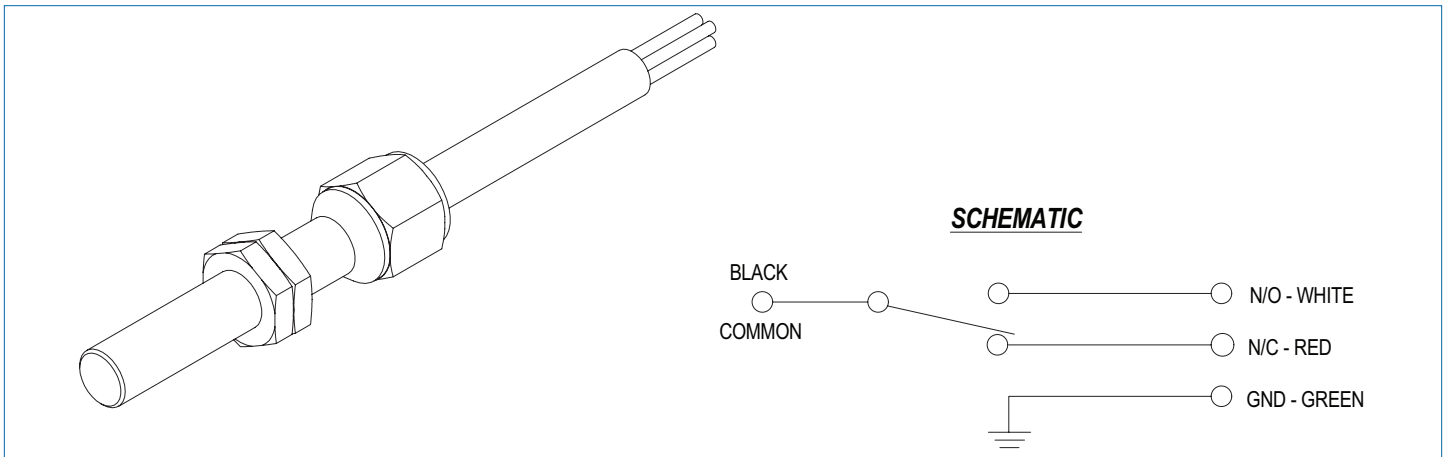


Figure 15: 86694-BASIC SWITCH

### 5.7.2. STANDARD PROX SWITCH

- i** OPERATING PRESSURE: 3.000 PSI

Approvals: UL approval cULus Listed, General Purpose, CSA approval cCSAus Listed, General Purpose

- i** OPERATING VOLTAGE: 10-30V DC

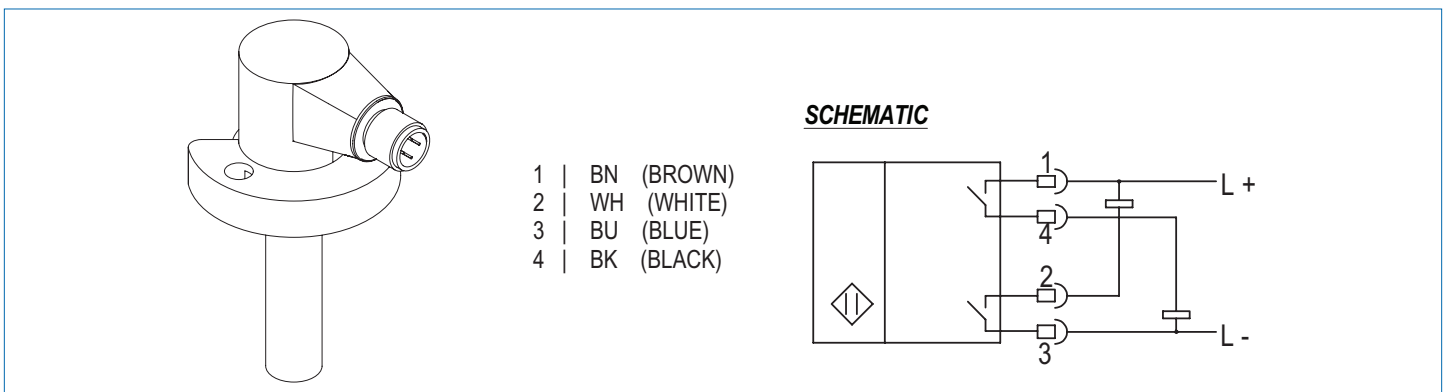
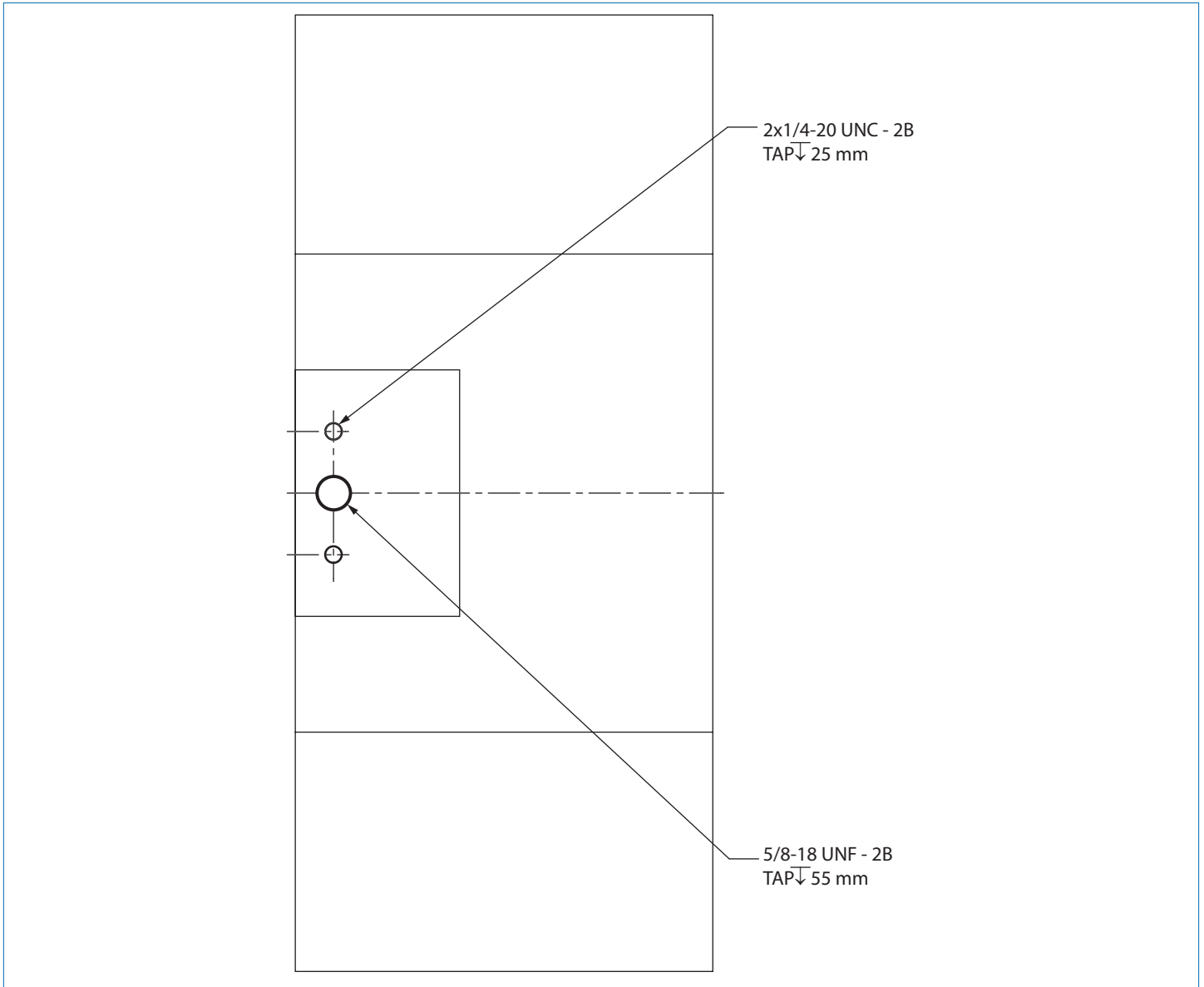


Figure 16: 83173-TAB SWITCH

- ✔ Proximity switches can be ordered with the H-Drive gas booster and installed from the factory. If they are factory installed, no adjustment should be necessary. Proximity switches rarely require adjusting but if an adjustment is needed, refer to **Replacing Proximity Switches** in the Maintenance section of this manual for specific installation instructions.



**Figure 17:** Hydraulic drive proximity switch covers location.



# 6.0 Operation

With efficiency and serviceability in mind, H-Drive® gas boosters have been designed to deliver optimum performance at various operating pressures. The resultant technology ensures the very best performance throughout continuous heavy-duty applications.

The below procedures and guidelines are about a general gas system. Refer to your site operations process and HPU operations manual for specific controls and sequence instructions. All safeguards for applicable local regulations, directives, and standards should be adhered to in addition to those listed in this manual.

## **WARNING!**

**All personnel must comply with required PPE mandates before operations.**

It is the owner's responsibility to ensure all personnel have adequate PPE and are wearing PPE appropriately.

- Serious injuries can result without the proper use of PPE.

## **WARNING!**

**High risk of injury and equipment damage due to improper operation.**

Be sure to execute all operating steps by the instruction and information in this manual.

- Before starting any work, ensure that all connections, gases, and safety devices are installed correctly and are properly functioning.
- Never bypass a safety device or operate the system if the safety devices are inoperable.

## **WARNING!**

**You must not operate the gas booster without gas.**

Even if you are testing any aspect of the system, you still need to connect the gas.

- The gas must be connected before the inaugural startup.
- Do not operate the system without gas connected.

## **NOTICE!**

**Be sure that you understand the complete system before operating.**

Study the manual and technical data received with the unit.

## 6.1 H-DRIVE GAS BOOSTER CAPACITY AND REQUIREMENTS

The H-Drive gas boosters have been designed to safely handle a broad range of critical, high-pressure gas compression and transfer needs at high flow rates and pressures, even in the most demanding applications. The performance of each of the models is highly dependent on overall system design, correct fittings, and operating parameters.

Please see the following information to understand the H-Drive's performance characteristics better.

## 6.2 CONDITIONS FOR SAFE USE

The following information details the conditions that must be adhered to for the safe operation of the H-Drive gas booster.

### WARNING!

**The parameters outlined on the product identification plate must be entirely adhered to.**

Failure can lead to personnel, system, and workspace dangers.

### WARNING!

**Do not operate the gas booster or gas booster system unless you have read this manual or have been trained by the owner.**

### 6.2.1 EARTH GROUNDING

The owner or user must verify that the system is adequately earthed or grounded before operations. A ground continuity tester should be utilized at various positions on the booster, including, but not limited to, each gas section and the hydraulic section. Consult the factory for specific unit grounding techniques.

### WARNING!

**The danger of severe injury or death is possible if the system is not grounded correctly.**

A fault in your electrical installation may result in an electric shock or a potential ignition hazard.

- A means of earth grounding must be provided to an equipotential bonding system.
- A properly earth-grounded device doesn't leak out any current.

### 6.2.2 PRESSURE

The maximum pressure limits must NOT be exceeded under any circumstances. Haskel advises the end user to monitor inlet gas, interstage gas (two-stage models only), and outlet gas pressures with suitably certified and rated pressure transducers or analog gauges (outside of Haskel supply).



Refer to the [H-Drive Gas Booster Capacity](#) for further information on maximum pressure limits for each H-Drive model.

### 6.2.3 TEMPERATURE

Several aspects of the system require the user to carefully monitor temperature readings to ensure that the system is within the design's specified temperature parameters. Extreme cold and heat temperatures can have catastrophic effects on the system and may result in serious damage to equipment and severe injuries to the user.

The operator must adhere to the temperature parameters as indicated in this manual. The control system provider must ensure the correct action is applied upon reaching any operating temperature limit. Refer to [System Control Indicators](#) for more information.

### 6.2.3.1 HYDRAULIC OIL TEMPERATURES

- ✓ For optimum performance, oil temperatures should be maintained to be **in line with the parameters defined in the following pages of this manual.**
- ✓ Oil temperatures should **NEVER** exceed **the maximum allowable limit.**
- ✓ If located outdoors, oil temperatures may need to be controlled with an immersion heater. If oil temperatures go below the minimum limit, the viscosity becomes too thick, putting the hydraulics at risk.
- ✓ **Adherence to the control of oil temperature must be complied with.**
- ⓘ End user is advised to provide a suitable means of controlling oil temperature and an appropriate means of monitoring the oil supply temperature to the cylinder.

### 6.2.3.2 SURFACE TEMPERATURES

- ✓ The surface temperature of the booster must not exceed **190°C (392°F) in adherence to the ATEX/IECEx temperature classification.**
- ⓘ End user is advised to provide a suitable means of monitoring surface temperature at the gas outlet points of each gas barrel.
- ✓ Refer to the **System Integration** section of this manual for more information about monitoring surface temperatures.

### 6.2.3.3 AMBIENT TEMPERATURES

- ✓ The operator is responsible for ensuring the H-Drive operates within the ambient temperature limits defined on the product identification plate, located on the hydraulic cylinder casing. Consult the factory for applications that may exceed the ambient temperature limits.
- ⓘ End user is advised to provide a suitable means of monitoring the ambient temperature.

Note maximum hydraulic and gas pressures, as well as flow and cycle rates as defined on the product label, example below.


		<b>HYDRAULICALLY DRIVEN GAS BOOSTER</b>			
Part Number		Mfg. Date			
Type		Serial Number			
<b>HYDRULIC SECTION</b>		<b>GAS SECTION</b>			
MAXIMUM PRESUURE	3800	PSIG	MAXIMUM SUPPLY PRESUURE		PSIG
MAXIMUM CYCLES	18	PER MINUTE	MAXIMUM OUTPUT PRESUURE		PSIG
AT	44.1	G.P.M FLOW RATE			
Haskel International, LLC., Burbank, Ca., USA					

Figure 18: H-Drive gas booster product identification plate example.

## 6.3 OPERATING PARAMETERS

The following information details key parameters to ensure that the H-Drive gas booster is operated safely and efficiently.

### 6.3.1 HYDRAULIC CYLINDER PARAMETERS

The following information details the allowable operating parameters and limits of the hydraulic cylinder.

	PARAMETER (METRIC)	PARAMETER (IMPERIAL)
Maximum operating pressure*	262 bar	3800 psi
Minimum oil operating temperature	15°C	59°F
Maximum oil operating temperature**	70°C	158°F
Minimum cycle speed	5 cycles per minute (CPM)	
Maximum Cycle Speed***	18 cycles per minute (CPM)	

**Table 8: Allowable operating parameters for the hydraulic cylinder.**

\*The end user/system integrator must provide a means of monitoring the pressure delivered to the hydraulic cylinder to ensure compliance with the parameters defined above.

\*\*This is the maximum allowable temperature limit, it is recommended to operate with an oil temperature at around 40°C to extend the life of the hydraulic seals. The end user/system integrator must provide a means of monitoring hydraulic temperatures to ensure compliance with the parameters defined above.

\*\*\* Consult factory for any applications that require great than 18 cpm

#### 6.3.1.1 CYLINDER CONTROL

The hydraulic circuit of any HDGB system contain the following items: pump motor assembly, reservoir, filtration system, coolant circuit, master controller, and directional control valve. This section will discuss the directional control area of that circuit.

Directional control valve direct fluid to hydraulic ports A and B on HDGB. These are sequenced by a signal from a master controller. The two types of directional valve are as follows:

- Proportional Control Solenoid Valve (PCSV) - (Preferred Method) – 4 way, 3 position valve with control capability to regulate the ramp rates and soak values.  
See Chart below for example of timing. Desired cycle speed (CPM) is determined by volume of the Hydraulic pump and the total time sequence to complete the cycle. A cycle is comprised of two strokes of the Hyd. cylinder (Both directions). The below example is a pressure profile example of a double acting booster (HGD-90) with a PCSV operating at 15 cpm. Start sequence ramps PCSV from zero to full value in approx. 500 millisecond (R1/R3). The pressure rises to soak level (Full load) at approx. 1600 ms. The soak level (V1/V2) is the full volume set by volume stop on Hyd Power unit (GPM/LPM). In this example its 37 gpm to achieve the 15 cpm. The next event is triggered by a Proximity Switch signal or timed sequence at end of stroke. This is de-acceleration ramp (R2/R4) is approx. 90 ms. The sequence is repeated mirror image for Solenoid B.

A Haskel Representative can assist with any applications questions that exist at system design phase.

- Discrete Solenoid Directional Valve – (Less desired Method) Direct solenoid control is usually configured: 4 Way, 3 position, 24 VDC Coils

To control or trigger start signal the following two methods can be used, they are as follows:

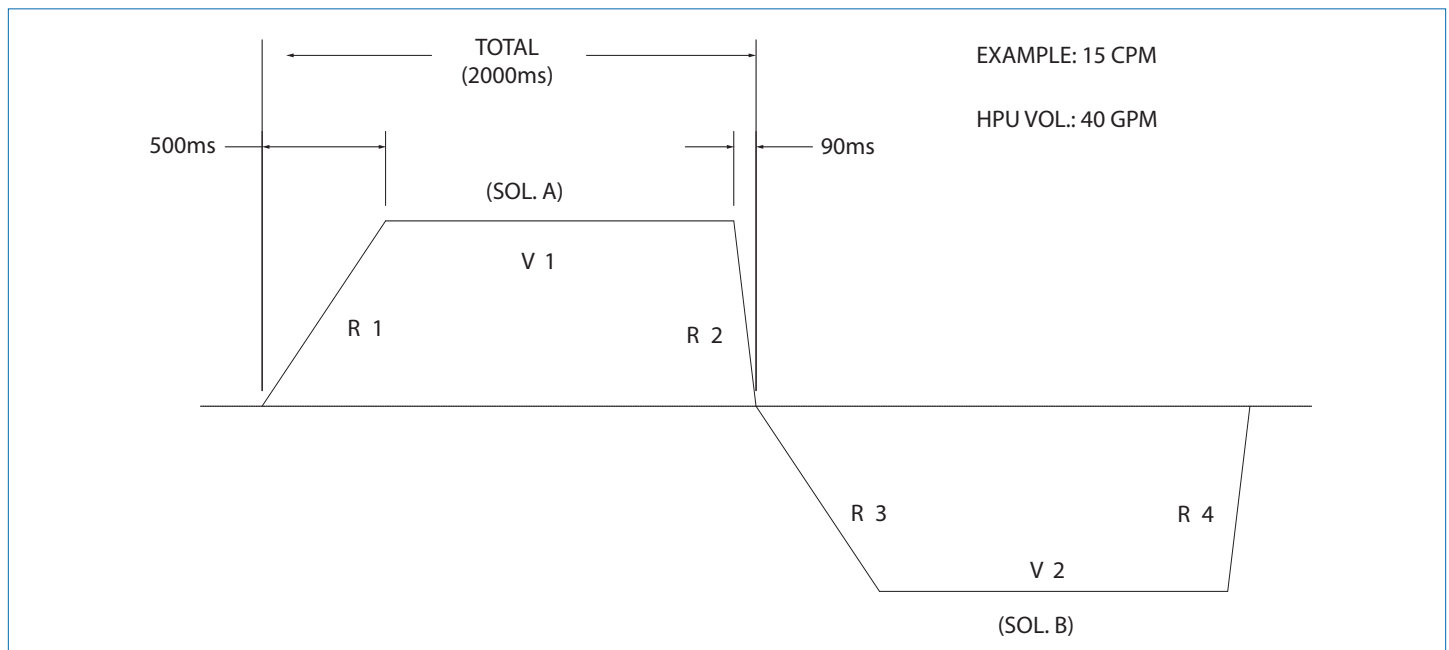
- Timed Method - Timed event from a controller (No proximity switch)
- Proximity Method – End of stroke, is sequenced from a proximity switch signal to the controller. See Section 5.7 for details.  
**Note:** A maximum time limit per stroke should be incorporated in controller code to override operation. This will sequence a reverse signal on that timed out value. This will prevent a stop signal if the proximity switch. were to Hang-up or not functioning properly.

**Caution:** A method to soft Start the hydraulics is required to avoid piston damage and promote smooth operation of hydraulic cylinder. This is particularly critical for initial startups and in low gas load conditions (reference section 6.6 for general startup procedure).

CPM	GPM	LPM	TOTAL SOAK TIME SEC	STROKE TIME	R1/R3 RAMP MS	R2/R4 RAMP MS	V1/V2 SOAK MS
5	12.1	45.7	6.0	6000	700	90	5210
6	14.5	54.8	5.0	5000	700	90	4210
7	16.9	63.9	4.3	4286	600	90	3596
8	19.3	73.1	3.8	3750	600	90	3060
9	21.7	82.2	3.3	3333	600	90	2643
10	24.1	91.3	3.0	3000	600	90	2310
11	26.5	100.5	2.7	2727	600	90	2037
12	29.0	109.6	2.5	2500	600	90	1810
13	31.4	118.7	2.3	2308	577	90	1641
14	33.8	127.9	2.1	2143	536	90	1517
15	36.2	137.0	2.0	2000	500	90	1410
16	38.6	146.1	1.9	1875	469	90	1316
17	41.0	155.3	1.8	1765	441	90	1234
18	43.4	164.4	1.7	1667	417	90	1160

**Table 9: Proportional Vlv timing data**

- Notes:
1. General practice is to plan +10-15 % Capacity flow, and pressure for Hyd Pump sizing. This will allow adequate volume (V1/V2) for flow requirement when using a Proportional Valve (PCSV) circuit.
  2. V1, V2 represent the flow capacity of the pump. This can be set by Max Volume stop on Hyd pump or by the max value from PCSV.
  3. R1/R3 are acceleration ramps set to max volume of pump at end of ramp time. R2/R4 are decelerations ramps. They can be triggered by time sequence or a Prox. Switch signal.
  4. Solenoid A and B are mirror image or identical values.



**Figure 19: Proportional Vlv timing**

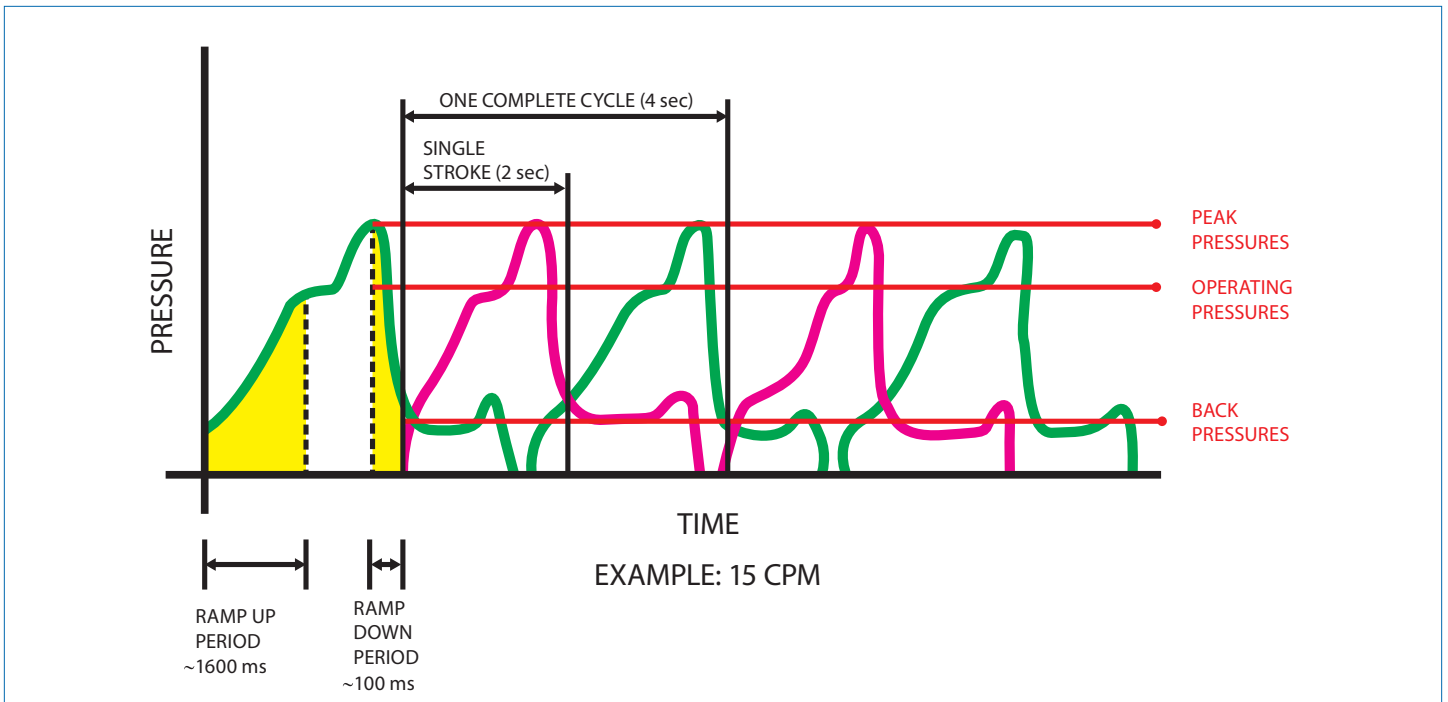


Figure 20: Typical hydraulic pressure profiles during normal operation.

### 6.3.1.2 HYDRAULIC CYLINDER FLOW RATES

The cycle speed of the hydraulic booster is based on the flow rate from the HPU. The hydraulic cylinder is common to all H-Drive gas boosters, and the amount of flow required to operate at each desired speed can be found in the table below.

ALL MODELS		
OPERATING SPEED	REQUIRED HYDRAULIC OIL FLOW	
5 CPM	46.2 liters/min	12.2 gallons/min
10 CPM	92.7 liters/min	24.5 gallons/min
15 CPM	140 liters/min	37 gallons/min
18 CPM	167 liters/min	44.1 gallons/min

Table 10: Amount of flow required to operate at desired cycle speed of the hydraulic booster.

### 6.3.1.3 OIL TYPE

The hydraulic cylinder has been designed for use with a medium-grade petroleum base hydraulic fluid with a viscosity of 90 – 150 SSU at 37°C (100°F).

- ✔ An example of an acceptable fluid to use is **Tellus 32 or 46** oil, or equivalent.
- ✔ Equivalents: Chevrom Rando HDZ ISO 32, Mobile DTE 10 Excel 32.
- ✔ Maximum oil temperature limit is 70°C (150°F).
- ✔ The minimum oil temperature is 15°C (60°F).

## Coolant Types

Water-based coolants are the usual coolant of choice. The coolant must contain a corrosion inhibitor such as glycol. Coolant should be compatible with EPDM.

80/20 or 90/10 water to glycol ratio recommended.

- i** Do not use pure water as a coolant.

## 6.3.2 GAS SECTION PARAMETERS

The following information details the allowable operating parameters and limits of the the gas sections.

	HGD-63	HGD-90	HGD-150	HGT-90/63	HGT-150/63	HGT-150/90
Minimum inlet gas pressure	6.9 barg (100 psig)	3.4 barg (50 psig)	3.4 barg (50 psig)	3.4 barg (50 psig)	3.4 barg (50 psig)	3.4 barg (50 psig)
Maximum inlet gas pressure	1,034 barg (15,000 psig)	690 barg (10,000 psig)	310 barg (4,500 psig)	690 barg (10,000 psig)	310 barg (4,500 psig)	310 barg (4,500 psig)
Maximum outlet gas pressure	1,034 barg (15,000 psig)	690 barg (10,000 psig)	310 barg (4,500 psig)	1,034 barg (15,000 psig)	1,034 barg (15,000 psig)	690 barg (10,000 psig)
Maximum interstage gas pressure	N/A	N/A	N/A	690 barg (10,000 psig)	310 barg (4,500 psig)	310 barg (4,500 psig)
Minimum gas inlet temperature	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)
Maximum inlet gas temperature	37°C* (99 °F)	37°C* (99 °F)	37°C* (99 °F)	37°C* (99 °F)	37°C* (99 °F)	37°C* (99 °F)
Maximum outlet gas temperature	190°C (374°F)	190°C (374°F)	190°C (374°F)	190°C (374°F)	190°C (374°F)	190°C (374°F)
Maximum compression ratio	6:01	6:01	6:01	36:01	36:01	36:01

**Table 11: Allowable operating parameters and limits of the gas sections of the H-Drive gas booster.**

\* Consult the factory for inlet temperature exceeding 37°C (100°F).

\* 36:1 is overall compression ratio.



**WARNING!**

**The pressure and temperature limits must be adhered to in all circumstances.**

Haskel advises the end user to provide provisions of monitoring all parameters, refer to the **System Integration** section.

### 6.3.2.1 GAS SECTION FLOWRATES

To determine the required cycle speed to achieve a desired flow rate, draw a horizontal line through the ‘Y’ axis at the point of the desired flowrate. Draw a vertical line through the ‘x’ axis representing the gas supply pressure and the intersection of both lines will indicate an approximate required cycling speed.

- ✔ The inlet/supply flowrate must be able to support the outlet flowrate.

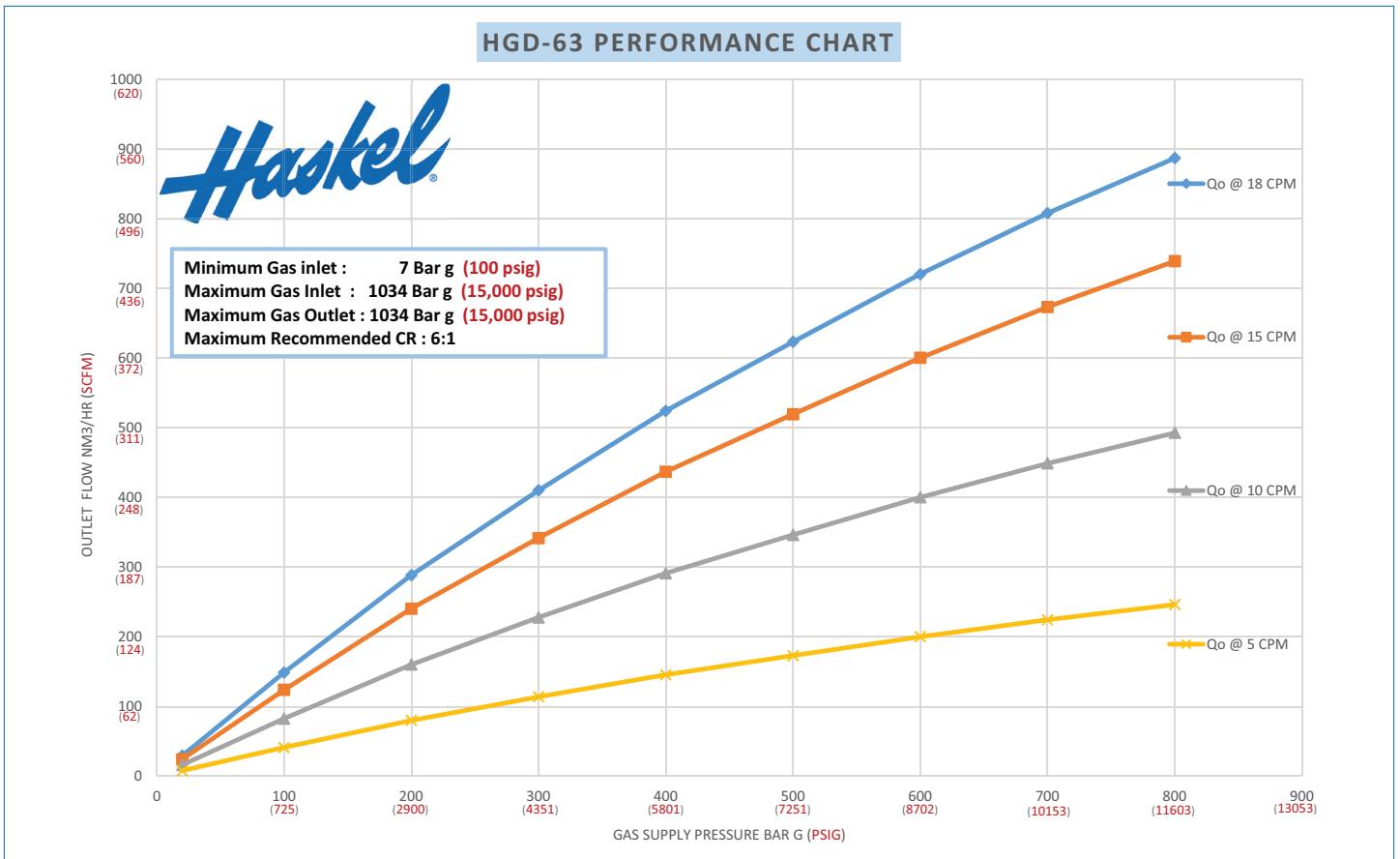


Figure 21: Example flowrate for HGD-63 model booster.

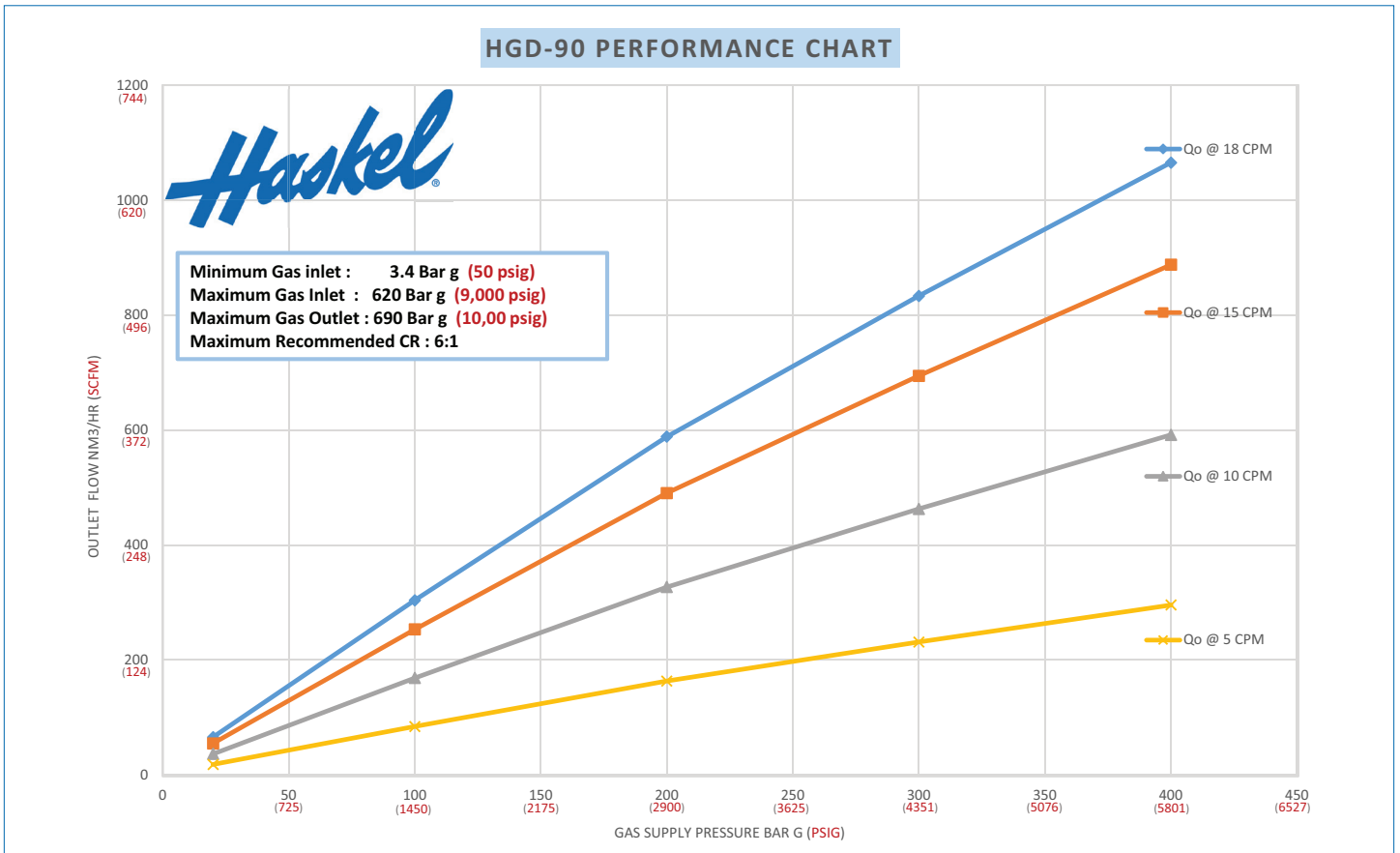


Figure 22: Example flowrate for HGD-90 model booster.



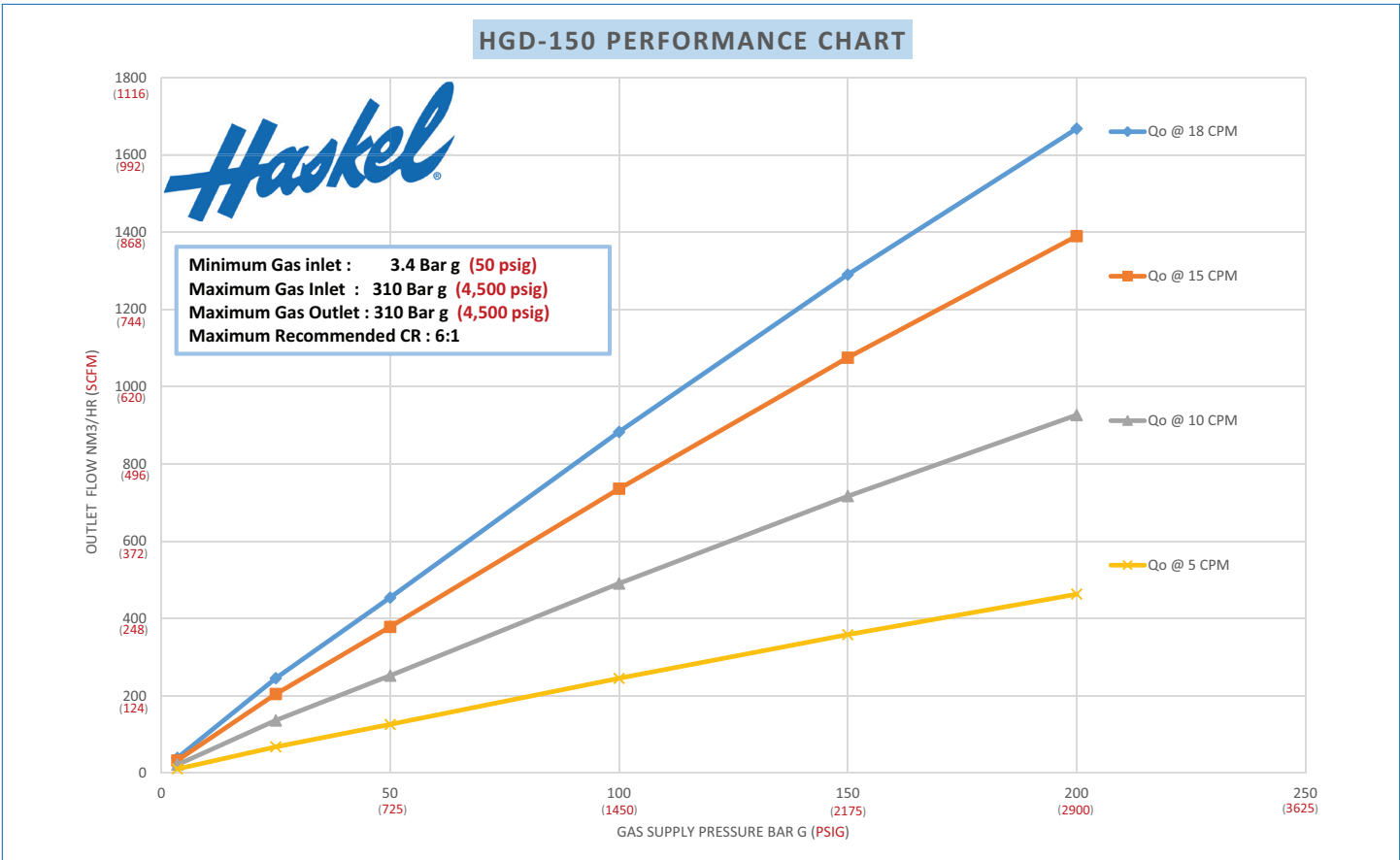


Figure 23: Example flowrate for HGD-150 model booster.

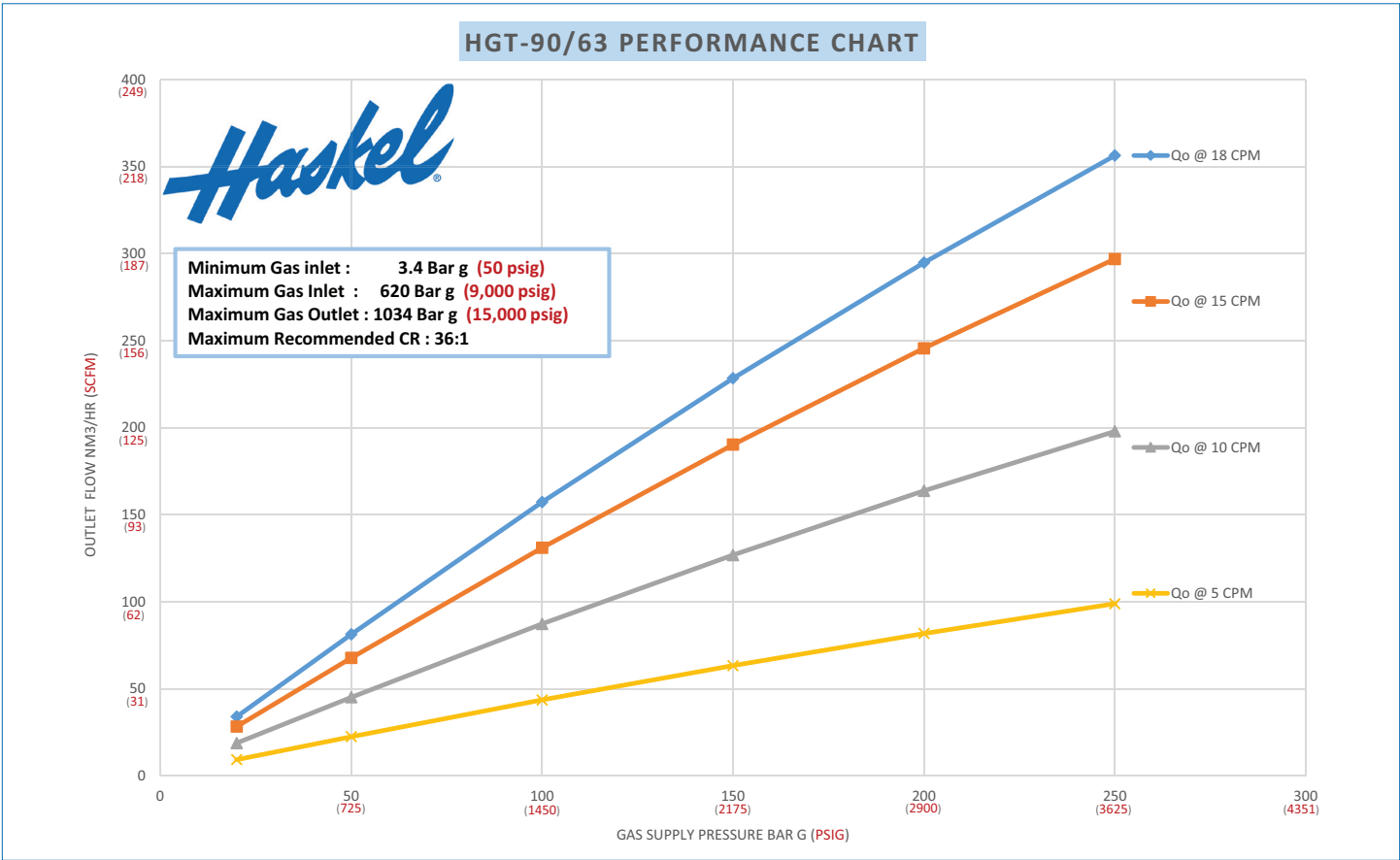


Figure 24: Example flowrate for HGT-90/63 model booster.

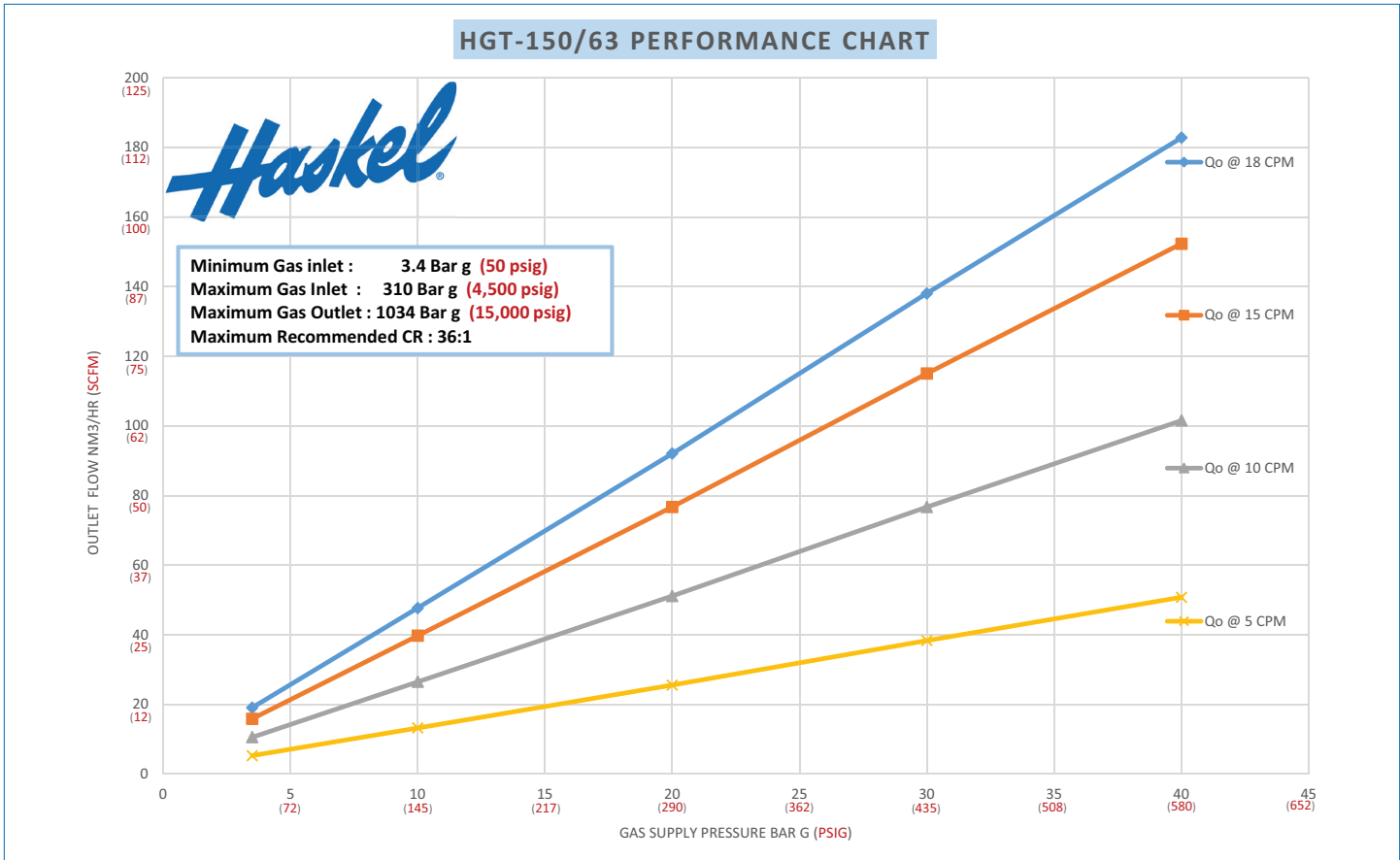


Figure 25: Example flowrate for HGT-150/63 model booster.

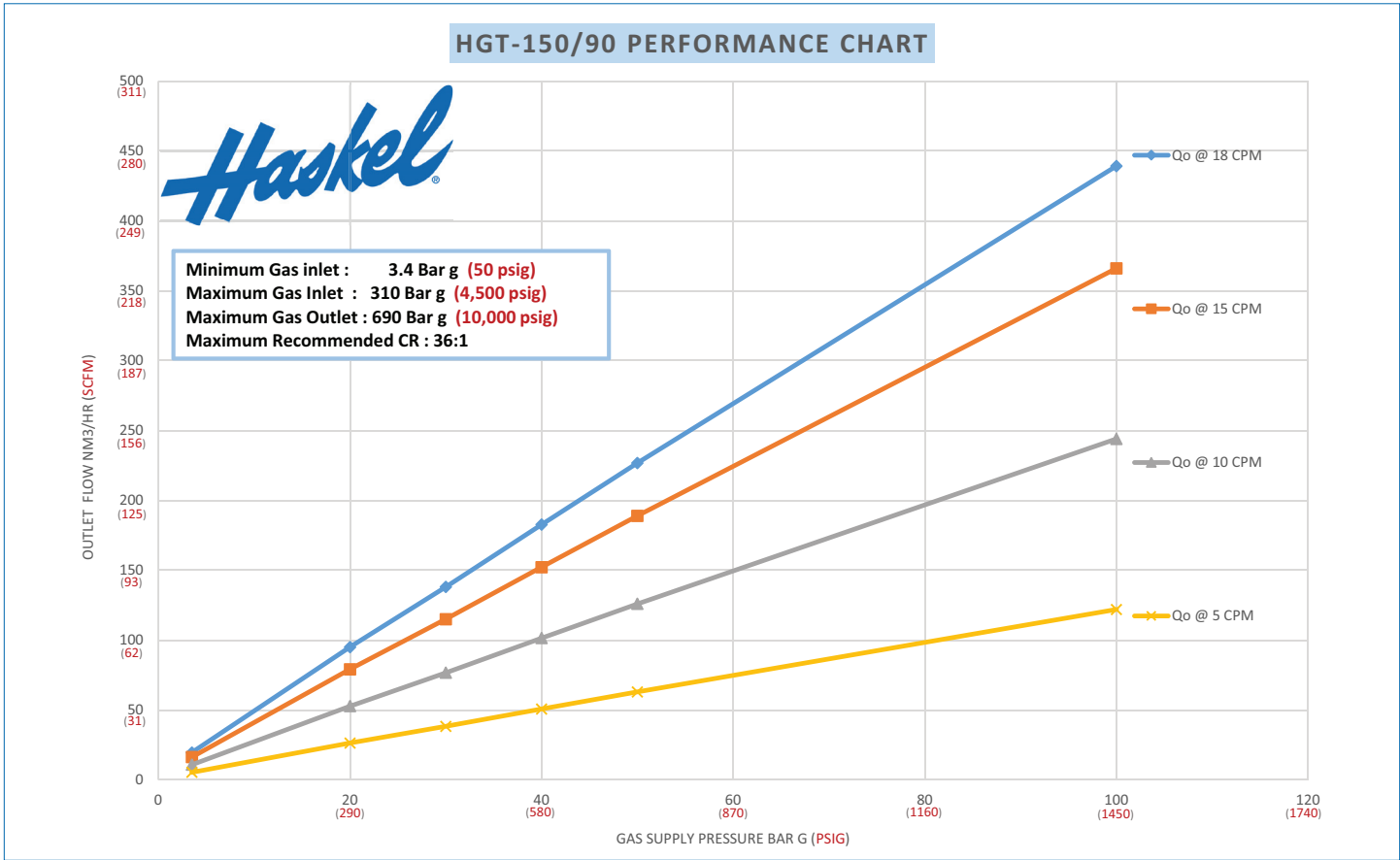


Figure 26: Example flowrate for HGT-150/90 model booster.

### 6.3.3 PERMITTED GASES

Haskel gas boosters are used for boosting the most commonly available industrial gases. However, the gas should be dry. Depending on the gas and application, construction materials, venting, special cleaning, and other considerations may be required.

**⚠️WARNING!**

**The H-Drive booster must NOT be operated with other gas types outside the list detailed below.**

Haskel does not bare any responsibility for failure to comply with this instruction.

Consult factory for gas applications outside those listed below

**⚠️WARNING!**

**Risk of an accident if using a gas that is not permitted for the gas booster and system.**

If instructions regarding permitted displacement media are not observed, the result could be severe accidents to personnel and damage to the system.

- Only compress gases that are permissible for the gas booster.
- Observe special instructions for that displacement media when using explosive gases such as hydrogen.

**The gases listed below are permissible for use with the H-Drive gas boosters.**

MEDIUM (GASES)	SYMBOL	MODEL TYPE
Nitrogen	N <sub>2</sub>	All models
Argon	Ar	All models
Hydrogen	H <sub>2</sub>	HG _ - _ _ - 2 - 2 - _ Models
Helium	He	All models
Carbon Dioxide	CO <sub>2</sub>	HG _ - _ _ - _ - _ - 32 Models
Methane (CNG)	CH <sub>4</sub>	HG _ - _ _ - 2 - 2 - 30 Models
Air (consult factory)	N <sub>2</sub> +O <sub>2</sub>	All models

**Table 12: Acceptable gases to use as displacement media in the H-Drive gas booster.**

- i** The gases listed above are non-reactive with austenitic stainless steel. Compressed natural gas or any of the above gases should not contain hydrogen sulfide (sour gas) or other corrosive agents when in contact with austenitic stainless steel.
- ✓** When utilizing hazardous gases as a displacement media, refer to **Operating with Hazardous Gases** for further information.

## 6.4 OPERATING WITH HAZARDOUS GASES

**Haskel** HYDRAULICALLY DRIVEN  
GAS BOOSTER

CE

II 2G Ex h IIC T3 Gb T= -40°C + 65°C  
SIRA 17XT051

MODEL No  TYPE

SERIAL No  MFG. DATE

HYDRAULIC SECTION		GAS SECTION	
MAXIMUM PRESSURE	<input type="text"/> PSIG	MAXIMUM SUPPLY PRESSURE	<input type="text"/> PSIG
MAXIMUM CYCLES	<input type="text"/> PER MINUTE		
AT	<input type="text"/> G.P.M. FLOW RATE	MAXIMUM OUTPUT PRESSURE	<input type="text"/> PSIG

CONDITION HYDRAULIC OIL TEMP TO: +15°C TO + 70°C  
Haskel International, LLC., Burbank, CA., USA

Figure 27: H-Drive gas booster product identification plate example. (ATEX)

The Haskel H-Drive hydraulic booster is certified to be installed within a potentially explosive environment under the ATEX directive with adherence to the following marking conditions:

### Ex II 2G Ex h IIC T3 Gb

(Refer to product certification plate)

The parameters outlined on the product identification plate **MUST** be entirely adhered to.

Using the gas booster outside the indicated operating conditions risks damaging the product and the system it is installed within and may result in serious injury to the operator.

It is the owner and operator's responsibility to understand all risks of managing the installation and operation of the gas booster to ensure that all necessary safeguards are in place per the applicable local regulations, directives, and standards. A full DSEAR assessment or equivalent is recommended in accordance with local regulations and standards. Only suitable competent personnel can install and operate.

Any enclosed space around the gas booster that could be a potentially explosive area (ATEX zone) must be fitted with gas detection and ventilation. Any area where the likelihood of gas presence increases must be mitigated by either or all, depending on the risk, forced ventilation, purge procedures, or regular leak checks. The components in these areas must be suitably ATEX rated. An initial system leak test is to be conducted before operation.

Purge hazardous gas from the gas booster when the booster is not in service for more than 48 hours.

Refer to **Purging the System** for further information.

## 6.5 PRELIMINARY STARTUP CHECKLIST

The following is a checklist that all operators should refer to before starting up the H-Drive gas booster:

- ☑ Verify that the inlet, outlet, and interstage (two-stage models only) gas tubing is connected to the appropriate check valve and adequately secured.
- ☑ Verify that the hydraulic circuit is connected correctly and adequately secured.
- ☑ Verify that the cooling circuit is connected correctly and adequately secured.
- ☑ Verify that all connections, tubing, and piping are free of visible damage.
- ☑ Verify that the gas booster is free of visible damage.
- ☑ Verify that the gas booster tie rods are torqued to spec.
- ☑ Verify that the entire system is free of leaks.
- ☑ Verify that enclosed spaces around the gas booster are fitted with gas detection or proper ventilation
- ☑ Verify that the control system is functioning correctly.
- ☑ Verify that all instrumentation used is functioning correctly.
- ☑ Verify that all safety devices are functioning correctly.

## 6.6 GENERAL STARTUP PROCEDURE

### **WARNING!**

**Before any start-up, inspect the system, connections, components, monitoring, and safety devices to ensure they function correctly.**

The preliminary start-up checklist listed above must be performed before and during operation.

### **WARNING!**

**Failure to follow specified steps in their prescribed order during start-up may result in significant material damage.**

Before initial commissioning, ensure that every installation task has been completed and concluded per the instructions in this manual.

- Verify that a leak test of all line connections has been performed before start-up.

### **WARNING!**

**You must not operate the hydraulic cylinder without gas pressure in both gas sections.**

### **CAUTION!**

**The end user is responsible for any other hazards or potential ignition during the product's operation.**

Refer to the **Ignition Hazards** assessment information for further details.







### **CAUTION!**

**Ensure all personnel has appropriate PPE in place before startup.**

To start the H-Drive gas booster system safely, follow the steps below in the specified order.



- ☑ These instructions are intended for initial start up or if the H-Drive has been left idle for more than 24 hours. These are not intended for immediate start/stop operations when system set points are achieved.

## Initial Startup Instructions

1. Turn on the cooling supply using an external chiller.
2. Conduct leak checks on all cooling ports and connections employing a visible inspection.
3. Conduct process gas purge procedure (if required).  
 Refer to **Purging the System** in the maintenance section for further details on purge requirements and instructions.
4. Slowly open the process gas supply by regulating the supply valve.  
 Gas should be initially loaded at a maximum rate of 55 bar/min (800 psig/min).
5. Slowly open the interstage circuit (two-stage models only) by regulating the interstage valve.  
 Gas should be initially loaded at a maximum rate of 55 bar/min (800 psig/min).
6. Slowly open the outlet circuit by regulating the outlet valve.  
 Gas should be initially loaded at a max rate of 55 bar/min (800 psig/min).
7. Conduct audible and bubble leak checks on all gas ports and connections.
8. Power up the hydraulic power unit.  
 Refer to the hydraulic power unit manual for powering up the HPU.
9. Verify oil temperature is within the allowable operating limits.  
 Refer to **Hydraulic Cylinder Parameter**.
10. Slowly sequence the hydraulic valve to initiate cycling of the gas booster and disengage the hydraulic piston from the cylinder head, via the settings on your control system. Initial stroke must include a variable flowrate starting at 0.5 LPM, or lower if achievable.

### CAUTION!

**A method to soft start the hydraulics is required to avoid piston damage and promote smooth operation of the hydraulic cylinder.**

11. Increase flowrate to a speed consistent with 50% of desired cycles per minute for the remainder of initial cycle.
12. Conduct leak checks on all hydraulic ports and connections, including the proximity switch or proximity switch port cover.
13. Verify that the appropriate hydraulic pressures are achieved.  
 Refer to **HPU Pressure Parameters** by H-Drive Model for further information regarding expected pressure levels by H-Drive model.
14. System is now ready to operate at the desired cycle rate.  
 Refer to the HPU Flowrate Requirements section of this manual for further information regarding cycle rate.
15. Verify that the proximity switch is in operation (if used).

**The system is ready for use.**

## 6.7 NORMAL OPERATION

The following information must be adhered to during the normal operation of the H-Drive gas booster.

- ☑ Booster shall remain within the temperature limits listed in this manual.
- 🔊 Refer to [Temperature](#) for recommended guidelines.
- ☑ Booster shall remain within the pressure limits listed in this manual.
- 🔊 Refer to [Gas Section Parameters](#) for recommended guidelines.
- ☑ Booster shall remain within the compression ratio limits listed in this manual.
- 🔊 Refer to the [Gas Section Parameters](#) for compression ratio information.
- ☑ Booster shall remain within cycle rate limits listed in this manual.
- 🔊 Refer to [Hydraulic Cylinder Flowrate Requirements](#) for cycle rate information.
- ☑ System yields should be estimated based on the initial performance of the gas booster.
- 🔊 Refer to [Troubleshooting](#) if the system yields are drastically reduced.
- ☑ The gas booster shall only be operated with a compatible hydraulic drive and process fluids. The hydraulic drive and process fluids must be free of foreign materials.
- 🔊 Refer to [Permitted Gases](#) for compatible media.
- ☑ The control system shall ensure that the correct course of action is applied upon reaching the maximum operating parameters.
- 🔊 Refer to [System Control Indicators](#) for correct courses of action.

## 6.8 SYSTEM CONTROL INDICATORS

Cylinder speeds/cycle frequency are governed by the control system. The provision of which is the responsibility of the end user. It is the responsibility of the control system provider to ensure the correct course of action is applied upon reaching the following defined parameters:

INDICATOR	ACTION
Oil temperature to the hydraulic cylinder - 160°F (70°C)	Shut down the system operator reset
Oil pressure to the hydraulic cylinder - 262 barg (3,800 psig)	Shut down the system operator reset
Gas temperature at the outlet of each cylinder - 190°C (375°F)	Idle system
Gas pressure at the outlet of each cylinder:  63mm barrel - 1,034 barg (15,000 psig) 90mm barrel - 689 barg (10,000 psig) 150mm barrel - 310 barg (4,500 psig)	Controller reset

**Table 13:** System indicators that should trigger an operator action.

## 6.9 GENERAL SHUTDOWN PROCEDURE

### WARNING!


**Failure to follow specified steps in their prescribed order during shutdown may result in significant material damage.**  
Before shutting the system down, ensure that each task is clearly understood.


### CAUTION!

**Ensure all personnel has appropriate PPE in place before startup.**  
To safely shut down the H-Drive gas booster system, follow the below steps in the specified order.

 The H-Drive gas boosters do not have a main switch. The gas booster stops operating after the hydraulic drive is shut off.

### Shutdown Instructions

1. Turn off the hydraulic valve sequencing to stop the gas booster from cycling via your control system.
2. Power down the hydraulic power unit.
-  Refer to the HPU manual for the proper shutdown procedure of the HPU.
3. Isolate the outlet gas circuit by shutting the outlet valve.
4. Isolate the interstage gas vessel by shutting the interstage valve.
5. Shut off the process gas supply by shutting the supply valve.
6. Vent the process gas from the gas booster by opening the vent valve.
7. Shut down the cooling supply by powering down the external chiller.
8. Conduct an inert gas purge procedure (if required).

 Refer to **Purging the System** procedure in the maintenance section for further details on purge requirements and instructions.



# 7.0 Maintenance and Servicing

The H-Drive gas boosters have been designed to deliver optimum performance at various operating pressures. While seals have been designed for extended life, and technological advancements ensure the best performance throughout continuous heavy-duty applications, maintenance is critical for safe, long-term operations. This section details each task that must be performed on the gas booster over its lifetime. For any maintenance on any system component outside the scope of the gas booster, recommendations are provided on how to address those tasks.

**⚠️WARNING!**

**If using a hazardous gas, you must purge the gas section with an inert gas before servicing.**

After servicing, purge the same inert gas out of the barrels with the process gas to be compressed.

**⚠️CAUTION!**

**Do not start maintenance/repair with positive pressure on the system.**

Isolate inlet gas source, outlet gas, and vent to atmospheric pressure before starting work.

## 7.1 SERVICE SCHEDULE

The following table identifies Haskel's components, system service, and maintenance schedule recommendations. Each item is subsequently explained with instructions on how to complete the maintenance exercise.

**⚠️NOTICE!**

**Failure to comply with or adhere to the recommended service schedule may invalidate your warranty.**

GAS SECTION	SERVICE INTERVAL (YEARS)	YEAR															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
CV SEAL KIT	1	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
GAS PISTON SEAL KIT	1	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
TIE RODS	4				█			█				█					
GAS PISTON BODY	7.5							█									
GAS BARREL	7.5							█									
INLET CHECK ASM	7.5							█									
OUTLET CHECK ASM	7.5							█									
<b>HYDRAULIC SECTION</b>																	
HYD. ROD SEAL	4				█			█					█				
PROX SW.	4				█			█					█				
HYD. PISTON SEAL	7.5							█									
HYDRAULIC CYLINDER (HONE)	7.5							█									
<b>HYDRAULIC SYSTEM (RECOMMENDED)</b>																	
HYD. HOSES	3			█			█			█			█				
HYD. OIL	5					█					█						
COMPLETE UNIT																█	

**Table 14: Maintenance and schedule for the H-Drive gas booster and system.**



For a more detailed service schedule checklist, please see the **System Check List** in the **Appendix**.

## 7.2 GAS BOOSTER MAINTENANCE

Refer to the **Service Schedule** for all tasks about maintaining the H-Drive gas booster. The service schedule indicates which tasks should be performed at specific intervals. A detailed maintenance log is advised to track the system's performance as a standard practice. It may also be necessary to reference the record if further repairs are required.

### PPE AND TOOLS REQUIRED FOR MAINTENANCE.

#### PPE required:

- Protective hard hat
- Protective clothing
- Protective eyewear

#### Tools required:

- Handheld temperature reading device
- Flow meter (0-2,000 SCCM recommended)
- Vent port fittings
- Calibrated torque wrench or gun
- Allen wrench for M16 bolts
- 50mm (2 in) adjustable wrench
- Clean cotton cloths
- 10-32 screw, 120mm (5 in) minimum length (for piston removal)
- Snap ring removal tools such as pliers (for piston seal package removal)
- 70 OR 90% Isopropyl Alcohol.
- Lint-free cloth
- Krytox240AZ lubricant
- 460mm (18 in) large adjustable wrench
- 2" open end adapter for Torque wrench capable of torque to 68 N-m (50 ft-lbs)
- Torque wrench capable of torque up to 410 ft-lbs (556 N-m)
- Torque socket-head for M24 hex nuts
- 1 x 3/16" Allen key
- 1 x 10mm Allen key
- 2 x 1" A/F spanner
- 1 x 1" A/F torque wrench (24 ft-lbs / 35 Nm)
- 1 x multi-meter / electrical continuity tester
- Compressed air/gas supply, regulator, and fittings
- Drip tray
- Oil spill kit
- 14mm Allen wrench
- Torque meter able to torque at 135 N-m (100 ft-lbs)
- 14mm square drive hex-bit socket for torque meter
- Plastic-head mallet
- Torque wrench capable of torque to 50 ft-lbs (68 N-m)

## 7.2.1 ROUTINE INSPECTION INSTRUCTIONS

The following maintenance tasks should be part of a set routine inspection. A detailed maintenance log is advised to track the system's performance as a standard practice.

### 7.2.1.1 CHECK GAS INLET AND OUTLET PRESSURE LEVELS

The gas inlet and outlet pressure should be continuously monitored. Checking the gas inlet/outlet pressure levels is essential to ensure your system is operating within the design requirements.

#### Gas inlet and outlet pressure levels:

1. Check the inlet, outlet, and interstage (two-stage models only) pressure gauges.
2. Confirm that the pressure levels are within the normal operating parameters.
3. See **Systems Integration** for verifying normal operating pressure levels.
4. Note normal operating pressure ranges for the specific application.
5. If running outside your normal range, refer to the **Troubleshooting** section of this manual.
6. Check to see if the interstage levels are reduced or at an unusual rate (two-stage boosters only).

### 7.2.1.2 CHECK GAS INLET AND OUTLET TEMPERATURE

The gas inlet and outlet temperature should be monitored continuously. Checking the gas inlet and outlet temperatures is essential to ensure your system operates within the design requirements.

The gas system needs adequate cooling to operate efficiently. The gas coming through the inlet of the booster should not exceed **38°C (100°F)**. Excessive inlet gas temperatures may affect the system's operation and cause potential damage to the booster.

To monitor the gas outlet temperature, Haskel recommends installing a thermocouple approximately 1 in. from the discharge port of the gas pumping section. Any temperature above **190°C (374°F)** at this juncture may cause potential damage to the booster. Follow the actions detailed in the **System Control Indicators** section.

**If a thermocouple is not installed on your gas booster, the surface temperature at specific pick points can be used to check the gas inlet and outlet temperatures.**

#### **WARNING!**

**Hot surfaces if checking surface temperature manually.**

#### For a double-acting gas booster (any HGD model)

1. Check the gas inlet and outlet temperatures by using a handheld temperature device near the surface of each gas valve.

#### For a two-stage gas booster (any HGT model)

1. Check the gas inlet temperature by using a handheld temperature device near the surface of the gas inlet valve.
2. There are two points on the gas booster to measure the gas outlet temperature.
3. Check the gas outlet temperature at both points using a handheld device at the gas outlet valve.

☑ The gas inlet temperature should not exceed 38°C (100°F).

☑ The gas outlet temperature should not exceed 190°C (374°F)

🔊 If the gas outlet temperature exceeds 190°C (374°F), stop operation and refer to the **Troubleshooting** section of this manual.

### 7.2.1.3 CHECK HYDRAULIC OIL TEMPERATURE

The hydraulic oil temperature should be monitored continuously. Checking the oil temp in the system is essential to ensure your system is operating within the design requirements.

#### Hydraulic oil temperature:

The temperature of the hydraulic fluid in hydraulic systems can be measured either with simple measurement devices (thermometers) or with a measuring device that issues signals to the control unit.

The simplest method is measuring the temperature of the pressure fluid in the tank. However, this method constitutes a rough estimate and does not allow conclusions to be drawn regarding the temperature of the pressure fluid at specific locations within the system. For example, the temperature of the pressure fluid may be very high at specific throttle points. If the temperature of the pressure fluid must be known at particular points within the hydraulic system, pressure-resistant sensors must also be fitted at these locations.

The temperature measurement is critical as temperatures greater than 60°C (140°F) can prematurely age the hydraulic fluid and seals. Significant temperature differences can also result in large differences in the fluid's viscosity.

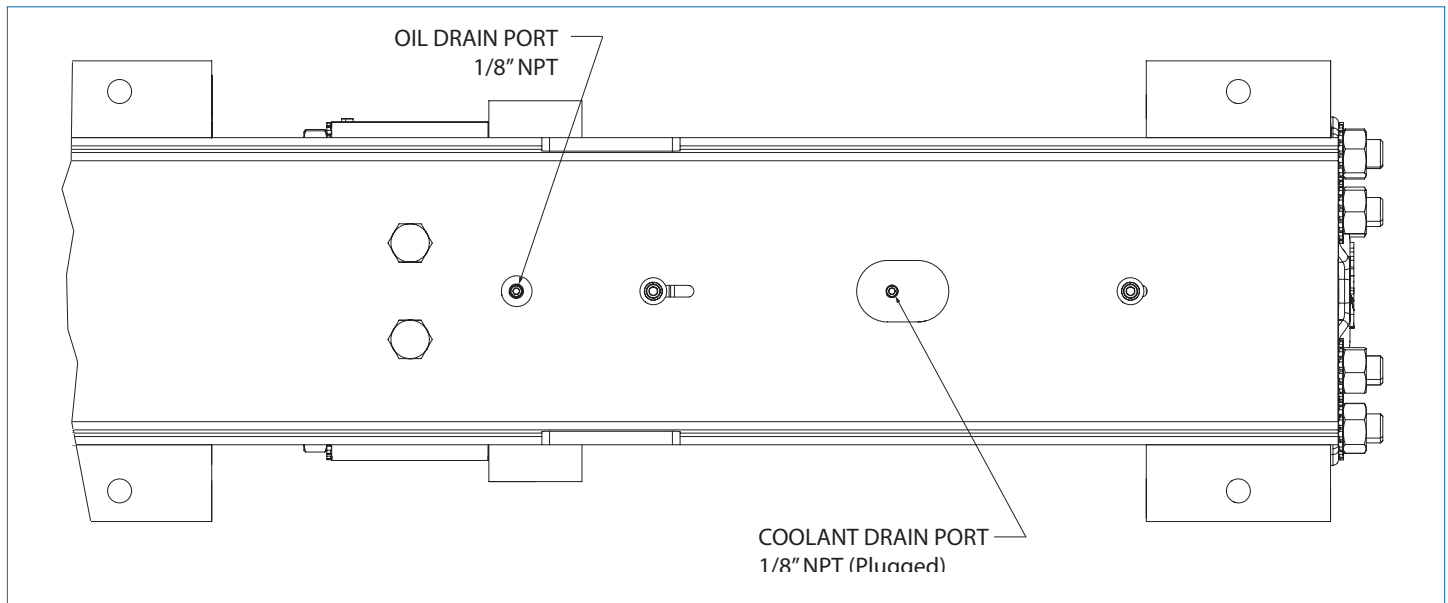
Thermo-switches or thermostats may be used to switch on a cooling or heating system when necessary to keep the temperature constant and within range.

#### If your hydraulic oil temperature is outside the specified operating range:

- ✔ Follow actions detailed in the **System Control Indicators** section
- ✔ Consult the HPU manufacturer and refer back to your system's P&ID.

### 7.2.1.4 CHECK FOR OIL LEAKS

Checking for hydraulic oil leaks at the booster is essential to ensure your system operates within the design requirements. [Reference Figure 28](#) for hydraulic oil drain port location. The hydraulic oil drain port should never be plugged during normal operation.



**Figure 28:** Hydraulic oil and Coolant Drain Locations (Bottom View of Booster).

- ✔ Maximum oil temperature limit is 70°C (150°F).
- ✔ The minimum oil temperature is 15°C (60°F).

It is recommended that a clear plastic line be installed from the booster hydraulic drain port to an oil catch basin. This will aid in the ease of oil leak inspection.

 **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

- All potential energy sources should be isolated.

## Oil leak rate:

1. Depressurize the system and remove all potential energy sources
2. Visually inspect oil drain ports or lines for leaks (**Reference Figure 28, gas and hydraulic energy sources.**).
3. If a minor leak is present, monitor the oil leak rate daily and schedule hydraulic rod seal service
4. If a significant leak is present, stop operation and conduct hydraulic rod seal service

### 7.2.1.5 PERFORM A PISTON SEAL BYPASS TEST

A piston seal bypass test should be performed every 500 hours of operation. Performing a piston seal bypass test is essential to ensure your system operates within the design requirements.

- ☑ This is a static test (Hydraulics are Idled).

## To perform a piston seal bypass test:

1. After system has been brought to nominal temperatures and pressures, idle the hydraulics and allow system to stabilize.
  2. Static leak test can be conducted with minimum of 60% nominal pressure per stage.
  3. Connect the flow meter to the vent port.
  4. Read the flow meter to determine the leakage rate on the flow meter.
- ☑ If external leakage through the vent port, as indicated on the flow meter, exceeds 750 SCCM, refer to **Troubleshooting**.

 **CAUTION!**

**Booster may move due to changing gas pressures (unbalanced loads). Repeated measurements may be required.**

### 7.2.1.6 CHECK TORQUE VALUE OF CHECK VALVES

Ensuring the check valves are installed correctly to the pre-defined torque specifications is essential in ensuring the booster will operate safely and correctly. Insufficient torque may cause the check valves to be loosened easily by vibrations, while excess torque can damage the booster. It is also good practice to apply torque seal after verification and perform regular audits once the correct torque has been established.

 **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

 **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**


Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

## Loose torque on the gas check valves:

1. Disconnect tube and fitting from check valve being inspected.
2. Remove check valve from the end cap and torque body and fitting to specifications.

 Reference **Check valve assembly views Figure 33 - Figure 38**.

3. Use the calibrated torque wrench or gun to verify the torque on the check valve to the end cap.

 Refer to the **Torque Specifications** in this manual for further information regarding the gas check valve torque requirements.

### 7.2.1.7 CHECK TORQUE VALUE OF TIE RODS

Utilizing the proper torque is an essential part of any reliable joint bolt. Insufficient torque will cause the joint to be loosened easily by vibrations, while excess torque can lead to overstretching and breaking your bolts. It is also good practice to apply torque seal after verification and perform regular audits once the correct torque has been established.

#### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut down the system before purging.

#### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**


Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

## To check for loose torque on the tie rods, Haskel recommends:

1. Use the calibrated torque wrench or gun to verify the torque on the tie rods.

#### **NOTICE!**

**Refer to the tightening sequence label on the gas section. Use the same sequence to verify the tie rods' torque in 13 Kg-m (100 ft-lbs) increments.**

 Refer to the **Torque Specifications** in this manual for tie rod torque requirements.

### 7.2.2 PURGING THE SYSTEM

#### **WARNING!**

**If the H-Drive gas booster has been compressing a flammable/explosive gas medium (such as hydrogen, methane, or butane), the system must be purged with an inert gas to dilute the volatile gas concentration below the lower explosive limit (LEL) of the gas type before any maintenance steps.**

Always ensure the system has been made safe in the area where the work is required by disconnecting the power source. All energy supplies, such as gas, electrical, or mechanical, must be locked out so that any maintenance activity being conducted is entirely safe.

- Always conduct maintenance in well ventilated area.
- Always purge the system with an inert gas to remove any potential for an explosive atmosphere.
- Verify with analog gauges that all pressure is vented, as digital indicators may malfunction..
- When reinstating the machine, a proper process gas purge sequence must be followed to ensure safety and gas purity.

**In system applications, most flammable gas is vented out of the system/booster, but residual amounts of gas may remain trapped behind valves.**

**Purging gas sections of the process gas is required:**

- **Before repairs:** purging the system allows flammable gases such as hydrogen (H<sub>2</sub>) and methane (CH<sub>4</sub>) to be expelled before repairs. Purging with inert gas, such as nitrogen (N<sub>2</sub>), removes the potential for creating an explosive atmosphere in the maintenance area.
- **During idle times:** when equipment is to be idled for extended periods (for more than two weeks, for example), purging with nitrogen (N<sub>2</sub>) will mitigate any long-term exposure of hazardous gasses like (H<sub>2</sub>) and methane (CH<sub>4</sub>) on the metal system components. It also prevents the ingress of moisture and particulates into the gas section during idle periods. Isolating a low-pressure blanket of Nitrogen (N<sub>2</sub>) at approximately 3.5-7 barg (50-100 psig) is adequate for this containment. This process is sometimes referred to as inerting.

**Inert Gas Purge Sequence:**

1. Route the vented gas to a safe location away from the equipment and the operator **7-9 m (25-30 ft)**.
2. Vent all process gas to zero gas pressure or the lowest possible level.
3. Introduce the purge gas—nitrogen (N<sub>2</sub>)—at the inlet port at 3.5-7 barg (50-100 psig).
4. Route the purged gas to a safe location away from equipment and operator 7-9 meters (25-30 ft).
5. Purge or flow nitrogen (N<sub>2</sub>) to the outlet port for 10 minutes.
6. Vent to zero, same as step 2, and prepare for disassembly.
7. If inerting or blanketing for a long-term idle, isolate the inlet and outlet valves after the 10-minute purge to hold the 3.5-7 barg (50-100 psig) pressure in the gas circuit.

**Explosive Gas (H<sub>2</sub>) Purge Sequence:**

Always conduct inert gas purge sequence prior to introducing explosive gas (H<sub>2</sub>). NEVER mix oxygen and explosive gas. If in doubt, re-conduct inert gas purge procedure.

1. Route the vented gas to a safe location away from the equipment and the operator 7 - 9m (25 - 30ft).
2. Close vents and introduce Hydrogen via the inlet port at 10 - 18 barg (145 - 261 psig).
3. Close vents and introduce the explosive gas (i.e. Hydrogen (H<sub>2</sub>)) at the inlet port at 10 - 18 barg (145 - 261 psig).
4. Open vents, ensure venting through system.
5. Allow system to vent down to 2 barg (29 psig).
6. Repeat steps 3 - 5 for a total of 8 times

30 barg (435 psig) initial fill at the end of the purge sequence will dilute the gas further and may be used as a final step of the purge sequence to achieve the purity figures of ISO 14687-2: Hydrogen Fuel Quality.

## 7.2.3 ROUTINE MAINTENANCE INSTRUCTIONS

The following maintenance tasks should be part of your gas booster's routine maintenance. A detailed maintenance log is advised to track the system's performance as a standard practice.

### 7.2.3.1 REPLACE GAS SECTION SEALS

If the H-Drive is experiencing external leaks or abnormal operating conditions, refer to the [Troubleshooting](#) guide. Haskel recommends keeping a gas section seal kit on hand as a spare if maintenance is required. Replacing seals is essential to ensure your system is operating optimally.

#### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See [Purging the System](#) for additional information.

- Always shut the system down before purging.

#### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

### Gas section seals:

1. Disconnect the gas pipework or tubing to the inlet and outlet connections of the gas sections.
2. Cap all open ports during service to maintain cleanliness.
3. Loosen the tie rods on the cylinder head (end cap) but do not entirely remove them.

#### **NOTICE!**

**Refer to the tightening sequence label on the gas section. Use the same sequence for loosening the tie rods in 13 Kg-m (100 ft-lbs) increments.**

4. Loosen the check valve assemblies from the end caps but do not entirely remove them.
5. Remove the end caps. Use a rubber mallet to assist in removal from the barrel.

#### **NOTICE!**

**Trapped gas in the end cap o-ring may decompress and make a popping sound when removed, this is normal.**

6. Remove the cooling jacket leg screws from the base plate. The hydraulic drive cylinder should remain bolted to the base plate.
7. Remove the gas section and adaptor piece.
8. Inspect all seals and bearings for irregular wear.

#### **NOTICE!**

**Do not separate cooling jacket and gas barrel unless leak is present or pmi schedule dictates o-ring replacement**

9. If the piston seal requires replacement, refer to the [Replace Gas Piston Seal](#) section.
10. Inspect all seal surfaces for any score marks. Minimal burnishing discoloration is normal. Scratches with real depth may require the damaged part to be reworked or replaced based on the severity of the scratches.
11. While the gas section is apart, clean the inside of the barrel and components with alcohol and a lint-free cloth.
12. Consult the factory for maximum diameter and finish requirements.

 The H-Drive pistons are self-aligned by bearings. Bearing dust accumulation in the gas barrels is normal.

13. Replace O-rings, seals, and backups as necessary upon inspection
14. Apply a thin layer of Krytox240AZ lubricant to all O-rings before installation.
15. Push the adapter piece back against the hydraulic drive end cap.
16. Push the barrel assembly against the adapter piece and hold it in place.
17. Replace end cap O-ring and backup.
18. Install the end cap and check valve assemblies.



**i** A small gap between the end cap and the cooling barrel is normal.

19. Install the retainer piece against the end cap.

**i** Ensure that the retainer piece center bore matches the round extruded feature on the end cap. This will ensure that the retainer piece and end caps are aligned.

20. Install washers.

**i** The grooved surface of the washers should face the retainer piece, and the flat surface should face the nuts.

21. Hand tighten the nuts.


22. Follow the tightening pattern and instruction label placed on the cooling barrels to torque the tie rods.

**i** Ensure gas section retainer piece is resting flush on mounting plate. If not loosen nuts and repeat steps 21 - 22.

23. Hand tight the gas section leg screws to the base plate. **Do NOT** torque.


 Refer to the **Section 7.5** to find the exploded view of the gas section for visual detail.

 Only use Haskel gas section seal replacement kits

 Refer to the **Section 7.5** for your gas booster's seal kit P/N.

### 7.2.3.2 REPLACE GAS PISTON SEALS

If the H-Drive is experiencing excessive leaks through vent ports or abnormal operating conditions, refer to the **Troubleshooting** guide. Haskel recommends keeping a gas piston seal kit on hand as a spare if maintenance is required. Replacing seals is essential to ensure your system is operating optimally.

 Generally, seals should be replaced after 1,500 hours of operation, depending upon the duty and severity of the cycle.

#### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut down the system before purging.

#### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

### Gas piston seals:

1. Disconnect the gas pipework or tubing to the inlet and outlet connections of the gas sections.
2. Cap all open ports during service to maintain cleanliness.
3. Loosen the tie rods on the cylinder head (end cap) but do not entirely remove them.

#### **NOTICE!**

**Refer to the tightening sequence label on the gas section. Use the same sequence for loosening the tie rods in 13 Kg-m (100 ft-lbs) increments.**








4. Remove tie rod bolts and retainer plate.
5. Remove the end cap. Use a rubber mallet to assist in removal from the barrel.
6. Remove the gas piston assembly. Use the 10-32 screw and hand tighten the piston center threaded hole. Pull the piston out using the screw.

#### **NOTICE!**

**Trapped gas in the end cap o-ring may decompress and make a popping sound when removed, this is normal.**

7. Remove the snap ring from the piston body.
8. Remove the bearings, piston seal packages, and wear rings.
9. Clean piston and inspect for wear marks, replace if damaged or evidence of piston or barrel scoring. Barrel scoring will require

new gas barrel.

10. Replace seal package, front bearing (if applicable), and retainer.
11. Inspect and replace wear rings.
12. Replace end cap O-ring and backup.
13. Reinstall the piston assembly in the correct orientation shown in (Reference figures in the **Drawings** section of this manual for your specific H-Drive model).
14. Apply a thin layer of Krytox240AZ lubricant to all O-rings before installation.
15. Install the end cap and check valve assemblies.
  -  A small gap between the end cap and the cooling barrel is normal.
16. Install the retainer piece against the end cap.
  -  Ensure that the retainer piece center bore matches the round extruded feature on the end cap. This will ensure that the retainer piece and end caps are aligned.
17. Install washers.
  -  The grooved surface of the washers should face the retainer piece, and the flat surface should face the nuts.
18. Hand tighten the nuts.
19. Follow the tightening pattern and instruction label placed on the cooling barrels to torque the tie rods.
20. Hand tight the gas section leg screws to the base plate. **Do NOT** torque.
  -  Ensure gas section retainer piece is resting flush on mounting plate. If not loosen nuts and repeat steps 18 - 19.
  -  Refer to the **Appendix** to find the exploded view of the gas section for visual detail.
  -  Only use Haskel gas section seal replacement kits
  -  Refer to the **Parts List** for your gas booster's seal kit P/N.

### 7.2.3.3 REPLACE INLET AND OUTLET CHECK VALVE SEALS

Replacing seals is essential to ensure your system is operating efficiently.

#### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut down the system before purging.

#### **CAUTION!**


**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

#### **CAUTION!**

**When installing a new check valve, pay attention to the existing inlet and outlet ports. Swapping inlet and outlet check valves can result in over-pressurizing the gas barrels and tubing.**

Match words “in” and “out” on the end cap ports with the check valve body etchings.

-  Check valves are considered spare parts and replaced as factory-tested assemblies.

## Check valve seals

1. Disconnect the gas pipework or tubing to the inlet and outlet connections of the gas sections.
2. Cap all open ports during service to maintain cleanliness.
3. Loosen and remove the check valves from the booster.
4. Disassemble check valve (Reference figures in the **Drawings** section of this manual for your specific H-Drive model).
5. Inspect and clean check valve body with IPA and a lint-free cloth.
6. Replace check valve body if the damage is observed.
7. Reassemble the check valve with new internal components.
8. Reinstall check valves to the end cap, ensuring the words “in” and “out” on the check valve match the ones on the end cap.
9. Use the torque wrench to pre-tighten assemblies.
10. Apply a final torque of  $68 \pm 7$  N-m ( $50 \pm 5$  ft-lbs).

### 7.2.3.4 REPLACE TIE RODS

Replacing the tie rods is essential to ensure your system can safely operate within the design requirements.

#### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut down the system before purging.

#### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

- ✓ Haskel suggests scheduling tie rod replacement with gas section service schedule if possible.

## Tie rods:

1. Loosen the tie rods in 135 N-m (100 ft-lbs) increments according to the tightening instruction sequence.
2. Once you have reached approximately 135 N-m (100 ft-lbs) torque on each nut, start replacing the tie rods one by one to avoid disassembling the whole gas section.
3. Tie rods are screwed into the hydraulic drive end cap. Unscrew by hand and remove.
4. Replace the tie rods, washers, and nuts. Do not reuse any washer and nut.
5. Screw the tie rods in the hydraulic drive end cap by hand.
6. Install the nuts and washers.
7. The flat side of the washers should face the nuts.
8. Leave at least two threads out from each nut.
9. Hand tight all the nuts first.
10. Torque in 135 N-m (100 ft-lbs) increments, following the tightening instructions label on the gas section to torque.
11. Start torquing the nuts on the end cap side.
12. Continue torque process until tie rods are torqued to 556 N-m (410 ft-lbs).
13. Once all nuts are torqued, check the torques on the hydraulic drive side.

## 7.2.3.5 REPLACE PROXIMITY SWITCHES

Replacing the proximity switches is essential to ensure your system operates within the design requirements.

### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut the system down before purging.

### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

### **CAUTION!**

**Ensure the systems have been switched off long enough to cool down the oil inside the hydraulic drive.**

This installation results in oil drainage from the connecting hoses and hydraulic drive cylinder through proximity switch ports.

- Use a large catch tray underneath the hydraulic drive to capture the drained oil.

**This work instruction shows the field installation process of 2 x 86694 Proximity Switch on the 88062 Hydraulic Cylinder of the Haskel H-Drive**

### **NOTICE!**

**This procedure should only be conducted on an H-Drive that has been isolated from any gas and hydraulic oil supply and does not retain any pressure.**

## Proximity switches:

### Proximity switch preparation

1. Remove 86694 proximity switch from box & retain documentation & half nuts.
2. Check the body of the proximity switch for mechanical damage; if the damage is present, consult Haskel customer service.
3. Inspect cable for a sign of mechanical damage (NOTE: keep the cable coiled as this will make installation easier)
4. Check that the ATEX marking is correct on the proximity switch body.
5. Install both half nuts fully on the proximity switch body
6. Install CNF00321 flat washer on proximity switch body.
7. Install CNF00319 pressure washer on proximity switch body.
8. Set proximity switch down away from any metallic debris.
9. Repeat steps for the 2nd Proximity switch.

## H-Drive preparation (right-hand side proximity switch)

### ⚠ NOTICE!

**H-Drives are shipped with oil residue in the hydraulic section, which may spill out during this process.**

If this task is being performed on an H-drive that has been in service, the amount of oil will be significantly more (up to 5 LPM).

1. Using a 10mm Allen key, remove both transit caps #20 SAE hydraulic connections on the 88062 hydraulic drive section.

### CAUTION: OIL SPILL RISK

2. With the proximity switch ports facing the operator, attach a suitable fitting to insert gas into the **left-hand side** of the hydraulic drive section.
3. Gently apply 2 bar gas pressure onto the hydraulic piston. This will cause the hydraulic piston to travel to the right-hand side, and any residual oil will be pushed out of the right-hand hydraulic oil port.

### CAUTION: OIL SPILL RISK

4. Gently relieve the gas pressure from the hydraulic piston.

## Proximity switch installation (right-hand side)

1. Using a 3/16" Allen key, remove the 2 x socket head cap-screws from the proximity switch port retaining cap.

### CAUTION: OIL SPILL RISK

2. Ensure that the O-ring has detached and its newly exposed face is clean and debris-free.
3. Screw the proximity switch into the port until it stops (this should be approximately 55mm).
4. Using a multimeter, check that the proximity switch is registering the presence of the hydraulic piston (continuity between black and white cables).
5. Unscrew the proximity switch by 1/2 to 1 turn (0.05" [1.2 mm]. Max Sensing Distance: 0.072" [1.82 mm]).
6. Using a multimeter, check that the proximity switch is still registering the presence of the hydraulic piston.
7. Repeat steps 3 - 6 twice to ensure that the switch is correctly seated.
8. Using a spanner, hold the head of the proximity switch in position.
9. Using the other spanner, tighten the first half nut down until the pressure washer starts to compress.
10. Tighten the first half nut using the torque wrench to 34 Nm (25 lb-ft).
11. Tighten down the second half nut using a second spanner to lock both in place.
12. Using the multimeter, confirm the operation of the proximity switch.

## Repeat sections 2 and 3 for the left-hand proximity switch

## 7.2.3.6 REPLACE HYDRAULIC CYLINDER ROD SEALS

Replacing seals is essential to ensure your system operates within the design requirements.

### Hydraulic cylinder rod seals:

- ✔ Before performing this service, both gas sections should be removed entirely from the base plate.
- 📢 Refer to [Drawings Section Hydraulic cylinder rod service, 3-D view, reference 88628](#) for reference.

1. Use a catch tray to collect hydraulic fluid during this service process.
2. Isolate the inlet and outlet hydraulic oil lines to and from the gas booster.
3. Disconnect the hydraulic connections (2 ports).
4. Use best practices to remove oil from the hydraulic cylinder on the side being serviced before continuing. Proximity ports may be used as a drain location.
5. Clean the hydraulic cylinder shaft with alcohol and a lint-free cloth, allowing it to air dry.
6. Loosen the cylinder head screws in a cross pattern, but do not remove them. There are 12 screws on each side.
7. Loosen the screws further to remove.

#### **WARNING!**

**Remove the cylinder head slowly, as residual oil will leave through the gap.**

8. Apply a thin layer of hydraulic fluid to the cylinder rod.
9. Pull out the hydraulic cylinder end cap. Use a rubber mallet if necessary.
10. Replace the hydraulic cylinder rod seals with a new seal kit.
11. Put the piston rod assembly back into the barrel.
12. Replace the hydraulic cylinder end cap.
13. Apply a thin layer of hydraulic fluid to the cylinder rod.
14. Replace the cylinder head screws.
15. Torque cylinder head screws to 68 N-m (50 ft-lbs) in a cross pattern.
16. Then torque the cylinder head screws to 120 N-m (88 ft-lbs) in a cross pattern.
17. Reinstall the proximity switches if used.
18. Connect the hydraulic hoses (2) to the cylinder ports.
19. Torque connections to a maximum of 271 N-m (200 ft-lbs).

## 7.2.3.7 REPLACE HYDRAULIC PISTON SEALS

Replacing seals is essential to ensure your system operates within the design requirements.

### Hydraulic seals:

✔ Before performing this service, both gas sections should be removed entirely from the base plate.

📢 Refer to [Hydraulic cylinder rod service, 3-D view, reference 88628](#) for reference.

1. Use a catch tray to collect hydraulic fluid during this service process.
2. Isolate the inlet and outlet hydraulic oil lines to and from the gas booster.
3. Disconnect the hydraulic connections (2 ports).
4. Disconnect the proximity switches one by one.

**⚠WARNING!**

**Oil will drain through the ports.**

If proximity switches are not used on your system, remove one of the proximity switch covers to drain the oil. Replace the covers when the oil is drained.

5. Clean the hydraulic cylinder shaft with alcohol and a lint-free cloth, allowing it to air dry.
6. Loosen the cylinder head screws in a cross pattern, but do not remove them. There are 12 screws on each side.
7. Loosen the screws further to remove.

**⚠WARNING!**

**Remove the cylinder head slowly, as residual oil will leave through the gap.**

8. Apply a thin layer of hydraulic fluid to the cylinder shaft.
9. Pull out the cylinder head. Use a mallet if necessary.
10. Pull piston rod assembly from the barrel.
11. Replace the hydraulic seals.
12. Replace the rod seals.
13. Put the piston rod assembly back into the barrel.
14. Replace the cylinder head. Use a mallet if necessary.
15. Apply a thin layer of hydraulic fluid to the cylinder shaft.
16. Replace the cylinder head screws.
17. Torque cylinder head screws to 68 N-m (50 ft-lbs) in a cross pattern.
18. Then torque the cylinder head screws to 120 N-m (88 ft-lbs) in a cross pattern.
19. Mount the cylinder back onto the base plate using the four base plate screws. Follow instructions from the [Installation](#) section of this manual to reinstall the gas booster.
20. Reinstall the proximity switches if used. Follow instructions from the [Installation](#) section of this manual to reinstall the proximity switches.
21. Connect the hydraulic hoses (2) to the cylinder ports.
22. Torque connections to a maximum of 271 N-m (200 ft-lbs).

## 7.2.3.8 REPLACE GAS BARREL

### **WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut off the system before purging.

### **CAUTION!**

**Maintain a clean environment while servicing this product.**

Foreign objects entering the internal assemblies may cause scoring the gas barrels and permanent seal wear.

- Clean parts with clean alcohol and a lint-free cloth.
- Cover parts/assemblies removed for service until reassembly.

### **CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, and outlet gas, and vent to atmospheric pressure before starting work.

## Gas barrel:

1. Disconnect the gas pipework or tubing to the inlet/outlet of the gas sections.
2. Cap all open ports during service to maintain cleanliness.
3. Loosen tie rods on the cylinder head (end cap) but do not entirely remove them.

### **CAUTION!**

**Refer to the tightening sequence label on the gas section. Use the same sequence for loosening the tie rods in 13 Kg-m (100 ft-lbs) increments.**

4. Keep the hydraulic drive cylinder bolted to the base plate.
5. Remove the end caps. Use a rubber mallet to assist in removal from the barrel.
6. Inspect the barrel for any scratches or scoring. Minimal burnishing discoloration is normal.
7. Remove the gas piston assembly. Use the 10-32 screw and hand tighten the piston center threaded hole. Pull the piston out using the screw.
8. Inspect and replace piston seals if necessary (see **Replace Piston Seals**).
9. Set the piston seals aside and cover until ready for reassembly.
10. Remove screws from the gas section legs to the base plate.
11. Remove gas barrel assembly.
12. Remove the gas barrel from the cooling jacket.
13. Replace the gas barrel using new O-rings and a new snap ring.
14. Apply a thin layer of Haskel lubricant to the exterior of the barrel to assist with installing it into cooling jacket.
15. Push the adapter piece back against the hydraulic drive end cap.
16. Push the barrel assembly against the adapter piece and hold it in place.
17. Replace the end cap O-ring and backup.
18. Apply a thin layer of Krytox240AZ lubricant.
19. Reinstall piston in the proper orientation (Reference figures in the **Drawings** section of this manual for your specific H-Drive model).
20. Install the end cap and check valve assemblies.

 A small gap between the end cap and the cooling barrel is normal.



21. Install the retainer piece against the end cap.

- i** Ensure that the retainer piece center bore matches the round extruded feature on the end cap. This will ensure that the retainer piece and end caps are aligned.

22. Install washers.

- i** The grooved surface of the washers should face the retainer piece, and the flat surface should face the nuts.

23. Hand tighten the nuts.

24. Follow the tightening pattern and instruction label placed on the cooling barrels to torque the tie rods.

- i** Ensure gas section retainer piece is resting flush on mounting plate. If not loosen nuts and repeat steps 23 - 24.

### 7.2.3.9 REPLACE INLET AND OUTLET CHECK VALVES

#### **⚠WARNING!**

**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See **Purging the System** for additional information.

- Always shut down the system before purging.

#### **⊗CAUTION!**

**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate the inlet gas source, outlet gas, and vent to atmospheric pressure before starting work.

- i** Check valves are considered spare parts and replaced as factory-tested assemblies.

#### **⊗CAUTION!**

**When installing a new check valve, pay attention to the existing inlet and outlet ports. Swapping inlet and outlet check valves can result in over-pressurizing the gas barrels and tubing.**

Match words “in” and “out” on the end cap ports with the check valve body etchings.

### Inlet and outlet check valves:

1. Disconnect the gas pipework or tubing to the inlet/outlet of the gas sections.
2. Cap all open ports during service to maintain cleanliness.
3. Use the torque wrench to loosen and remove the outlet check valves.
4. Reinstall new factory-tested check valves.
5. Ensure the check valves are reinstalled in the correct orientation.
6. Use the torque wrench to pre-tighten assemblies.
7. Apply a final torque of  $68 \pm 7$  N-m ( $50 \pm 5$  ft-lbs).

## 7.4 TORQUE REQUIREMENTS

Torque is a significant variable when it comes to safely installing the gas booster and performing maintenance on the system over time. You can both over and under torque a bolt. Typically, an under-torqued bolt will deform and be unable to provide as much clamping force as needed. An over-torqued bolt will break.

Please refer to the following table when performing any tasks on the gas booster that require torqued fittings.

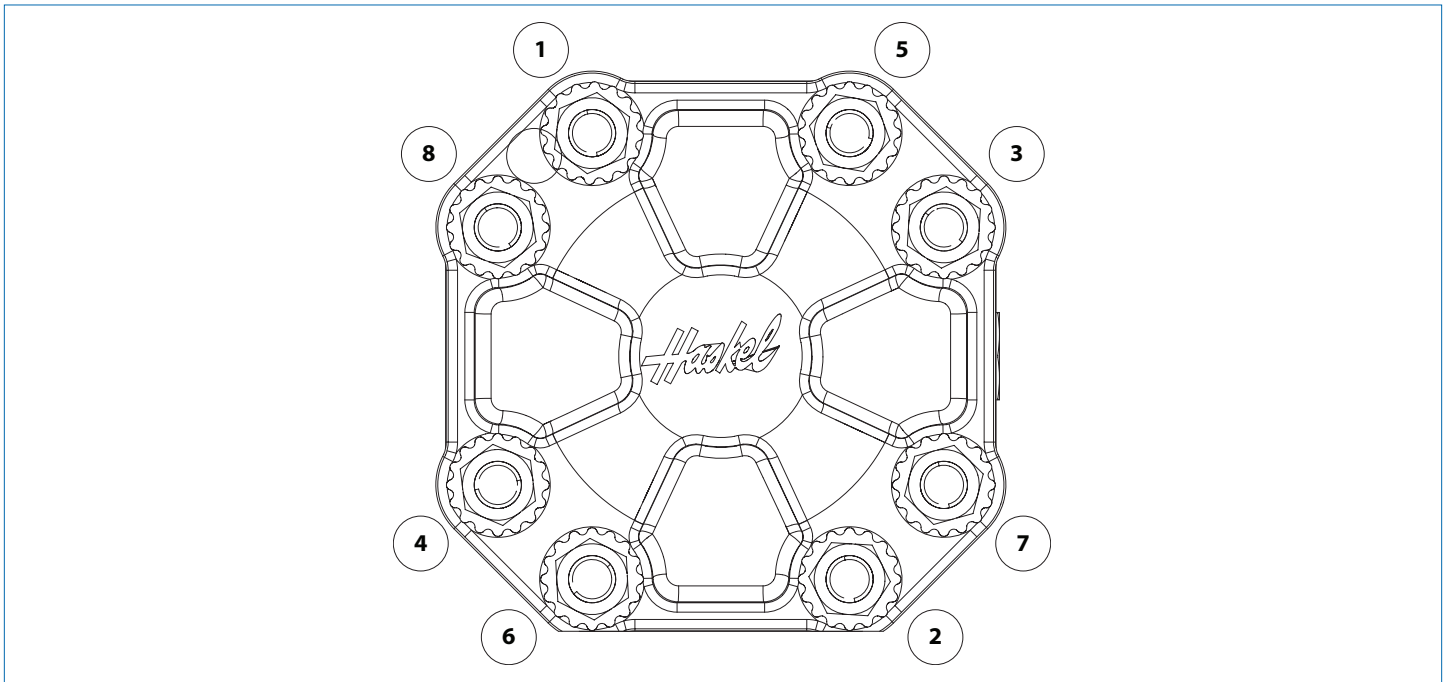
SECTION	FASTENER DESCRIPTION	TORQUE
gas section	tie rods	555 ± 13 N-m (410 ± 10 ft-lbs)
hydraulic section	proximity switch screws	10 N-m (8 ± 0.5 ft-lbs)
gas section	cooling connections	68 N-m (50 ft-lbs)
hydraulic section	hydraulic hoses	271 N-m (200 ft-lbs)
gas section	gas connection	68 N-m (50 ft-lbs)
gas section	vent connections	68 N-m (50 ft-lbs)
gas section	cooling barrel drain	27 ± 7 N-m (20 ± 5 ft-lbs)
hydraulic section	proximity switches	17 ± 1 N-m (12.5 ± .5 ft-lbs)
hydraulic section	hydraulic drive mounting holes	3.45 Kg-m (25 ft-lbs)

SECTION	FASTENER DESCRIPTION	TORQUE
gas section	inlet and outlet check valves	68 N-m (50 ft-lbs)
hydraulic cylinder	M16 bolts	120 N-m (88 ft-lbs)
hydraulic cylinder	eyebolts	135 N-m (100 ft-lbs)

**Table 15: Torque specifications per component for the H-Drive gas booster.**

- i** Apply anti-seize compound to tie rod threads and use the figure below to torque tie rods in 100 ft-lbs increments until above torque specification is achieved. Leave at least three threads exposed from the nut on each side. Retainer plate should be resting flush on base plate. If not, loosen nuts and re-torque.



**Figure 29: End cap torque sequence.**

## 7.5 DRAWINGS AND SCHEMATICS

### 7.5.1 COMMON PART LIST - H DRIVE

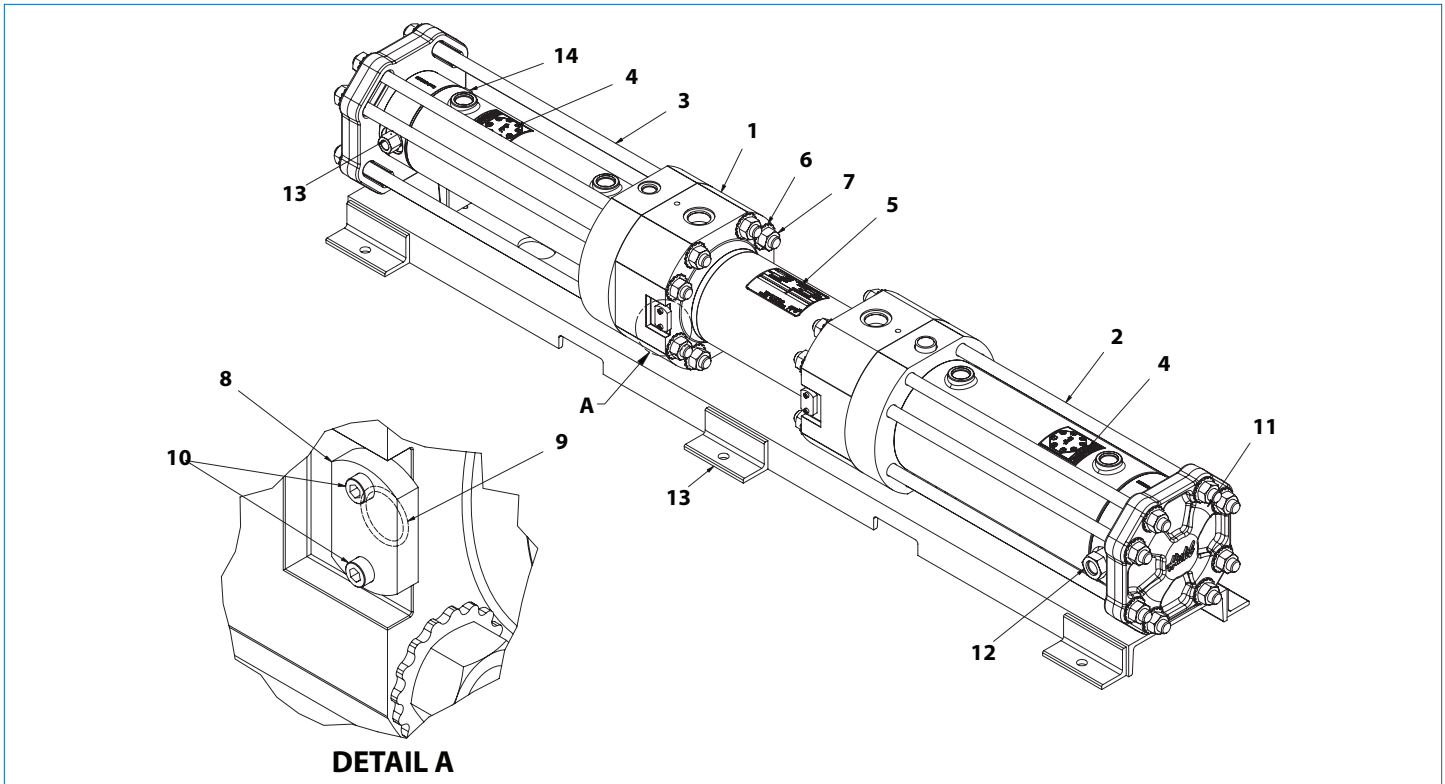


Figure 30: Common Part List

PART LIST								
Item	Description	Model						Qty
		150/90-1-X	150/90-2-X	150/63-1-X	150/63-2-X	90/63-1-X	90/63-2-X	
1	Hyd Cylinder Assy	88062	88062	88062	88062	88062	88062	1
2	Gas Section Assy (1st Stage)	88095	88095-2	88095	88095-2	88096	88096-2	1
3	Gas Section Assy (2nd Stage)	88096	88096-2	88097	88097-2	88097	88097-2	1
4	Label, Torque Instructions, H-Drive	88125	88125	88125	88125	88125	88125	2
5	Label, Name Plate, H-Drive	88137	88137	88137	88137	88137	88137	1
6	Washer	CNF00383	CNF00383	CNF00383	CNF00383	CNF00383	CNF00383	16
7	Nut	CNF00384	CNF00384	CNF00384	CNF00384	CNF00384	CNF00384	16
8	Retainer Cap	86579	86579	86579	86579	86579	86579	2
9	O-Ring	568018-9	568018-9	568018-9	568018-9	568018-9	568018-9	2
10	Screw	CNF00385	CNF00385	CNF00385	CNF00385	CNF00385	CNF00385	4
11	Inlet Check Valve Assembly (1st Stage)	50685-3	50685-3	50685-3	50685-3	87025-2	87025-2	1
12	Outlet Check Valve Assembly (1st Stage)	86518-3	86518-3	86518-3	86518-3	86950-2	86950-2	1
13	Inlet Check Valve Assembly (2nd Stage)	87025-2	87025-2	87025-2	87025-2	87025-2	87025-2	1 1
14	Outlet Check Valve Assembly (2nd Stage)	86950-2	86950-2	86950-2	86950-2	86950-2	86950-2	1 1
15	Mntg Brkt, H-Drive	88594	88594	88594	88594	88594	88594	1

Table 16: Common Part List.

PART LIST

Item	Description	Model						Qty
		150-1-X	150-2-X	90-1-X	90-2-X	63-1-X	63-2-X	
1	Hyd Cylinder Assy	88062	88062	88062	88062	88062	88062	1
2	Gas Section Assy	88095	88095-2	88096	88096-2	88097	88097-2	2
4	Label, Torque Instructions, H-Drive	88125	88125	88125	88125	88125	88125	2
5	Label, Name Plate, H-Drive	88137	88137	88137	88137	88137	88137	1
6	Washer	CNF00383	CNF00383	CNF00383	CNF00383	CNF00383	CNF00383	16
7	Nut	CNF00384	CNF00384	CNF00384	CNF00384	CNF00384	CNF00384	16
8	Retainer Cap	86579	86579	86579	86579	86579	86579	2
9	O-Ring	568018-9	568018-9	568018-9	568018-9	568018-9	568018-9	2
10	Screw	CNF00385	CNF00385	CNF00385	CNF00385	CNF00385	CNF00385	4
11	Inlet Check Valve Assembly	50685-3	50685-3	88281	88281	88281	88281	2
12	Outlet Check Valve Assembly	86518-3	86518-3	88282	88282	88282	88282	2
15	Mntg Brkt, H-Drive	88594	88594	88594	88594	88594	88594	1

Table 16: Common Part List..

## 7.5.2 GENERAL ASSEMBLY - H DRIVE

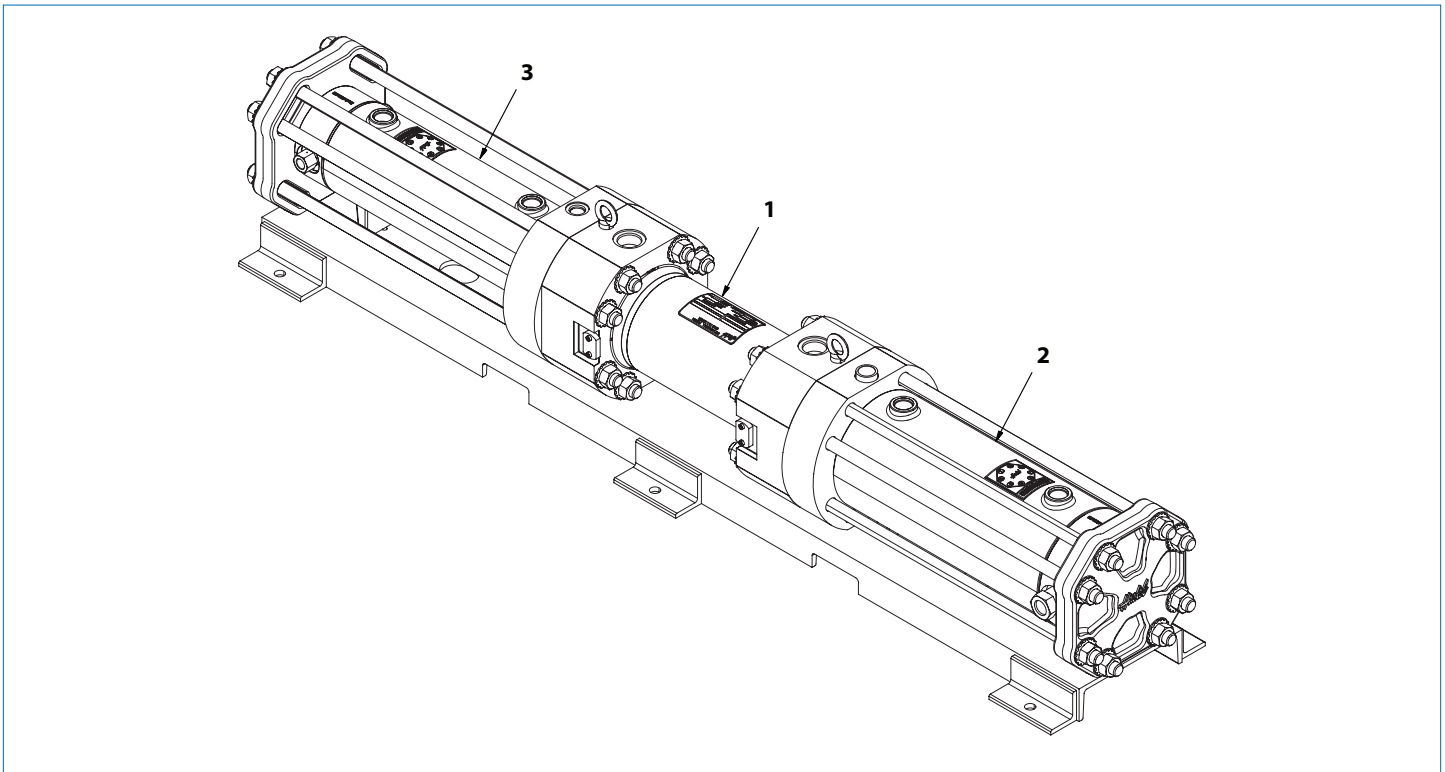


Figure 31: General Assembly

PART LIST			
HGT -1 50/63			
Item	Description	DWG No	Qty
1	Hyd Cylinder Assy, 150mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 150mm, 12" Stroke, H-Drive	88095*	1
3	Gas Section Assy, 63mm, 12" Stroke, H-Drive	88097*	1
* Model Specific - Reference Drawing 88123			
HGT -1 50/90			
1	Hyd Cylinder Assy, 150mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 150mm, 12" Stroke, H-Drive	88095*	1
3	Gas Section Assy, 90mm, 12" Stroke, H-Drive	88096*	1
* Model Specific - Reference Drawing 88122			
HGT - 90/63			
1	Hyd Cylinder Assy, 150mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 90mm, 12" Stroke, H-Drive	88096*	1
3	Gas Section Assy, 63mm, 12" Stroke, H-Drive	88097*	1
* Model Specific - Reference Drawing 88124			

PART LIST			
HGD -1 50			
Item	Description	DWG No	Qty
1	Hyd Cylinder Assy, 150mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 150mm, 12" Stroke, H-Drive	88095*	1
* Model Specific - Reference Drawing 88092			
HGD -90			
1	Hyd Cylinder Assy, 90mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 90mm, 12" Stroke, H-Drive	88096*	1
* Model Specific - Reference Drawing 88093			
HGD - 63			
1	Hyd Cylinder Assy, 63mm Bore, 12" Stroke, 3800 psi	88062	1
2	Gas Section Assy, 63mm, 12" Stroke, H-Drive	88097*	1
* Model Specific - Reference Drawing 88094			

REPAR KITS			
Item	Description	DWG No	KIT Part Number
1	Hydraulic Cylinder	88628	88065 (complete) ,88065-1 (rod seals only), 88065-2 (piston seal only)
2	150 Gas Section	88095	88321
3	90 Gas Section	88096	88332
4	63 Gas Section	88097	88323

## 7.5.3 EXPLODED VIEW - H DRIVE

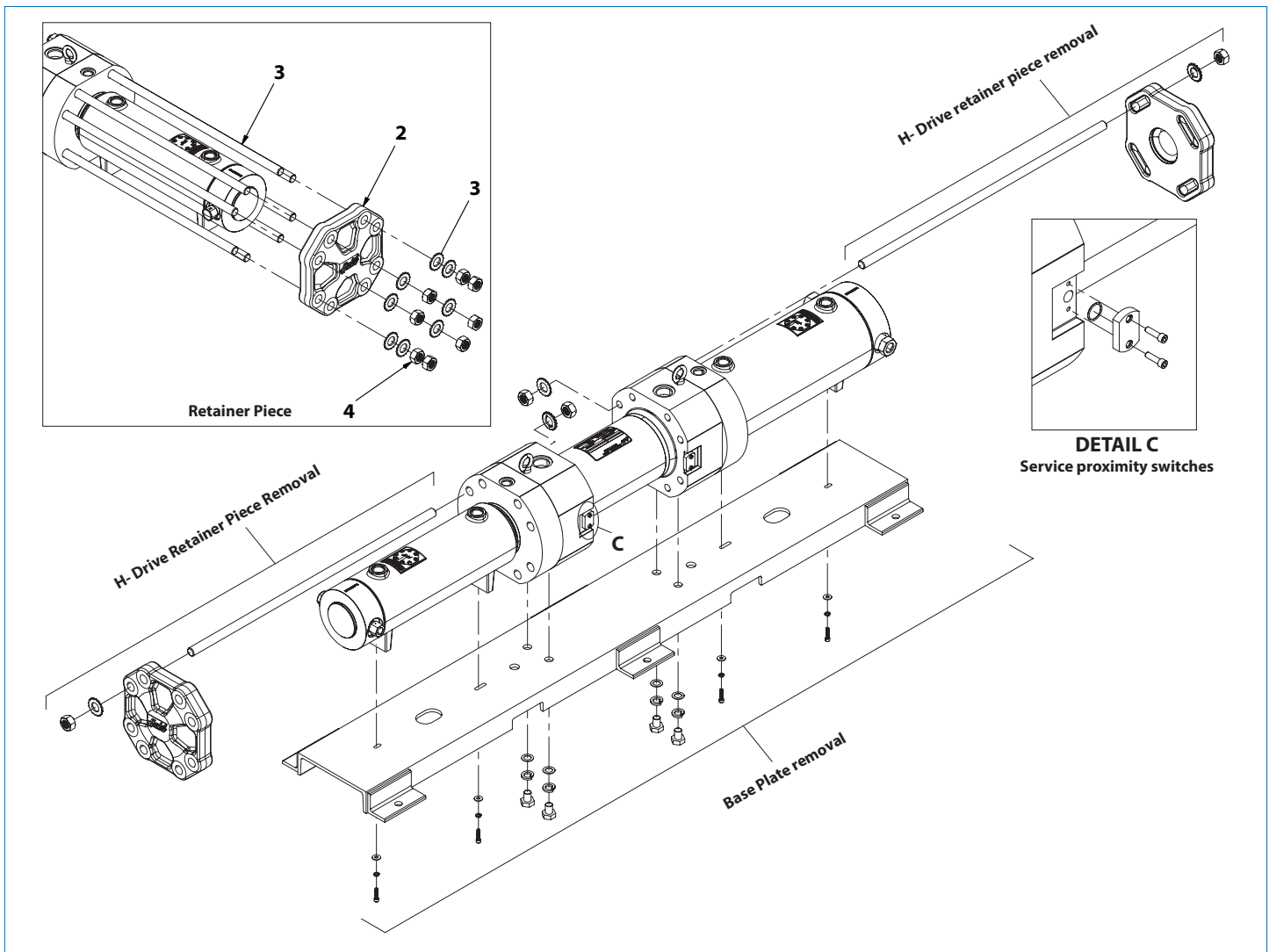


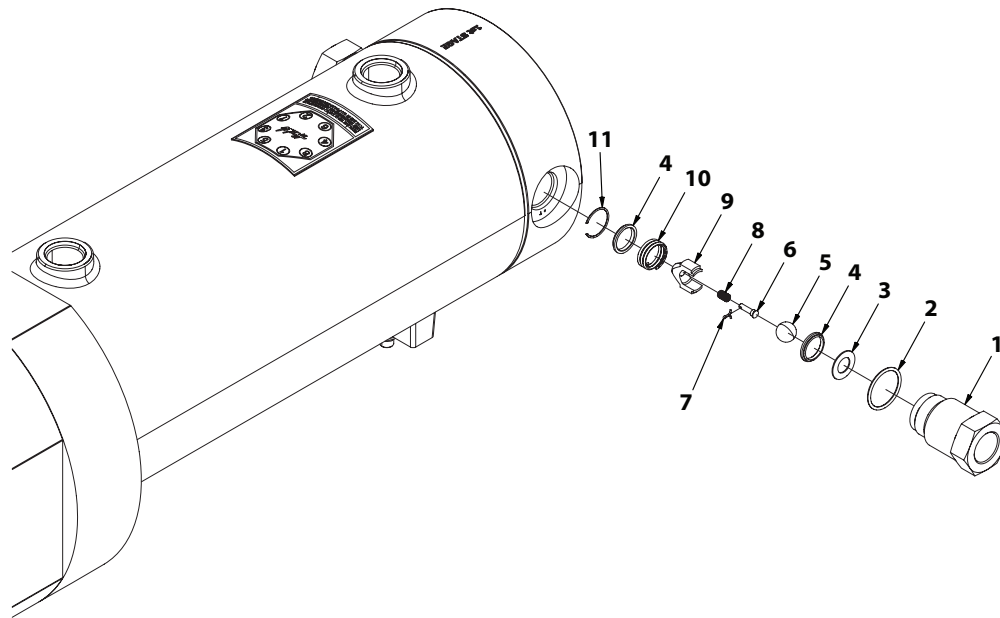
Figure 32: H - Drive Exploded View

### PART LIST

Item	Description	DWG No	Qty
1	Tie Rod, M24x3	88115	16
2	Retainer Piece, Gas Section, H-Drive	88108	2
3	Washer, Hytorc, Steel, Black Oxide, 24mm Bolt	CNFO0383	32
4	Nut, Steel, Grade 8, Zinc Plate, M24x3, 19mm Long	CNFO0384	32

### REPAR KITS

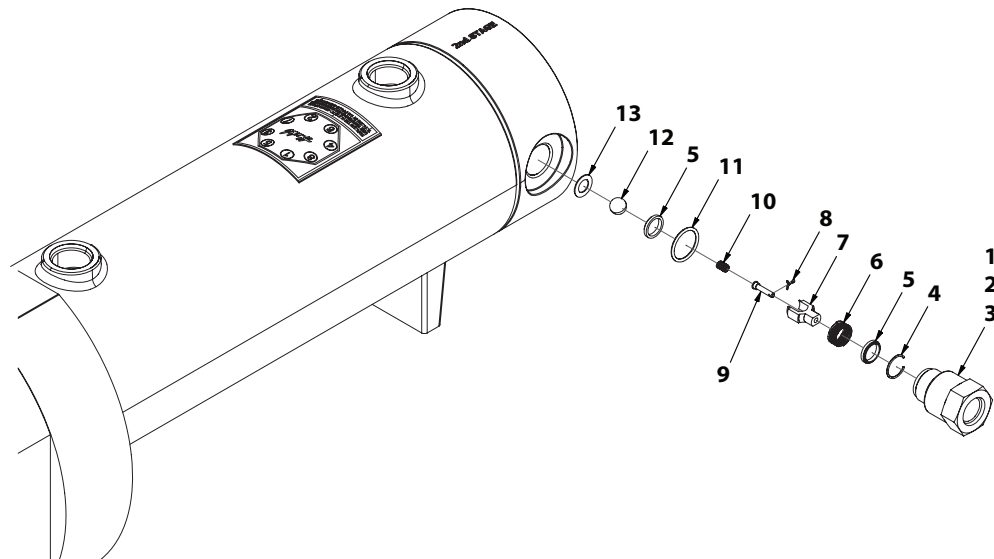
Item	Description	DWG No	KIT Part Number
1	Tie Rod	N/A	88152



**Inlet check valve assembly (50685-3)**

**Figure 33: Inlet check valve (50685-3)**

PART LIST			
Item	Description	DWG No	Qty
1	Fitting 1" Inlet SAE (316 SS)	50686-1	1
2	O-Ring (Viton-90)	568920-31	1
3	Seat	28402	1
4	Ring	28403	2
5	Ball	26130-24	1
6	Spring Guide	53518-1	1
7	Cotter Pin	MS24665-1012	1
8	Spring	28405	1
9	Guide	28404	1
10	Spring	17977	1
11	Snap-Ring	28406	1

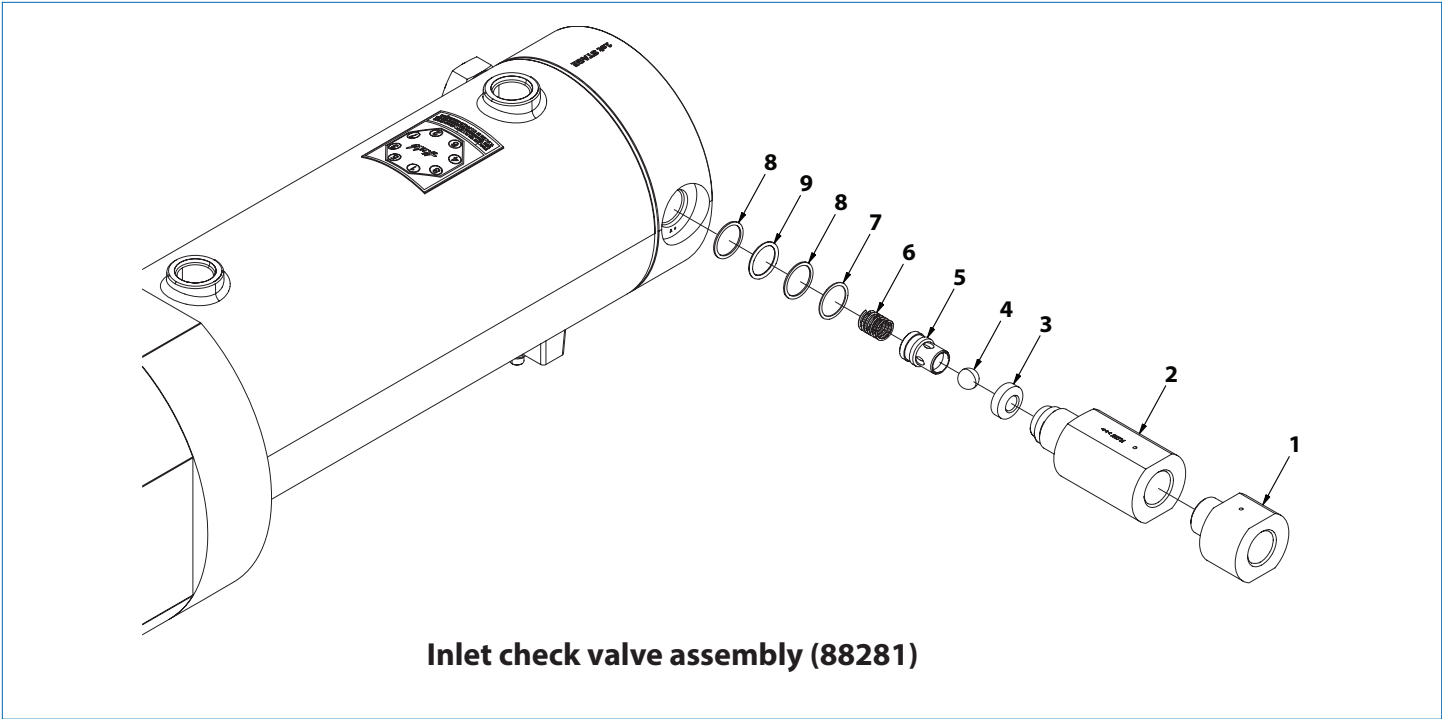


**Outlet check valve assembly (86518-3)**

**Figure 34: Outlet check valve (86518-3)**

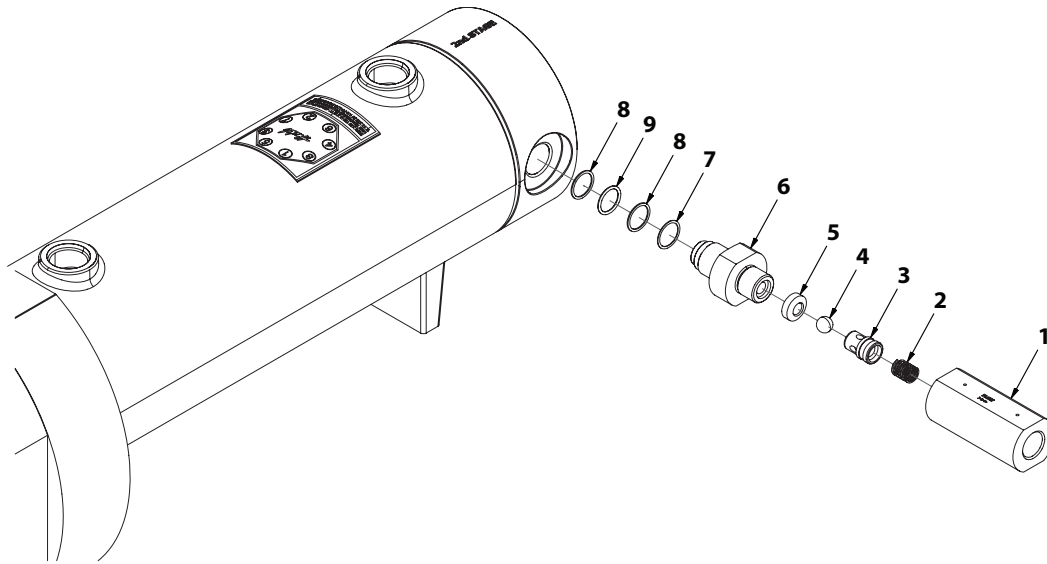
PART LIST			
Item	Description	DWG No	Qty
1	Fitting, Outlet 3/4" SAE Port (316 SS)	86506	1
4	Snap Ring	28632	1
5	Retainer	28634	2
6	Spring	28628	1
7	Cage, 3/4 NPT, CK	28626	1
8	Cotter Pin	MS24665-1012	1
9	Spring Guide	53518	1
10	Spring	28405	1
11	O-Ring (Viton-90)	568916-31	1
12	Ball	26130-20	1
13	Seat	28633	1





**Figure 35:** Inlet check valve (88281)

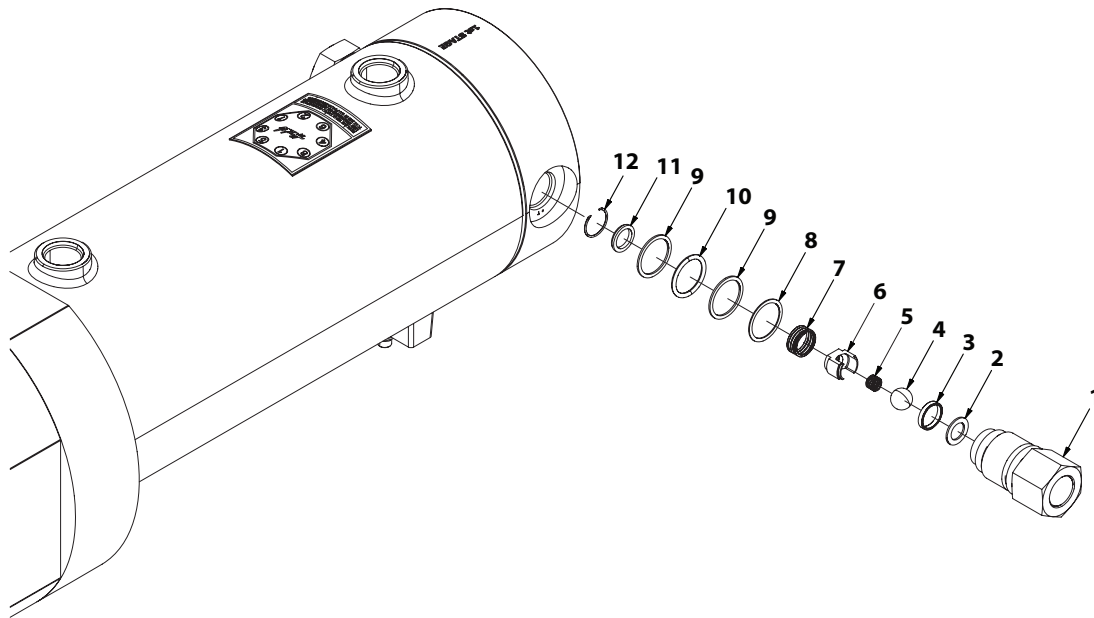
PART LIST			
Item	Description	DWG No	Qty
1	Gland	88283	1
2	Body	88286	1
3	Seat	88284-2	1
4	Ball	CN003291	1
5	Retainer	88285	1
6	Spring	PH-1058	1
7	Back-Up	86511	1
8	Back-Up	86513	2
9	O-Ring	568118-31	1



**Outlet check valve assembly (88282)**

**Figure 36: Outlet check valve (88282)**

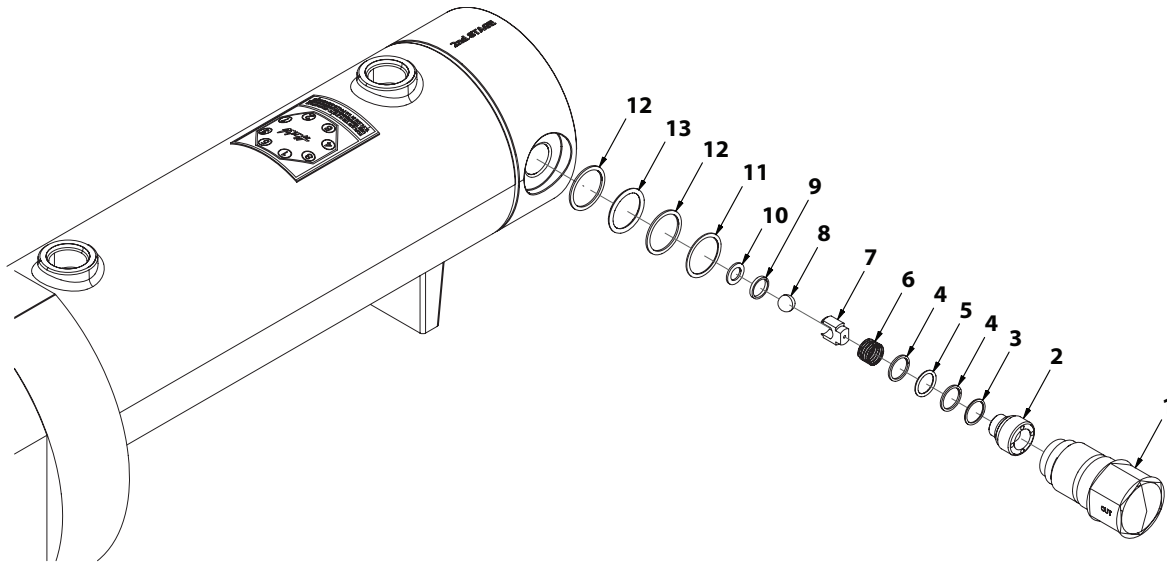
PART LIST			
Item	Description	DWG No	Qty
1	Gland	88288	1
2	Body	88287	1
3	Seat	88284-2	1
4	Ball	CNO03291	1
5	Retainer	88285	1
6	Spring	PH-1058	1
7	Back-Up	86511	1
8	Back-Up	86513	2
9	O-Ring	568118-31	1



**Inlet check valve assembly (87025-2)**

**Figure 37: Inlet check valve (87025-2)**

PART LIST			
Item	Description	DWG No	Qty
1	Inlet Fitting	87024-2	1
2	Seat	28119	1
3	Ring	29374	1
4	Ball	26130-16	1
5	Spring	28116-2	1
6	Retainer	28117	1
7	Spring	28123	1
8	Back-Up	86511	1
9	Back-Up	86513	2
10	O-Ring	568118-31	1
11	Retainer	28132	1
12	Retaining Ring	28124	1

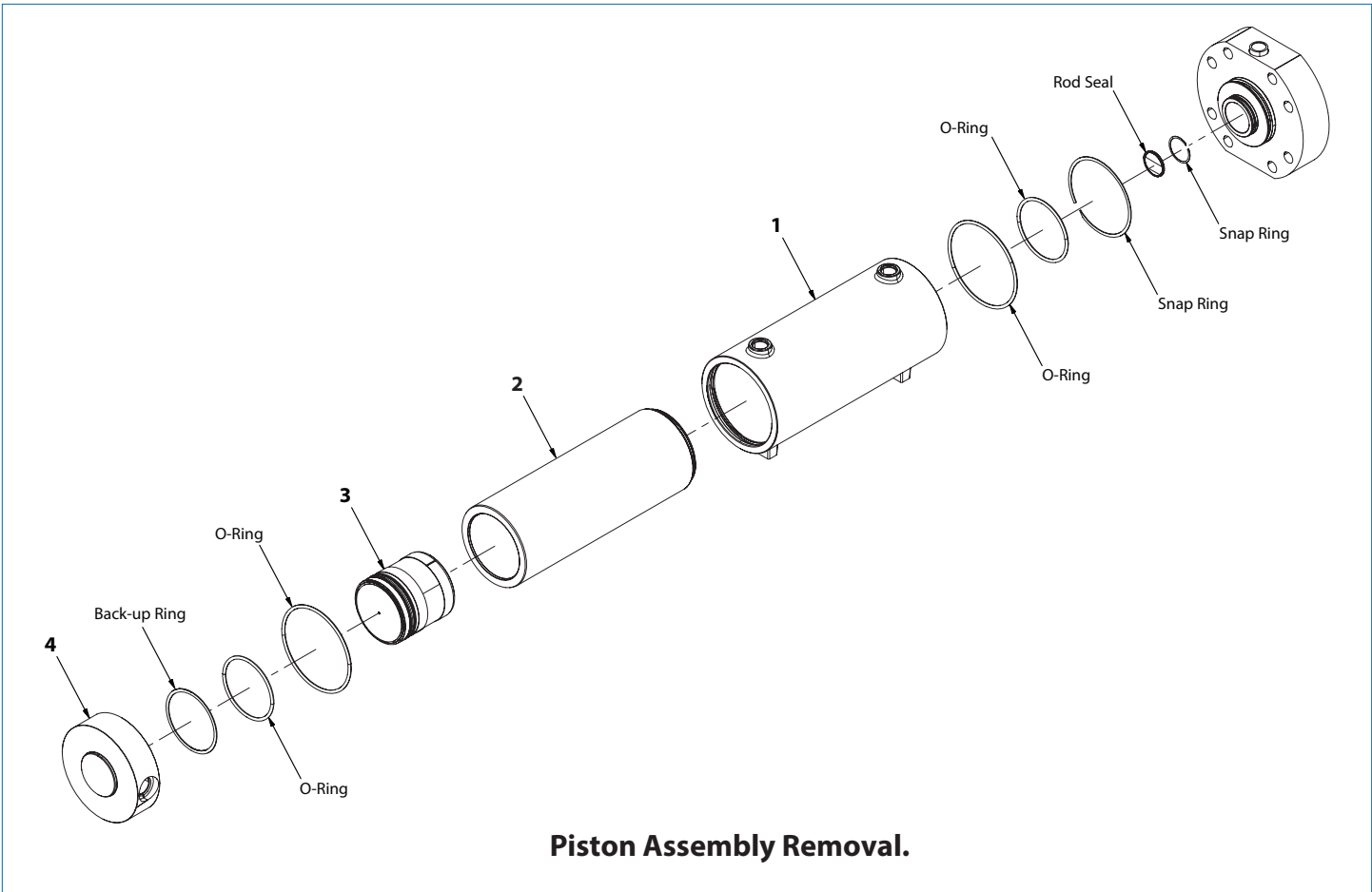


**Outlet check valve assembly (86950-2)**

**Figure 38: Outlet check valve (86950-2)**

PART LIST			
Item	Description	DWG No	Qty
1	Outlet Fitting	86948-2	1
2	Retainer	86949	1
3	Back-Up	86896	1
4	Back-Up	86897	2
5	O-Ring	568014-7	1
6	Spring	56788	1
7	Cage	56786	1
8	Ball	26130-12	1
9	Ring	56739	1
10	Seat	56741	1
11	Back-Up	86511	1
12	Back-Up	86513	2
13	O-Ring	568118-31	1

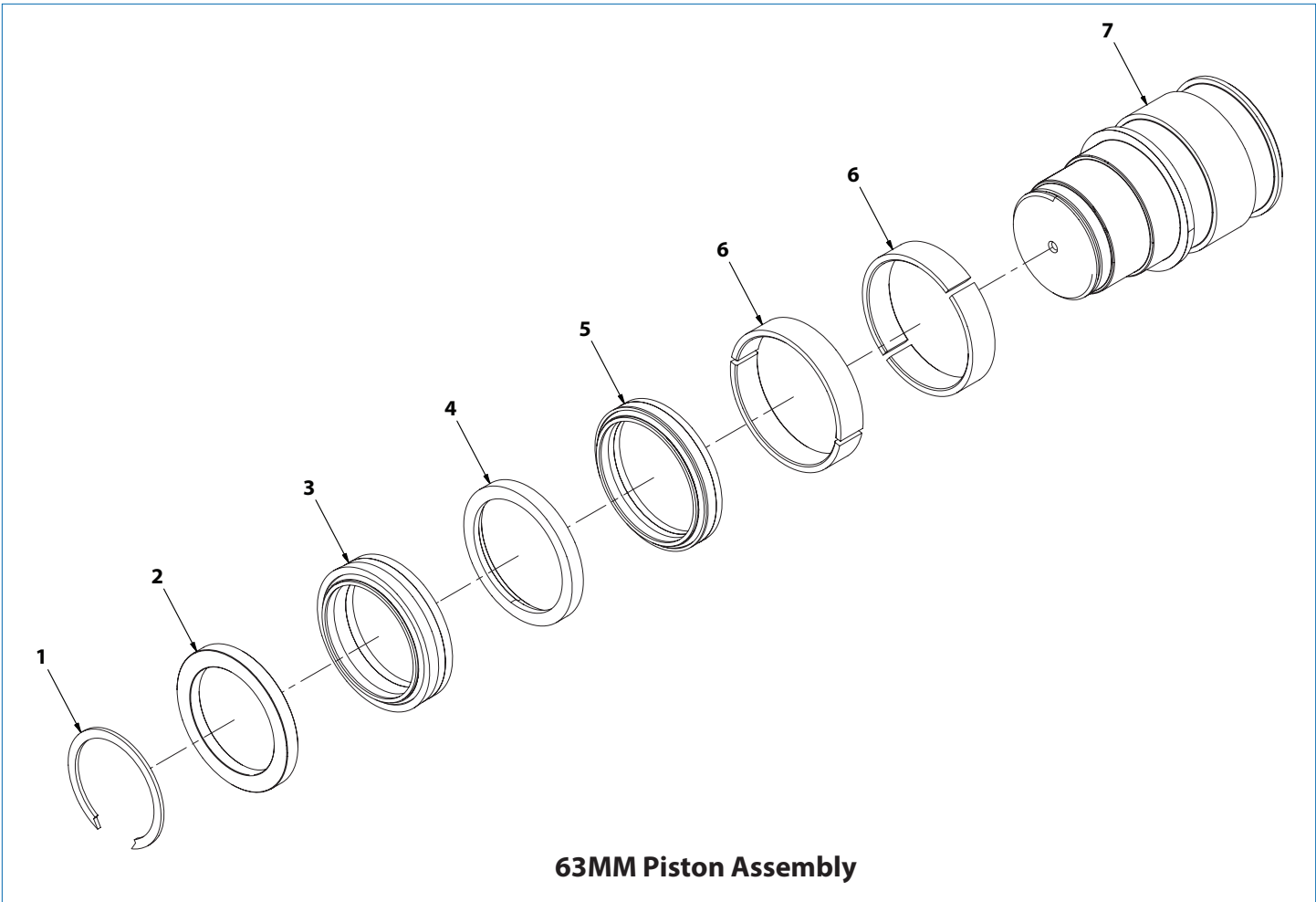
REPAR KITS				
Model	Description	DWG No	KIT Part Number	Tool
HGD-150	Inlet check valve	50685-3	88541	50722
	Outlet check valve	86518-3	88542	28627
HGD-90	Inlet check valve	88281	88289	---
	Outlet check valve	88282	88289	---
HGD-63	Inlet check valve	88281	88289	---
	Outlet check valve	88282	88289	---
HGT-150/63	Inlet check valve (1st Stage)	50685-3	88541	50722
	Inlet check valve (2nd Stage)	87025-2	86951	29370
	Outlet check valve (1st Stage)	86518-3	88542	28627
	Outlet check valve (2nd Stage)	86950-2	88083	86669-T
HGT-150/90	Inlet check valve (1st Stage)	50685-3	88541	50722
	Inlet check valve (2nd Stage)	87025-2	86951	29370
	Outlet check valve (1st Stage)	86518-3	88542	28627
	Outlet check valve (2nd Stage)	86950-2	88083	86669-T
HGT-90/63	Inlet check valve (1st Stage)	87025-2	86951	29370
	Inlet check valve (2nd Stage)	87025-2	86951	29370
	Outlet check valve (1st Stage)	86950-2	88083	86669-T
	Outlet check valve (2nd Stage)	86950-2	88083	86669-T



**Piston Assembly Removal.**

**Figure 39: Piston Assembly Removal**

PART LIST			
150MM GAS SECTION PARTS LIST			
Item	Description	DWG No	Qty
1	Cooling Jacket, 150mm Gas Section, H-Drive	88112	1
2	Barrel, 150mm, H-Drive	88099*	1
3	Piston Assembly, 150mm Gas Section, H-Drive	88102	1
4	End Cap, 150mm, H-Drive	88535*	1
* Model Specific - Reference Drawing 88095			
90MM GAS SECTION PARTS LIST			
1	Cooling Jacket, 90mm Gas Section, H-Drive	88113	1
2	Barrel, 90mm, H-Drive	88100*	1
3	Piston Assembly, 90mm Gas Section, H-Drive	88306	1
4	End Cap, 90mm, H-Drive	88110*	1
* Model Specific - Reference Drawing 88096			
60MM GAS SECTION PARTS LIST			
1	Cooling Jacket, 63mm Gas Section, H-Drive	88114	1
2	Barrel, 63mm, H-Drive	88101*	1
3	Piston Assembly, 63mm Gas Section, H-Drive	88311	1
4	End Cap, 63mm, H-Drive	88111*	1
* Model Specific - Reference Drawing 88097			

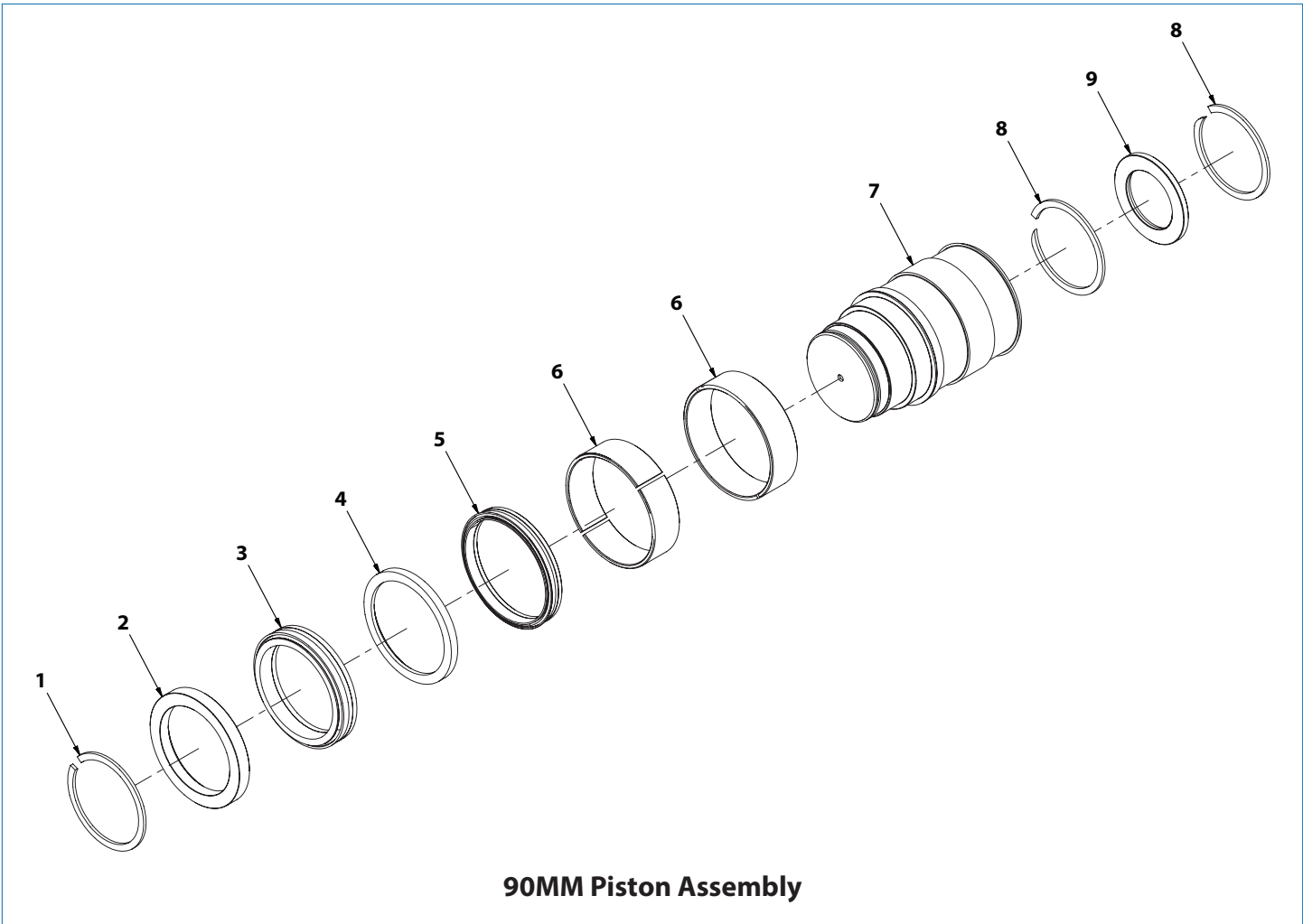


**63MM Piston Assembly**

**Figure 40: 63MM Piston Assembly**

PART LIST 63MM PISTON ASSEMBLY			
Item	Description	Part No	Qty
1	Snap Ring	FSE-0187-S02	1
2	Front Bearing	88308	1
3	Primary Seal Set	88317	1
4	Stainless Back Up Support	88470	1
5	Secondary Seal Set	88318	1
6	Piston Wear Ring	88310	2
7	Piston Body	88309	1

REPAR KITS			
Item	Description	DWG No	KIT Part Number
1	63 Gas piston	88311	N/A

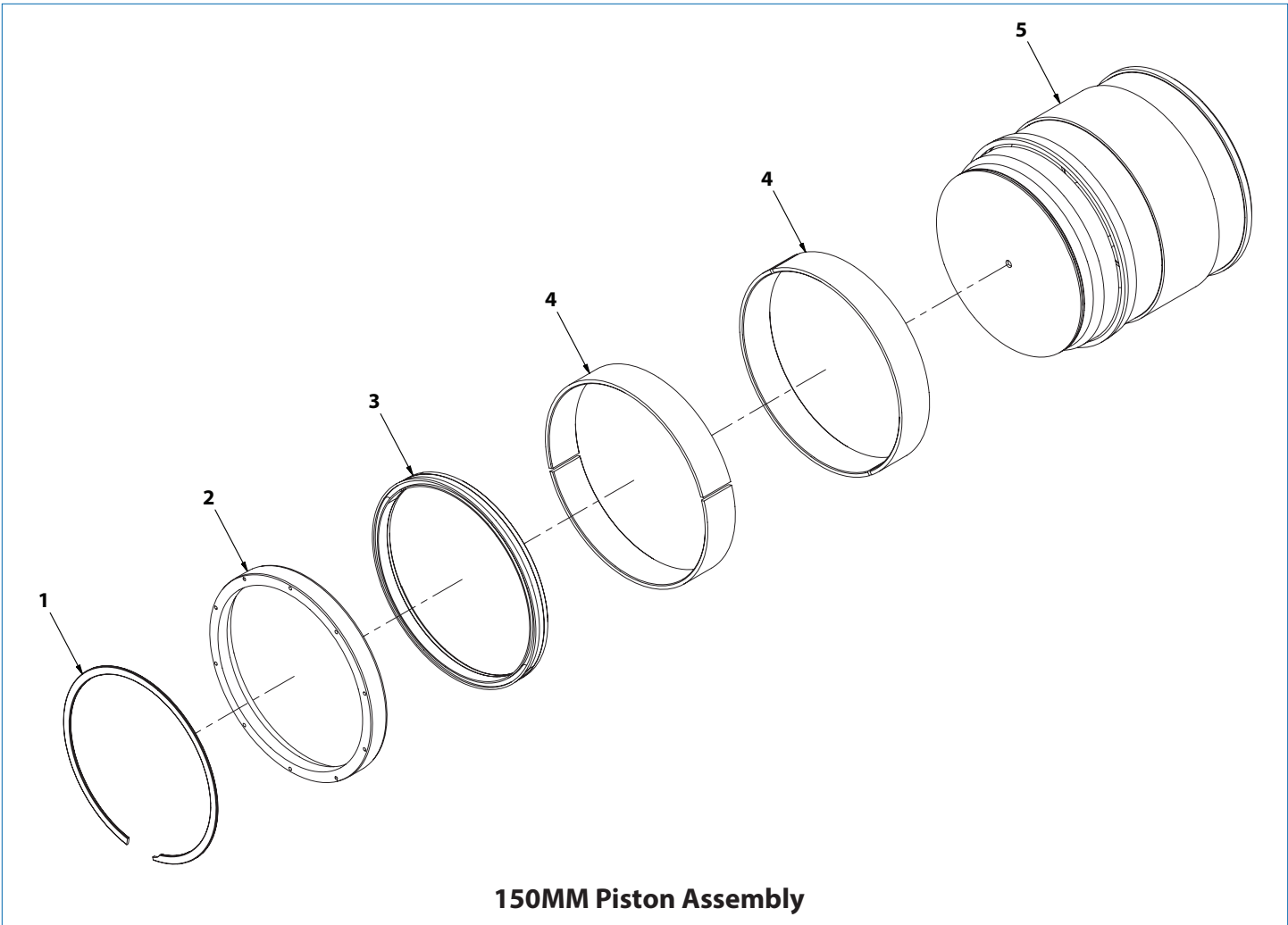


**90MM Piston Assembly**

**Figure 41: 90MM Piston Assembly**

PART LIST			
90MM PISTON ASSEMBLY			
Item	Description	Part No	Qty
1	Snap Ring	FSE-0275-S02	1
2	Front Bearing	88295	1
3	Primary Seal Set	88263	1
4	Stainless Back Up Support	88471	1
5	Secondary Seal Set	88264	1
6	Wear Ring, 90mm Piston	88291	2
7	Piston Body	88290	1
8	Snap Ring	FHE-0275-S02	2
9	Piston Insert Ring	88307	1

REPAR KITS			
Item	Description	DWG No	KIT Part Number
1	90 Gas piston	88306	N/A



**150MM Piston Assembly**

**Figure 42: 150MM Piston Assembly**

PART LIST			
150MM PISTON ASSEMBLY			
Item	Description	Part No	Qty
1	Snap Ring	VS-525-S02	1
2	Front Bearing	88133	1
3	Primary Seal Set	88127	1
4	Piston Wear Ring	88312	2
5	Piston Body	88105	1

REPAR KITS			
Item	Description	DWG No	KIT Part Number
1	150 Gas piston	88102	88545



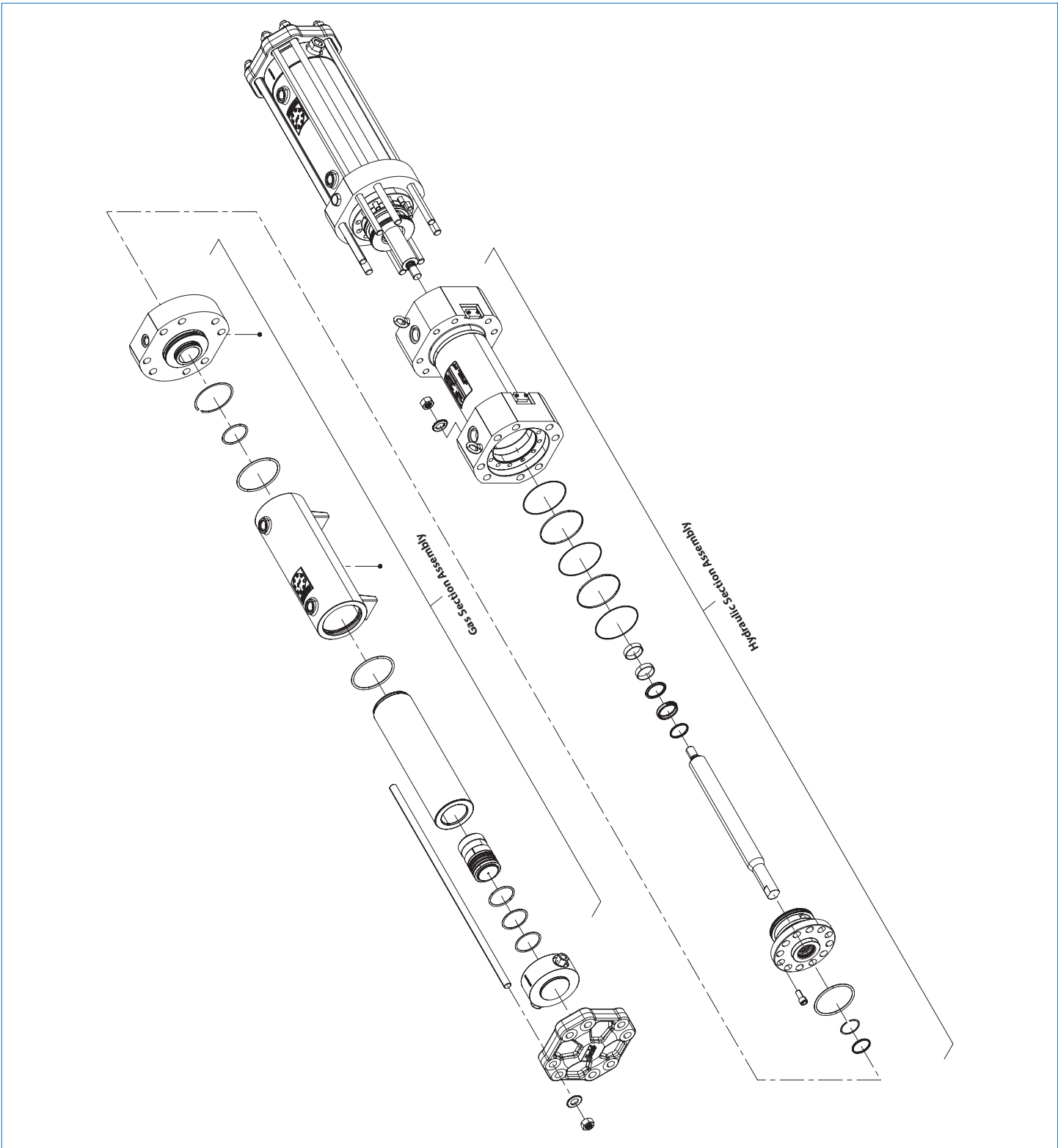


Figure 43: H - Drive Exploded View

REFERENCE DRAWINGS	
Description	DWG No
HGD-150	88092
HGD-90	88093
HGD-63	88094
HGT-150/63	88123
HGT-150/90	88122
HGT-90/63	88124

# 8.0 Faults

Possible causes for faults and fault corrections tasks are described in the following section. In the event that the fault cannot be corrected with the help of the information below, contact Haskel for gas booster concerns and your HPU OEM for the hydraulic power unit concerns.



**WARNING!**



**Danger of injury due to improper fault corrections.**

Improperly executed fault correction tasks can cause severe injuries and significant material damage.

- If removing components, ensure that they are properly reinstalled and that all connections are tightened with the specific bolt-tightening torque.
- Before restarting the system, ensure that all fault correction tasks have been properly executed and concluded in accordance with the instructions in this manual.



**WARNING!**



**Before performing any maintenance on the gas booster, purge the system with an inert gas.**

See [Purging the System](#) for additional information.

- Always shut down the system before purging.



**CAUTION!**



**Do not start any maintenance/repair procedure with positive pressure on the system.**

Isolate inlet gas source, outlet gas, and vent to atmospheric pressure before starting work.

## 8.1 FAULT TABLE

FAULT DESCRIPTION	POSSIBLE CAUSE	REMEDY	REFERENCE
Large hydraulic pressure spikes.	Gas section leakage.	Inspect the gas section. Repair gas section components as needed.	<a href="#">GAS BOOSTER MAINTENANCE</a>
	Gas unloaded condition.	Check the inlet pressure delivery. Verify against HPU pressure parameters.	<a href="#">HYDRAULIC PRESSURE UNIT GUIDELINES</a>
	Elevated hydraulic pressure/flow.	Check the HPU for proper function.	<a href="#">HPU MANUAL</a>
Gas leaks externally.	Gas barrel seal leakage. End cap seal leak. Check valve floating seal leak. Check valve body torque out of spec.	Replace gas section seals.	<a href="#">REPLACE GAS SECTION SEALS</a>
High outlet gas temperature	Decayed inlet pressure / excessive compression ratio.	Ensure inlet pressure is sufficient as to not exceed max compression ratio of booster (6:1 for double acting, 36:1 for two stage).	<a href="#">OPERATIONS</a>
	Heat exchanger fault.	Ensure heat exchanger is functioning properly and providing adequate cooling capacity for your application. Consult factory for application specific cooling requirements.	<a href="#">CONSULT FACTORY</a>
	High inlet gas temperature.	Ensure inlet gas temperature is within limits stated in this manual.	<a href="#">OPERATIONS</a>
	Excessive cycle rate.	Ensure cycle rates are within limits stated in this manual.	<a href="#">OPERATIONS</a>
	Outlet check valve failure.	Inspect check valve for proper functionality and contamination. Replace check valve as needed.	<a href="#">MAINTENANCE</a>

FAULT DESCRIPTION	POSSIBLE CAUSE	REMEDY	REFERENCE
Gas booster not cycling or is cycling slowly.	HPU system fault.	Ensure HPU is functioning properly and delivering adequate flow.	🔊 <b>HYDRAULIC POWER UNIT MAINTENANCE</b>
	Proximity switch fault (if used).	Ensure proximity switches are functioning properly, replace as needed.	🔊 <b>MAINTENANCE</b>
	Hydraulic piston seal or cylinder damaged.	Inspect hydraulic section for wear or damage, replace parts as needed.	🔊 <b>MAINTENANCE</b>
"Excessive interstage pressure (two-stage models)"	Excessive inlet pressure.	Ratio of inlet pressure and horsepower input may be too high. Consult factory for application specific horsepower requirements.	🔊 <b>CONSULT FACTORY</b>
Loud bang at startup	Low inlet pressure.	"Ensure there is sufficient inlet pressure in booster." "	🔊 <b>OPERATIONS</b>
	Hydraulics not soft started.	Ensure HPU startup controls conform to those stated in this manual.	🔊 <b>OPERATIONS</b>

# 9.0 Troubleshooting

FAULT DESCRIPTION	POSSIBLE CAUSE	REMEDY	REFERENCE
Booster unstable	Mounting plate not rated for size / weight of booster. Mounting plate flatness not within requirements.	Ensure Mounting Plate Conforms To Requirements Stated In This Manual.	🔧 <b>MOUNTING PLATE REQUIREMENTS</b>
	Booster not torqued to mounting plate.	Check Torque On Mounting Plate.	🔧 <b>MAINTENANCE</b>
	Gas section retainer plate not in contact with mounting plate.	Loosen Gas Section Tie Rods, Allow Gas Section Retainer Plate To Drop To Mounting Plate, Re-Torque.	🔧 <b>MAINTENANCE</b>
Gas not flowing through booster	Faulty inlet or outlet check valve.	Inspect Check Valve For Proper Functionality / Contamination Replace Check Valve Is Needed.	🔧 <b>MAINTENANCE</b>
	Inlet and outlet check valve swapped.	Ensure Check Valves Are In Appropriate Orientation.	🔧 <b>BOOSTER TECHNICAL DRAWINGS / SYSTEM P&amp;ID</b>
Excessive gas leak through vent port	Gas piston seal damaged Gas barrel damaged.	Inspect Gas Piston Seal And Barrel, Replace As Needed.	🔧 <b>MAINTENANCE</b>
Excessive hydraulic oil leak through oil drain port	Rod seals damaged Hydraulic rod damaged.	Replace Hydraulic Rod Seals Inspect Hydraulic Rod For Scores Or Scratches Inspect Gas Section For Contamination.	🔧 <b>MAINTENANCE</b>
Hydraulic oil leak at proximity switch	Proximity switch face seal extrusion.	Replace Proximity Switch Or Cover Plate (If Applicable)	🔧 <b>MAINTENANCE</b>
Coolant leak	Cooling barrel seals damaged Coolant drain port loose Coolant connection fittings loose.	Replace Cooling Barrel Seals Remove And Re-Torque Coolant Drain Port Torque Coolant Connection Fittings.	🔧 <b>MAINTENANCE</b>
Gas booster not building pressure	Extreme external leakage.	Inspect tubing and gas end cap. Replace tubing and/or seals if necessary.	🔧 <b>CHECK THE HYDRAULIC HOSE FOR WEAR OR LEAKAGE</b> 🔧 <b>REPLACE GAS SECTION SEALS</b>
	Gas section seals faulty.	Inspect the gas vent for leakage above 200 CCM. Replace piston seal.	🔧 <b>REPLACE GAS PISTON SEALS</b>
	Faulty inlet or outlet check valves.	Inspect check valves for contaminants. Replace check valves if needed.	🔧 <b>REPLACE INLET AND OUTLET CHECK VALVE SEALS</b>
	Inlet and outlet check valves are swapped.	Match the location of the "inlet" and "outlet" indicators on the check valve bodies. Match the indicators on the seal bodies to those on the end caps.	🔧 <b>REPLACE INLET AND OUTLET CHECK VALVE SEALS</b>







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