B722-01-880
Issue C

Instruction Manual

T960306
LIGO-R960014-00-V

EXT Turbomolecular Pumps
EXT70 and EXT250

Description	*Item Number*
EXT70/NW40	*B722-03-000*
EXT70/NW50	*B722-04-000*
EXT70/ISO63	*B722-01-000*
EXT70/63CF	*B722-02-000*
EXT250/ISO100	*B736-01-000*
EXT250/100CF	*B736-02-000*

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Publication title	Publication Number
EXT Pump Accessories	D580-66-880
EXC Controllers	D396-14-880

1 INTRODUCTION

1.1 Scope of this manual

This manual provides installation, operation and maintenance instructions for the Edwards EXT70 and EXT250 Turbomolecular Pumps. You must use the Pumps as specified in this manual.

The EXT Turbomolecular Pumps are designed for use with an Edwards EXC Controller. Read this manual and the instruction manual supplied with your EXC Controller before you attempt to install or operate the equipment. The EXC Controller instructions contain details of how to set up a pumping system and how to control accessories such as an air-cooler, vent-valve and bakeout band.

Important safety information in this manual 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 units used throughout this manual conform to the SI international system of units of measurement.

1.2 General description

The EXT turbomolecular pumps are multi-stage axial-flow turbines, optimised for operation in molecular flow conditions. The internal structures of the EXT70 and EXT250 Turbomolecular Pumps are shown in Figures 1 and 2.

The multi-stage, light alloy turbine rotor (12) is machined from one piece to form rows of angled blades fitted to a central shaft (6). The blades of the rotor rotate between the blades of the stator. The stator assembly (11) is a series of thin disks separated by spacer rings (10). The blades are angled so that the gas in the vacuum chamber is compressed and is transferred to the pump-outlet.

The rotor and stator blades have an open structure at the pump-inlet and a more closed structure at the outlet. This configuration gives an optimum combination of pumping speed and compression when the pump is operated with gases of both high and low molecular weight.

The rotor is driven by a high-efficiency, brushless d.c. motor. The motor (7) has a magnetized rotor fitted onto the shaft, and a wound stator located in the pump-body. For the blades to be effective, their speed must be close to the thermal velocity of the gas molecules. The rotor is therefore rotated at up to 90000 $r.min^{-1}$.

The rotor assembly is supported at the inlet end by a frictionless magnetic bearing (3) and by a precision ball bearing (8) at the outlet end. The ball bearing is lubricated from an oil reservoir and wick mechanism (9).

EXT pumps are supplied with an inlet-screen (2) fitted in the bore of the inlet-flange. The inlet-screen protects you from the sharp blades and also protects the pump against damage caused by debris which falls into the pump.

EXT pumps have a vent-port which you can use to vent the pump and your vacuum system to atmospheric pressure. The vent-port introduces vent gas part way up the pump rotor to ensure maximum cleanliness. The pump is supplied with a manual vent-valve fitted to the vent-port. As described in Section 3.4, you can replace the manual vent-valve with a TAV5 solenoid-operated vent-valve (available as an accessory: see Section 7).

The EXT250 pump has a purge-port (Figure 5, item 1) in the motor and bearing housing chamber. You can introduce an inert purge gas through the purge-port to protect the bearing lubricant from the effects of high oxygen concentrations. You can fit an optional purge restrictor to the purge-port to control the flow rate of the purge gas and to filter the gas supply (see Section 7).

Electrical connection between the EXT and the EXC Controller is by a 19-way connector and a pump-to-controller cable. The cable is a separate item and is available in a choice of lengths (see Section 7 for details).

The pump may be air-cooled using an optional air-cooler accessory, or water-cooled by passing water through the water-cooler provided. Two riffled hose connectors are provided for connection of your cooling-water supply and return pipelines. The EXT70 may be cooled by natural convection to the surrounding air. A thermal sensor monitors the temperature of the motor and the pump-body.

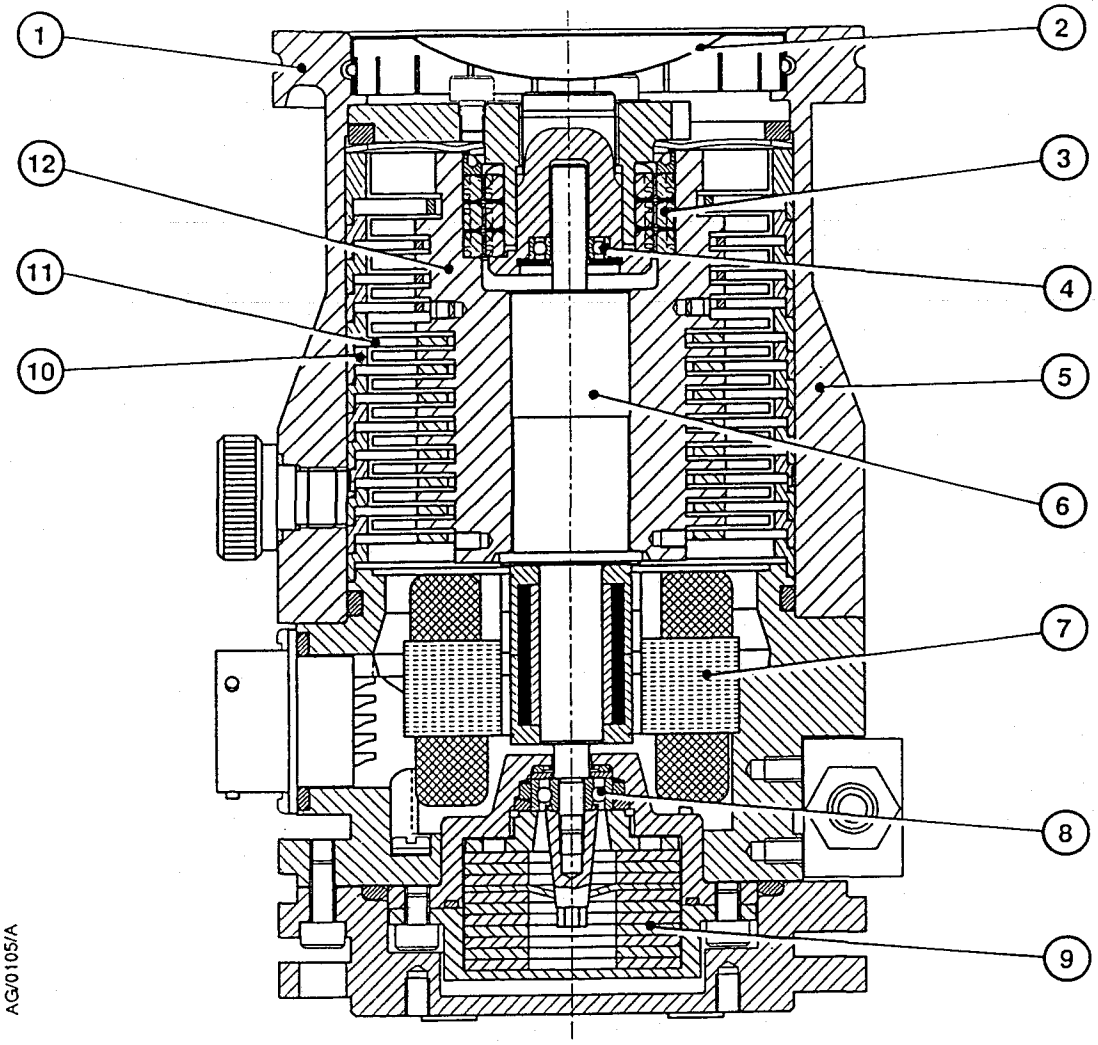
1.3 Vent options and vent control

To maintain the cleanliness of your vacuum system, we recommend that, whenever you switch the pump off, you vent the pump (or vacuum system) when the speed of the EXT pump is between full rotational speed and 50% of full rotational speed. At and above 50% of full rotational speed, the rotor spins fast enough to suppress any backstreaming of hydrocarbon oil from your backing pump.

However, if you vent the pump when it is at full rotational speed and the rate of pressure rise is too high, the pump may be damaged. You must therefore either limit the rate of pressure rise or only open the vent-valve after the EXT pump speed has fallen to 50% of full rotational speed. The rate of pressure rise cannot be controlled by the manual vent-valve, so if you use the manual vent-valve, you must only open the vent-valve after the EXT pump speed has fallen to 50% of full rotational speed.

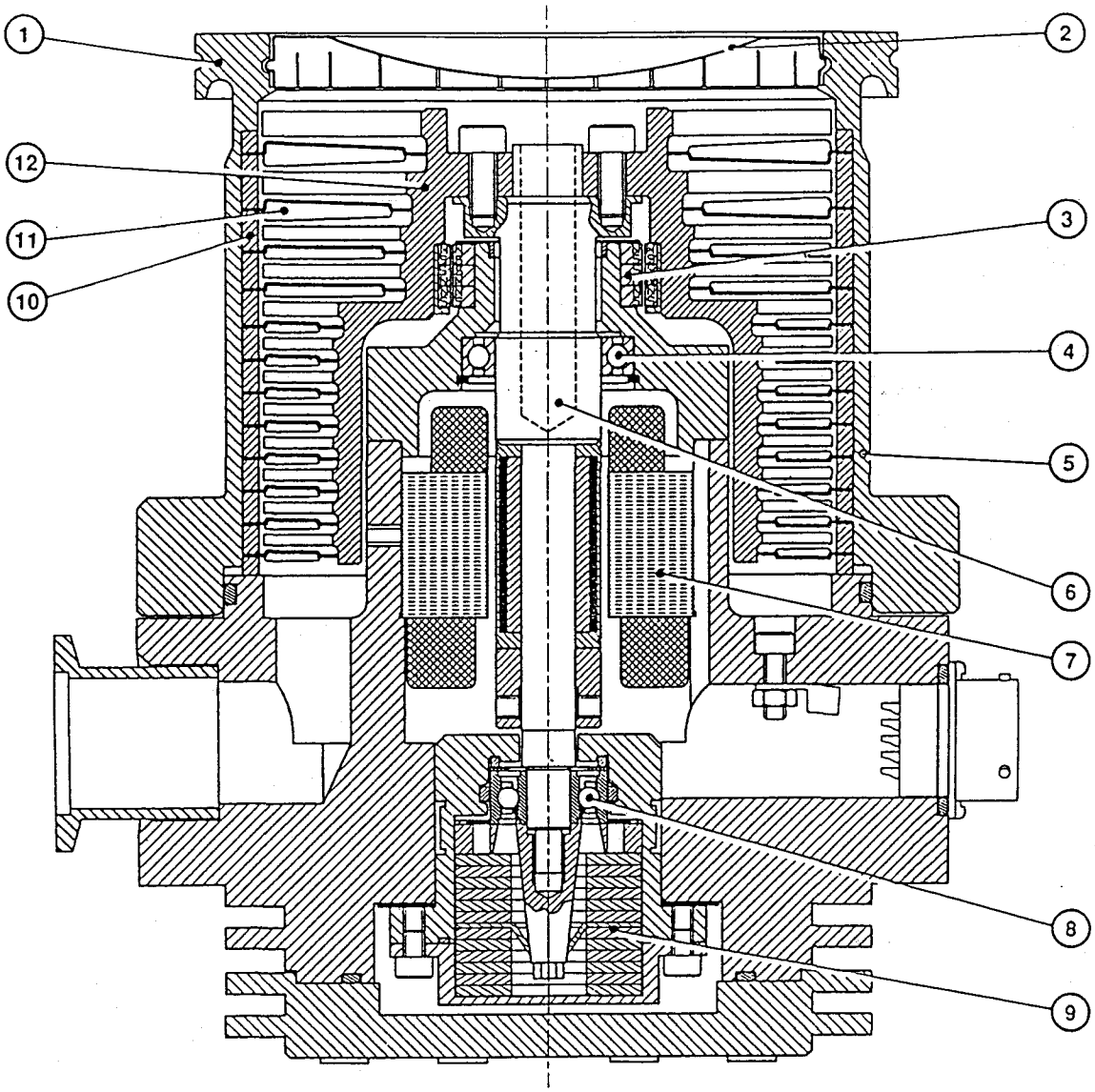
You may be able to fit an orifice to the inlet of your vent-valve to limit the rate of pressure rise. The size of the orifice depends on the volume of your vacuum system: refer to Sections 2.3 and 3.4 for more information. Note that the TAV5 vent-valve has a 0.5 mm orifice, so you can only use the TAV5 vent-valve to vent the pump at full rotational speed if the vacuum system has a volume of 5 l or more.

If you cannot fit an orifice to the inlet of your vent-valve, you must only open the vent-valve after the speed of the EXT pump has fallen to 50% of full rotational speed. If you use the EXC Controller to control your TAV5 vent-valve, configure the Controller to select this option: refer to Section 3.4 for more information. The EXC Controller is factory set to vent when the EXT pump is at 50% of full rotational speed after you have selected Stop.



1. Inlet-flange
2. Inlet-screen
3. Magnetic bearing
4. Safety bearing
5. Envelope
6. Shaft
7. DC motor
8. Lower bearing
9. Oil reservoir
10. Spacer ring
11. Stator
12. Rotor

Figure 1 - Cross-section view of EXT70 Turbomolecular Pump



1. Inlet-flange
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12. Rotor

Figure 2 - Cross-section view of EXT250 Turbomolecular Pump

2 TECHNICAL DATA

2.1 General

Performance	See Table 2
Dimensions	See Figures 4 and 5
Maximum inlet-flange temperature	100°C
Maximum magnetic field	5 mT
Installation category	IEC1010 part 1, Category 1
Pollution degree	IEC1010 part 1, Category 2
Equipment type	Fixed Equipment, for indoor use only

2.2 Pumping media

> WARNING
>
> Vent dangerous gases and gas mixtures safely. Do not expose people to these gases.

> WARNING
>
> Do not use EXT pumps to pump explosive gas mixtures as the pumps are not suitable for this purpose.

> CAUTION
>
> Do not use an EXT to pump gases containing more than 20% oxygen unless the pump is gas purged. If you do, the lubricant will polymerise and the pump will fail prematurely.

Note that concentrations of gases may be modified by the compression of the pump.

2.2.1 EXT70 and EXT250 pumps without gas purge

These pumps are designed to pump the following residual gases normally used in high-vacuum systems :

- Air
- Nitrogen
- Carbon dioxide
- Carbon monoxide
- Krypton
- Helium
- Neon
- Argon
- Hydrogen
- Ethane
- Propane
- Butane
- Methane

You can use the pumps to pump oxygen and water vapour, subject to the following conditions :

- Oxygen — The oxygen concentration must be less than 20% by volume.
- Water vapour — You must ensure that vapour does not condense inside the pump; refer to Section 3.7.1.

If you wish to pump a gas not in the list above, contact your supplier for advice. If you do not contact your supplier, you may invalidate the warranty on the pump. EXT70 and EXT250 pumps are not suitable for pumping aggressive or corrosive gases.

2.2.2 EXT250 pumps with gas purge

When purged with an inert gas, EXT250 pumps can be used to pump oxygen in concentrations above 20% by volume.

2.3 Vent gas specification and vent control data

Although the pump may be vented to atmospheric air, high relative humidity of the air may greatly increase the subsequent pumping time. To reduce pump-down times you should vent the pump with dry, clean gases.

Vent gas	Dry air, nitrogen, argon or other inert gases
Maximum dew point at atmospheric pressure	- 22 °C
Maximum size of particulates	1 µm
Maximum concentration of oil	0.1 parts per million
Maximum allowed rate of pressure rise	See Figure 3
Vent-valve orifice diameter	See Table 1

Vacuum system volume (l)	Orifice diameter (mm)
< 20	< 1.0
< 10	< 0.7
< 5	< 0.5
< 2.5	< 0.35
< 1.25	< 0.25

Table 1 - Vent-valve orifice diameter

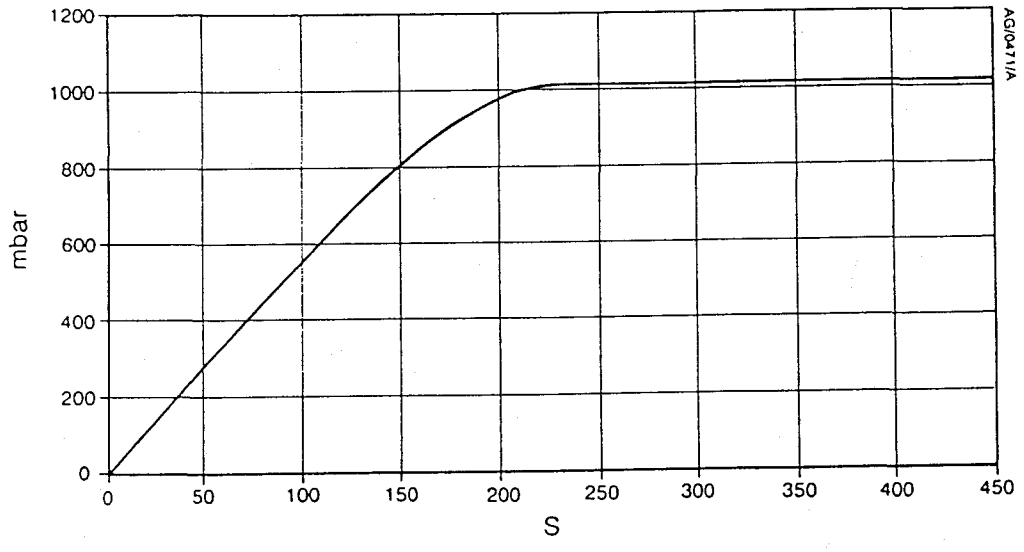


Figure 3 - Maximum allowed rate of pressure rise during venting: pressure against time

Parameter	Pump → Units ↓	EXT70	EXT70	EXT70	EXT250
Mass	kg	1.4	1.4	3.4 (CF), 1.5 (ISO)	5.6 (CF), 8.0 (ISO)
Inlet-flange		DN40NW	DN50NW	DN63CF DN63ISO-K	DN100CF DN100ISO-K
Outlet-flange		DN16NW	DN16NW	DN16NW	DN25NW
Vent-port		$^1/_8$ inch BSP	$^1/_8$ inch BSP	$^1/_8$ inch BSP	$^1/_8$ inch BSP
Purge-flange		-	-	-	DN10NW
Pumping speed N_2 ‡	$l.s^{-1}$	52	60	65	240
He ‡	$l.s^{-1}$	53	56	60	250
H_2 ‡	$l.s^{-1}$	46	48	50	190
Compression ratio N_2		$> 1 \times 10^8$	$> 1 \times 10^8$	$> 1 \times 10^8$	$> 1 \times 10^8$
He		6000	6000	6000	2×10^4
H_2		500	500	500	1500
Ultimate pressure *	mbar	$< 5 \times 10^{-9}$	$< 5 \times 10^{-9}$	$< 5 \times 10^{-10}$ (CF) $< 5 \times 10^{-9}$ (ISO-K)	$< 5 \times 10^{-10}$ (CF) $< 5 \times 10^{-9}$ (ISO-K)
Minimum backing pump displacement	m^3h^{-1}	0.6	0.6	1.3	4.5
Maximum continuous inlet pressure (water-cooling at 15 °C) §					
EXC120	mbar	9×10^{-1}	9×10^{-1}	9×10^{-1}	1×10^{-1}
EXC300	mbar	9×10^{-1}	9×10^{-1}	9×10^{-1}	3×10^{-1}
Maximum continuous inlet pressure (air-cooling at 35 °C) §	mbar	9×10^{-2}	9×10^{-2}	9×10^{-2}	3×10^{-2}
Maximum continuous inlet pressure (free convection at 35 °C) §	mbar	9×10^{-3}	9×10^{-3}	9×10^{-3}	-
Recommended backing pump †		E2M0.7	E2M0.7	E2M1.5	E2M5
Operating attitude		Vertical and upright through to horizontal	Vertical and upright through to horizontal	Vertical and upright through to horizontal	Vertical and upright through to horizontal
Nominal rotational speed	$r.min^{-1}$	90000	90000	90000	60000
Standby rotational speed	$r.min^{-1}$	63000	63000	63000	42000
Starting time to 90% speed					
EXC120/120E	sec	90	90	90	100
EXC300	sec	90	90	90	90
Cooling method		Free convection/ forced-air/water	Free convection/ forced-air/water	Free convection/ forced-air/water	Forced-air/water
Ambient air temperature					
Free convection	°C	0 - 30	0 - 30	0 - 30	-
Forced-air	°C	0 - 35	0 - 35	0 - 35	0 - 35
Water temperature	°C	10 - 20	10 - 20	10 - 20	10 - 20
Noise level (at 1 metre)	dBA	< 50	< 50	< 50	< 50
Recommended controller		EXC120/E	EXC120/E	EXC120/E	EXC120/E
EXC120/E maximum VA input (including heater band)	VA	250	250	250	250
EXC120/E normal power	VA	60	60	60	60
Other compatible controller		EXC300	EXC300	EXC300	EXC300
EXC300 maximum VA input (including heater band)	VA	480	480	480	480
EXC300 normal power	VA	60	60	60	60
Quiescent power consumption	W	10	10	10	25

‡ Pumping speeds are without inlet-screen. Inlet-screens are supplied fitted and reduce speed by approximately 10%.
* Ultimate pressure 48 hours after bakeout with 2-stage rotary vane backing-pump.
§ Above this pressure, rotational speed drops below nominal.
† A larger backing-pump may be required for maximum throughput.

Table 2 - Technical data

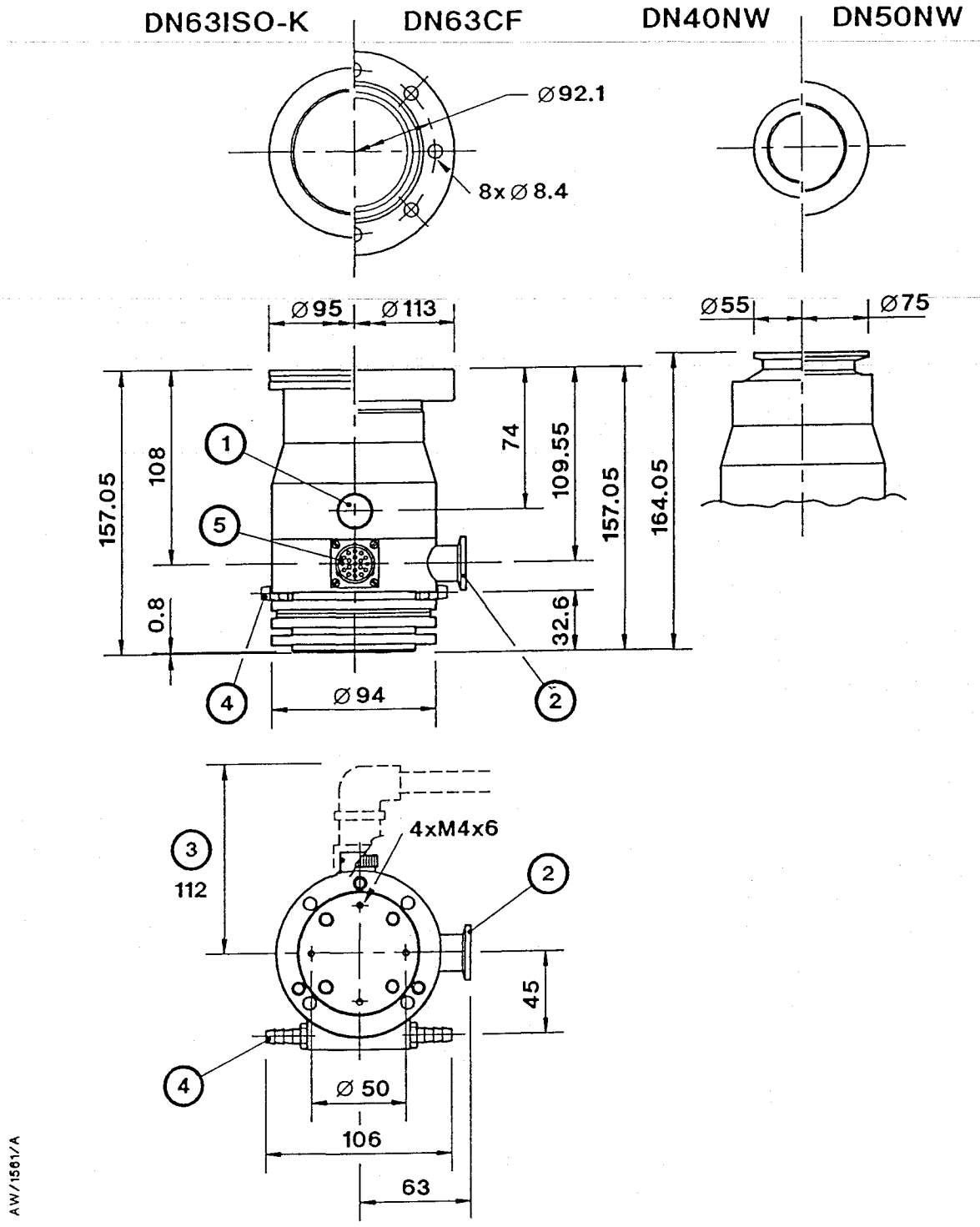
2.4 Purge gas specification (for EXT250 only)

Purge gas	Dry nitrogen, argon or other inert gases
Maximum dew point at atmospheric pressure	-22 °C
Maximum size of particulates	1 μm
Maximum concentration of oil	0.1 parts per million
Allowable purge gas flow (when required)	20 to 100 sccm
Recommended purge gas flow	25 sccm
Maximum allowable purge gas supply pressure	2 bar (gauge) ; 29 psi (gauge)

2.5 Cooling-water

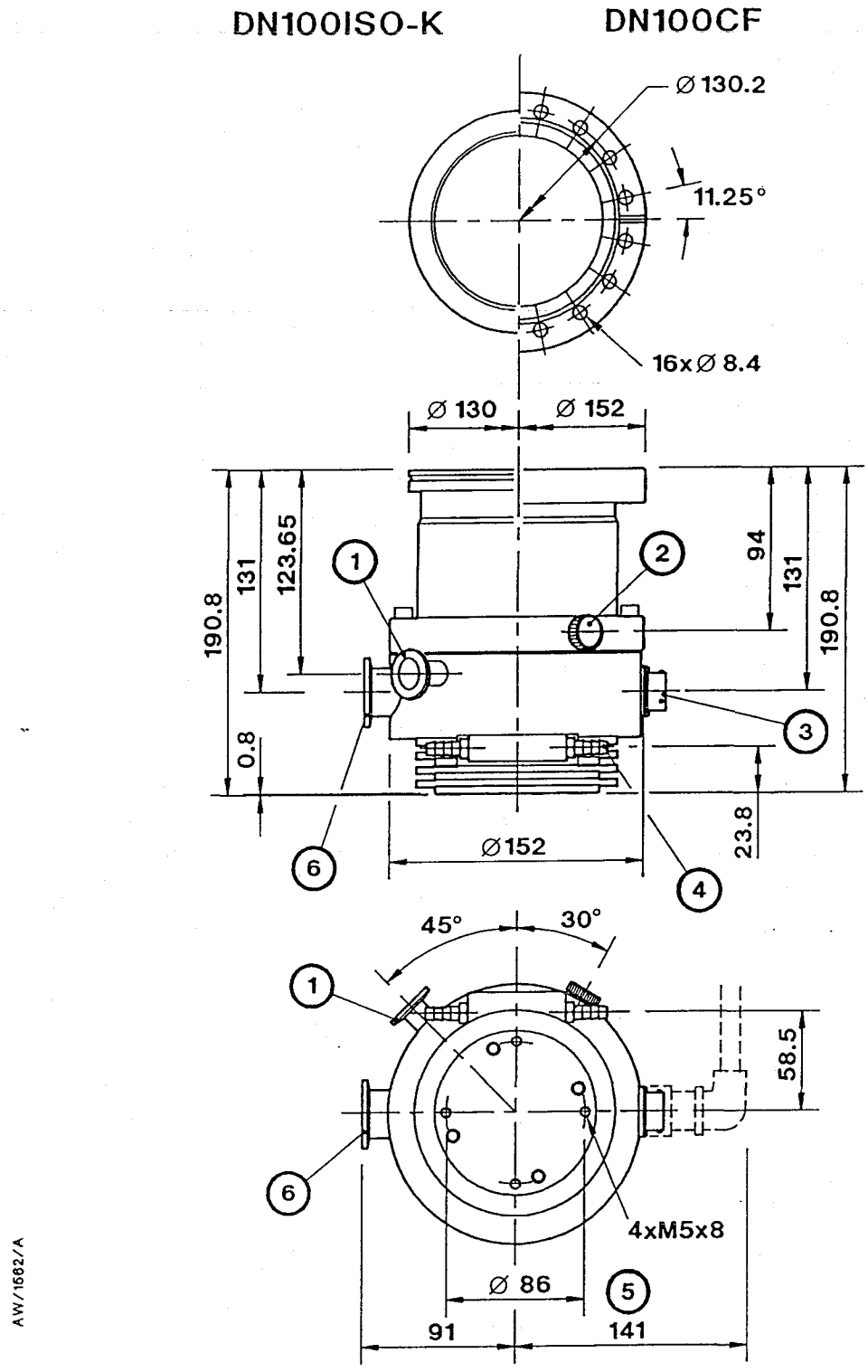
The following cooling-water specification corresponds to a typical high-quality drinking water specification. Check with your water supply authority if you are in doubt about the quality of your supply.

Quality	Mechanically clean and optically clear with no deposits or turbidity.
pH value	6.0 to 8.0
Maximum calcium carbonate concentration	75 parts per million
Maximum chloride concentration	100 parts per million
Minimum oxygen concentration	4 parts per million
Minimum water-cooling flow rate (at 15°C)	15 $l.hr^{-1}$
Water temperature	See Table 2
Maximum water pressure	5 bar (gauge) ; 72.5 psi (gauge)



1. Vent-valve
2. Backing-port
3. Allowance for right-angle cable connector
4. Cooling-water connectors
5. Electrical-supply connector

Figure 4 - EXT70 Turbomolecular Pump dimensions



1. Purge-port
2. Vent-valve
3. Electrical supply connector
4. Cooling-water connectors
5. Allowance for right-angle cable connector
6. Backing-port

Figure 5 - EXT250 Turbomolecular Pump dimensions

3 INSTALLATION

3.1 Unpack and inspect

The pump is packed to prevent damage in transit. Take care when you unpack the pump to avoid excessive shocks which could damage the bearings and reduce the life of the pump. The pump is supplied with the inlet and outlet sealed to prevent entry of dust and vapour. Do not remove these seals until you are ready to install the pump on your vacuum system.

Remove all packing materials and check the pump. If the pump 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 supplier's invoice number. Retain all packing materials for inspection. Do not use the pump if it is damaged.

Check that your package contains the items listed in Table 3. If any of these items is missing, notify your supplier in writing within three days.

Qty	Description	Check (✓)
1	Turbomolecular pump	❑
1	Inlet seal or compression gasket	❑

Table 3 - Checklist of items

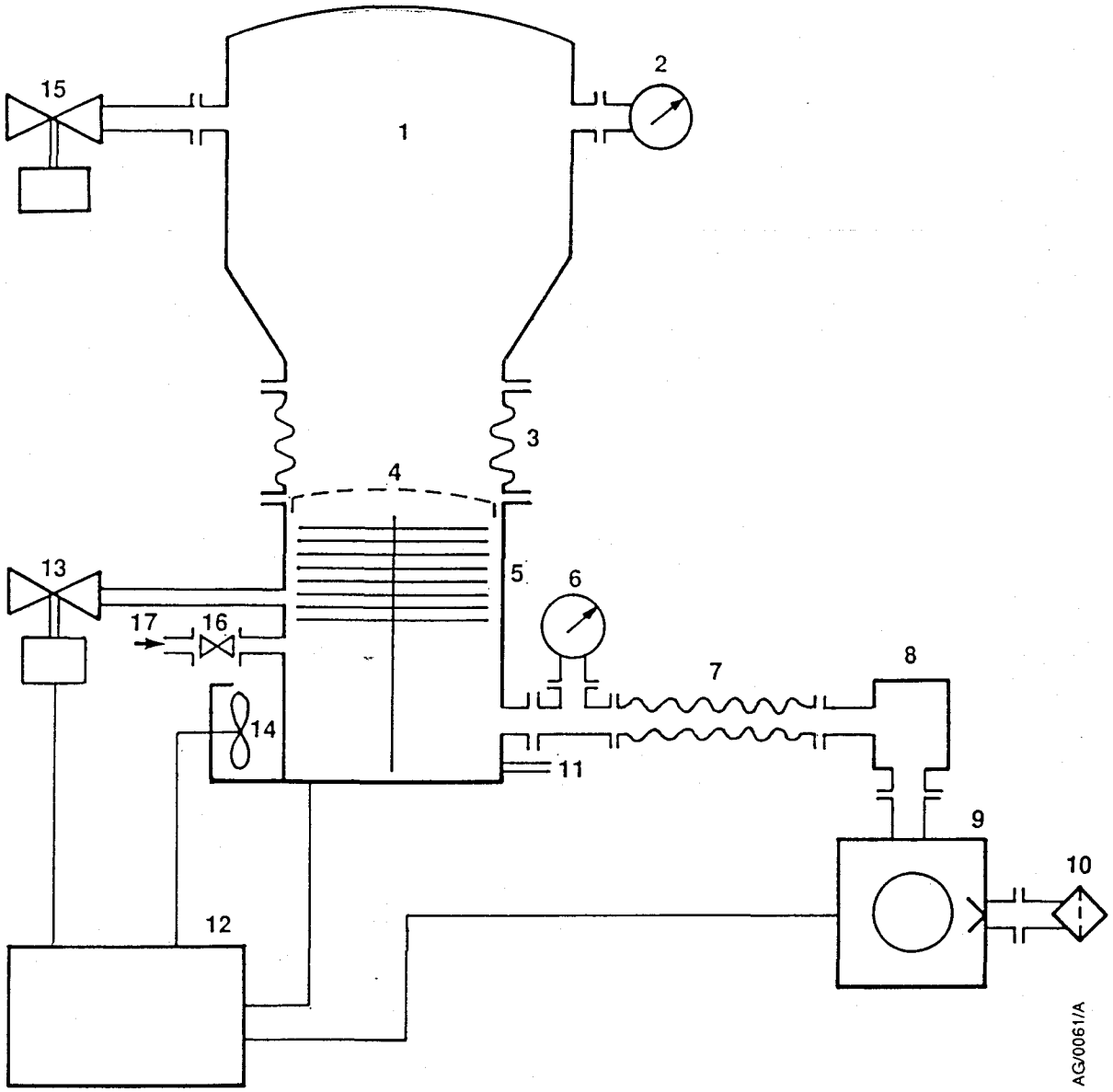
If the pump is not to be used immediately, store the pump in suitable conditions as described in Section 6.1.

Do not discard the packing materials; retain them to repack the pump when you return it for service.

3.2 Typical installation

A typical pumping system with an EXT pump is shown in Figure 6. When necessary, purge the EXT pump with inert gas as described in Section 3.5.

The accessories available for these EXT pumps are detailed in Section 7; the accessories are shown in Figure 9.



1. Vacuum system
2. High-vacuum gauge
3. Vibration isolator
4. Inlet-screen
5. EXT pump
6. Vacuum gauge
7. Flexible bellows
8. Foreline trap
9. Rotary backing-pump
10. Mist filter
11. Cooling-water connectors
12. EXC controller
13. Vent-valve
14. Air-cooler
15. Alternative position for vent-valve
16. PRX10 purge restrictor
17. Regulated purge gas supply

Figure 6 - Typical pumping system

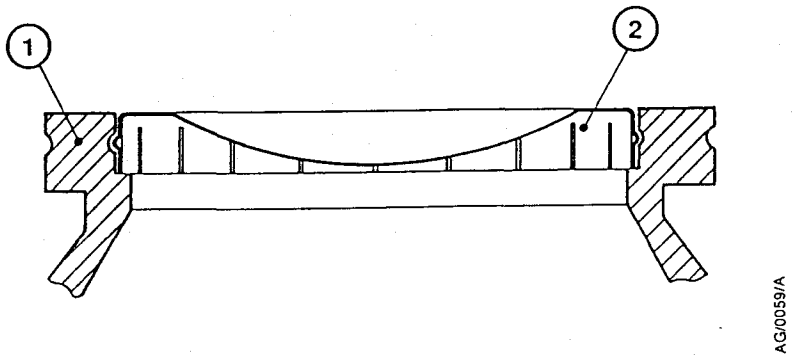
3.3 Connect to the vacuum system

> WARNING
>
> Install the pump in the vacuum system before you connect the EXC Controller. This will ensure that the pump cannot operate and injure people during installation.

3.3.1 Inlet-screen

Do not remove the inlet-screen unless you can be sure that there is no danger that debris can fall into the pump. In order to avoid the danger of injury from the rotor blades, do not remove the inlet-screen until you are ready to mount the pump onto your system. If the screen is removed, the pumping speed will increase by approximately 10%. It is not possible to remove the inlet-screen from a pump with an NW inlet-flange.

To remove the inlet-screen from pumps with ISO or CF flanges, carefully extract it from the inlet-flange using a bent wire hook. To replace a screen which has been removed, install it as shown in Figure 7, with the Edwards logo uppermost. Ensure that the dimples on the rim of the screen engage in the groove in the pump flange. If necessary, gently bend the tags of the screen outwards to ensure a tight fit.



1. EXT inlet-flange
2. Inlet-screen

Figure 7 - Correct installation of the inlet-screen

3.3.2 Inlet connection

Mount the pump onto your vacuum system. The pump can be mounted in any attitude from vertical and upright through to horizontal ($\pm 2^{o}$). If you mount the pump horizontally, the backing port must point vertically downwards ($\pm 20^{o}$) to reduce the risk of contamination from the backing pump oil.

Make sure that the pump-inlet and all components fitted to the pump-inlet are clean and dust-free. If the pump-inlet is not kept clean, the pump-down time may be increased.

Secure the inlet-flange of the pump to your vacuum system. The inlet-connection of the EXT pump is a CF flange, an ISO collar flange or an NW flange. Use the Edwards Co-seal supplied with the pump to seal the inlet-flange of the pump with an ISO collar. Use the copper compression gasket supplied with the pump to seal the inlet-flange of a pump with a CF collar. For either flange option, use a full complement of bolts. Alternatively, use a minimum of four claw clamps to secure ISO flanged pumps. Use the Edwards Co-seal supplied with the pump and a suitable NW clamp to seal the inlet-flange of a pump with an NW flange.

Ensure that no torque or other forces are transmitted to the pump from the vacuum system or the associated pipelines. If necessary, fit an inlet vibration isolator between the pump-inlet and the vacuum system (see Section 7). If your pump supports the weight of the vacuum system, ensure that the base of the pump is fixed to a firm support; use the tapped fixing-holes in the base of the pump. In this case, the mass of your vacuum system should be no more than 10 kg for an EXT70 pump or 20 kg for an EXT250 pump. If you fit a vibration isolator, ensure that the installation includes some form of restraint to prevent fractures of the vibration isolator in the unlikely event of total seizure of the pump rotor.

3.3.3 Backing connection

Use suitable vacuum tubing and connectors to connect the NW flange of the backing-port to your backing-pump. If necessary, use flexible pipe or bellows to reduce the transmission of vibration from the backing-pump to the EXT pump.

We recommend that you use an Edwards two-stage backing-pump. The backing-pump can also be controlled by the EXC Controller. The minimum size of the backing-pump required is given in Table 2. You may have to use a larger backing-pump if you run the pump at a high inlet pressure or high throughput or if you purge the pump with more than 25 sccm of purge gas.

Do not use the EXT pump with a backing pressure below 1×10^{-4} mbar. Lower backing pressures will increase the evaporation rate of the lubricating oil and so will reduce the life of the bearings.

3.4 Vent-valve connection and control

When you design your system and when you install a vent-valve, take note of the information in Sections 1.3 and 2.3. You can vent the EXT pump and your vacuum system by any of the following methods:

- Use the manual vent-valve supplied.
- Use a TAV5 solenoid vent-valve accessory (see Section 7) in place of the manual vent-valve.
- Use a TAV5 vent-valve connected to a convenient flange on your vacuum system.
- Use an alternative valve connected to your vacuum system.

If you use the manual vent-valve, you must open the vent-valve only after the EXT pump speed has fallen to 50% of full rotational speed.

If you use the TAV5 vent-valve, you can only use the TAV5 vent-valve to vent your pump when it is at full speed if the vacuum system has a volume of 5 l or more. If you use the EXC Controller to control your TAV5 vent-valve, you can configure the Controller to open the vent-valve after the EXT pump speed has fallen to below 50% of full rotational speed: do not select the 'Vent On Stop' option (refer to the EXC Controller instruction manual for more information).

If you use another vent-valve, refer to Section 2.3 and fit a suitable orifice to the inlet of your vent-valve. If you cannot fit an orifice to your vent-valve, you must open the vent-valve only after the speed of the EXT pump has fallen to 50% of full rotational speed.

If you connect the vent-valve to your vacuum system, select a point upstream of the EXT pump to prevent backstreaming of oil from the backing pump. Do not connect the vent-valve to the backing pipeline. Connect the inlet of the vent-valve to the vent gas supply (refer to Section 2.3 for the vent gas specification).

3.5 Purge gas connection (EXT250 only)

3.5.1 Connect the purge gas

If you want to supply a purge gas to the pump, remove the DN10NW blanking-flange from the purge-port and connect your purge gas supply to the purge-port. Your purge gas must comply with the specification given in Section 2.4.

You must limit the flow rate of the purge gas to the allowed range, also specified in Section 2.4. To limit the flow rate, use a flow controller or a pressure regulator and calibrated flow restrictor.

The PRX10 purge restrictor accessory (see Section 7.3) is suitable for this purpose. Adjustment of the PRX10 is described in the instruction manual supplied with the accessory.

3.5.2 Recommended purge gas flow

The recommended purge gas flow for typical applications is 25 sccm. This flow will protect the pump when you pump oxygen inconcentrations above 20% by volume.

3.5.3 Adjust the PRX10 purge restrictor

The PRX10 purge restrictor, as supplied, is adjusted to restrict the flow rate of nitrogen (at a supply pressure of 1 bar) to 25 sccm. You can use a higher supply pressure to increase the flow rate of nitrogen as shown in Table 4.

Nitrogen supply pressure (bar absolute)	Nitrogen flow rate (sccm)
1	25
1.5	38
2	50
2.5	63
3	75

Table 4 - Nitrogen flow rate through the PRX10

Alternatively, if you want to use a different purge gas, use the procedure below to set the required flow rate.

1. Connect a calibrated mass flow meter between your purge gas supply and the PRX10 purge restrictor. Take a note of the purge gas flow rate. Do not allow the flow rate to rise above the maximum flow rate specified in Section 2.4.

2. Undo the lock-nut on the PRX10 adjustment screw.

3. Use a small screwdriver to turn the adjustment screw anti-clockwise to increase the flow rate or clockwise to reduce the flow rate.

4. When the require flow rate is set, tighten the lock-nut on the adjustment screw.

3.6 Electrical installation

Always make the electrical connections to the EXT pump after the pump has been installed on your vacuum system.

The EXC Controller provides the electrical supply to the EXT pump through the multiway pump-to-controller cable. Connect and lock the bayonet-connectors at the ends of the cable to the mating connectors on the pump and the EXC Controller. If the cable is disconnected at either end while the pump is operating, the EXC Controller output is switched off, which makes the cable safe.

The EXC Controller is designed to allow a pumping system to be configured in a variety of ways, from a basic manually-operated system to a fully automatic system with remote control. Refer to the instruction manual supplied with the EXC Controller to complete the electrical installation.

3.7 Cooling

> CAUTION
>
> When you bake the EXT pump to above 70°C at the inlet-flange, you must cool the pump by forced-air or water-cooling to prevent damage to the bearing lubricant.

We recommend that, whenever possible, you cool the EXT pump by forced-air or water-cooling, however if necessary you can use natural convection to cool the EXT70 in certain applications. Table 5 shows the acceptable cooling methods which you can use for different applications.

If you use natural convection or forced-air to cool the pump, you must ensure that there is an adequate supply of cooling-air to the pump.

3.7.1 Forced-air cooling

An air-cooler accessory is available for the EXT pumps (refer to Section 7). Fit the air-cooler as described in the instruction manual supplied with it. If you wish to use an alternative fan for air-cooling, ensure that the flow rate is above 70 m^3hr^{-1} (40 cfm)

Application conditions	Cooling method	
	EXT70	EXT250
Ambient temperature < 30 °C, light pumping duty with inlet-flange temperature < 70 °C	Natural convection, forced-air or water-cooling	Forced-air or water-cooling
Ambient temperature 30 to 35 °C or inlet-flange temperature > 70 °C, light pumping duty	Forced-air or water-cooling	Forced-air or water-cooling
During bakeout band operation, light pumping duty	Forced-air or water-cooling	Forced-air or water-cooling
With continuous high gas throughput	Forced-air or water-cooling	Forced-air or water-cooling
When the EXT pump is cycled repeatedly from atmospheric to ultimate pressure	Forced-air or water-cooling	Forced-air or water-cooling
Combinations of high ambient temperature, bakeout band operation, high gas throughput and repeatedly cycled operation	Water-cooling	Water-cooling

Table 5 - Pump cooling methods for different applications

3.7.2 Water-cooling

The cooling-water supply must comply with the specification given in Section 2.5. Pipes in the water-cooling circuit may become blocked if the cooling-water contains too much calcium carbonate or if it contains particulates which are too large. Corrosion of the water-cooling circuit may occur if there is too little calcium carbonate and oxygen in the water. Good quality drinking water is usually suitable for water-cooling. If in doubt, you must check the quality of your cooling-water supply and, if necessary, provide treatment and filtration.

Connect the cooling-water supply to the pump water-cooling block as described below. Either of the two water-cooling connectors can be used for the water supply or return connections.

1. Push reinforced hose (approximately 6 mm internal diameter) over the ends of the riffled hose connectors supplied with the pump.

2. Attach the hose with strong hose clips and make sure that they are tightened securely.

Alternatively, unscrew the riffled hose connectors and make direct connections to the $^{1}/_{8}$ BSP female threaded fittings.

You must turn off the cooling-water supply when you switch off the pump to prevent condensation of vapours inside the pump. The EXC Controller can drive a solenoid-valve for this purpose.

You can unscrew the two M4 cap-head fixing-screws to remove the water-cooler from the pump without breaking the cooling-water circuit. Make sure that there is a layer of thermal contact grease on the water-cooler before you refit it to the pump.

4 OPERATION

> WARNING
>
> Do not operate the pump unless it is connected to your vacuum system. If you do, the pump rotor can cause injury. The pump rotor rotates at very high speeds and you may not be able to see that the pump is rotating.

4.1 Start-up

Use the procedure below to start up a basic, manually-controlled pumping system with a manual vent-valve and an EXC Controller. Refer to the EXC Controller instruction manual where the backing-pump and accessories are automatically controlled by the EXC Controller.

1. Turn the manual vent-valve clockwise to close it.
2. Turn on the cooling-water supply (if water-cooling is used).
3. Start the backing-pump.
4. When the vacuum system pressure is approximately 1 mbar or less, press the Start/Stop button on the EXC Controller to start the EXT pump.
5. The pump will then accelerate to full operating speed. When this has been reached, the upper LED of the speed indicator on the front panel of the EXC Controller will light.

4.2 Stand-by

You can press the Standby button on the EXC Controller to operate the EXT pump at reduced rotational speed. Select Standby before or after Start-up, for any of the following reasons:

- To extend pump-bearing life and still maintain adequate vacuum pumping performance (for example, when you leave a system under vacuum over holiday periods)
- To increase system pressure or to extend the maximum inlet pressure range of the pump where this suits a particular process
- To avoid pump excitation of any resonances which may exist on sensitive instrumentation.

4.3 Shut-down

Note: In an emergency only, open the vent-valve quickly to decelerate the pump rotor in the shortest possible time.

Use the procedure below to shut down a basic, manually-controlled pumping system with a manual vent-valve and an EXC Controller. Refer to the EXC Controller instruction manual where the backing-pump and accessories are automatically controlled by the EXC Controller.

1. Switch off the backing-pump and press the Start/Stop button on the EXC Controller to switch off the EXT pump.

2. When the EXT pump rotational speed has fallen to below 50% of full rotational speed, turn the manual vent-valve anticlockwise to open it. Ensure that the rate of pressure rise does not exceed the allowed rate of pressure rise, otherwise you can damage the pump: refer to Sections 1.3 and 2.3.

3. If water-cooling is in use, turn off the cooling-water supply.

4.4 Safety interlocks and control system

The pump protection and safety interlock features are listed below. Refer to the instruction manual supplied with the EXC Controller for a full description of these features :

- The EXC Controller monitors the temperature of the EXT pump and the electrical power consumption of the pump. If the EXC Controller detects excessive power consumption or temperature, the rotational speed of the pump motor is reduced until the power and temperature return to normal
- If the rotational speed is reduced to 50% of nominal speed, then the pump is stopped immediately (or after a user defined time delay) and the Fail LED on the EXC Controller lights
- If pump rotational overspeed is detected by the EXC Controller, the pump is stopped immediately and the FAIL LED on the EXC Controller lights.

If the Fail LED lights, switch off the backing-pump immediately and vent the EXT pump. Once the EXT pump has stopped, rectify the cause of the failure (refer to Section 5.4), press the EXC Controller Start/Stop button to reset the Fail condition, and restart the EXT pump. If the pump is hot, allow sufficient time for it to cool before you restart it.

4.5 Bakeout

> CAUTION
>
> When you bake the EXT pump to above 70°C at the inlet-flange, you must cool the pump by forced-air or water-cooling, to prevent damage to the bearing lubricant.

If you heat your EXT pump (and your vacuum system), you will speed up the degassing process so that the pump will reach ultimate vacuum in the shortest possible time. If you heat the pump, this will also prevent condensation of vapours inside the pump.

You can use the Edwards BX bakeout band to heat the pump (refer to Section 7). Fit the band around the pump, just below the inlet-flange. When you bake the pump or the system, make sure that the temperature of the inlet-flange does not exceed 100°C.

If you bake your vacuum system and the temperature of the system exceeds 200°C, you must put a radiation shield between the system and the EXT pump. This radiation shield will reduce the heat radiated onto the pump rotor.

Typically, a bakeout of four hours is long enough to remove water condensation from the pump. However, the bakeout time will depend on the amount of condensation in the pump and the vacuum system, and the ultimate pressure you want to achieve.

5 MAINTENANCE

WARNING

Allow the pump-rotor to stop, then disconnect the pump from the EXC Controller before you remove the pump from your vacuum system for maintenance or fault-finding procedures.

5.1 Introduction

The maintenance operations for the EXT Turbomolecular pumps are described in the following sections. The ISX inlet-screen, the WCX water-cooler and inlet-flange seals are available as spares (refer to Section 7); fit these spares as described in Section 3.

5.2 Bearing maintenance

When supplied, the pump contains sufficient lubricant to supply the bearings for life. No routine maintenance is therefore required between bearing replacements. The bearings are not user-serviceable. The bearings will need to be replaced when they reach the end of their service life. This is typically more than 20,000 hours, but may be less depending upon the type of pumping duty on which the pump was used.

When the bearings need replacement, we recommend that you exchange your pump for a factory reconditioned replacement. Alternatively, you can send your pump to an Edwards Service Centre to have the bearings replaced.

When you return EXT pumps to Edwards Service Centres please obey the procedure included at the end of this manual. However, the instruction to drain all fluids does not apply to the lubricant in the EXT pump oil-reservoirs.

5.3 Clean the pump

WARNING

Clean the pump in a well-ventilated location. When you use cleaning solutions and solvents to clean the pump, observe all precautions specified by the manufacturer.

Use a cleaning solution which is suitable for the contaminants in the pump. You can use any organic solvent to clean the EXT pump, but we recommend that you use non-CFC solvents, such as isopropanol or ethanol.

For environmental reasons, keep wastage of cleaning solutions and solvents to a minimum.

5.3.1 Clean the pump without disassembly

> WARNING
>
> Do not use the following procedure if the pump has been contaminated with dangerous substances. If you do, you may be exposed to the dangerous substances.

If the EXT pump is contaminated, it will not be possible to achieve the specified ultimate vacuum or pump-down time will increase. Slight contamination, such as oil deposits, can be removed without dismantling the pump using the following procedure.

1. Immerse the pump upside down in a vessel filled with a suitable cleaning solution.
2. Make sure that the level of cleaning solution is at least 25 mm below the small gap between the black pump-body and the stainless steel envelope, as shown in Figure 8. Do not immerse the pump further as this may damage the bearings.
3. Leave the pump in the cleaning solution for 10 to 15 minutes. During this period, gently lift and lower the pump several times to flush the rotor and stator components.
4. Repeat Steps 1 to 3 at least once more with fresh cleaning solution.
5. Keep the pump upside down throughout and remove the pump from the cleaning solution and place it vertically with its high-vacuum flange on a suitable draining surface for about an hour. Turn the rotor occasionally, to allow the cleaning solution to drain and evaporate completely. Do not keep the pump upside down for more than 2 hours; if you do, oil may drain from the bearing reservoir.

Note: The first pump-down after cleaning may take much longer than usual as the cleaning solution residues are pumped. If necessary, bake the pump (see Section 4.5) to speed up the process on water-cooled pumps.

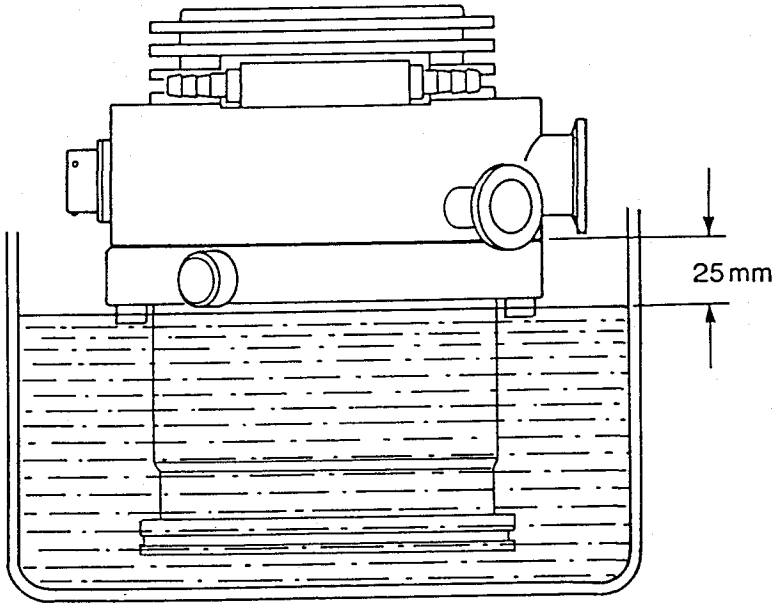


Figure 8 - Correct immersion of the pump in a suitable cleaning solution

5.3.2 Heavy contamination

If the pump is heavily contaminated, it must be dismantled and cleaned at an Edwards Service Centre.

5.4 Fault finding

Symptom	Check	Action
The pump does not rotate. After pressing start - Fail LED not lit.	Is the EXC Controller power LED lit?	If not, check that the electrical supply is on, check that the switch at the rear of the EXC Controller is on, check the fuse in the rear of the EXC Controller. If all of the above are OK then the EXC Controller is faulty. Consult Edwards or your supplier
	Is the EXC Controller Start/Stop LED flashing?	If so, check that the correct links are made on the EXC Controller logic interface (refer to the instruction manual supplied with the EXC Controller). Check that any system interlocks are correctly made (refer to the instruction manual supplied with the EXC Controller). Check that the pump-to-controller lead is connected. If all of the above are OK then consult Edwards or your supplier.
	Is the EXC Controller first speed indication LED lit?	If not, the EXC Controller is faulty. If lit, then the EXT pump is faulty. Consult Edwards or your supplier.
The EXC Controller trips into Fail - at any speed.	Are the system interlocks correctly connected?	Ensure that the system interlocks do not open after the EXT pump has started.
The EXC Controller trips into Fail during the ramp-up and before 50% speed is reached.	Is the inlet pressure too high?	If so, reduce the pumping load, or check for a gross leak into the system.

Symptom	Check	Action
The EXC Controller trips into Fail during the ramp-up and before 50% speed is reached (continued).	Is the EXT pump running too hot?	Increase the cooling-water flow or decrease the water temperature or do both. You may need to change from air-cooling to water-cooling. (Refer to Section 2 for maximum inlet pressure and cooling requirements). Check that external heat sources (such as system bakeout heaters) are not excessive.
	Does the rotor rotate freely?	If not, the EXT pump-bearings are damaged. Consult Edwards or your supplier.
	None of the above.	Increase the timer setting (refer to the instruction manual supplied with the EXC Controller). If the EXC Controller still trips into Fail consult Edwards or your supplier.
The EXC Controller trips into Fail after 50% speed has been reached - the first two speed LEDs are lit.	Is the pressure too high?	If so, reduce the pumping load or check for a gross leak into the system.
		If the high gas load is temporary, configure the EXC Controller to delay the Fail trip on 50% speed and set an appropriate delay time (refer to the instruction manual supplied with the EXC Controller).
	Is the EXT pump running too hot?	Increase the cooling-water flow or decrease the water temperature or do both. You may need to change from air-cooling to water-cooling.
	Does the EXT pump rotor rotate freely?	If not, the EXT pump-bearings are damaged. Consult Edwards or your supplier.
The EXC Controller trips into Fail - all the speed LEDs are lit.	-	Consult Edwards or your supplier.

Symptom	Check	Action
Ultimate pressure cannot be reached.	Is the pressure limited by water vapour ?	Bake the system and pump.
	Are any of the vacuum gauges contaminated ?	If so, clean or replace them.
	Is the pumping speed insufficient (due to poor conductance between the pump and the gauge or too large a chamber) ?	Increase the conductance or reduce the volume.
	Is the backing pressure < 0.2 mbar ?	If not, check for backing line leaks. If the throughput is high, you may need a larger backing-pump.
	Is the high-vacuum area of the system contaminated ?	If so, clean the high-vacuum system.
	Check the rest of your system for leaks and contamination.	If found, clean the contaminated areas and repair the leaks.
	Remove the pump from the system and test the ultimate pressure of the pump alone (see Section 2 for specification).	If poor, check the pump for contamination and if necessary clean as described in Section 5.3. Leak-check the pump. If the leak rate > 1×10^{-7} mbar ls^{-1} consult Edwards or your supplier.
The EXT is very noisy or there is excessive vibration or both.	Is the pump rotational speed the same as the resonant frequency of the attached system ?	If so, change the natural frequency of your system or isolate the pump using flexible bellows.
	Is the vibration being transmitted from the rotary pump ?	If so, fit flexible bellows or a vibration isolator in the backing line.
	Is the noise irregular and getting progressively worse ?	If so, a bearing is defective. Consult Edwards or your supplier.
	Is the EXT making a constant high-pitched noise ?	If so, the rotor is out of balance. Consult Edwards or your supplier.

6 STORAGE AND DISPOSAL

6.1 Storage

Use the following procedure to store the pump.

1. Place protective covers over the inlet, outlet, purge and vent ports.
2. Place the pump in its packing materials. For fastest pump-down when the pump is put back into service, seal the pump inside a plastic bag together with a suitable desiccant.
3. Store the pump in cool, dry conditions until required for use. When required, prepare and install the pump as described in Section 3.
4. Keep the pump upright at all times to prevent the drainage of oil from the bearing reservoir.
5. Avoid long-term storage if possible. When long-term storage is necessary, the pump should be set up and run for at least eight hours every six months.

6.2 Disposal

Dispose of the EXT Turbomolecular Pump and any components and accessories safely in accordance with all local and national safety and environmental requirements.

Particular care must be taken with any components which have been contaminated with dangerous process substances.

Do not incinerate the pump. The pump contains phenolic and fluorosilicone materials which can decompose to very dangerous substances when heated to high temperatures.

7 SPARES AND ACCESSORIES

7.1 Introduction

Edwards products, spares and accessories are available from Edwards companies in Belgium, Brazil, Canada, France, Germany, Hong Kong, Italy, Japan, Korea, Switzerland, United Kingdom, USA and a worldwide network of distributors. The majority of these 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 Spares

7.2.1 ISX inlet-screen

An inlet-screen is fitted to your pump as supplied to prevent damage from the entry of debris into the pump. The Item Numbers of replacement inlet-screens are given below. Select the inlet-screen according to the pump inlet-flange size. You cannot replace the inlet-screen on an EXT70 pump with an NW inlet-flange

Flange size	Inlet-screen	Item Number
DN63ISO-K/DN63CF	ISX63	B580-51-005
DN100ISO-K/DN100CF	ISX100	B580-51-001

7.2.2 WCX water-cooler

A water-cooler is fitted to your pump as supplied. The Item Number of a replacement water-cooler which fits all pumps is given below.

Pump	Water-cooler	Item Number
EXT70/EXT250	WCX500	B580-61-001

7.2.3 Inlet-flange seals

EXT pumps are supplied with a seal to match the inlet-flange. The Item Numbers of replacement seals are listed below.

Flange size	Inlet seal	Item Number
DN63ISO-K	ISO63 Co-seal, fluoroelastomer	B271-58-064
DN40NW	DN40NW Co-seal, fluoroelastomer	B271-58-453
DN50NW	DN50NW Co-seal, fluoroelastomer	B271-58-466
DN100ISO-K	ISO100 Co-seal, fluoroelastomer	B271-58-071
DN100CF	100CF Copper gasket (pack of 5)	C082-00-003
DN63CF	63CF Copper gasket (pack of 5)	C081-00-003

7.3 Accessories

7.3.1 Installation

The accessories available for use with the EXT turbomolecular pumps are described in the following Sections. Figure 9 shows how the accessories are fitted to an EXT pump.

7.3.2 EXC Controller

The Edwards EXC Controllers provide the facilities necessary for operating a pumping system based on an EXT pump. The following EXC Controllers are available:

Controller	Voltage	Item Number
EXC120	100-240 V	D396-16-000
EXC120E	100-240 V	D396-17-000
EXC300	100-120/200-240 V	D396-14-000

7.3.3 Pump-to-controller cable

A pump-to-controller cable must be used with each pump. It is not supplied with the EXT Pump or the EXC Controller. The following cables are available:

Cable	Length	Item Number
Pump-to-controller	1 m	D396-18-010
Pump-to-controller	3 m	D396-18-030
Pump-to-controller	5 m	D396-18-050

7.3.4 BX bakeout band

A BX bakeout band accelerates the degassing of the pump to enable it to achieve lower pressures. It may also be used to protect the pump from condensation of contaminants. The bakeout bands are available in 110-120 V or 220-240 V versions and may be powered from a rear panel socket on the EXC Controller.

Pump	Bakeout band	Item Number
EXT70	BX70 (110 V)	B580-52-040
	BX70 (240 V)	B580-52-060
EXT250	BX250 (110 V)	B580-52-041
	BX250 (240 V)	B580-52-061

7.3.5 FL20K foreline trap

The foreline trap minimises oil vapour backstreaming from the backing-pump and is recommended where the highest system cleanliness is required.

Foreline trap	Item Number
FL20K	A133-05-000

7.3.6 TAV vent-valve and vent-port adaptor

A solenoid-operated vent-valve is available for system venting. The valve is 24 V d.c., normally-open, and can be driven automatically from the EXC Controller. The solenoid-valve is fitted in place of the manual-valve, or alternatively can be fitted with an adaptor (supplied with the valve) and be used with any suitable NW10 flanged port on your vacuum system.

An NW10 - $^1/_8$ inch BSP male adaptor is also available. This adaptor allows the vent-port to be used with any suitable NW10 fitting: see Figure 9, item 9.

Product	Item Number
TAV5 vent-valve	B580-66-010
NW10 - $^1/_8$ inch male adaptor	B580-66-011

7.3.7 ACX air-cooler

An ACX air-cooler can be fitted to all pumps in the EXT range. However, please refer to Section 3 to check the suitability of air-cooling in a particular application.

Pump	Air-cooler	Item Number
EXT70	ACX70	B580-53-050
EXT250	ACX250	B580-53-150

7.3.8 Vibration isolators

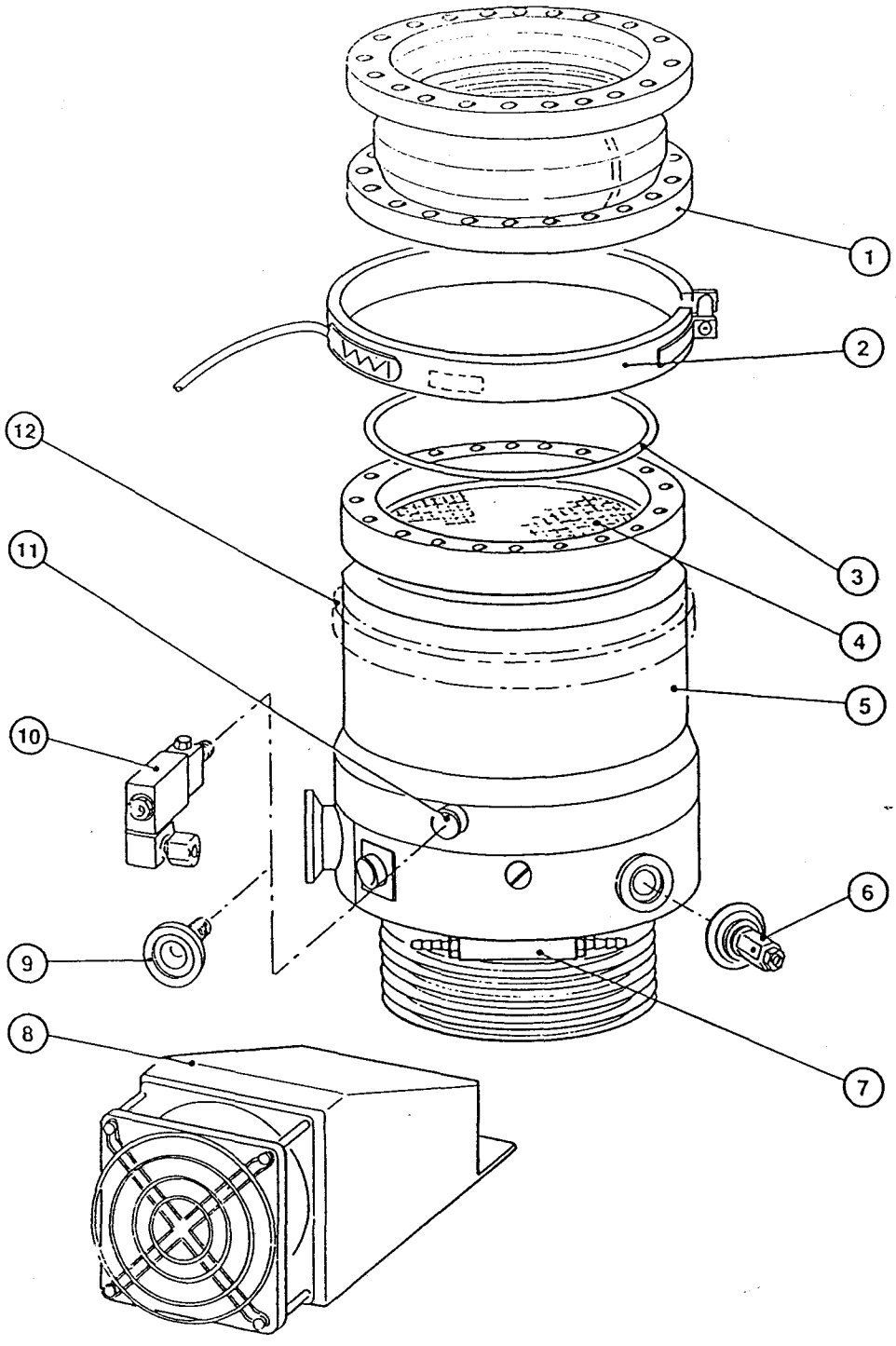
In applications where the small amount of vibration generated by the turbomolecular pump is a problem, a vibration isolator can be fitted. The isolator consists of two special flanges separated by a flexible bellows and a rubber, anti-vibration, outer collar. The isolator required is dependent on the pump flange size.

Flange size	Item Number
DN63ISO-K	B580-15-000
DN63CF	B580-01-000
DN100ISO-K	B580-20-000
DNI00CF	B580-05-000

7.3.9 PRX purge restrictor

A modified DN10NW centring-ring is available to filter the purge gas and restrict its flow rate to the recommended flow of 25 sccm. The restrictor is suitable for all EXT pumps fitted with a purge-port.

Purge restrictor	Flange size	Item Number
PRX10	NW10	B580-65-001



1. Vibration isolator
2. Bakeout band
3. Inlet-flange seal (supplied)
4. Inlet-screen (supplied)
5. EXT pump
6. Purge restrictor
7. Water-cooler (supplied)
8. Air-cooler *
9. DN10NW adaptor
10. Solenoid vent-valve
11. Vent-port (supplied with manual-valve fitted)
12. Bakeout band position

* The design of the air-cooler varies according to pump model

Figure 9 - Installation of optional accessories (and spares)

Edwards International

EUROPE

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Geschäftsbereich Komponenten
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Fax: 2 771 9415

EDWARDS