

Instruction Manual

6 Inch MSeal Booster Pumps and Process Isolation Booster Pumps



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Declaration of Conformity

We, Edwards,
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West Sussex RH10 9LW, UK

declare under our sole responsibility that the product(s)

900607MHR101	607 MHR Booster, PFPE Prep	9006075HR101	607 5HR Booster, PFPE Prep
900607MVR101	607 MVR Booster, PFPE Prep	9006075VR101	607 5VR Booster, PFPE Prep
900615MHR101	615 MHR Booster, PFPE Prep	9006155HR101	615 5HR Booster, PFPE Prep
900615MVR101	615 MVR Booster, PFPE Prep	9006155VR101	615 5VR Booster, PFPE Prep
90061BMHR101	61B MHR Booster, PFPE Prep	90061B5HR101	615 5HR Bypass Booster, PFPE Prep
90061BMVR101	61B MVR Booster, PFPE Prep	90061B5VR101	615 5VR Bypass Booster, PFPE Prep
900622MHR101	622 MHR Booster, PFPE Prep	9006225HR101	622 5HR Booster, PFPE Prep
900622MVR101	622 MVR Booster, PFPE Prep	9006225VR101	622 5VR Booster, PFPE Prep
900607MHR	607 MHR Booster	9006075HR	607 5HR Booster
900607MVR	607 MVR Booster	9006075VR	607 5VR Booster
900615MHR	615 MHR Booster	9006155HR	615 5HR Booster
900615MVR	615 MVR Booster	9006155VR	615 5VR Booster
90061BMHR	61B MHR Booster	90061B5HR	615 5HR Bypass Booster
90061BMVR	61B MVR Booster	90061B5VR	615 5VR Bypass Booster
900622MHR	622 MHR Booster	9006225HR	622 5HR Booster
900622MVR	622 MVR Booster	9006225VR	622 5VR Booster

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

EN1012-2: 1997	Safety Requirements, Vacuum Pumps
EN60034-1: 1999	Rotating Electrical Machines - Rating & Performance

following the provisions of

73/023/EEC	Low Voltage Directive.
89/336/EEC	Electromagnetic Compatibility Directive.
98/37/EC	Machinery Safety Directive.

P. Meares - Technical Manager

7th July 2009, Shoreham

Date and Place

This product has been manufactured under a quality system registered to ISO9001



Declaration of Conformity

We, BOC Edwards,
Manor Royal,
Crawley,
West Sussex RH10 2LW, UK

declare under our sole responsibility that the product(s)


900607MHR601	607 booster, horizontal flow mech seal 400 V, 50 Hz, IEC MTR DD 2P, 7.5 kW
900607MVR601	607 booster, vertical flow mech seal 400 V, 50 Hz, IEC MTR DD 2P, 7.5 kW
900615MHR601	615 booster, horizontal flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, 11 kW
900615MVR601	615 booster, vertical flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, 11 kW
90061BMHR601	615 booster, horizontal flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, BYPASS ,18.5 kW
90061BMVR601	615 booster, vertical flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, BYPASS ,18.5 kW
900622MHR601	622 booster, horizontal flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, 18.5 kW
900622MVR601	622 booster, horizontal flow mech seal, 400 V, 50 Hz, IEC IP55 MTR 2 pole, 18.5 kW

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or other normative document(s)

EN1012-2: 1997	Safety Requirements, Vacuum Pumps.
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following the provisions of

73/023/EEC	Low Voltage Directive.
89/336/EEC	Electromagnetic Compatibility Directive.
98/37/EC	Machinery Safety Directive.



Clive Tunna,
Global Technical Manager, BOC Edwards GV

4th DECEMBER 2006

Date and Place

CRAWLEY

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Associated publications

Publication title	Publication number
Vacuum pump and vacuum system safety	P400-40-100

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Contents

1 Introduction

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the Edwards 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. Read this manual before you install or use the booster pump. The booster pumps covered by this manual are listed in Section 2.3. You must only use PFPE-prepared bareshaft booster pumps on oxygen or reactive gas service: see Section 1.3.

Read this manual before you install and use the booster pump. Important safety information is highlighted as WARNING and CAUTION instructions; you must obey these instructions. The use of WARNINGS and CAUTIONS is defined below.



WARNING

Warnings are given where failure to observe the instruction could result in injury or death to people.

CAUTION

Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment and process

The following IEC warning labels appear on the pump:



Warning - refer to accompanying documentation.



Warning - risk of electric shock.



Warning - trip hazard.



Warning - use protective equipment.



Warning - moving parts present.



Warning - hot surfaces.



Warning - heavy object.



Warning - entanglement.



Warning - possible explosion.

The units used throughout this manual conform to the SI international system of units of measurement.

1.2 ATEX directive implications

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

1.3 Description



WARNING

Standard booster pumps are not intended for use with hazardous, reactive, flammable and explosive gases. Consult Edwards 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 Edwards 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 Figures 1 and 2.

1.4 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 (r.p.m.). 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 1 to determine the operational limits for the booster pumps. The limits are based on compression and pumping speeds for the specific application. Table 1 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.

Edwards 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

	Pump model			
	607	615	615B*	622
Maximum pressure differential	5.06 x 10 ⁴ Pa 506 mbar 380 Torr	5.06 x 10 ⁴ Pa 506 mbar 380 Torr	Not applicable	3.33 x 10 ⁴ Pa 333 mbar 250 Torr
Maximum temperature rise	135 °C 275 °F	135 °C 275 °F	135 °C 275 °F	121 °C 250 °F
Maximum discharge temperature	191 °C 375 °F	191 °C 375 °F	191 °C 375 °F	177 °C 350 °F
Maximum displacement †	2056 m ³ h ⁻¹ 1212 cfm	4412 m ³ h ⁻¹ 2600 cfm	4412 m ³ h ⁻¹ 2600 cfm	6528 m ³ h ⁻¹ 3840 cfm
Inlet and exhaust connection: ASA	6 inches	8 inches	8 inches	8 inches
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)				

1.5 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.)

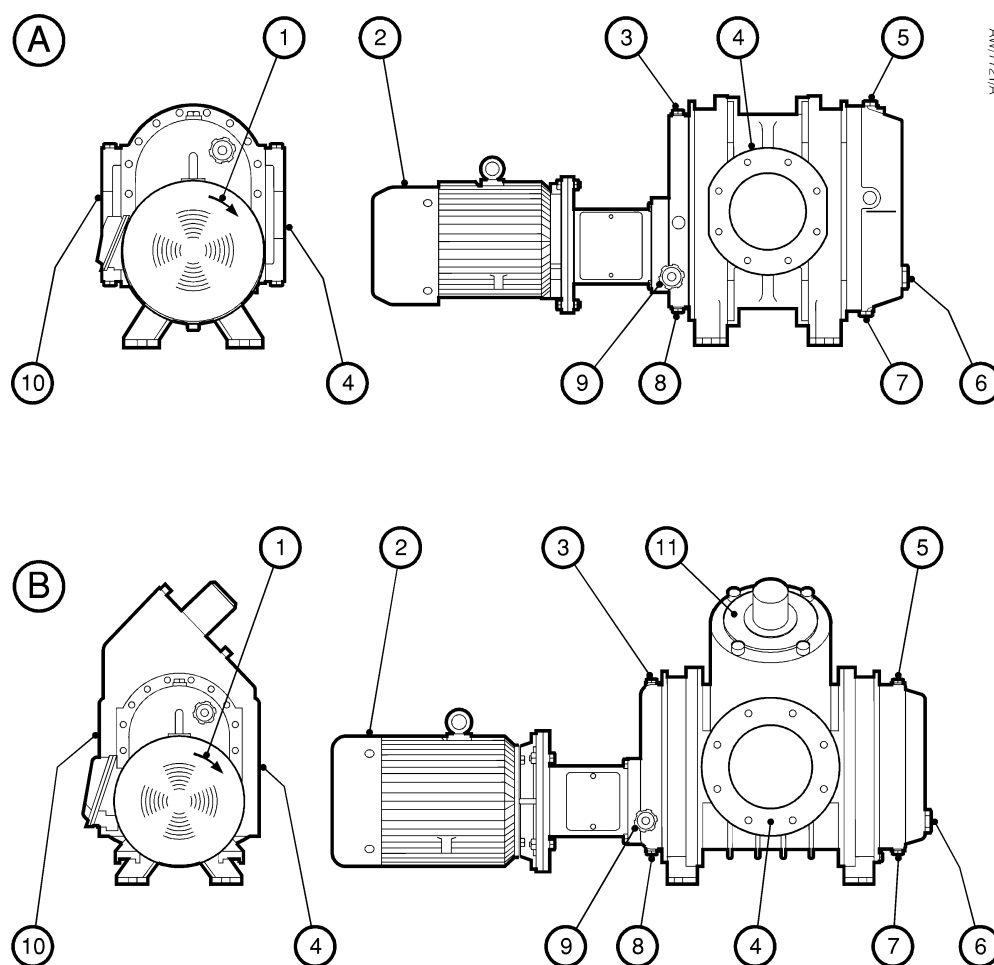
The 615 booster pump is available with an optional bypass valve (see Section 1.9) which allows pump operation from atmospheric pressure and reduces pump-down time. The booster pumps can be prepared hydrocarbon free for oxygen service. Variable frequency (speed) drives are available for the pumps.

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).

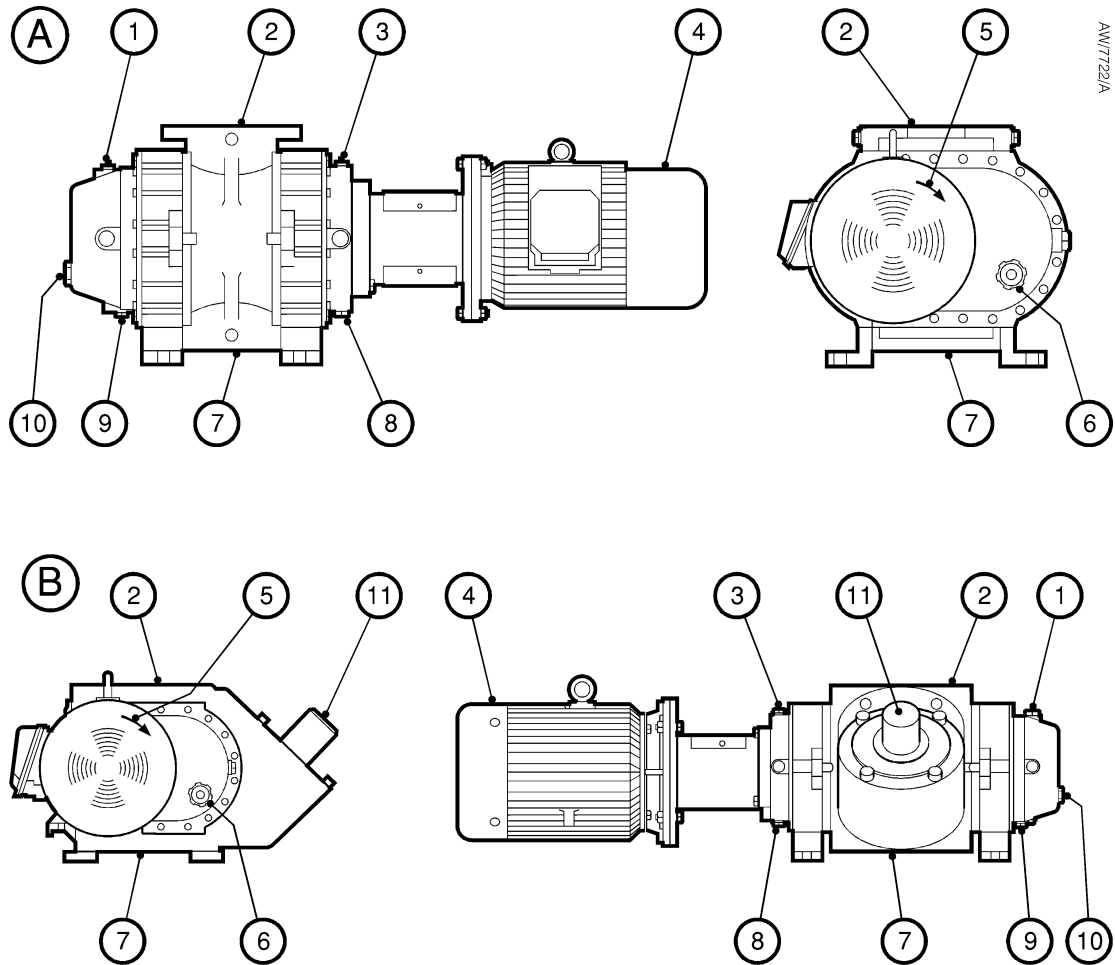
Figure 1 - General arrangement of the H (horizontal) booster



- A. Standard direct drive pump
B. Direct drive pump with bypass valve

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

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



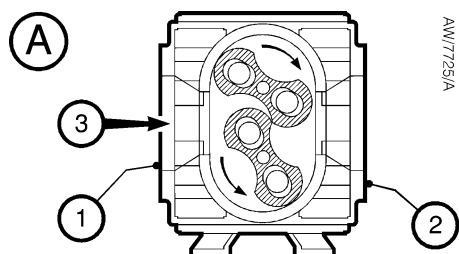
- A. Standard direct drive pump
B. Direct drive pump with bypass valve

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

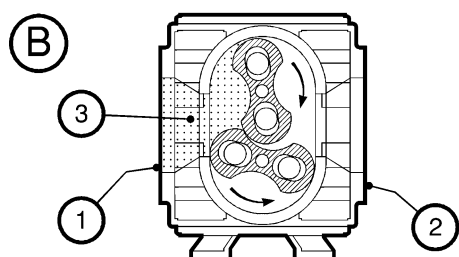
1.6 Principle of operation

The basic operation of an H (horizontal) booster is shown in Figure 3.

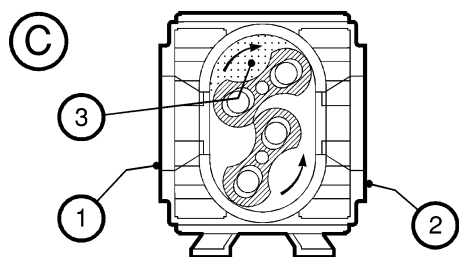
Figure 3 - Principle of operation



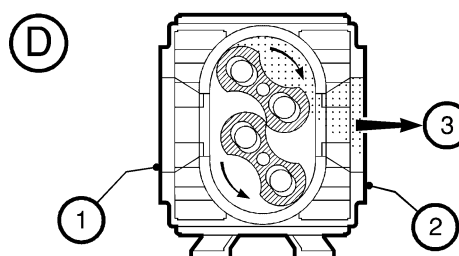
Detail A - Gas (3) enters the pump body through the inlet (1). In the pump body, the upper impeller rotor rotates clockwise, and the lower impeller rotor rotates anticlockwise (counterclockwise).



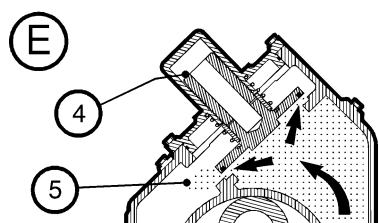
Detail B - As the impeller rotors rotate, gas (3) is drawn into the volume between the pump body wall and the rotors.



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.

1.7 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 (r.p.m.). The loads induced into the drive shaft depend on the power applied to the shaft. Edwards specifies 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 12 for specific details on pulley diameters. Edwards can provide booster pumps and motors sized for most applications.

1.8 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 Edwards to improve performance on booster pumps without bypass valves. Consult Edwards for application information. Various voltage, frequency, speed and power motors are available. Large power motors (> 22.37 kW, 30 h.p.) cannot be supported by a motor support alone.

1.9 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 (r.p.m.). The bypass valve regulates the pressure differential across the booster pump to 7.9 x 10³ 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 Edwards if pump-down exceeds 45 minutes. Refer to Figure 3 detail E for a cross-section view of a bypass booster pump.

1.10 Oxygen and reactive gas service

Edwards 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 & industrial systems" publication (Edwards Publication Number P400-40-100).

2 Technical Data

2.1 Operating and storage conditions

Table 2 - Operating and storage conditions

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

2.2 Pump technical data

Performance data, electrical data and mechanical data for the booster pumps are provided in Tables 3 to 8.

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

	900-607-MH05 900-607-MV05	900-607-MH20 900-607-MV20	900-615-MH10 900-615-MV10	900-615-MH15 900-615-MV15
Pumping speed	1040 m ³ h ⁻¹ 612 cfm	1040 m ³ h ⁻¹ 612 cfm	2210 m ³ h ⁻¹ 1300 cfm	4420 m ³ h ⁻¹ 2600 cfm
Nominal power	3.75 kW 5 hp	15 kW 20 hp	7.5 kW 10 hp	11 kW 15 hp
Voltage	230/460 V ac	208-230/460 V ac	208-230/460 V ac	208-230/460 V ac
Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Phases	3	3	3	3
Enclosure	TEFC IP55	TEFC IP55	TEFC IP55	TEFC IP55
Full load current	13 A/6.6 A	53 A/48 A/24 A	27.2 A/24.6 A/ 12.3 A	39.8 A/36 A/18 A
Motor speed	1725 r min ⁻¹ 1725 rpm	1760 r min ⁻¹ 1760 rpm	1750 r min ⁻¹ 1750 rpm	3500 r min ⁻¹ 3500 rpm
Recommended fuse/circuit breaker	20 A/10 A	70 A/35 A	35 A/17.5 A	50 A/25 A
Dimensions	Figures 4 and 5	Figures 4 and 5	Figures 4 and 5	Figures 4 and 5
Total mass (pump and motor)	274 kg 603 lb	406 kg 897 lb	385 kg 847 lb	392 kg 865 lb
Motor mass	34 kg 75 lb	167 kg 367 lb	84 kg 185 lb	91 kg 200 lb

Table 4 - Technical data: 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)

	900-61B-5V10	900-61B-MH10 900-61B-MV10	900-61B-MH25 900-61B-MV25	900-622-MH25 900-622-MV25 900-622-5H25 900-622-5V25
Pumping speed	2210 m ³ h ⁻¹ 1300 cfm	2210 m ³ h ⁻¹ 1300 cfm	4420 m ³ h ⁻¹ 2600 cfm	6528 m ³ h ⁻¹ 3840 cfm
Nominal power	7.5 kW 10 hp	7.5 kW 10 hp	18.6 kW 25 hp	18.6 kW 25 hp
Voltage	208-230/460 V ac	208-230/460 V ac	208-230/460 V ac	208-230/460 V ac
Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Phases	3	3	3	3
Enclosure	TEFC IP55	TEFC IP55	TEFC IP55	TEFC IP55
Full load current	27.2 A/24.6 A/ 12.3 A	27.2 A/24.6 A/ 12.3 A	66.3 A/60 A/30 A	66.3 A/60 A/30 A
Motor speed	1750 r min ⁻¹ 1750 rpm	1750 r min ⁻¹ 1750 rpm	3500 r min ⁻¹ 3500 rpm	3500 r min ⁻¹ 3500 rpm
Recommended fuse/circuit breaker	35 A/17.5 A	35 A/17.5 A	80 A/40 A	80 A/40 A
Dimensions	Figure 7	Figures 6 and 7	Figures 6 and 7	Figures 4 and 5
Total mass (pump and motor)	392 kg 865 lb	392 kg 865 lb	533 kg 1175 lb	619 kg 1365 lb
Motor mass	84 kg 185 lb	84 kg 185 lb	167 kg 367 lb	167 kg 367 lb

Table 5 - Technical data: 607MHR/MVR601 and 615MHR/MVR601 direct drive MSeal booster pumps (with IEC motors)

	900607MHR601* 900607MVR601*		900615MHR601* 900615MVR601*	
	50 Hz operation	60 Hz operation	50 Hz operation	60 Hz operation
Pumping speed	1734 m ³ h ⁻¹ 1020 cfm	2080 m ³ h ⁻¹ 1224 cfm	3684 m ³ h ⁻¹ 2167 cfm	4420 m ³ h ⁻¹ 2600 cfm
Nominal power	7.5 kW 10 hp	7.5 kW 10 hp	11 kW 15 hp	11 kW 15 hp
Voltage	200/400 V ac	230/460 V ac	200/400 V ac	230/460 V ac
Frequency	50 Hz	60 Hz	50 Hz	60 Hz
Phases	3	3	3	3
Enclosure	IP55	IP55	IP55	IP55
Full load current	27.8 A/13.9 A	24 A/12 A	40 A/20 A	34.4 A/17.2 A
Motor speed	2905 r min ⁻¹ 2905 rpm	3510 r min ⁻¹ 3510 rpm	2940 r min ⁻¹ 2940 rpm	3555 r min ⁻¹ 3555 rpm
Recommended fuse/circuit breaker	40 A/20 A	35 A/17.5 A	60 A/30 A	50 A/25 A
Dimensions	Figures 4 and 5	Figures 4 and 5	Figures 4 and 5	Figures 4 and 5
Total mass (pump and motor)	330 kg 726 lb	330 kg 726 lb	446 kg 981 lb	446 kg 981 lb
Motor mass	74 kg 163 lb	74 kg 163 lb	118 kg 260 lb	118 kg 260 lb
* These are CE-compliant dual-frequency booster pumps				

Table 6 - Technical data: 61BMHR/MVR601 and 622MHR/MVR601 direct drive MSeal booster pumps (with IEC motors)

	90061BMHR601 * 90061BMVR601 *		900622MHR601 * 900622MVR601 *	
	50 Hz operation	60 Hz operation	50 Hz operation	60 Hz operation
Pumping speed	3684 m ³ h ⁻¹ 2167 cfm	4420 m ³ h ⁻¹ 2600 cfm	5440 m ³ h ⁻¹ 3200 cfm	6258 m ³ h ⁻¹ 3840 cfm
Nominal power	18.5 kW 25 hp	18.5 kW 25 hp	18.5 kW 25 hp	18.5 kW 25 hp
Voltage	200/400 V ac	230/460 V ac	200/400 V ac	230/460 V ac
Frequency	50 Hz	60 Hz	50 Hz	60 Hz
Phases	3	3	3	3
Enclosure	IP55	IP55	IP55	IP55
Full load current	57.2 A/28.6 A	67 A/33.5 A	57.2 A/28.6 A	67 A/33.5 A
Motor speed	2950 r min ⁻¹ 2950 rpm	3550 r min ⁻¹ 3550 rpm	2950 r min ⁻¹ 2950 rpm	3555 r min ⁻¹ 3555 rpm
Recommended fuse/circuit breaker	70 A/35 A	90 A/50 A	70 A/35 A	90 A/50 A
Dimensions	Figures 6 and 7	Figures 6 and 7	Figures 6 and 7	Figures 6 and 7
Total mass (pump and motor)	538 kg 1185 lb	538 kg 1185 lb	624 kg 1375 lb	624 kg 1375 lb
Motor mass	116 kg 260 lb	74 kg 163 lb	145 kg 319 lb	145 kg 319 lb
* These are CE-compliant dual-frequency booster pumps				

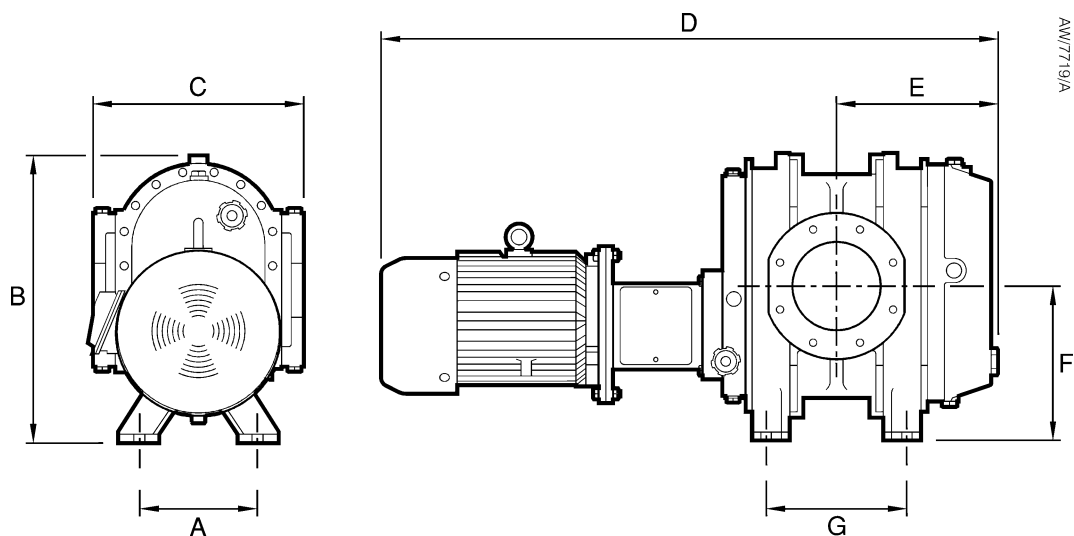
Table 7 - Technical data: bareshaft MSeal booster pumps

	900-607-MHR 900607MHR101	900-615-MHR 900615MHR101	900-61B-MHR 90061BMHR101	900-622-MHR 900622MHR101
Dimensions	Figure 8	Figure 8	Figure 10	Figure 8
Pump mass	220 kg 483 lb	279 kg 614 lb	342 kg 753 lb	429 kg 945 lb
	900-607-MVR 900607MVR101	900-615-MVR 900615MVR101	900-61B-MVR 90061BMVR101	900-622-MVR 900622MVR101
Dimensions	Figure 9	Figure 9	Figure 11	Figure 9
Pump mass	218 kg 480 lb	277 kg 610 lb	341 kg 749 lb	428 kg 941 lb

Table 8 - Technical data: bareshaft process isolation booster pumps

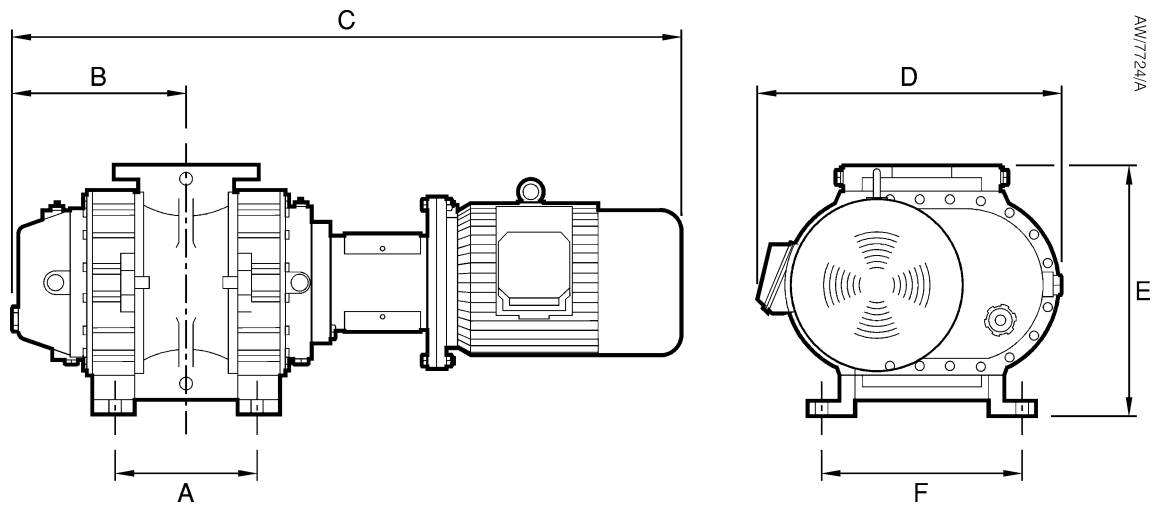
	900-607-5HR 9006075HR101	900-615-5HR 9006155HR101	900-61B-5HR 90061B5HR101	900-622-5HR 9006225HR101
Dimensions	Figure 8	Figure 8	Figure 10	Figure 8
Pump mass	235 kg 516 lb	294 kg 647 lb	357 kg 786 lb	445 kg 978 lb
	900-607-5VR 9006075VR101	900-615-5VR 9006155VR101	900-61B-5VR 90061B5VR101	900-622-5VR 9006225VR101
Dimensions	Figure 9	Figure 9	Figure 11	Figure 9
Pump mass	224 kg 492 lb	283 kg 623 lb	346 kg 762 lb	433 kg 954 lb

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



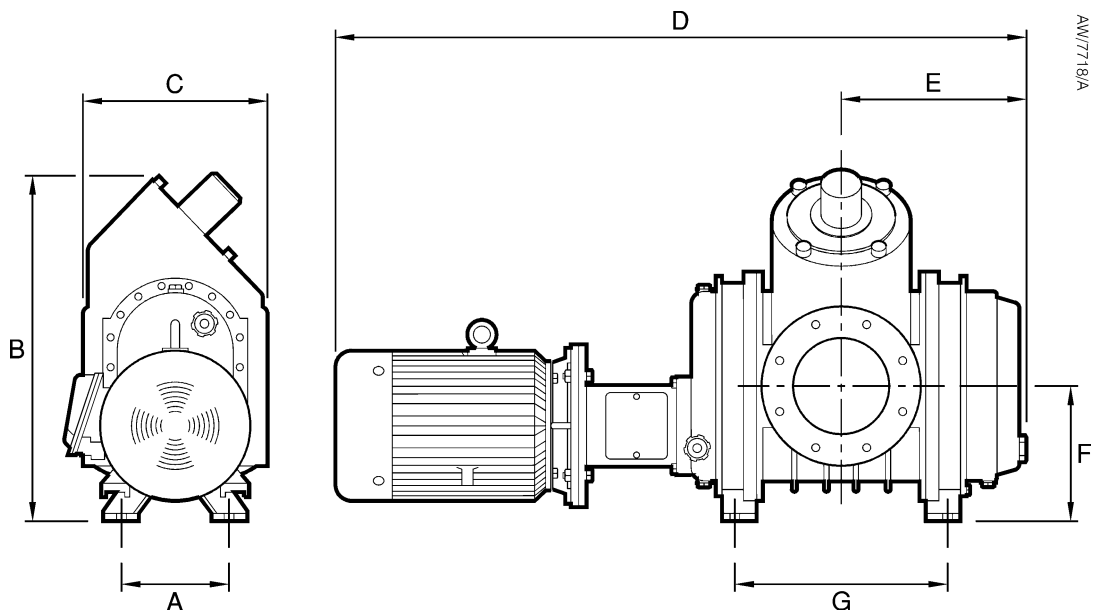
Pump	Dimensions: mm (inch)						
	A	B	C	D	E	F	G
900-607-MH05	228 (8.5)	543 (21.4)	406 (16.0)	1087 (42.8)	309 (12.1)	292 (11.5)	270 (10.7)
900-607-MH20	228 (8.5)	543 (21.4)	406 (16.0)	1225 (48.2)	309 (12.1)	292 (11.5)	270 (10.7)
900-615-MH10	228 (8.5)	543 (21.4)	406 (16.0)	1367 (53.8)	409 (16.1)	292 (11.5)	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)
900607MHR601	228 (8.5)	543 (21.4)	406 (16.0)	1164 (46.6)	309 (12.1)	292 (11.5)	270 (10.7)
900615MHR601	228 (8.5)	543 (21.4)	406 (16.0)	1515 (59.6)	409 (16.1)	292 (11.5)	470 (18.5)
900622MHR601	228 (8.5)	543 (21.4)	438 (17.3)	1694 (66.9)	490 (19.3)	292 (11.5)	648 (25.5)

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



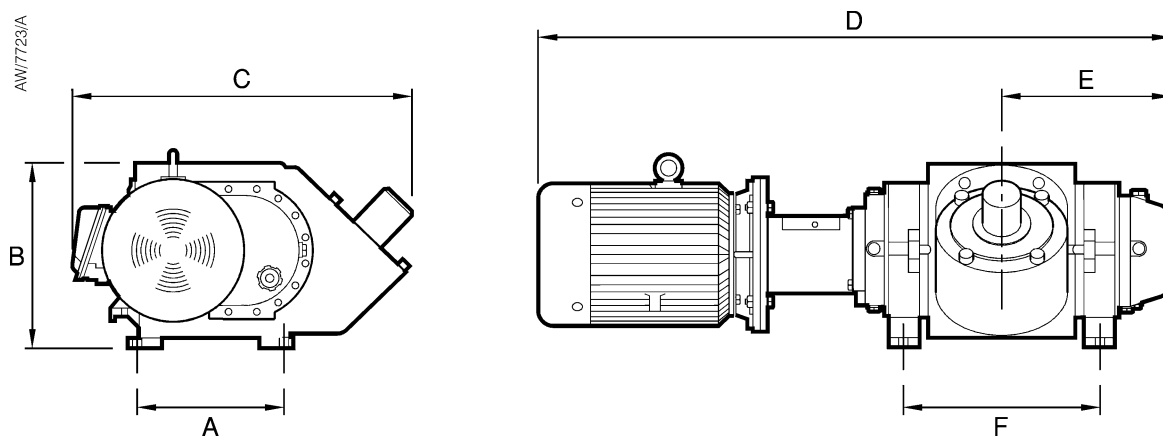
Pump	Dimensions: mm (inch)					
	A	B	C	D	E	F
900-607-MV05	254 (10.0)	308 (12.1)	1087 (42.8)	502 (19.6)	406 (16.0)	350 (13.8)
900-607-MV20	254 (10.0)	308 (12.1)	1224 (48.2)	502 (19.6)	406 (16.0)	350 (13.8)
900-615-MV10	454 (17.9)	409 (16.1)	1367 (53.8)	502 (19.6)	406 (16.0)	350 (13.8)
900-615-MV15	454 (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)
900607MVR601	254 (10.0)	308 (12.1)	1184 (46.6)	537 (21.1)	406 (16.0)	350 (13.8)
900615MVR601	454 (17.9)	409 (16.1)	1526 (60.2)	581 (22.9)	432 (17.0)	350 (13.8)
900622MVR601	648 (25.5)	409 (16.1)	1696 (66.8)	579 (22.8)	473 (18.6)	350 (13.8)

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



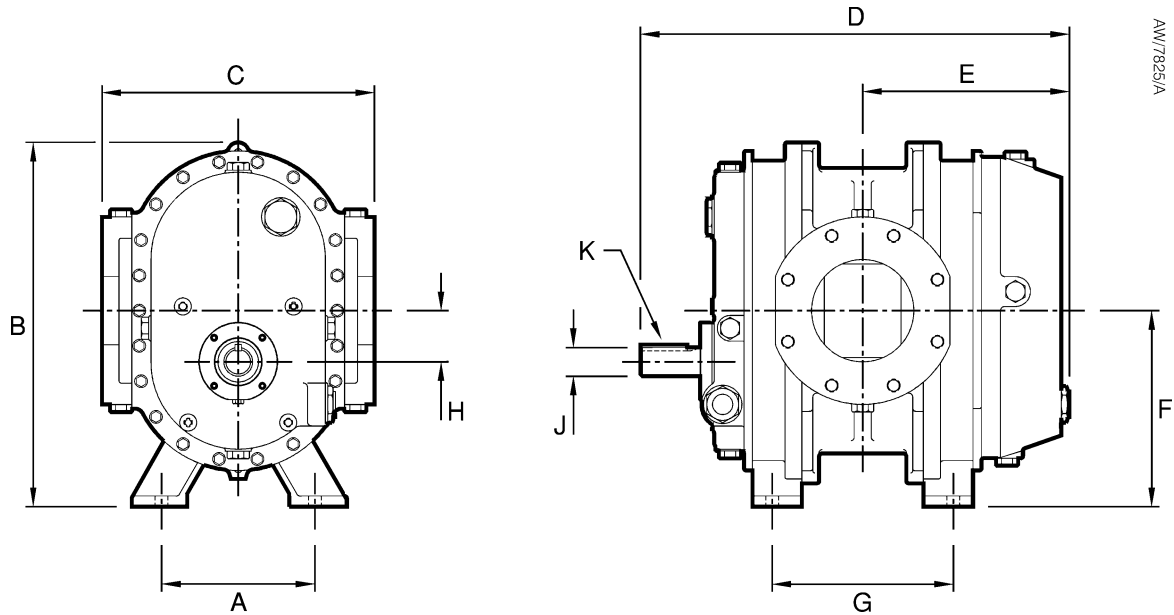
Pump	Dimensions: mm (inch)						
	A	B	C	D	E	F	G
900-61B-MH10	229 (9.0)	763 (30.0)	406 (16.0)	1367 (53.8)	409 (16.1)	292 (11.5)	471 (18.5)
900-61B-MH25	229 (9.0)	763 (30.0)	406 (16.0)	1479 (58.2)	409 (16.1)	292 (11.5)	471 (18.5)
90061BMHR601	229 (9.0)	763 (30.0)	406 (16.0)	1515 (59.6)	409 (16.1)	292 (11.5)	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)
90061BMVR601	349 (13.8)	406 (16.0)	791 (31.1)	1520 (59.9)	413 (16.3)	454 (17.9)

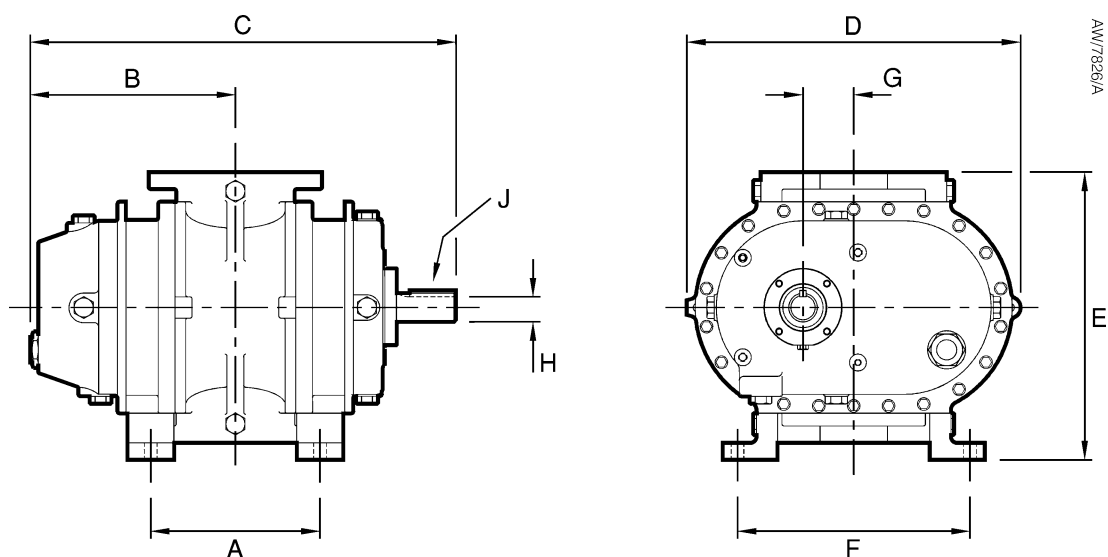
Figure 8 - Bareshaft H (horizontal) booster pump dimensions



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

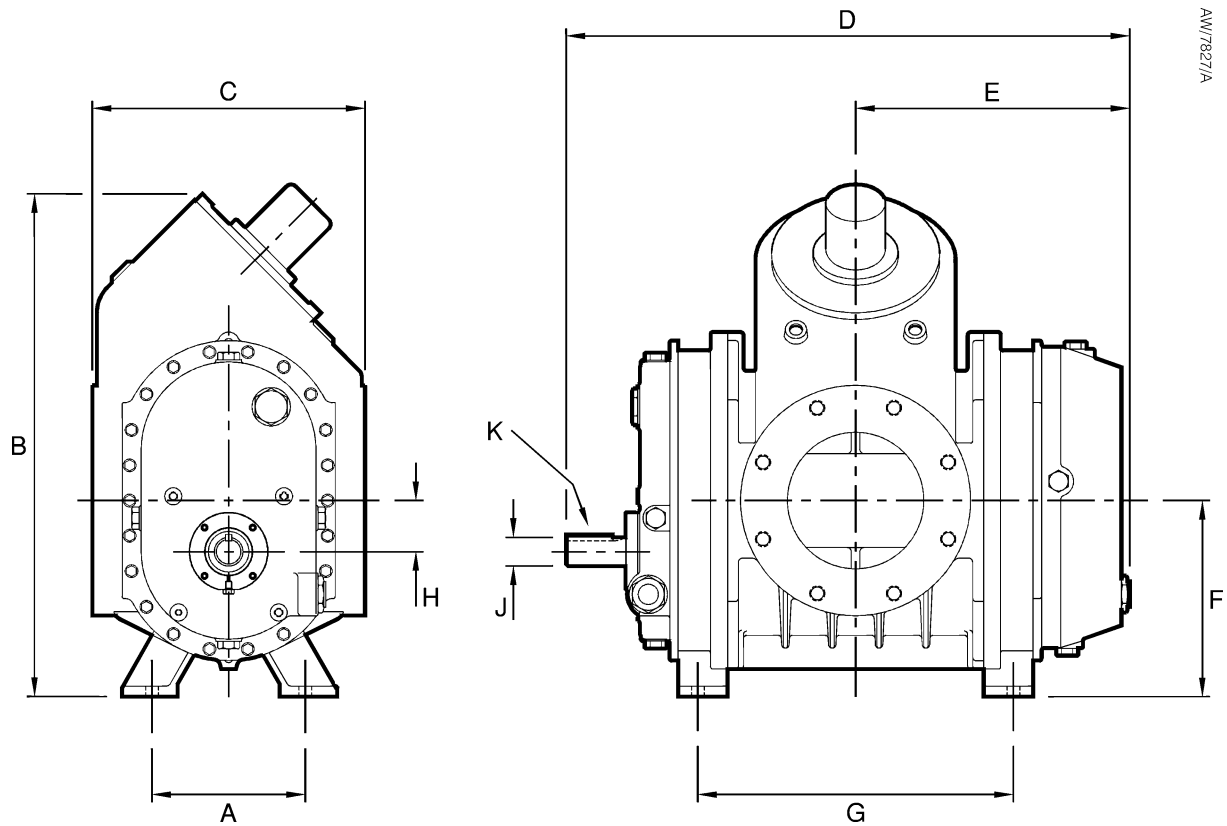
Figure 9 - Bareshaft V (vertical) booster pump dimensions



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

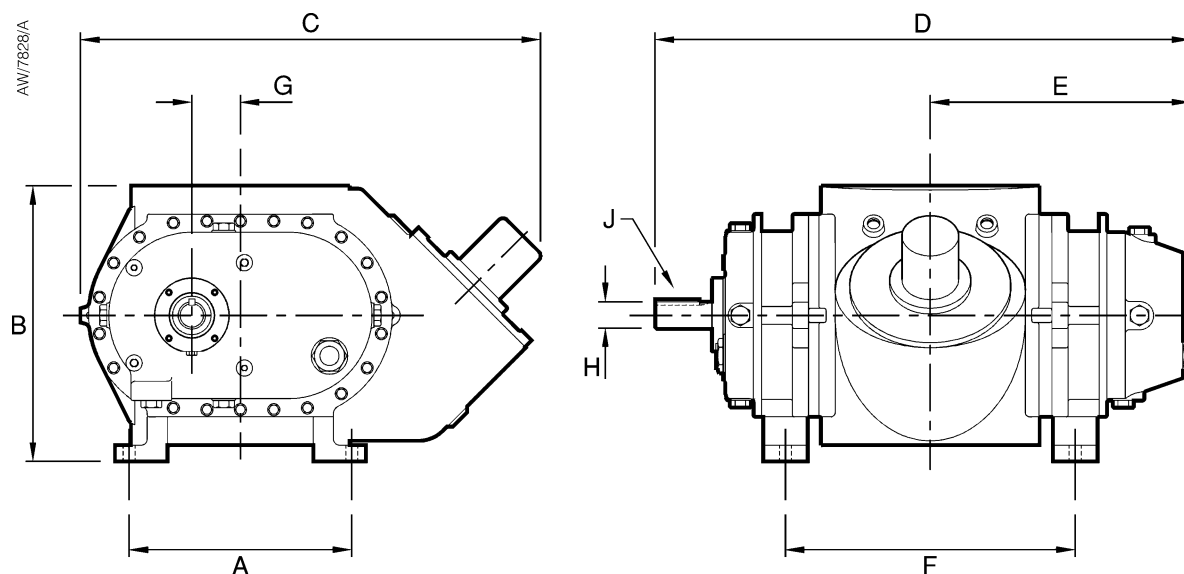
Figure 10 - Bareshaft H (horizontal) booster pump with bypass valve dimensions



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)	*

2.3 Item numbers

Table 9 - Item numbers: direct drive MSeal booster pumps and process isolation booster pumps

Nominal supply voltage and frequency	Nominal power	Item Number	
		MSeal booster pumps	Process isolation booster pumps
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	3.75 kW, 5 h.p. 3.75 kW, 5 h.p.	900-607-MH05 900-607-MV05	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	15 kW, 20 h.p. 15 kW, 20 h.p.	900-607-MH20 900-607-MV20	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	7.5 kW, 10 h.p. 7.5 kW, 10 h.p.	900-615-MH10 900-615-MV10	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	11 kW, 15 h.p. 11 kW, 15 h.p.	900-615-MH15 900-615-MV15	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	7.5 kW, 10 h.p. 7.5 kW, 10 h.p.	900-61B-MH10 900-61B-MV10	900-61B-5V10
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900-61B-MH25 900-61B-MV25	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900-622-MH25 900-622-MV25	
200 V, 50 Hz, 3-phase 400 V, 50 Hz, 3-phase	7.5 kW, 10 h.p. 7.5 kW, 10 h.p.	900607MHR601 900607MVR601	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	7.5 kW, 10 h.p. 7.5 kW, 10 h.p.	900607MHR601 900607MVR601	
200 V, 50 Hz, 3-phase 400 V, 50 Hz, 3-phase	11 kW, 15 h.p. 11 kW, 15 h.p.	900615MHR601 900615MVR601	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	11 kW, 15 h.p. 11 kW, 15 h.p.	900615MHR601 900615MVR601	
200 V, 50 Hz, 3-phase 400 V, 50 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	90061BMHR601 90061BMVR601	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	90061BMHR601 90061BMVR601	
200 V, 50 Hz, 3-phase 400 V, 50 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900622MHR601 900622MVR601	
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900622MHR601 900622MVR601	
200 V, 50 Hz, 3-phase 400 V, 50 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900622MHR601 900622MVR601	900-622-5H25 900-622-5V25
230 V, 60 Hz, 3-phase 460 V, 60 Hz, 3-phase	18.5 kW, 25 h.p. 18.5 kW, 25 h.p.	900622MHR601 900622MVR601	

Table 10 - Item numbers: bareshaft MSeal booster pumps and process isolation booster pumps

Pump type	Item Number	
	Standard (hydrocarbon) pumps	Oxygen service (hydrocarbon free) pumps
Bareshaft Mseal booster pumps	900-607-MHR	900607MHR101
	900-607-MVR	900607MVR101
	900-615-MHR	900615MHR101
	900-615-MVR	900615MVR101
	900-61B-MHR	90061BMHR101
	900-61B-MVR	90061BMVR101
	900-622-MHR	900622MHR101
	900-622-MVR	900622MVR101
Bareshaft process isolation booster pumps	900-607-5HR	9006075HR101
	900-607-5VR	9006075VR101
	900-615-5HR	9006155HR101
	900-615-5VR	9006155VR101
	900-61B-5HR	90061B5HR101
	900-61B-5VR	90061B5VR101
	900-622-5HR	9006225HR101
	900-622-5VR	9006225VR101

3 Installation

3.1 Safety



WARNING

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.
- Consult Edwards publication P400-40-100 (Vacuum pump and vacuum system safety - chemical and industrial systems) 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.

3.2 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 Edwards 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).

3.3 Unpack and inspect



WARNING

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 Section 2.2 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 Section 6 of this manual.

3.4 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 12 and use one of the following two methods:

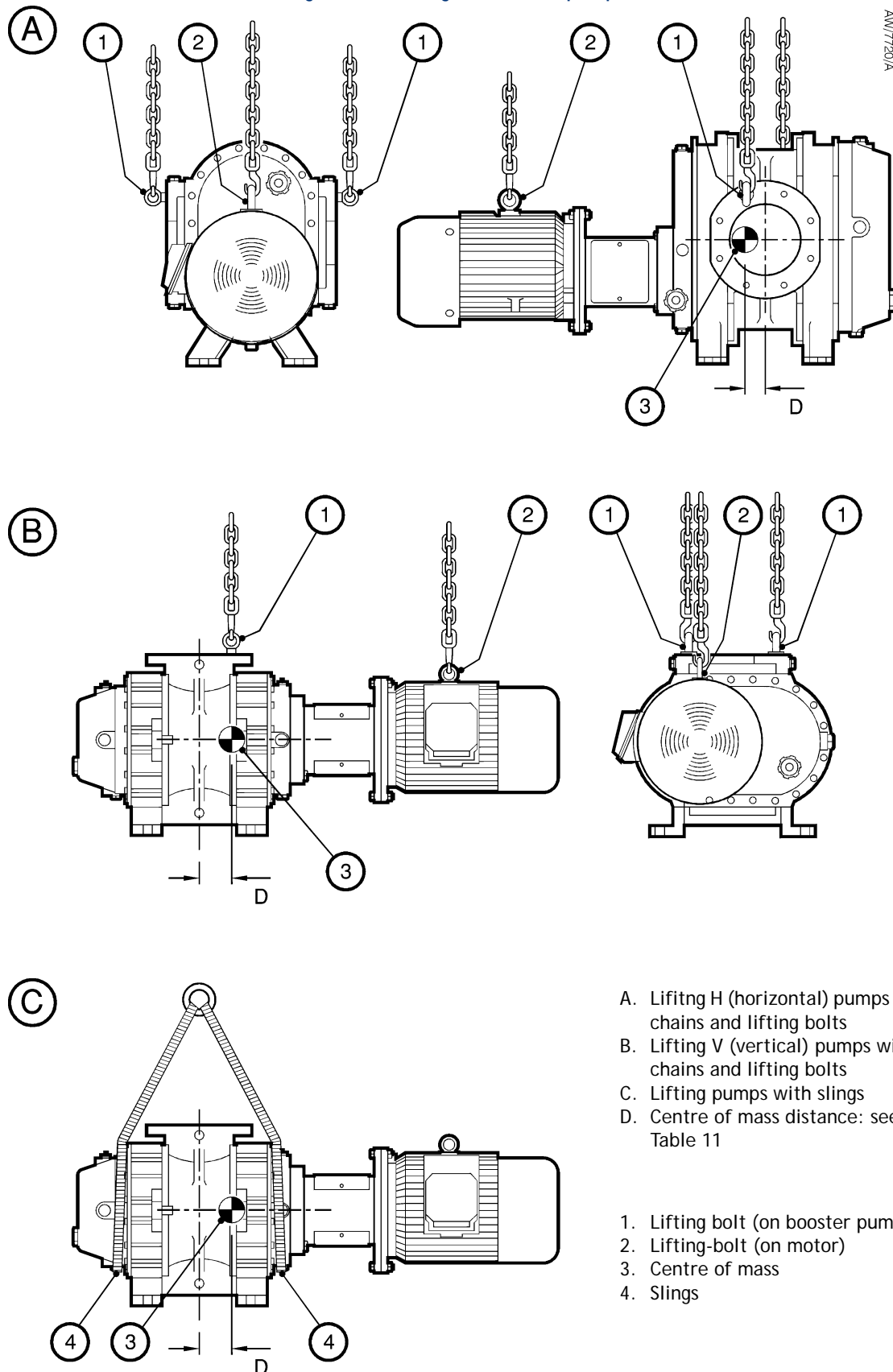
1. To use lifting-bolts and chains (see details A and B):
 - Fit two 3/4-10 lifting bolts (1, not supplied) to the pump.
 - On a booster pump with a motor: fit a suitable size lifting bolt to the motor (if necessary).
 - Attach lifting chains to the lifting bolts (1, 2) and connect the chains to your lifting equipment.
2. To use slings (see detail C):
 - Attach slings (4) around the pump body.
 - Connect the slings to your lifting equipment.

You must use lifting equipment and chains/slides 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 Tables 4 to 8 for the mass of the pump, and to Table 11 and Figure 12 for the centre of mass location.

Figure 12 - Lifting the booster pump



- A. Lifting H (horizontal) pumps with chains and lifting bolts
 B. Lifting V (vertical) pumps with chains and lifting bolts
 C. Lifting pumps with slings
 D. Centre of mass distance: see Table 11

Table 11 - Centre of mass dimensions

North American direct drive booster pumps		UK/Europe/Rest of the world direct drive booster pumps	
Item Number	Centre of mass (Figure 12 dimension 'D'): mm (inches)	Item Number	Centre of mass (Figure 12 dimension 'D'): mm (inches)
900-607-MH05	68 (2.75)	900607MHR601	193 (7.6)
900-607-MH20	380 (15)	900607MVR601	193 (7.6)
900-607-MV05	68 (2.75)	900615MHR601	172 (6.8)
900-607-MV20	380 (15)	900615MVR601	172 (6.8)
900-615-MH10	156 (6.1)	90061BMHR601	275 (10.8)
900-615-MV10	156 (6.1)	90061BMVR601	275 (10.8)
900-615-MH15	172 (6.8)	900622MHR601	265 (10.4)
900-615-MV15	172 (6.8)	900622MVR601	265 (10.4)
900-61B-MH10	115 (4.5)		
900-61B-MV10	115 (4.5)		
900-61B-5V10			
900-61B-MH25	275 (10.8)		
900-61B-MV25	275 (10.8)		
900-622-MH25	265 (10.4)		
900-622-5H25			
900-622-MV25	265 (10.4)		
900-622-5V25			
Bareshaft MSeal booster pumps		Bareshaft process isolation booster pumps	
Item Number	Centre of mass (Figure 12 dimension 'D'): mm (inches)	Item Number	Centre of mass (Figure 12 dimension 'D'): mm (inches)
900-607-MHR 900607MHR101	16 (0.6)	900-607-5HR 9006075HR101	16 (0.6)
900-607-MVR 900607MVR101	16 (0.6)	900-607-5VR 9006075VR101	16 (0.6)
900-615-MHR 900615MHR101	16 (0.6)	900-615-5HR 9006155HR101	16 (0.6)
900-615-MVR 900615MVR101	16 (0.6)	900-615-5VR 9006155VR101	16 (0.6)
900-61B-MHR 90061BMHR101	16 (0.6)	900-61B-5HR 90061B5HR101	16 (0.6)
900-61B-MVR 90061BMVR101	16 (0.6)	900-61B-5VR 90061B5VR101	16 (0.6)
900-622-MHR 900622MHR101	16 (0.6)	900-622-5HR 9006225HR101	16 (0.6)
900-622-MVR 900622MVR101	16 (0.6)	900-622-5VR 9006225VR101	16 (0.6)

3.5 Locate the booster pump



WARNING

Use suitable lifting equipment to move the booster pump. If you do not, you can injure yourself or damage the pump. Refer to Section 2 and Table 11 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 Section 2.1. 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.

3.6 Connect the vacuum and exhaust pipelines



WARNING

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

CAUTION

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, consult Edwards 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.

3.6.1 Vacuum inlet pipeline

CAUTION

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.

Edwards recommends 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.

3.6.2 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.

3.6.3 Exhaust pipeline



WARNING

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.

3.7 Belt drive booster pump installation



WARNING

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 12 shows the minimum permissible pulley diameters. Contact Edwards for advice if you want to use a motor with a power rating which exceeds 30 kW (40 h.p.). Obey all of the safety precautions outlined in Section 3.1

Table 12 - Minimum pulley diameters

Minimum pulley diameter	£ 11 kW £ 15 h.p.	15 to 18.75 kW 20 to 25 h.p.	22 to 30 kW 30 to 40 h.p.
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 Edwards have the pulley and belt tension already preset. Recheck the alignment and tension (See Tables 13 and 14) 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. Edwards supplied belt systems 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 14. 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 13 - Torque ratings

Locking bush number	Torque		Locking bush number	Torque	
	N m	lbf ft		N m	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
2517	48.8	36	4545	276.5	204
2525	48.8	36	5050	352.5	260

Table 14 - Belt tensions

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

3.8 Direct drive booster pump installation



WARNING

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.

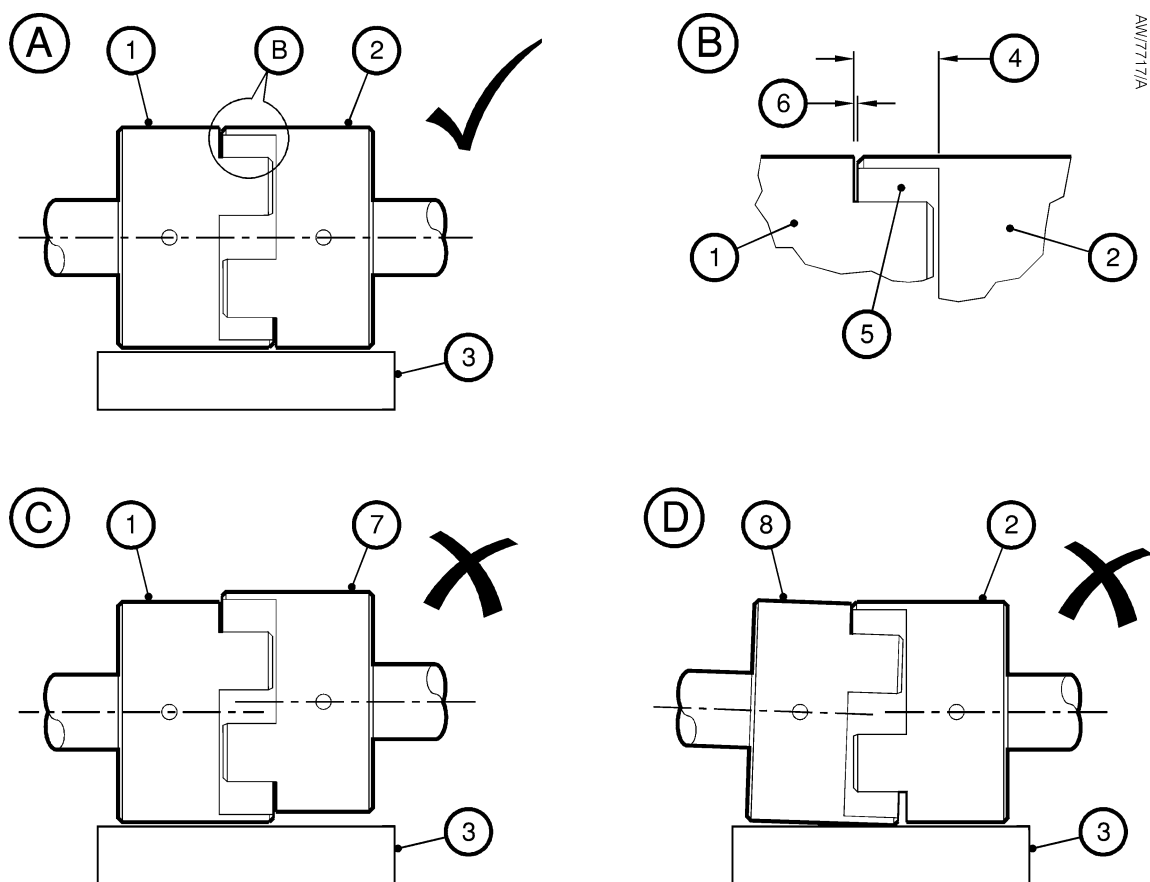
If you install your own motor and drive components, they must comply with all local and national safety regulations. Follow all of the safety precautions outlined in Section 3.1.

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 Edwards 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 (½-13) on the half-coupling to a torque of 61 to 68 N m (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 (r.p.m.) rotation speed indicated (stamped) on the coupling. Never operate the booster pump at speeds above 3600 r min-1 (r.p.m.).
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)

3.9 Fill the booster pump with oil



WARNING

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 a Edwards Service Centre for overhaul and cleaning by qualified Edwards 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

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 Section 5.3 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.

3.9.1 Hydrocarbon oil

Before you operate the booster pump, ensure that the oil levels are correct (See Table 15). 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 Figures 1 and 2 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 15 - 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.

3.9.2 Perfluoropolyether (PFPE) oil



WARNING

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 (See Table 15). Add oxygen service (PFPE) oil into the reservoirs as necessary, as described in Section 3.9.1. 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 a Edwards 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.

3.10 Electrical connections

3.10.1 Electrical supply configuration



WARNING

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

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



WARNING

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

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

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 trained technician 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 Edwards warranty, and can result in serious injury or death, and damage to the equipment.

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 Section 2. Contact Edwards for recommendations on the protection and safety devices necessary for your specific application.

3.10.2 Check the direction of rotation



WARNING

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: see Figures 1 and 2.

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.

4 Operation

4.1 Operational safety

**WARNING**

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

**WARNING**

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

**WARNING**

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.

4.2 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 Section 3.1 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.

4.3 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 the Pre-start checks (Section 4.2) 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.

4.4 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.

5 Maintenance

5.1 Safety information



WARNING

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 technician 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 technician 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 (See Section 6.2).
- 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 oC (500 oF) 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. Edwards Material Safety Data Sheets for fluorinated materials used in the booster pump are available on request: contact your supplier or Edwards.
- 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.

5.2 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 Edwards for more information.

5.3 Maintenance plan

Table 16 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 16 - 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	Retime the booster pump if required. Contact Edwards for service.
Overhaul the pump	6 yearly *	Contact your supplier or Edwards to arrange for an overhaul of the pump.

* Or as advised by your supplier or Edwards.

5.4 General maintenance

Refer to Sections 3.1 and 4 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.

5.5 Oil-level checks



WARNING

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

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 (see Figures 1 and 2). 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 (see Figures 1 and 2).

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.

5.6 Changing the oil



WARNING

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 a Edwards Service Centre for overhaul and cleaning by qualified Edwards 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

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

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 (see Figures 1 and 2), 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 Section 6.
4. Fill the oil reservoir with oil: refer to Section 5.5.

5.7 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 3.8. Replace any worn or damaged parts.
4. Refit the safety guards.

5.8 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 Section 3.7. Replace any worn or damaged belts.
4. Refit the safety guards.

5.9 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 your supplier or Edwards to arrange for a rebuild of the pump.
5. Refit the safety guards.

5.10 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.

5.11 Check the timing

WARNING



Use the appropriate personal protective equipment when you adjust the impeller timing.

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

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

5.12 Troubleshooting

Troubleshooting and recommended solutions are provided in Table 17.

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, Edwards offers vacuum leak detection services.

Table 17 - Troubleshooting

Symptom	Probable cause	Recommended solution
The booster pump does not start	Electrical Rotor rub or damage Casing distortion Foreign material	Check the electrical supply and control wiring. Restore the clearances. Relieve any pipe strain or body distortion. Check the system for foreign material, and clean as necessary.
No gas flow	Speed too low Wrong rotation Obstruction in piping Bypass open	Check for belt slip and adjust as necessary. Check for correct direction of rotation, switch any two phase connections if necessary. Check pipelines, valves for open flow path. Use a momentary gas rush to free the valve.
Low capacity	Speed too low Excessive pressure rise Obstruction in piping Excessive belt slip System leak	Check the backing pump. Check the inlet/outlet (discharge) pressure against predicted values. Remove the obstruction. Adjust as necessary. Check the vacuum system, valves, fittings, and plugs for leaks, and seal as necessary.
Excessive power	Speed too high Pressure too high Wrong rotation Impeller rub	Check pump speed. Compare with the rated speed. Check the inlet/outlet (discharge) pressure against predicted values. Check for correct direction of rotation, switch any two phase connections if necessary. 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 Booster pump body distortion Excessive operating pressure Excessive temperature	Correct the clearances. Relieve any pipe strain or body distortion. Remove the cause. Remove the cause.

Table 17 - Troubleshooting

Symptom	Probable cause	Recommended solution
Excessive booster pump temperature	Filter clogged Oil Overfilled Excessive pressure differential Poor vacuum	Clean or replace the filter. Correct the oil level. Check the cut-in pressure setting and the backing pump. Check the system for leaks and purge rates, seal any leaks found.
Overheating bearings or gears	Oil level incorrect Contaminated oil Coupling misalignment Excessive belt tension	Correct the oil level. Change the oil. Realign the coupling. Readjust the alignment and tension.
Knocking	Impeller timing Booster pump body distortion Excessive operating pressure Excessive temperature Worn bearings Worn gears	Check the timing and readjust as required. Relieve any pipe strain or body distortion. Remove the cause. Remove the cause. Replace the bearings. Replace the gears.
Vibration	Drive misalignment Insufficient anchoring support Impeller drag Worn bearings Worn gears	Readjust the alignment and tension. Add support to eliminate vibration. Adjust the timing and clearance. Replace the bearings. Replace the gears.
Loss of oil	Oil filler or drain plug leak Vacuum leak Worn seal	Replace the plug 'O' rings. Check seal 'O' rings and vacuum joints. Replace the seal, static ring and 'O' rings.
Abnormal noise	Impeller tip drag Worn bearings Gear backlash Improper belt tension Hubs rubbing Motor misalignment	Check the timing and readjust as required. Replace the bearings. Replace the gears. Re-tension the belts. Check that the hubs are not touching. Correct the motor alignment.
Seal squeal	Improper oil level	Lower the oil level.

6 Storage and Disposal

6.1 Storage

CAUTION

Observe the storage temperature limits stated in Section 2.1. 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 Section 4.4.
3. Disconnect the pump from the electrical supply and vacuum system.
4. Disassemble, clean and reassemble the pump. (Where necessary, contact your supplier or Edwards 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 Section 3.

6.2 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.

Storage and Disposal

7 Services and Spares

7.1 Introduction

Edwards products, spares and accessories are available from Edwards 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 comprehensive Edwards training courses.

Order spare parts and accessories from your nearest Edwards company or distributor. When you order, state for each part required:

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

7.2 Service

Edwards products are supported by a world-wide network of Edwards 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 Edwards engineers to support on-site maintenance, service or repair of your equipment.

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

7.3 Spares

The spares available for the booster pumps are listed in Table 18.

Table 18 - Spares

Spares Kit	Item Number
6 Inch MSeal Seal Kit	607-552-001
6 Inch MSeal Maintenance Kit *	607-552-002
Process Isolation 6XX-5HR Kit †	607-552-004

* This Kit is the same as Kit 607-552-001, but with bearings.

† This Kit is for process isolation booster pumps, and must be used in conjunction with Kit 607-552-001 or 607-552-002.

