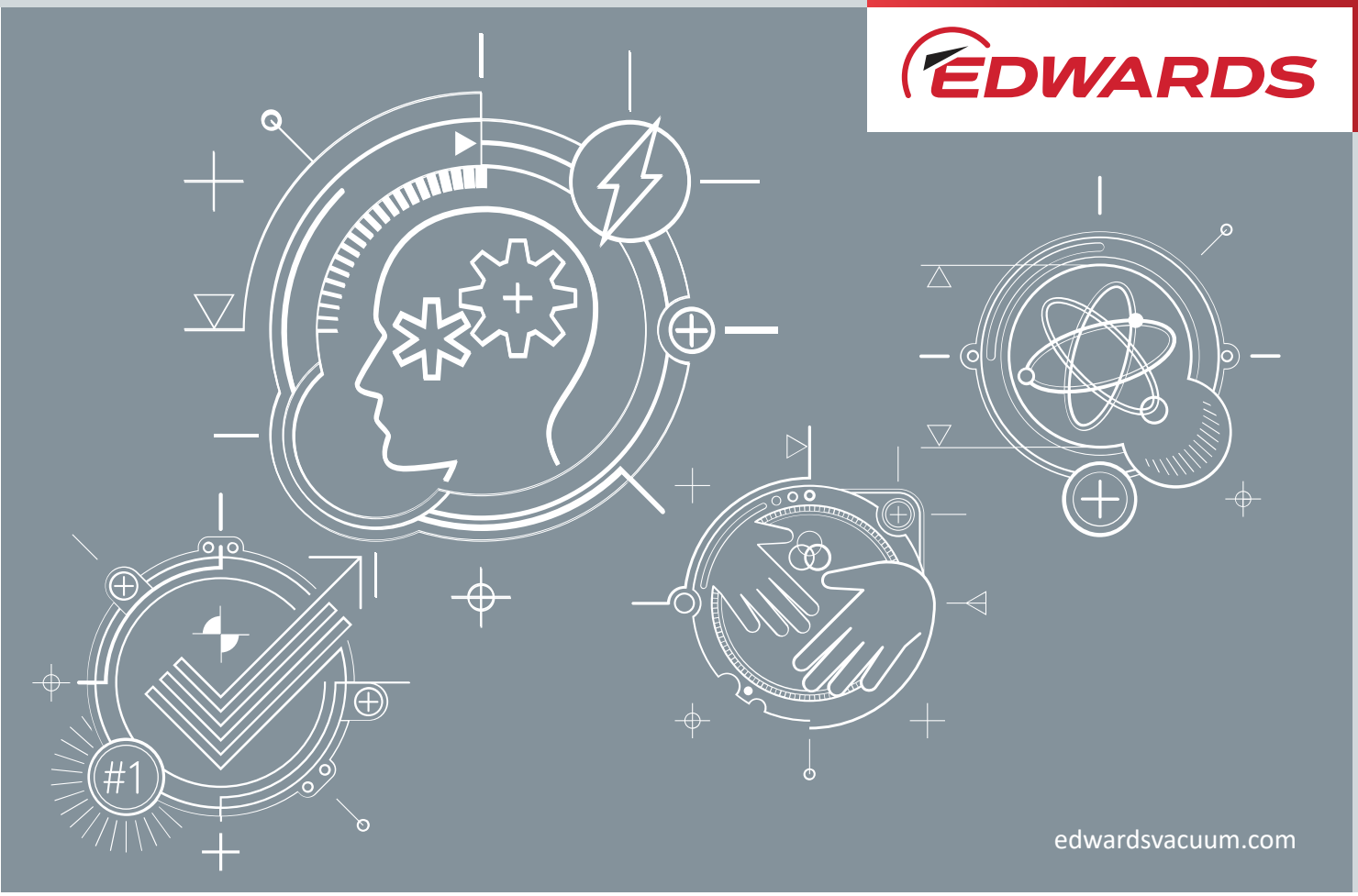


# Stokes 6 Inch MSeal and Process Isolation Booster Pumps

INSTRUCTION MANUAL

S9002880_A – Remastered 2023

Original Instructions

# Copyright notice



Published: 1/18/2023

# Associated publications

| Publication title | Publication number |
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# Disclaimer

The content of this manual may change from time to time without notice. We accept no liability for any errors that may appear in this manual nor do we make any expressed or implied warranties regarding the content. As far as practical we have ensured that the products have been designed and constructed to be safe and without risks when properly installed and used in accordance with their operating instructions.

We accept no liability for loss of profit, loss of market or any other indirect or consequential loss whatsoever.

Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

# Contents

# List of Figures

# 1. Safety and compliance

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use. Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions.

The instruction manual is an important safety document that we often deliver digitally. It is your responsibility to keep the instruction manual available and visible while working with the equipment. Please download the digital version of the instruction manual for use on your device or print it if a device will not be available.

## 1.1 Definition of Warnings and Cautions

Important safety information is highlighted as warning and caution instructions which are defined as follows. Different symbols are used according to the type of hazard.

**WARNING:**

**If you do not obey a warning, there is a risk of injury or death.**

**CAUTION:**

**If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.**

**NOTICE:**

**Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.**

We reserve the right to change the design and the stated data. The illustrations are not binding.

## 1.2 Trained personnel

For the operation of this equipment “trained personnel” are:

- skilled workers with knowledge in the fields of mechanics, electrical engineering, pollution abatement and vacuum technology and
- personnel specially trained for the operation of vacuum pumps

## 1.3 Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that we use on the product or in the product documentation have the following meanings:

| | |
|---|---|
|  | Warning/Caution<br>An appropriate safety instruction must be followed or caution to a potential hazard exists. |
|  | Warning - Dangerous voltage<br>Identifies possible hazards from hazardous voltages. |
|  | Warning - Heavy object<br>Identifies a possible hazard from a heavy object. |
|  | Warning - Hot surfaces<br>Identifies a potential hazard from a hot surface. |
|  | Warning - Moving parts present<br>Identifies parts that move. You must let the parts that turn stop before you remove the electrical power. |
|  | Warning - Risk of explosion<br>There is a risk of explosion when you do the task. |
|  | Warning - Trip hazard<br>There is a risk of slipping, tripping or falling as a result of spilled liquids, trailing cords and pipes or other low-lying objects. |
|  | Warning - Use protective equipment<br>Use appropriate protective equipment for the task. |

# 2. Introduction

This manual provides installation, operation and maintenance instructions for the MSeal Booster Pumps and Process Isolation Booster Pumps (referred to as "booster pump" or "pump" throughout the remainder of the manual). You must use the booster pump as specified in this manual. You must only use PFPE-prepared bareshaft booster pumps on oxygen or reactive gas service: see *Description* on page 8.

## 2.1 ATEX directive implications

The booster pump is not designed to meet European ATEX requirements.

## 2.2 Description

**WARNING: CONFORMING USE**

**Risk of injury or damage to the equipment. Standard booster pumps are not intended for use with hazardous, reactive, flammable and explosive gases. Consult us for advice before you use a booster pump on one of these applications.**

The booster pumps are single stage, positive displacement precision engineered machines. You must use the booster pump with a suitable backing or roughing pump. The booster pump is not intended for stand-alone operation. The pump gears provide for quiet operation while maintaining proper impeller timing.

The booster pumps are supplied as standard with keyless timing, drive side roller bearings, mechanical vacuum seal, and large oil-level sight-glasses. These features provide for ease of maintenance and improve reliability.

The pump identification plate provides specific details about the pump, including: pump type, part number and serial number and so on. We recommend that you have this information available when you contact us for advice, parts or service.

Direct drive booster pumps are supplied with hydrocarbon lubricating oil in the oil reservoirs. Standard bareshaft booster pumps are also supplied with hydrocarbon lubricating oil in the oil reservoirs. Special service (oxygen service) bareshaft booster pumps are specially prepared free of hydrocarbons in the factory and are supplied without oil in the reservoirs. You must use PFPE lubricating oil in special service (oxygen service) pumps.

MSeal booster pumps have a mechanical shaft seal on the drive shaft, and labyrinth shaft-seals between the gearbox and the swept volume. Process isolation booster pumps have a mechanical shaft seal on the drive shaft, and mechanical seals between the gearbox and the swept volume.

The booster pump general arrangements are shown in *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster*.

## 2.3 General information

The booster pumps are available in horizontal (H) and vertical (V) configurations. The models of booster pumps are the 607, 615 and 622 and these model numbers denote

the pump body lengths: 7.0, 15.0 and 22.0 inches. The booster pumps are available as bareshaft (belt driven) pumps, and as direct drive pumps (with shaft-mounted motors).

The booster pump gear centre distance is 6 inches. The booster pump have normal operation limits from 800 to 3600 r $min^{-1}$ (rpm). The volumetric pumping rates increase with body length and rotational speed. Pump components in contact with the pumped gases are cast iron and carbon steel.

Refer to *Table: Application data* to determine the operational limits for the booster pumps. The limits are based on compression and pumping speeds for the specific application. *Table: Application data* provides the maximum performance limits of the pumps. The limits, backing pump speed and gas loads determine the cut-in pressure and continuous operation pressure limits.

We can recommend cut-in and operation limits when supplied with chamber size, backing pump and gas load information. The first limit reached during operation is the limiting factor. Control devices such as timers and pressure and temperature switches may be required to properly control the operation of the booster pumps.

***Table 1 Application data***

| Parameter | Pump model | | | |
|---|---|---|---|---|
| | **607** | **615** | **615B*** | **622** |
| Maximum pressure differential | 5.06 x $10^4$ Pa<br>506 mbar<br>380 Torr | 5.06 x $10^4$ Pa<br>506 mbar<br>380 Torr | Not applicable | 3.33 x $10^4$ Pa<br>333 mbar<br>250 Torr |
| Maximum temperature rise | 135 °C<br>275 °F | 135 °C<br>275 °F | 135 °C<br>275 °F | 121 °C<br>250 °F |
| Maximum discharge temperature | 191 °C<br>375 °F | 191 °C<br>375 °F | 191 °C<br>375 °F | 177 °C<br>350 °F |
| Maximum displacement † | 2056 $m^3h^{-1}$ | 4412 $m^3h^{-1}$ | 4412 $m^3h^{-1}$ | 6528 $m^3h^{-1}$ |
| | 1212 cfm | 2600 cfm | 2600 cfm | 3840 cfm |
| Inlet and exhaust connection: ASA | 6 inch | 8 inch | 8 inch | 8 inch |
| Noise level average at ultimate vacuum* | < 85 dB(A) | < 85 dB(A) | < 85 dB(A) | < 85 dB(A) |

** With bypass valve*

*† At 3600 r $min^{-1}$ (3600 rpm)*

## 2.4 Booster pump models

The booster pumps are available in two versions:

- H model booster pumps have vertical connections and are configured for horizontal gas flow through the pump. (“H” appears in the item number of these pumps.)
- V model booster pumps have horizontal connections and are configured for vertical gas flow through the pump. (“V” appears in the item number of these pumps.)

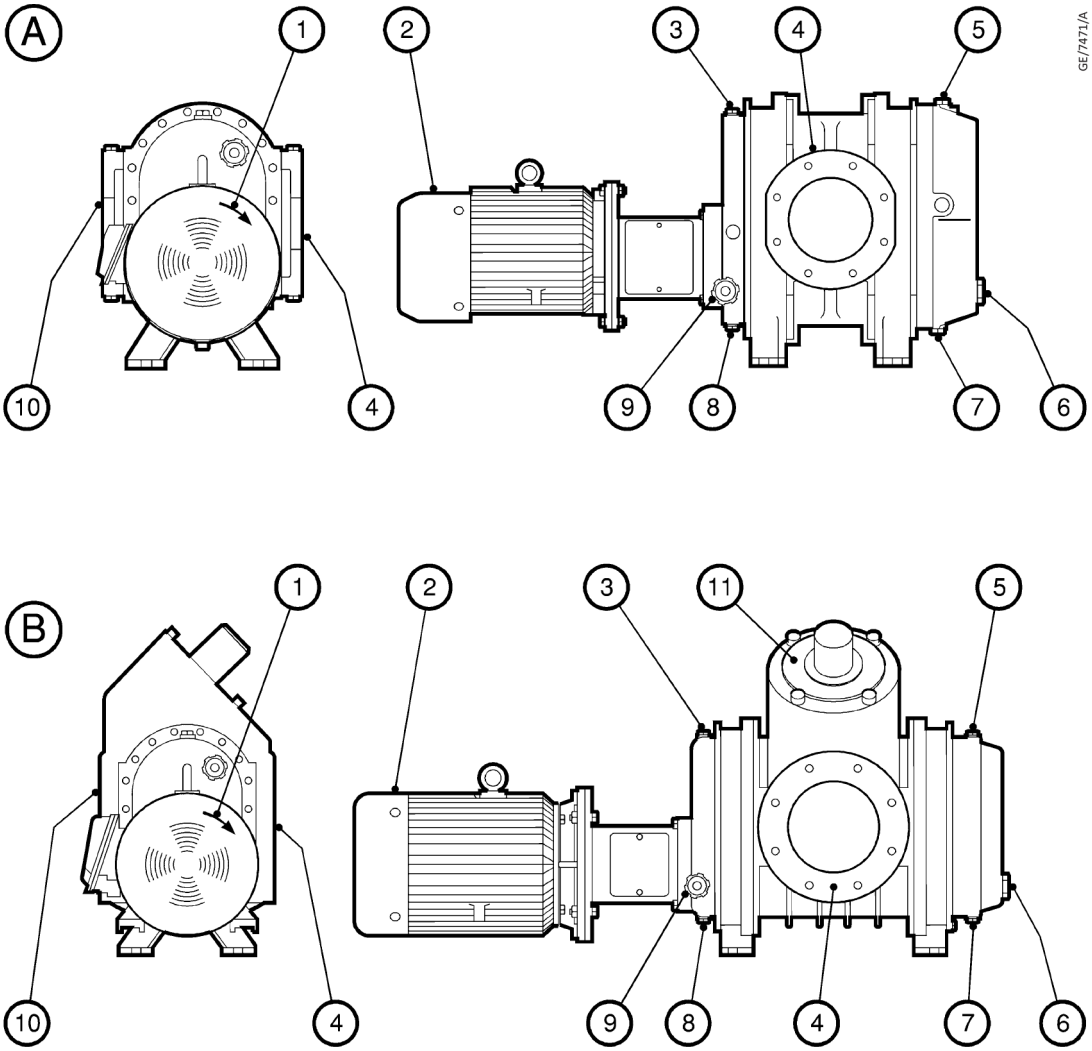
The 615 booster pump is available with an optional bypass valve (refer to *Integral bypass valve (model 615 pumps only)*) which allows pump operation from atmospheric pressure and reduces pump-down time. The booster pumps can be prepared hydrocarbon free for oxygen service. Variable frequency (speed) drives are available for the pumps.

You must never operate the booster pump unless it is installed in a proper vacuum system with adequate guarding to protect people from injury. You must fit safety guards to bareshaft booster pumps before operation.

Note that:

- “B” in the pump Item Number specifies that the pump has a bypass valve.
- “5H” or “5V” in the pump Item Number specifies that the pump is a process isolation booster pump, otherwise the pump is an MSeal booster pump.
- “HR” or “VR” at the end of the Item Number specifies that the pump is a standard service bareshaft pump (with hydrocarbon oil), “HR101” or “VR101” at the end of the Item Number specifies that the pump is an oxygen service (hydrocarbon free) bareshaft pump, otherwise the pump is a standard service pump (with hydrocarbon oil).

**Figure 1** General arrangement of the H (horizontal) booster

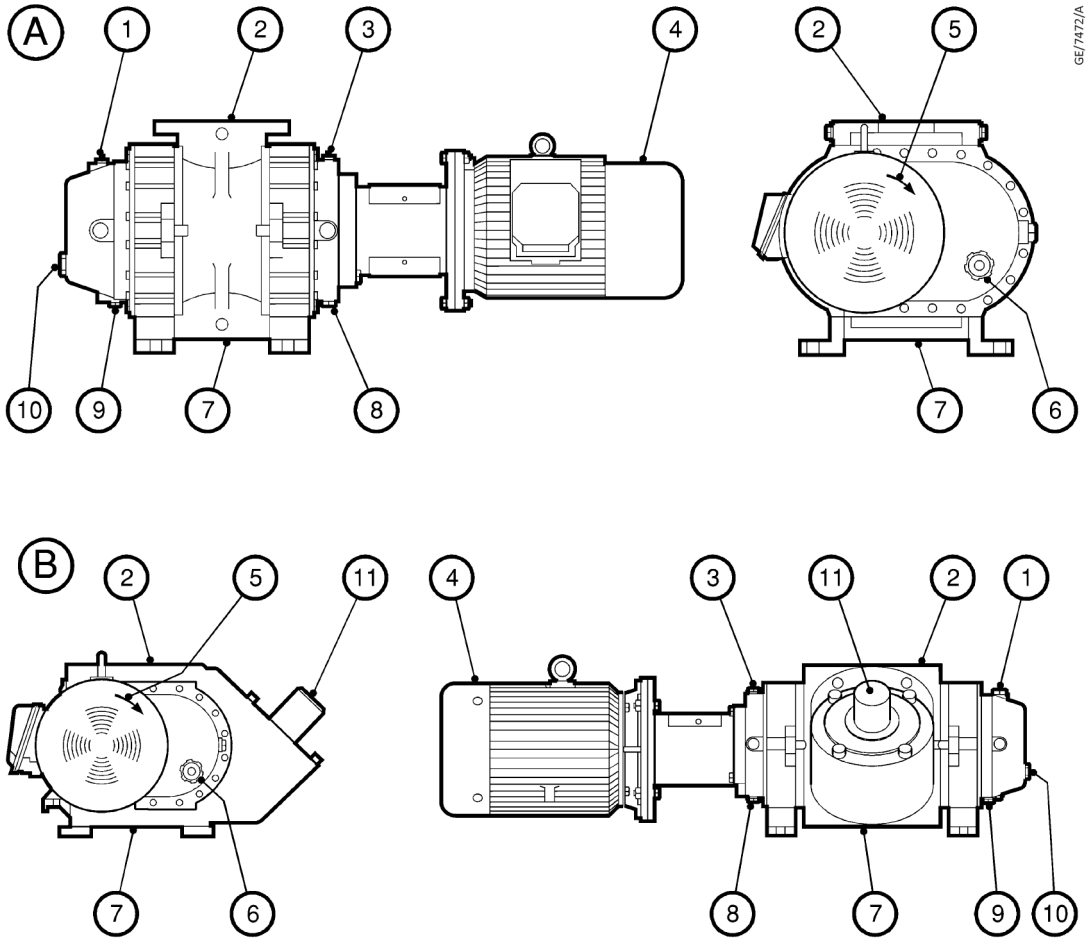



*A. Standard direct drive pump*

*B. Direct drive pump with bypass valve*

1. *Direction of rotation arrow*
2. *Motor (IEC frame shown)*
3. *Oil filler plug (drive end)*
4. *Inlet*
5. *Oil filler plug (gear end)*
6. *Oil-level sight-glass (gear end)*
7. *Oil drain plug (gear end)*
8. *Oil drain plug (drive end)*
9. *Oil-level sight-glass (drive end)*
10. *Outlet*
11. *Bypass valve*

**Figure 2** General arrangement of the V (vertical) booster




*A. Standard direct drive pump*

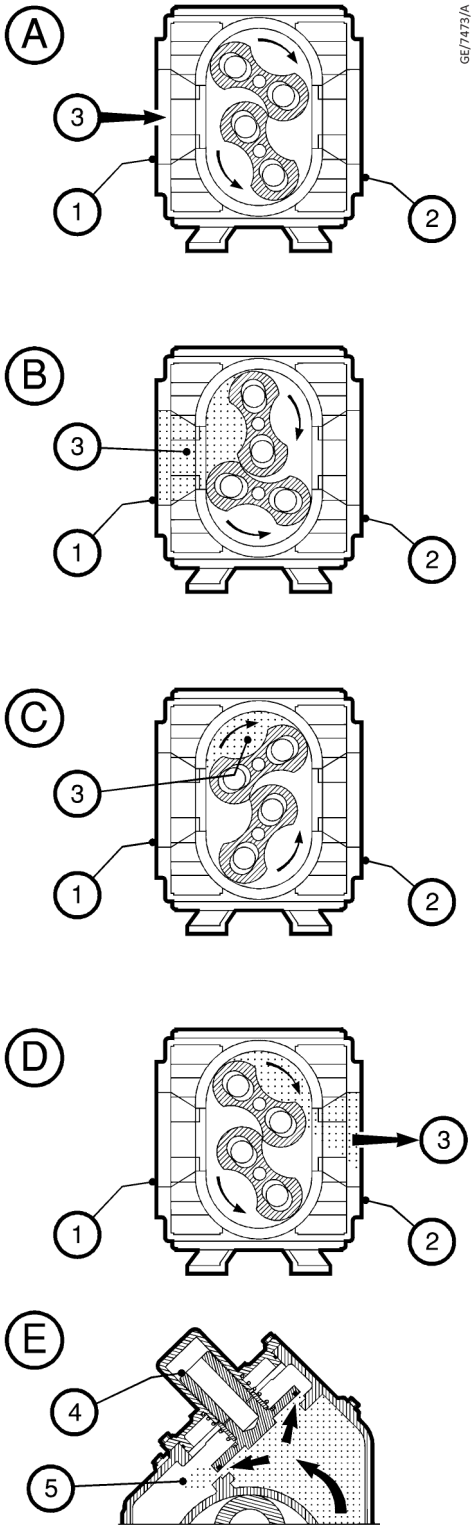
*B. Direct drive pump with bypass valve*

1. *Oil filler plug (gear end)*
2. *Inlet*
3. *Oil filler plug (drive end)*
4. *Motor (IEC frame shown)*
5. *Direction of rotation arrow*
6. *Oil-level sight-glass (drive end)*
7. *Outlet*
8. *Oil drain plug (drive end)*
9. *Oil drain plug (gear end)*
10. *Oil-level sight-glass (gear end)*
11. *Bypass valve*

## 2.5 Principle of operation

The basic operation of an H (horizontal) booster is described below:

**Figure 3** Principle of operation




1. *Inlet*
2. *Outlet*
3. *Gas*
4. *Bypass valve*
5. *Compressed gas*

**Detail A**

Gas (3) enters the pump body through the inlet (1). In the pump body, the upper impeller rotor rotates clockwise, and the lower impeller rotor rotates anticlockwise (counterclockwise).

**Detail B**

As the impeller rotors rotate, gas (3) is drawn into the volume between the pump body wall and the rotors.

**Detail C**

As the rotors rotate further, gas (3) is trapped between the pump body wall and the rotors, and is transferred towards the outlet (2). The rotors rotate with precise timing to maintain the proper clearances, limiting gas back flow.

**Detail D**

As the rotors rotate further, the gas (3) is discharged through the pump outlet (2). The pump discharges four volumes for every full rotation of the drive shaft.

**Detail E**

Bypass valve operation (only applicable to pumps with a bypass valve) - The optional integral bypass valve limits the pressure differential across the pump. During pump operation, if the compression creates an excessive pressure differential across the pump, the bypass valve (4) opens, to allow a portion of the compressed gases (5) to flow back towards the inlet side of the pump.

## 2.6 Bareshaft (belt drive) booster pumps

The booster pumps have been designed to withstand loading from standard V-belts, for standard operation from 800 to 3600 r $min^{-1}$ (rpm). The loads induced into the drive shaft depend on the power applied to the shaft. We specify a minimum pulley diameter for the drive shaft based on motor power. You must never use a pulley with a smaller diameter than those specified in this manual. Refer to *Table: Belt tensions* for specific details on pulley diameters. We can provide booster pumps and motors sized for most applications.

## 2.7 Direct drive booster pumps (with shaft-mounted motors)

Direct drive eliminates the tension loads associated with belt drives. The direct drive booster pump consists of a standard booster pump, coupling, motor support, and C-face (NEMA) or D-flange (IEC) motor. Optional variable frequency drives are available from us to improve performance on booster pumps without bypass valves. Consult us for application information. Various voltage, frequency, speed and power motors are available. Large power motors (> 22.37 kW, 30 hp) cannot be supported by a motor support alone.

## 2.8 Integral bypass valve (model 615 pumps only)

Model 615 booster pumps can be supplied with an integral bypass valve for operation from atmospheric pressure. The bypass regulates the amount of compression across the booster pump body. The limiting speed for the bypass booster pump is 3600 r $min^{-1}$ (rpm). The bypass valve regulates the pressure differential across the booster pump to 7.9 x $10^3$ Pa (79 mbar, 60 Torr). Maximum discharge temperature and maximum temperature rise are the same as for the standard 615 booster pumps. Under some operating conditions, it is not possible to operate the bypass booster pumps continuously because of the heat generated from gas compression. These conditions depend on chamber size and backing pump speeds. Consult us if pump-down exceeds 45 minutes. Refer to *Principle of operation* on page 12, detail E for a cross-section view of a bypass booster pump.

## 2.9 Oxygen and reactive gas service

We can prepare bareshaft booster pumps for hazardous gas duties (where pumped gases could react with the hydrocarbon lubricants in standard pumps). When prepared for hazardous gas duties, the booster pumps will be free of hydrocarbons and must be used with inert lubricating oil which will not react with the hazardous gases pumped.

You must take special care when operating booster pumps on oxygen pumping duties: refer to the "Vacuum pump and vacuum system safety - chemical and industrial systems" in *Associated publications*.

# 3. Technical data

## 3.1 Operating and storage conditions

*Table 2 Operating and storage conditions*

| Parameters | Value |
|---|---|
| Ambient operating temperature range | 12 to 40 °C (54 to 104 °F) |
| Ambient storage temperature range | -30 to 70 °C (-22 to 158 °F) |
| Normal surface temperature of the pump body at ultimate vacuum (operation), ambient temperature of 20 °C (68 °F) | 50 to 70 °C (122 to 158 °F) |
| Maximum ambient operating humidity | 90% RH |

## 3.2 Pump technical data

Refer to the respective tables (listed below) for performance data, electrical data and mechanical data of pumps.

| Table | Description |
|---|---|
| *Table: 607-MH/MV05, 607-MH/MV20,615-MH/MV10 and 615-MH/MV15* | Direct drive MSeal booster pumps (with NEMA motors) |
| *Table: 61B-5V10, 622-5H/5V25, 61B-MH/MV10, 61B-MH/MV25 and 622-MH/MV25* | Direct drive process isolation booster pump and direct drive MSeal booster pumps |
| *Table: 607MHR/MVR601 and 615MHR/MVR601* | Direct drive MSeal booster pumps (with IEC motors) |
| *Table: 61BMHR/MVR601 and 622MHR/MVR601* | Direct drive MSeal booster pumps (with IEC motors) |
| *Table: 607MHR/MVR and 615MHR/MVR* | Direct drive MSeal booster pumps (with IEC motors) |
| *Table: 61BMHR/MVR and 622MHR/MVR* | Direct drive MSeal booster pumps (with IEC motors) |
| *Table: Bareshaft MSeal booster pumps* | Direct drive MSeal booster pumps |
| *Table: Bareshaft process isolation booster pumps* | Bareshaft process isolation booster pumps |

We recommend that you connect the electrical supply to the pump through a suitable starter or circuit breaker which has thermal over-current protection and a thermistor control module which complies with IEC34-11 or BS4999 Part III. You must adjust the over-current protection to suit your installation , the full-load current ratings are shown on the motor rating plate. The fuse ratings must be calculated by a qualified electrician. The supplier of your thermal over-current protection device may specify fuse ratings to make sure correct operation of the over-current protection device. Ensure that the fuse you use is suitable for the starting currents given on the motor rating plate.

*Table 3 607-MH/MV05, 607-MH/MV20, 615-MH/MV10 and 615-MH/MV15 direct drive MSeal booster pumps (with NEMA motors)*

| Parameters | 900-607-MH05<br>900-607-MV05 | 900-607-MH20<br>900-607-MV20 | 900-615-MH10<br>900-615-MV10 | 900-615-MH15<br>900-615-MV15 |
|---|---|---|---|---|
| Pumping speed | 1040 $m^3h^{-1}$ | 1040 $m^3h^{-1}$ | 2210 $m^3h^{-1}$ | 4420 $m^3h^{-1}$ |
| | 612 cfm | 612 cfm | 1300 cfm | 2600 cfm |
| Nominal power | 3.75 kW | 15 kW | 7.5 kW | 11 kW |
| | 5 hp | 20 hp | 10 hp | 15 hp |
| Voltage | 230/460 V a.c. | 208-230/460 V a.c. | 208-230/460 V a.c. | 208-230/460 V a.c. |
| Frequency | 60 Hz | 60 Hz | 60 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | TEFC IP55 | TEFC IP55 | TEFC IP55 | TEFC IP55 |
| Motor speed | 1725 r $min^{-1}$ | 1760 r $min^{-1}$ | 1750 r $min^{-1}$ | 3500 r $min^{-1}$ |
| | 1725 rpm | 1760 rpm | 1750 rpm | 3500 rpm |
| Dimensions | Refer to drawing | | | |
| Total mass (pump and motor) | 274 kg | 406 kg | 385 kg | 392 kg |
| | 603 lbs | 897 lbs | 847 lbs | 865 lbs |
| Motor mass | 34 kg | 167 kg | 84 kg | 91 kg |
| | 75 lbs | 367 lbs | 185 lbs | 200 lbs |

*Table 4 61B-5V10 and 622-5H/5V25 direct drive process isolation booster pump, and 61B-MH/ MV10 61B-MH/MV25 and 622-MH/MV25 direct drive MSeal booster pumps (with NEMA motors)*

| Parameters | 900-61B-5V10 | 900-61B-MH10<br>900-61B-MV10 | 900-61B-MH25<br>900-61B-MV25 | 900-622-MH25<br>900-622-MV25<br>900-622-5H25<br>900-622-5V25 |
|---|---|---|---|---|
| Pumping speed | 2210 $m^3h^{-1}$ | 2210 $m^3h^{-1}$ | 4420 $m^3h^{-1}$ | 6528 $m^3h^{-1}$ |
| | 1300 cfm | 1300 cfm | 2600 cfm | 3840 cfm |
| Nominal power | 7.5 kW | 7.5 kW | 18.6 kW | 18.6 kW |
| | 10 hp | 10 hp | 25 hp | 25 hp |
| Voltage | 208-230/460 V a.c. | 208-230/460 V a.c. | 208-230/460 V a.c. | 208-230/460 V a.c. |
| Frequency | 60 Hz | 60 Hz | 60 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | TEFC IP55 | TEFC IP55 | TEFC IP55 | TEFC IP55 |
| Motor speed | 1750 r $min^{-1}$ | 1750 r $min^{-1}$ | 3500 r $min^{-1}$ | 3500 r $min^{-1}$ |
| | 1750 rpm | 1750 rpm | 3500 rpm | 3500 rpm |
| Dimensions | Refer to drawing | | | |

| Parameters | 900-61B-5V10 | 900-61B-MH10<br>900-61B-MV10 | 900-61B-MH25<br>900-61B-MV25 | 900-622-MH25<br>900-622-MV25<br>900-622-5H25<br>900-622-5V25 |
|---|---|---|---|---|
| Total mass (pump and motor) | 392 kg | 392 kg | 533 kg | 619 kg |
| | 865 lbs | 865 lbs | 1175 lbs | 1365 lbs |
| Motor mass | 84 kg | 84 kg | 167 kg | 167 kg |
| | 185 lbs | 185 lbs | 367 lbs | 367 lbs |

***Table 5 607MHR/MVR601 and 615MHR/MVR601 direct drive MSeal booster pumps (with IEC motors)***

| Parameters | 900607MHR940*<br>900607MVR940* | | 900615MHR940*<br>900615MVR940* | |
|---|---|---|---|---|
| | 50 Hz operation | 60 Hz operation | 50 Hz operation | 60 Hz operation |
| Pumping speed | 1734 $m^3h^{-1}$ | 2080 $m^3h^{-1}$ | 3684 $m^3h^{-1}$ | 4420 $m^3h^{-1}$ |
| | 1020 cfm | 1224 cfm | 2167 cfm | 2600 cfm |
| Nominal power | 7.5 kW | 7.5 kW | 11 kW | 11 kW |
| | 10 hp | 10 hp | 15 hp | 15 hp |
| Voltage | 380/400 V a.c. | 230/460 V a.c. | 380/400 V a.c. | 230/460 V a.c. |
| Frequency | 50 Hz | 60 Hz | 50 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | IP55 | IP55 | IP55 | IP55 |
| Motor speed | 2905 r $min^{-1}$ | 3510 r $min^{-1}$ | 2940 r $min^{-1}$ | 3555 r $min^{-1}$ |
| | 2905 rpm | 3510 rpm | 2940 rpm | 3555 rpm |
| Dimensions | Refer to drawing | | | |
| Total mass (pump and motor) | 313 kg | 313 kg | 403 kg | 403 kg |
| | 689 lbs | 689 lbs | 887 lbs | 887 lbs |
| Motor mass | 57 kg | 57 kg | 75 kg | 75 kg |
| | 126 lbs | 126 lbs | 165 lbs | 165 lbs |

** These pumps use CE, NEMA and China IE3 efficiency approved IEC motors.*

***Table 6 61BMHR/MVR601 and 622MHR/MVR601 direct drive MSeal booster pumps (with IEC motors)***

| Parameters | 90061BMHR940*<br>90061BMVR940* | | 900622MHR940*<br>900622MVR940* | |
|---|---|---|---|---|
| | 50 Hz operation | 60 Hz operation | 50 Hz operation | 60 Hz operation |
| Pumping speed | 3684 $m^3h^{-1}$ | 4420 $m^3h^{-1}$ | 5440 $m^3h^{-1}$ | 6258 $m^3h^{-1}$ |
| | 2167 cfm | 2600 cfm | 3200 cfm | 3840 cfm |

| Parameters | 90061BMHR940*<br>90061BMVR940* | | 900622MHR940*<br>900622MVR940* | |
|---|---|---|---|---|
| | 50 Hz operation | 60 Hz operation | 50 Hz operation | 60 Hz operation |
| Nominal power | 18.5 kW | 18.5 kW | 18.5 kW | 18.5 kW |
| | 25 hp | 25 hp | 25 hp | 25 hp |
| Voltage | 380/400 V a.c. | 230/460 V a.c. | 380/400 V a.c. | 230/460 V a.c. |
| Frequency | 50 Hz | 60 Hz | 50 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | IP55 | IP55 | IP55 | IP55 |
| Motor speed | 2950 r $min^{-1}$ | 3550 r $min^{-1}$ | 2950 r $min^{-1}$ | 3555 r $min^{-1}$ |
| | 2950 rpm | 3550 rpm | 2950 rpm | 3555 rpm |
| Dimensions | Refer to drawing | | | |
| Total mass (pump and motor) | 516 kg | 516 kg | 573 kg | 573 kg |
| | 1136 lbs | 1136 lbs | 1260 lbs | 1260 lbs |
| Motor mass | 94 kg | 94 kg | 94 kg | 94 kg |
| | 207 lbs | 207 lbs | 207 lbs | 207 lbs |

** These pumps use CE, NEMA and China IE3 efficiency approved IEC motors.*

***Table 7 607MHR/MVR and 615MHR/MVR direct drive MSeal booster pumps (with IEC motors)***

| Parameters | 900607MHR934*<br>900607MVR934* | | 900615MHR934*<br>900615MVR934* | |
|---|---|---|---|---|
| | 50 Hz operation | 60 Hz operation | 50 Hz operation | 60 Hz operation |
| Pumping speed | 1734 $m^3h^{-1}$<br>1020 cfm | 2080 $m^3h^{-1}$<br>1224 cfm | 3684 $m^3h^{-1}$<br>2167 cfm | 4420 $m^3h^{-1}$<br>2600 cfm |
| Nominal power | 7.5 kW<br>10 hp | 7.5 kW<br>10 hp | 11 kW<br>15 hp | 11 kW<br>15 hp |
| Voltage | 200 V a.c | 200/380 V a.c | 200 V a.c. | 200/380<br>V a.c. |
| Frequency | 50 Hz | 60 Hz | 50 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | IP55 | IP55 | IP55 | IP55 |
| Motor speed | 2925 r $min^{-1}$<br>2925 rpm | 3510 r $min^{-1}$<br>3510 rpm | 2920 r $min^{-1}$<br>2920 rpm | 3520 r $min^{-1}$<br>3520 rpm |
| Dimensions | Refer to drawing | | | |
| Total mass (pump and motor) | 313 kg<br>689 lbs | 313 kg<br>689 lbs | 403 kg<br>887 lbs | 403 kg<br>887 lbs |
| Motor mass | 57 kg<br>126 lbs | 57 kg<br>126 lbs | 75 kg<br>165 lbs | 75 kg<br>165 lbs |

** These pumps use Korean and Japanese IE3 approved IEC motors.*

*Table 8 61BMHR/MVR and 622MHR/MVR direct drive MSeal booster pumps (with IEC motors)*

| Parameters | 90061BMHR934*<br>90061BMVR934* | | 900622MHR934*<br>900622MVR934* | |
|---|---|---|---|---|
| | 50 Hz operation | 60 Hz operation | 50 Hz operation | 60 Hz operation |
| Pumping speed | 3684 $m^3h^{-1}$<br>2167 cfm | 4420 $m^3h^{-1}$<br>2600 cfm | 5440 $m^3h^{-1}$<br>3200 cfm | 6258 $m^3h^{-1}$<br>3840 cfm |
| Nominal power | 18.5 kW<br>25 hp | 18.5 kW<br>25 hp | 18.5 kW<br>25 hp | 18.5 kW<br>25 hp |
| Voltage | 200 V a.c. | 200/380 V a.c. | 200 V a.c. | 200/380 V a.c. |
| Frequency | 50 Hz | 60 Hz | 50 Hz | 60 Hz |
| Phases | 3 | 3 | 3 | 3 |
| Enclosure | IP55 | IP55 | IP55 | IP55 |
| Motor speed | 2930 r $min^{-1}$<br>2930 rpm | 3520 r $min^{-1}$<br>3520 rpm | 2930 r $min^{-1}$<br>2930 rpm | 3520 r $min^{-1}$<br>3520 rpm |
| Dimensions | Refer to drawing | | | |
| Total mass (pump and motor) | 516 kg<br>1136 lbs | 516 kg<br>1136 lbs | 573 kg<br>1260 lbs | 573 kg<br>1260 lbs |
| Motor mass | 94 kg<br>207 lbs | 94 kg<br>207 lbs | 94 kg<br>207 lbs | 94 kg<br>207 lbs |

** These pumps use Korean and Japanese IE3 approved IEC motors.*

*Table 9 Bareshaft MSeal booster pumps*

| Parameters | 900-607-MHR<br>900607MHR101 | 900-615-MHR<br>900615MHR101 | 900-61B-MHR<br>90061BMHR101 | 900-622-MHR<br>900622MHR101 |
|---|---|---|---|---|
| Dimensions | Refer to drawing | | | |
| Pump mass | 220 kg<br>483 lbs | 279 kg<br>614 lbs | 342 kg<br>753 lbs | 429 kg<br>945 lbs |

*Table 10 Bareshaft MSeal booster pumps*

| Parameters | 900-607-MVR<br>900607MVR101 | 900-615-MVR<br>900615MVR101 | 900-61B-MVR<br>90061BMVR101 | 900-622-MVR<br>900622MVR101 |
|---|---|---|---|---|
| Dimensions | Refer to drawing | | | |
| Pump mass | 218 kg<br>480 lbs | 277 kg<br>610 lbs | 341 kg<br>749 lbs | 428 kg<br>941 lbs |

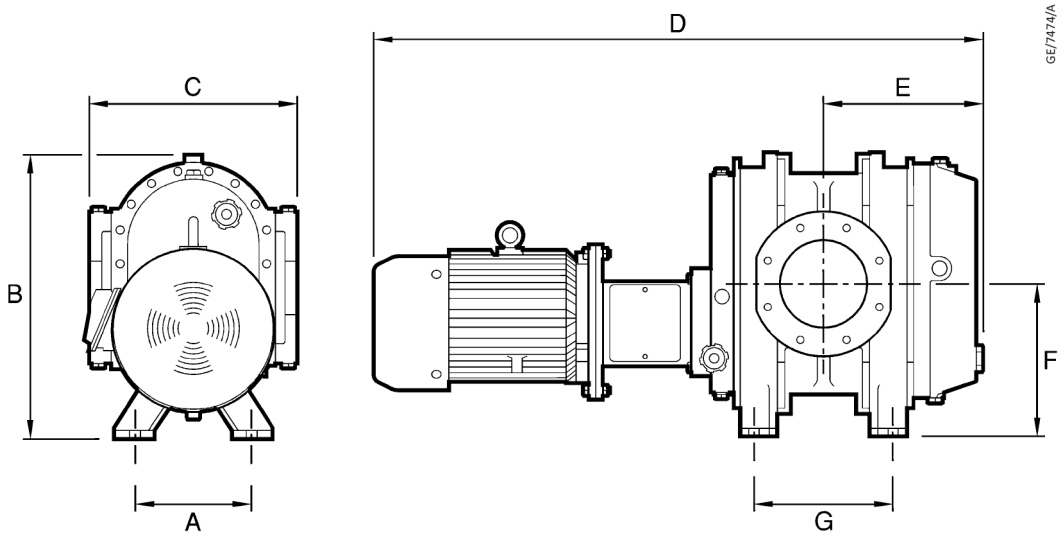
*Table 11 Bareshaft process isolation booster pumps*

| Parameters | 900-607-5HR<br>9006075HR101 | 900-615-5HR<br>9006155HR101 | 900-61B-5HR<br>90061B5HR101 | 900-622-5HR<br>9006225HR101 |
|---|---|---|---|---|
| Dimensions | Refer to drawing | | | |
| Pump mass | 235 kg<br>516 lbs | 294 kg<br>647 lbs | 357 kg<br>786 lbs | 445 kg<br>978 lbs |

*Table 12 Bareshaft process isolation booster pumps*

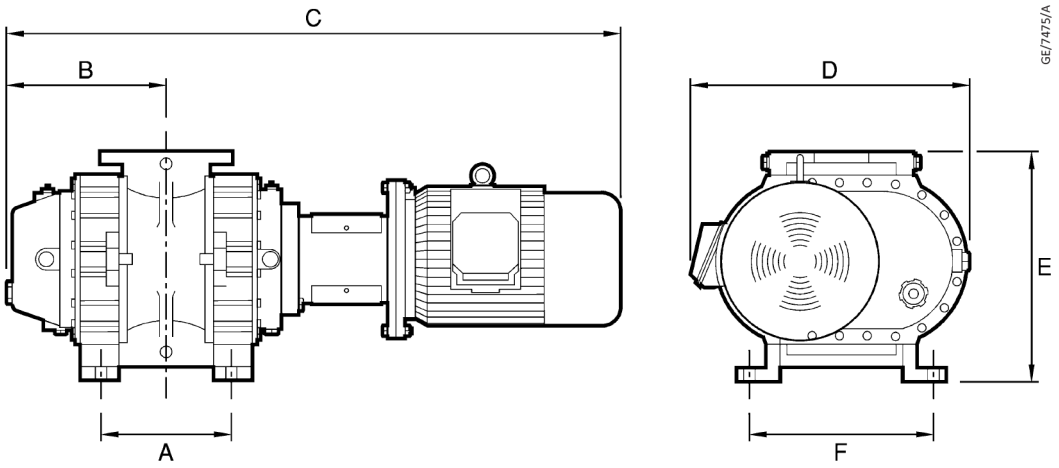
| Parameters | 900-607-5VR<br>9006075VR101 | 900-615-5VR<br>9006155VR101 | 900-61B-5VR<br>90061B5VR101 | 900-622-5VR<br>9006225VR101 |
|---|---|---|---|---|
| Dimensions | Refer to drawing | | | |
| Pump mass | 224 kg<br>492 lbs | 283 kg<br>623 lbs | 346 kg<br>762 lbs | 433 kg<br>954 lbs |

**Figure 4** Direct drive H (horizontal) booster pump dimensions



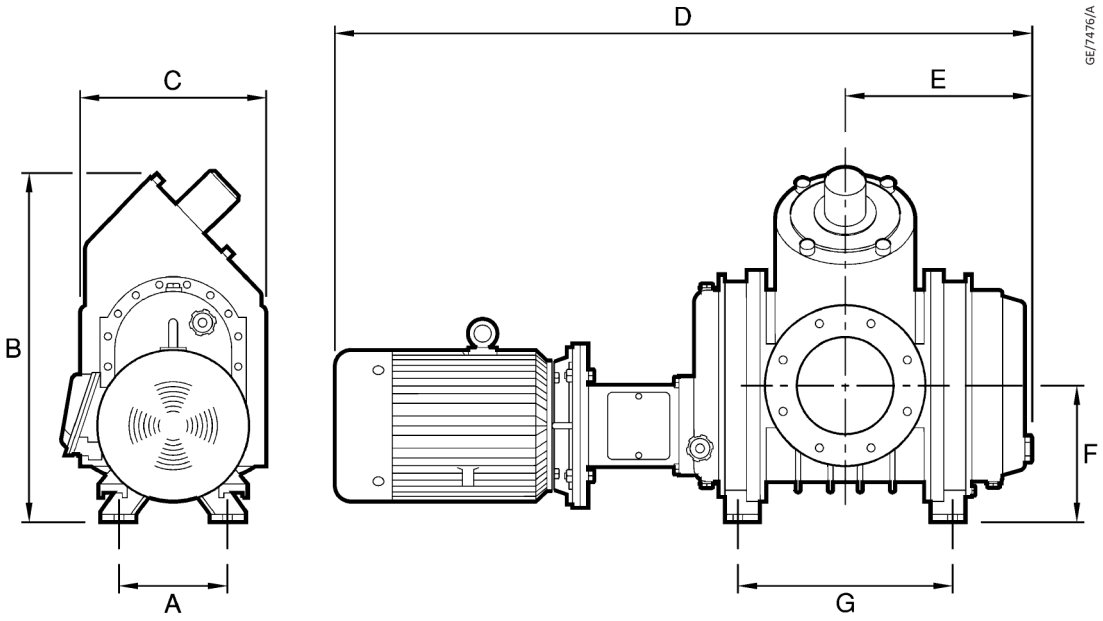

| Pump | Dimensions: mm (inch) | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| 900-607-MH05 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1087 (42.8) | 309 (12.1) | 292 (11.5) | 270 (10.7) |
| 900-607-MH20 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1225 (48.2) | 309 (12.1) | 292 (11.5) | 270 (10.7) |
| 900-615-MH10 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1367 (53.8) | 409 (16.1) | 292 (11.5) | 470 (18.5) |
| 900-615-MH15 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1367 (53.8) | 409 (16.1) | 292 (11.5) | 470 (18.5) |
| 900-622-MH25 | 228 (8.5) | 543 (21.4) | 438 (17.3) | 1657 (65.2) | 498 (19.6) | 292 (11.5) | 648 (25.5) |
| 900-622-5H25 | 228 (8.5) | 543 (21.4) | 438 (17.3) | 1657 (65.2) | 498 (19.6) | 292 (11.5) | 648 (25.5) |
| 900607MHR940 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1266 (49.8) | 309 (12.1) | 292 (11.5) | 270 (10.7) |
| 900615MHR940 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1514 (59.6) | 409 (16.1) | 292 (11.5) | 470 (18.5) |
| 900622MHR940 | 228 (8.5) | 543 (21.4) | 438 (17.3) | 1753 (69.0) | 490 (19.3) | 292 (11.5) | 648 (25.5) |
| 900607MHR934 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1252 (49.3) | 309 (12.1) | 292 (11.5) | 270 (10.7) |
| 900615MHR934 | 228 (8.5) | 543 (21.4) | 406 (16.0) | 1790 (70.5) | 409 (16.1) | 292 (11.5) | 470 (18.5) |
| 900622MHR934 | 228 (8.5) | 543 (21.4) | 438 (17.3) | 1574 (62.0) | 490 (19.3) | 292 (11.5) | 648 (25.5) |

**Figure 5** Direct drive V (vertical) booster pump dimensions



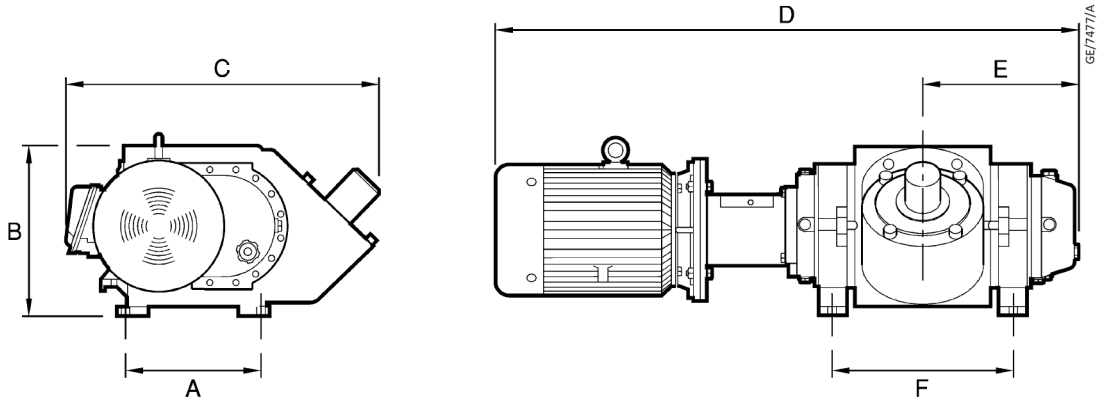

| Pump | Dimensions: mm (inch) | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| 900-607-MV05 | 254 (10.0) | 308 (12.1) | 1087 (42.8) | 502 (19.6) | 406 (16.0) | 350 (13.8) |
| 900-607-MV20 | 254 (10.0) | 308 (12.1) | 1224 (48.2) | 502 (19.6) | 406 (16.0) | 350 (13.8) |
| 900-615-MV10 | 454 (17.9) | 409 (16.1) | 1367 (53.8) | 502 (19.6) | 406 (16.0) | 350 (13.8) |
| 900-615-MV15 | 454 (17.9) | 409 (16.1) | 1367 (53.8) | 502 (19.6) | 406 (16.0) | 350 (13.8) |
| 900-622-MV25 | 648 (25.5) | 496 (19.6) | 1657 (55.2) | 502 (19.6) | 473 (18.6) | 350 (13.8) |
| 900-622-5V25 | 648 (25.5) | 496 (19.6) | 1657 (55.2) | 502 (19.6) | 473 (18.6) | 350 (13.8) |
| 900607MVR940 | 254 (10.0) | 308 (12.1) | 1286 (50.6) | 537 (21.1) | 406 (16.0) | 350 (13.8) |
| 900615MVR940 | 454 (17.9) | 409 (16.1) | 1525 (60.0) | 581 (22.9) | 432 (17.0) | 350 (13.8) |
| 900622MVR940 | 648 (25.5) | 409 (16.1) | 1755 (69.1) | 579 (22.8) | 473 (18.6) | 350 (13.8) |
| 900607MVR934 | 254 (10.0) | 308 (12.1) | 1542 (60.7) | 537 (21.1) | 406 (16.0) | 350 (13.8) |
| 900615MVR934 | 454 (17.9) | 409 (16.1) | 1215 (47.8) | 581 (22.9) | 432 (17.0) | 350 (13.8) |
| 900622MVR934 | 648 (25.5) | 496 (19.6) | 1579 (62.2) | 579 (22.8) | 473 (18.6) | 350 (13.8) |

**Figure 6** Direct drive H (horizontal) booster pump with bypass valve dimensions



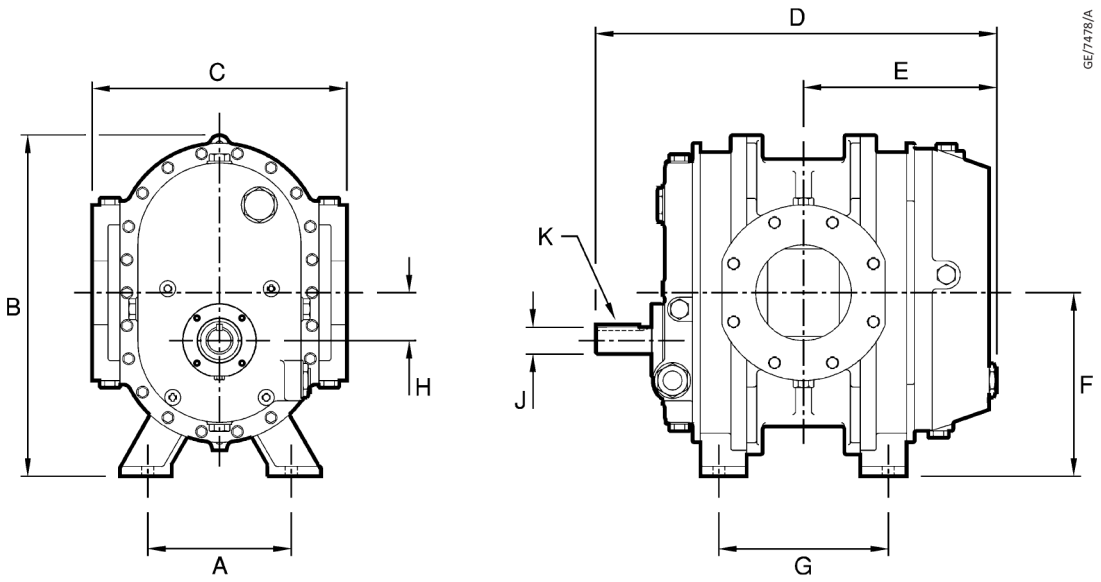

| Pump | Dimensions: mm (inch) | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| 900-61B-MH10 | 229 (9.0) | 763 (30.0) | 406 (16.0) | 1367 (53.8) | 409 (16.1) | 292 (11.5) | 471 (18.5) |
| 900-61B-MH25 | 229 (9.0) | 763 (30.0) | 406 (16.0) | 1479 (58.2) | 409 (16.1) | 292 (11.5) | 471 (18.5) |
| 90061BMHR940 | 229 (9.0) | 763 (30.0) | 406 (16.0) | 1574 (62.0) | 409 (16.1) | 292 (11.5) | 471 (18.5) |
| 90061BMHR934 | 229 (9.0) | 763 (30.0) | 406 (16.0) | 1479 (58.2) | 409 (16.1) | 292 (11.5) | 471 (18.5) |

**Figure 7** Direct drive V (vertical) booster pump with bypass valve dimensions




| Pump | Dimensions: mm (inch) | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| 900-61B-5V10 | 349 (13.8) | 406 (16.0) | 722 (28.4) | 1367 (53.8) | 409 (16.1) | 454 (17.9) |
| 900-61B-MV10 | 349 (13.8) | 406 (16.0) | 722 (28.4) | 1367 (53.8) | 409 (16.1) | 454 (17.9) |
| 900-61B-MV25 | 349 (13.8) | 406 (16.0) | 722 (28.4) | 1479 (58.2) | 409 (16.1) | 454 (17.9) |
| 90061BMVR940 | 349 (13.8) | 406 (16.0) | 791 (31.1) | 1574 (62.0) | 413 (16.3) | 454 (17.9) |
| 90061BMVR934 | 349 (13.8) | 406 (16.0) | 791 (31.1) | 1753 (69.0) | 409 (16.1) | 454 (17.9) |

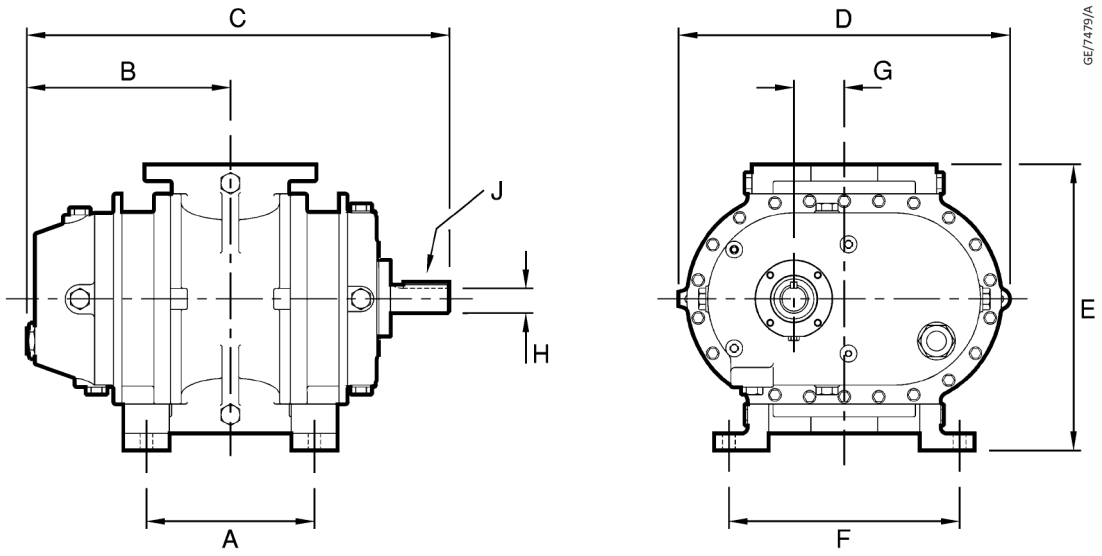
**Figure 8** Bareshaft H (horizontal) booster pump dimensions




| Pump | Dimensions: mm (inch) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **J** | **K** |
| 900-607-MHR | 228 (8.5) | 543 (21.4) | 406 (16.0) | 641 (25.2) | 309 (12.1) | 292 (11.5) | 270 (10.7) | 76 (3.0) | 43 (1.7) | * |
| 900-615-MHR | 228 (8.5) | 543 (21.4) | 406 (16.0) | 843 (33.2) | 409 (16.1) | 292 (11.5) | 470 (18.5) | 76 (3.0) | 43 (1.7) | * |
| 900-622-MHR | 228 (8.5) | 543 (21.4) | 438 (17.3) | 1018 (40.1) | 498 (19.6) | 292 (11.5) | 648 (25.5) | 76 (3.0) | 43 (1.7) | * |

** 9 mm (3/8 inch) square key*

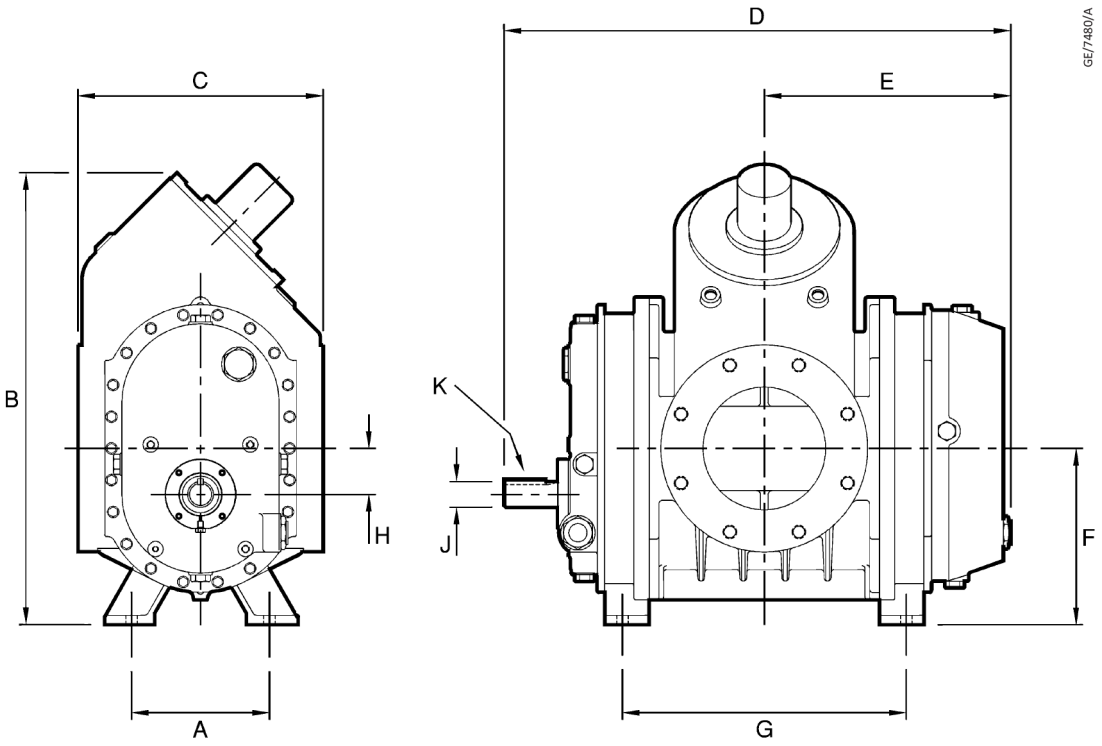
**Figure 9** Bareshaft V (vertical) booster pump dimensions




| Pump | Dimensions: mm (inch) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **J** |
| 900-607-MVR | 254 (10.0) | 308 (12.1) | 641 (25.2) | 502 (19.8) | 406 (16.0) | 350 (13.8) | 76 (3.0) | 43 (1.7) | * |
| 900-615-MVR | 454 (17.9) | 409 (16.1) | 843 (33.2) | 502 (19.8) | 406 (16.0) | 350 (13.8) | 76 (3.0) | 43 (1.7) | * |
| 900-622-MVR | 636 (25.0) | 497 (19.6) | 1018 (40.1) | 502 (19.8) | 438 (17.2) | 350 (13.8) | 76 (3.0) | 43 (1.7) | * |

** 9 mm(3/8 inch) square key*

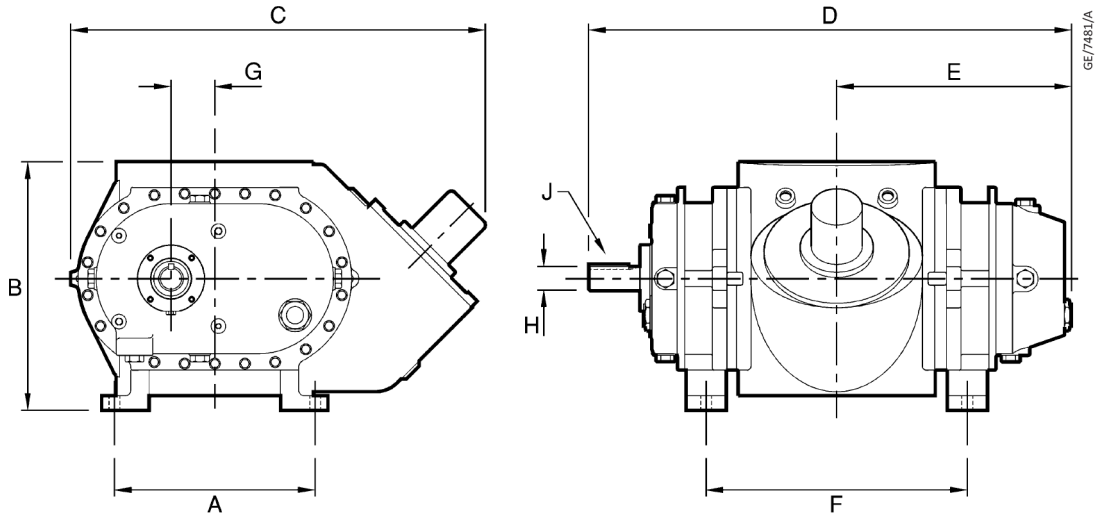
**Figure 10** Bareshaft H (horizontal) booster pump with bypass valve dimensions




| Pump | Dimensions: mm (inch) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | J |
| 900-61B-MVR | 350 (13.8) | 431 (17.0) | 718 (28.3) | 843 (33.2) | 411 (16.2) | 454 (17.9) | 76 (3.0) | 43 (1.7) | * |

* 9 mm (3/8 inch) square key

**Figure 11** Bareshaft V (vertical) booster pump with bypass valve dimensions




| Pump | Dimensions: mm (inch) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | J |
| 900-61B-MVR | 350 (13.8) | 431 (17.0) | 718 (28.3) | 843 (33.2) | 411 (16.2) | 454 (17.9) | 76 (3.0) | 43 (1.7) | * |

# 4. Installation

## 4.1 Safety

**WARNING: INSTALLATION SAFETY**

**Obey the safety instructions listed below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.**

- A suitably trained and supervised technician must install the booster pump. The installation technician must obey all local and national safety requirements.
- Ensure that the installation technician is familiar with the safety procedures which relate to the pump oil and the products processed by the pumping system.
- Refer to "Vacuum pump and vacuum system safety - chemical and industrial systems" in *Associated publications* before you install and use the booster pump to process hazardous or flammable materials.
- Vent and purge the pumping system before you start installation work.
- Check that all the required components are available and of the correct type before you start work.
- Ensure that debris does not get into the booster pump when you install it.
- Disconnect the other components in the pumping system from the electrical supply so that they cannot be operated accidentally.
- Do not reuse O-rings and co-seals.
- Ensure that all electrical cables and purge gas pipelines are safely positioned, secured and routed, so that they do not present a trip hazard.
- Provide adequate access to all pump servicing points and oil-level sight-glasses.
- Leak test the system after installation work is complete and seal any leaks found, to prevent leakage of hazardous substances out of the system and leakage of air into the system.

## 4.2 System design considerations

Consider the following points when you design the pumping system:

- You must mount the booster pump on a firm, level surface.
- Adequately support vacuum pipelines to prevent the transmission of stress to pipeline joints.
- If necessary, incorporate flexible pipelines in your system pipelines to reduce the transmission of vibration and to prevent loading of the coupling joints. If you use flexible pipelines, you must ensure that you use flexible pipelines which have a maximum pressure rating which is greater than the highest pressure that can be generated in the system.
- Ensure that the design incorporates all appropriate safety precautions if toxic, inflammable or explosive gases or particulates will be pumped. Your design must ensure that:
  - Where a flammable gas is pumped, the concentrations of the gas in air must be less than 25% of its LEL (Lower Explosive Limit) concentrations.

- Where a toxic gas is pumped, the concentration of the gas must be less than 25% of the occupational exposure limit for the gas.
- Where a toxic or asphyxiant gas is pumped, the booster pump must be located in a well-ventilated area.
- You must be able to purge the pumping system with an inert gas when you shut down the pumping system, to dilute dangerous gases to safe concentrations. Contact us or your supplier if you are in doubt.

If the booster pump is to be fitted in a new system, ensure that all preliminary pipelines have been installed and that a suitable base for the booster pump has been prepared before you start installation.

Ensure that the following services and facilities are available for connection to the booster pump:

- Electrical supply
- Backing pump
- Inlet screen (if required, to prevent debris from entering the pump during commissioning)

## 4.3 Unpack and inspect

**WARNING: HEAVY OBJECT**

**Risk of injury or damage to the equipment. Use suitable lifting equipment to remove the booster pump from its packaging. If you do not, you can cause injury to people, or you can damage equipment. Refer to *Pump technical data* on page 15 for pump mass.**

Remove all packing materials, remove the booster pump from its packing box, remove the protective covers from the inlet and exhaust ports, and inspect the pump.

If the booster pump is damaged, notify the supplier and your carrier in writing within three days; state the Item Number of the pump together with the order number and supplier's invoice number. Retain all packing materials for inspection. Do not use the pump if it is damaged.

If the booster pump is not to be used immediately, refit the protective covers. Store the pump in suitable conditions as described in *Storage* on page 50 of this manual.

## 4.4 Move the booster pump to its operating location

Use a fork-lift truck to move the booster pump (attached to the shipping crate) to the installation location. Lift the booster pump with the forks well outward of the centre of mass, to prevent the booster pump tipping over when you move it.

When the booster pump has been unpacked and disconnected from its shipping crate, lift the pump; refer to *Figure: Lift the booster pump* and use one of the following two methods:

1. To use lifting bolts and chains (recommended lifting method for NEMA motors) (see details A and B):
   - Fit two 3/4-10 lifting bolts (1, not supplied) to the pump.

- On a booster pump with a motor: fit a suitable size lifting bolt to the motor (if necessary).
- Attach lifting chains to the lifting bolts (1, 2) and connect the chains to your lifting equipment.

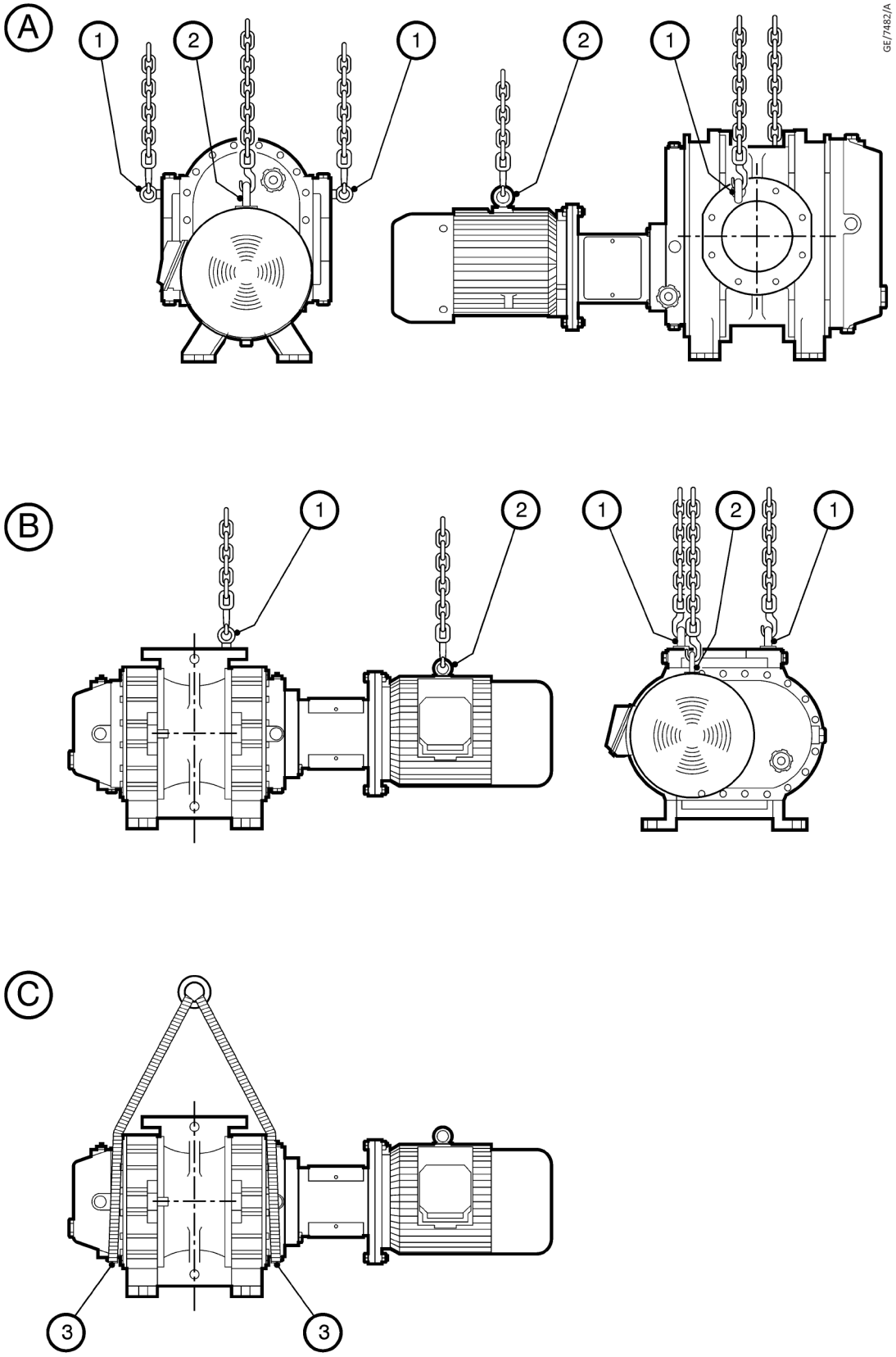
2. To use slings (recommended lifting method for IEC motors) (see detail C):
   - Attach slings (4) around the pump body.
   - Connect the slings to your lifting equipment.

You must use lifting equipment and chains/slings which are suitably rated for the mass of the pump.

Use caution when you move a booster pump with a direct drive motor attached; fix the pump in position immediately after it has been located.

Refer to *Pump technical data* on page 15 for the mass of the pump.

**Figure 12** Lift the booster pump




*A. Lifitng H (horizontal) pumps with chains and lifting bolts*
*B. Lifting V (vertical) pumps with chains and lifting bolts*
*C. Lifting pumps with slings*
*1. Lifting bolt (on booster pump)*
*2. Lifting bolt (if fitted on motor)*
*3. Slings*

## 4.5 Locate the booster pump

**WARNING: HEAVY OBJECT**

**Risk of injury or damage to the equipment. Use suitable lifting equipment to move the booster pump. If you do not, you can injure yourself or damage the pump. Refer to *Pump technical data* on page 15 for pump mass information.**

You must mount the booster pump on a smooth, flat, level surface. The degree of variation in level should not exceed 5.2 mm $m^{-1}$ (0.063 inch $ft^{-1}$) in any direction. Check that all four pump feet contact the mounting base. Do not distort the booster pump body. You must securely fix the booster pump in position before you operate it.

Before you install the pump, check that there are no foreign materials or debris in the vacuum pipelines or in the impeller cavities in the body of the pump. Check that the impellers rotate freely.

The booster pumps are designed for optimal performance in clean environments with ambient temperatures as specified in *Operating and storage conditions* on page 15. If you use the booster pumps in areas of higher temperatures, this will result in higher discharge temperatures, and possible over-temperature cut-outs. If you use the booster pumps in dirty locations or where oil vapour is present, this can result in overheating of the motor, belt slippage, or premature wear. When the pump is used in a dirty environment, ensure that you inspect and clean the equipment as necessary.

Locate the pump as close as possible to the equipment/chamber which will be evacuated. Position the pump so that electrical and vacuum pipeline connections can be easily made. Provide adequate access space around and above the pump, so that the pump can be easily serviced. Avoid long lengths of vacuum pipeline from the equipment/chamber being evacuated to the booster pump.

The booster pumps are precision balanced devices. You must mount the booster pump on a sufficiently rigid base, and secure it to the floor to reduce potential system vibration. Vacuum pipelines attached to the booster pump can vibrate excessively if they are not properly supported or secured. Booster pump vibration is usually the results of insufficient support.

## 4.6 Connect the vacuum and exhaust pipelines

**WARNING: TRIP HAZARD**

**Risk of injury. Install all pipelines so that they do not present a trip hazard. If you do not, you can cause injury to people.**

**CAUTION: OPERATION SAFETY**

**Risk of damage to the equipment. Install a removable inlet filter so that particles, debris or loose components cannot enter the pump during commissioning.**

All vacuum pipelines should be as short as possible and should be no smaller than the diameter of the booster pump inlet. When you need to install a long length of pipeline, use pipe which has a diameter larger than the diameter of the pump inlet. Conductance-

check the pipelines to ensure that the pumping speed of the system will not be decreased. Do not install restrictive pipelines or valves in the exhaust pipeline; these may cause the exhaust pressure to exceed atmospheric pressure. If necessary, contact us for advice and assistance when you need to size long lengths of pipelines.

Use a clean rag dampened with Loctite Safety Solvent (or another cleaning solution compatible with the gases to be pumped) to clean the booster pump impellers and flanges if they have accumulated dirt during installation or storage. It is important that the flanges are clean; if they are not, you will not be able to obtain a good vacuum seal.

Install an isolation valve in the foreline to the booster pump, so that the pump can be isolated from the chamber/vacuum system.

### 4.6.1 Vacuum inlet pipeline

**CAUTION: FAILURE OF PARTS**

**Risk of damage to the equipment. Ensure that foreign matter (particulate) cannot get into the pump. If it does, it can cause serious damage and premature failure of internal pump part.**

Ensure that the vacuum pipeline is leak-tight. Install a flexible connection between the booster pump inlet and the vacuum pipeline, to reduce vibration and prevent booster pump body distortions. Properly support the pipelines, to minimise vibration. You must not use the body of the booster pump to support long lengths of pipelines.

We recommend that you install a high-vacuum, fully-opening valve, for ease of start-up and so that you can check the pump ultimate pressure with no gas throughput. This valve will allow you to isolate the vacuum pumps from the vacuum system. We recommend that you install a vacuum pressure gauge, so that you can monitor pump performance. Install a vent valve in the booster pump inlet or foreline. Install a filter-silencer, to prevent the entry of foreign materials into the system.

Ensure that the vacuum system and connecting pipelines are clean and free of weld splatter, dirt or grit.

We recommend that you install inlet filters and traps, to prevent entry of foreign matter. If you use inlet filters and traps, we recommend that you change the pump oil more frequently.

You may need to install other devices such as interstage temperature switches, timers, vacuum pressure switches and so on, to protect the booster pump from thermal and mechanical overload. This will depend on the size of the booster pump, the backing pump capacity and vacuum chamber size.

### 4.6.2 Accessory port pipelines

Accessory connection ports are provided in the body of the booster pump. You may use these ports to connect vent valves and vacuum pressure gauges. Vacuum pressure gauges should be connected as follows: remove the 0.5 inch O-ring plug (0.75-16 straight thread) and fit a vacuum ball valve, connected to an elevated vacuum pressure gauge. Use a short run of vacuum pipe so that the valve is not too close to the hot body of the booster pump.

Coat all threaded vacuum joints with a liquid thread sealant (such as Loctite 714 or equivalent). Do not use tape thread sealant, which will create small vacuum leaks.

### 4.6.3 Exhaust pipeline

**WARNING: HOT SURFACE**

**Risk of burns. The temperature of parts of the exhaust pipeline may exceed 70 °C (160 °F). Under extreme conditions, surfaces of the booster pump may reach 190 °C (375 °F). Provide adequate guarding and warnings, to protect people from the hot surfaces.**

The diameter of the exhaust pipeline must be no smaller than the diameter of the booster pump outlet. Ensure that the exhaust gases (which may include pump oil and process gases) are safely handled and treated, in accordance with local, State and National regulations.

When you install a horizontal booster pump on an oil-sealed backing pump, mount the booster pump above the backing pump inlet, so that oil does not collect in the booster pump. Install sample ports in the exhaust pipeline, so that you can check system temperatures and pressures. Do not install restrictive piping or valves in the exhaust pipeline, as these may cause the exhaust pressure to exceed atmospheric pressure.

## 4.7 Belt drive booster pump installation

**WARNING: OPERATION SAFETY**

**Risk of injury. Never operate the booster pump without proper safety guarding installed.**

Ensure that the alignment of the pulleys and the tension of the booster pump drive belt are correct. Comply with the installation requirements specified in this manual and inspect the drive system regularly, to avoid mechanical problems and unnecessary repairs. Belt axial load should be less than 890 N (200 lb). *Table: Belt tensions* shows the minimum permissible pulley diameters. Contact us for advice if you want to use a motor with a power rating which exceeds 30 kW (40 hp). Obey all of the safety precautions outlined in *Safety* on page 26.

*Table 13 Minimum pulley diameters*

| Minimum pulley diameter | ≤ 11 kW<br>≤ 15 hp | 15 to 18.75 kW<br>20 to 25 hp | 22 to 30 kW<br>30 to 40 hp |
|---|---|---|---|
| mm | 132 | 160 | 178 |
| inches | 5.2 | 6.3 | 7.0 |

Pulley misalignment can damage the bearing, belts and seal(s). Pulley alignment does not change during operation. The motor and booster pump drive shafts must be parallel to avoid uneven loading of belts. Your motor and drive components must comply with local and national safety regulations. Check for free rotation of the booster pump before you start the booster pump.

New belts usually lose some tension during initial operation, and you should re-check the belts during the first few days of operation. Tension all belts in accordance with the belt manufacturer's instructions. Excessive tension can induce unnecessary loading on the booster pump bearings and bending moments on the booster pump drive shaft. Extreme over-tensioning may cause the pump drive shaft to fail, due to fatigue damage.

Booster pumps with belt drive systems supplied by us have the pulley and belt tension already preset. Recheck the alignment and tension (refer *Table: Oil quantities* and *Table: Maintenance plan*) before initial operation; use the following procedure:

1. Ensure that the shaft, hub and pulley components are free of lubricants, corrosion and protective coatings.
2. Check the pulley alignment with a straight edge or tight cord. The pulley faces must contact the straight edge at all four points. Misalignment will significantly increase belt wear.
3. If pulley alignment or removal is required: loosen the motor hub set screws several turns; remove one set screw completely; install the set screw in the centre position and then tighten the screw to free the locking bush. Reposition the pulley and then reinstall the set screws in the original position in the locking bush. Tighten the set screws evenly to the specified torque. Note that the locking bush number is stamped on the inner hub face.
4. Belt span distance, belt deflection and deflection force determine the correct belt tension. Determine the span distance between contact points on the pulleys. The deflection must be 0.397 mm per 25.4 mm of span (1/64 inch per 1 inch of span).
5. Determine the correct belt force, based on the smallest pulley diameter and belt type. Belt systems supplied by us are usually a 3 groove "B" design. Check each belt for even loading. Uneven loading indicates pulley misalignment or non-parallel shafts.
6. Ideal tension is the minimum tension to overcome peak loading. Never exceed 1.25 times the force specified in *Table: Maintenance plan*. Lock down the tension adjustment mechanism.
7. Turn the pulleys over three times by hand. Check for free and easy rotation.
8. Recheck the tension before you refit the safety guards and operate the booster pump.

When any one belt needs to be replaced, replace all of the other belts at the same time. Check the tension frequently during the first few days of operation. Never apply belt dressing. If you are installing your own belt or pulley drive system, install all components in accordance with the manufacturer's instructions. Check belts and pulleys every 2000 hours.

***Table 14 Torque ratings***

| Locking bush number | Torque | | Locking bush number | Torque | |
|---|---|---|---|---|---|
| | Nm | lbf ft | | Nm | lbf ft |
| 1310 | 19.6 | 14.5 | 3020 | 90.8 | 67 |
| 1610 | 19.6 | 14.5 | 3030 | 90.8 | 67 |
| 1615 | 19.6 | 14.5 | 3535 | 112.5 | 83 |
| 2012 | 31.1 | 23 | 4040 | 191.1 | 141 |

| Locking bush number | Torque | | Locking bush number | Torque | |
|---|---|---|---|---|---|
| | Nm | lbf ft | | Nm | lbf ft |
| 2517 | 48.8 | 36 | 4545 | 276.5 | 204 |
| 2525 | 48.8 | 36 | 5050 | 352.5 | 260 |

*Table 15 Belt tensions*

| Belt type | Smallest pulley diameter: mm (inch) | Speed range: r min $^{-1}$/rpm | Belt force, per belt: N (lbf) | |
|---|---|---|---|---|
| | | | Normal | New belts |
| B, BX | 111.8 to 142.2 (4.4 to 5.6) | 860 to 2500<br>2501 to 4000 | 23.5 (5.3)<br>20.0 (4.5) | 35.1 (7.9)<br>29.8 (6.7) |
| | 147.3 to 218.4 (5.8 to 8.6) | 860 to 2500<br>2501 to 4000 | 28.0 (6.3)<br>26.6 (6.0) | 41.8 (9.4)<br>39.5 (8.9) |
| 3VX | 104.6 to 175.2 (4.12 to 6.90) | 1000 to 2500<br>2501 to 4000 | 21.7 (4.9)<br>19.5 (4.4) | 32.4 (7.3)<br>29.3 (6.6) |
| 5V, 5VX | 180.3 to 276.8 (7.1 to 10.9) | 500 to 1740<br>1741 to 3000 | 56.4 (12.7)<br>49.8 (11.2) | 84.0 (18.9)<br>74.2 (16.7) |
| | 299.7 to 406.4 (11.8 to 16.0) | 500 to 1740<br>1741 to 3000 | 68.9 (15.5)<br>64.9 (14.6) | 104.0 (23.4)<br>96.9 (21.8) |

## 4.8 Direct drive booster pump installation

**WARNING: OPERATION SAFETY**

**Risk of injury. Never operate the booster pump without proper safety guarding installed.**

Drive coupling alignment must be correct. Misalignment or a worn out coupling spacer (spider) will damage the booster pump bearing and seal(s). Comply with the installation requirements specified in this manual and inspect the drive system regularly, to avoid mechanical problems and unnecessary repairs.

If you install your own motor and drive components, they must comply with all local and national safety regulations. Follow all of the safety precautions outlined in *Safety* on page 26.

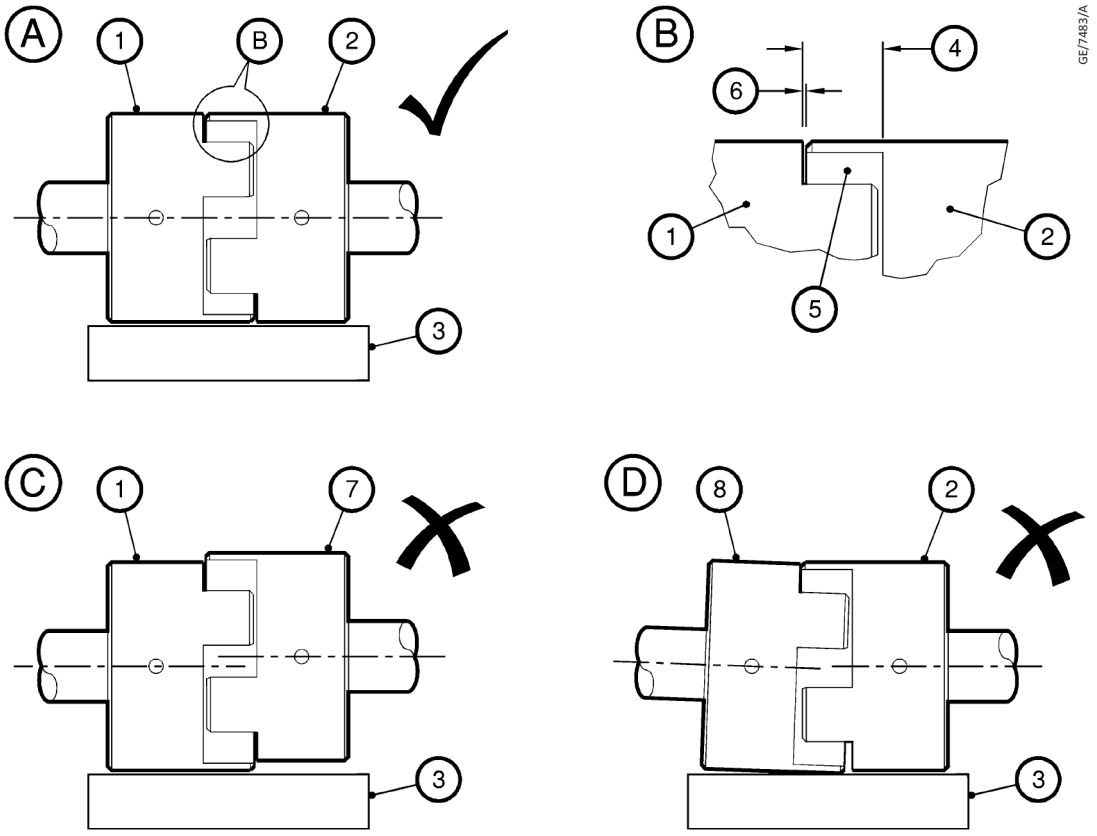
Direct drive booster pumps are supplied with the motor coupling already set. Recheck the alignment before initial operation. Values listed below are for L190 couplings. Contact us for advice on other coupling sizes. Check the condition of the coupling spider every 2000 hours.

1. Ensure that the shaft, coupling and other components are free of lubricants, protective coatings and burrs.
2. Slide one half-coupling onto each shaft. Check that the keys fit tightly.
3. Position the hubs on the shafts so that there is a gap of approximately 25.4 mm (1.0 inch) between the hub recesses for the polymer spider, and so that there is an equal amount of support for both coupling halves. When one of the half-couplings

is in its final position, tighten the set screw ((1/2) -13) on the half-coupling to a torque of 61 to 68 Nm (45 to 50 lbf ft).

4. Slide back the free half-coupling and install the polymer spider. Reposition the free half-coupling to the correct spacing, and tighten the set screw as described above.
5. If you cannot slide back the hub: torque the second half-coupling at the correct spacing; separate the components and install the polymer spider; reassemble the coupling hubs together with the correct spacing.
6. Check for parallel alignment with a straight edge across the two coupling halves at several places around the coupling. Do not rotate the coupling. Measure the space under the straight edge. The misalignment measurement must be less than 0.013 mm (0.005 inch). Correct alignment will ensure the best performance and longest coupling life. Reposition the shafts if the maximum misalignment is exceeded.
7. Determine the angular alignment across the coupling. Take the measurements from the surface where the couplings neck down from the spider diameter to the diameter with the set screw(s). Determine the maximum and minimum values. The difference between these two measurements must be less than 0.38 mm (0.015 inch). Reposition the shafts if the maximum tolerance is exceeded. Recheck for parallel alignment if you reposition the coupling.
8. Rotate the coupling after you have set the proper alignment. The shaft should rotate freely and easily. Never operate a coupling above the maximum permissible power of the r $min^{-1}$ (rpm) rotation speed indicated (stamped) on the coupling. Never operate the booster pump at speeds above 3600 r $min^{-1}$ (rpm).
9. Install proper safety guards before you operate the booster pump.

**Figure 13** Coupling




*A. Correct alignment*
*B. Correct coupling settings*
*C. Incorrect alignment*
*D. Incorrect alignment*

*1. Pump drive coupling half (correctly aligned)*
*2. Motor drive coupling half (correctly aligned)*
*3. Straight edge*
*4. Coupling clearance: 2.54 mm (1 inch)*
*5. Spider*
*6. Clearance: 0.5 mm (0.02 inch)*
*7. Motor drive coupling half (incorrectly aligned)*
*8. Pump drive coupling half (incorrectly aligned)*

## 4.9 Fill the booster pump with oil

**WARNING: EXPLOSION HAZARD**

**Risk of explosion. Changing the oil in a booster pump from hydrocarbon to PFPE (Fomblin) could potentially cause a safety hazard. Fomblin pumps are generally used in hazardous applications which may involve the pumping of gases with high concentrations of oxygen. If hydrocarbon oil comes into contact with gases with an oxygen concentration greater than 25%, an explosion can occur.**
**Therefore, if you want to convert a booster pump that has been used with hydrocarbon oil to use PFPE (Fomblin) oil, you cannot simply flush the pump with new PFPE oil. You must return the pump to our Service Centre for overhaul and cleaning by qualified service engineers. The change in oil type requires a complete strip-down of the pump, and thorough cleaning of all parts, so that all traces of hydrocarbon oil are removed.**

**CAUTION: OPERATION SAFETY**

**Risk of damage to the equipment. Ensure that you use the proper grade of oil and that the oil levels in the pump are correct. If you do not, pump performance will be affected and the pump may be damaged.**

Ensure that the oil-levels in the booster pump are correct before you operate the pump. Check the oil levels daily. Always use the correct oil. Do not use oils other than those specified in this manual; if you do, you will invalidate the warranty of the pump. Refer to *Maintenance plan* on page 44 for maintenance frequencies. The use of substitute oils may make the booster pump unsafe. If you use the booster pump on harsh and dirty applications, you will need to change the oil more frequently.

### 4.9.1 Hydrocarbon oil

Before you operate the booster pump, ensure that the oil levels are correct (refer to the *Table: Oil quantities*). The oil levels should be at the centre position of each sight-glass. Do not add oil while the booster pump is operating. Shut down the booster pump and vent the pump to atmospheric pressure before you fill the pump with oil, or drain oil from the pump.

The booster pump has two oil reservoirs:

- Bearing housing, drive end
- Bearing housing, gear end

Refer to *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster* for the locations of the oil filler and drain ports.

With the booster pump shut down and at atmospheric pressure, add V-Lube H oil through both filler ports until each oil-level sight-glass is half full. Do not overfill with oil, or allow the oil level to fall below the bottom of the sight-glass. If you have overfilled a reservoir, oil may spill over into the body of the pump and contaminate the vacuum system.

If you overfill the drive end reservoir, the booster pump may make a squealing noise (from the seal) during operation. Lower the oil level slightly to eliminate the noise.

The bearings in the drive end reservoir are splash lubricated from an oil slinger that dips into the oil sump. The gears are lubricated by partial immersion in the oil sump. Splashing from the gears lubricates the bearings.

*Table 16 Oil quantities*

| Bearing housing | Oil capacity: ml (oz) | |
|---|---|---|
| | H (horizontal) pumps | V (vertical)pumps |
| Drive end | 750 (26) | 1350 (46) |
| Gear end | 1200 (41) | 2800 (95) |

When the booster pump is in operation, the oil level will fluctuate due to the pumping action of the gears and slinger. If you cannot see an oil level because the sight-glass is dirty, remove the sight-glass (when you change the oil) and clean the viewing surface.

Each time you remove a filler plug or drain plug, inspect the plug O-ring for cuts or damage, and replace it as necessary. The plug O-rings need to provide a vacuum seal for correct pump operation.

### 4.9.2 Perfluoropolyether (PFPE) oil

**WARNING: EXPLOSION HAZARD**

**Risk of explosion. Only use the type of PFPE oil specified below. If you use another type of oil, this can result in an explosion.**

Before you operate the booster pump, ensure that the oil levels are correct (refer to the Table: Oil quantities in *Hydrocarbon oil* on page 37). Add oxygen service (PFPE) oil into the reservoirs as necessary, as described in *Hydrocarbon oil* on page 37. Each oil-level should be at the centre position of the oil-level sight-glass.

Oxygen service equipment requires the use of PFPE oil. You must only use Fomblin® Y-25/6 oil. Do not use another type of oil, or mix oil types when you add oil.

We recommend that you return oxygen service booster pumps to our Service Centre if major repairs are needed. Minor repairs can be made in the field. Because of the possibility of a dangerous reaction to dirt and chemical compositions in an oxygen rich environment, absolute cleanliness of parts, tools, wipers and technician hands and clothes is required.

## 4.10 Electrical connections

### 4.10.1 Electrical supply configuration

**WARNING: ELECTRICAL HAZARD**

**Risk of electric shock. The electrical installation must conform to all local and national safety regulations. Use a suitably rated fused and protected electrical supply and an earth (ground) point.**

**WARNING: TRIP HAZARD**

**Risk of tripping. Install electrical cables so that they do not present a trip hazard that could result in injury to people.**

**WARNING: ELECTRICAL HAZARD**

**Risk of electric shock. Provide suitable strain relief on the electrical supply cable. If you do not, the cable (or wires in the cable) may become disconnected from the pump, and there may be a risk of injury or death by electrical shock.**

**WARNING: ELECTRICAL HAZARD**

**Risk of electric shock. You must be able to isolate and lock-out the electrical supply from the booster pump. If you do not, there will be a risk of injury or death by electrical shock during maintenance or servicing.**

### CAUTION: OPERATION SAFETY

**Risk of damage to the equipment. Configure the electrical supply to the booster pump so that the pump is automatically switched off if the backing pump stops. If you do not, the booster pump may overheat and be damaged.**

**Note:**

*Connect the electrical supply to the motor through a contactor which has a manual reset control.*

A suitably qualified person must correctly install the necessary overloads, motor starter, and control and safety devices, and connect the electrical supply to the booster pump. Control devices may include temperature switches and pressure switches. If the necessary control and safety devices are not installed, this may invalidate any warranty, and can result in serious injury or death, and damage to the equipment.

For motor wiring information refer to the wiring diagram supplied in the motor terminal box. You can configure the dual voltage motors to operate with either the high range or low range electrical supply. We endeavour to supply dual voltage motors preset to the highest of the selectable voltages. For motor current information please refer to the motor rating plate.

Incorporate a manual restart, to prevent automatic cycling in the event of an overload. The booster pump control system must be configured so that a hazardous condition does not arise after electrical supply failure, or when the electrical supply is restored after a failure. Controls should be clearly visible and easily accessible, and be organised to help the operator to understand their functions and their effect on the booster pump and vacuum system.

All electrical connections and controls must meet local and national regulations and standards. You must incorporate over-current protection and a mains electrical disconnect. Ensure that all electrical wiring is protected from dripping water and has appropriate strain relief. Where necessary, incorporate additional controls to protect the equipment and people if the performance limits of the booster pump may be exceeded.

Where necessary, depending on booster pump size, backing pump capacity and chamber size, incorporate other devices such as interstage temperature switches, timers or vacuum pressure switches, to protect the booster pump from thermal and mechanical overload.

Because of the wide range of applications for the booster pumps and the various vacuum systems and configurations, specific sizes or models of the protective equipment, safety devices and control devices cannot be specified in this manual. Information used in the selection of these devices can be found in *Technical data* on page 15. Contact us for recommendations on the protection and safety devices necessary for your specific application.

### 4.10.2 Check the direction of rotation

**WARNING: MOVING PARTS**

**Risk of injury. Blank off the inlet or connect the booster pump to the vacuum system before you check the direction of rotation. If you do not, there is a danger of entanglement or of objects being trapped in the rotating rotors.**

It is possible for the three phase electrical supply to the motor to be phased incorrectly. If the supply is phased incorrectly, the rotors will rotate in the reverse direction or remain stationary.

Watch the motor fan and switch on the electrical supply to the booster pump for two or three seconds, then switch the pump off. The correct direction of rotation is shown by an arrow on the motor: Refer to *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster*.

If the direction of rotation is incorrect, isolate the external electrical supply, correct the electrical connections to the booster pump, then perform the direction check again.

# 5. Operation

## 5.1 Operational safety

**WARNING: VACUUM HAZARD**

**Risk of injury. Do not expose any part of your body to vacuum. If you do, you may be injured.**

**WARNING: HOT SURFACE**

**Risk of burns. During operation, parts of the booster pump can become very hot. Ensure that you do not touch the booster pump.**

**WARNING: MOVING PARTS**

**Risk of injury. Do not operate the booster pump with the inlet or outlet open to atmosphere. If you do, your fingers or other parts of your body may get trapped and you may be injured by the rotating pump mechanism.**

Ensure that the cooling air flow around the booster pump motor is not restricted.

## 5.2 Pre-start checks

Refer to the appropriate sections of this manual relevant to your booster pump, before you start the pump:

1. Ensure that all safety precautions in *Safety* on page 26 have been complied with.
2. Ensure that the booster pump and vacuum and exhaust pipelines are correctly located and secured in place.
3. Check that the oil-levels in the oil reservoirs are correct.
4. Ensure that the vacuum system foreline, the booster pump inlet pipeline and the exhaust pipeline have been checked for debris.
5. Check the booster pump for free rotation.
6. Check that the booster pump operates with the correct direction of rotation.
7. Check that the motor-to-booster pump alignment is correct (direct drive booster pumps only).
8. Check that the alignment of pulleys and belt tensions are correct (pulley driven booster pumps only).
9. Check that the motor has been correctly connected and that the necessary overloads and safety protective devices have been used.
10. Ensure that all precautions have been taken to avoid possible injury or hazardous situations.
11. Ensure that inert or other safe gases are available, to purge process gases and to vent the pump to atmospheric pressure.

## 5.3 Start-up

Use the following procedure to start the pumping system. If any problems are found, stop the booster pump and other equipment and vent the vacuum system to atmospheric pressure. Do not continue to operate the system unless all problems have been corrected.

1. Refer to *Pre-start checks* on page 41 and ensure that all necessary installation requirements have been met.
2. Close the isolation valve to isolate the vacuum pumps from the vacuum system or chamber.
3. Start the backing pump.
4. When the appropriate cut-in pressure is reached, start the booster pump.
5. Operate the booster pump with the inlet blanked-off for five minutes, then check for unusual noises and excessive vibration.
6. Continue to operate the booster pump (with the inlet blanked-off) for one hour, then check for unusual noises and excessive vibration.
7. Open the vacuum system isolation valve, and continue to operate the booster pump at normal operating conditions for approximately 15 minutes. After this time, check for unusual noises and excessive vibration.
8. During the first week of operation of the booster pump, check the following daily:
   - With the booster pump stopped, check that the oil levels are correct (in the middle of the sight-glasses).
   - Check that the drive system operates correctly and is undamaged.

## 5.4 Shutdown

Ensure that you take necessary precautions to prevent a hazardous, toxic, flammable or explosive situation in the vacuum system, chamber, vacuum pumps, and exhaust system. Always use inert or other safe gases to purge process gases and to vent the vacuum system. Note that by-products of the vacuum process could collect in the pump oils and create potential hazards.

1. Close the vacuum system isolation valve to isolate the pumps from the vacuum system or chamber.
2. Shut down the booster pump.
3. Shut down the backing pump and vent the vacuum system, to avoid reverse operation. Vent the vacuum system with a gas that will not create a hazardous, toxic, flammable or explosive situation.

# 6. Maintenance

## 6.1 Safety information

**WARNING: MAINTENANCE SAFETY**

**Risk of injury or damage to the equipment. Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.**

- A suitably trained and supervised person must maintain the booster pump.
- Dismantle the booster pump in a clean workshop environment, with the correct tools and safety facilities available.
- Ensure that the maintenance person is familiar with the safety procedures which relate to the pump oil and the products pumped. Wear appropriate safety-clothing when you come in contact with contaminated components. Dismantle and clean contaminated components inside a fume- cupboard.
- Check that all the required parts are available and of the correct type before starting work.
- Isolate the pump and other components from the electrical supply so that they cannot be operated accidentally.
- Allow the pump to cool (so that it is at a safe temperature for skin contact) before you start maintenance work.
- Vent and purge the pumping system with nitrogen before you start maintenance work.
- Do not reuse O-rings and Co-Seals.
- Dispose of components and waste oil safely (Refer to *Disposal* on page 51).
- Take care to protect sealing faces from damage.
- After maintenance is complete, recheck the direction of pump rotation if the electrical supply has been disconnected.
- The booster pump and pump oil will be contaminated with the process chemicals that have been pumped during operation. Ensure that the pump is decontaminated before maintenance and that adequate precautions have been taken to protect people from the effects of dangerous substances if contamination has occurred.
- Do not touch or inhale the thermal breakdown products of fluorinated materials which may be present if the pump has been heated to 260 °C (500 °F) and above. These breakdown products are very dangerous. Fluorinated materials in the booster pump include oils, greases and seals. The booster pump may have overheated if it was misused, if it malfunctioned, or if it was in a fire. Material Safety Data Sheets for fluorinated materials used in the booster pump are available on request: contact us or your supplier.
- If necessary, maintain the motor as specified in the manufacturers information supplied with the motor.
- Leak test the system after maintenance and seal any leaks found, to prevent leakage of dangerous substances out of the system and leakage of air into the system.

## 6.2 Leak detection

Carry out a leak test if the specified booster pump ultimate vacuum cannot be achieved. A properly carried out leak test will isolate sections of the pipelines until the leak-source is found. The use of a leak detector will speed the process. If required, contact us for more information.

## 6.3 Maintenance plan

*Table: Maintenance plan* details the maintenance operations necessary to maintain the booster pumps in normal use. We recommend that you change the oil more frequently if the booster pump is used under severe operating conditions, such as contamination within the vacuum system or excessively high operating temperatures within the booster pump. (The operating conditions will determine the frequency of oil changes.) Worn pulleys and over tensioning shortens belt life by as much as 50%. If wear allows the belts to contact the bottom of the pulley, slippage and belt burn may result. Convex wear on the side of the belts indicates pulley groove wear. Alignment problems are identified by significant wear on one side of a belt only.

***Table 17 Maintenance plan***

| Operation | Frequency | Procedure |
|---|---|---|
| Check the oil levels | Daily | Check the levels and add oil as required. |
| Change the oil | 2000 hourly | Drain the oil from the pump, and clean any filings from the magnetic drain plug. Refill the pump with new oil. |
| Check the coupling condition | 2000 hourly | Replace the spider if worn. |
| Check the belts and pulleys | 6 monthly | Replace the belts or pulleys if worn. |
| Check the bearing condition | 6 monthly | Check the endplay. Service if required. |
| Clean the motor and drive | Yearly | Remove any dirt to reduce wear and to promote heat transfer. |
| Check the timing | 2 yearly | Re-time the booster pump if required. Contact us for service. |
| Check the ring clamp bolts | 2 yearly | Re-tighten the bolts if required. Contact us for service. |
| Overhaul the pump | 6 yearly* | Contact us or your supplier to arrange for an overhaul of the pump. |

** Or as advised by us or your supplier.*

## 6.4 General maintenance

Refer to *Safety* on page 26 and *Operation* on page 41 before you shut down the booster pump for maintenance, and restart the booster pump after maintenance. Only allow suitably trained and supervised technicians to maintain the booster pump.

## 6.5 Oil-level checks

**WARNING: MAINTENANCE SAFETY**

**Risk of injury or damage to the equipment. Never attempt to add or drain oil while the booster pump is operating. Shut down and lock-out the booster pump and vent it to atmospheric pressure before you fill the pump with oil, or drain oil from the pump.**

**CAUTION: MAINTENANCE SAFETY**

**Risk of injury or damage to the equipment. Ensure that you use the proper grade of oil and that the oil levels in the pump are correct. If you do not, pump performance will be affected and the pump may be damaged.**

Look at the sight-glasses (refer to *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster*). The oil level in each reservoir should be in the centre position on the sight-glass. If you need to add oil:

1. Shut down the vacuum system and vent it to atmospheric pressure.
2. Remove the oil filler plug (refer to *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster*).
3. Add oil as necessary until the oil level is half-way up the sight-glass. Only use oil specified in this manual.
4. Inspect the plug O-ring for cuts or damage, and replace it as necessary. Refit the oil filler plug.

## 6.6 Change the oil

**WARNING: EXPLOSION HAZARD**

**Risk of explosion. Changing the oil in a booster pump from hydrocarbon to PFPE (Fomblin) could potentially cause a safety hazard. Fomblin pumps are generally used in hazardous applications which may involve the pumping of gases with high concentrations of oxygen. If hydrocarbon oil comes into contact with gases with an oxygen concentration greater than 25%, an explosion can occur.**
**Therefore, if you want to convert a booster pump that has been used with hydrocarbon oil to use PFPE (Fomblin) oil, you cannot simply flush the pump with new PFPE oil. You must return the pump to our Service Centre for overhaul and cleaning by qualified service engineers. The change in oil type requires a complete strip-down of the pump, and thorough cleaning of all parts, so that all traces of hydrocarbon oil are removed.**

**WARNING: MAINTENANCE SAFETY**

**Risk of injury or damage to the equipment. Never attempt to add or drain oil while the booster pump is operating. Shut down and lock-out the booster pump and vent it to atmospheric pressure before you fill the pump with oil, or drain oil from the pump.**

**WARNING: HOT OIL**

**Risk of injury. Allow sufficient time for the booster pump to cool before you change the oil. If you do not, you can be injured by the hot oil.**

Use the following procedure to drain and refill each reservoir with oil:

1. Shut down the vacuum system and vent it to atmospheric pressure.
2. Place a suitable container under the drain plug (refer to *Figure: General arrangement of the H (horizontal) booster* and *Figure: General arrangement of the V (vertical) booster*), then remove the drain plug and allow the oil to drain out of the pump.
3. Inspect the plug O-ring for cuts or damage, and replace it as necessary. Refit the drain plug, then dispose of the oil: refer to *Disposal* on page 51.
4. Fill the oil reservoir with oil: refer to *Oil-level checks* on page 45.

## 6.7 Coupling maintenance

1. Shut down the vacuum system and vent it to atmospheric pressure. Allow the booster pump to cool to a safe temperature.
2. Remove the safety guards when the pump is in a safe state.
3. Inspect the coupling as described in *Direct drive booster pump installation* on page 34. Replace any worn or damaged parts.
4. Refit the safety guards.

## 6.8 Belt drive maintenance

1. Shut down the vacuum system and vent it to atmospheric pressure. Allow the booster pump to cool to a safe temperature.
2. Remove the safety guards when the pump is in a safe state.
3. Inspect the belts as described in *Belt drive booster pump installation* on page 32. Replace any worn or damaged belts.
4. Refit the safety guards.

## 6.9 Check the bearing condition

1. Shut down the vacuum system and vent it to atmospheric pressure. Allow the booster pump to cool to a safe temperature.
2. Remove the safety guards when the pump is in a safe state.
3. Loosen the coupling and or belts to remove tension from the drive shaft.
4. Use a dial indicator on the shaft to determine the end play. Total end play must be less than 0.12 mm (0.005 inch):
   - If the end play is not excessive, continue at Step 5.
   - If the end play is excessive, contact us or your supplier to arrange for a rebuild of the pump.
5. Refit the safety guards.

## 6.10 Clean the motor and drive

1. Shut down the vacuum system and vent it to atmospheric pressure. Allow the booster pump to cool to a safe temperature.
2. Remove the safety guards when the pump is in a safe state.
3. Use a compressed air line or a soft brush to remove any dirt and dust from the motor and drive components.
4. Refit the safety guards.

## 6.11 Check the timing

**WARNING: HAZARDOUS WORKING CONDITION**

**Risk of injury. Use the appropriate personal protective equipment when you adjust the impeller timing.**

Only suitably trained personnel should inspect the impeller timing. Our service engineers are available to carry out such inspections on site or at our Service Centre.

Failure to properly time the booster pump can cause catastrophic damage to the pump.

## 6.12 Troubleshooting

Troubleshooting and recommended solutions are provided in *Table: Troubleshooting*.

No pump will give good results on a poor vacuum system. If the vacuum performance in the system is unsatisfactory, the usual cause is leakage into the system. If your system has poor vacuum performance, you should first tighten all connections and fittings, and check that all valves are closed. Use liquid sealant to make the pipeline connections; do not use Teflon tape.

A pressure rise test will help to localise a vacuum leak. To carry out such a test, successively isolate and evacuate each section of the vacuum system, then measure the in-leakage rate (the pressure rise) of each isolated section, to isolate the leak. Use a vacuum leak detector to speed up this process.

If required, we offer vacuum leak detection services.

***Table 18 Troubleshooting***

| Symptom | Probable cause | Recommended solution |
|---|---|---|
| The booster pump does not start | Electrical | Check the electrical supply and control wiring. |
| | Rotor rub or damage | Restore the clearances. |
| | Casing distortion | Relieve any pipe strain or body distortion. |
| | Foreign material | Check the system for foreign material, and clean as necessary. |

| Symptom | Probable cause | Recommended solution |
|---|---|---|
| No gas flow | Speed too low | Check for belt slip and adjust as necessary. |
| | Wrong rotation | Check for correct direction of rotation, switch any two phase connections if necessary. |
| | Obstruction in piping | Check pipelines, valves for open flow path. |
| | Bypass open | Use a momentary gas rush to free the valve. |
| Low capacity | Speed too low | Check the backing pump. |
| | Excessive pressure rise | Check the inlet/outlet (discharge) pressure against predicted values. |
| | Obstruction in piping | Remove the obstruction. |
| | Excessive belt slip | Adjust as necessary. |
| | System leak | Check the vacuum system, valves, fittings, and plugs for leaks, and seal as necessary. |
| Excessive power | Speed too high | Check pump speed. Compare with the rated speed. |
| | Pressure too high | Check the inlet/outlet (discharge) pressure against predicted values. |
| | Wrong rotation | Check for correct direction of rotation, switch any two phase connections if necessary. |
| | Impeller rub | Check the outside of the pump cylinder, endplates, high temperature areas and impellers for contact. |
| Impeller tip drags on impeller or booster pump body | Insufficient clearances | Correct the clearances. |
| | Booster pump body distortion | Relieve any pipe strain or body distortion. |
| | Excessive operating pressure | Remove the cause. |
| | Excessive temperature | Remove the cause. |
| Excessive booster pump temperature | Filter clogged | Clean or replace the filter. |
| | Oil Overfilled | Correct the oil level. |
| | Excessive pressure differential | Check the cut-in pressure setting and the backing pump. |
| | Poor vacuum | Check the system for leaks and purge rates, seal any leaks found. |
| Overheating bearings or gears | Oil level incorrect | Correct the oil level. |
| | Contaminated oil | Change the oil. |
| | Coupling misalignment | Realign the coupling. |
| | Excessive belt tension | Readjust the alignment and tension. |

| Symptom | Probable cause | Recommended solution |
|---|---|---|
| Knocking | Impeller timing | Check the timing and readjust as required. |
| | Booster pump body distortion | Relieve any pipe strain or body distortion. |
| | Excessive operating pressure | Remove the cause. |
| | Excessive temperature | Remove the cause. |
| | Worn bearings | Replace the bearings. |
| | Worn gears | Replace the gears. |
| Vibration | Drive misalignment | Readjust the alignment and tension. |
| | Insufficient anchoring support | Add support to eliminate vibration. |
| | Impeller drag | Adjust the timing and clearance. |
| | Worn bearings | Replace the bearings. |
| | Worn gears | Replace the gears. |
| Loss of oil | Oil filler or drain plug leak | Replace the plug O-rings. |
| | Vacuum leak | Check seal O-rings and vacuum joints. |
| | Worn seal | Replace the seal, static ring and O-rings. |
| Abnormal noise | Impeller tip drag | Check the timing and readjust as required. |
| | Worn bearings | Replace the bearings. |
| | Gear backlash | Replace the gears. |
| | Improper belt tension | Re-tension the belts. |
| | Hubs rubbing | Check that the hubs are not touching. |
| | Motor misalignment | Correct the motor alignment. |
| Seal squeal | Improper oil level | Lower the oil level. |

# 7. Storage

### CAUTION: PUMP SAFETY

**Risk of damage to the pump. Observe the storage temperature limits stated in *Operating and storage conditions* on page 15. Storage below -30 °C (-22 °F) will permanently damage the booster pump seals and oils.**

Use the following procedure to store the booster pump:

1. Purge the vacuum system and the booster pump with dry nitrogen and disconnect the pump from the vacuum system.
2. Shut down the pump as described in *Shutdown* on page 42.
3. Disconnect the pump from the electrical supply and vacuum system.
4. Disassemble, clean and reassemble the pump. (Where necessary, contact us or your supplier for advice.)
5. Place and secure protective covers on the inlet and outlet (exhaust) ports.
6. Store the pump in cool, dry conditions until it is required for use. When required, prepare and install the pump as described in *Installation* on page 26.

# 8. Disposal

Dispose of the booster pump and any components removed from it safely in accordance with all local and national safety and environmental requirements.

Take particular care with components and waste oil which have been contaminated with dangerous process substances.

Do not incinerate fluoroelastomer seals and O-rings.

# 9. Services and Spares

## 9.1 Introduction

Our products, spares and accessories are available from our companies in Belgium, Brazil, China, France, Germany, Israel, Italy, Japan, Korea, Singapore, United Kingdom, U.S.A and a world-wide network of distributors. The majority of these centres employ Service Engineers who have undergone our comprehensive training courses.

Order spare parts and accessories from our nearest company or distributor. When ordering, state for each part required:

- Model and Item Number of your equipment
- Serial number
- Item Number and description of part.

## 9.2 Service

Our products are supported by a world-wide network of Service Centres. Each Service Centre offers a wide range of options including: equipment decontamination; service exchange; repair; rebuild and testing to factory specifications. Equipment which has been serviced, repaired or rebuilt is returned with a full warranty.

Your local Service Centre can also provide engineers to support on-site maintenance, service or repair of your equipment.

For more information about service options, contact your nearest Service Centre or the company.

## 9.3 Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must complete a Declaration of Contamination Form. The form tells us if any substances found in the equipment are hazardous, which is important for the safety of our employees and all other people involved in the service of your equipment. The hazard information also lets us select the correct procedures to service your equipment.

If you are returning equipment note the following:

- If the equipment is configured to suit the application, make a record of the configuration before returning it. All replacement equipment will be supplied with default factory settings.
- Do not return equipment with accessories fitted. Remove all accessories and retain them for future use.
- The instruction in the returns procedure to drain all fluids does not apply to the lubricant in pump oil reservoirs.

Download the latest documents from *edwardsvacuum.com/HSForms/*, follow the procedure in HS1, fill in the electronic HS2 form, print it, sign it, and return the signed copy to us.

**NOTICE:**

**If we do not receive a completed form, your equipment cannot be serviced.**

## 9.4 Spares

The spares available for the booster pumps are listed in *Table: Spares*.

*Table 19 Spares*

| Spares kit | Item number |
|---|---|
| 6 Inch MSeal seal kit | 607552001 |
| 6 Inch MSeal maintenance kit * | 607552002 |
| Process isolation 6XX-5HR kit † | 607552004 |

** This kit is the same as kit 607552001, but with bearings.*

*† This kit is for process isolation booster pumps, and must be used in conjunction with kit 607552001 or 607552002.*

# Declaration of Conformity

We, Edwards Limited,
Crawley Business Quarter,
Manor Royal,
Crawley,
West Sussex, RH10 9LW, UK

declare under our sole responsibility, as manufacturer and person within the EU authorised to assemble the technical file, that the product(s)

| | | | |
|---|---|---|---|
| 900607MHR940 | 900622MHR940 | 9006075HR940 | 9006225HR940 |
| 900607MHR934 | 900622MHR934 | 9006075HR934 | 9006225HR934 |
| 900607MVR940 | 900622MVR940 | 9006075VR940 | 9006225VR940 |
| 900607MVR934 | 900622MVR934 | 9006075VR934 | 9006225VR934 |
| 900615MHR940 | 90061BMHR940 | 9006155HR940 | 90061B5HR940 |
| 900615MHR934 | 90061BMHR934 | 9006155HR934 | 90061B5HR934 |
| 900615MVR940 | 90061BMVR940 | 9006155VR940 | 90061B5VR940 |
| 900615MVR934 | 90061BMVR934 | 9006155VR934 | 90061B5VR934 |

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

| | |
|---|---|
| EN1012-2:1996+A1:2009 | Compressors and Vacuum Pumps. Safety Requirements. Vacuum Pumps |
| EN60034-1:2010 | Rotating electrical machines. Rating and performance |
| EN60034-30-1:2014 | Rotating electrical machines. Efficiency classes of line operated AC motors (IE code) |
| EN50581:2012 | Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substances |

and fulfils all the relevant provisions of

| | |
|---|---|
| 2006/42/EC | Machinery Directive |
| 2014/35/EU | Low Voltage Directive |
| 2011/65/EU | Restriction of Certain Hazardous Substances (RoHS) Directive |
| 2009/125/EC | Ecodesign Directive, following the requirements of Regulation (EC) No. 640/2009 (as amended) |

*Note: This declaration covers all product serial numbers from the date this Declaration was signed onwards.*

*Mr Peter Meares*
*Senior Technical Support Manager, General Vacuum*

10.08.2015, Burgess Hill

*Date and Place*

*This product has been manufactured under a quality management system certified to ISO 9001:2008*