

# Instruction Manual

## EXT Compound Turbomolecular Pumps: EXT556H and EXT556HF

<i>Description</i>	<i>Item Number</i>
EXT556H / DN160ISO-K	B777-51-000
EXT556H / DN160CF	B777-52-000
EXT556H / DN160ISO-K (fine inlet)	B777-61-000
EXT556HF / DN160ISO-K	B777-57-000
EXT556HF / DN160CF	B777-58-000

Chemtech Scientific provides access to this content as a courtesy.  
We do not own the content contained in this document.  
All rights and credit go directly to its rightful owners.  
[www.chemtechsci.com](http://www.chemtechsci.com)  
Call us at: 484-424-9415



# Declaration of Conformity

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

declare under our sole responsibility that the product(s):

EXT556H Compound TurboMolecular Pumps:

EXT556H DN160ISO-K	B777-51-000
EXT556H DN160CF	B777-52-000
EXT556H DN160ISO-K (fine inlet)	B777-61-000
EXT556HF DN160ISO-K	B777-57-000
EXT556HF DN160CF	B777-58-000

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

EN12100: 2003	Safety of machinery. Basic concepts, general principals for design Technical principals.
EN1012-2: 1997	Compressors and Vacuum Pumps – Safety Requirements – Part 2: Vacuum Pumps.
EN61010-1: 2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.*
EN61326: 1998 (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.

\_\_\_\_\_  
B. D. Brewster, Technical Manager,  
Burgess Hill Products

\_\_\_\_\_  
Date and Place

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

# CONTENTS

Section	Title	Page
1	INTRODUCTION	1
1.1	Scope and definitions	1
2	TECHNICAL DATA	3
2.1	General	3
2.2	Pumping media	3
2.2.1	Pumps without gas purge	4
2.2.2	Pumps with gas purge	4
2.3	Vent gas specification and vent control data	4
2.4	Purge gas specification	5
2.5	Water cooling	5
2.6	Materials exposed to gases pumped	6
3	INSTALLATION	11
3.1	Unpack and inspect	11
3.2	Typical installation	11
3.3	Connection to the vacuum system	11
3.3.1	The inlet screen (supplied fitted)	13
3.3.2	Inlet connection	13
3.3.3	Backing connection	15
3.4	Vent options, vent valve connection and control	15
3.5	Purge gas connection	17
3.5.1	Connect the purge gas	17
3.5.2	Recommended purge gas flow	17
3.6	Electrical installation	17
3.7	Cooling	19
3.7.1	Introduction	19
3.7.2	Forced air cooling	19
3.7.3	Water cooling	20
3.8	Magnetic Fields	20
4	OPERATION	21
4.1	Start up	21
4.2	Stand-by	21
4.3	Shut-down	21
4.4	Safety interlocks and control system	22
4.5	Bakeout (conflat only)	22
5	MAINTENANCE	23
5.1	Introduction	23
5.2	Bearing maintenance	23
5.3	Rotor life	23
5.4	Clean the pump	23
5.5	Fault finding	24

## CONTENTS (continued)

Section	Title	Page
6	STORAGE AND DISPOSAL	27
6.1	Storage	27
6.2	Disposal	27
7	SERVICE, SPARES AND ACCESSORIES	29
7.1	Introduction	29
7.2	Service	29
7.3	Spares	29
7.3.1	ISX inlet-screen	29
7.3.2	Inlet-flange seals	30
7.4	Accessories	30
7.4.1	Installation	30
7.4.2	EXC controller	30
7.4.3	Pump-to-controller cable	32
7.4.4	EXDC drive modules	32
7.4.5	BX bakeout band (conflat only)	32
7.4.6	FL20K foreline trap	33
7.4.7	TAV vent-valve and vent-port adaptor	33
7.4.8	ACX air-cooler	33
7.4.9	WCX water-cooler	34
7.4.10	Vibration isolators	34
7.4.11	PRX purge-restrictor	34
7.4.12	VRX vent-restrictor	34

## ILLUSTRATIONS

Figure	Title	Page
1	Mounting attitude of the EXT556H pump	9
2	Typical pumping system	12
3	Diagram of inlet screen - remove screws 'A' in order to remove the inlet screen. Do not remove screws 'B'	14
4	Maximum rate of pressure rise when venting	16
5	Dimensions and features of EXT556H pumps	18
6	Installation of EXT556H optional accessories and spares	31

## TABLES

Table	Title	Page
1	General information	3
2	Vent gas and vent control data	4
3	Purge gas specification	5
4	Cooling water specification	5
5	Technical data	6
6	List of items supplied	11
7	Vent restrictor orifice diameter (with atmospheric pressure at the inlet)	15
8	Fault finding	24
9	ISX inlet-screen	29
10	Inlet-flange seals	30
11	EXC controller	30
12	Pump-to-controller cable	32
13	EXDC drive modules	32
14	BX bakeout band	32
15	FL20K foreline trap	33
16	TAV vent-valve and vent-port adaptor	33
17	ACX air-cooler	33
18	WCX water-cooler	34
19	Vibration isolators	34
20	PRX purge-restrictor	34
21	VRX vent-restrictor	34

## ASSOCIATED PUBLICATIONS

Publication Title	Publication Number
EXC120/120E/300/300M Turbomolecular Pump Controllers	D396-14-880
EXC250E/250L Turbomolecular Pump Controllers	D396-36-880
EXDC Turbomolecular Pump Drive Modules	D396-40-880


# 1 INTRODUCTION

## 1.1 Scope and definitions

This manual provides installation, operation, maintenance and storage instructions for the BOC Edwards EXT556H compound turbo-molecular pumps. Please read and follow all the instructions in this manual.

The EXT556H pump is designed for use with a BOC Edwards EXC or EXDC controller. Read this manual and the instruction manual supplied with your controller before you attempt to install or operate the equipment. The controller manual contains details of electrical installation.

Important safety information in this manual is highlighted as WARNING and CAUTION instructions. Please obey these instructions. The use of warnings and cautions is defined below.

	<b>WARNING</b>
Warnings are given where failure to observe the instruction could result in injury or death to people.	

<b>CAUTION</b>
Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment or process.

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



Warning - refer to accompanying documentation.



Warning - hot surfaces.



Warning - risk of electric shock.



Warning - Large attractive forces will be experienced when the pump is subjected to magnetic fields.

The units used throughout this manual conform to the SI system of units of measurement. Also, throughout this manual, wherever flow rates are specified, the abbreviation 'sccm' is used to mean standard  $\text{cm}^3 \text{min}^{-1}$ : this is a flow of  $1\text{cm}^3 \text{min}^{-1}$  at an ambient temperature of  $0^\circ\text{C}$  and a pressure of 1013 mbar ( $1.013 \times 10^5 \text{Pa}$ ).


## 2 TECHNICAL DATA

### 2.1 General

General items	Reference data
Performance	See Table 5
Dimensions and features	See Figure 5
Maximum permitted external magnetic field	
EXT556H DN160CF	3 mT horizontal, 5 mT vertical
EXT556H DN160ISO-K	2.5 mT horizontal, 5 mT vertical
EXT556HF ISO and CF variants	50mT in any orientation
Installation category	EN61010 part 1, category 1
Pollution degree	EN61010 part 1, category 2
Equipment type	Fixed equipment, for indoor use only
Operating altitude	up to 3000 m
Ambient temperature	5 °C - 35 °C (air cooled) 5 °C - 40 °C (water cooled)
Relative humidity	10 - 95% non condensing


Table 1 - General information

### 2.2 Pumping media




**WARNING**

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



**WARNING**

Do not use EXT556H pumps to pump explosive gas mixtures as the pumps are not suitable for this purpose.



**WARNING**

Do not use the EXT556H pump to pump mercury vapour, and do not allow mercury to come into contact with the pump. If you do, the rotor may corrode and fail.

**CAUTION**

Do not use an EXT556H pump to pump gases containing more than 20% oxygen unless a bearing purge is applied as stated in Section 2. If you do the lubricant will be damaged and the pump will fail prematurely.

*Note: Concentrations of gases may be modified by the compression of the pump.*

### 2.2.1 Pumps without gas purge

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

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

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 unless a bearing purge is applied as detailed in Section 2.2.2.

- Water vapour

You must ensure that vapour does not condense inside the pump - refer to Section 3.7.3.

If you wish to pump a gas not previously listed, contact your supplier for advice. If you do not contact your supplier you may invalidate the warranty on the pump.

The pumps are not suitable for pumping aggressive or corrosive gases.

### 2.2.2 Pumps with gas purge

When purged with an inert gas the 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 atmosphere, relatively high air humidity may greatly increase the subsequent pump-down time. To reduce pump-down times you should vent the pump with dry, clean gases.

Vent gas system items	Reference data
Vent gas	Dry air, nitrogen, argon or other inert gases
Maximum dew point at atmospheric pressure	-22 °C
Maximum size of particulate	1 micron
Maximum concentration of oil	0.1 parts per million
Time for rotational speed to reach 50%	>15 seconds
Maximum allowed rate of pressure rise	see Figure 4

Table 2 - Vent gas and vent control data



## 2.4 Purge gas specification

Purge gas system items	Reference data
Purge gas	Dry nitrogen, argon or other inert gases
Maximum dew point at atmospheric pressure	-22 °C
Maximum size of particulates	1 micron
Maximum concentration of oil	0.1 parts per million
Allowable purge gas flow (when required)	20 to 150 sccm (0.33 to 2.48 mbar l s-1, 33 to 248 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, $3 \times 10^5$ Pa)

Table 3 - Purge gas specification

## 2.5 Water cooling

The following water cooling 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.

Cooling water system items	Reference data
Quality	Mechanically clean and optically 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
Recommended water cooling flow rate (at 15 °C)	15 l hr <sup>-1</sup>
Water temperature	See Table 5
Maximum water pressure	5 bar (gauge), 73.5 psig, $6 \times 10^5$ Pa
Materials exposed to cooling water	Copper, brass and nickel plating

Table 4 - Cooling water specification

## 2.6 Materials exposed to gases pumped

The following materials and component types are exposed to the gases pumped: aluminium alloys, stainless steels, fluoroelastomer and nitrile 'O' rings, hydrocarbon lubricant, rare earth magnets, silicon nitride, phenolic resin and carbon fibre epoxy resin.

Parameter	EXT556H	Notes
Mass EXT556H DN160ISO-K	13.4 kg	
Mass EXT556H DN160CF	21.2 kg	
Mass EXT556HF DN160ISO-K	19.3 kg	
Mass EXT556HF DN160CF	20.5 kg	
Main inlet flange	DN160ISO-K/DN160CF	
Outlet flange	DN25NW	
Vent port	1/8 inch BSPP	
Purge port	1/8 inch BSPP	
Inlet pumping speed *		
N <sub>2</sub>	540 l s <sup>-1</sup>	
He	580 l s <sup>-1</sup>	
H <sub>2</sub>	500 l s <sup>-1</sup>	
Ar	510 l s <sup>-1</sup>	
Inlet compression ratio		**
N <sub>2</sub>	>10 <sup>10</sup>	Pb < 20 mbar
He	10 <sup>8</sup>	Pb < 12 mbar
H <sub>2</sub>	10 <sup>6</sup>	Pb < 7 mbar
Ar	>10 <sup>10</sup>	Pb < 20 mbar
Ultimate pressure <sup>1</sup>		
CF	<10 <sup>-10</sup> mbar	
ISO	<2 x 10 <sup>-9</sup> mbar	
Minimum backing pump displacement	12 m <sup>3</sup> h <sup>-1</sup>	
Recommended backing pump	RV12	
Maximum continuous inlet pressure (light gas pumping) ††		These pressures relate to the aluminium envelope variant B777-51-000. Performance will vary for other pump variants when air cooled.
Forced air cooled, 30 °C ambient	1.5 x 10 <sup>-3</sup> mbar	
Forced air cooled, 35 °C ambient	1.0 x 10 <sup>-3</sup> mbar	
Water cooling at 15 °C	2.0 x 10 <sup>-3</sup> mbar	

Table 5 - Technical data

EXT556H

Parameter	EXT556H	Notes
Maximum continuous inlet pressure (argon pumping) ††		These pressures relate to the aluminium envelope variant B777-51-000. Performance will vary for other pump variants when air cooled.
Forced air cooled, 30 °C ambient	8.0 x 10 <sup>-4</sup> mbar	
Forced air cooled, 35 °C ambient	5.0 x 10 <sup>-4</sup> mbar	
Water cooling at 15 °C	1.0 x 10 <sup>-3</sup> mbar	Water cooling while pumping high concentrations of argon is not recommended
Maximum continuous backing pressure (light gas pumping) ††		These pressures relate to the aluminium envelope variant B777-51-000. Performance will vary for other pump variants when air cooled.
Forced air cooled, 30 °C ambient	10 mbar	
Forced air cooled, 35 °C ambient	6 mbar	
Water cooling at 15 °C	7.5 mbar	
Maximum continuous backing pressure (argon pumping) ††		These pressures relate to the aluminium envelope variant B777-51-000. Performance will vary for other pump variants when air cooled.
Forced air cooled, 30 °C ambient	2.9 mbar	
Forced air cooled, 35 °C ambient	1.8 mbar	
Water cooling at 15 °C	2.2 mbar	Water cooling while pumping high concentrations of argon is not recommended
Operating attitude	See note at right	Vertical (inlet uppermost) to Horizontal, not inverted. Range of rotation of ± 60° about the axis. Refer to Figure 1.
Nominal rotational speed	50000 rpm	
Start time to 90% speed:		
EXC250	< 8 minutes	
EXC300	< 8 minutes	
EXDC160	< 8 minutes	

Table 5 - Technical data (continued)

**EXT556H**

Parameter	EXT556H	Notes
Cooling method <sup>‡</sup>	forced air / water	
Ambient air temperature for forced air cooling	0 °C - 35 °C	
Minimum cooling water flow rate (water at 15 °C)	15 l h <sup>-1</sup>	
Water temperature	10 °C - 20 °C	
Noise level at 1 metre	<60 dBA	
Recommended controllers	EXC250, EXC300, EXDC160	
Quiescent power consumption	35 W	
<p>* Pumping speeds are without inlet screen. The coarse and fine inlet screen reduces the pumping speed by 11% and 17% respectively.</p> <p>** Pb = backing pressure</p> <p>†† Above this pressure the rotational speed of the pump drops below nominal. Heavy gas for example an atomic mass greater than 28 AMU and light gas for example atomic mass less than or equal to 28 AMU.</p> <p>‡ If air cooling is required, BOC Edwards recommend the ACX555.</p> <p><sup>1</sup> Ultimate pressure is measured 48 hours after bakeout with a 2 stage rotary pump.</p>		

Table 5 - Technical data (continued)

EXT556H

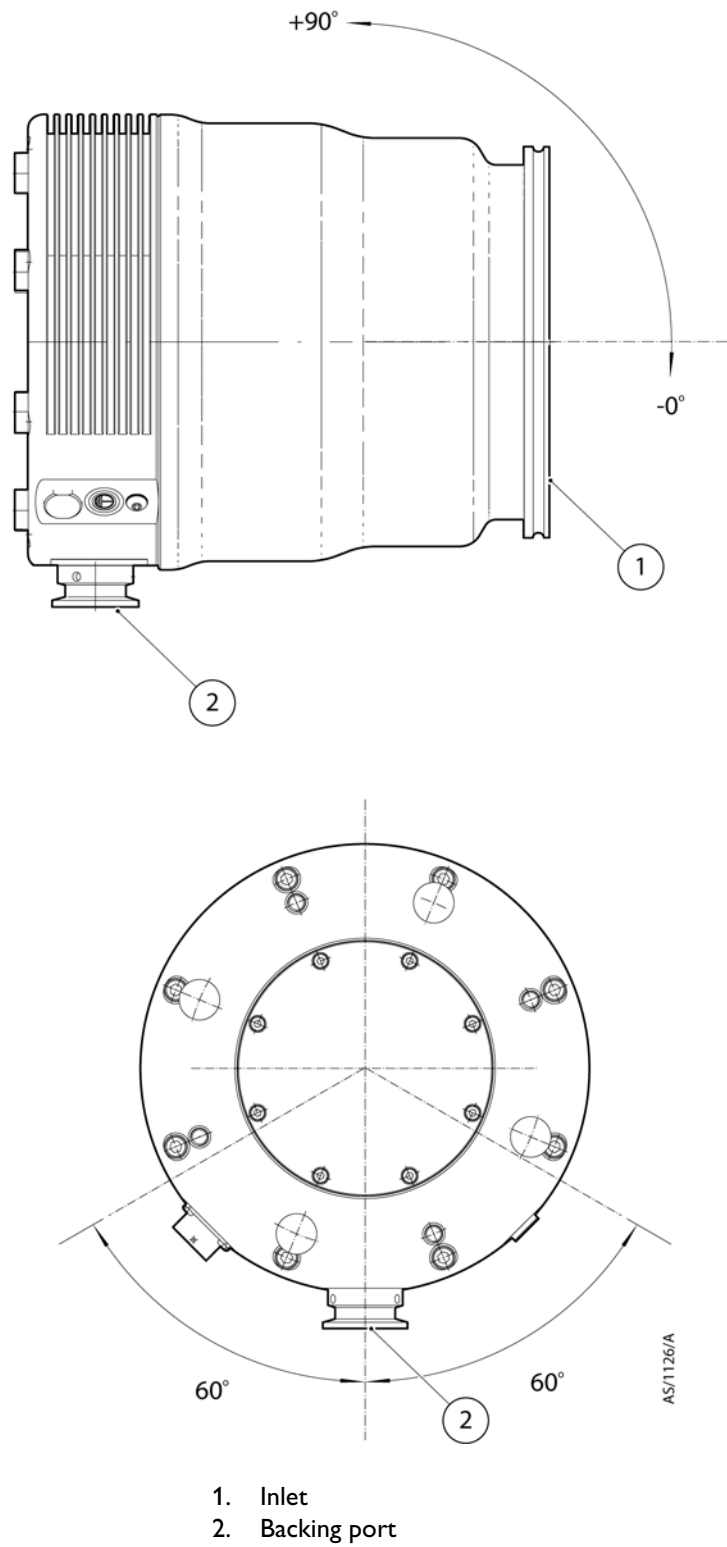


Figure 1 - Mounting attitude of the EXT556H pump

## 3 INSTALLATION

### 3.1 Unpack and inspect



#### WARNING

The EXT556H DN160CF pump variant weighs 21 kg. Observe correct manual handling techniques when manoeuvring it.

#### CAUTION

Do not damage the envelope surface of the HF variant as this may cause corrosion and a reduction in performance. In this event the pump must be returned to your nearest service centre.

Take care when you unpack the pump to avoid excessive mechanical shocks which could damage the bearings and reduce the life of the pump. The pump is supplied with the inlet and the 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 the outer cardboard packaging and check the pump. If the pump is damaged, notify your supplier and 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 the packing materials for inspection. Do not use the pump if it is damaged.

Check that your package contains the items listed in Table 6. 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. It is advised that you retain all packing materials for use should you return the pump for service.

### 3.2 Typical installation

A typical pump system with an EXT556H pump is shown in Figure 2. The accessories available for the EXT556H pump are detailed in Section 7.4. The accessories are shown in Figure 6.

### 3.3 Connection to the vacuum system

Carefully remove the pump from packaging media and connect to the vacuum system.

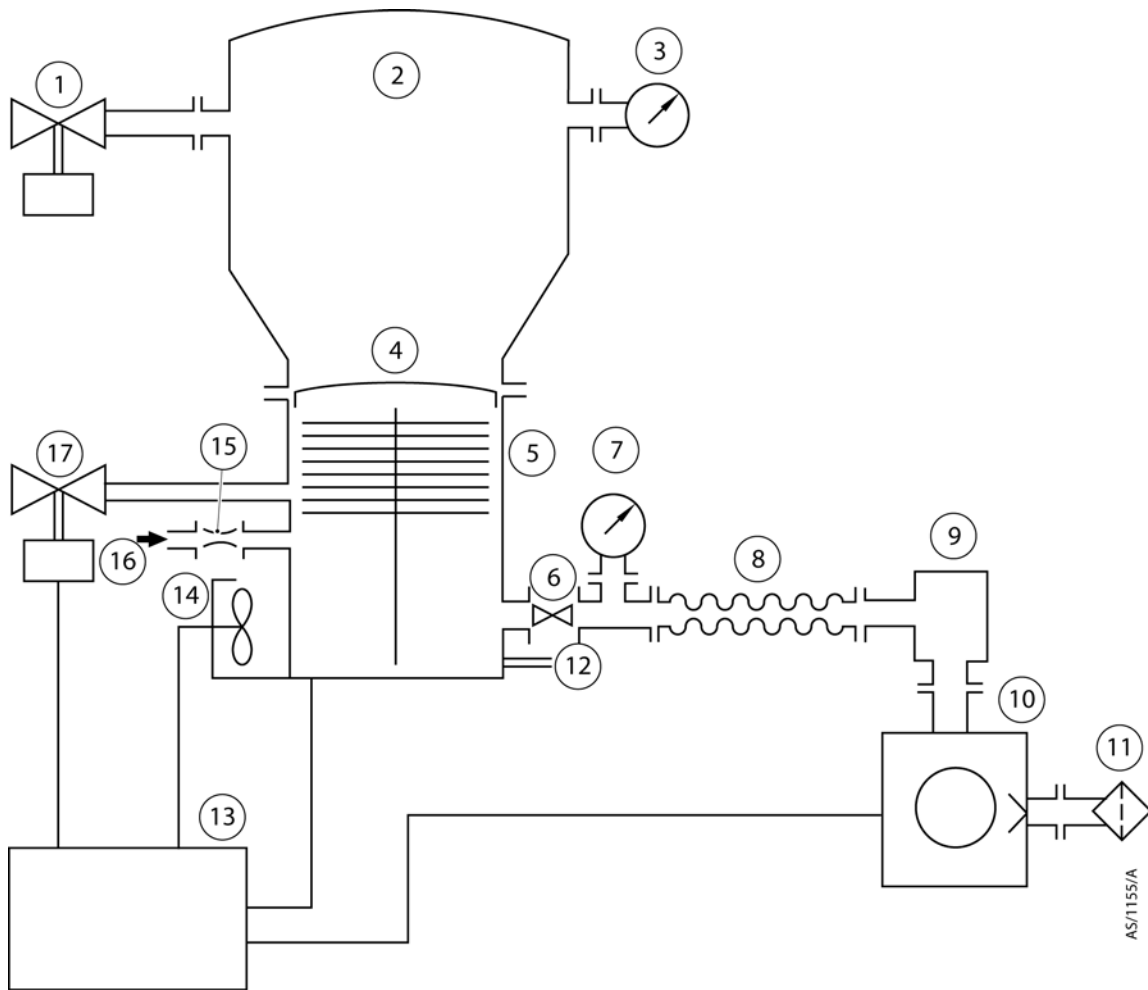


#### WARNING

Install the pump on the vacuum system before you connect the controller to the power supply. This will ensure that the pump cannot operate and injure people during installation.

Qty	Description
1	EXT556H turbomolecular pump
1	Inlet screen (fitted)
1	Inlet seal (trapped 'O' ring, co-seal or copper compression gasket)

Table 6 - List of items supplied



AS/1155/A

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

Figure 2 - Typical pumping system

### 3.3.1 The inlet screen (supplied fitted)



#### WARNING

Removal of inlet screen will expose people to the risk of injury from sharp edges.

#### CAUTION

Removal of the inlet screen could allow debris to fall into the pump, which could cause serious damage to the pump.

Do not remove the inlet screen unless you can be sure that there is no danger that debris can fall into the pump. If the inlet screen are removed, the pumping speed through the inlet will increase by 11% for a coarse and 17% for a fine screen.

To remove the inlet screen, undo the three screws ('A') which hold it down (Figure 3). If you need to replace the inlet screen, do so by undoing these screws, changing the inlet screen, and replacing the screws. Ensure that screws are firmly tightened.

#### CAUTION

Do not remove the three screws which retain the locking plate ('B' in Figure 3). If you do so the pump settings may change and the pump may cease to operate or have a shortened life.

### 3.3.2 Inlet connection



#### WARNING

Ensure that the EXT556H pump is securely fixed to the vacuum system following the instructions below. If you do not, and the pump seizes, the stored energy of the rotor can cause rapid movement of the pump, which may cause injury to people and further damage to equipment.

#### CAUTION

The pump is able to operate up to the horizontal attitude axially. If it is mounted off-vertical, ensure that the backing port is within 60° of vertical. Refer to Figure 1.

Ensure that the EXT556H pump is securely fixed to the vacuum system following the instructions below.

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. Use the vacuum seal provided with the pump.

If you are using an EXT556H ISO160 pump, connect it to the vacuum system using an ISO160 rotatable flange with a full complement of bolts. Alternatively use at least 8 claw clamps.

If you are using an EXT556H DN160CF, use a full complement of 20 M8 bolts to attach the pump to your vacuum system.



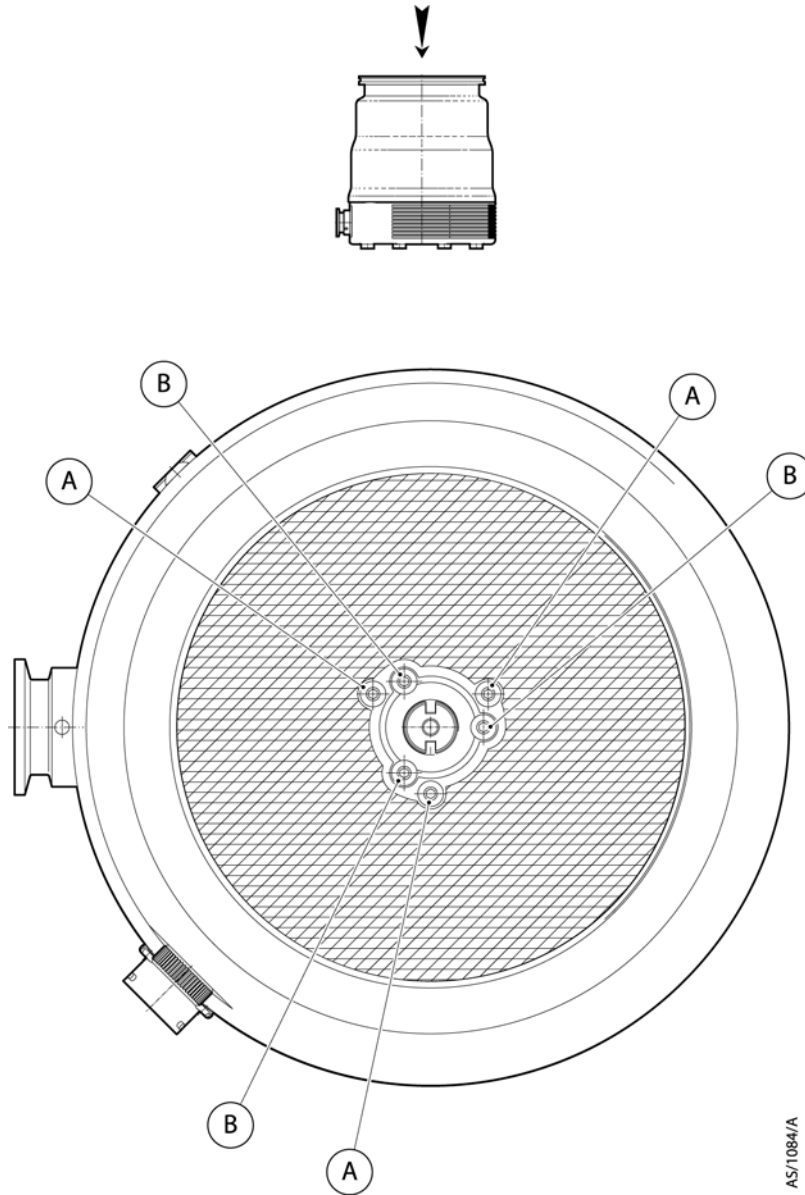


Figure 3 - Diagram of inlet screen - remove screws 'A' in order to remove the inlet screen. Do not remove screws 'B'

## EXT556H

If the inlet flange of the EXT556H is not connected to a rigid, firmly fixed vacuum system, ensure that the base of the pump is fixed to a firm support. Remove the four feet and secure the pump using eight M8 bolts through the tapped fixing holes in the base of the pump. These bolts should be in ISO 898-1 class 8.8 or higher, and should be tightened up to approximately 7Nm torque. If you are using a WCX555 water cooling accessory, mount through the cooling plate into the tapped holes on the base of the pump.

If the pump inlet is connected to the vacuum system using a vibration isolator, use the tapped fixing holes in the base of the pump to secure the pump to a firm support as described above. Alternatively, fit suitable restraints to prevent movement of the pump and fracture of the vibration isolator in the unlikely event of a 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 EXT556H pump.

We recommend that you use a BOC Edwards RV backing pump. The minimum size of the backing pump required is given in Table 5. 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.

#### CAUTION

If the EXT pump is to be backed by the interstage port of another turbomolecular pump, make sure that the backing pressure does not fall below  $5 \times 10^{-4}$  mbar ( $5 \times 10^{-2}$  Pa). Lower backing pressures will increase the evaporation rate of the lubricant and so will reduce the life of the bearings.

### 3.4 Vent options, vent valve connection and control

To maintain the cleanliness of your vacuum system we recommend that, whenever you switch the pump off, you vent the pump or the vacuum system when the speed of the EXT556H 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 hydrocarbon oil from your backing pump. Venting may be accomplished by one of the following methods:

- Use a TAV5 or TAV6 solenoid vent valve accessory (see Section 7) in place of the manual vent valve.
- Use a TAV5 or TAV6 solenoid vent valve connected to a convenient flange on your vacuum system upstream of the turbo pump.
- Use an alternative valve connected to your vacuum system upstream of the turbomolecular pump.

The maximum rate of pressure rise is given in Figure 4.

Vacuum system volume (litres)	Orifice diameter (mm)
< 20	< 1.0
< 10	< 0.7
< 5	< 0.5
< 2	< 0.35

Table 7 - Vent restrictor orifice diameter (with atmospheric pressure at the inlet)

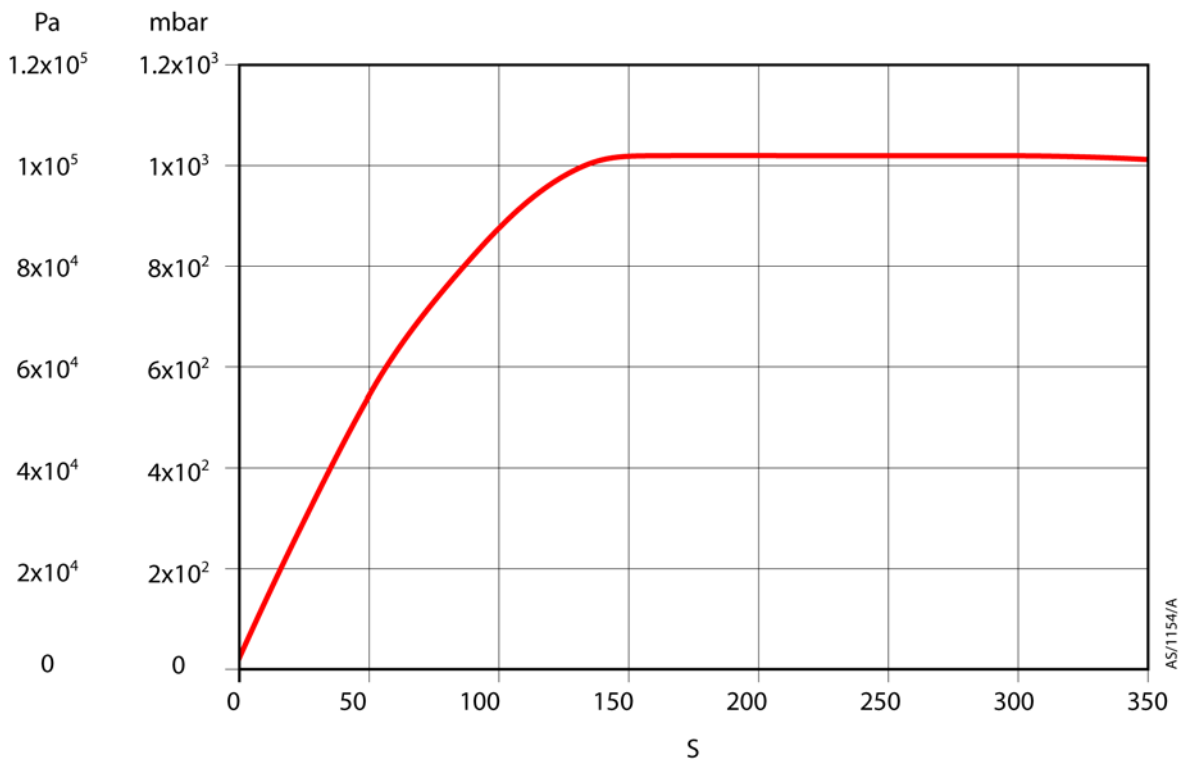


Figure 4 - Maximum rate of pressure rise when venting

**CAUTION**

If you vent the pump when it is at full rotational speed and the rate of pressure rise is too high the pump bearing life may be reduced.

When using the manual vent valve supplied you must only open the vent valve when the rotational speed of the EXT556H pump has fallen to 50% of full rotational speed.

If you use a TAV vent valve or other solenoid vent valve, you should only use the vent valve to vent the pump from full speed if the vacuum system has a volume of 20 litres or more. If the system has a volume of less than 20 litres you should incorporate a suitable restrictor (see below and Table 7). Alternatively, if you are using an EXC controller to operate the vent valve, you can configure the valve so that it opens once the pump has reached 50% of full rotational speed.

Do not vent from the backing line as this may lead to contamination entering the turbo pump and hence reduced bearing life. If you vent into your vacuum system, select a point upstream of the pump to prevent oil backstreaming from the backing line.

If you use the TAV5 or TAV6 vent valve you can control it using an EXC controller or by other methods. Table 7 gives an indication of the appropriate size of orifice to be fitted to the vent valve for given vacuum system volumes in order that the vent rate is kept within the limits given in Figure 4.

Refer to Section 2 for information on vent gas specification.

### 3.5 Purge gas connection

#### 3.5.1 Connect the purge gas

If you want to supply a purge gas to the pump, fit a vent port adapter (see Section 7) in place of the purge port plug (Figure 5, item 4). Connect your gas supply to the purge port. Your purge gas must comply with the specification given in Section 2.

You must limit the purge gas flow rate to the allowed range, also specified in Section 2. 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) is suitable for this purpose. Adjust the PRX10 as described in the instruction manual supplied with the accessory.

#### 3.5.2 Recommended purge gas flow

The recommended minimum purge gas flow for typical applications is 25 sccm ( $0.42 \text{ mbar l s}^{-1}$ ,  $42 \text{ Pa l s}^{-1}$ ). This flow will protect the pump when you pump oxygen in concentrations above 20% by volume.

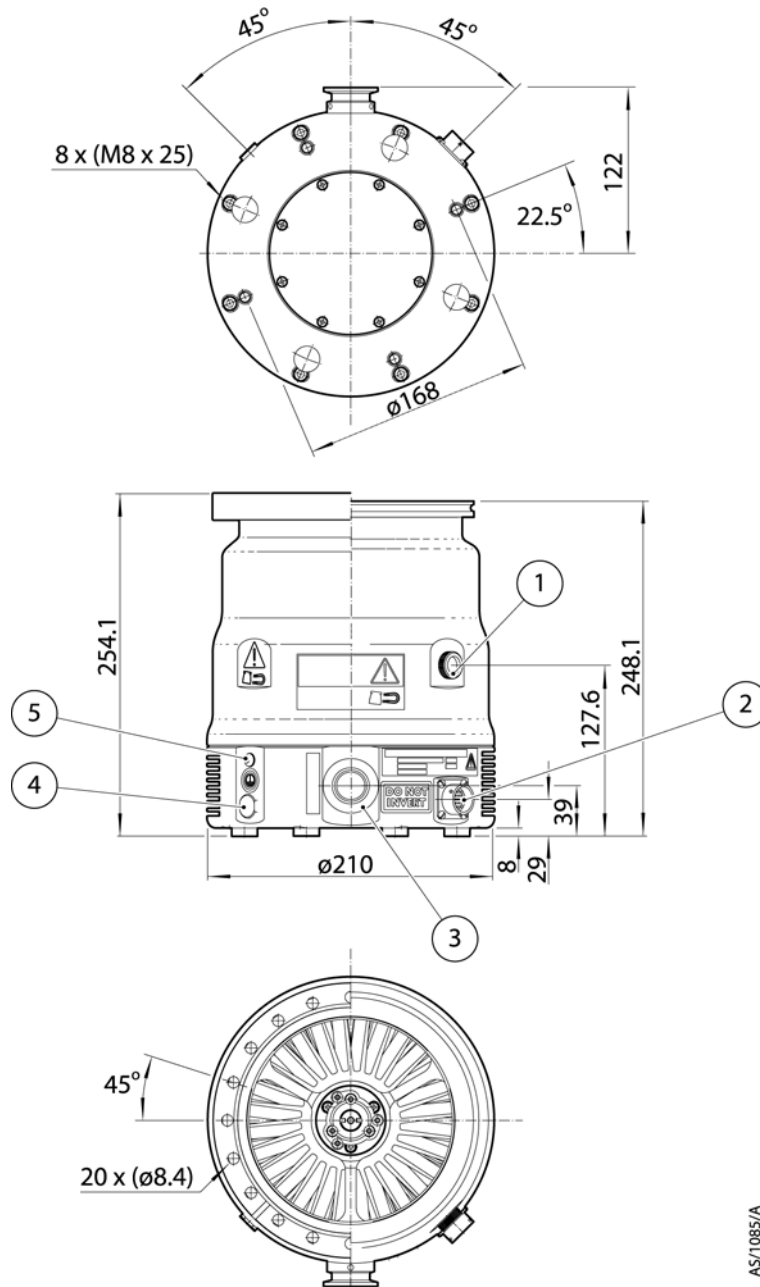
### 3.6 Electrical installation

**WARNING**

You must electrically bond the EXT556H pump to earth (ground) using the earth (ground) screw provided on the pump (item 5, Figure 5) to ensure that the pump complies with EN61010.

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

EXT556H




- 1. Vent valve
- 2. Electrical supply connector
- 3. Backing port (NW25)
- 4. Purge plug
- 5. Earth bond point

Figure 5 - Dimensions and features of EXT556H pumps

The EXC controller provides the electrical supply to the EXT556H pump 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 EXC controller (if applicable).

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 controller to complete the electrical installation.

It is the responsibility of the customer to ensure the stability of the system and the correct application of all electrical and vacuum connections. It is also the responsibility of the customer to ensure that no service connections present slip or trip hazards.

	<b>WARNING</b>
Do not remove the EXDC controller/EXC controller cable from the pump until the pump has come to a complete halt. To do so would expose personnel to hazardous voltages and potentially damage the EXDC/EXC controller.	

### 3.7 Cooling

#### 3.7.1 Introduction

<b>CAUTION</b>
You must cool the pump by forced-air or water cooling to prevent damage to the bearing.

You must use water cooling in any of the following operating conditions:

- When backing pressure is high (see Table 5).
- When you bake the EXT pump or the vacuum system close to the pump.
- When the ambient temperature is above 35 °C.
- When there is high continuous gas throughput (see Table 5).

In all other operating conditions, you can use forced air cooling. If you use forced air cooling you must ensure that there is an adequate supply of cooling air to the pump.

#### 3.7.2 Forced air cooling

An air cooler accessory is available for the EXT556H pump (see Section 7). Fit the air cooler as described in the instructions supplied with it. If you wish to use alternative air cooling, ensure that the flow rate is above 280 m<sup>3</sup> h<sup>-1</sup> (80 l s<sup>-1</sup>, 160 cfm).

### 3.7.3 Water cooling

A water cooling accessory is available for the EXT556H pump (see Section 7). Fit the water cooler as described in the instructions supplied with it.

#### CAUTION

To prevent excessive thermal gradients from developing across the bearing, do not use thermal transfer paste between the water-cooling accessory and the turbo-pump body.

#### CAUTION

Whilst pumping gases with  $m/m's > 28$ amu, or in the event that you are required to bake the pump, then you must ensure that you limit the inlet and backing pressure according to the values given in Table 5.

The cooling water 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 or 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 ruffled 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 ruffled hose connectors on the water cooler.
2. Attach the hose with strong hose clips and make sure that they are tightened securely.
3. If the pump is mounted off the vertical, ensure that the water cooling plate connectors are positioned below the electrical connector so that any leaking water does not drip onto it.

You must turn off the cooling water supply when you switch off the pump to prevent condensation of vapours inside the pump. EXC controllers can operate a solenoid valve for this purpose. Refer to the controller manual for details.

If you want to remove the pump for maintenance but do not want to break the cooling water circuit, unscrew the fixing screws and remove the water cooler from the pump.

### 3.8 Magnetic Fields



#### WARNING

The EXT556HF variant will experience large attractive forces whilst in or near magnetic fields. Ensure that the pump is firmly secured to the installation before presenting into a magnetic field.

## 4 OPERATION



### WARNING

Do not operate the EXT556H 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 the rotating blades might not be visible.

### 4.1 Start up

Use the following procedure to start up a basic manually controlled pumping system with a manual vent valve and an EXC250 or EXC300 controller. Refer to the controller instruction manual.

1. Turn the manual vent valve clockwise to close it.
2. Turn on the cooling water supply (if cooling water is used) or switch on the power supply to the air cooler.
3. Start the backing pump.
4. When the vacuum system pressure is 10 mbar or less, use the controller start/stop button or the appropriate signal command to the controller to start the pump.
5. The pump will accelerate to full operating speed.

### 4.2 Stand-by

The EXC250 controller has a 95% speed standby option - this can be used to stop 'beating' between two EXT556H pumps on a system. Refer to the controller manual for details.

The EXC300 also has a standby option, operated using the standby button on the front of the controller. This runs the pump at 70% rotational speed. This can be used to allow system pressure to increase where this suits a particular process. However, you should not run the pump in this mode for long periods of time, as the pump is not designed to be run at this speed for its lifetime.

### 4.3 Shut-down

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 if the backing pump and accessories are controlled by the EXC controller.

1. Close the valve in the backing line connecting the EXT556H pump to the backing pump.
2. Press the start/stop button on the EXC controller to switch off the EXT556H.
3. When the EXT556H speed has fallen to 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 3.4 and 2.3.
4. If water cooling is in use, wait until the pump has come to a complete stop, then turn off the cooling water supply.
5. As the rotor turns freely and is spinning in a vacuum, if the pump is not vented at all the rotor will take around 40 minutes to coast to a complete halt.



#### 4.4 Safety interlocks and control system



#### WARNING

When the power is restored following a power cut, the pump will restart automatically. The pump must remain connected to the vacuum system to prevent risk of injury.

The pump protection and safety interlock features are listed below. Refer to the EXC/EXDC controller instruction manual for a full description of these features.

- The EXC/EXDC 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 rotor is reduced until the power and temperature return to normal.
- If the rotational speed of a pump powered by an EXC controller 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.
- The EXDC controller will not trip out into fail if the power or temperature limits are exceeded. Instead, the rotational speed of the pump will continue dropping until the power and the temperature readings come back within acceptable limits. In the case of rotational overspeed, the controller will reduce the power until the pump returns to normal speed.

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 5.5), press the EXC Controller Start/Stop button to reset the Fail condition, and restart the EXT pump according to the guidelines in Section 4.1. If the pump is hot, allow sufficient time for it to cool before you restart it.

#### 4.5 Bakeout (conflat only)

#### CAUTION

If you bake the EXT556H pump you must use water cooling to prevent damage to the bearing lubricant. You must also ensure that the temperature of the inlet flange does not exceed 100°C to avoid damage to the bearing.

If you heat your EXT556H 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.

If you bake your vacuum system and the temperature of the system exceeds 110 °C, you must put a radiation shield between the system and the EXT556H 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 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 EXT556H Turbomolecular pumps are described in the following sections. The inlet-screen, the WCX water-cooler accessory 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 3.7.3.

### 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; this depends on the type of pumping duty on which the pump is 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 EXT556H pumps to Edwards Service Centres please use the procedure included at the end of this manual.

### 5.3 Rotor life

#### CAUTION

The fatigue life of EXT Turbo-pump rotors is typically 40,000 to 50,000 cycles. As a precautionary measure, BOC Edwards recommends that pumps are returned for a major service (rotor replacement) after 20,000 cycles of rest to full speed and back to rest, or after 10 years use, whichever occurs first.

### 5.4 Clean the pump

#### CAUTION

Do not attempt to clean any parts of the pump other than external surfaces. Use of solvents may damage internal pump components. Do not use abrasive materials on any surface of the HF variant.

If the EXT556H pump is contaminated inside, it may not be possible to achieve the specified ultimate vacuum, or pump-down time may increase. The pump should be returned to a BOC Edwards Service Centre where the pump will be dismantled and cleaned. Use the procedure included at the end of this manual.

**WARNING**

Clean the external surfaces of 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. Avoid inhalation of any particulates which may be present in the pump.

You can use any organic solvent to clean the external surfaces of your 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

Refer to Table 8 for the possible causes of faults and for the recommended actions to rectify faults. Table 8 is applicable to a basic, manually controlled pumping system with an EXC Controller configured for local (manual) operation.

Note that if you use an EXC Controller configured for remote operation to control the EXT556H pump, or if you use an EXDC Pump Drive Module to control the EXT556H pump, some of the checks and actions in Table 8 may not apply to your system.

Refer to the fault finding section of the instruction manual supplied with your EXC Controller or EXDC Pump Drive Module for further fault finding information.

Symptom	Check	Action
The pump does not rotate. After pressing start - Fail LED not lit.	<p>Is the EXC Controller power LED lit?</p> <p>Is the EXC Controller Start/Stop LED flashing?</p>	<p>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.</p> <p>If all of the above are OK then the EXC Controller is faulty. Consult BOC Edwards or your supplier.</p> <p>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).</p> <p>Check that any system interlocks are correctly made (refer to the instruction manual supplied with the EXC Controller).</p> <p>Check that the pump-to-controller lead is connected.</p> <p>If all the above checks are OK then consult BOC Edwards or your supplier.</p>

Table 8 - Fault finding

EXT556H

Symptom	Check	Action
	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 BOC 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? Is the backing pressure too high?  Is the EXT pump running too hot?  Does the rotor rotate freely?  Is the timer set incorrectly?	If so, reduce the pumping load, or check for a gross leak into the system.  Increase the cooling or decrease the gas load. (Refer to Section 2 for maximum inlet pressure and cooling requirements). Check that external heat sources (such as system bakeout heaters) are not excessive.  If not, the EXT pump-bearings are damaged. Consult BOC Edwards or your supplier.  Increase the timer setting (refer to the instruction manual supplied with the EXC Controller). If the EXC Controller still trips into Fail consult BOC 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?  Is the EXT pump running too hot?  Does the rotor rotate freely?	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).  Increase the cooling to the pump or decrease the gas load.  If not, the EXT pump-bearings are damaged. Consult BOC Edwards or your supplier.
The EXC Controller trips into Fail - all the speed LEDs are lit	-	Consult BOC Edwards or your supplier.
Ultimate pressure cannot be reached.	Is the pressure limited by water vapour?	Bake the system and pump.

Table 8 - Fault finding (continued)

Symptom	Check	Action
	<p>Are any of the vacuum gauges contaminated?</p> <p>Is the pumping speed insufficient (due to poor conductance between the pump and the gauge or too large a chamber)?</p> <p>Is the backing pressure &gt; values given in Table 7?</p> <p>Is the high-vacuum area of the system contaminated?</p> <p>Check the rest of your system for leaks and contamination.</p> <p>Remove the pump from the system and test the ultimate pressure of the pump alone (see Section 3 for specification).</p>	<p>If so, clean or replace them.</p> <p>Increase the conductance or reduce the volume.</p> <p>Check for backing line leaks. If the backing pressure is too high, you may need a larger backing-pump.</p> <p>If so, clean the high-vacuum system.</p> <p>If found, clean the contaminated areas and repair the leaks.</p> <p>If poor, check the pump for contamination and if necessary clean as described in Section CAUTION. Leak-check the pump. If the leak rate &gt; <math>10^{-8}</math> mbar l s<sup>-1</sup> (<math>10^{-6}</math> Pa l s<sup>-1</sup>) consult BOC Edwards or your supplier.</p>
The EXT is very noisy or there is excessive vibration or both.	<p>Is the pump rotational speed the same as the resonant frequency of the attached system?</p> <p>Is the vibration being transmitted from the rotary pump?</p> <p>Is the noise irregular and getting progressively worse?</p> <p>Is the EXT making a constant high-pitched noise?</p>	<p>If so, change the natural frequency of your system or isolate the pump using flexible bellows.</p> <p>If so, fit flexible bellows or a vibration isolator in the backing line.</p> <p>If so, a bearing is defective. Switch off the pump and consult BOC Edwards or your supplier.</p> <p>If so, the rotor might be out of balance. Consult BOC Edwards or your supplier.</p>
None of the above.	-	Consult BOC Edwards or your supplier.

Table 8 - 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.
4. 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

WARNING	
	In the unlikely event of a failure of the pump rotor, carbon fibre or rare earth magnet dust may be generated. In this event, use appropriate Personal Protective Equipment when handling and disposing of the pump, and ensure that all pump inlets and outlets are capped off before disposal.

Dispose of the EXT556H 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 SERVICE, SPARES AND ACCESSORIES

### 7.1 Introduction

BOC Edwards products, spares and accessories are available from BOC 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 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 worldwide 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 provide BOC Edwards engineers to support on-site maintenance, service or repair of your equipment. Please ensure that all accessories (i.e. water/air cooler) are removed prior to returning the pump for service.

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 Numbers of replacement inlet-screens are given in Table 9. There are two mesh sizes available - fine and coarse. Select the mesh size appropriate to your requirements. The fine mesh (1 mm hole size) provides better protection against falling objects e.g. fine pieces of filament, small grub screws. The coarse mesh (2 mm hole size) gives better pumping performance. The coarse inlet screen is provided as standard.

Flange size	Inlet-screen	Item Number
DN160ISO-K/DN160CF	Inlet screen (coarse)	B580-51-007
	Inlet screen (fine)	B580-51-008

Table 9 - ISX inlet-screen

### 7.3.2 Inlet-flange seals

EXT pumps are supplied with an inlet seal. The Item Numbers of replacement seals are given in Table 10.

Inlet-flange	Inlet seal	Item Number
DN160ISO-K	ISO160 trapped 'O' ring, fluoroelastomer	B271-58-172
DN160CF	Copper compression gasket (pack of 5)	C083-00-003

Table 10 - Inlet-flange seals

## 7.4 Accessories

### 7.4.1 Installation

The accessories available for use with the EXT556H turbomolecular pumps are described in the following Sections. Figure 6 shows how the accessories are fitted to an EXT pump.

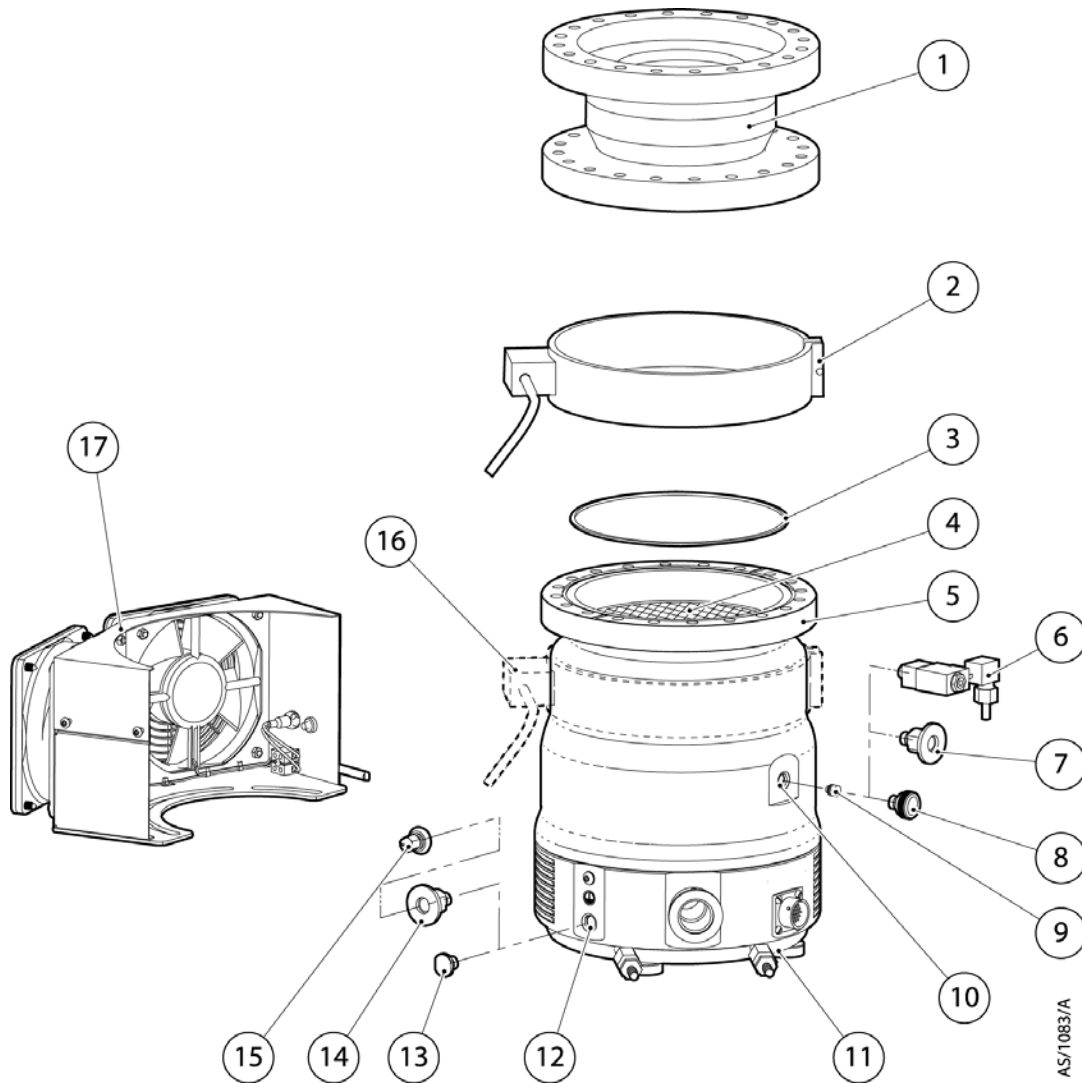
### 7.4.2 EXC controller

The Edwards EXC Controllers provide the facilities necessary for operating a pumping system based on an EXT556H pump. The Item Numbers of the EXC Controllers are given in Table 11.

Controller	Voltage	Item Number
EXC250E	90 - 264 V ac	D396-35-000
EXC250L	90 - 264 V ac	D396-36-000
EXC300	90 - 132/180 - 264 V ac	D396-14-000

Table 11 - EXC controller





AS/1083/A

- |                                 |  |                             |
|---------------------------------|--|-----------------------------|
| 1. Vibration isolator           | 8. Manual vent valve (fitted)                          | 13. Purge plug (fitted)     |
| 2. Bakeout band                 | 9. VRX vent restrictor                                 | 14. DN10NW adaptor          |
| 3. Inlet flange seal (supplied) | 10. Vent port (supplied with manual vent valve fitted) | 15. PRX purge restrictor    |
| 4. Inlet screen (fitted)        | 11. WCX water cooling accessory                        | 16. Bakeout band position   |
| 5. EXT556H pump                 | 12. Purge port   | 17. ACX air cooler assembly |
| 6. TAV solenoid vent valve      |  |                             |
| 7. DN10NW adaptor               |  |                             |

Figure 6 - Installation of EXT556H optional accessories and spares

### 7.4.3 Pump-to-controller cable

You must fit a pump-to-controller cable between an EXC Controller and the EXT pump. A cable is not supplied with the EXT Pump or the EXC Controller (except EXC250L). 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

Table 12 - Pump-to-controller cable

### 7.4.4 EXDC drive modules

Fit an EXDC Drive Module as an alternative to an EXC Controller and pump-to-controller cable.

Drive module	Item Number
EXDC160 80V	D396-41-000

Table 13 - EXDC drive modules

### 7.4.5 BX bakeout band (conflat only)

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
EXT556H/HF DN160CF	BX501 (110 V)	B580-52-044
	BX501 (240 V)	B580-52-064

Table 14 - BX bakeout band

#### 7.4.6 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

Table 15 - FL20K foreline trap

#### 7.4.7 TAV vent-valve and vent-port adaptor

Two solenoid-operated vent-valves are available for system venting. The valves are 24 V dc, 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.

The vent-port adaptor allows the vent-port or the purge-port to be used with any suitable NW10 fitting: refer to Figure 6.

Product	Item Number
TAV5 vent-valve	B580-66-010
TAV6 vent-valve	B580-66-020
NW10-1/8 inch BSP male adaptor	B580-66-011

Table 16 - TAV vent-valve and vent-port adaptor

#### 7.4.8 ACX air-cooler

An ACX air-cooler can be fitted to the EXT pump. However, please refer to Section 3.7 and to Table 5 to check the suitability of air-cooling in a particular application.

Pump	Air-cooler	Item Number
EXT556H/HF	ACX555	B580-53-561

Table 17 - ACX air-cooler

**7.4.9 WCX water-cooler**

If you wish to water cool your pump, you must order the water cooling plate:

Water cooler	Item Number
WCX555	B580-67-003

Table 18 - WCX water-cooler

**7.4.10 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 depends on the pump inlet-flange size.

Inlet-flange size	Item Number
DN160ISO-K	B580-49-000
DN160CF-K	B581-10-000

Table 19 - Vibration isolators

**7.4.11 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

Table 20 - PRX purge-restrictor

**7.4.12 VRX vent-restrictor**

Use a VRX fixed orifice vent-restrictor to restrict the flow of vent gas into the EXT pump. Refer to Section 3.4 for information on the selection 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

Table 21 - VRX vent-restrictor