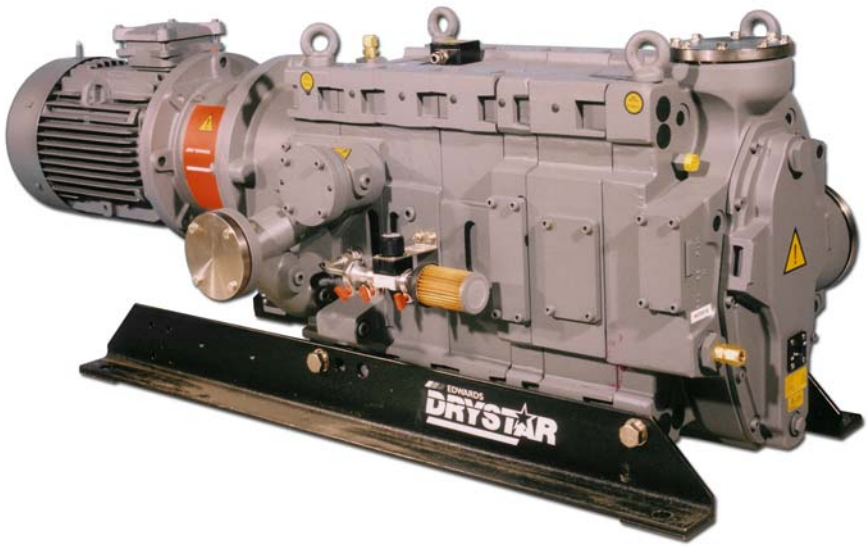
A705-74-880
Issue K Original

Instruction Manual

GV Dry Vacuum Pumps



Description	Electrical Supply	Item Number
GV260 Dry Vacuum Pump	380 - 415 V, 50 Hz	A705-71-900
GV260 Dry Vacuum Pump	230 / 460 V, 60 Hz	A705-71-908
GV410 Dry Vacuum Pump	380 - 415 V, 50 Hz	A705-73-900
GV410 Dry Vacuum Pump	230 / 460 V, 60 Hz	A705-73-908
GV600 Dry Vacuum Pump	380 - 415 V, 50 Hz	A705-74-900
GV600 Dry Vacuum Pump	230 / 460 V, 60 Hz	A705-74-908
GV600 Bareshaft Dry Vacuum Pump	50 Hz	A705-74-985
GV600 Bareshaft Dry Vacuum Pump	60 Hz	A705-74-986
GV600F Bareshaft Dry Vacuum Pump	50 Hz	A705-75-985
GV600F Bareshaft Dry Vacuum Pump	60 Hz	A705-75-986

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Declaration of Conformity

We, BOC Edwards,
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declare under our sole responsibility that the product(s)

GV600 Dry Vacuum Pump 380 – 415 V, 50 Hz	A705-74-900
GV410 Dry Vacuum Pump 380 – 415 V, 50 Hz	A705-73-900
GV260 Dry Vacuum Pump 380 – 415 V, 50 Hz	A705-71-900
GV600 Dry Vacuum Pump 230 / 460 V, 60 Hz	A705-74-908
GV410 Dry Vacuum Pump 230 / 460 V, 60 Hz	A705-73-908
GV260 Dry Vacuum Pump 230 / 460 V, 60 Hz	A705-71-908

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

EN 1012-2	Mechanical Safety – Part 2: Vacuum Pumps.
EN 60204-1	Electrical Safety: Machines.

following the provisions of

73/23/EEC	Low Voltage Directive.
89/336/EMC	Electromagnetic Compatibility Directive.
98/37/EC	Machinery Safety Directive.

Stephen E. Ormrod

Dr. S. E. Ormrod, Technical Director

29th September 2000

Date and Place

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

P900-77-000 Issue A 2B01-010

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Tables

Associated publications

Publication title	Publication number
Vacuum pump and vacuum system safety	P300-20-000

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1 INTRODUCTION

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the Edwards GV260/GV410/GV600 Dry Vacuum pumps (these are abbreviated to'GV Pump' for the remainder of this manual). You must use the GV Pump as specified in this manual.

Read this manual before you install, operate and maintain the GV 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 - hot surfaces.

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

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1.2 General description

WARNING

During operation, some parts of the pump become hot; these areas are identified by 'hot surface' labels (see Section 1.1). Do not touch these areas of the pump and avoid accidental contact between these areas of the pump and electrical cables and wires.

WARNING

Do not operate the pump with a coupling cover or blanking plates removed. If you do, there will be a risk from exposure to rotating mechanisms.

WARNING

Do not operate the pump with the pump-inlet or pump-outlet open to atmosphere. If you do, there will be a risk from the rotating mechanisms, from the exposure to vacuum, or from hot exhaust gases.

The GV260, GV410 and GV600 pump are rugged, reliable dry vacuum pumps designed for general vacuum use.

Each pump is a four stage, positive displacement rotary pump in which three pairs of Intermeshing claw rotors and one pair of Roots rotors are held in correct phase relation by a pair of timing-gears. The timing-gears and the adjacent double-row angular contact ball bearings at the low vacuum end of the pump and the roller bearings at the high vacuum end of the pump are oil lubricated.

The GV pump is shown in Figure 1. The pump has lifting-bolts (5) and is mounted on a robust skidframe (9). Fixing holes (8) in the skidframe can be used to secure the pump in its operating position.

Figure 1 - GV Pump : Key

1. Gearbox
2. Cooling-water outlet
3. Temperature measurement point
4. Thermal snap-switch box
5. Lifting-bolt (x4)
6. Pump-inlet (upper)
7. Temperature Control Valve (TCV)
8. Skid Fixing holes
9. Skid Frame
10. Gas-ballast flow valve
11. Exhaust-purge port (blanked)
12. Interstage relief valve (GV410 and GV600 only)
13. Pump-outlet
14. Gearbox: oil-level sight-glass
15. Coupling cover
16. Pump-motor
17. Motor terminal box
18. Arrow showing motor rotation direction
19. Motor cooling fan
20. Gearbox oil drain-plug
21. Gearbox oil filler-plug
22. High vacuum bearings oil drain-plug
23. High vacuum bearings oil-filler plug
24. High vacuum bearings sight-glass
25. Sintered filter plug
26. Pump inlet (side)
27. Water jacket drain plug
28. Inlet gauging ports
29. Head plate side port cover plate
30. PRV purge port
31. Shaft-seal purge inlet
32. Cooling-water inlet

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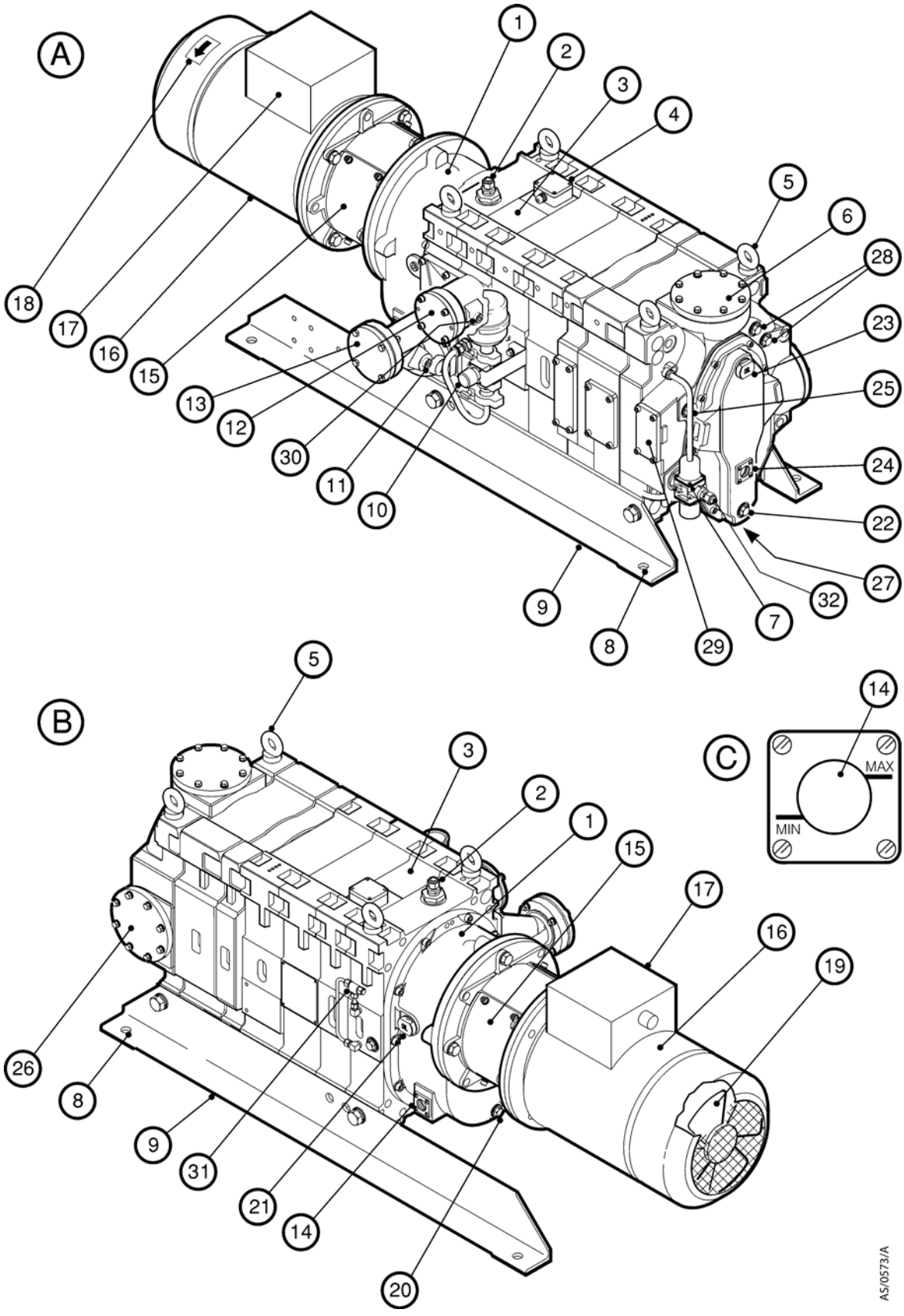
Figure 1 - GV Pump



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1.3 Gas system

The pump has a shaft-seals purge system and a gas-ballast system.

A dry compressed air supply can be connected to the shaft-seals purge inlet (Figure 1 item 31). The shaft-seals purge pipeline then delivers the dry air purge to the shaft-seals. This dry air purge: ensures that the shaft-seals are maintained at a positive pressure during pump operation; prevents the entry of corrosive or toxic process vapour into the pump gearbox. It also prevents contamination of the process gases by pump oil and damage to the shaft-seals.

The gas-ballast system can deliver ambient air to the pump gas-ballast inlet to dilute process gases or to prevent condensation of vapour. The filtered airflow is controlled by a valve (Figure 8, item 8). A flap-valve (Figure 8, item 2) prevents the escape of process gases out of the gas-ballast system into the local atmosphere.

If required dry nitrogen supplies can be connected to the pump, to deliver nitrogen gas-ballast and nitrogen shaft-seals purge instead of air: refer to Section 3.10.

For clean applications an atmospheric shaft seal purge kit is available. This kit enables atmospheric air to be passed via a non-return valve into the pump shaft seals, thus eliminating any air or nitrogen supply. Refer to Section 3.10.

1.4 Cooling system

The GV pump has a direct cooling system, in which cooling-water connected through the water inlet: (Figure 1 item 32) circulates around the pump-body and then passes out of the pump through the outlet (Figure 1 item 2). The inlet to the system is fitted with a temperature control valve (refer to Figure 1, item 7) which holds the pump at an operating temperature of 122°F (50°C) (measured at the position shown in Figure 1, item 3). If the application requires pump operating temperatures of 112 to 194°F (50 to 90°C) an Indirect Cooling Kit accessory must be fitted. Refer to Section 7.4.4. For higher temperature operation it is recommended that SHC630 oil be used in the pump.

A thermal snap-switch box (Figure 1 item 4) is fitted to the pump-body. This has two thermal snap-switches that are pre set to function in warning and shut down modes:

1.4.1 Warning Switch

The output of the warning thermal snap-switch will go ‘open circuit‘ when the temperature of the pump-body is higher than 154°F (68°C) (see Section 2.3). Use this output to provide a warning of high pump temperature.

1.4.2 Shut Down Switch

The output of the shutdown thermal snap-switch will go ‘open circuit‘ when the temperature of the pump-body is above 167°F (75°C) (see Section 2.3). Use this output to shutdown the pump when it is too hot.

The pump-motor (Figure 1, item 16) is air-cooled by an integral cooling-fan (Figure 1, item 19).

1.5 Inter-stage pressure relief valve (PRV)

The GV410 and GV600 pumps have an inter-stage pressure relief valve (Figure 1, item 12) fitted between the third stage and the last stage of the pump. This relief valve allows the pump to function with greater efficiency throughout the pressure range.

At high pump inlet pressures the inter-stage pressure forces the valve open thus allowing process gases to pass directly from the third stage into the pump-outlet, without compression in the fourth stage of the pump. At low pump inlet pressures the inter-stage pressure is low and the valve is held closed by atmospheric pressure. Process gases pass through all stages of the pump and are compressed in the fourth stage before they pass into the pump-outlet.

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1.6 Drive operation

The pump has a flexible drive coupling which transmits the drive from the pump-motor (Figure 1, item 16) to the pump rotors.

Refer to Figure 12. A coupling hub (14) is fitted to the pump shaft (9) and a drive hub (16) is fitted to the motor shaft (18). A coupling insert (15) fits between the coupling and drive hubs.

The drive hub incorporates a number of drilled holes. With a coupling cover (Figure 12, item 12) removed, a steel rod can be fitted (or other suitable tool) into one of these holes, and you can then manually turn the drive shaft, and so turn the pump. This facility is useful if, for example, you need to drain fluid from the pump following a hydraulic lock (see Table 4).

1.7 Liquid pumping capability

The GV pump can ingest liquid streams up to 1 l/min flow rate. For a continuous pumped liquid stream you are advised to contact your supplier or Edwards for applications advice. Liquid streams in excess of 1 l/min should to be avoided.

1.8 Safe area operation

GV pumps must not be used in the following hazardous areas:

- Zone 0, Zone 1 or Zone 2 (gases), or Zone Z (10) or Zone Y (11) (dusts), as classified by standard BS5345 Part 1.
- Division 1 or Division 2 (gases and dusts), as classified by North American authorities.

These hazardous areas require the use of flameproof equipment. If a pump is required to operate in these areas, contact your supplier or Edwards for advice.

1.9 Accessories

A number of accessories are available for the GV pump. These accessories can be used to configure the pump for specific applications. These accessories are listed in Section 7.

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2 TECHNICAL DATA

2.1 General

Dimensions	See Figure 2
Mass	See Figure 2
Pump-motor rating	See Table 2
Full load and no-load current ratings	See Table 1
Typical pump rotation speed	
50 Hz electrical supply	2950 rpm
60 Hz electrical supply	3565 rpm
Pump-inlet connection	ISO100
Pump-outlet connection	ISO63
Recommended pump-inlet seal	Fluoroelastomer trapped O-ring
Recommended pump-outlet seal	Fluoroelastomer trapped O-ring
Ambient operating temperature range	41 to 104°F (5 to 40°C) (For operation outside the recommended range consult Edwards.)
Maximum ambient operating humidity	90% RH
Maximum outlet pressure;	1.15 bar absolute, 1.15 x 10^5 Pa
Typical continuous A-weighted sound pressure level	See Table 2
Performance	See Table 2

2.2 Services

Electrical supply	See front cover
Voltage tolerance	± 10% from nominal
Frequency	± 2% from nominal
Harmonics	Not greater than 10%
Imbalance	Not greater than 2%
Interruptions	Not more than 3 ms
Voltage dip for one cycle	Not greater than 20%
Cooling water supply	
Water quality	Ryznar Stability Index 6.5 to 7
Supply temperature range	41 to 95°F (5 to 35°C)
Maximum supply pressure	10 bar, 1 x 10^6 Pa
Minimum required pressure differential across supply and return	2 bar 2 x 10^5 Pa
Typical heat removed from pump	See Table 2
Maximum water consumption	See Table 2
Supply Interface	1/2" BSP female connection
Shaft-seals air/nitrogen purge	
Regulated pressure of purge to shaft seals	0.41 to 0.54 bar above exhaust back-pressure
Supply interface	Compression fittings, suitable for ¼" outside diameter rigid tube

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Table 1 - Motor Supply Current (A)±5%

Motor supply current (A)					
Pump	Supply	Pump inlet at ultimate vacuum	Pump inlet at atmospheric pressure	Rated full load current for continuous motor operation	Locked rotor condition
GV260	50 Hz 415v	11	18	20.8	173
GV260	60 Hz 460v	11	22	22.9	142
GV410	50 Hz 415 V	17	23	28.1	219
GV410	60 Hz 460 V	15	26	28.4	199
GV600	50 Hz 415 V	17	41	39.5	324
GV600	60 Hz 460 V	16	44*	33.8	216

* Motors carry S2 ratings that enable them to run safely with this current when the pump is subjected to high inlet pressures. Supply protection circuit breakers should be set at this level as described in Section 3.6.1.

2.3 Cooling system

Cooling system type	Direct water-cooling
Cooling-water requirements	See Section 2.2 and Table 2
Thermal snap-switches	
Warning thermal snap-switch	
Opening temperature	154°F (68°C)
Closing temperature	144°F (62°C)
Shutdown thermal snap-switch	
Opening temperature	167°F (75°C)
Closing temperature	147°F (64°C)
Contact ratings	
Maximum voltage	240 V
Maximum load (inductive)	120 VA
Maximum current (resistive load)	12 A

Table 2 - Technical Data

Pump Type						
DATA	GV260 50 Hz	GV260 60 Hz	GV410 50 Hz	GV410 60 Hz	GV600 50 Hz	GV600 60 Hz
Mass: kg	767	785	819	848	1022	959
Continuous power	11 kW	20 hp	15 kW	25 hp	22 kW	30 hp
Noise: dB (A *)	<76	<78	<76	<78	<76	<78
Max. pumping speed: $m^3 h^{-1}$	240	320	380	460	560	540
Displacement: $m^3 h^{-1}$	336	405	526	635	793	727
Ultimate: mbar	<0.065	<0.04	<0.065	<0.04	<0.05	<0.04
Maximum heat removed: kW	7.0	8.0	10.0	13.2	14.5	16.5
Maximum coolant flow: l/min	5.0	5.0	5.6	9.0	4.5	5.5

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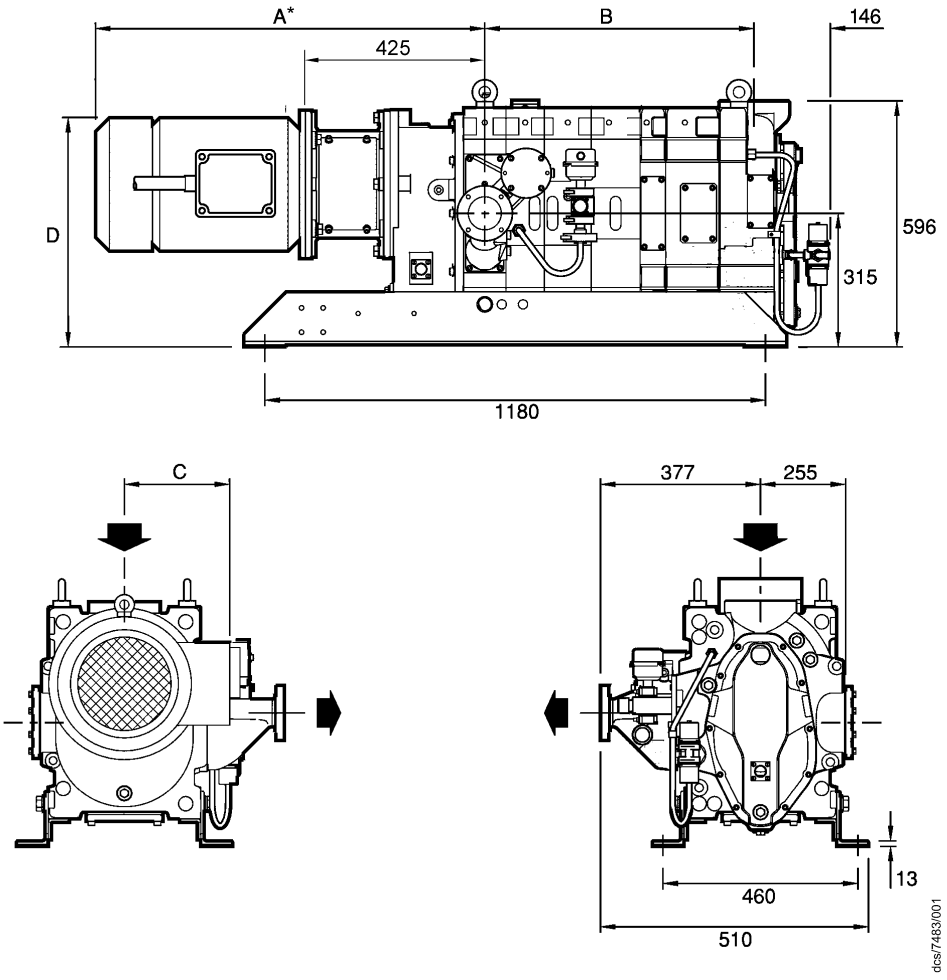
Table 2 - Technical Data

Pump Type						
DATA	GV260 50 Hz	GV260 60 Hz	GV410 50 Hz	GV410 60 Hz	GV600 50 Hz	GV600 60 Hz
Max. gas ballast flow: l/min @ 6psig	150	150	150	150	150	150
Motor flange PCD	300 mm	12.5 inch	300 mm	12.5 inch	300 mm	12.5 inch
Motor spigot	250 mm	11 inch	250 mm	11 inch	250 mm	11 inch

* Pump installed with exhaust duct and standard silencer, running at ultimate. The noise figures above are measured generally in accordance with BS EN ISO 4871:1997.

Figure 2 - GV Dry Vacuum Pump Dimensions (mm)



Pump	A *	B	C	D
GV260 50 Hz	911	461	270	549
GV260 60 Hz	956	461	276	549
GV410 50 Hz	911	544	250	549
GV410 60 Hz	899	544	276	569
GV600 50 Hz	977	634	250	569
GV600 60 Hz	1014	594	276	569

* Dependent on motor fitted i.e. Bareshaft pump supplied.

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2.4 Lubrication system

The Edwards Material Safety Data Sheets for the recommended oil referenced in the sections below are available upon request.

2.4.1 Gearbox

WARNING

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

Gearbox oil capacity:

Minimum	1.4 litres
Maximum	1.9 litres

Recommended oil for pump in standard configuration;

Mobil SHC629 Antiwear Synthetic Gear Oil

Recommended oil for pump operating between 122 to 194°F (50 to 90°C) case temperature;

Mobil SHC630 Antiwear Synthetic Gear Oil

Recommended perfluoropolyether oil:

Drynert 25/6

Fomblin Y25/6

Krytox 1525

2.4.2 High vacuum bearings

Oil box capacity:

Minimum	1.1 litres
Maximum	1.2 litres

Mobil SHC629 Antiwear Synthetic Gear Oil

Recommended oil for pump operating between 122 to 194°F (50 to 90°C) case temperature;

Mobil SHC630 Antiwear Synthetic Gear Oil

2.5 Area classification in accordance with BS 5345

Standard pumps	Safe Area designation only

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2.6 Materials of Construction

Pump casing	SG Cast iron
Rotors	SG Cast iron
Motor mounting flange	SG Cast iron
Pressure relief valve (P.R.V)	PFA Coated cast iron
Shafts	Heat-treated carbon steel
Piston rings	Heat-treated carbon steel
Drive gears	Heat-treated carbon steel
Bearing housing	Stainless steel
Shaft sleeves	Stainless steel
Throwers	Stainless steel
Valve body	Stainless steel
Valve seat	Stainless steel
Valve pad	Stainless steel
Ancillary brackets	Stainless steel
Coolant pipes and fittings	Stainless steel
Shaft seals	Stainless steel / PTFE
Skids	Mild steel
Motor fan cowl	Mild steel
Pump casing blanking plates	Mild steel
Motor casing	Aluminium alloy
Oil vent assembly in oil box	Aluminium alloy
Coolant inlet strainer	Brass
O-rings	Viton
Oil vent filter in head plate	Sintered polyethylene
Oil vent filter in oil box	High-density polyethylene
Labels	Lexan polycarbonate film
Interstage pressure relief valve bushes	PEEK

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3 INSTALLATION

3.1 Safety

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 install your GV pump.
- Ensure that the GV pump is suitable for your application. Contact Edwards or your supplier if you want to use the GV pump on any other application than those recommended by Edwards.
- Ensure that you comply with all local and national safety requirements during installation.
- Ensure that the installation technician is familiar with the safety procedures which relate to the products pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components. Dismantle and clean contaminated foreline components inside a fume-cupboard. The GV pump should NOT be dismantled under any circumstances.
- Vent and purge the process system before you start installation work.
- Check that all the required components are available and of the correct type before you start.
- Disconnect the other components in the process system from the electrical supply so that they cannot be operated accidentally.
- If necessary, contact Edwards or your supplier for advice on inlet isolation-valves, outlet check-valves or other components suitable for your application and system design.

Consult safety booklet P400-40-100 for advice on safety issues.

3.2 Unpack and inspect

WARNING

Use suitable lifting equipment to move the pump. Refer to Section 2 "Technical Data" for the pump mass.

Note: *For Bareshaft products, refer to Section 5.13.2 and Table 2, for motor specifications.*

1. Use a forklift truck or a pallet truck to place the pallet in a suitable position.
2. Remove the cardboard sleeve, which covers the pump, and then remove the protective foil bag from around the pump.
3. Inspect the equipment. If the pump or any other item is damaged notify your supplier and the carrier in writing within three days. State the Item Number of the GV pump together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the pump if it is damaged.
4. Check that you have received the items listed in Table 3. If any of these items is missing, notify your supplier in writing within three days.

If the GV pump is not to be used immediately, replace the packing materials. Store the pump in suitable conditions as described in Section 6.

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Table 3 - Checklist of Components

Qty	Description	Check (4)
1	GV pump	o
Fittings kit, comprising;		
1	Swagelok nut	o
1	Swagelok ferrule	o
1	Swagelok nut	o
1	Swagelok ferrule	o
1	ISO 63 trapped O-ring	o
1	ISO 100 trapped O-ring	o
1	Coolant outlet pump fitting 1 ¼" BSP	o

3.3 Locate the GV Pump

WARNING

Use suitable lifting equipment to move the pump. Refer to Section 2 "Technical Data" for the pump mass.

WARNING

Ensure that the cooling-air flow around the pump-motor is not restricted by allowing a minimum gap of 18 inch (450mm) between the motor body and adjacent installations. Failure to do so may result in the motor overheating causing the electrical supply to be cut off and thus stopping the pump.

Note: *If you operate the pump in an environment with an ambient temperature of 41°F (5°C) or lower, contact your supplier or Edwards for advice.*

Refer to Figure 1. Remove from the fixing-holes (8) the four nuts and bolts that secure the pump frame (9) to the pallet.

Attach suitable lifting-equipment to the four lifting bolts (5) to move the pump.

Locate the pump as near as possible to the equipment being evacuated so that the Vacuum, Water and Exhaust connections can be conveniently made. Provide for adequate space for convenient servicing where possible.

The pump should be mounted on a rigid foundation, such as a concrete floor, and made level by shimming or grouting, if necessary. Mount the pump to foundation without putting a strain or twist in the pump housing. Refer to Figure 2 for foundation mounting dimensions. Ensure that the surface is clean and free from debris and contamination (such as oil). Refer to Figure 1. Use suitable bolts through the four fixing-holes (8) to secure the pump in position.

Remove cap from exhaust and inlet openings only when ready to make a piping connection. Also remove the plastic plug (by unscrewing) from the gas ballast valve. When pump is to be subjected to temperatures below freezing, either drain the water jacket through the housing drain plug to prevent cracking the housing or add anti-freeze to it. Follow this same procedure for storage.

3.4 Check the gearbox oil-level

Refer to Figure 1. The pump is supplied filled with oil. Before you operate the pump, check that the gearbox oil-level is correct: the oil-level must be between the MIN and MAX marks on the bezel of the gearbox oil-level sight-glass (14). If necessary, pour more oil into the gearbox: refer to Section 5.3.

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3.5 Check the high vacuum bearing oil-level

Refer to Figure 1. The pump is supplied filled with oil. Before pump operation, check that the high vacuum bearings oil-level is correct: the oil-level must be between the MIN and MAX marks on the bezel of the high vacuum bearings oil-level sight-glass (24). If necessary, pour more oil into the high vacuum bearings oil box: refer to Section 5.4.

3.6 Electrical connections

WARNING

Ensure that the electrical installation of the pump conforms with your local and national safety requirements. It must be connected to a suitably fused and protected electrical supply and a suitable earth (ground) point.

3.6.1 Introduction

WARNING

The motor thermistors should be connected to a control circuit as shown in Figure 3. Failure to do so could result in the motor overheating and a possible fire hazard.

The pump should be electrically connected to the pump as described in the following sections.

Figure 3 shows a schematic diagram of the recommended electrical circuit for correct operation and shutdown of the pump and closure of an optional pump-inlet isolation-valve (9), if the shutdown thermal snap-switch (8) opens or the motor thermistor relay (12) opens.

Connect the electrical supply to the pump-motor through a suitable contactor. The contactor must incorporate a motor protection circuit breaker, which, for the GV260 and GV410 pumps, meets the full load current ratings stated in Table 1. For GV600 pumps, the motor protection circuit breaker must meet the current ratings for the pump inlet at atmospheric pressure stated in Table 1.

Refer to Figure 1. Note that there are earth (ground) points in the pump-motor terminal box (17) and in the thermal snap-switch box (4).

The motor windings are fitted with thermistors that are terminated in a junction block in the motor connection enclosure. The thermistors should be connected to a control circuit that will switch off the supply to the motor in the event of the windings overheating.

Table 4 - Earth (Ground) Points

Location	Size
Thermal snap-switch box	M4 hole
Pump-motor	M4 bolt

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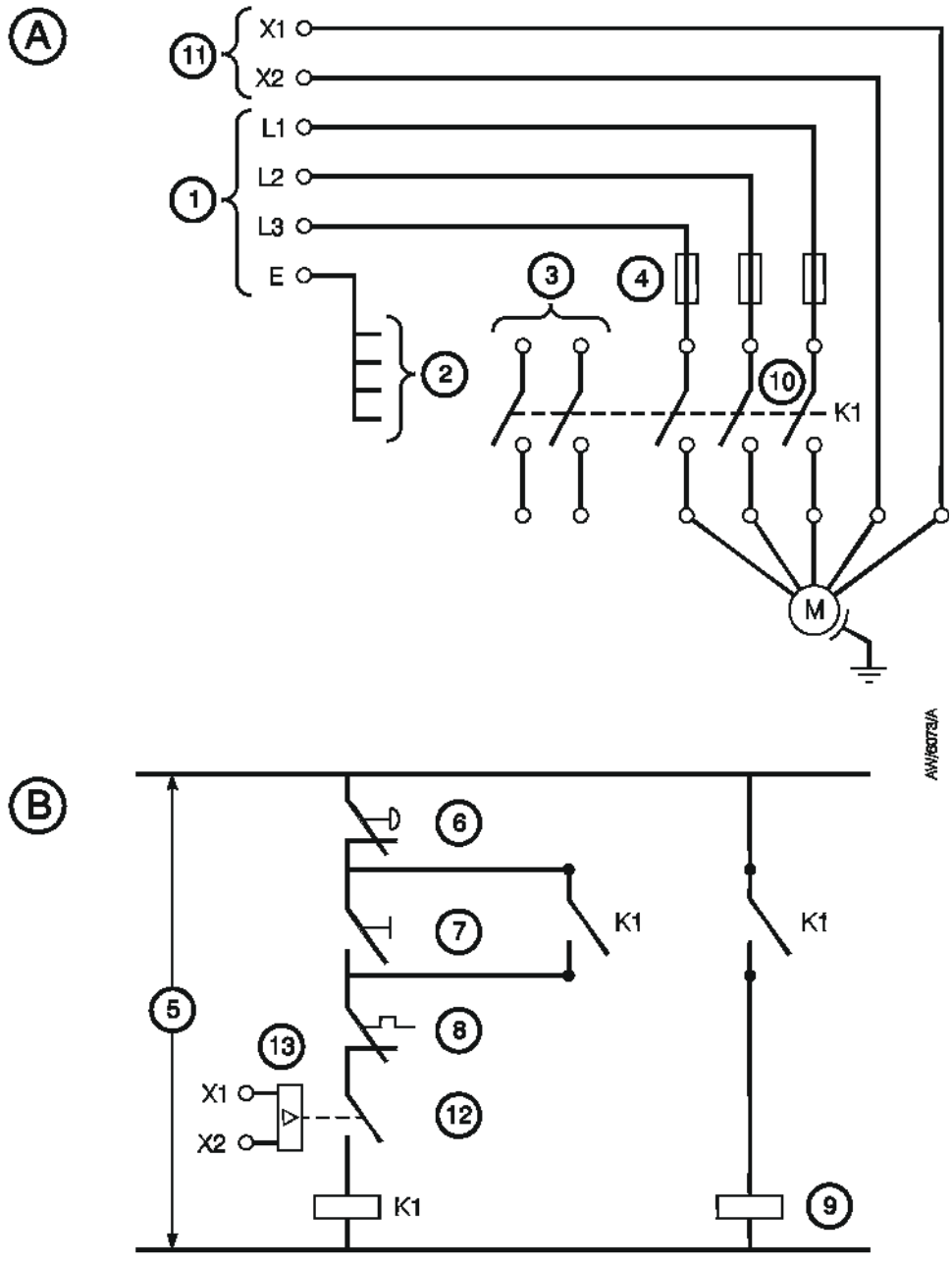
Figure 3 - Schematic Diagram of Recommended Electrical Connections



A Pump-motor connections

B Control circuit

1. Electrical supply
2. Earth (ground) points
3. Auxiliary contacts (2 off, normally closed)
4. Fuse or circuit breaker
5. Control voltage
6. Stop control
7. Start contol
8. Shut down thermal snap-switch
9. Inlet valve control solenoid (optional)
10. Contactor
11. Thermistor Connections
12. Thermistor Relay
13. Thermistor control amplifier

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3.6.2 Connect the electrical supply to the pump-motor (380 - 415 V, 50 Hz electrical supplies)

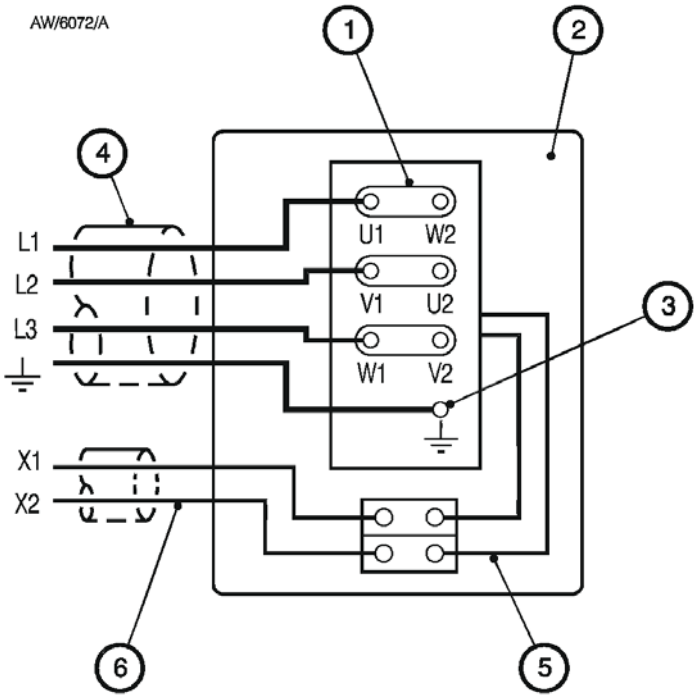
WARNING

Ensure all power supplies are Isolated before commencing work.

Connect the electrical supply from the contactor to the pump-motor as described below.

1. Remove the cover from the pump-motor terminal-box (Figure 1, item 17).
2. Either use the cable glands supplied if acceptable for your cable and proceed to step 4, or fit your own glands as described in step 3 below.
3. Fit a suitable cable-gland and nut to the entry hole, then pass the supply cable through the cable-gland and tighten the gland. The cable-gland must be rated to provide seal protection of IP55 (in IEC 529) or better to the terminal-box.
4. Refer to Figure 4. Ensure that the links (1) are correctly configured on terminals U1 and W2, V1 and U2, and W1 and V2.

Figure 4 - Electrical Connections: 380/415 V, 50 Hz Electrical Supplies



1. Motor terminal connectors supplied with motor)
2. Motor terminal box
3. Earth connections
4. Power lead
5. Motor Thermistor wires (supplied with motor)
6. Control thermistor wires

5. Connect the phase conductors (L1, L2, L3) of the supply cable (4) to terminals U1, V1 and W1, as shown in Figure 4, using a suitable secure method. It is recommend that you use ring crimp terminals.
6. Connect the earth (ground) wire to the earth (ground) terminal (3) using a suitable secure method. It is recommend that you use ring crimp terminals.

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7. Tighten the cable-gland nut strain-relief screws.
8. Fit a suitable cable-gland and nut to the second gland entry hole, then pass the thermistor control cable through the gland and tighten the gland. The cable-gland must be rated to provide seal protection of IP55 (in IEC 529) or better to the terminal-box.
9. Connect thermistor terminals X1 and X2 to wires passed through the second cable gland.
10. Connect the thermistor wires to a suitable control circuit.
11. Refit the terminal-box cover.

3.6.3 Connect the electrical supply to the pump-motor (230/460 V, 60 Hz electrical supplies)

WARNING

Connect the phase conductors (L1, L2 and L3) of the supply cable (1) to terminals TI, T2 and T3.

WARNING

Ensure all power supplies are Isolated before commencing work.

Make the wiring connections to the pump-motor in accordance with the US National Electrical Code and with approved local and site practices.

Connect the electrical supply from the contactor to the pump-motor as described below.

Refer to Figure 5. Note that the GV260 and GV410 and GV600 230/460 V 60Hz pumps may be supplied either with the motor wires (3) fitted to a terminal block (4) or with the terminal wires (3) unterminated. If the pump is supplied with the motor wires unterminated, use a suitable, secure method to link the motor wires and to connect the phase wires of your electrical supply cable; we recommend that you fit a terminal block as shown in Figure 5. The following procedure assumes that you have fitted a terminal block to the motor wires.

1. Remove the cover from the pump-motor terminal-box (Figure 1, item 17).
2. Either use the cable glands supplied if acceptable for your cable and proceed to step 4, or fit your own glands as described in step 3 below.
3. Fit a suitable cable-gland and nut to the entry hole, then pass the supply cable through the cable-gland and tighten the cable-gland. The cable-gland you use must be rated to provide seal protection of IP55 (in IEC 529) or better to the terminal-box
4. Refer to Figure 5. Ensure that the links (6) are correctly configured for your electrical supply voltage; note that the links required are shown in Table 5:

Table 5 - Link Configurations

Electrical Supply	Links	Wiring configuration
230 V (detail A)	T1-T6-T7, T2-T4-T8, T3-T5-T9	Delta
460 V (detail B)	T4-T7, T5-T8, T6-T9	

5. Tighten the cable-gland nut strain-relief screws and refit the terminal-box cover.
   - For a 230 V electrical supply, configure the links as shown in detail A.
   - For a 460 V electrical supply, configure the links as shown in detail B.

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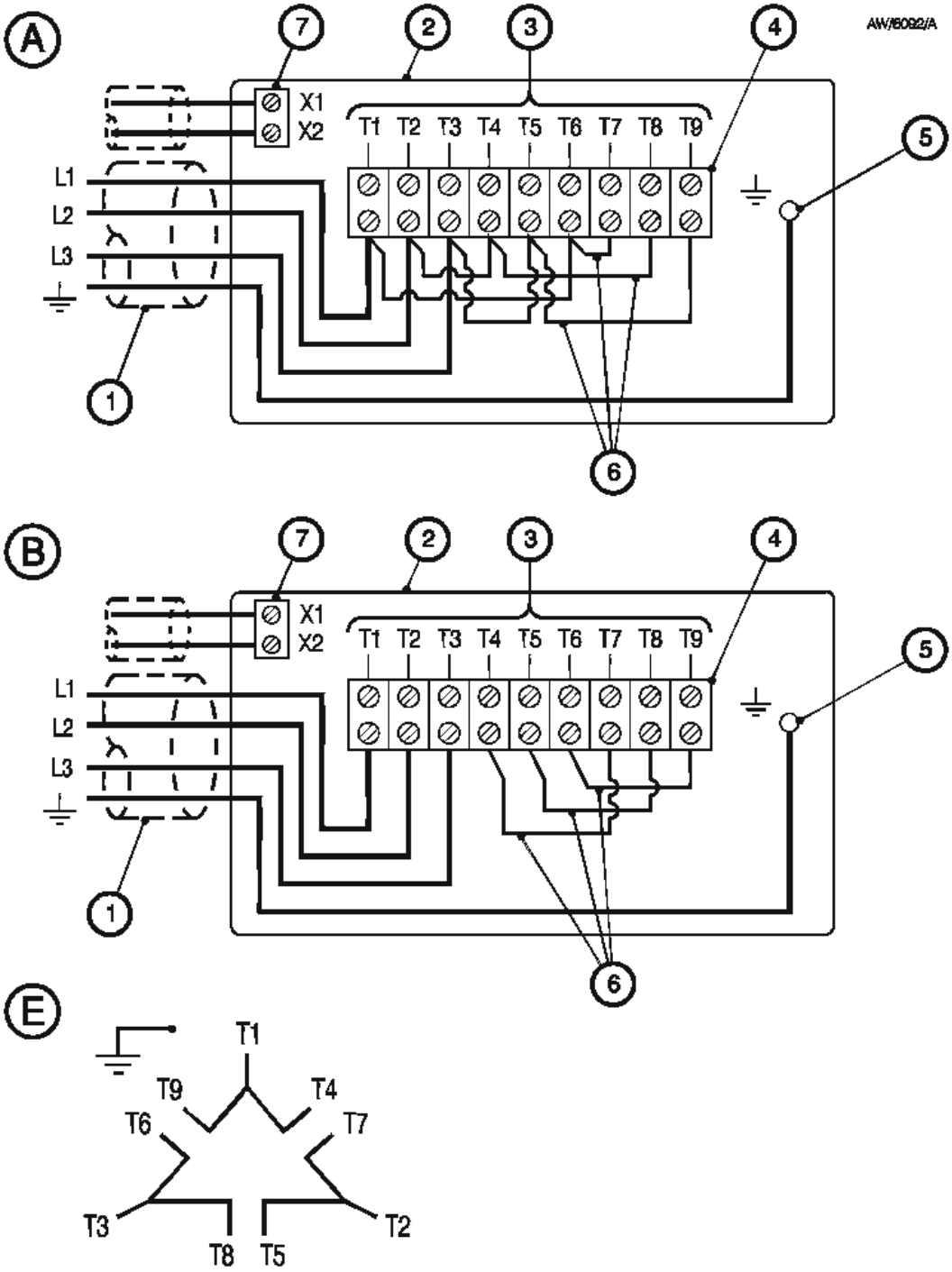
Figure 5 - Electrical Connections: 230/460 V, 60 Hz Electrical Supplies



A Wiring configuration: 230 V supply

B Wiring configuration: 460 V supply

E Schematic wiring diagram: Delta

1. Electrical supply cable
2. Terminal-box
3. Motor wires
4. Terminal-block
5. Earth (ground) terminal
6. Links
7. Motor thermistor wires

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3.6.4 Connect to the thermal snap-switches

WARNING

You must connect the shutdown thermal snap-switch so that the pump stops when the thermal snap-switch opens. If not there may be a risk of fire.

WARNING

Incorporate a manual reset device in your control equipment. If not,and a fault which causes the shutdown thermal snap-switch to open is not corrected the pump will automatically switch on again when it cools down. If maintenance or fault finding on the pump has started, there will then be a risk of injury.

CAUTION

Ensure that you route the snap-switch away from hot surfaces of the pump or other equipment. If not, the cable may be damaged.

Connect the output of the warning thermal snap-switch to your control equipment to provide an indication that the pump is too hot.

Connect the output of the shutdown thermal snap-switch to the electrical-overload control-loop of your contactor, so that the contactor will automatically switch off the pump if it is too hot: refer to Figure 3.

The thermal snap-switches will reset (that is, close again) when the pump cools down to a preset temperature (see Section 2). We therefore recommend that your control equipment incorporates a manual reset device so that the pump does not automatically switch on again when it cools down.

Use the following procedure to connect the thermal snap-switches. The output from the thermal snap-switches will be normally closed and will open when the pump is too hot.

1. Refer to Figure 6. Undo and remove the four screws (1) that secure the cover (2) to the thermal snap-switch box (3), and then remove the cover.
2. Remove the plastic bag from inside the box, this bag contains the crimp connectors and Insulators required to connect the snap-switches.
3. Pass a suitably rated (see Section 2.3) four-core cable through the cable gland (5).
4. Fit the crimp connectors to the ends of the four wires in the cable (4), and then fit the insulators around the connections.
5. Fit the crimp connectors on one pair of wires (11) to the spade terminals (10) of the shutdown thermal snap-switch (9).
6. Connect the other ends of the same pair of wires to the electrical-overload loop of your contactor.
7. Fit the crimp connectors on the remaining pair of wires (6) to the spade terminals (7) on the warning thermal snap-switch (8)
8. Connect the other end of the same pairs of wires to the warning circuit of your control equipment.
9. Tighten the cable-gland (5) to secure the cable in position.
10. Refit the cover (2) and secure with the four screws (1).

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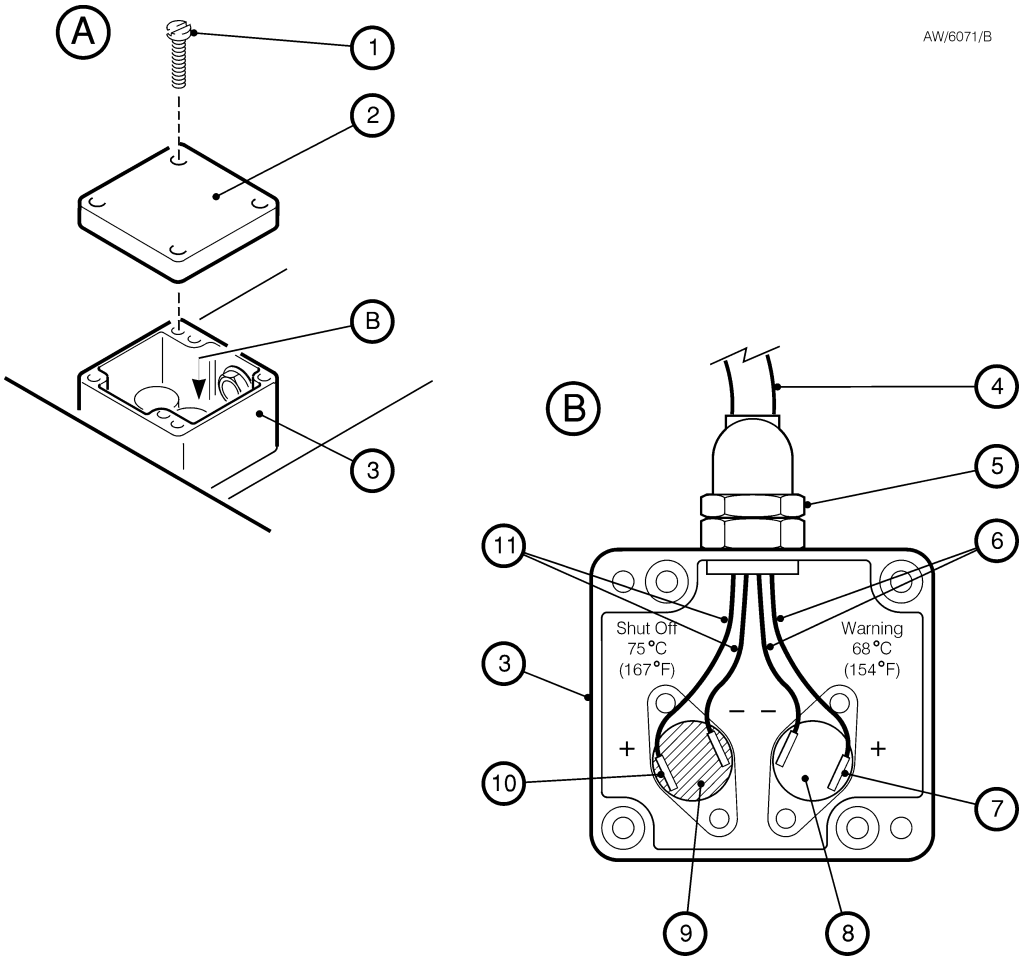
Figure 6 - Thermal Snap Switch Connections



1. Screws (4 off)
2. Cover
3. Thermal snap-switch box
4. Four-core cable
5. Cable-gland
6. Warning wires
7. Spade terminals
8. Warning thermal snap-switch
9. Shut-down thermal snap-switch
10. Spade terminals
11. Shut-down wires

3.7 Check the direction of pump rotation

WARNING

Risk of injury. You must ensure that the direction of rotation of the pump is correct before you operate the pump. If the pump direction of rotation is incorrect, the inlet pipeline will be pressurised and may be damaged.

WARNING

Risk of injury. The coupling cover must be replaced before continuing commissioning.

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1. Refer to Figure 12. Undo and remove the four bolts (13) that secure the coupling cover (12) to the coupling housing, then remove the coupling cover.
2. Look into the coupling housing (7) and watch the drive hub (16), switch on the pump for one or two seconds, then switch the pump off.
3. If the drive hub (16) does not rotate in the correct direction shown by an arrow on the pump-motor. (Figure 1, item 18), the direction of rotation is incorrect. If the direction of rotation is incorrect:
   - Isolate the pump from the electrical supply.
   - Reverse the electrical supply phase-wires L1 and L2 in the pump-motor terminal-box: refer to Section 3.5.
   - Repeat Step 2 to ensure that the direction of rotation is now correct.
4. Refer to Figure 12. Refit the coupling cover (12) and secure with the four bolts (13). Tighten the bolts to a torque between 3 and 5 Nm.

3.8 Fit a mechanical booster pump (optional)

If there is a requirement to use an mechanical booster pump or pumps with the GV pump, it must be fitted at this stage of installation. This enables a booster to be fitted on top of the pump utilising the two inlet ports. Refer to Figure 1 items (6) and (26).

Details of the standard connection kits available from Edwards are given in Section 7.4. Refer to the installation procedures in the instruction manual supplied with the connection kit. The side inlet to the pump is protected by a cover flange and can be used for connection of a side-mounted booster. Contact Edwards for specialist advice about this application.

3.9 Connect the cooling-water supply

CAUTION

The pump must be filled with cooling-water before running or there is a risk of damage to the pump on starting.

The following procedure assumes that direct cooling (as supplied) will be used for the GV pump. If you want to use indirect cooling on the GV pump, install the appropriate Indirect Cooling Kit (see Section 7.4) and connect to the cooling-water supply as described in the instruction manual supplied with the Kit.

Take note of the following when you connect the cooling-water supply and return pipelines:

If there is a requirement to connect more than one GV pump to the water supply, they must be connected in parallel and not in series.

We recommend that a suitable ball-type flow indicator is incorporated in your water return pipeline, to provide a visual indication of cooling-water flow through the GV pump.

If the water supply contains particulates. We recommend that a suitable filter is fitted in the water supply pipeline,

To ensure a constant running temperature a Temperature Control valve (TCV) is fitted in the cooling-water supply line. This valve controls the pump temperature by opening when the cooling jacket reaches 122°F (50°C) and by closing when the pump cooling-water temperature is below 122°F (50°C).

This valve is factory set to give optimum pump performance and is not adjustable. Do not attempt to modify the valve.

Because there is no cooling-water flow when the pump is first switched on, there is a requirement to charge the pump-cooling jacket with cooling-water during installation.

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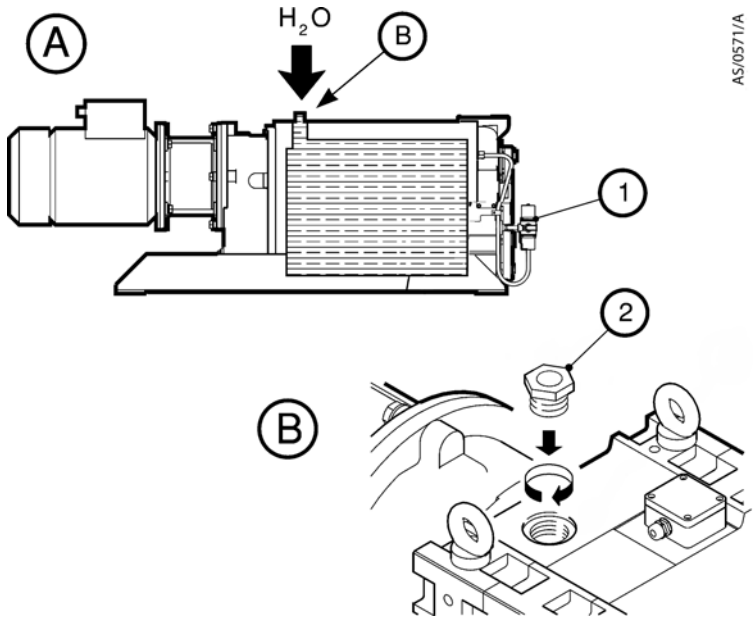
1. Refer to Figure 7. Remove the red blanking caps from the cooling-water outlet port (3) and the cooling-water inlet (as shown in Figure 1). Fill pump case with cooling-water and fit the outlet connection into the outlet port (3) using sealant (Loctite 577 or equivalent).
2. Fit the end of your cooling-water supply pipeline to the Temperature Control Valve (TCV) with a suitable ½" BSP adaptor using sealant (Loctite 577 or equivalent).
3. Fit the end of your cooling-water return pipeline to the outlet connection using a suitable ½" BSP adaptor using sealant (Loctite 577 or equivalent).
4. Cooling-water supply lines should be rated to 7 bar working pressure and to 338°F (170°C).

Figure 7 - Cooling Schematic



1. TCV/Coolant inlet connection 2. Coolant outlet connection

3.10 Connect the shaft-seals purge and gas-ballast gas supplies

3.10.1 Introduction

Select the correct shaft-seals purge and gas-ballast requirements for your application. It is recommended that nitrogen supply be connected to the gas systems if toxic, corrosive or flammable materials are to be pumped.

If a compressed air supply is required to the shaft-seal purge inlet, use the procedure in Section 3.10.2. The gas-ballast system can deliver filtered atmospheric air to the pump gas-ballast inlet, therefore it may not be necessary to connect an air supply to the gas-ballast system.

If required to connect nitrogen supplies to the shaft-seals inlet and to the gas-ballast system. Use the procedures in Section 3.10.2 and Section 3.10.3.

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3.10.2 Connect the shaft-seals purge air or nitrogen supply

WARNING

If Hazardous gases are to be pumped, fit a suitable non-venting (to atmosphere) nitrogen supply to the shaft-seals purge inlet, to prevent the escape of dangerous gases from the pump.

CAUTION

Your compressed air or nitrogen supply pressure must comply with the requirements of Section 2.2. If it does not, the shaft-seals purge pipeline may become over-pressurised and the shaft-seals may fail.

Ensure that the compressed air or nitrogen gas supply must be clean and dry.

We recommend the installation of suitable non-relieving regulator pressure control devices, a pressure gauge, and an automatically operated isolation-valve in your compressed air or nitrogen supply so that:

- The shaft-seals purge air or nitrogen supply is on whenever the pump is on.
- If you connect a nitrogen supply, the nitrogen supply is off whenever the pump is off.
- Whenever the shaft-seals purge air or nitrogen supply is on, you must maintain the pressure to the shaft-seals as specified in Section 2.2.

Use the following procedure to connect your shaft-seals purge air or nitrogen supply; A rigid metal (such as stainless steel) pipeline with an outside diameter of ¼" (6.4mm) must be fitted for the air or nitrogen supply pipeline.

1. Refer to Figure 1. Remove the red blanking cap from the shaft-seals purge inlet (31).
2. Remove the ¼" (6.4mm) compression nut and ferrule from the fittings kit and fit them finger-tight onto the shaft-seals purge inlet connection (31).
3. Fit the end of the air or nitrogen supply pipeline to the shaft-seals purge inlet connection (31), then tighten the nut to secure the pipeline in place.

3.10.3 Connect a nitrogen gas-ballast supply (optional)

WARNING

If hazardous gases are to be pumped, fit a suitable non-venting (to atmosphere) nitrogen supply to the gas-ballast system, to prevent the escape of dangerous gases from the pump.

To enable connection to the flow valve the nitrogen supply pipeline must terminate in a KF16 fitting.

If required a non venting (to atmosphere) nitrogen gas-ballast supply to the pump can be connected. The supply should be set to shaft seal purge pressure. A non-venting (to atmosphere) nitrogen gas-ballast supply to the pump must be connected if you pump dangerous gases.

When connecting a nitrogen supply to the gas-ballast system, it is recommend that you incorporate a suitable non-relieving pressure gauge in the nitrogen supply pipeline.

Refer to Figure 8. Use the following procedure to connect a nitrogen supply to the gas-ballast system:

1. Undo and remove the clamp (9) and the NW16 trapped O-ring (10) and remove the air filter (11).
2. Use the clamp (9) and trapped O-ring (10) to connect your nitrogen supply pipeline to the gas-ballast flow valve (8).

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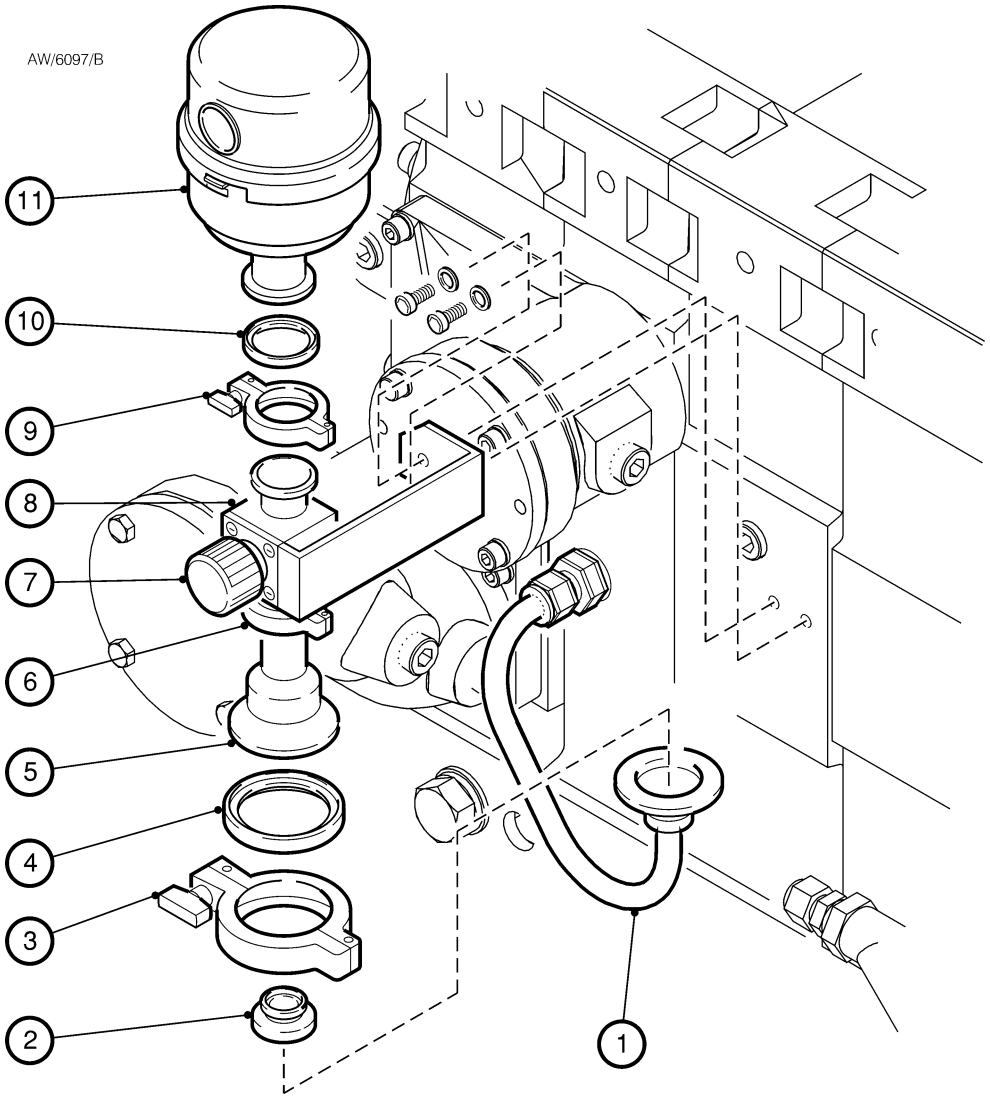
Figure 8 - Exploded View of the Gas-Ballast Assembly



1. Elbow
2. Flap valve
3. Clamp
4. Trapped O-ring
5. Adaptor: 16 to 25 mm
6. Clamp and Co-Seal
7. Gas-ballast flow valve control
8. Gas-ballast flow valve
9. Clamp
10. Trapped O-ring
11. Air filter

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3.11 Connect the pump-inlet and pump-outlet

WARNING

Scope of operation of pump excludes flammable process gas in the flammable zone. Take all necessary safety precautions when you pump toxic, flammable or explosive gases. If not, there will be a danger of injury.

WARNING

Ensure that your system can provide adequate gas-ballast and/or inlet purge to dilute toxic, flammable, explosive gases or oxidants to safe limits. If you do not, there will be a risk of emission of hazardous gases. The gas ballast feed system in the case of diluting flammable gases to avoid the flammable zone is safety critical. Refer to Edwards safety booklet P400-40-100.

WARNING

When the pump is switched off, gas will flow in reverse direction through the pump and there will be a rapid pressure rise in the inlet pipeline and your process system. If this will cause a dangerous situation (or adversely affect your process), you must incorporate suitable devices (such as a fast-acting inlet isolation-valve or an outlet check-valve) in your system pipelines.

3.11.1 Connect the pump to your process system

When connecting the pump to the process system it is important to take note of the following;

- Support process pipelines to stop the transmission of stress to pipeline joints.
- To reduce vibration and stress in the system. use a flexible connection in the pipeline from the process system to the pump.
- If there is a possibility that the pump will be exposed to or produce dangerous chemicals. Isolate the pump from the atmosphere. If necessary, contact Edwards or your supplier for advice on inlet isolation-valves, outlet check-valves or other components suitable for your application and system design.
- To minimise the ingress of dust into the pump in dusty applications, incorporate an inlet filter in the inlet pipeline. If process particles above 25-micron size are expected, it is recommended that a suitable filter be incorporated into the inlet installation.
- To achieve the best pumping speed, ensure that the pipeline, which connects the process system to the pump, is as short as possible and has an internal diameter not less than the pump-inlet.
- Do not allow debris to get into the pump during installation. Ensure that debris (such as weld slag) cannot get into the pump during operation.

Use the following procedure to connect the inlet of the GV Pump to your process system. This procedure assumes that a mechanical booster pump has not been fitted. If a mechanical booster pump has been fitted, use the instructions given in the appropriate instruction manual supplied with the mechanical booster pump.

1. Refer to Figure 1. Undo and remove the eight M8 x 35 hex-head bolts that secure the blanking-plate to the pump-inlet (6) and remove the blanking-plate. Retain the bolts.
2. Use the combined trapped O-ring and mesh filter supplied to connect the pump-inlet (6) to your vacuum system; secure with the bolts retained in Step 1.

Note: *If required, you can adapt the blanking-plate removed in Step 1 above to fit your system pipelines: drill a suitable size hole in the centre of the blanking-plate, then weld the blanking-plate to your pipeline.*

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3.11.2 Connect the pump-outlet

WARNING

Exhaust should be piped to a suitable treatment plant to prevent the discharge of dangerous gases or vapours to the surrounding atmosphere.

WARNING

Safety devices should be incorporated to prevent operation of the pump when the exhaust pipeline is restricted or blocked. If not, the exhaust pipeline may become over-pressurised and may burst.

CAUTION

Install an outlet catchpot to prevent the drainage of condensate back into the pump. If not, condensate that drains back into the pump may damage it or cause it to seize.

The exhaust pipeline system must be designed so that the pressure in the pipeline during pump operation is less than 1.15 bar absolute (1.15 x 105 Pa). If the pressure in the pipeline is higher than this pressure, the pump will operate at a high temperature and may trip because of excessive electrical current consumption.

Flexible bellows must be incorporated in the exhaust pipeline to reduce the transmission of vibration and to prevent loading of coupling-joints. The bellows must have a maximum pressure rating which is greater than the highest pressure that can be generated in your system, and which can withstand the maximum temperatures that can be generated by your process conditions.

Use the following procedure to connect the pump-outlet to your exhaust pipeline:

1. Refer to Figure 1. Undo and remove the four M8 x 50 hex-head bolts, nuts and washers that secure the blanking-plate to the pump-outlet (13) and remove the blanking-plate. Retain the bolts, nuts and washers.
2. Use the trapped O-ring supplied to connect the pump-outlet (13) to your exhaust pipeline; secure with the bolts, nuts and washers retained in Step 1.

Note: *If required, you can adapt the blanking-plate removed in Step 1 above to fit your exhaust pipeline: drill a suitable size hole in the centre of the blanking-plate, then weld the blanking-plate to your pipeline.*

The exhaust manifold and the Pressure relief valve are fitted with purge ports (Figure 1, items 11 and 30) that may be used to dilute the exhaust gas if required. The ports can also be used for instrumentation if necessary.

3.11.3 External Evacuation of High Vacuum Bearing Oil Box

If desired, the high vacuum oil box can be externally evacuated. This is achieved by utilising connections located underneath the high vacuum head plate evacuation port cover plate (Figure 1, item 29). For advice on this facility and associated applications please contact Edwards.

3.12 Leak test the installation

WARNING

Leak-test the system after installation and maintenance and seal any leaks found to prevent the leakage of dangerous substances out of the system and leakage of air into the system.

When supplied, the leak rate of the pump is tested to be less than $1x10^{-3}$ mbar ls^{-1} ($1x10^{-1}$ Pa ls^{-1}, $2.1x10^{-6}$). The required leak rate for your system will depend on your safety and process requirements.

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3.13 Commission the pump

1. Isolate the pump from your process system.
2. Ensure that the gas-ballast flow valve (Figure 1, item 10) is closed.
3. Turn on the cooling-water supply; the shaft-seals purge air or nitrogen supply, the gas-ballast nitrogen supply (if fitted) and your exhaust-extraction system. Ensure that the pressures and flow rates are as specified in Section 2.2.

Note: *There should be no cooling-water flow because the pump is cold and the TCV will be closed.*

4. Check that there are no leaks in the water, air, nitrogen (if fitted) and exhaust-extraction system connections. Seal any leaks found.
5. Switch on the pump.
6. Check that the pressure shown on your shaft-seals purge air or nitrogen pressure gauge is as specified in Section 2.2. If necessary, adjust the pressure of the air or nitrogen supply.
7. Leave the pump to operate with the inlet valve closed and allow the pump operating temperature to stabilise.

Note: *To check the operating temperature of the pump, measure the temperature of the pump at the point shown in Figure 1, item 3.*

8. Check that the pump operating temperature is between 122 to 140°F (50 to 60°C) as measured at the point indicated above and that a suitable cooling-water flow condition has been reached.
9. Turn off the pump, the cooling-water supply, the shaft-seals air or nitrogen purge supply and the gas-ballast nitrogen supply (if fitted).

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4 OPERATION

WARNING

During operation, some parts of the pump become hot; these areas are identified by 'hot surface' labels (see Section 1.1). Do not touch these areas of the pump and avoid accidental contact between these areas of the pump and electrical installations.

WARNING

Do not operate the pump with a coupling cover removed.

WARNING

Do not operate the pump with the pump-inlet or pump-outlet open to atmosphere.

The procedures in the following sections assume that you have a pump-inlet isolation-valve fitted to your pump.

4.1 Start the pump

Use the procedure below to start the pump.

1. Check the gearbox oil-level in the sight-glass on the side of the pump: refer to Section 3.4.
2. Check the high vacuum bearings oil-level in the sight-glass on the front of the pump: refer to Section 3.5.
3. Turn on your cooling-water supply; shaft-seals purge air or nitrogen supply, gas-ballast nitrogen supply (if fitted) and exhaust-extraction system (if fitted).
4. Switch on the pump.
5. Continue at Section 4.2 to allow the pump to warm up.

4.2 Pump warm up

CAUTION

Allow the pump to warm up and use full gas-ballast and inlet purge (if fitted) before you pump condensable vapours. If you do not, the vapours may condense in the pump and corrode or damage the pump.

CAUTION

In the first 30 seconds of pump down, open the inlet isolation-valve slowly. If there is liquid in the inlet pipeline, a sudden ingress of liquid entrained in the process gas stream could damage the pump.

To allow the pump to warm up and to achieve its operating temperature, leave the pump to operate with the inlet isolation-valve closed. A temperature of between 113 to 131°F (45 to 55°C) measured at the point adjacent to the thermal snap- switch (see Figure 1). If a quick warm up time is desired, please contact Edwards for applications advice.

When the pump has warmed up to its operating temperature, you can start process pumping.

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4.3 Check the purge pressures and flows

Carry out the following checks immediately after pump start and regularly during pump operation:

Check that the pressure of your shaft-seals purge air or nitrogen supply is correct and adjust if necessary (refer to Section 2.2).

If fitted, check that the pressure of your gas-ballast supply, purge air supply and / or nitrogen supply is correct and adjust if necessary.

If necessary, open the gas-ballast flow valve (Figure 1, item 10) to achieve the required gas-ballast flow into the pump.

4.4 Pump Shut down

CAUTION

Purge the pump before shut down. If you do not, process vapours may condense in the pump and corrode or damage it.

Note: *If the pump will be shut down for a long time in an environment where the temperature is close to freezing, we recommend that you drain the cooling-water from the pump to prevent damage to the pump: refer to Section 6.1.*

Use the following procedure to shut down the pump.

1. Isolate the pump-inlet from the process gases.
2. Refer to Figure 1. Purge the pump of contaminants: operate the pump with full gas-ballast (that is, with the gas-ballast flow valve (10) open) for at least 15 minutes. Alternatively, use one of the following methods:
   - Operate the pump for at least 45 minutes.
   - Operate the pump at an inlet pressure between 100 mbar and 300 mbar for at least 15 minutes; this is the recommended method for dusty processes.
   - Operate the pump with full inlet purge (if fitted) for at least 15 minutes.
3. Close the gas-ballast flow valve (10), or switch off inlet purge (if fitted).
4. Switch off the pump.
5. When the pump has cooled down, turn off the cooling-water supply.
6. Switch off the shaft-seals purge nitrogen or air supply (if fitted).
7. For prolonged shut down it is recommended that the exhaust of the pump is disconnected and sealed to prevent moisture ingress. Ensure that the exhaust sealing mechanism is removed before re-start.

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5 MAINTENANCE

5.1 Safety

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.

WARNING

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

- A suitably trained and supervised technician must maintain the pump.
- Ensure that the maintenance technician is familiar with the safety procedures that relate to the synthetic oils used and the products pumped. Wear the appropriate safety clothing when you come into contact with contaminated components and pump oil. Dismantle and clean contaminated components inside a fume-cupboard.
- Use suitable lifting equipment and wear safety shoes when you replace the pump-motor or the pump module.
- Allow the pump to cool to a safe temperature before you start maintenance work. Note that the coolant jacket may contain coolant with residual pressure and should be vented.
- Isolate the pump and other components in the process system from the electrical supply so that they cannot be operated accidentally.
- Recheck the pump rotation direction if the electrical supply has been disconnected.
- Do not reuse O-rings or gaskets if they are damaged.
- Protect sealing-faces from damage.
- Do not touch or inhale the thermal breakdown products of fluorinated materials that may be present if the pump has overheated to 500°F (260°C) and above. These breakdown products are very dangerous. The pump may have overheated if it was misused, if it malfunctioned, or if it was in a fire. Edwards Material Safety Data Sheets for the fluorinated materials used in the pump are available on request: contact your supplier or Edwards.
- Leak-test the system after installation work is complete and seal any leaks found to prevent leakage of dangerous substances out of the system and leakage of air into the system: refer to Section 3.12.

5.2 Maintenance plan

The maintenance plan in Table 6 details the maintenance operations Edwards recommend to maintain the pump in normal operation. Instructions for each operation are given in the section shown. In practice, the frequency of maintenance is dependent on your process. In clean processes, you may be able to decrease the frequency of maintenance operations; in harsh processes you may have to increase the frequency of maintenance operations. Adjust the maintenance plan according to your experience.

Use Edwards spares and maintenance kits (refer to Section 7.3). These contain all of the necessary seals, and other components necessary to complete maintenance successfully.

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Table 6 - Maintenance Plan

Operation	Frequency	Refer to Section
Check the gearbox oil level and fill the gearbox with oil (if necessary)*	Weekly	5.3
Check the high vacuum bearings oil level and fill with oil (if necessary)	Weekly	5.4
Inspect the gas-ballast system	Monthly	5.5
Inspect the pipelines and connections	Quarterly	5.6
Inspect the interstage relief valve and replace the hinge bushes, flap and O-ring (if necessary)***	18 Months	5.7
Change the gearbox oil and clean the oil-level sight-glass #	18 Months	5.8
Change the high vacuum bearings oil and clean the oil-level sight-glass #	18 Months	5.9
Replace high vacuum vent filter #	18 Months	5.10
Clean the cooling-jacket #	18 Months	5.11
Replace the interstage relief valve (GV600 and GV410 only)	When necessary	5.12
Replace the pump-motor **	When necessary	5.13
Replace the coupling insert ##	Yearly	5.14
Overhaul the pump ****	Every 6 years	5.15

You must have a Routine Maintenance Kit to do these maintenance operations. Oil change frequency is recommended based on the pump running at 122°F (50°C) case temperature. If the pump is run at elevated temperatures, it is recommended that SHC630 oil be used and a higher frequency of oil change may be required. Consult Edwards for advice.

* If the gearbox or high vacuum bearing oil is contaminated (indicated by a change in colour of the oil, for example, water contamination will turn the oil a white colour), you must change the oil. You may be able to remove the contaminants from the oil by filtration.

** You must have a new pump-motor and a Motor Fitment Kit to do this maintenance operation.

*** You must have a PRV Overhaul kit to do this operation.

**** You must have an Inlet End (Upper) Bearing Kit, a Gearbox End Bearing Kit, a Swept Volume Kit and a Swing PRV Overhaul Kit to overhaul the pump.

You will need a Motor Fitment Kit to do this maintenance operation.

5.3 Checking and filling the gearbox oil (if necessary)

WARNING

The pressure in the gearbox will be equal to the pressure of the shaft-seals purge gas supply. Always equalise pressure before removing the oil filler-plug or oil drain plug to avoid oil being ejected under pressure from the gearbox.

WARNING

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

In order to check the gearbox oil level, the pump must be switched off and stationary.

If the gearbox requires oil frequently, or if there is a sudden loss of a large amount of oil, the pump may be faulty: shut down the pump and contact your supplier or Edwards.

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Figure 1 shows the locations of the two gearbox oil-level sight-glasses on the pump.

Refer to Figure 10 and check that the pump gearbox oil-level is at the MAX mark on the bezel of the oil-level sight-glass (10): detail A. If the oil-level is below the MAX mark, replenish using following procedure:

1. Refer to Figure 10. Loosen the oil filler-plug (12) and wait for two or three seconds for the pressure in the gearbox to equalise before removing together with the O-ring (13) from the oil filler port. Place a suitable funnel in the oil-filler port, then pour oil through the funnel into the pump gearbox until the oil-level is at the MAX mark on the bezel of the oil-level sight-glass (see detail A).
2. If you overfill the gearbox: place a suitable container under the oil drain-plug (3); unscrew and remove the drain-plug (3) and bonded seal (4) and allow oil to drain from the gearbox; when the oil level reaches the MAX mark on the sight-glass (see detail A), refit and tighten the oil drain-plug (3) and bonded seal (4); continue at Step 1 again, to check that the oil-level is now correct.
3. Refit the oil filler-plug (12) and O-ring (13) to the oil-filler port (1).

5.4 Checking and filling the high vacuum bearing oil (if necessary)

WARNING

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

CAUTION

Purge the pump before shut down. If you do not, process vapours may condense in the pump and corrode or damage it.

In order to check the gearbox oil level, the pump must be switched off and stationary.

If the high vacuum oil box requires oil frequently, or if there is a sudden loss of a large amount of oil, the pump may be faulty: shut down the pump and contact your supplier or Edwards.

Figure 1 shows the location of the high vacuum bearings oil-level sight-glass on the pump. Check that the pump high vacuum bearings oil-level is at the MAX mark on the bezel of the oil-level sight-glass (24): see Figure 11, detail A. If the oil-level is below the MAX mark replenish using the following procedure.

1. Refer to Figure 11. Remove the oil filler-plug (3) and O-ring (2) from the oil-filler port (1), place a suitable funnel in the oil-filler port, then pour oil through the funnel into the pump high vacuum bearing oil box until the oil-level is at the MAX mark on the bezel of the oil-level sight-glass (see Figure 11, detail A).
2. If you overfill the high vacuum bearing oil box: place a suitable container under the oil drain-plug (10); unscrew and remove the drain-plug (10) and O-ring (11) and allow oil to drain from the gearbox; when the oil level reaches the MAX mark on the sight-glass, refit and tighten the oil drain-plug (10) and O-ring (11); continue at Step 1 again, to check that the oil-level is now correct.
3. Refit the oil filler-plug (3) and O-ring (2) to the oil-filler port. As this is a vacuum seal care must be taken to ensure that the seal is clean and fitted correctly.

5.5 Inspect the gas-ballast system

Use the following procedure to inspect the gas-ballast system. If a nitrogen gas-ballast supply is not connected the gas-ballast air filter must be replaced every six years as part of the pump overhaul (see Section 5.15). The air filter will require replacing more frequently if you use the GV pump in an environment where there are excessive air-borne particulates; refer to Section 7.3 for the Item Number for a new air filter.

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1. Refer to Figure 8. If a nitrogen gas-ballast supply is connected, continue at Step 4; otherwise continue at Step 2 to inspect the air filter.
2. To inspect the air filter (11), twist the top half of the housing clockwise to release. If there are excessive deposits lodged in the filter element, replace with a new one.
3. Refit the housing half and twist to the left until it clicks into the sealed position.
4. Inspect all of the clamps (3, 6 and 9) in the gas-ballast system and check that they are secure. Tighten any loose connections.

5.6 Inspect the pipelines and connections

1. Inspect all cooling-water pipelines and connections; check that they are not corroded or damaged. Replace any of the pipelines and connections that are corroded or damaged. Check that all cooling-water connections are secure. Tighten any connections that are loose.
2. Inspect all air or nitrogen supply pipelines and connections; check that they are not corroded or damaged. Replace any pipelines and connections that are corroded or damaged. Check that all air or nitrogen supply connections are secure. Tighten any connections that are loose.
3. Inspect all electrical cables; check that they are not damaged and have not overheated. Replace any cables that are damaged or have overheated. Check that all electrical connections are secure. Tighten any connections that are loose.
4. Inspect all process and exhaust pipelines; check that they are not corroded or damaged. Replace any pipelines that are corroded or damaged. Check that all process and exhaust connections are secure. Tighten any connections that are loose.

5.7 Inspect the interstage relief (GV410 and GV600 pumps only)

If the interstage relief valve does not operate correctly, use the following procedure to inspect it.

1. Refer to Figure 9. Remove the four M8 bolts (11) which secure the retainer (9) to the exhaust manifold (3).
2. Fit two of the bolts (11) into the jacking holes (10) and tighten the bolts to remove the retainer (9) from the exhaust manifold (3).
3. Remove the flap-valve (7) from the exhaust manifold (3).
4. Inspect the valve:
   - If the retainer (9) or valve body (2) are damaged or corroded, you must replace the interstage relief valve: refer to Section 5.12.
   - If the flap-valve (7), hinge bushes (1) or the valve O-ring (6) are damaged, replace the damaged component(s).
5. Clean the inside of the exhaust manifold (3) to remove any deposits; if necessary, use a suitable cleaning solution. If you use a cleaning solution, ensure that all of the solution is removed before you fit the new interstage relief valve components.
6. Inspect the O-rings (4, 5, 8) and, if necessary, fit new O-rings.
7. If necessary, refit the two-hinge bushes (1) to the valve flap (7), then fit the valve flap to the valve body (2).
8. Refit the valve body (2) in the exhaust manifold (3).
9. Fit the retainer (9) to the exhaust manifold (3) and secure with the four bolts (11). Tighten the bolts to a torque of 10 Nm.

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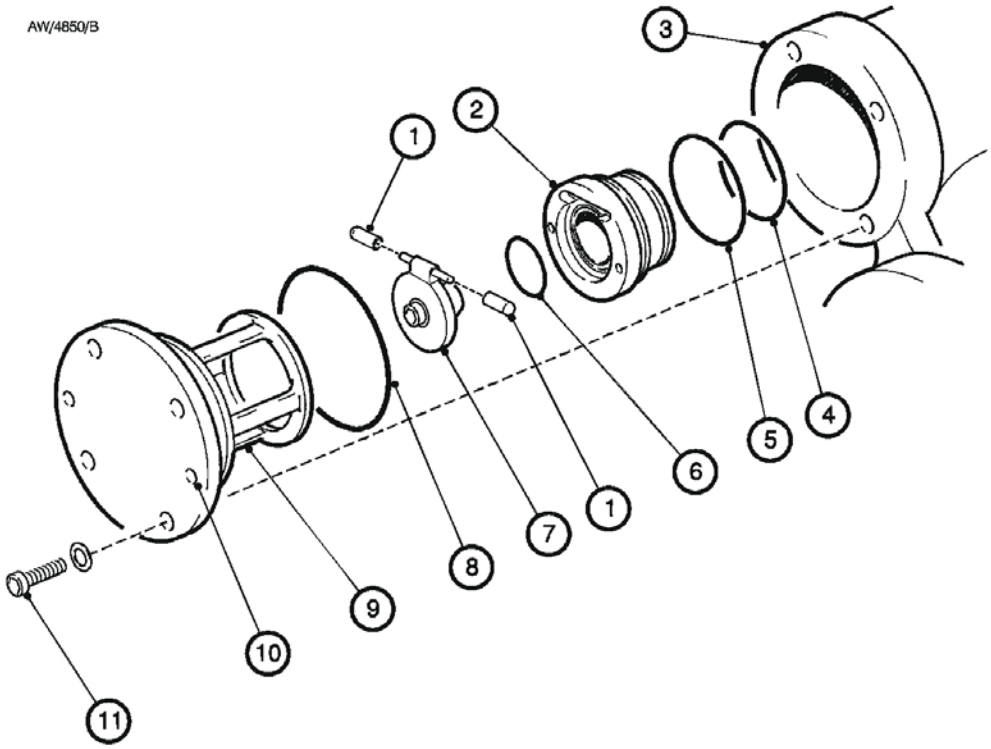
Figure 9 - Exploded View of the Interstage Pressure Relief Valve (GV410 and GV600 Pumps Only)



1. Hinge bush
2. Valve body
3. Exhaust manifold
4. O-ring
5. O-ring
6. Valve O-ring
7. Flap-valve
8. O-ring
9. Retainer
10. Jacking hole
11. Bolt (4 off)

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5.8 Change the gearbox oil and clean the oil-level sight-glasses

WARNING

The pressure in the gearbox will be equal to the pressure of the shaft-seals purge gas supply. Always equalise pressure before removing the oil filler-plug or oil drain plug to avoid oil being ejected under pressure from the gearbox.

WARNING

Changing the oil in a 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 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 an 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

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

WARNING

Ensure that you do not come into contact with the used pump oil. The used oil may be hot and can cause injury.

Refer to Figure 1. You must clean the oil-level sight-glasses (14) when you change the gearbox oil. Use the following procedure to clean each sight-glass.

1. Refer to Figure 10. Loosen the oil filler-plug (12) and wait for two or three seconds for the pressure in the gearbox to equalise before removing together with the O-ring (13) from the oil filler port (1).
2. Place a suitable container under the oil drain-port (5); ensure that the container has sufficient capacity for the oil in the pump (see Section 2).
3. Unscrew and remove the oil drain-plug (3) and the bonded seal (4) and allow the oil to drain from the gearbox. Dispose of the bonded seal.
4. Undo and remove the four M5 screws (11) from the sight-glass bezel (10) on one of the oil-level sight-glasses.
5. Remove the bezel (10), O-ring (9), sight-glass (8), O-ring (7) and compression ring (6). Dispose of the O-rings.
6. Clean all sight-glass components and the sight-glass recess in the gearbox (2) with a soft lint-free cloth. If necessary, use a suitable cleaning solution; if you use a cleaning solution, ensure that all of the solution is removed before you reassemble the sight-glass.
7. Refit the compression ring (6) in the sight-glass recess in the gearbox (2).
8. Fit two new O-rings (7, 9) and the sight-glass (8), then fit the bezel (10) and secure with the four M5 screws (11).
9. Place a suitable funnel in the oil filler-port (1).
10. If the oil drained from the pump is very discoloured, flush the gearbox with new or clean oil two or three times, until the oil which drains from the gearbox is clean.

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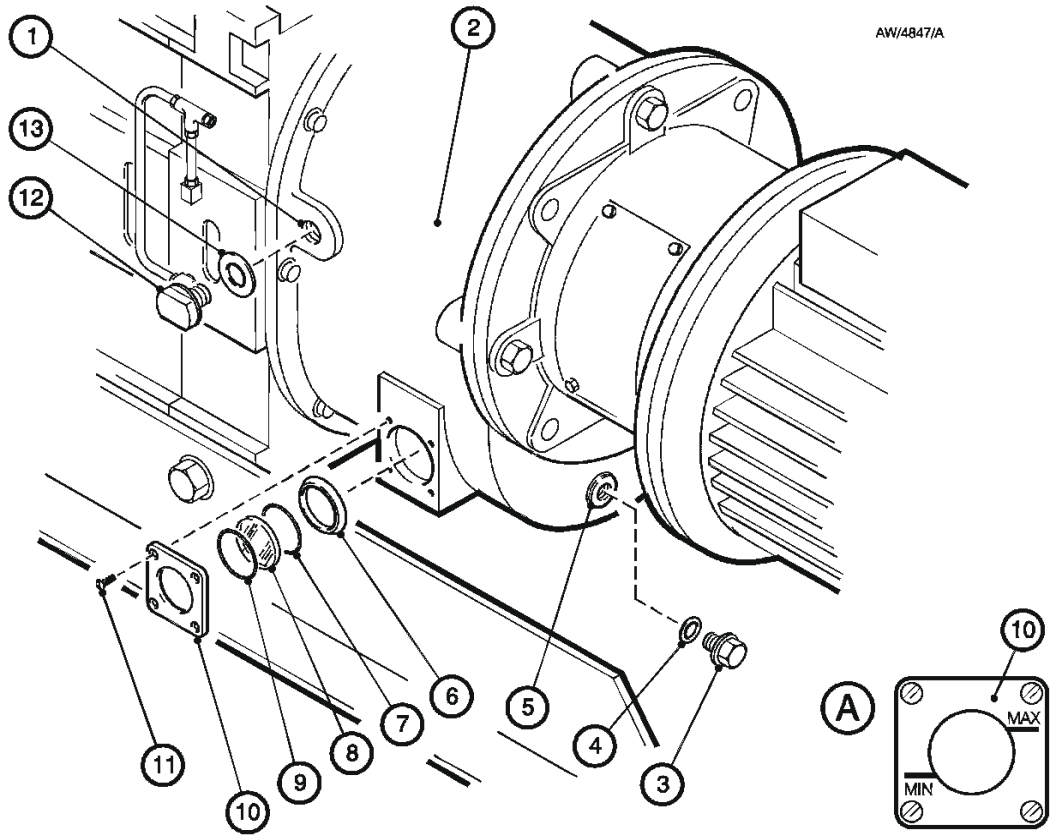
11. Wipe clean the oil drain-plug (3), and then fit a new bonded seal (4) to the drain-plug.

12. Fit the oil drain-plug (3) and bonded seal (4) to the oil drain-port (5).

Figure 10 - Oil-Level Sight-Glass and Oil Filler and Drain Ports



1. Oil filler-port
2. Gearbox
3. Oil drain-plug
4. Bonded seal
5. Oil drain-port
6. Compression ring
7. O-ring
8. Sight glass
9. O-ring
10. Bezel
11. Screws (4 off)
12. Oil filler plug
13. O-ring

13. Fill the gearbox through the funnel, with the correct grade and quantity of oil. Allow the oil to drain into the gearbox and then check the level on the oil sight-glass (refer to Section 5.3).

14. Remove the funnel and refit the oil filler-plug (12) and O-ring (13) to the oil filler-port (1).

15. Dispose of the used oil safely: refer to Section 6.2.

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5.9 High-vacuum bearings oil change

WARNING

Ensure that you do not come into contact with the used pump oil. The used oil may be hot and can cause injury.

WARNING

Particular caution should be exercised when working with Fomblin oil that may have been exposed to temperatures above 260°C. Refer to the Edwards Materials Data Sheets for detailed information.

CAUTION

A vacuum may remain in the high vacuum bearings oil box. Loosen oil filter plug to equalise pressure before undoing drain oil-drain plug.

Use the following procedure to change the high-vacuum bearings oil:

Refer to Figure 11 (the high vacuum bearings sight-glass components are identical to the gearbox sight-glass components).

Clean the oil-level sight-glass (6) when you change the gearbox oil. Use the following procedure to clean the sight-glass.

1. Remove the oil filler-plug (3) and O-ring (2).
2. Place a suitable container under the oil drain-port (12); ensure that the container has sufficient capacity for the oil in the pump (see Section 2).
3. Unscrew and remove the oil drain-plug (10) and the O-ring (11) and allow the oil to drain from the high vacuum bearing oil box. Dispose of the O-ring.
4. Undo and remove the four M5 screws (9) from the sight-glass bezel (8).
5. Remove the bezel (8), O-ring (7), sight-glass (6), O-ring (5) and compression ring (4). Dispose of the O-rings.
6. Clean all of the sight-glass components and the sight-glass recess in the high vacuum bearing oil box (13) with a soft lint-free cloth. If necessary, use a suitable cleaning solution; if you use a cleaning solution, ensure that all of the solution is removed before you reassemble the sight-glass.
7. Refit the compression ring (4) in the sight-glass recess in the high vacuum bearing oil box (13).
8. Fit two new O-rings (5 and 7) and the sight-glass (6), then fit the bezel (8) and secure with the four M5 screws (9).
9. Place a suitable funnel in the oil filler-port (1).
10. If the oil drained from the pump is very discoloured, flush the oil box with new or clean oil two or three times, until the oil which drains from the gearbox is clean.
11. Wipe clean the oil drain-plug (10), then fit a new O-ring (11) to the drain-plug.
12. Fit the oil drain-plug (10) and O-ring (11) to the oil drain-port (12).
13. Fill the oil box through the funnel, with the correct grade and quantity of oil. Allow the oil to drain into the reservoir of the oil box and then check the level on the oil sight-glass (refer to Section 5.4).
14. Remove the funnel and refit the oil filler-plug (3) and O-ring (2) to the oil filler-port (1).
15. Dispose of the used oil safely: refer to Section 6.2.

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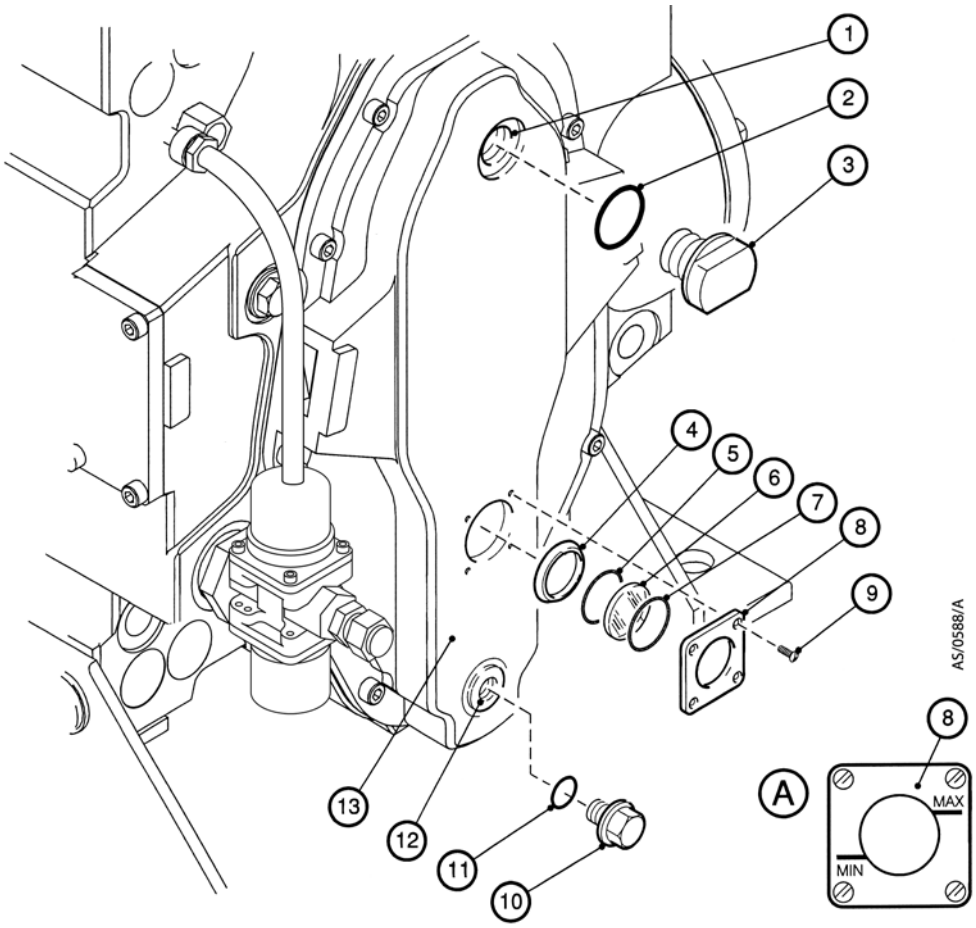
Figure 11 - High Vacuum Bearings Sight-Glass and Oil Filler and Drain Ports



1. Oil filler-port
2. O-ring Gearbox
3. Oil filler-plug
4. Compression ring
5. O-ring
6. Sight-glass
7. O-ring
8. Bezel
9. Screws (4 off)
10. Oil drain-plug
11. O-ring
12. Oil drain-port
13. Vacuum bearing oil box

5.10 Replace the high vacuum vent filter

1. Refer to Figure 1. Undo ½" plug (25) unscrew old filter.
2. Fit new filter from the Routine Maintenance kit (see Section 7.3). Take care not to over tighten the filter.
3. Replace ½" plug.

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5.11 Flush the cooling jacket

WARNING

If the water flow through the cooling jacket is blocked or restricted, the water in the pump may get very hot. Allow the pump to cool down before you remove the cooling-water connections. If you do not, hot water may be ejected from the pump and may cause injury.

The cooling jacket will reqire flushing every 12 months or when the cooling efficiency is reduced because of deposits or other contamination in the cooling jacket. The pressure and flow rate of the water supply that you use to flush the cooling jacket must be equal to or higher than the normal cooling-water supply. Do not exceed the pressure specified in Section 2.2.

1. Switch off your cooling-water supply.
2. Refer to Figure 1. Disconnect the cooling-water supply and return pipelines from the cooling-water inlet (32) and outlet (2) connections.
3. Fit a suitable water supply pipeline to the water outlet connection (2), and fit a suitable water return pipeline to the cooling-water inlet (32).
4. Turn on the water supply to flush the cooling jacket in the reverse direction, and wash out any deposits from the cooling jacket.
5. Allow the water to flow for a few minutes, switch off the water supply, and then disconnect the water return pipeline.
6. Place a suitable splash tray under the cooling-water inlet (32), then unscrew and remove the 1¼"-½" BSPT reducing bush (that is, the large fitting to which the TCV adaptor is fitted) from the port in the end of the pump.
7. Use a suitable tool to remove any sediment from the port.
8. Turn on the water supply for a short time to flush any remaining deposits from the cooling-jacket.
9. Disconnect the water supply pipeline from the cooling-water outlet connection (2), then dispose of the water and deposits in the splash tray.
10. Apply a suitable thread sealant (such as Loctite 577) to the threads of the 1¼"-½" BSPT reducing bush, and then refit the fitting to the port in the end of the pump.
11. Refit your pump cooling-water supply and return pipelines to the water inlet (32) and outlet (2) connections.

5.12 Replace the interstage relief valve

1. You must replace the interstage relief flap-valve if it is damaged. This item is available in the Swing PRV Overhaul Kit: refer to Section 7.3.
2. Refer to Figure 9. Undo and remove the four M8 bolts (11) that secure the valve retainer (9) to the exhaust manifold (3).
3. Place two of the bolts in the jacking holes (10) and tighten the bolts to remove the retainer (9) from the exhaust manifold.
4. Remove the O-ring (8), flap-valve (7), hinge bushes (1), valve body (2) and O-rings (4 and 5) from the exhaust manifold (3).
5. Clean the inside of the exhaust manifold to remove any deposits; if necessary, use a suitable cleaning solution. If you use a cleaning solution, ensure that all of the solution is removed before you fit the new interstage relief valve.
6. Fit the new interstage relief valve to the exhaust manifold and secure with the four M8 bolts (11). Tighten the bolts to a torque of 10 Nm (7.4 lbf.ft).

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5.13 Pump-motor

WARNING

The pump-motor is heavy and can cause injury. Use suitable lifting equipment.

Note: *If you have supplied your own pump - motor you are responsible for its maintenance which must be carried out in accordance with the motor manufacturer's recommendations. If the motor is an Edwards supplied product, please consult the supplied literature or contact Edwards for further information.*

5.13.1 Remove the pump-motor

- Use the following procedure to remove the pump-motor. Ensure that the pump-motor is adequately supported throughout and does not fall: the weight of the pump-motors are as follows:
- GV260: 380 - 415 V, 50 Hz - 104 kg
- GV260: 230 - 460 V, 60 Hz - 130 kg
- GV410: 380 - 415 V, 50 Hz - 111 kg
- GV410: 230 - 460 V, 60 Hz - 142 kg
- GV600: 380 - 415 V, 50 Hz - 172 kg
- GV600: 230 - 460 V, 60 Hz - 165 kg

1. Refer to Figure 1. Remove the cover from the pump-motor terminal-box (17) and disconnect your electrical supply cable from the terminal-box.
2. Refer to Figure 12. Fit slings and suitable lifting equipment to support the pump-motor, then remove the fixing bolts (1) which secure the pump-motor (19) to the coupling housing (7).
3. Use the lifting equipment to move the pump-motor (19) away from the pump, and then carefully lower the pump-motor, so that it rests on the floor in an upright orientation (that is, with the drive hub (16) at the top).
4. Undo and remove the set screw (5) in the coupling hub (14).
5. Use a suitable puller tool to remove the coupling hub (14) from the pump shaft (9), and then remove the key (8) from the pump shaft. Dispose of the key.
6. Dispose of the pump-motor: refer to Section 6.2.
7. Inspect the polyurethane drive insert (18): if necessary, replace it.

5.13.2 Fit the new pump-motor

WARNING

The pump-motor is heavy and can cause injury. Use suitable lifting equipment.

CAUTION

Ensure that the pump-motor flange and the bottom flange of the coupling housing are clean and free of burrs. If not, the pump-motor and coupling housing may be misaligned and damage the pump-motor, the pump or the drive coupling when you operate the pump.

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1. Refer to Figure 12. Dispose of the key supplied with the new pump-motor.

Note: *For motor power and flange compatibility, refer to Table 2.*

2. Inspect the motor shaft (18) of the new pump-motor (19). The motor shaft must be free of burrs and dirt. If necessary, clean or refinish the motor shaft.
3. Inspect the motor shaft bore of the drive hub (16). The bore must be free of burrs and dirt. If necessary, clean or refinish the bore.
4. Fit the new key (2), (supplied in the Motor Fitment Kit) into the motor shaft (18).
5. Ensure that the set screw (4) does not protrude into the bore of the drive hub (16): if necessary, loosen the set screw.
6. Fit the drive hub (16) onto the motor shaft (18). Do not fully tighten the set screw.
7. Ensure that the coupling hub (14) is fully located on the pump shaft (9), against the shaft bearing nut (11). If necessary:
   - Loosen the set screw (5) in the coupling hub (14).
   - Move the coupling hub so that it is fully on the pump shaft (9), against the shaft bearing nut (11).
   - Apply a suitable thread sealant (such as Loctite 242) to the set screw (5), and then fully tighten it.
8. Slide the holding ring (17) over the coupling hub (14).
9. Inspect the bottom flange of the coupling housing (7) and the flange of the pump-motor (19). The flanges must be free of burrs and dirt. If necessary clean or refinish the flanges.
10. Use suitable lifting equipment to lift the pump-motor off the floor and move it close to the pump.
11. If necessary, fit slings around the pump-motor (19) and attach suitable lifting equipment to the slings. Use both sets of lifting equipment to turn the pump-motor so that it is horizontal, with the pump-motor terminal-box at the top, and with the drive hub (16) towards the coupling housing (7).
12. Undo and remove the four bolts (13) that secure one of the coupling covers (12) to the coupling housing (7), then remove the coupling cover.
13. Undo and remove the four bolts (13) that secure the other coupling cover (12) to the coupling housing (7), then remove the coupling cover.
14. Move the pump-motor (19) so that the motor flange locates against the flange of the coupling housing (7), and so that the bolt holes in the two flanges are aligned.
15. Use the bolts (1) to secure the pump-motor (19) to the coupling housing (7).
16. Loosen the set screw (4) on the drive hub (16), then move the drive hub along the shaft until the gear teeth on the drive hub (16) and coupling hub (14) are parallel, and the gap between the teeth on the two hubs is 2.5 ±1mm.
17. Check that the gap (detail A, item 20) is as shown in Table 7 below.
18. If the gap is not correct:
    - Check that the flange of the pump-motor (19) is correctly located against the flange of the coupling housing (7)
    - If the pump-motor is correctly fitted, loosen the set screw (4) on the drive hub (16) and adjust the position of the coupling hub, then tighten the set screw again. Continue at Step 16 to check that the gap is now set correctly.
19. Apply a suitable thread sealant (such as Loctite 242) to the set screw (4) then fully tighten it to secure the drive hub (16) to the motor shaft (18).

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Table 7 - Hub Gap Setting

Pump	Gap Setting
GV260M, 50Hz	-1.5 mm*
GV260M, 60Hz	7 mm
GV410M, 50Hz	-1.5 mm*
GV410M, 60Hz	26 mm
GV600M, 50Hz	-1.5 mm*
GV600M, 60Hz	26 mm

* Motor shaft end protrudes beyond coupling face.

20. Fit the coupling insert (15) to the gaps between the teeth and the drive hub (16) and coupling hub (14).
21. Turn the holding ring (17) so that the reference line on the holding ring is aligned with the split in the coupling insert (15), then slide the holding ring over the element.
22. Tighten the set screws (3) to secure the holding ring (17) in place.
23. Ensure that all of the fixing bolts (1) are tightened to a torque between 128 and 132 Nm (94 and 97 lbf ft).
24. Use the four bolts (13) to secure one of the coupling covers (12) to the coupling housing (7). Tighten the bolts to a torque between 3 and 5 Nm (2.2 and 3.7 lbf ft).
25. Use the four bolts (13) to secure other of the coupling covers (12) to the coupling housing (7). Tighten the bolts to a torque between 3 and 5 Nm (2.2 and 3.7 lbf ft).

5.14 Replace the coupling insert

Use the following procedure to replace the coupling insert(s):

1. Refer to Figure 12. Undo the four bolts (13) that secure one of the coupling covers (12) to the coupling housing (7), then remove the coupling cover.
2. Undo the four bolts (13) that secure the other coupling cover (12) to the coupling housing (7), then remove the coupling cover.
3. Loosen the set screws (3) on the holding ring (17), and then slide the holding ring off the coupling insert (15).
4. Remove the coupling insert and dispose of it: refer to Section 6.2.
5. Fit the new coupling insert (15) to the gaps between the teeth on the drive hub (16) and coupling hub (14).
6. Turn the holding ring (17) so that the reference on the holding ring s aligned with the split in the coupling insert (15), and then slide the holding ring over the element.
7. Tighten the set screws (3) to secure the holding ring (17) in place.
8. Use the four bolts (13) that secure one of the coupling covers (12) to the coupling housing (7). Tighten the bolts to a torque between 3 and 5 Nm (2.2 and 3.7 lbf ft).
9. Use the four bolts (13) that secure the other coupling cover (12) to the coupling housing (7). Tighten the bolts to a torque between 3 and 5 Nm (2.2 and 3.7 lbf ft).

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Figure 12 - Exploded View of Pump Motor, Coupling Drive and Coupling Housing

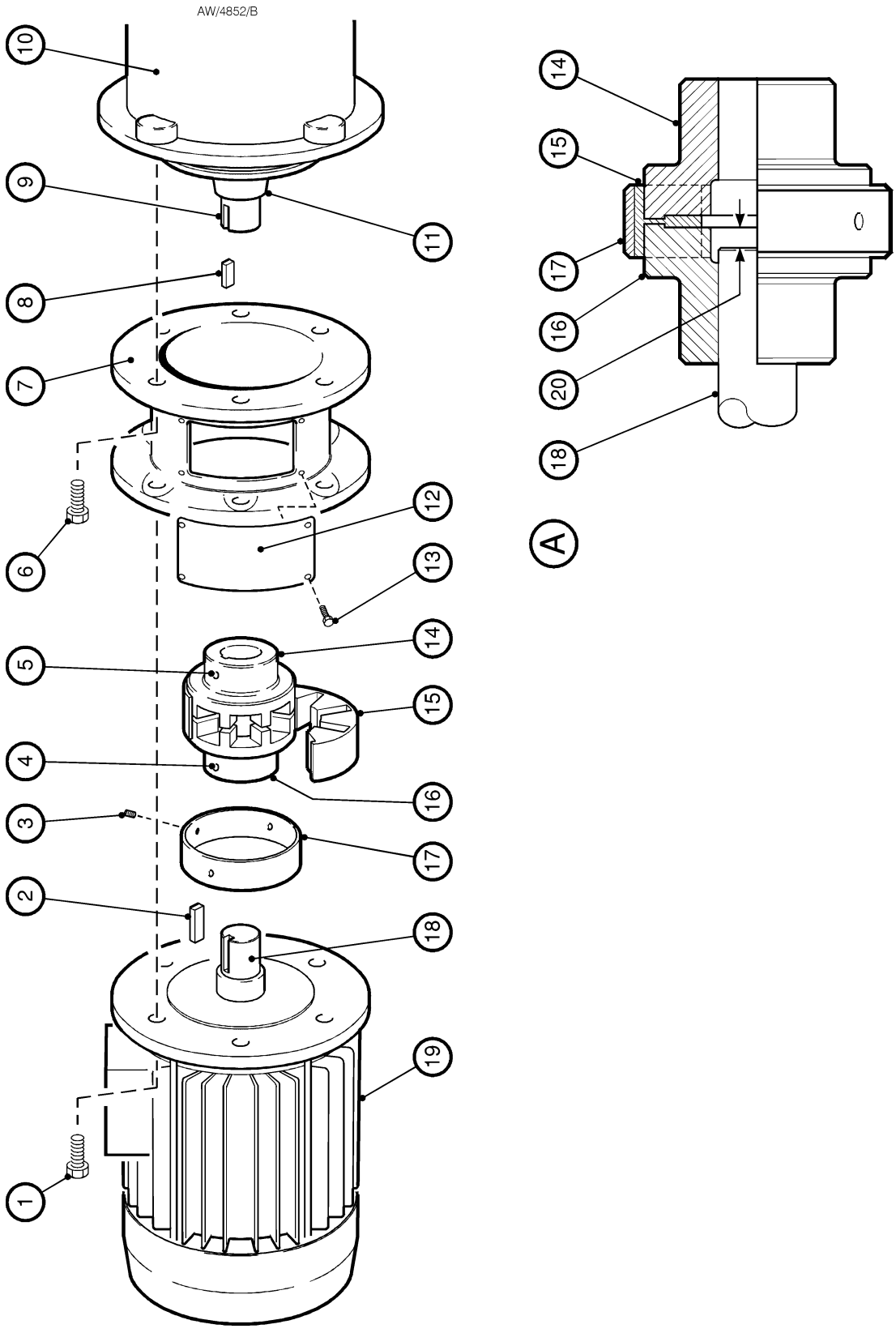

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Figure 12 - Exploded View of Pump Motor, Coupling Drive and Coupling Housing - Key

1. Bolt
2. Key
3. Set screws
4. Set screw
5. Set screw
6. Bolt
7. Coupling housing
8. Key
9. Pump shaft
10. Gearbox
11. Shaft bearing nut
12. Coupling cover
13. Bolt
14. Coupling hub
15. Coupling insert
16. Drive hub
17. Holding ring
18. Motor shaft
19. Pump-motor
20. Gap

5.15 Overhaul the pump

We recommend that the pump be given a major overhaul every six years. Such an overhaul is outside the scope of this manual and should be done by qualified Edwards service personnel: contact your supplier or Edwards.

5.16 Trouble shooting Guide

Table 8 - Troubleshooting guide

Symptom	Check	Action
The pump suddenly stops.	Has the shutdown thermal snap-switch operated to stop the pump because the pump is operating at too high a temperature?	Check that there is a sufficient flow of cooling-water through the pump: check that the cooling-water supply is on and is within pressure and temperature requirements (refer Section 2).
	Has the cooling-water supply been interrupted, or has it failed?	If your cooling-water supply is on and is at the correct pressure and temperature, the cooling jacket may be blocked: clean the cooling jacket (refer to Section 5.11).
	Has the pump seized because the shutdown thermal snap-switch is faulty?	Check the operating temperature of the pump (at the position shown in Figure 1, item 3). If the operating temperature is significantly higher than the normal operating temperature of between 122 to 140°F (50 to 60°C) and the pump does not turn over, the pump may have seized due to coolant water failure and snap-switch failure. Contact your supplier or Edwards for advice.
	Is there a hydraulic lock in the pump? Has the pump seized due to deposits?	Isolate electrical supply. Isolate pump from process. Remove the coupling cover and rotate the pump drive shaft by inserting a bar into the holes in the motor coupling. If the pump can be freed, replace cover and revert to normal pump start up procedure. If not, contact your supplier or Edwards.

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Table 8 - Troubleshooting guide

Symptom	Check	Action
The pump operates at too high a temperature or the pump temperature is unstable.	Is the cooling-water flow inadequate or is the flow being interrupted?	Before you restart the pump, check for correct cooling-water flow (see above).
The pump operates with poor performance in pumping speed and/or ultimate vacuum.	Is the interstage relief valve stuck in the open position?	Inspect the interstage relief valve and overhaul it or replace it if necessary (refer to Section 5.12).
The pump-motor trips out due to excessive electrical current consumption when the pump is operating with inlet pressure in the range 300 to 1000 mbar	Is the interstage relief valve stuck in the closed position? (GV410 and GV600 only)	Inspect the valve and if necessary replace it (refer to Section 5.12).
The gearbox and oil are contaminated with the process substances pumped.	Has the shaft-seal purge failed?	Check the pressure of the air or nitrogen purge flow to the shaft-seals; if necessary adjust the air or nitrogen pressure. Change the gearbox oil before you restart the pump (refer to Section 5.8).
	Have the seals in the pump failed?	The seals must be replaced. Contact your supplier or Edwards for advice.
The gearbox is noisy.	Is the oil level low?	Check the oil level and fill as necessary (refer to Section 5.3).
The pump does not operate.	Is the pump-motor faulty?	Make all the other appropriate checks in this table. If there is no other apparent cause for failure of the pump to operate, check the pump-motor and if necessary replace it (refer to Section 5.13).

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6 STORAGE AND DISPOSAL

6.1 Storage

If the pump is stored in an environment with an ambient temperature below -6°F (14°C), drain the oil from the pump: use the procedures in Section 5.7 and 5.8, then refit the oil drain-plug to the pump before you store it.

Use the following procedure to store the pump:

1. Ensure that the pump has been purged and shut down as described in Section 4.4. Disconnect the pump from the electrical supply.
2. Refer to Figure 1. Place a suitable container under the cooling-water connections (2 and 32), then remove your cooling-water supply and return pipelines from the connections and allow the cooling-water to drain from the pump.
3. Disconnect the shaft-seals purge air or nitrogen supply from the shaft-seals purge inlet (31). If fitted, disconnect the gas-ballast nitrogen supply from the gas-ballast system.
4. Disconnect the pump inlet (6) and outlet (13) from your process and exhaust pipelines.
5. Fit blanking-plates to the pump-inlet (6) and pump-outlet (13). Place protective covers over the pump services connection points.
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 "Installation". If the pump will be subjected to temperatures below freezing then the water jacket must either be drained or have anti-freeze added to it.

6.2 Disposal

WARNING

Care must be taken to disassemble a pump or to dispose of used components. In particular, care should be taken with fluoro-elastomer products (e.g. seals) which may have decomposed as the result of being subjected to high temperatures and components and oil which have been contaminated with dangerous process substances.

Dispose of the pump, cleaning solution, deposits removed from the pump, used pump oil, grease and any components safely in accordance with all local and national safety and environmental requirements.

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7 SERVICE, SPARES AND ACCESSORIES

7.1 Introduction

Edwards products, spares and accessories are available from Edwards companies listed on the final page of this document. 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, please state for each part required:

- Model and Item Number of your equipment
- Serial number (if any)
- Item Number and description of the part.

7.2 Service

Edwards products are supported by a worldwide 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 that 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 and maintenance kits

Spare	Item Number
Mobil SHC 929 oil (1 litre, 0.25 US gallon)	H110-23-010
Mobil SHC 629 oil (4 litres, 1 US gallon)	H110-23-011
Routine Maintenance Kit	A705-73-825
Motor Fitment Kit	A705-11-805
Inlet End (Upper) Bearing Kit	A705-73-826
Gearbox End Bearing Kit	A705-11-828
Swept Volume Kit (GV260M)	A705-71-827
Swept Volume Kit	A705-73-827
O-ring Kit	A705-73-821
Air filter	A223-05-076
Swing PRV Overhaul Kit (GV410 and GV600 only)	A705-11-833
Oil Dialysis Kit	A705-73-823
Oil Filter Kit	A705-73-824
Gas Ballast Maintenance Kit	A705-11-830
Motor coupling insert spare	A705-73-758

7.4 Accessories

A number of accessories are available for the GV600 pump; these are described in the following sections.

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7.4.1 Exhaust Silencers

Fit an exhaust silencer to attenuate the pulses in the exhaust pressure, and to reduce pump-induced resonance in your exhaust-extraction system.

Accessory	Item Number
Exhaust Silencer	A505-71-000

7.4.2 Exhaust-Purge Kit

Fit an Exhaust-Purge Kit to allow you to connect an air or nitrogen exhaust-purge to the GV pump.

Accessory	Item Number
Exhaust-Purge Kit	A505-68-000

7.4.3 Booster Connection Kits

Use a Booster Connection Kit to allow you to fit an EH mechanical booster pump to the inlet of the GV pump.

Accessory	Item Number
EH250 Booster Connection Kit	A505-70-000
EH500 Booster Connection Kit	A505-73-000
EH1200/2600/4200 Booster Connection Kit	A505-99-000

7.4.4 Indirect Cooling Kits

If the pump is to be used within an operating temperature in the range of 122 to 194°F (50 to 90°C) then an indirect cooling kit will be required.

Fit an Indirect Cooling Kit to allow you to use indirect cooling on the GV600 pump. Two types of kit are available: fit a Kit with TCV (Thermostatic Control Valve) when you want to control the operating temperature of the GV pump. With either kit, it is recommended that the pump oil be changed from SHC629 to SHC630.

Accessory	Item Number
Indirect Cooling Kit with TCV	A505-66-000
Indirect Cooling Kit	A505-67-000

7.4.5 Other accessories

A number of other accessories are available for the GV pumps, as listed below; contact your supplier or Edwards for details of these accessories:

- Acoustic enclosure for the GV pump
- Acoustic enclosure for the GV pump with mechanical booster pump
- Pump motor acoustic jacket
- Gas control system
- Motor control module
- Cooling-water control panel
- Atmospheric shaft seal purge kit

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- Air blast cooler
- Atmospheric shaft seal purge kit

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