Instruction Manual

GV160 Dry Vacuum Pumps

Description		Item Number
GV160 pump, 220-240/380-415 V, 3-phase, 50 Hz	(Europe)	A704-11-916
GV160 pump, 208-230/460 V, 3-phase, 60 Hz	(USA)	A704-11-995
GV160 pump, 200 V, 3-phase, 50 Hz	(Japan)	A704-11-917
GV160 pump, 200-208/380 V, 3-phase, 60 Hz	(Japan)	A704-11-934

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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 GV160 Dry Vacuum Pumps (abbreviated to GV160 in the remainder of this manual). You must use the GV160 as specified in this manual.

Read this manual before you install and operate your GV160. 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.

1.2 The GV160 pump

The GV160 dry pump operates at pressures between atmospheric and ultimate vacuum without any lubricating or sealing fluid in the pumping chamber. This ensures a clean pumping system without back-migration of oil into the system being evacuated.

The GV160 is a three-stage, positive-displacement rotary pump in which pairs of intermeshing rotors (of different profiles mounted on common shafts) are held in correct phase relation by a pair of timing-gears. The timing-gears and the adjacent double-row angular contact ball-bearings are oil lubricated.

The pump casing material is cast-iron, the shafts and rotors are made from SG iron. The internal and external shaft-seals on the pump shafts and the motor drive-shaft are made from polytetrafluoroethylene (PTFE).

Bearings are located on the high vacuum end of the shaft, near to the pump-inlet. These bearings are packed with perfluoropolyether (PFPE) grease. As supplied, the bearing end-cover is connected internally to the pump-inlet and is evacuated when the GV160 pump is operating. If required, you can use your own external evacuation pump to evacuate the bearing end-cover.

1.3 Cooling system

The pump is cooled by water which flows through an integral cooling-jacket. The pump-motor is air-cooled by a cooling-fan which is integral to the motor.

The thermal snap-switch box (Figure 1, item 4) on the pump-body has two thermal snap- switches:

- The output of the warning thermal snap-switch will go open circuit when the temperature of the pump-body is higher than normal. Use this output to provide a warning of high pump temperature.
- The output of the shut-down thermal snap-switch will go open circuit when the temperature of the pump-body is too high. Use this output to shut-down the pump when it is too hot.

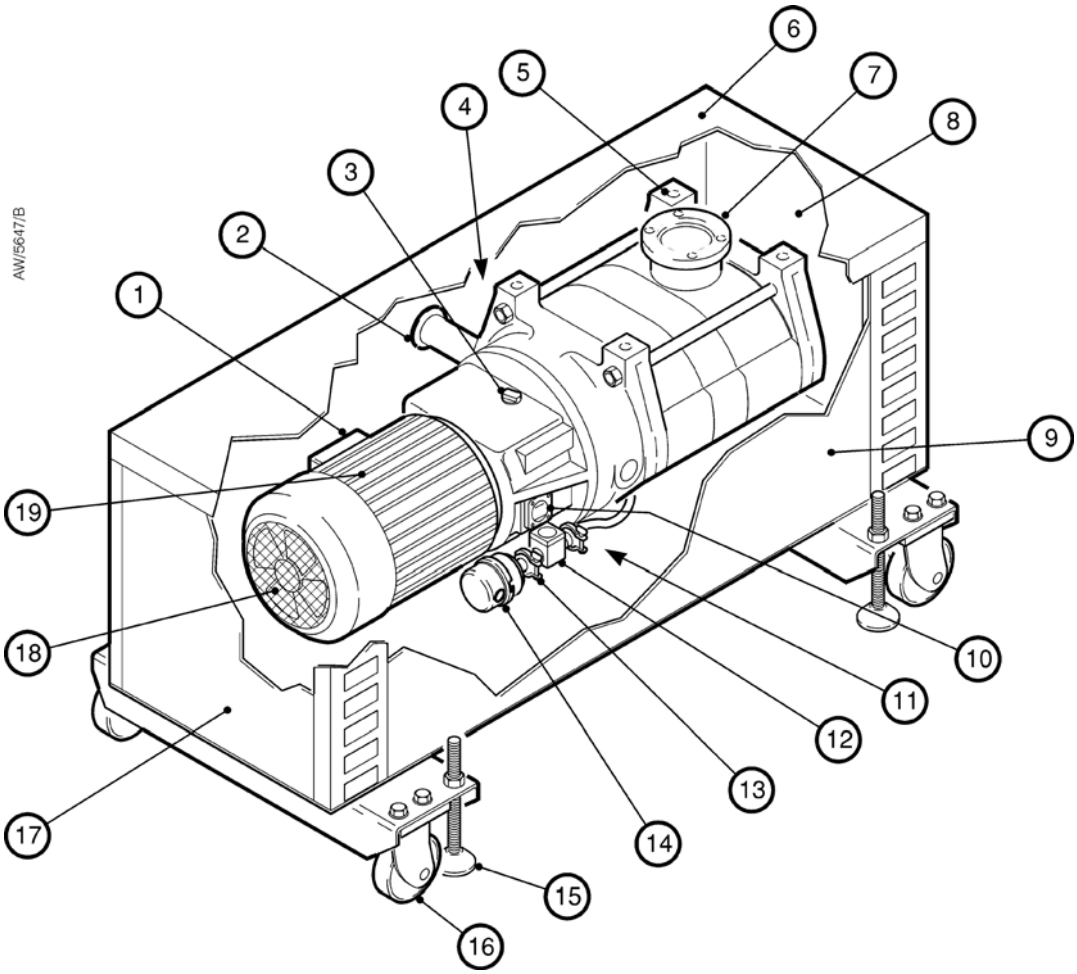
1.4 Gas system

The GV160 has a shaft-seals purge system and a gas-ballast system.

You must connect a dry compressed air or nitrogen supply to the shaft-seals purge inlet (Figure 10, item 5): refer to Section 3.9. The shaft-seals purge pipeline then delivers the dry air or nitrogen purge to the shaft-seals. This purge: ensures that the shaft-seals are maintained at a positive pressure during pump operation; prevents the entry of corrosive or toxic process vapours into the pump gearbox; prevents contamination of the process gases by pump oil; prevents damage to the shaft-seals by debris.

Refer to Figure 1. As supplied, the gas-ballast system can deliver ambient air to the pump gas-ballast inlet. The air-flow is filtered by the air-filter (14) and is controlled by a manually operated gas-ballast flow valve (12). If required for your application, you can connect a dry nitrogen supply to the gas-ballast system, to deliver nitrogen gas-ballast: refer to Section 3.9.

Figure 1 - The GV160 pump



1. Pump-motor terminal-box
2. Pump-outlet
3. Oil filler-plug
4. Thermal snap-switch box
5. Lifting-bolt hole
6. Top acoustic panel
7. Pump-inlet
8. Bearing-end acoustic panel
9. Side acoustic panel
10. Oil-level sight-glass
11. Oil drain-plug (under the pump)
12. Gas-ballast flow valve
13. Clamp
14. Gas-ballast air-filter
15. Levelling foot
16. Castor
17. Motor-end acoustic panel
18. Motor cooling-fan
19. Pump-motor

1.5 Safe area operation

You must **not** use the GV160 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 European authorities.
- Division 1 or Division 2 (gases and dusts), as classified by North American authorities.

1.6 Accessories

A list of the accessories available for the GV160 pump is given in Section 7.

2 Technical data

2.1 General

Overall dimensions	See Figure 2
Mass	360 kg, 794 lb
Motor rating	See Section 2.4
Rotational speed	2000 r min^{-1}
Warm-up time	15 min
Vacuum connections	
Inlet	ISO63
Outlet	NW40
Vacuum system maximum leak-rate	1 x 10^{-3} mbar l s^{-1}, 1 x 10^{-1} Pa l s^{-1}, 0.75 x 10^{-3} torr l s^{-1}
Ambient operating temperature range	5 to 40 °C, 41 to 104 °F
Maximum ambient operating humidity	90% RH
Maximum exhaust pressure	2 psig (1150 mbar absolute), 1.15 x 10^5 Pa, 8.62 x 10^2 torr

2.2 Performance data

Pumping speed range	See Figure 3 and 5
Power curve	See Figure 4 and 6
Peak pumping speed	150 m^3 h^{-1}, 5.3 x 10^3 ft^3 h^{-1}
Displacement (swept volume)	200 m^3 h^{-1}, 7.06 x 10^3 ft^3 h^{-1}
Ultimate vacuum	
without gas-ballast	2 x 10^{-1} mbar, 20 Pa, 1.5 x 10^{-2} torr
with full gas-ballast	2.5 x 10^{-1} mbar, 25 Pa, 1.9 x 10^{-2} torr
Water vapour pumping speed at 80 mbar (8 x 10^3 Pa, 60 torr)	5 kg h^{-1}, 11 lb h^{-1}

2.3 Services

Electrical supply	
Number of phases	3
Supply voltage	
Europe	220-240/380-415 V ± 6% at 50 Hz
USA	208-230/460 V ± 6% at 60 Hz
Japan	200 V ± 6% at 50 Hz, or 208-208/380 V ± 6% at 60 Hz
Cooling-water	
Ryznar Stability Index (RSI)	6.5 to 7.0
Water consumption	600 l h^{-1}, 158.5 US gallons h^{-1*}
Maximum supply pressure	100 psi, 6.89 x 10^5 Pa
Minimum required pressure differential across supply and return	30 psi, 2.06 x 10^5 Pa

Shaft-seal purge	
Supply pressure	6 to 8 psig, 1.4 x 10^5 to 1.5 x 10^5 Pa
Maximum supply pressure	8 psig, 1.5 x 10^5 Pa
Maximum flow rate	25 l min^{-1}, 0.88 ft^3 min^{-1}
Gas ballast nitrogen supply (if fitted)	
Supply pressure	6 to 8 psig, 1.4 x 10^5 to 1.5 x 10^5 Pa
Maximum supply pressure	8 psig, 1.5 x 10^5 Pa
Maximum flow rate	100 l min^{-1}, 3.52 ft^3 min^{-1}

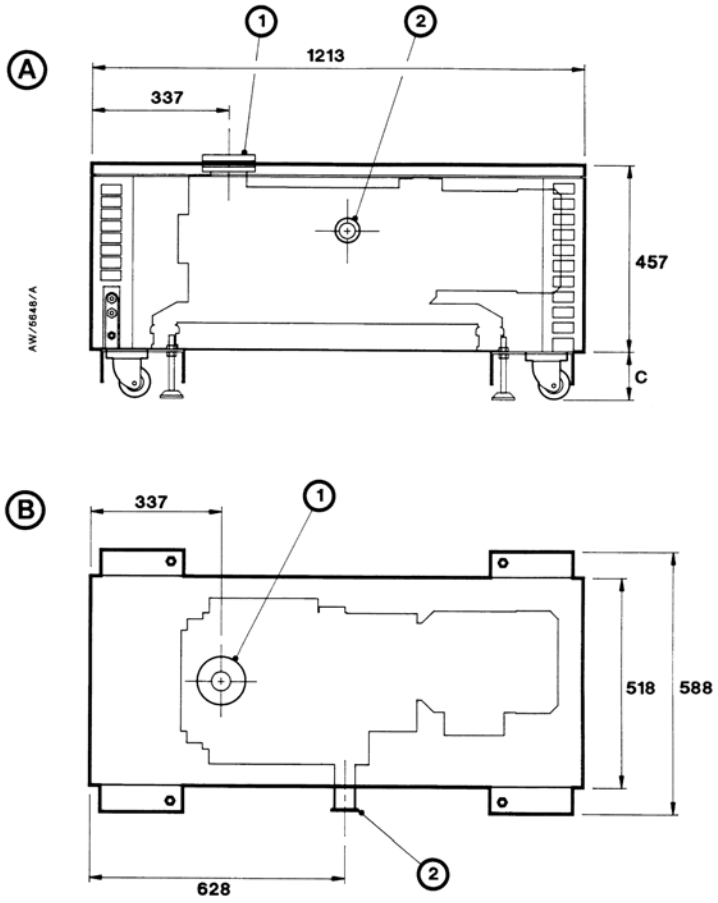
* *Cooling-water flow rates as low as 102 l h^{-1} (1.7 l min^{-1}), 26.95 US gallons h^{-1} are acceptable under some conditions. Note that the pump case temperature will increase with decreased cooling-water flow rates.*

2.4 Full load current ratings and starting currents

Table 1 - Full load current ratings and starting currents

Country	Supply voltage	Supply frequency	Rating (kW)	Full load (A)	Starting current (A)
Europe	220-240 V	50 Hz	7.5	25.5	160
Europe	380-415 V	50 Hz	7.5	14.5	93
USA	208 V	60 Hz	7.0	25.2	185
USA	230 V	60 Hz	8.5	28.4	205
USA	460 V	60 Hz	8.5	14.2	102
Japan	200 V	50 Hz	7.5	31.0	220
Japan	200-208 V	60 Hz	7.5	31.0	220
Japan	380 V	60 Hz	7.5	19.5	129

Figure 2 - Dimensions (mm)



A. Elevation view
B. Plan view
C. Minimum 119 (with levelling feet fully up)

1. Pump-inlet
2. Pump-outlet

Figure 3 - Pumping speed curve: pumping speed (m3 h^{-1}) against inlet pressure (mbar/Pa)

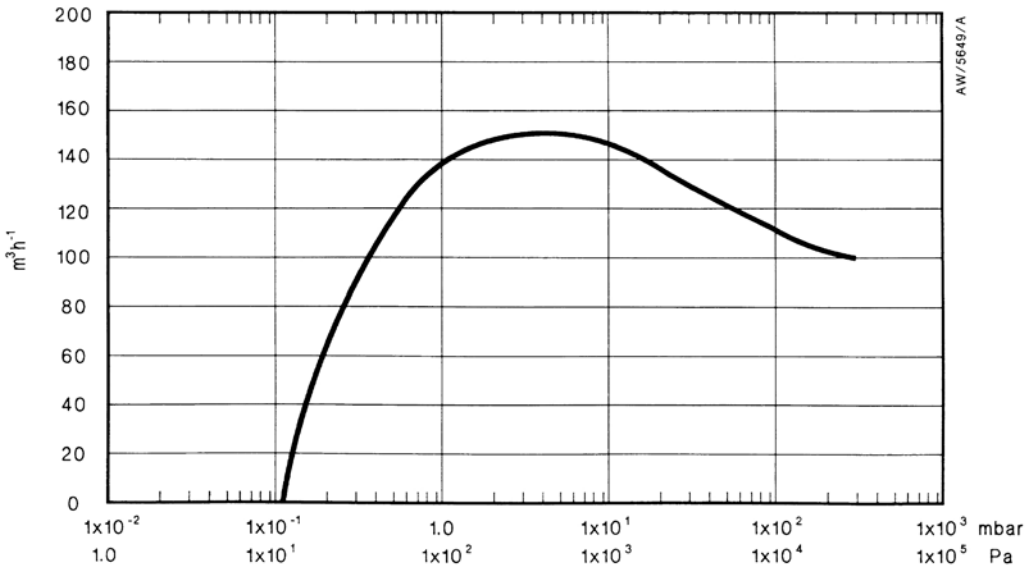


Figure 4 - Power curve: input power (kW) against inlet pressure (mbar/Pa)

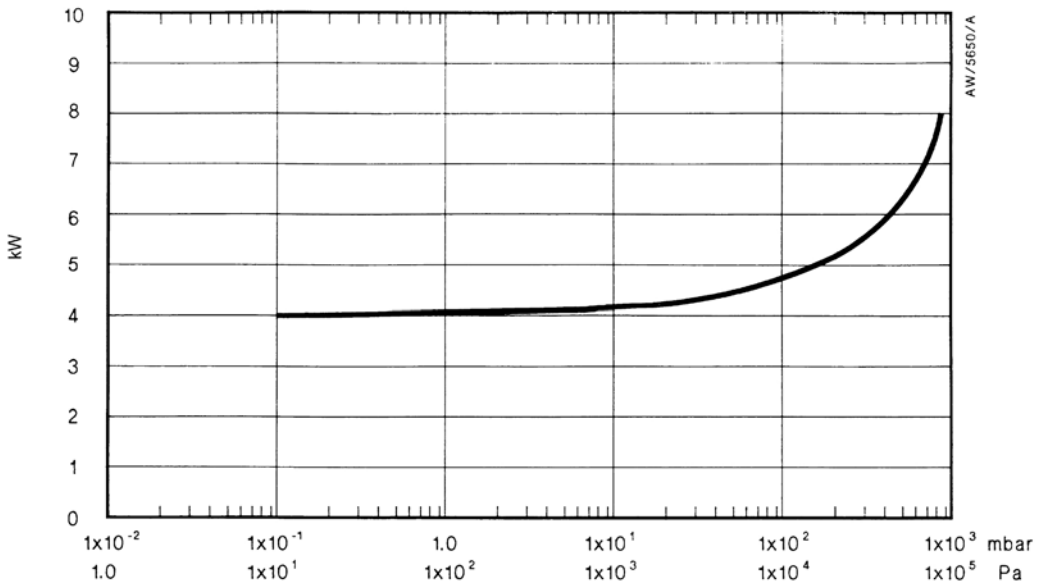


Figure 5 - Pumping speed curve: pumping speed (cfm) against inlet pressure (torr)

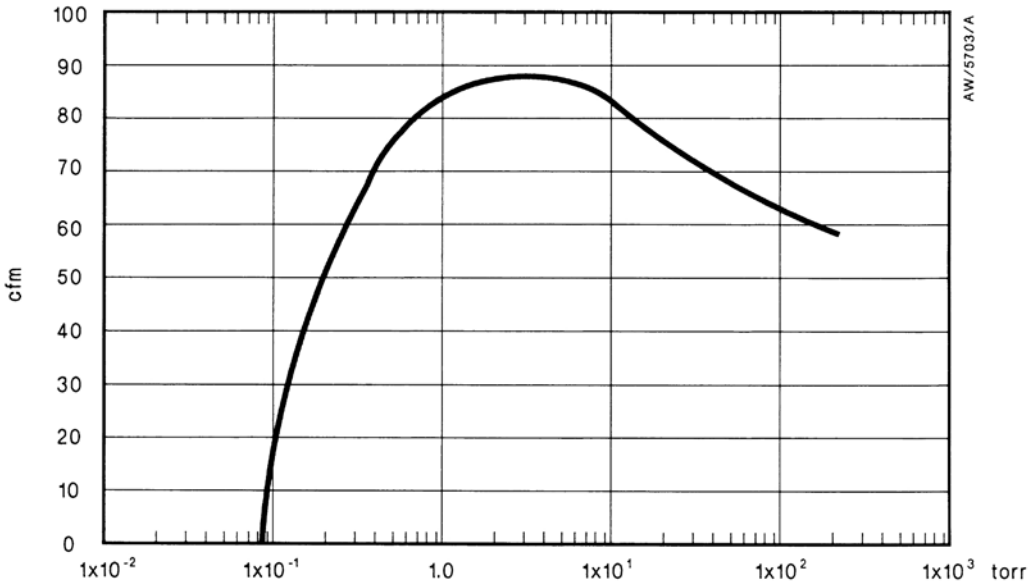
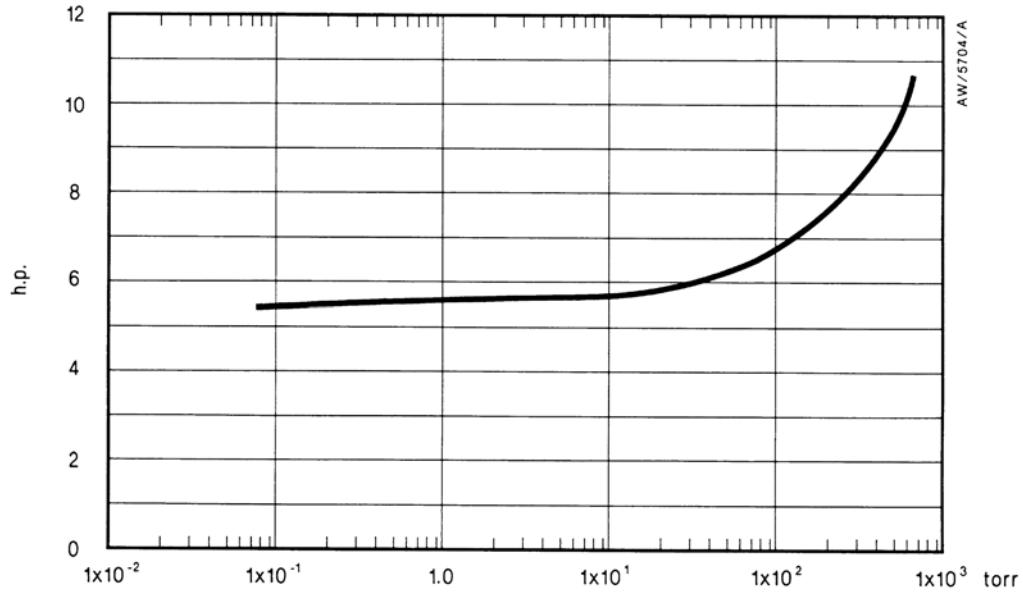


Figure 6 - Power curve: input power (h.p.) against inlet pressure (torr)



2.5 Temperature control system

Warning thermal snap-switch	
Opening temperature	88°C, 190°F
Closing temperature	78°C, 172°F
Shut-down thermal snap-switch	
Opening temperature	95°C, 203°F
Closing temperature	85°C, 185°F
Contact ratings	
Maximum voltage	240 V
Maximum load (inductive)	120 VA
Maximum current (resistive load)	12 A

2.6 Lubrication system

Note: *Edwards Material Safety Data Sheets for the oils and greases referenced below are available on request.*

2.6.1 Gearbox

Fluid capacity (timing gearbox)	1.2 litres, 2.1 pints
Recommended oil	Mobil SHC 629
ISO viscosity grade	150

2.6.2 High vacuum bearings

Grease type	Perfluoropolyether
Recommended grease	Fomblin RT15, Krytox 240AD

2.7 Noise data

With all acoustic panels fitted	< 85 dB (A)

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 GV160 pump.
- Ensure that the installation technician is familiar with the safety precautions which relate to the products pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components. Dismantle and clean contaminated components inside a fume-cupboard.
- Vent and purge the process system before you start any 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.
- Do not work unsupervised.
- Do not reuse O-rings and Co-Seals.
- Ensure that you connect, disconnect and tighten Swagelok connectors correctly: refer to Appendix A1.

3.2 Unpack and inspect

WARNING

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

1. Use a fork-lift truck or a pallet truck to position the pallet in a convenient position.
2. Open the cardboard box and remove the packing material from around the pump.
3. Refer to Figure 1. Undo the catches and take off the top acoustic panel (6) from the pump enclosure.
4. Fit the four lifting-bolts supplied in the fitting kit to the lifting-bolt holes (5); ensure that the lifting-bolts are tight. Use suitable lifting-gear attached to the lifting-bolts to remove the pump from its pallet. Do not try to lift the pump by hand (see Section 2 for the mass of the pump).
5. Inspect the pump. 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 pump together with your order number and your suppliers invoice number. Retain all packing materials for inspection. Do not use the pump if it is damaged.
6. Check that the pallet contains the items listed in Table 2. If any of these items is missing, notify your supplier in writing within three days.
7. Check the information shown on the pump-motor data plate to make sure that the pump is suitable for use with your electrical supply voltage and frequency. Do not continue to install and use the pump if it is not suitable for use with your electrical supply.
8. If the pump is not to be used immediately, replace the packing materials. Store the pump in suitable conditions as described in Section 6.

Table 2 - Checklist of components

Qty	Description	Check (✓)
1	GV160 Pump fitted with enclosure panels	❑
	Fitting-kit, which contains:	
4	Lifting-bolts	❑
2	Swagelok nuts, front and rear ferrules: 1/2 inch	❑
1	Swagelok nut, front and rear ferrules: 1/4 inch	❑
1	Inlet Co-Seal	❑
1	NW40 clamping ring	❑
1	NW40 trapped O-ring	❑
4	Nuts, bolts and washers (to secure the inlet)	❑

3.3 Locate the pump

WARNING

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

Note: *Ensure that the cooling-air flow around the pump-motor is not restricted. Ensure that there is sufficient room to allow you to remove the end and side acoustic panels and to access the pump.*

1. Use suitable lifting-equipment attached to the lifting bolts (fitted in Section 3.2) and move the pump close to its final operating position.
2. Refer to Figure 1. Push the pump on its castors (16) into its final operating position. The pump must be located on a firm, level surface. Ensure that the surface is clean and free from debris and contamination (such as oil).
3. Adjust the levelling feet (15) to raise the pump off the castors (16). Continue to adjust the levelling feet until the pump is level.
4. Remove the two side acoustic panels (9) and the motor-end acoustic panel (17).

3.4 Fill the pump gearbox with oil

Check that the pump is filled with oil to the MAX mark on the oil-level sight-glass (Figure 1, item 10). If necessary, fill the pump gearbox with oil: refer to Section 5.3.

3.5 Electrical installation

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.

3.5.1 Introduction

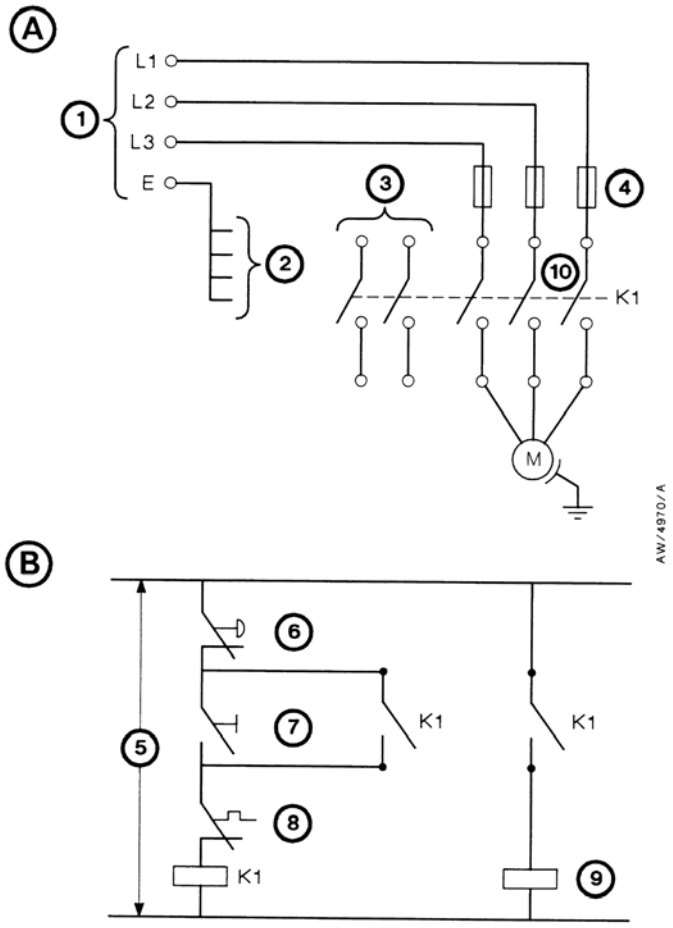
Make the electrical connections to the pump as described in the following sections. Figure 7 shows a schematic diagram of the recommended electrical circuit for correct operation and shut-down of the pump (and closure of an optional pump-inlet isolation-valve) when the shut-down thermal snap-switch opens, or when the output of the motor-protection thermistor indicates that the pump-motor is too hot.

We recommend that you connect the electrical supply to the pump through a suitable starter or circuit breaker which has thermal over-current protection which complies with IEC34-11 or BS4999 Part III. You must adjust the over-current protection to suit your installation. Ensure that the fuse you use is suitable for the starting currents given in Table 1.

Note that the pump will restart automatically when the electrical supply is restored after it has been interrupted. If you do not want the pump to automatically restart, connect the electrical supply to the pump-motor through control equipment which must be manually reset after an electrical supply interruption.

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

Figure 7 - Schematic diagram of the recommended electrical connections



1. To your 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 control
8. Shut-down thermal snap-switch
9. Inlet-valve control solenoid (optional)
10. Contactor

A. Pump-motor connections
B. Control circuit

Earth (ground) points	
Location	**Size**
Thermal snap-switch box	M4 tapped hole
Pump-motor	-

3.5.2 Connect the electrical supply to the pump-motor

CAUTION

Ensure that the pump-motor terminal-box is correctly configured for your electrical supply. If it is not correctly configured, you can damage the pump-motor when you operate it.

Note: *Wiring instructions for the pump-motor are also shown on a label inside the terminal-box cover.*

The universal voltage and frequency motors can be configured for low voltage operation (220-240 V at 50 Hz, or 200-208 V or 208-230 V at 60 Hz) or for high voltage operation (380-415 V at 50 Hz, or 380 V or 460 V at 60 Hz).

Figure 8 and 9 show the required wiring configurations for the electrical supply voltages and frequencies as defined in Table 3.

Table 3 - Pump-motor terminal-box wiring configurations

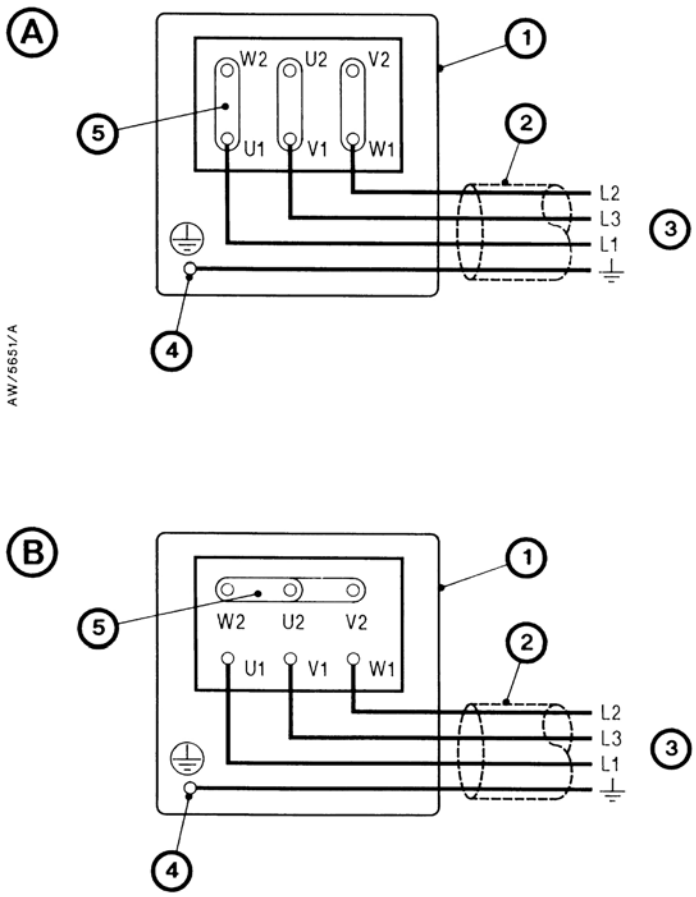
Country	Electrical supply		Refer to
	Voltage	Frequency	
Europe	220-240 V	50 Hz	Figure 8, detail A
Europe	380-415 V	50 Hz	Figure 8, detail B
Japan	200 V	50 Hz	Figure 8, detail A
Japan	200-208 V	60 Hz	Figure 8, detail A
Japan	380 V	60 Hz	Figure 8, detail B
USA	208-230 V	60 Hz	Figure 9, detail A
USA	460 V	60 Hz	Figure 9, detail B

Use the following procedure to connect the electrical supply to the pump-motor, through a suitable contactor which has an overload protection facility. Use appropriately rated 4-core cable and a suitable cable-gland.

1. Refer to Figure 1. Remove the cover from the pump-motor terminal-box (1), then pass your electrical supply cable into the pump-motor terminal-box.
2. Refer to Figure 8 or Figure 9 as appropriate:
   - If the required electrical supply connections are as shown in Figure 8, ensure that the links (5) are correctly configured for your electrical supply: refer to Table 3.
   - If the required electrical supply connections are as shown in Figure 9, ensure that the motor wires (U1, U2, U5, V1, V2, V5, W1, W2 and W5) are correctly configured for your electrical supply: refer to Table 3.
3. Refer to Figure 8 or 9, detail A or B as appropriate (see Table 3). Connect the phase wires in your electrical supply cable (2) to the correct terminals in the pump-motor terminal-box, then connect the earth (ground) wire to the earth (ground) terminal (4).
4. Connect the other ends of the wires in your electrical supply cable (2) to your electrical supply (3); do not switch on the electrical supply yet.

The above procedure will ensure that the pump will rotate in the correct direction if phase 1 of your electrical supply corresponds to line L1 in Figure 8 and 9, phase 2 corresponds to line L2 and phase 3 corresponds to line L3. However, we recommend that you check the direction of rotation of the pump as described in Section 3.6. You must use the procedure in Section 3.6 to check the direction of rotation if you do not know the phase order of your electrical supply.

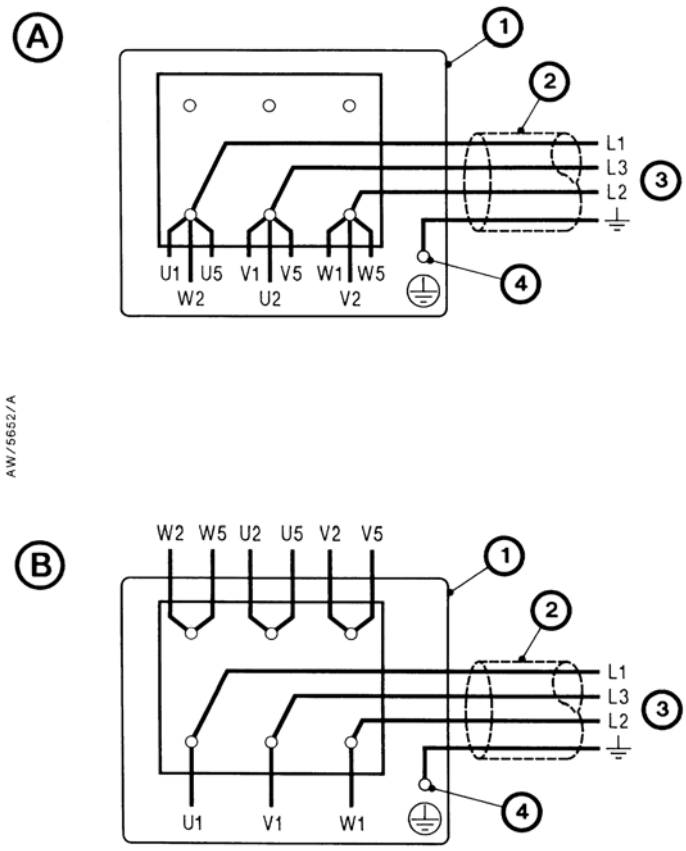
Figure 8 - Electrical supply connections: terminal-box with links



A. 200 V, 50 Hz/200-208 V, 60 Hz/220-240 V, 50 Hz
B. 380-415 V, 50 Hz/380 V, 60 Hz

1. Pump-motor terminal-box
2. Electrical supply cable
3. Electrical supply
4. Earth (ground) terminal
5. Links

Figure 9 - Electrical supply connections: terminal-box without links



A. 208-230 V, 60 Hz
B. 460 V, 60 Hz

1. Pump-motor terminal-box
2. Electrical supply cable
3. Electrical supply
4. Earth (ground) terminal

3.5.3 Connect the thermal snap-switch

WARNING

You must connect the shut-down thermal snap-switch so that the pump stops when the thermal snap-switch opens. If you do not, there may be a risk of fire or explosion.

WARNING

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

CAUTION

Ensure that you route the thermal snap-switch cable away from hot surfaces of the pump or other equipment. If you do 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.

You **must** connect the output of the shut-down 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 7.

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 to the thermal snap-switches. If you connect to the thermal snap-switches as described below, the output from the thermal snap-switches will be normally closed and will open when the pump is too hot.

1. Refer to Figure 10. Undo and remove the four screws (3) which secure the cover (2) to the thermal snap-switch box (1), then remove the cover.
2. Remove the plastic bag from inside the box, then open the bag; this bag contains the crimp connectors and insulators you will use to connect to the snap-switches.
3. Pass a suitably rated four-core cable through the cable-gland (5).
4. Fit the crimp connectors to the ends of the four wires in the cable (4), 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 shut-down 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 ends 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 (3)

3.6 Check the direction of pump rotation

WARNING

You must ensure that the direction of rotation of the pump is correct before you operate the pump. If you do not, and the pump direction of rotation is incorrect, the inlet pipeline will be pressurised and may be damaged and there will be a risk of injury to people or explosion or fire.

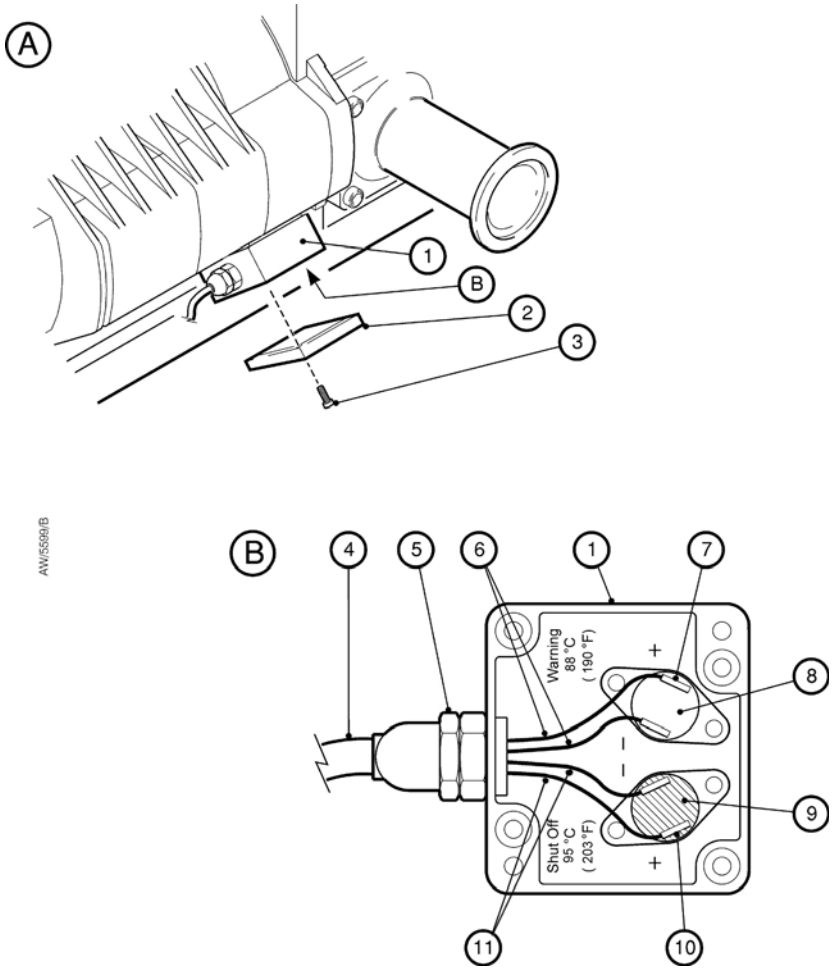
1. Refer to Figure 1. Loosen the blanking plates on the pump-inlet (7) and pump-outlet (2), so that the blanking-plates are free to move, but so that they cannot come off the inlet and outlet.
2. Look at the pump-motor cooling-fan (18), switch on the pump for one or two seconds, then switch the pump off again.

3. If the cooling-fan (18) rotated anticlockwise when viewed from the pump-motor end of the pump, 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.
   - Repeat Step 2 and 3 to ensure that the direction of rotation is now correct.
4. When the direction of rotation is correct, refit the cover to the pump-motor terminal-box (1).

3.7 Fit a mechanical booster pump (optional)

If you want to use a mechanical booster pump with the GV160 pump, fit it now. Details of the 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.

Figure 10 - Connect to the thermal snap-switches



1. Thermal snap-switch box
2. Cover
3. Screws (4 off)
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

3.8 Connect the cooling-water supply

CAUTION

If your pump is to be installed in an area where the ambient temperature falls close to or below freezing point, take all appropriate precautions to prevent the cooling-water freezing inside the pump cooling-jacket.

CAUTION

Make sure you connect the cooling-water supply and return pipelines to the correct connectors on the pump. If the cooling-water pipelines are incorrectly fitted, the pump may overheat and may be damaged.

Your cooling-water must meet the requirements of Section 2.3. If it does not, you may get a build-up of deposits inside the pump cooling-jacket. If you have any doubt about the quality of your supply, contact your local water authority who can tell you its RSI and advise on treatments which you can carry out to make your supply suitable for use with the GV160 pump.

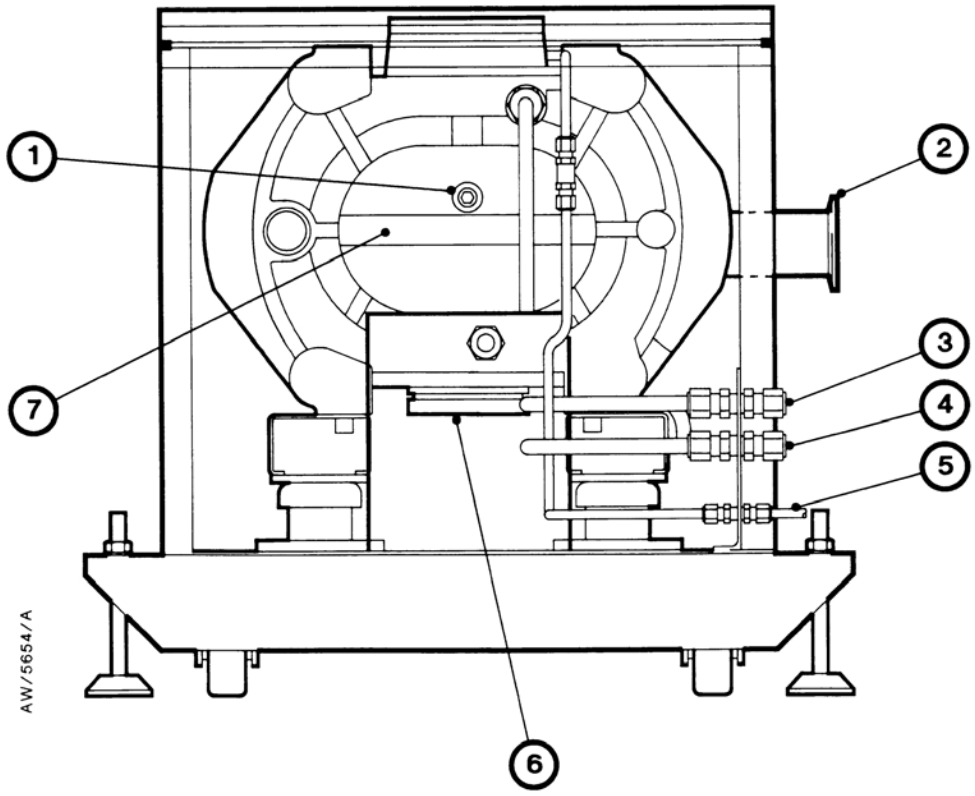
If you use a treated closed-circuit cooling system, we recommend that you fill it (and refill it) with de-ionised or reverse-osmosis treated water.

The cooling-water connections on the pump are suitable for use with pipelines with an outside diameter of 1/2 inch. If you connect more than one pump to the cooling-water supply, you must connect them in parallel and not in series.

Use the following procedure to connect your cooling-water hoses to the GV160 pump:

1. Refer to Figure 11. Take one of the 1/2 inch Swagelok compression nuts, a front ferrule and a rear ferrule from the fitting-kit and fit them finger-tight onto the cooling-water inlet (4).
2. Fit the end of your cooling-water supply pipeline to the Swagelok compression fitting on the cooling-water inlet (4), then tighten the Swagelok compression nut to secure the pipeline in place.
3. Take the other 1/2 inch Swagelok compression nut, front ferrule and rear ferrule from the fitting-kit and fit them finger-tight onto the cooling-water outlet (3).
4. Fit the end of your cooling-water return pipeline to the Swagelok compression fitting on the cooling-water outlet (3), then tighten the Swagelok compression nut to secure the pipeline in place.

Figure 11 - Services connections and inlet-stage sump blanking-plate



1. Bearing end-cover evacuation plug
2. Pump-outlet
3. Cooling-water outlet
4. Cooling-water inlet
5. Shaft-seals purge inlet
6. Inlet-stage sump blanking-plate
7. Bearing end-cover

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

3.9.1 Introduction

You must determine the correct shaft-seals purge and gas-ballast requirements for your application. You **must** connect nitrogen supplies to the gas systems if you want to pump dangerous substances.

- If nitrogen shaft-seals purge and gas-ballast are not required for your application, use the procedure in Section 3.9.2 to connect a compressed air supply to the shaft-seals purge inlet. As supplied, the gas-ballast system can deliver filtered atmospheric air to the pump gas-ballast inlet, so you do not need to connect an air supply to the gas-ballast system.
- If required for your application, connect nitrogen supplies to the shaft-seals inlet and to the gas-ballast system. Use the procedures in Section 3.9.2 and 3.9.3 to connect nitrogen supplies to the shaft-seals purge inlet and to the gas-ballast system.

3.9.2 Connect the shaft-seals purge air or nitrogen supply

WARNING

If you want to pump dangerous gases, 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 2.3. If it does not, the shaft-seals purge pipeline may become over-pressurised and the shaft-seals may fail.

Note: *Your compressed air or nitrogen gas supply must be clean and dry.*

We recommend that you install suitable pressure control devices, a pressure gauge, and an automatically operated isolation-valve in your compressed air or nitrogen supply configured 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 2.3.

Use the following procedure to connect your shaft-seals purge air or nitrogen supply; you must use a rigid metal (such as stainless steel) pipeline with a diameter of 1/4 inch for your air or nitrogen supply pipeline.

1. Refer to Figure 11. Remove the red blanking cap from the shaft-seals purge inlet (5).
2. Remove the 1/4 inch Swagelok compression nut and ferrules from the fittings-kit and fit them finger-tight onto the shaft-seals purge inlet (5).
3. Fit the end of your air or nitrogen supply pipeline to the shaft-seals purge inlet (5), then tighten the Swagelok compression nut to secure the pipeline in place.

3.9.3 Connect a nitrogen gas-ballast supply (optional)

WARNING

If you want to pump dangerous gases, 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.

Note: *Ensure that the gas-ballast nitrogen supply is clean and dry.*

If required for your application, you can connect a non-venting (to atmosphere) nitrogen gas-ballast supply to the pump. The gas-ballast system has a check-valve, however some of the process gas pumped can leak through the check-valve when you rough pump at pressures above 650 mbar (6.5×10^4 Pa, 4.87×10^2 torr). Therefore, you must connect a non-venting (to atmosphere) nitrogen gas-ballast supply to the pump if you want to pump dangerous gases.

When you connect a nitrogen supply to the gas-ballast system, we recommend that you incorporate a suitable pressure gauge in the nitrogen supply pipeline.

Use the following procedure to connect a nitrogen supply to the gas-ballast system:

1. Refer to Figure 1. Undo and remove the NW10 clamp (13) which secures the air-filter (14) to the gas-ballast pipe. Remove the air-filter (14).
2. Connect your nitrogen supply to the gas-ballast pipe through an NW10 adaptor. Your nitrogen supply must meet the specification given in Section 2.
3. Refit the NW10 clamp (13) to secure the adaptor.

3.10 Connect the pump-inlet and pump-outlet

WARNING

Take all necessary precautions when you pump toxic, flammable or explosive gases. If you do not, there will be a danger of injury or death to people.

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 if it will 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.

3.10.1 Connect the pump to your process system

When you connect the pump to the process system:

- Support process pipelines to stop the transmission of stress to pipeline joints.
- Use a flexible connection in the pipeline from the process system to the pump to reduce vibration and stress in the system pipelines.
- You must be able to isolate the pump from the atmosphere and from your process system if you have pumped or produced dangerous chemicals.
- On very dusty applications, incorporate an inlet filter in the inlet pipeline, to minimise the ingress of dust into the pump.
- To get 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.
- 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.

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 four cap-head bolts, nuts and washers which secure the blanking-plate to the pump-inlet (7) and remove the blanking-plate. Retain the bolts, nuts and washers for future use.
2. Use the Co-Seal supplied in the fitting-kit to connect the pump-inlet to your vacuum system; secure with the bolts supplied in the fitting-kit, or the bolts retained in Step 1.

3.10.2 Connect the pump-outlet

WARNING

If you fit a valve to the exhaust pipeline, the valve must be interlocked to turn off the gas supply to the shaft-seals purge and the gas ballast if used.

WARNING

The exhaust pipeline will be hot and must be suitably protected to prevent contact by people.

WARNING

Pipe the exhaust to a suitable treatment plant to prevent the discharge of vapours to the surrounding atmosphere.

WARNING

Incorporate safety devices to prevent operation of the pump when the exhaust pipeline is restricted or blocked. If you do 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 you do not, condensate which drains back into the pump may damage it or cause it to seize.

Incorporate flexible bellows in the exhaust pipeline to reduce the transmission of vibration and to prevent loading of coupling-joints. If you use flexible bellows, you must ensure that you use bellows which 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 NW40 fittings supplied in the fitting-kit to connect the pump-outlet to your exhaust- extraction system.

3.11 Evacuation of the bearing end-cover

If required, use the following procedure to connect an external evacuation pump to evacuate the bearing end-cover:

1. Refer to Figure 13. Remove the six screws (7) which secure the bearing end-cover (6) to the high vacuum head-plate (4).
2. Lift away the end-cover and carefully remove the sealing O-ring (2).
3. Use a suitable tool to prise the felt filter (1) out from the head-plate (4).
4. Apply a light wipe of sealing compound to a 1/4-inch BSP tapered plug and fit the plug to the head-plate (4).
5. Inspect the O-ring (2) removed in Step 2. If the O-ring is damaged, replace it with a new O-ring.
6. Apply a light wipe of PFPE grease to the O-ring (2) and place it in its groove on the head-plate (4). Refit the bearing end-cover (6) to the head-plate (4) and secure with the six screws (7).
7. Remove the 3/8-inch BSP bearing end-cover evacuation-plug (1) from the bearing end-cover (7).
8. Use suitable 3/8-inch BSP fittings to fit a suitable pipeline to the end-cover. Connect the other end of the pipeline to your evacuation pump.

3.12 Leak-test the installation

WARNING

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

Leak-test the system after installation and seal any leaks found. Substances which leak from the system may be dangerous to people and there may be a danger of explosion if air leaks into the system.

As supplied, the leak rate of the pump is tested to be less than 1 x 10^{-3} mbar l s^{-1} (1 x 10^{-1} Pa l s^{-1}, 7.5 x 10^{-4} torr ls^{-1}, 9.87 x 10^{-4} atm ft^3 min^{-1}). The required leak rate for your system will depend on your safety and process requirements.

3.13 Commission the installation

1. Isolate the pump from your process system.
2. Ensure that the gas-ballast flow valve (Figure 1, item 12) 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.
4. Check that there are no leaks in the water, air, nitrogen (if fitted) and exhaust-extraction system connections. Seal any leaks found.
5. Allow the cooling-water to flow for five to six minutes, to ensure that the cooling-jacket is full of water.
6. Turn on the electrical supply to switch on the pump.
7. Check that the pressure shown on your shaft-seals purge air or nitrogen pressure gauge is as specified in Section 2. If necessary, adjust the pressure.
8. Leave the pump to operate for approximately 15 minutes to allow the pump temperature to stabilise, then check that the pump operates normally and that there are no leaks in the water connections and pipelines.
9. Turn off the pump, the shaft-seals purge air or nitrogen supply and the gas-ballast nitrogen supply (if fitted).
10. When the pump has cooled down, switch off the cooling-water supply.

3.14 Refit the acoustic panels

Refer to Figure 1. Refit the motor-end acoustic panel (16) and the two side acoustic panels (8), then refit the top acoustic panel (6) and secure with the catches.

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4 Operation

WARNING

During operation, some parts of the pump become hot. Do not touch these areas of the pump and avoid accidental contact between these areas of the pump and electrical cables and wires, and so forth.

WARNING

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

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

4.1 Start the pump

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.

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 5.3.
2. 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).
3. Switch on the pump.
4. Continue at Section 4.2 to check the purge pressures and flows

4.2 Check the purge pressures and flows

WARNING

Ensure that you do not touch the pump-body when you adjust the gas-ballast valve. During operation, parts of the pump can become hot.

Do 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 nitrogen supply is correct and adjust if necessary.
- If necessary, adjust the gas-ballast flow valve (Figure 1, item 12) to achieve the required gas-ballast flow into the pump:
  - Turn the adjuster knob clockwise to reduce the gas-ballast flow; turn the knob fully clockwise to switch off gas-ballast flow.
  - Turn the adjuster knob anticlockwise to increase the gas-ballast flow.

4.3 Shut down the pump

CAUTION

Purge the pump before you shut it 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.*

1. Isolate the pump-inlet from the process gases.
2. Purge the pump of contaminants: operate the pump with full gas-ballast (that is, with the gas-ballast flow valve (Figure 1, item 12) open for at least 15 minutes. Alternatively, use one of the following methods:
   - Operate the pump at or close to atmospheric pressure 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, or switch off inlet purge (if fitted).
4. Switch off the pump and turn off the shaft-seals purge air or nitrogen supply (if fitted).
5. When the pump has cooled down, turn off the cooling-water supply.

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.

- A suitably trained and supervised technician must maintain the pump.
- Ensure that the maintenance technician is familiar with the safety procedures which relate to the synthetic oils and greases used and the products pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components, grease and pump oil. Dismantle and clean contaminated components inside a fume-cupboard.
- Allow the pump to cool to a safe temperature before you start maintenance work.
- Isolate the pump and other components in the process system from the electrical supply so that they can not 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 which may be present if the pump has overheated to 260 °C (500 °F) 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 maintenance 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.
- Ensure that you connect, disconnect and tighten Swagelok connectors correctly: refer to Appendix A1.

5.2 Maintenance plan

The plan shown in Table 4 details the maintenance operations necessary to maintain the GV160 pump in normal operation. Instructions for each operation are given in the section shown. In practice, the frequency of maintenance depends 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 maintenance and service kits (refer to Section 7.3). These contain all of the necessary seals, grease and other components necessary to complete maintenance successfully.

Table 4 - Maintenance plan

Operation	Frequency	Refer to Section
Check the gearbox oil-level	Weekly	5.3
Inspect the pipelines and connections	6 to 12 Monthly	5.4
Change the gearbox oil and clean the oil-level sight-glasses	6 to 12 Monthly	5.5
Relubricate the rotor bearings	Yearly	5.6
Change the head-plate felt-filter	Yearly	5.7
Change the gas-ballast air filter element	Yearly	5.8
Clean the inlet-stage sump	As required	5.9
Flush the cooling-jacket	As required	5.10
Replace the pump-motor bearings	Every 35000 hours of operation	5.11

5.3 Check the gearbox oil-level

WARNING

The pressure in the gearbox will be equal to the pressure of your shaft-seals purge gas supply. Loosen the oil filler-plug and wait for two or three seconds for the pressure in the gearbox to equalise before you remove the oil filler-plug or oil drain plug. If you do not, oil may be ejected under pressure from the gearbox.

Note: *If you need to pour oil into the gearbox 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.*

Refer to Figure 1 and check that the pump gearbox oil-level is at the MAX mark on the bezel of the oil-level sight-glass (10) If the oil-level is below the MAX mark, add the correct grade of oil (refer to Section 2 for the recommended oil) as follows:

1. Undo the catches and remove the top acoustic cover (6) and the side acoustic cover (9, on the sight-glass side) from the pump.
2. Remove the oil filler-plug (3) and the rubber bonded seal from the oil-filler port, fit a suitable funnel to 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 (4).
3. If you overfill the gearbox: place a suitable container under the oil drain-plug (11); unscrew and remove the drain-plug (11) and bonded seal 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 (11) and bonded seal; continue at Step 2 again, to check that the oil-level is now correct.
4. Ensure that the rubber bonded seal is correctly in place on the oil filler-plug (3), then refit the filler-plug to the oil-filler port.
5. Refit the side acoustic cover (9), then refit the top acoustic cover (6) and secure with the catches.

5.4 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.

5.5 Change the gearbox oil and clean the oil-level sight-glass

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 a Edwards Service Centre for overhaul and cleaning by qualified service engineers. The change in oil type requires a complete strip down of the pump, and thorough cleaning of all parts, so that all traces of hydrocarbon oil are removed.

WARNING

The pressure in the gearbox will be equal to the pressure of your shaft-seals purge gas supply. Loosen the oil filler-plug and wait for two or three seconds for the pressure in the gearbox to equalise before you remove the oil filler-plug or oil drain plug. If you do not, oil may be ejected under pressure from the gearbox.

WARNING

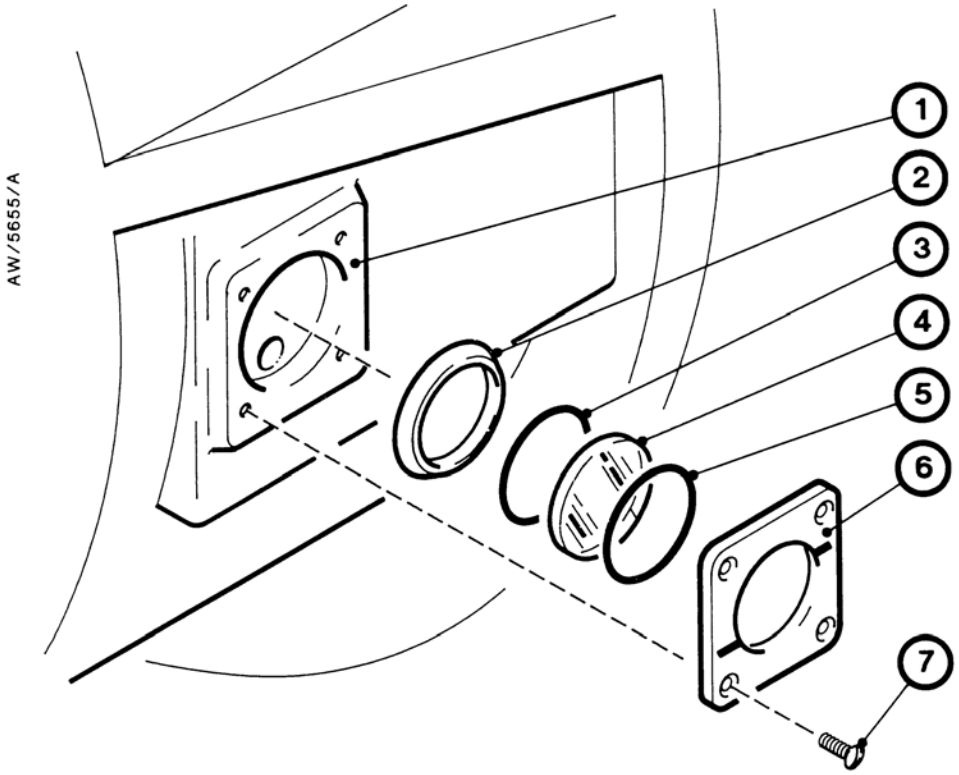
Ensure that you do not come into contact with the used pump oil. The used oil may be hot and can cause injury.

Refer to Figure 1. You must clean the oil-level sight-glass (10) when you change the gearbox oil. Use the following procedure to change the oil and to clean the sight-glass.

1. Refer to Figure 1. Undo the catches and remove the top acoustic cover (6) and the side acoustic cover (9, on the sight-glass side) from the pump.
2. Remove the oil filler-plug (3) and bonded seal.
3. Place a suitable container under the oil drain-plug (11); ensure that the container has sufficient capacity for the oil in the pump (see Section 2).
4. Unscrew and remove the oil drain-plug (11) and the bonded seal and allow the oil to drain from the gearbox.
5. Refer to Figure 12. Undo and remove the four M5 screws (7) from the sight-glass bezel (6) on the sight-glass.
6. Remove the bezel (6), O-ring (5), sight-glass (4), O-ring (3) and compression ring (2). Dispose of the O-rings.
7. Clean all of the sight-glass components and the sight-glass recess in the gearbox (1) 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.
8. Refit the compression ring (2) in the sight-glass recess in the gearbox (1).
9. Fit two new O-rings (3, 5) and the sight-glass (4), then fit the bezel (6) and secure with the four M5 screws (7).
10. Place a suitable funnel in the oil filler-port.

11. 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.
12. Refer to Figure 1. Wipe clean the oil drain-plug (11), then fit a new bonded seal to the drain-plug.
13. Fit the oil drain-plug (11) and bonded seal to the oil drain-port.
14. Fill the gearbox through the funnel, with the correct grade and quantity of oil (refer to Section 2 for the recommended oil). Allow the oil to drain into the gearbox and then check the level on the oil sight-glass (refer to Section 5.3).
15. Remove the funnel. Ensure that the rubber bonded seal is correctly fitted to the oil filler-plug (3), then refit the oil filler-plug (3) and bonded seal to the oil filler-port.
16. Dispose of the used oil safely: refer to Section 6.2.
17. Continue at Section 5.6 to relubricate the rotor bearings

Figure 12 - Clean the oil-level sight-glass



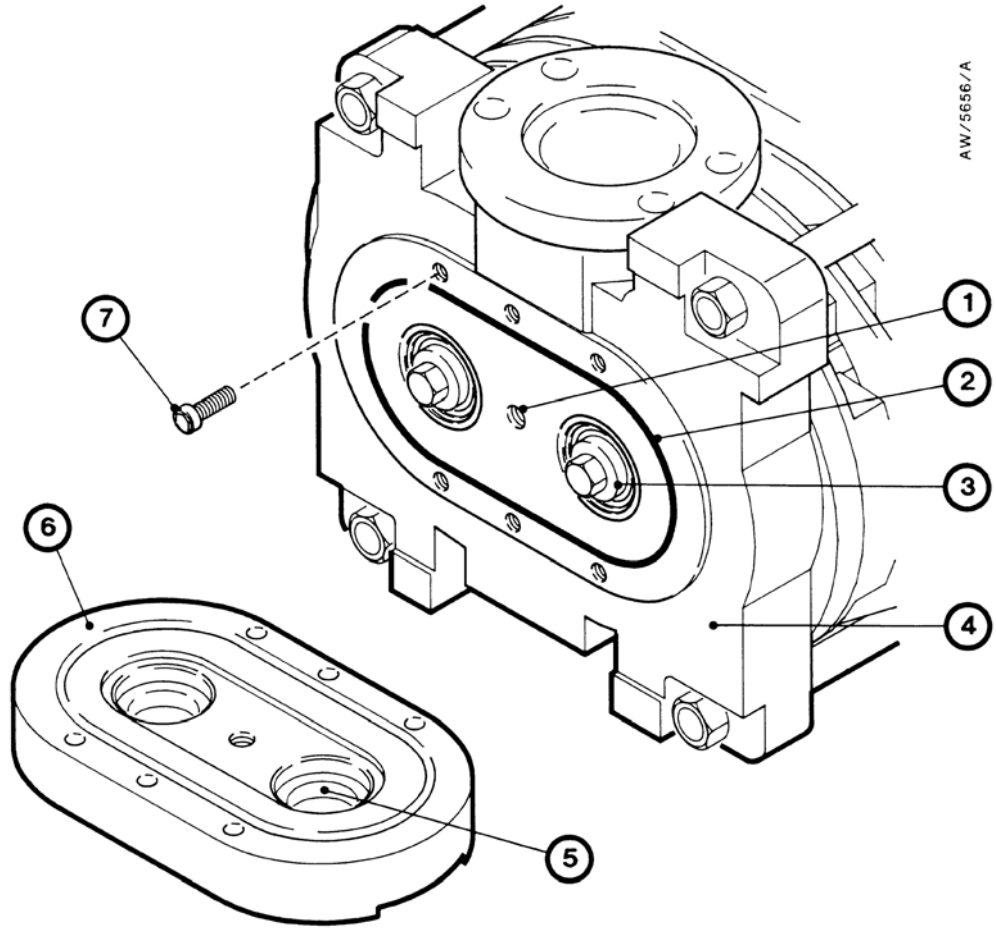
1. Gearbox
2. Compression ring
3. O-ring
4. Sight-glass
5. O-ring
6. Bezel
7. Screws

5.6 Relubricate the rotor bearings

Relubricate the rotor bearings as described below.

1. Refer to Figure 1. Remove the bearing-end acoustic panel (8).
2. Refer to Figure 13. Remove the six fixing-screws (7) which secure the bearing end-cover (6) to the high vacuum head-plate (4).
3. Lift away the bearing end-cover (6) and remove the sealing O-ring (2). Dispose of the O-ring (see Section 6.2).
4. Use a plastic or wooden spatula to remove as much old grease as possible from the end-cover (6) and bearings (3). Do not use your fingers for this operation.
5. Inspect the bearings (3) for obvious signs of wear or the presence of debris. If the bearings are worn, return the pump to a Edwards Service Centre for repair.
6. If the bearings (3) are in a satisfactory condition, force new PFPE grease (supplied in the maintenance kit) into the bearings, so that a smooth layer of grease covers the case and bearings. Do not put grease into the bearing cavities (5) and do not over-pack the bearings or the pump will run hot.
7. If you have not fitted a pump to evacuate the bearing end-cover (see Section 3.11) and you have reached the planned time to replace the head-plate felt filter (this is carried out annually), replace the filter as described in Section 5.7. Otherwise, continue at Step 8 below.
8. Apply a light wipe of PFPE grease to the new O-ring seal (2) and position it in its groove in the head-plate (4). Refit the bearing end-cover (6) to the high vacuum head-plate (4) and secure with the six screws (7).
9. Continue at Section 5.7 to replace the head-plate felt filter.

Figure 13 - Relubricate the rotor bearings



1. Felt filter location
2. O-ring
3. Bearing
4. High-vacuum end-plate
5. Bearing cavity
6. Bearing end-cover
7. Screw

5.7 Replace the head-plate felt filter

If you have not connected an external pump to evacuate the bearing end-cover (see Section 3.11), you must change the felt filter in the head-plate annually. As you must remove the bearing end-cover to replace the felt filter, we recommend that you change the felt filter when you relubricate the rotor bearings (see Section 5.6). Use the following procedure; this procedure assumes that you have already carried out Step 1 to 6 in Section 5.6:

1. Refer to Figure 13. Use a suitable tool to prise out the felt filter (1) from the high vacuum head-plate (4). Dispose of the filter (see Section 6).
2. Place the new felt filter (1, supplied in the maintenance kit) into the head-plate (4).
3. Refit the end-cover to the pump as in Section 5.6, Step 7.
4. If you have not connected a nitrogen gas-ballast supply to the pump, continue at Section 5.8 to replace the gas-ballast air filter. Otherwise, continue at Step 5.
5. Refit to Figure 1. Refit the bearing-end acoustic panel (8) and the side acoustic panel (9), then refit the top acoustic panel (6) and secure with the catches.

5.8 Replace the gas-ballast air filter element

Note: *A new gas-ballast air filter element is included in the routine maintenance kit (see Section 7.3).*

If you have not connected a nitrogen gas-ballast supply to the pump, use the following procedure to replace the gas-ballast air filter element:

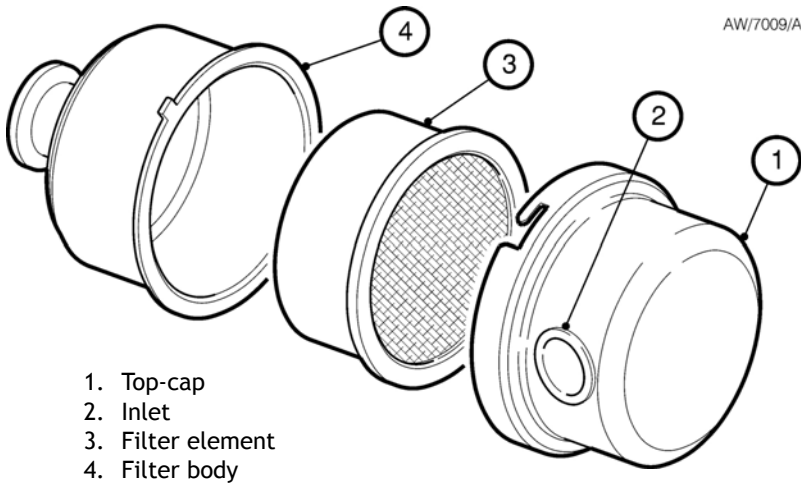
1. Refer to Figure 14. Turn the top-cap (1) clockwise (when viewed from the top-cap end of the gas-ballast air filter) to release it from the filter body (4), then remove the top-cap.
2. Remove and dispose of the used filter element (3).
3. Fit the new filter element (3) into the filter body (4).
4. Refit the top-cap (1) to the filter body (4) and turn it anticlockwise until it clicks, to secure it to the filter body: ensure that the inlet (2) on the top-cap does not point upwards, otherwise debris, dust or liquids may enter the filter body.
5. Refit the acoustic panels: refer to Step 5 of Section 5.7.

5.9 Clean the inlet-stage sump

Clean the inlet-stage sump regularly if you use the GV160 to pump dusty or tarry vapours; use the following procedure:

1. Refer to Figure 11. Remove the two screws on the clamp which secures the inlet-stage sump blanking-plate (6) to the pump.
2. Remove the clamp, the blanking-plate and the sealing O-ring. Dispose of the O-ring.
3. Use a suitable tool (for example, a flexible handled, large diameter bottle-brush) to clean the sump. Do not use your fingers for this operation.
4. Clean the blanking-plate (6). If you use a cleaning solution to clean the plate, make sure that all traces of the solution are removed before you refit the plate.
5. Apply a light wipe of high vacuum grease to the new O-ring. Refit the O-ring and blanking-plate (6) to the pump, then use the clamp and the two fixing-screws to secure the blanking plate in place.

Figure 14 - Exploded view of the gas-ballast air filter



1. Top-cap
2. Inlet
3. Filter element
4. Filter body

5.10 Flush the cooling-jacket

Flush the cooling-jacket to clean it; that is, allow water to flow rapidly through the cooling-jacket in the reverse direction of normal flow. Use the following procedure:

1. Turn off the cooling-water supply.
2. Refer to Figure 11. Place a suitable container under the cooling-water inlet (4), then disconnect your cooling-water supply pipeline. Allow the water to drain out of the pump, then empty the container.
3. Disconnect the cooling-water return pipeline from the cooling-water outlet (3).
4. Connect the flushing-water supply pipeline to the pump cooling-water outlet (3).
5. Reposition the container under the cooling-water inlet (4); alternatively, if required, fit a waste water pipeline to the inlet.
6. Turn on the flushing-water supply. The pressure and flow rate of the supply should be equal to or higher than the normal cooling-water pressure and flow rate. Do not exceed the figures stated in Section 2.
7. Allow the water to flow for a few minutes, then turn off the flushing-water supply.
8. Disconnect the flushing-water supply pipeline (and the waste pipeline, if fitted). Allow the water to drain out of the pump, then empty the container.
9. If necessary:
   - Undo the catches and remove the top acoustic panel (6), remove the side acoustic panels (9), then disconnect the cooling-water supply and return hoses from the pump body.
   - Use a suitable tool to probe the pump-body cooling-water outlet and the cooling-water inlet and remove any remaining sediment.
   - Reconnect the cooling-water supply and return hoses to the pump-body.
   - Refit the side acoustic panels (9), then refit the top acoustic panel (6) and secure with the catches.
10. Reconnect your cooling-water supply and return pipelines to the cooling-water inlet and outlet connections. If you removed any acoustic panels in Step 9, refit them.
11. Prime the pump:
    - Turn on the cooling-water supply.
    - Allow the cooling-water to flow for five or six minutes to ensure that the cooling-jacket is full of water.
    - Inspect the water connections and check that there are no leaks; seal any leaks found.

5.11 Replace the pump-motor bearings

WARNING

Do not replace the pump-motor bearings unless you have been suitably trained in the necessary procedures. If you are not suitably trained, you may damage the motor and it may not operate correctly or safely.

You must only replace the pump-motor bearings if you have been suitably trained in all of the procedures required to remove and refit the motor, to dismantle and reassemble the motor, and to replace the motor bearings.

When you replace the pump-motor bearings:

- You will need a Motor bearing kit (see Section 7.3).
- Only use approved procedures to remove and refit the pump-motor, to dismantle and reassemble the pump-motor, and to replace the pump-motor bearings.
- You must lightly lubricate the new bearings with a suitable grease, such as:
  - BP LC2 Energrease
  - Castrol LMX
  - Esso N2 Unirex
  - Mobil HP Mobilgrease.
- To drive the bearings onto the rotor shaft, use a short length of suitable tube or a suitable drift to apply pressure **only** to the inner races of the bearings.

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6 Storage and disposal

6.1 Storage

Store the pump as follows:

1. If applicable, ensure that the pump has been shut down as described in Section 4.2 and disconnect all services, process and exhaust connections.
2. Drain the water from the cooling-jacket as described in Section 5.10.
3. Fit blanking-plates to all vacuum inlets and outlets. Place protective covers over the pump services connection points.
4. Store the pump in clean dry conditions until required.
5. When required for use, prepare and install the pump in accordance with Section 3 of this manual.

6.2 Disposal

Note: *If you have any doubts about the disposal requirements for specific substances or components, contact your supplier or Edwards for advice.*

Dispose of the GV160 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.

Take particular care with the following:

- Fluoroelastomers which may have decomposed as the result of being subjected to high temperatures
- Oil, grease or components which have been contaminated with dangerous process substances.

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7 Service, spares and accessories

7.1 Introduction

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

Order spare parts and accessories from your nearest Edwards company or distributor. When you order, 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 world-wide network of Edwards Service Centres. Each Service Centre offers a wide range of options including: equipment decontamination; service exchange; repair; rebuild and testing to factory specifications. Equipment which has been serviced, repaired or rebuilt is returned with a full warranty.

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

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

7.3 Spares

The spares available for the GV160 pump are as follows:

Product	Item Number
GV160 routine maintenance kit	A704-11-825
GV160 motor fitting kit	A704-11-805
GV160 pump service module kit	A704-11-815
GV160 replacement pump service module	A704-65-000
Mobil SHC 629 oil: 1 litre (0.26 US gallons)	H110-23-010
Mobil SHC 629 oil: 5 litres (1.32 US gallons)	H110-23-011
Fomblin RT15 grease (100 g)	H113-50-003
Motor bearing kit	A071-99-074

7.4 Accessories

The accessories listed below are available for the GV160 pump. Each accessory contains all the necessary components for assembling and installing the accessory. Full functional descriptions and fitting details are included in the instruction manual supplied.

Accessory	Item Number
Exhaust-silencer	NCD-089-000
Booster connection kits	
EH250 connection kit	NCD-086-000
EH500 connection kit	NCD-087-000
EH1200 connection kit	NCD-088-000

Appendix A1 Correct use of swagelok connectors

Note: *We recommend that you use a second spanner to hold the connector in position when you connect or disconnect a Swagelok connector.*

A1.1 Fit a Swagelok connector

1. Refer to Figure A1 detail A. Undo and remove the nut (4) from the Swagelok connector (1). Ensure that the front (tapered) ferrule (2) and the rear ferrule (3) are correctly orientated as shown in detail A, then loosely refit the nut (4) to the connector (1).
2. Refer to detail B. Insert the tube (5) through the nut (4) and into the Swagelok connector (1). Ensure that the tube rests firmly on the shoulder inside the fitting, and that the nut (4) is finger tight.
3. Tighten the nut (4) until you cannot rotate the tube (5). If you cannot turn the tube because of how it is installed, tighten the nut by 1/8th of a turn.
4. Refer to detail C. Mark the nut (4) at the six o clock position.
5. Refer to detail D. Hold the body of the connector steady, then turn the nut (4) by 11/4 turns (to the nine o clock position) to fully tighten the connection.

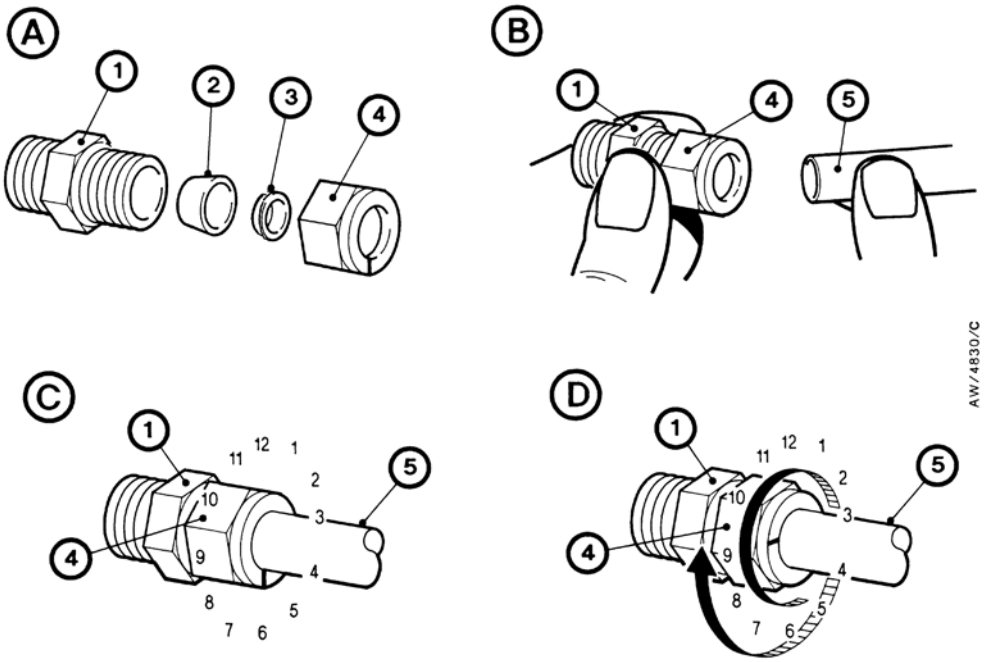
A1.2 Reconnect a Swagelok connector

You can disconnect and reconnect a Swagelok connector many times and still obtain a correct leak-proof seal. Refer to Figure A2 detail A which shows a Swagelok connector after you have disconnected it. Use the following procedure to reconnect it:

1. Refer to detail B. Insert the tube (5) with the swaged ferrules (2, 3) into the Swagelok fitting (1), until the front ferrule (2) is fully in the body of the fitting.
2. Refer to detail C. Tighten the nut (4) by hand.
3. Use a wrench or spanner to turn the nut (4) to its original position (you will feel an increase in resistance when the nut is in its original position), then tighten the nut slightly.

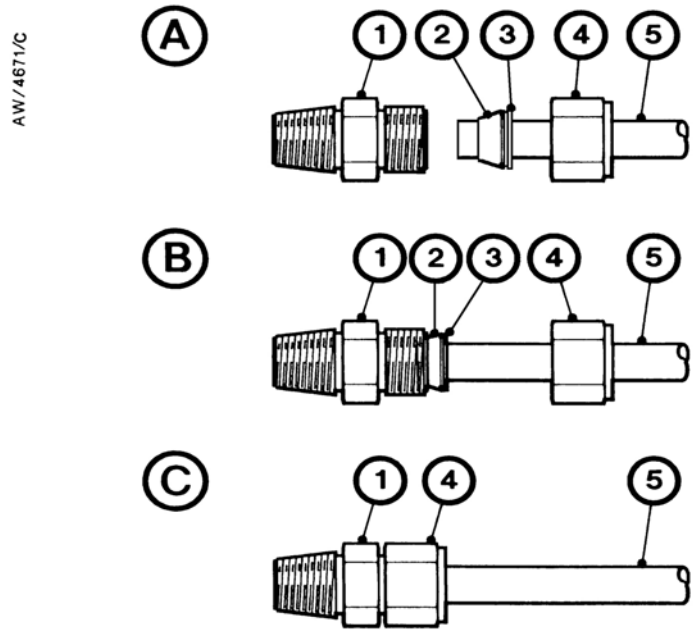
Appendix A1

Figure A1 - Fit a Swagelok fitting



1. Swagelok connector
2. Front (tapered) ferrule
3. Rear ferrule
4. Nut
5. Tube

Figure A2 - Retighten a Swagelok fitting



1. Swagelok connector
2. Front (tapered) ferrule
3. Rear ferrule
4. Nut
5. Tube