B735-21-880
Issue C

Instruction Manual

EXT250M Turbomolecular Pump

Description	*Flange size*	*Cable length*	*Item Number*
EXT250M Turbomolecular Pump, with EXC300M Controller and pump-to-controller cable			
	DN100ISO-K	*1 m*	*B735-21-010*
	DN100ISO-K	*3 m*	*B735-21-030*
	DN100ISO-K	*5 m*	*B735-21-050*
	DN100CF	*1 m*	*B735-22-010*
	DN100CF	*3 m*	*B735-22-030*
	DN100CF	*5 m*	*B735-22-050*

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Declaration of Conformity

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

EXT250M Turbomolecular Pumps:

EXT250M/ISO100	B735-01-000
EXT250M/100CF	B735-02-000

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

EN ISO12100-2: 2003	Safety of machinery. Basic concepts, general principals for design. Technical principals.
EN61010-1: 2001	safety requirements for electrical equipment for measurement, Control and laboratory use. General requirements.*
EN1012-2: 1997	Compressors and vacuum pumps. Safety requirements. Vacuum pumps.
EN61326: 1997 + A1: 1998 + A2: 2001 (Industrial Location, Class B Emissions)	Electrical equipment for measurement, control and laboratory use. EMC requirements.

* The pumps comply with EN61010-1 (2001) when installed in accordance with the instruction manual supplied with the pumps.

following the provisions of:

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

JDWatson

Dr J. D. Watson, Technical Director
Vacuum Equipment and Exhaust Management Product Divisions

1 DECEMBER 2004 SHOREHAM

Date and Place

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

P200-00-340 Issue A

BOC EDWARDS

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1 INTRODUCTION

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the BOC Edwards EXT250M Turbomolecular Pump. You must use the EXT250M as specified in this manual.

The EXT250M pump is designed for use with a BOC Edwards EXC300M Controller. Read this manual and the EXC300M Controller instruction manual before you install or operate the equipment. The EXC300M Controller instruction manual contains 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 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.

In accordance with the recommendations of EN61010, the following warning symbols may appear on the pump or its accessories:

Caution - refer to accompanying documents.

Caution - risk of electric shock.

Caution - hot surface.

Protective conductor terminal.

The units used throughout this manual conform to the SI international system of units of measurement. Where purge flow rates are specified, the abbreviation 'sccm' is used to mean 'standard cm^3 min^{-1}': this is a flow of 1 cm^3 min^{-1} at an ambient temperature of 0 ^oC and a pressure of 1013 mbar (1.013×10^5 Pa).

1.2 General description

The EXT250M Turbomolecular Pump is a multi-stage axial-flow turbine, optimised for operation in molecular flow conditions. The internal structure of the EXT250M Turbomolecular Pump is shown in Figure 1. In the following description, item numbers in brackets refer to items shown in Figure 1.

The multi-stage light alloy turbine rotor (22) is machined from one piece to form rows of angled blades fitted to a central shaft (3). The blades of the rotor rotate between the stator blades. The stator assembly has bladed half-discs (21) separated by spacer rings (20). The blades are angled so that the gas from 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 mass.

The rotor is driven by a high-efficiency, brushless d.c. motor. The motor has a magnetized rotor (7) fitted onto the shaft, and a wound stator (19) 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 60000 r min^{-1}. during pump operation.

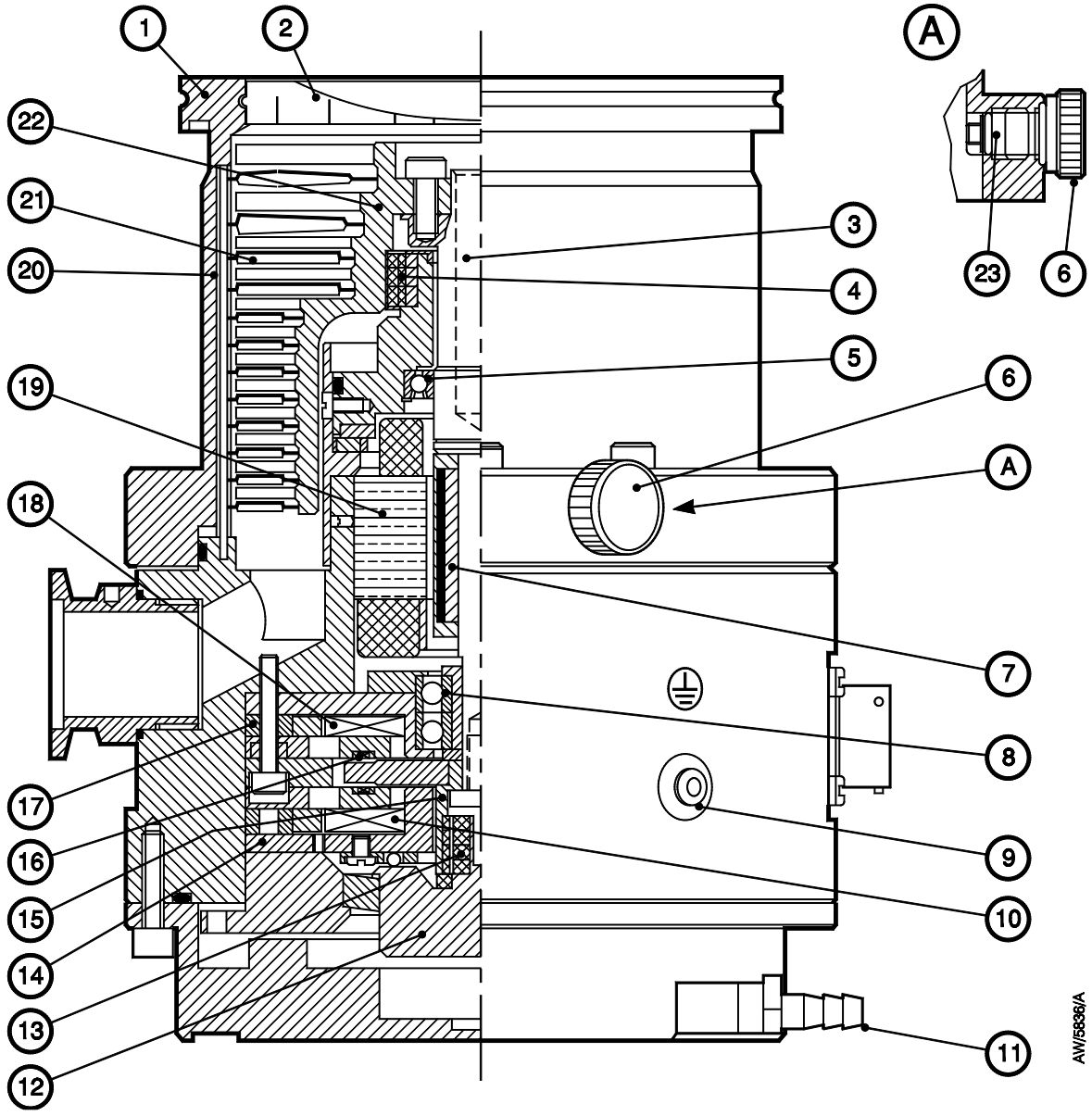
The rotor assembly is supported radially at both ends of the shaft by frictionless, passive magnetic bearings (4, 13). Both bearings incorporate resiliently-sprung mass dampers (12). An active electromagnetic bearing (14, 17), controlled by a drive circuit in the EXC300M Controller, provides axial support and stability. Sensor coils (16) detect any axial movement of the rotating armature (15) and cause the drive circuit to modulate the current in the drive coils (10, 18) to counter the movement.

The pump has safety bearings (5, 8). These safety bearings are precision ball-bearings which limit the displacement of the rotor assembly if excessive mechanical shocks occur when the pump is in operation. The bearings also support the rotor when the EXC300M Controller is switched off and in emergency operation caused by a vacuum accident or disconnection of the electromagnetic bearing drive.

The EXT250M is available with either an ISO collar or a CF inlet-flange. An inlet-screen (2) is fitted in the bore of the inlet-port. The inlet-screen protects you from the sharp blades and also prevents the entry of debris into the pump.

The pump has a vent-port which you can use to vent the pump and your vacuum system to atmospheric pressure. The vent-port introduces the vent gas part way up the pump rotor to ensure maximum cleanliness. The pump is supplied with a manual vent-valve (6) and a VRX10 vent-restrictor (23) fitted to the vent-port. As described in Section 3.4, you can remove or replace the vent-restrictor and you can replace the manual vent-valve with a TAV solenoid-operated vent-valve (available as an accessory: see Section 7).

The EXT250M pump has a purge-port (Figure 3, item 4) in the motor and bearing housing chamber. You can introduce an inert purge gas through the purge-port to protect the bearings and the motor from chemical attack by the gases pumped. 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). The purge-port is fitted with a VRX10 vent-restrictor; this prevents accidental venting by the purge gas. You can remove the vent-restrictor as described in Section 3.5.1.



1. Inlet-flange
2. Inlet-screen
3. Shaft
4. Passive magnetic bearing (radial)
5. Safety bearing (radial)
6. Vent-valve
7. DC motor rotot
8. Safety bearing (axial/radial)
9. Earth (ground) screw
10. Drive coil (lower)
11. Water connector
12. Damper
13. Passive magnetic bearing (radial)
14. Active electro-magnetic bearing (upper)
15. Rotating armature
16. Sensor coils
17. Active electro-magnetic bearing (upper)
18. Drive coil (upper)
19. DC motor stator
20. Spacer ring
21. Stator
22. Rotor
23. VRX10 vent-restrictor fitted in the vent-port *

* A VRX10 vent-restrictor is also fitted in the purge-port (not shown)

Figure 1 - Part-sectional view of EXT250M Turbomolecular Pump

Electrical connection between the EXT250M and the EXC300M Controller is by a 19-way connector and a pump-to-controller cable (supplied).

The EXT250M may be cooled by natural convection to the surrounding air, by forced-air cooling (with an optional air-cooler accessory), or by water cooling (by the flow of cooling-water through the water-cooler). The water-cooler has two riffled hose connectors for connection of your cooling-water supply and return pipelines. A thermal sensor monitors the temperature of the motor and the pump.

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.

If you vent the pump when it is at full rotational speed, you must limit the rate of pressure rise to avoid damage to the safety bearings. A VRX10 vent-restrictor is fitted to the EXT pump to limit the rate of pressure rise and allow you to open the manual vent-valve when the pump is at full rotational speed. The VRX range of vent-restrictors (see Section 7.4.8) have fixed orifices, so venting time will depend on the volume of your vacuum system. If you use a VRX vent-restrictor to vent the pump, the time required to vent to atmospheric pressure may be long, particularly if your vacuum system has a large volume. You can change the VRX vent-restrictor to suit the volume of your vacuum system to minimise venting time: refer to Section 3.4.

If you wait for the EXT pump speed to fall to 50% of full rotational speed before you open the manual vent-valve, you do not need a vent-restrictor. If you cannot fit a vent-restrictor (for example, if you vent through a suitable flange on your vacuum system), 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 a TAV vent-valve controlled by the EXC Controller, 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.

1.4 Safety bearings

The safety bearings of the EXT250M pump are dry-lubricated and have a limited useful life. In normal use, the safety bearings will survive several thousand operational cycles, including Start/Stop, electrical supply failure, external shocks and controlled venting (see Section 4.3).

If one of the accidents listed in Table 1 occurs, this will reduce the remaining life of the safety bearings

Accident	Effect	Result
The pump-to-controller cable is disconnected or broken.	The electrical supply to the electromagnetic bearing is lost.	The rotor assembly drops immediately onto the safety bearings with considerable noise as the EXT250M decelerates. The 'Emergency' LED on the EXC300M will go on.
The EXT250M is suddenly exposed to atmospheric pressure due to a massive leak or rupture of the vacuum system.	The force on the rotor will overcome the force of the electromagnetic bearing and the rotor will rebound against the safety bearings.	The 'Emergency' LED on the EXC300M will go on. There may be considerable noise if the pump rotor remains in contact with the safety bearings.
The EXT250M is exposed to excessive mechanical shock.	The rotor remains in contact with the safety bearings when the centrifugal force of the rotor exceeds the restoring force of the magnetic bearings.	The 'Emergency' LED on the EXC300M will go on. There may be considerable noise if the rotor remains in contact with the safety bearings.

Table 1 - Accidents which affect the life of the safety bearings

2 TECHNICAL DATA

2.1 General

Performance	See Table 2
Dimensions	See Figure 3
Maximum inlet-flange temperature	100 ^{o}C
Maximum magnetic field	5 mT
Installation category	EN61010-1, category 1
Pollution degree	EN61010-1, category 2
Equipment type	Fixed Equipment, for indoor use only
Inlet screen mesh size	Hexagonal holes, 1 mm

2.2 Pumping media

WARNING

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

WARNING

Do not use an EXT250M to pump explosive gas mixtures as the EXT250M is not suitable for this purpose.

CAUTION

Do not use an EXT250M to pump gases which contain more than 20% oxygen unless the pump is gas purged.

CAUTION

Do not use the EXT250M to pump mercury vapour and do not allow mercury (for example, from a Mcleod gauge) to come into contact with the pump. If you do, the pump rotor may corrode and fail.

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

2.2.1 EXT250M without gas purge

The EXT250M is 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 pump 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. The EXT250M is not suitable for pumping explosive, aggressive or corrosive gases.

2.2.2 EXT250M with gas purge

When purged with an inert gas, the EXT250M pump can be used to pump oxygen in concentrations above 20% by volume.

The recommended purge gas flow for typical applications is 25 sccm (0.42 mbar l s^{-1}, 42 Pa l s^{-1}). If you pump oxygen-rich gas mixtures, adjust the purge gas flow to dilute the oxygen concentration to less than 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 ^{o}C
Maximum size of particulates	1 μm
Maximum concentration of oil	0.1 parts per million
Maximum allowed rate of pressure rise	See Figure 2
Vent-valve orifice diameter	See Tables 4 and 5
Maximum pressure	2 bar (gauge), 29 psig, 3 x 10^5 Pa

2.4 Purge gas specification

Purge gas	Dry nitrogen, argon or other inert gases
Maximum dew point at atmospheric pressure	-22 ^{o}C
Maximum size of particulates	1 μm
Maximum concentration of oil	0.1 parts per million
Purge gas flow (when required)	20 to 100 sccm (0.33 to 1.67 mbar l s^{-1}, 33 to 167 Pa l s^{-1})
Recommended purge gas flow	25 sccm (0.42 mbar l s^{-1}, 42 Pa l s^{-1})
Maximum allowable purge gas supply pressure	2 bar (gauge), 29 psig, 3 x 10^5 Pa

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 ^{o}C)	See Table 2
Water temperature	see Table 2
Maximum water pressure	5 bar (gauge), 72 psig, 6 x 10^5 Pa

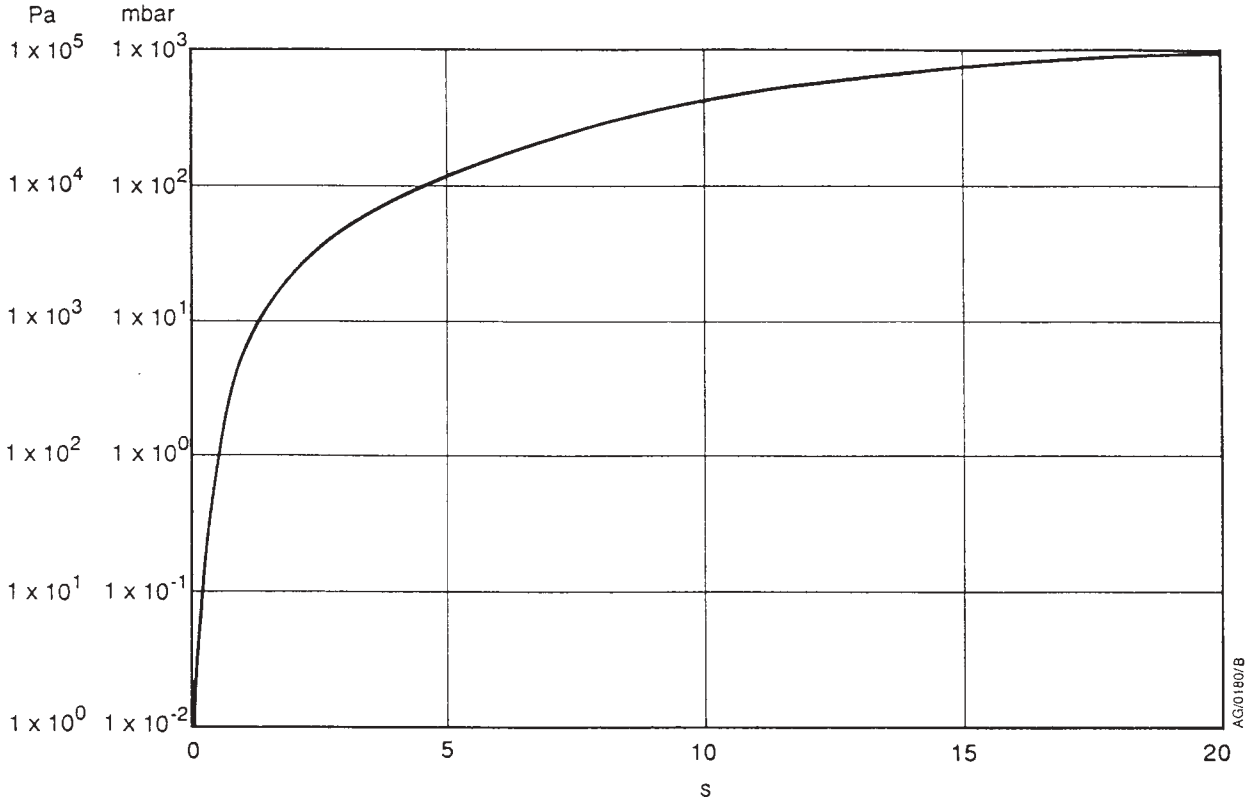
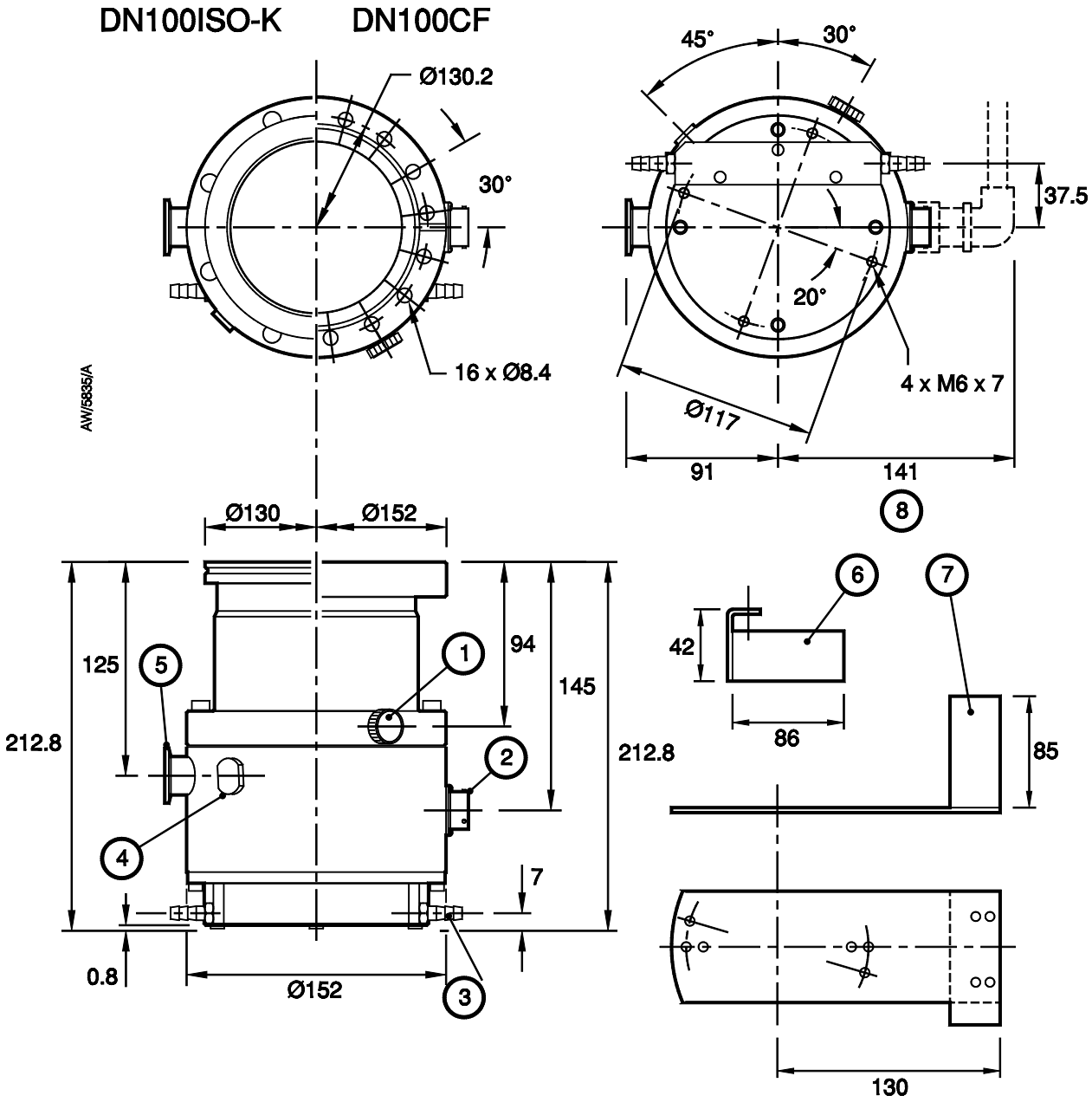


Figure 2 - Maximum allowed rate of pressure rise during venting: backing pressure plotted against time

Mass	11 kg (DN100CF)/8.5 kg (DN100ISO-K)
Inlet-flange Outlet-flange Vent-port Purge-flange	DN100CF/DN100ISO-K DN25NW 1/8-inch BSP female NW10
Pumping speed N_2 ‡ He ‡ H_2 ‡	240 l s^{-1} 250 l s^{-1} 190 l s^{-1}
Compression ratio N_2 He H_2	>1 x 10^8 2 x 10^4 1500
Ultimate pressure *	<5 x 10^{-10} mbar, <5 x 10^{-8} Pa (CF) <5 x 10^{-9} mbar, <5 x 10^{-7} Pa (ISO-K)
Minimum backing-pump displacement	4.5 m^3 h^{-1}
Maximum continuous inlet pressure (water cooling at 15°C) § Maximum continuous inlet pressure (air cooling at 35°C) § Maximum continuous inlet pressure (free convection at 35°C) §	2 x 10^{-1} mbar, 20 Pa 2 x 10^{-1} mbar, 20 Pa 5 x 10^{-2} mbar, 5 Pa
Recommended backing-pump †	E2M5
Operating attitude	Any orientation
Nominal rotational speed Standby rotational speed	60000 r min^{-1} 42000 r min^{-1}
Starting time to 90% speed Braking time with/without venting ❑	90 sec 1 min/11 min
Cooling method	Free convection/forced air/water
Ambient air temperature Free convection Forced air (flow rate > 70 m^3 h^{-1}, 40 cfm) Water temperature Required minimum water flow (at 15 °C)	 0 - 35 °C 0 - 40 °C 5 - 30 °C 15 l h^{-1}
Noise level (at 1 metre)	< 50 dBA
Maximum overpressure	2 bar gauge (3 x 10^5 Pa)
Recommended controller Apparent power input Quiescent electrical power consumption	EXC300M 480 VA 15 W

‡ Pumping speeds are without inlet-screen. Inlet-screens (supplied fitted) 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.
❑ The braking time (to below 10% of normal speed) without venting will be reduced if the EXC300M Controller provides the electrical supply for an air-cooler or a vent-valve

Table 2 - EXT250M technical data



1. Vent-valve
2. Electrical supply connector
3. Cooling-water connectors
4. Purge-port
5. Backing-port
6. Axial-mounted air-cooler accessory
7. Side-mounted air-cooler accessory
8. Allowance for right-angle cable connector

Figure 3 - EXT250M Turbomolecular Pump dimensions (mm)

3 INSTALLATION

WARNING

Safely route all vacuum, vent/purge gas and cooling-water pipelines, and all electrical cables and wires, so that people cannot trip over them.

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 below. If any of these items is missing, notify your supplier in writing within three days.

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.

Qty	Description	Check (✓)
1	EXT250M Turbomolecular Pump	❑
1	Trapped 'O' ring or compression gasket	❑
1	EXC300M Controller	❑
1	Pump-to-Controller Cable	❑

Table 3 - Checklist of items

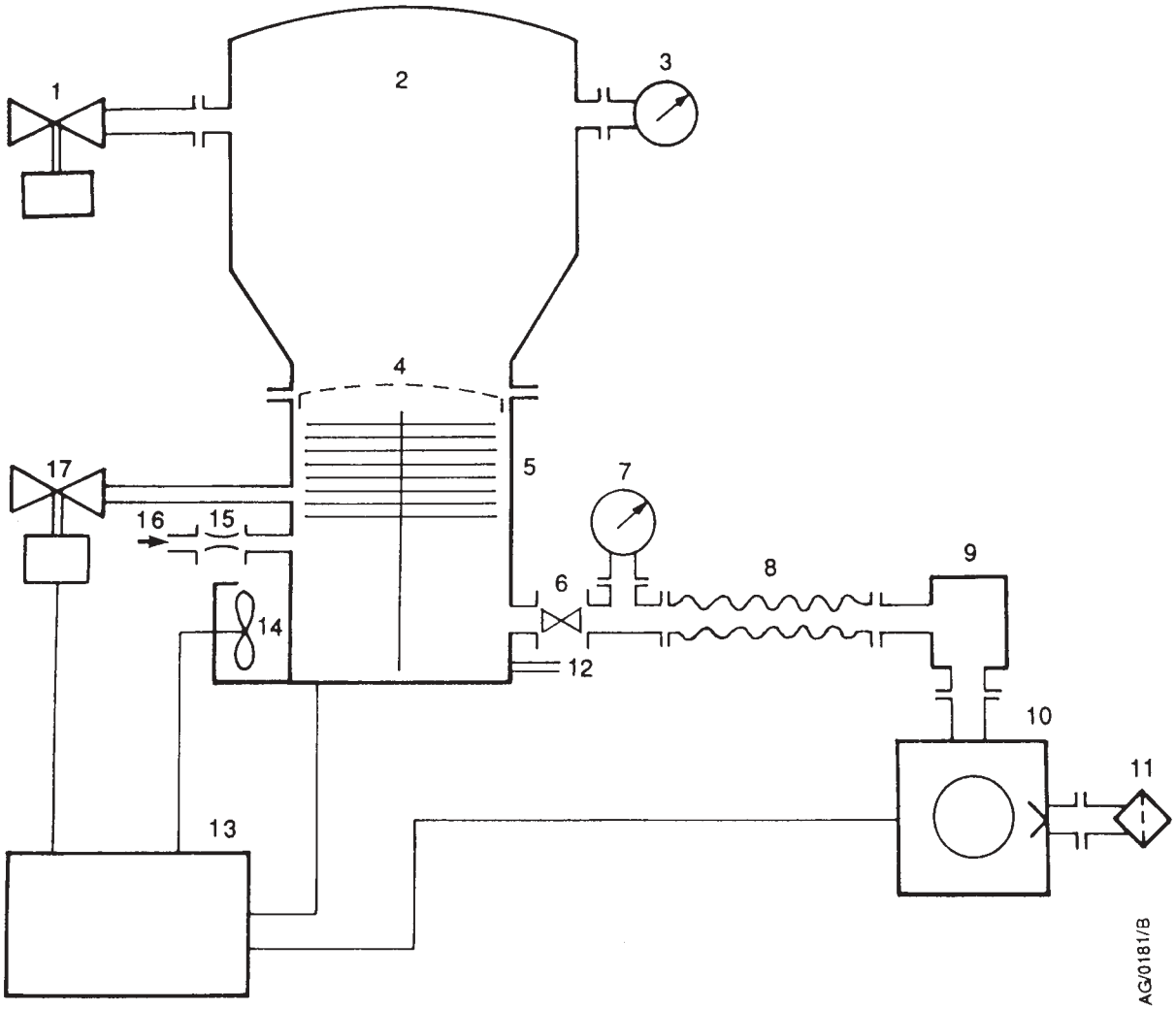
3.2 Typical installation

3.2.1 General

A typical pumping system with an EXT250M is shown in Figure 4. Note that the pump-inlet is connected directly to the vacuum system and that an optional backing-pump isolation-valve is fitted to the backing-port. This configuration is often used because the EXT250M is oil-free and may therefore be considered to be part of the high vacuum system.

When necessary, purge the EXT pump with inert gas as described in Section 3.5.

The accessories available for the EXT250M are detailed in Section 7; the accessories are shown in Figure 6.



1. Alternative position for vent-valve
2. Vacuum system
3. High-vacuum gauge
4. Inlet-screen
5. EXT250M pump
6. Isolation-valve (optional)
7. Vacuum gauge
8. Flexible bellows
9. Foreline trap
10. Rotary backing-pump
11. Mist filter
12. Cooling-water connectors
13. EXC300M Controller
14. Air-cooler
15. PRX10 purge-restrictor
16. Regulated purge gas supply
17. Vent-valve

Figure 4 - Typical pumping system

3.2.2 Protection of the safety bearings

You must take precautions to prevent the occurrence of the accidents listed in Table 1. If you do not, the safety bearings may be damaged. We recommend that you take the following precautions to prevent or limit damage to the safety bearings:

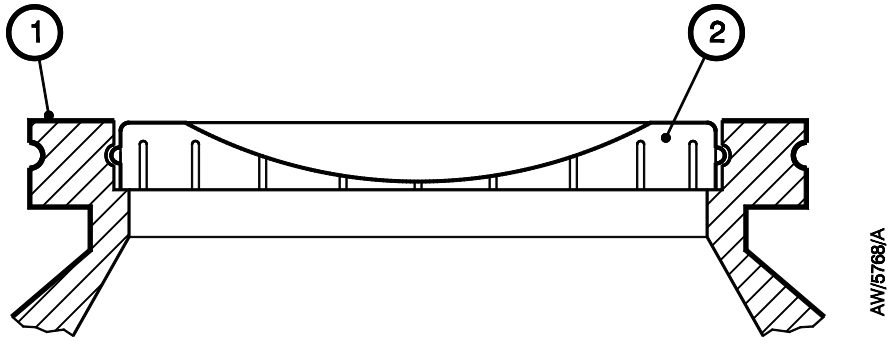
- Use physical barriers to protect the pump-to-controller cable against damage or accidental disconnection.
- Fit a suitable vent-restrictor to the inlet of your vent-valve if you want to vent your system when the pump speed is above 50% of full rotational speed. The vent and purge-ports of the pump are fitted with vent-restrictors which limit the rate of pressure rise to a safe value, even when the pump inlet-flange is blanked off.
- Fit a solenoid operated vent-valve (see Section 3.4) and control the vent-valve with the EXC300M Controller. The EXC300M Controller is supplied configured so that it opens the vent-valve if the 'Emergency' or 'Fail' LEDs go on.
- Construct your system so that it prevents the transmission of excessive mechanical shocks to the EXT250M pump.

3.3 Connect the EXT250M to your vacuum system

> WARNING
>
> Install the pump in your vacuum system before you connect the EXC300M 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 of debris falling 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 connect the pump to your system. If the inlet-screen is removed, the pumping speed will increase by approximately 10%.



1. EXT250M inlet-flange
2. Inlet-screen

Figure 5 - Correct installation of the inlet-screen

To remove the inlet-screen, carefully extract it from the inlet-flange with a bent wire hook. To replace a screen which has been removed, install it as shown in Figure 5, with the BOC 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.

3.3.2 Mechanical fixing

WARNING

Do not operate the EXT250M pump until it is securely fixed. If the pump seizes, the stored energy of the rotor can cause rapid movement of the pump, which may cause damage and injury to people.

There are two ways in which the EXT250M pump can be securely fixed. Ideally, the EXT250M pump should be securely fixed by its inlet-flange to a rigid, firmly fixed vacuum system: see Section 3.3.4. If this is not possible because of the nature of the vacuum system, the base of the EXT250M pump must be securely fixed to a firm support: see Section 3.3.3.

If your EXT250M pump is to be mounted on moveable equipment, the maximum acceleration of the pump, in any direction, must be less than 1 G. If the pump acceleration will be greater than 1 G, the pump must be switched off before it is moved. Ensure that no vibrations caused by external equipment will affect the pump. If necessary, support the EXT250M separately.

3.3.3 Base mounting

Ensure that the base of the EXT250M pump is securely fixed to a firm support (refer to Figure 3 for the fixing hole details). If the pump supports the weight of the vacuum system, the mass of the vacuum system must be no more than 20 kg.

You must also ensure that your mounting method meets the following requirements, so that the EXT250M pump will remain secure in the event of a pump seizure:

- The support mounting must be able to withstand a destructive torque of 620 Nm.
- Fit cap-head fixing screws through the tapped fixing-holes in the base of the pump (see Figure 3): use M5 screws.
- The fixing screws must comply with ISO 898-1, with a strength class of 12.9 (nominal tensile strength 1200 MPa).
- The fixing screw engagement length must be 6 mm or more.
- Tighten the fixing screws to a torque of 12 Nm (1.22 kgf m).

3.3.4 Inlet connection and orientation

The EXT250M pump can be fixed to the vacuum system by the inlet-flange. The pump can be mounted in any attitude. If the pump is mounted horizontally and you use a rotary vane pump to back the EXT250M pump, 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.

The inlet-connection of the EXT250M pump is a CF flange or an ISO flange:

- If the pump has a CF flange, use the copper compression gasket supplied with the pump and use a full complement of bolts to connect the inlet-flange of the pump to the vacuum system.
- If the pump has an ISO flange, use the BOC Edwards trapped 'O' ring supplied with the pump and use a minimum of four claw clamps to connect the inlet-flange of the pump to the vacuum system. Ensure that each claw clamp is tightened to a torque of 10 Nm or more.

  Alternatively, use a rotatable collar and the trapped 'O' ring supplied with the pump to connect the inlet-flange of the pump to the vacuum system; use a full complement of bolts with the rotatable collar.

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: refer to Section 7.4.6 for the Item Numbers, and refer to the instruction manual supplied with the vibration isolator for installation details. If you fit a vibration isolator, you must securely fix the base of the EXT250M pump as described in Section 3.3.3.

Note: The first time you pump down the system to vacuum, you must re-tighten the bolts which secure the inlet-flange.

3.3.5 Backing connection

Connect the backing-port to your backing-pump with suitable vacuum pipes and connectors. If necessary, use flexible pipe or bellows to reduce the transmission of vibration from the backing-pump to the EXT250M pump. To further reduce vibration from the backing-pump, secure a mid-section of the flexible vacuum pipe to the floor or to a substantial mass.

We recommend that you use a BOC Edwards two-stage backing-pump. The backing-pump can be controlled by the EXC300M Controller. The recommended size of the backing-pump required is given in Table 2. You may have to use a larger backing-pump if you operate the pump with high inlet pressure or high throughput or if you purge the pump with more than 25 sccm (0.42 mbar l s^{-1}, 42 Pa l s^{-1}) of purge gas.

Use a foreline trap available from BOC Edwards as an accessory (see Section 7) to ensure that the backing line is free from oil vapour. In addition, you can fit a backing pipeline isolation-valve directly to the backing-pump. This valve totally isolates the EXT250M and, as the EXT250M is oil-free, may be used in place of an isolation-valve at the pump-inlet.

3.4 Vent-valve connection and control

3.4.1 Vent configurations

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 EXT250M pump and your vacuum system by any of the following methods:

- Use the manual vent-valve and vent-restrictor supplied.
- Use the manual vent-valve and a different vent-restrictor (see Section 7.4.8).
- Use a TAV solenoid vent-valve accessory (see Section 7) in place of the manual vent-valve, together with a vent-restrictor, if necessary.
- Use a TAV vent-valve connected to a convenient flange on your vacuum system, with a vent-restrictor, if necessary.
- Use an alternative valve connected to your vacuum system, together with a vent-restrictor if necessary.

If you want to open the manual vent-valve when the pump speed is above 50% of full rotational speed, you must ensure that you have a suitable vent-restrictor fitted to suit your vacuum system: refer to Tables 4 and 5. If you do not have a suitable vent-restrictor fitted, you must only open the vent-valve after the EXT pump speed has fallen to 50% of full rotational speed. If you use the TAV vent-valve, you can only vent the EXT pump when it is at full rotational speed if the vacuum system has a volume of 10 litres or more. If the volume of your vacuum system is less than 10 litres, you must fit a suitable vent-restrictor to the TAV vent-valve. If you do not fit a suitable vent-restrictor, you must only open the vent-valve to vent the EXT pump after the EXT pump speed has fallen to 50% of full rotational speed.

If you use the EXC Controller to control your TAV 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, fit a suitable vent-restrictor to the inlet of your vent-valve (see Tables 4 and 5). If you cannot fit a vent-restrictor 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).

Notes: *If you use a fixed-orifice vent-restrictor, you may find that the time required to vent your system is unacceptably long. You may be able to reduce the vent time if you use an unrestricted vent port without a vent-restrictor and wait until the pump speed has fallen to 50% of full rotational speed before you vent the pump.*

If your system automatically controls an auxiliary vent-valve, you can use the auxiliary vent-valve with a suitable vent-restrictor together with a TAV vent-valve (controlled by the EXC Controller) for dual venting. When you want to stop the EXT pump and vent your system, open the auxiliary vent-valve when the EXT pump is at full speed and configure the EXC Controller to open the TAV vent-valve when the EXT pump speed falls to 50% of full rotational speed. If your auxiliary vent-valve is connected to the purge-port of the EXT pump, select a suitable VRX vent-restrictor (see Tables 4 and 5) and fit it to the purge-port as described in Section 3.5.1.

Vacuum system volume (l)	Suitable VRX Restrictor	Orifice diameter (mm)
≥ 25	VRX70	≤ 0.7
< 25	VRX50	≤ 0.5
< 10	VRX30	≤ 0.3
< 5	VRX20	≤ 0.2
< 2	VRX10	≤ 0.1

Table 4 - Vent-valve orifice diameter (with atmospheric pressure at the inlet of the vent-valve)

Vacuum system volume (l)	Suitable VRX Restrictor	Orifice diameter (mm)
≥ 25	VRX50	≤ 0.5
< 25	VRX30	≤ 0.3
< 10	VRX20	≤ 0.2
< 5	VRX10	≤ 0.1

Table 5 - Vent-valve orifice diameter (with 2 bar absolute, 2 x 10^5 Pa pressure at the inlet of the vent-valve)

3.4.2 Remove and replace the vent-port VRX vent-restrictor

To remove the VRX vent-restrictor, refer to Figure 1 and use the following procedure.

1. Remove the manual vent-valve (6) from the pump.

2. The vent-restrictor (23) has an M3 tapped hole. Fit an M3 screw to the tapped hole, then pull the screw to remove the vent-restrictor from the vent port.

To refit the vent-restrictor or fit a new vent-restrictor:

1. Apply a light wipe of vacuum grease to the 'O' ring on the vent-restrictor (23).

2. Fit an M3 screw to the tapped hole on the vent-restrictor (23) and push the vent-restrictor fully into the vent-port.

3. Remove the M3 screw, then refit and tighten the manual vent-valve (6).

3.5 Purge gas connection

3.5.1 Remove and replace the purge-port VRX vent-restrictor (if necessary)

If necessary use the following procedure to remove the VRX vent-restrictor in the purge-port (Figure 3, item 4).

1. Refer to Figure 6. Remove the blanking-plug (9) or any vacuum fittings from the purge-port.

2. Fit a long M3 screw (M3 x 50 is suitable) to the tapped hole in the vent-restrictor (6), then pull the screw to remove the vent-restrictor from the purge-port.

To refit the vent-restrictor or fit a new vent-restrictor:

1. Refer to Figure 6. Fit a long M3 screw (M3 x 50 is suitable) to the tapped hole on the vent-restrictor (6) and push the vent-restrictor fully into the purge-port. Ensure that the 'O' ring correctly seals the vent-restrictor in the purge-port.

2. Remove the M3 screw, then fit or refit the vacuum fittings to the purge-port.

3.5.2 Connect the purge gas

Refer to Figure 6. If you want to supply a purge gas to the pump, remove the blanking-plug (9) 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 2.3.

You must limit the flow rate of the purge gas to the allowed range, also specified in Section 2.3. Note that the VRX vent-restrictor (6) fitted to the purge-port will not limit the flow rate to a low enough value for purge purposes. To limit the flow rate, use a flow controller or a pressure regulator and calibrated flow restrictor. The PRX10 purge restrictor accessory (see Section 7.4) is suitable for this purpose.

3.6 Electrical installation

Always make the electrical connections to the EXT250M after it has been installed on your vacuum system.

The EXC300M Controller provides the electrical supply to the EXT250M through the 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 EXC300M Controller. Do not disconnect the cable while the pump is operating, as this will cause an accident and damage the safety bearings (see Section 3.2.2).

The EXC300M 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 EXC300M Controller to complete the electrical installation.

3.7 Cooling

CAUTION

When you bake the EXT250M pump to above 70 ^{o}C at the inlet-flange, you must cool the pump by forced-air or water-cooling to prevent automatic shut-down of the pump by the EXC Controller.

We recommend that, whenever possible, you cool the EXT250M pump by forced-air or water-cooling, however if necessary you can use natural convection to cool the pump on certain applications. Table 6 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.

Application conditions	Cooling method
Ambient temperature < 30 °C, light pumping duty, inlet-flange temperature < 70 °C	Natural convection, forced-air or water- cooling
Ambient temperature < 35 °C, continuous light pumping duty with inlet-flange temperature > 70 °C / baking Ambient temperature < 40 °C, light pumping duty, inlet-flange temperature < 70 °C Ambient temperature < 40 °C, cycling repeatedly from atmospheric pressure to ultimate pressure, light pumping duty with cycle-time > 15 mins, or inlet-flange temperature < 70 °C	Forced-air or water-cooling
Ambient temperature < 40 °C Continuous high throughput Repeated cycling from atmospheric pressure with cycle time < 15 mins or inlet-flange temperature > 70 °C Combinations of high ambient temperature, bakeout band operation, high gas throughput and repeatedly cycled operation	Water-cooling

Table 6 - Pump cooling methods for different applications

3.7.1 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 water-cooler as described below. Either of the two riffled hose connectors (Figure 1, item 11) on the water-cooler 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 on the water-cooler.

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 operate a solenoid-valve for this purpose.

When you remove the EXT pump for maintenance or when you replace the EXT pump, you can unscrew the three M4 cap-head fixing-screws to remove the water-cooler from the pump; you do not have to break the cooling-water circuit. Make sure that there is a layer of thermal contact grease on the water-cooler before you fit it to the pump.

3.7.2 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.

4 OPERATION

WARNING

Do not disconnect the pump-to-controller cable while the EXT250M is operating. If you do, there may be a risk of injury or death by electric shock, and the pump rotor will drop onto its safety bearings which will cause unnecessary wear.

WARNING

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

4.1 Start-up

CAUTION

Avoid sudden shocks and continuous heavy external vibration while the pump is operating, as this may cause the pump rotor to repeatedly touch the safety bearings.

Use the procedure below to start up a basic, manually-controlled pumping system with an EXC300M Controller. Refer to the EXC300M Controller instruction manual for simplified procedures, where the backing-pump and accessories are automatically controlled by the EXC300M Controller.

1. Switch on the EXC300M Controller. The pump electromagnetic bearing will levitate the rotor assembly.

2. Turn the manual vent-valve clockwise to close it.

3. Turn on the cooling-water supply (if water cooling is used).

4. Start the backing-pump.

5. When the vacuum system pressure is approximately 1 mbar (1×10^2 Pa) or less, press the Start/Stop switch on the EXC300M Controller to start the EXT250M. The pump will then accelerate to full operating speed.

The backing-pump and the EXT250M can be started simultaneously; this will allow the EXT250M rotor to act as an effective baffle throughout the pump-down cycle. However, if the volume of the vacuum chamber (together with the backing-pump) is more than approximately 25 litres, the time that the EXT250M takes to accelerate to half speed might cause the EXC300M Controller to enter a 'Fail' condition. To adjust the time allowed for the EXT250M to accelerate to half speed, refer to the instruction manual supplied with the EXC300M Controller.

Note: The first time you pump down the system to vacuum, you must re-tighten the bolts which secure the inlet-flange: refer to Section 3.3.4.

4.2 Standby

You can press the Standby button on the EXC300M Controller to operate the pump at reduced rotational speed. Select Standby before or after Start-up, for any of the following reasons:

- To extend safety 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.

Shut down the EXT250M as described below. Refer to the EXC300M Controller instruction manual where the backing-pump and accessories are automatically controlled by the EXC300M Controller.

1. Switch off the backing-pump and press the Start/Stop switch on the EXC300M Controller to switch off the EXT250M.
2. If a suitable vent-restrictor is fitted, turn the manual vent-valve anticlockwise to open it. If a suitable vent-restrictor is not fitted, wait until the pump speed has fallen to 50% of full rotational speed, then turn the manual vent-valve anticlockwise to open it.
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 EXC300M Controller for a full description of these features :

- The EXC300M Controller monitors the temperature and the electrical power consumption of the EXT250M pump. If the EXC300M 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 EXC300M Controller goes on.
- If pump rotational overspeed is detected by the EXC300M Controller, the pump is stopped immediately and the 'Fail' LED on the EXC300M Controller goes on.
- If the EXC300M Controller detects excessive displacement of the rotor assembly, then the pump is stopped immediately and the 'Emergency' LED on the EXC300M Controller goes on.
- If there is a power failure or the electrical supply is accidentally disconnected, the EXC300M Controller automatically switches the EXT250M to operate as a generator and shuts down the pumping system safely. As the EXT250M decelerates, regenerative braking is used to maintain the electrical supply to the electromagnetic bearing until a sufficiently low rotational speed has been reached for the rotor assembly to set down safely onto the safety bearings.

The EXC300M Controller is supplied configured to automatically stop the EXT pump if the 'Fail' or 'Emergency' LEDs go on. Isolate the pump from the backing pipeline or vent your system to prevent the backstreaming of oil and contamination of your vacuum system. Once the EXT250M has stopped, rectify the cause of the failure (refer to Section 5.5), press the EXC300M Controller Start/Stop button to reset the 'Fail' condition, and restart the EXT250M. If the pump is hot, allow sufficient time for it to cool before you restart it.

4.5 Emergency operation : loss of magnetic suspension

4.5.1 General

The EXT250M is designed to survive at least five full-speed touchdowns onto the safety bearings under vacuum. We recommend that you return the EXT250M to a BOC Edwards Service Centre after five touchdowns have occurred, or earlier if you have any doubts about the pump's performance (see Section 5).

4.5.2 Emergency shutdown

To prevent the dissipation of all of the energy stored in the rotating rotor into the safety bearings during touchdown, you must vent the EXT250M.

- With a manual system, vent the EXT250M and switch off the backing-pump to shorten the run-down time and reduce the energy dissipated in the safety bearings.
- In the case of vacuum failure, leave the EXC300M Controller switched to On so that the electromagnetic bearing will continue to operate and lift the rotor from the safety bearings as quickly as possible.

If the rotor decelerates from full rotational speed to standstill on the safety bearings, leave the EXT250M switched off for approximately one hour to allow it to cool before you restart it.

4.5.3 Excessive vibration

If external vibration or shocks cause the rotor assembly to continuously contact the safety bearings, the 'Emergency' LED on the EXC300M Controller goes on, the pump-motor stops immediately. The entry of debris into the pump can unbalance the rotor and cause the same effect.

4.6 Bakeout

CAUTION

When you bake the EXT250M to above 70 ^{o}C at the inlet-flange, you must cool the pump by forced air or water cooling, to prevent the pump from overheating.

If you heat your EXT250M 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 BOC 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 ^{o}C.

If you bake the vacuum system and the temperature of the system exceeds 200 ^{o}C, you must put a radiation shield between the system and the EXT250M. The 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

Disconnect the pump from the EXC300M Controller before you remove the pump from your vacuum system for maintenance or fault-finding procedures.

5.1 Introduction

The maintenance operations for the EXT250M 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 the ISX inlet-screen as described in Section 3.3.1; fit the WCX water-cooler as described in Section 3.7.1.

5.2 Bearing life

The EXT250M requires no routine maintenance.

The safety bearings will need to be replaced when they reach the end of their service life. This is typically more than five full speed touchdowns, but may be less; this depends on the type and the severity of the accidents which have occurred.

The bearings are not user-serviceable. When the bearings need replacement, we recommend that you exchange your pump for a factory reconditioned replacement. Alternatively, you can send your pump to a BOC Edwards Service Centre to have the bearings replaced.

When you return an EXT250M pump to a BOC Edwards Service Centre, please use the procedure included at the end of this manual. However, the instruction to drain all fluids does not apply.

5.3 Rotor life

The life of the EXT pump rotor is typically 40,000 to 50,000 cycles (of acceleration to full speed, and then deceleration to a stop). The pump rotor is not user-serviceable.

We therefore recommend that you exchange your pump for a factory reconditioned replacement every 20,000 cycles, or 10 years of use, whichever occurs first. Alternatively, you can send your pump to a BOC Edwards Service Centre for a major service (which will include rotor replacement).

When you return EXT pumps to BOC 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.

5.4 Clean the pump

WARNING

Clean the external surfaces of the EXT pump in a well-ventilated location. When you use cleaning solutions and solvents to clean the pump, observe all precautions specified by the manufacturer. Avoid inhalation of any particulates which may be present in the pump.

CAUTION

Do not attempt to clean any parts of the EXT pump other than the external surfaces. Organic solvents may damage internal pump components. Do not use abrasive materials to clean any part of the pump.

If the inside of the EXT pump is contaminated, it may not be possible to achieve the specified ultimate vacuum, or pump-down time may increase. In these circumstances, you should return the pump to a BOC Edwards Service Centre, where the pump will be dismantled and cleaned. Use the procedure given in the forms at the end of this manual to return the pump.

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

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

5.5 Fault finding

Symptom	Check	Action
The pump does not rotate after you press start; the 'Fail' LED is not on.	Is the EXC300M Controller power LED on? Is the EXC300M fan operating?	If not, check that the electrical supply is on, check that the switch at the rear of the EXC300M Controller is on, check the fuse in the rear of the EXC300M Controller. Check that the pump rotor is not seized. If all of the above are OK then the EXC300M Controller is faulty. Consult your supplier or your nearest BOC Edwards company.
	Is the EXC300M Controller Start/Stop LED flashing?	If so, check that the correct links are made on the EXC300M Controller logic interface (refer to the instruction manual supplied with the EXC300M Controller). Check that any system interlocks are correctly made (refer to the instruction manual supplied with the EXC300M Controller). Check that the pump-to-controller cable is connected If all of the above are OK then consult your supplier or your nearest BOC Edwards company.
	Is the EXC300M Controller first speed indication LED on?	If not, the EXC300M Controller is faulty. If the LED is on, then the EXT250M is faulty. Consult your supplier or your nearest BOC Edwards company.
The EXC300M Controller trips into 'Fail' at any speed	Are the system interlocks correctly connected?	Ensure that the system interlocks do not open after the EXT250M has started.
The EXC300M 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 large leak into the system.

Table 7 - Fault finding

Symptom	Check	Action
The EXC300M Controller trips into 'Fail' during the ramp-up and before 50% speed is reached (continued).	Is operating temperature of the EXT250M too high?	Increase the cooling-water flow or decrease the water temperature or do both. You may need to change from free convection to forced air cooling or 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.
	Is this the first ramp-up after a safety bearing touchdown? Can you hear a continuous noise from the safety bearings during the ramp-up?	The EXT250M pump safety bearings are damaged. Consult your supplier or your nearest BOC Edwards company.
		If none of the above, increase the timer setting (refer to the instruction manual supplied with the EXC300M Controller). If the EXC300M Controller still trips into 'Fail', consult your supplier or your nearest BOC Edwards company.
The EXC300M Controller trips into 'Fail' after 50% speed has been reached - the first two speed LEDs are on.	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 EXC300M Controller to delay the 'Fail' trip on 50% speed and set an appropriate delay time (refer to the instruction manual supplied with the EXC300M Controller).
	Is the operating temperature of the EXT250M too high?	Increase the cooling-water flow or decrease the water temperature or do both. You may need to change from free convection to forced air cooling or water cooling.
	Does the EXT250M pump rotor rotate freely?	If not, the EXT250M pump safety bearings are damaged. Consult your supplier or your nearest BOC Edwards company.

Table 7 - Fault finding (continued)

Symptom	Check	Action
The EXC300M Controller trips into 'Fail' and all the speed LEDs are on.	-	Consult your supplier or your nearest BOC Edwards company.
The EXC300M Controller trips into 'Emergency' at any speed.	Has there been a sudden accidental exposure of the EXT250M to atmospheric pressure?	Remove the gross leak. Allow the EXT250M to cool. Restart the EXT250M.
	Has there been a pump-to-controller cable disconnection or failure?	Reconnect the cable. Allow the EXT250M to cool. Restart the EXT250M.
	Is excessive vibration being transmitted from the vacuum system or has the EXT250M suffered large external shocks?	Remove or reduce the source of vibration or shock. Restart the EXT250M.
	Has the pump rotor been damaged or unbalanced by foreign material, deposition or etching?	Consult your supplier or your nearest BOC Edwards company.
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 (20 Pa) ?	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 return the pump as described in Section 5.3. Leak-check the pump. If the leak rate is > 1 x 10^{-7} mbar l s^{-1} (1 x 10^{-5} Pa l s^{-1}) consult your supplier or your nearest BOC Edwards company.

Table 7 - Fault finding (continued)

Symptom	Check	Action
The EXT250M 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 with 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 EXT250M making a constant high-pitched noise ?	If so, the rotor is out of balance. Consult your supplier or your nearest BOC Edwards company.
None of the above	-	Contact your supplier or your nearest BOC Edwards company.

Table 7 - Fault finding (continued)

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.

6.2 Disposal

Dispose of the EXT250M pump and any components and accessories safely in accordance with all local and national safety and environmental requirements.

Take particular care with any components which have been contaminated with dangerous process substances.

7 SERVICE, SPARES AND ACCESSORIES

7.1 Introduction

BOC Edwards products, spares and accessories are available from BOC 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 employ service engineers who have undergone comprehensive BOC Edwards training courses.

Order spare parts and accessories from your nearest BOC 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

BOC Edwards products are supported by a world-wide network of BOC 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 arrange provide BOC 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 BOC Edwards company.

7.3 Spares

7.3.1 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 Number of a replacement inlet-screen is given below.

Inlet-screen	**Item Number**
ISX100	B580-51-001

7.3.2 WCX water-cooler

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

Water-cooler	**Item Number**
WCX250M	B580-67-002

7.3.3 Inlet-flange seals

The EXT250M is supplied with a seal to match the inlet-flange. The Item Numbers of replacement seals are listed below.

Flange size	Inlet seal	Item Number
DN100ISO-K	ISO100 Trapped 'O' ring, fluoroelastomer	C105-23-001
DN100CF	100CF Copper gasket (pack of 5)	C082-00-003

7.3.4 EXC300M Controller

An EXC300M Controller is supplied with your EXT250M pump. The Item Number of a replacement EXC300M is given below.

Controller	Voltage	Item Number
EXC300M	100-120/200-240 V	D396-15-000

7.3.5 Pump-to-controller cable

A pump-to-controller cable is supplied with your EXT250M pump. The Item Numbers of replacement cables are given below.

Cable	Length	Item Number
EXT250M to EXC300M	1 m	D396-19-010
EXT250M to EXC300M	3 m	D396-19-030
EXT250M to EXC300M	5 m	D396-19-050

7.4 Accessories

7.4.1 Installation

The accessories available for use with the EXT250M are described in the following sections. Figure 6 shows how the accessories are fitted to an EXT250M pump.

7.4.2 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 EXC300M Controller.

Bakeout band	Voltage	Item Number
BX250	110 V	B580-52-041
BX250	240 V	B580-52-061

7.4.3 FL20K foreline trap

The foreline trap (Figure 4, item 9) 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

7.4.4 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 EXC300M Controller. The solenoid-valve can be fitted in place of the manual vent-valve or it can be fitted directly to the purge port. Alternatively, it can be fitted with the adaptor supplied and then used with any suitable NW10 flanged port on your vacuum system.

An NW10 to $^{1}/_{8}$-inch BSP male adaptor is also available. This adaptor allows the vent-port to be used with any suitable NW10 fitting and incorporates a removable fixed-flow restrictor.

Product	Item Number
TAV vent-valve	B580-66-010
NW10 to $^{1}/_{8}$-inch male adaptor	B580-66-011

7.4.5 ACX air-cooler

An ACX air-cooler can be fitted to the EXT250M pump. However, please refer to Section 3 to check the suitability of air cooling in a particular application.

Air-cooler	Item Number
ACX250	B580-53-150

7.4.6 Vibration isolators

In applications where the small amount of vibration generated by the EXT250M 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
DN100ISO-K	B580-20-000
DNI00CF	B580-05-000

7.4.7 PRX purge-restrictor

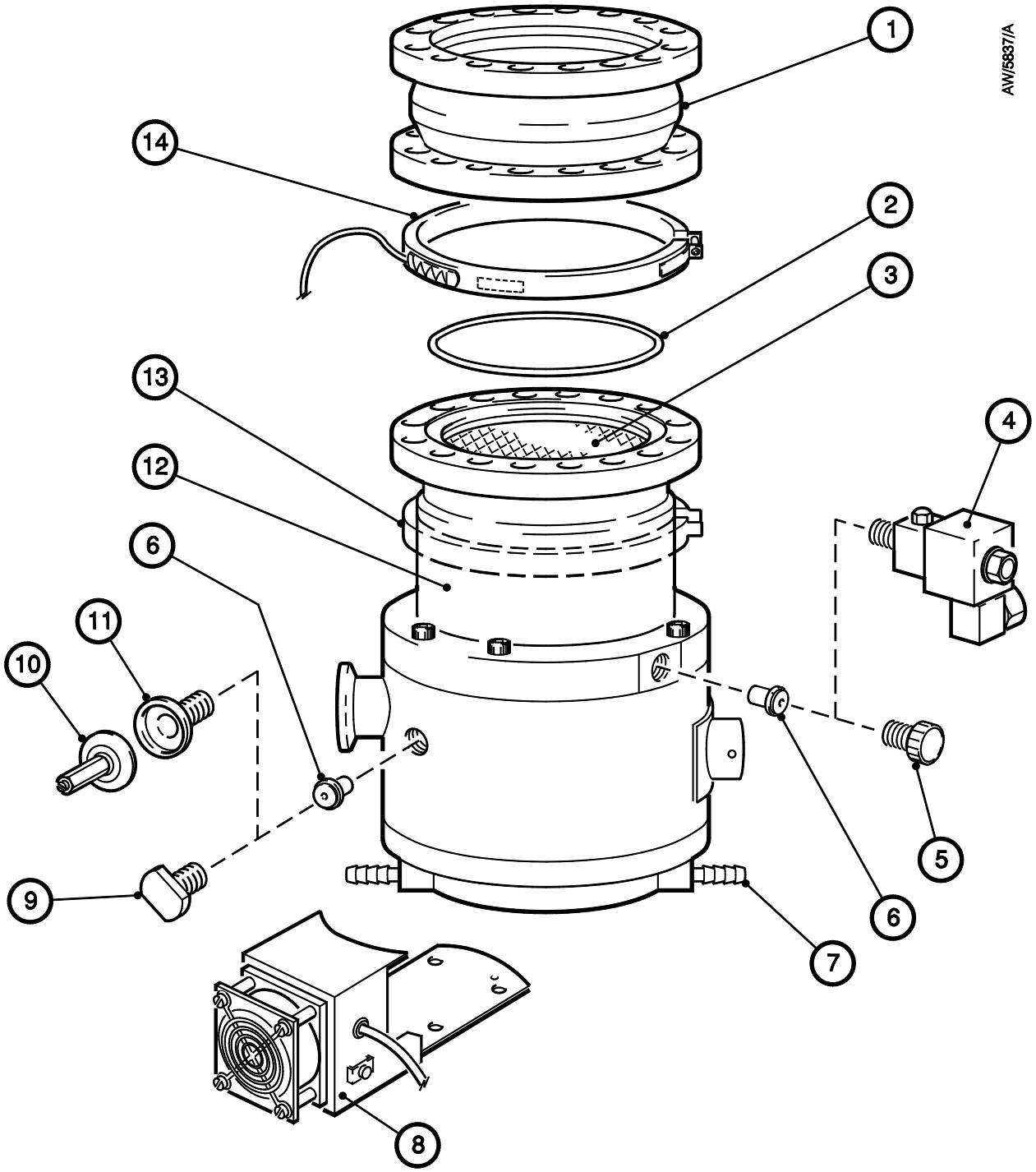
A modified NW10 centring-ring is available to filter the purge gas and restrict its flow rate to the recommended flow of 25 $cm^3\ min^{-1}$ ($4.17 \times 10^{-4}\ l\ s^{-1}$). The restrictor is suitable for all EXT250M pumps fitted with a purge-port.

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

7.4.8 VRX vent-restrictor

Use a VRX fixed orifice vent-restrictor to restrict the flow of vent gas into the EXT pump. You can fit a vent-restrictor directly in the vent-port or the purge-port of the pump, or you can fit a vent-restrictor to the inlet of a TAV vent-valve or PRX purge-restrictor. The EXT250M pump is supplied with a VRX10 vent-restrictor fitted in the vent port and purge port. Refer to Section 2.3 for information on the seelction of the correct VRX vent-restrictor.

Vent restrictor	Orifice diameter (mm)	Item Number
VRX10	0.1	B580-66-021
VRX20	0.2	B580-66-022
VRX30	0.3	B580-66-023
VRX50	0.5	B580-66-024
VRX70	0.7	B580-66-025



1. Vibration isolator
2. Inlet-flange seal (supplied)
3. Inlet-screen (supplied)
4. TAV vent-valve (optional accessory)
5. Manual vent-valve (supplied)
6. VRX10 vent-restrictor (supplied)
7. Water-cooler (supplied)
8. Air-cooler (side-mounting version shown; axial version also available)
9. Purge-port blanking-plug (supplied)
10. Purge-restrictor *
11. NW10 vent-port adaptor
12. EXT250M pump
13. Bakeout band position
14. Bakeout band

* Can be used instead of the VRX10

Figure 6 - Installation of EXT250M optional accessories (and spares)

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BOC EDWARDS

Form HS1

Return of BOC Edwards Equipment - Procedure

INTRODUCTION

Before returning your equipment, you must warn BOC Edwards if substances you used (and produced) in the equipment can be hazardous. This information is fundamental to the safety of our Service Centre employees and will determine the procedures employed to service your equipment.

Complete the Declaration (HS2) and send it to BOC Edwards before you dispatch the equipment. It is important to note that this declaration is for BOC Edwards internal use only, and has no relationship to local, national or international transportation safety or environmental requirements. As the person offering the equipment for shipment, it is your responsibility to ensure compliance with applicable laws.

GUIDELINES

- Equipment is '**uncontaminated**' if it has not been used, or if it has only been used with substances that are not hazardous. Your equipment is '**contaminated**' if it has been used with any substances classified as hazardous under EU Directive 67/548/EEC (as amended) or OSHA Occupational Safety (29 CFR 1910).
- If your equipment has been used with radioactive substances, biological or infectious agents, mercury, polychlorinated biphenyls (PCB's), dioxins or sodium azide, you must decontaminate it before you return it to BOC Edwards. You must send independent proof of decontamination (for example a certificate of analysis) to BOC Edwards with the Declaration (HS2). Phone BOC Edwards for advice.
- If your equipment is contaminated, you must either:
  - Remove all traces of contamination (to the satisfaction of laws governing the transportation of dangerous/hazardous substances).
  - Or, properly classify the hazard, mark, manifest and ship the equipment in accordance with applicable laws governing the shipment of hazardous materials.

Note: Some contaminated equipment may not be suitable for airfreight.

PROCEDURE

1. Contact BOC Edwards and obtain a Return Authorisation Number for your equipment.
2. Complete the Return of BOC Edwards Equipment - Declaration (HS2).
3. If the equipment is contaminated, you must contact your transporter to ensure that you properly classify the hazard, mark, manifest and ship the equipment, in accordance with applicable laws governing the shipment of contaminated/hazardous materials. As the person offering the equipment for shipment, it is your responsibility to ensure compliance with applicable law. **Note: Equipment contaminated with some hazardous materials, such as semiconductor by-products, may not be suitable for airfreight - contact your transporter for advice.**
4. Remove all traces of hazardous gases: pass an inert gas through the equipment and any accessories that will be returned to BOC Edwards. Where possible, drain all fluids and lubricants from the equipment and its accessories.
5. Seal up all of the equipment's inlets and outlets (including those where accessories were attached) with blanking flanges or, for uncontaminated product, with heavy gauge tape.
6. Seal equipment in a thick polythene/polyethylene bag or sheet.
7. If the equipment is large, strap the equipment and its accessories to a wooden pallet. If the equipment is too small to be strapped to a pallet, pack it in a suitable strong box.
8. Fax or post a copy of the Declaration (HS2) to BOC Edwards. The Declaration must arrive before the equipment.
9. Give a copy of the Declaration (HS2) to the transporter. You must tell your transporter if the equipment is contaminated.
10. Seal the original Declaration in a suitable envelope: attach the envelope securely to the outside of the equipment package, in a clear weatherproof bag.
    WRITE YOUR RETURN AUTHORISATION NUMBER CLEARLY ON THE OUTSIDE OF THE ENVELOPE OR ON THE OUTSIDE OF THE EQUIPMENT PACKAGE.

BOC EDWARDS

Form HS2

Return of BOC Edwards Equipment - Declaration

Return Authorisation Number:

You must:

- Know about all of the substances which have been used and produced in the equipment before you complete this Declaration
- Read the Return of BOC Edwards Equipment - Procedure (HS1) before you complete this Declaration
- Contact BOC Edwards to obtain a Return Authorisation Number and to obtain advice if you have any questions
- Send this form to BOC Edwards before you return your equipment

SECTION 1: EQUIPMENT

Equipment/System Name_____

Part Number _____

Serial Number_____

Has the equipment been used, tested or operated ?

YES ❑ Go to Section 2 NO ❑ Go to Section 4

IF APPLICABLE:

Tool Reference Number_____

Process _____

Failure Date_____

Serial Number of Replacement Equipment_____

SECTION 2: SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Are any substances used or produced in the equipment:

- Radioactive, biological or infectious agents, mercury, poly chlorinated biphenyls (PCBs), dioxins or sodium azide? (if YES, see Note 1) YES ❑ NO ❑
- Hazardous to human health and safety? YES ❑ NO ❑

Note 1 : BOC Edwards will not accept delivery of any equipment that is contaminated with radioactive substances, biological/infectious agents, mercury, PCB's, dioxins or sodium azide, unless you:

- Decontaminate the equipment
- Provide proof of decontamination

YOU MUST CONTACT BOC EDWARDS FOR ADVICE BEFORE YOU RETURN SUCH EQUIPMENT

SECTION 3: LIST OF SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Substance name	Chemical Symbol	Precautions required (for example, use protective gloves, etc.)	Action required after a spill, leak or exposure

SECTION 4: RETURN INFORMATION

Reason for return and symptoms of malfunction _____

_____

If you have a warranty claim:

- who did you buy the equipment from ? _____
- give the supplier's invoice number_____

SECTION 5: DECLARATION

Print your name:_____Print your job title:_____

Print your organisation:_____

Print your address:_____

_____

Telephone number: _____Date of equipment delivery: _____

I have made reasonable enquiry and I have supplied accurate information in this Declaration. I have not withheld any information, and I have followed the Return of BOC Edwards Equipment - Procedure (HS1).

Note: Please print out this form, sign it and return the signed form as hard copy.

Signed: _____Date_____

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