A533-50-880
Issue D

Instruction Manual

iH Dry Pumping Systems

BOC EDWARDS

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Declaration of Conformity

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

iH Dry Pumping Systems with the following components:

iH Dry Pumping Systems	iH80	iH600	iH1000
460V, 60Hz, 3-phase	A533-50-908	A533-51-908	A533-52-908
200/208V, 50/60Hz, 3-phase	A533-50-945	A533-51-945	A533-52-945
380/415V, 50Hz, 3-phase	A533-50-946	A533-51-946	A533-52-946
230V, 60Hz, 3-phase	A533-50-957	A533-51-957	A533-52-957

iHF Dry Pumping Systems	iH80F	iH600F	iH1000F
460V, 60Hz, 3-phase	A533-57-908	A533-58-908	A533-59-908
200/208V, 50/60Hz, 3-phase	A533-57-945	A533-58-945	A533-59-945
380/415V, 50Hz, 3-phase	A533-57-946	A533-58-946	A533-59-946
230V, 60Hz, 3-phase	A533-57-957	A533-58-957	A533-59-957

iH Alternative Nitrogen and Cooling-Water Connection Kits	A505-34-000
iH Interface Module Fitting Kit	A505-35-000
iH Enclosure Extraction Fan (For iH80 and iH600 Systems only)	A505-39-000
iH/iL Booster Pump Pressure Control Kit	A505-40-000
iH/iL Interstage Port Connection Kit	A505-53-000
iH/iL Light duty Exhaust Check Valve	A505-56-000

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

EN60204-1: 1997	Electrical Safety; Machines
EN61326: 1997 (Industrial location Class A Emissions)	Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements.
EN1012-2: 1996	Compressors and Vacuum Pumps – Safety Requirements, Part 2: Vacuum Pumps.
SEMI S2-93A	Safety Guidelines for Semiconductor Manufacturing Equipment.
EN13463-1: 2001	Non Electrical Equipment for Potentially Explosive Atmospheres.

following the provisions of:

73/023/EEC	Low Voltage Directive.
89/336/EEC	Electromagnetic Compatibility Directive.
94/9/EC	Equipment for use in Potentially Explosive Atmospheres (ATEX Directive) (Category 3GD) Intemal Atmospheres Only.
98/37/EC	Machinery Safety Directive.

JDWatson

8 FEBRUARY 2005 SHOREHAM

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

Date and Place

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

P200-00-220 Issue B

BOC EDWARDS

iH Dry Pumping Systems - Setup Password

The setup password for this equipment is preset as follows:

SETUP PASSWORD: 202

You can remove this sheet from the instruction manual and retain it in a safe place to prevent unauthorised access to the setup menus in the iH system.

P601-00-550
Issue A

Amendment to
A533-40-880
A533-50-880
A533-81-880

iH Dry Vacuum Pumping system

1. Scope of Amendment

This amendment corrects the information given in the iH instruction manuals listed above.

2. Correction

The low warning should read 31.8 and not 38 as currently stated in the following places:

- A533-40-880, Pages 2 – 17 and Tables 2 – 6.
- A533-50-880, Pages 2 – 18 and Tables 2 – 6.
- A533-81-880, Pages 2 – 14 and Tables 2 – 6.

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1 INTRODUCTION

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the BOC Edwards iH Dry Pumping Systems. You must use the iH systems as specified in this manual.

Read this manual before you install and operate the iH system. 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 or process.

Throughout this manual, page, figure and title numbers are in the form 'S-N', where 'S' specifies the section and 'N' specifies the number of the page, figure or table in the section.

The units used throughout this manual conform to the SI international system of units of measurements. Also, throughout this manual, wherever nitrogen flow rates are specified, the abbreviation 'slm' is used to mean 'standard l.min^{-1}': this is a flow of 1 l.min^{-1} at an ambient temperature of 0 ^{o}C and a pressure of 1013 mbar (1.013 x 10^{5} Pa).

NOTICE

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The following symbols may appear on the iH system:

Warning - refer to manual

Warning - heavy object

Warning - risk of electric shock

Warning - moving parts present

Warning - hot surfaces

Warning - use protective equipment

Warning - static sensitive devices

PE -Protective earth (ground)

RF earth (ground)

Warning - risk of catastrophic failure

Material Safety Data Sheets for BOC supplied chemicals can be attained by contacting: UK +44 (0) 1293 528844; France +331 (1) 47 98 24 01; Germany +49 (0) 6421 8030, or; USA (transportation emergency) +1 800-424-9300 (other inquiries) +1 800-848-9800;.

1.2 ATEX directive implications

- This equipment is designed to meet the requirements of Group II Category 3 equipment in accordance with Directive 94/9/EC of the European Parliament and the Council of 23rd March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. (The ATEX Directive).

  The ATEX Category 3 applies in respect of potential ignition sources internal to the equipment. An ATEX Category has not been assigned in respect of potential ignition sources on the outside of the equipment as the equipment has not been designed for use where there is an external potentially explosive atmosphere.

  There is no potential source of ignition within the pump during normal operation but there may be potential sources of ignition under conditions of predicted and rare malfunction as defined in the Directive. Accordingly, although the pump is designed to pump flammable materials and mixtures, operating procedures should ensure that under all normal and reasonably predicted conditions, these materials and mixtures are not within explosive limits. Category 3 is considered appropriate for the avoidance of ignition in the case of a rare malfunction which allows flammable materials or mixtures to pass through the pump while within their explosive limits.

- When flammable or pyrophoric materials are present within the equipment you must:
  - Not allow air to enter the equipment.
  - Ensure that the system is leak tight.
  - Use an inert gas purge (for example, a nitrogen purge) to dilute any flammable gases or vapours entering the pump inlet, and/or use an inert gas purge to reduce the concentration of flammable gases or vapours in the pump and in the exhaust pipeline to less than one quarter of the gases' published lower explosive limits (LEL).
- For further information, please contact BOC Edwards: refer to the Addresses page at the end of this manual for details of your nearest BOC Edwards company.

1.3 The iH system

The iH system operates at pressures between atmospheric and ultimate vacuum with no lubricating or sealing fluid in the pumping chamber(s). This ensures a clean pumping system without back-migration of oil into the system being evacuated.

The iH80 system has an HCDP80 dry pump; the iH600 system has an HCDP80 dry pump, with an HCMB600 mechanical booster pump fitted to the inlet of the HCDP80 pump; the iH1000 system has an HCDP80 dry pump, with an HCMB1000 mechanical booster pump fitted to the inlet of the HCDP80 pump. The HCDP80 pump is referred to as the HCDP pump and the HCMB600 and HCMB1000 pumps are referred to as the HCMB pumps throughout the remainder of this manual.

Both the HCDP and HCMB pumps have enclosed, water-cooled motors. The iH system is therefore suitable for applications in clean environments where fan cooling of motors is unacceptable.

The iH system has a gas system which introduces purge gas into the HCDP pump. This gas system is suitable for use on harsh duty processes. If you use the iH system on light or medium duty processes, you can use the economiser gas mode to reduce the consumption of purge nitrogen by the pumping system.

You can manually control the iH system through the Pump Display Terminal: see Section 1.13. Alternatively, you can use your process tool or other control equipment to control the operation of the iH system through an Interface Module accessory (refer to Section 8.5.3), or through an iM Communications Module accessory (see Section 8.5.2), or you can use the iH Single Equipment Monitor accessory to control the operation of the iH system (refer to Section 8.5.4). The remainder of this manual describes the use of the Pump Display Terminal to operate the iH system: for use of another accessory to operate the iH system, refer to the instruction manual supplied with the accessory.

1.3.1 iH-F variants

All iH-F variants include an innovative Breach Sensor that reduces the risk of hazardous gas leaks during run 'til crash. The iH-F Breach Sensor alerts the user, via the Pump Display Terminal (PDT) and Fabworks, if installed, with the words `Warning 7801 - O Ring' indicating that the pump requires attention. Please refer to table of warnings in Section 6 for further details.

WARNING

The iHF Breach Sensor is not a safety device.
Failure to use normal control measures in the event of a leak could result in injury to people and damage to equipment.

The components of the iH system are described in the following sections.

1.4 Safety

All of the components of the iH system are fitted inside an enclosure. Panels of the enclosure should only be removed for access during maintenance and should at no time be removed by the operator. Potential hazards on the iH system include electricity, hot surfaces, process chemicals, Fomblin oil and nitrogen and water under pressure. Detailed safety information is given in Section 3.1 (Installation), Section 6.1 (Maintenance) and BOC Edwards publication no. P300-20-000 'Vacuum pump and vacuum system safety'.

1.5 The HCDP dry pump

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

1.6 The HCDP gas system

The HCDP pump has a gas system which is suitable for use in harsh processes, such as ion implanters, PECVD (Plasma Enhanced Chemical Vapour Deposition), LPCVD nitride, LPCVD TEOS and Silicides. The gas system is also suitable for use in light or medium duty processes.

The gas system can be preset to operate in any one of the following four configurations: low gas; medium gas; medium gas and exhaust; high gas. As supplied, the gas system is preset for the high gas configuration. To change the gas system configuration, refer to Section 5.3.

The gas system has supply pipelines and components (such as valves), a Gas Module with a distribution manifold, gas purge controls and sensors, and pipelines which deliver purge nitrogen to the purge points on the HCDP pump.

The gas system provides the following purge flows to the HCDP pump:

- Shaft-seals purge: this purge flow is on whenever the HCDP pump is on.
- 2/3-interstage purge and 3/4-interstage purge: these purge flows are either both on or both off. The purge flows can be switched on or off by use of the Pump Display Terminal or by your own control equipment.
- Exhaust-purge: this purge flow is on whenever the HCDP pump is on and the gas system is either in the high gas configuration, or in the medium gas and exhaust configuration.
- Inlet-purge: this purge flow is only used in high gas configuration. The purge flow can be switched on or off by use of the Pump Display Terminal or by your own control equipment.

Refer to Figure 1-2 which shows a schematic diagram of the iH gas system.

The purge flow pressure is controlled by a pressure regulator (26). A mass flow transducer (25) measures the total flow of purge gas to the pump purge points. A check-valve (27) prevents the flow of process gases back into your nitrogen supply pipeline.

The 3/4-interstage purge and 2/3-interstage purge flows are switched on and off by the solenoid-valves (17 and 18). The inlet-purge, shaft-seals purge and exhaust-purge flows are switched on and off by the solenoid-valves (22, 19 and 24). The 2/3-interstage and 3/4-interstage purges solenoid-valve (21) operates in conjunction with the inlet-purge solenoid-valve (22), to provide reduced interstage purge flow when inlet-purge is switched on.

Variable restrictors (12 to 16 and 20) limit the purge flow rates.

A pressure transducer (23) monitors the pressure of the shaft-seals purge flow, and another pressure-transducer (9) monitors the pressure in the exhaust pipeline. The outputs of the pressure transducers are used to display the shaft-seals purge and exhaust pressures on the Pump Display Terminal.

If there is a pressure rise in the exhaust pipeline, the outputs of the exhaust pressure transducer (9) will bring up warning and alarm messages before causing the iH system to be shut down via the relay interlock circuit.

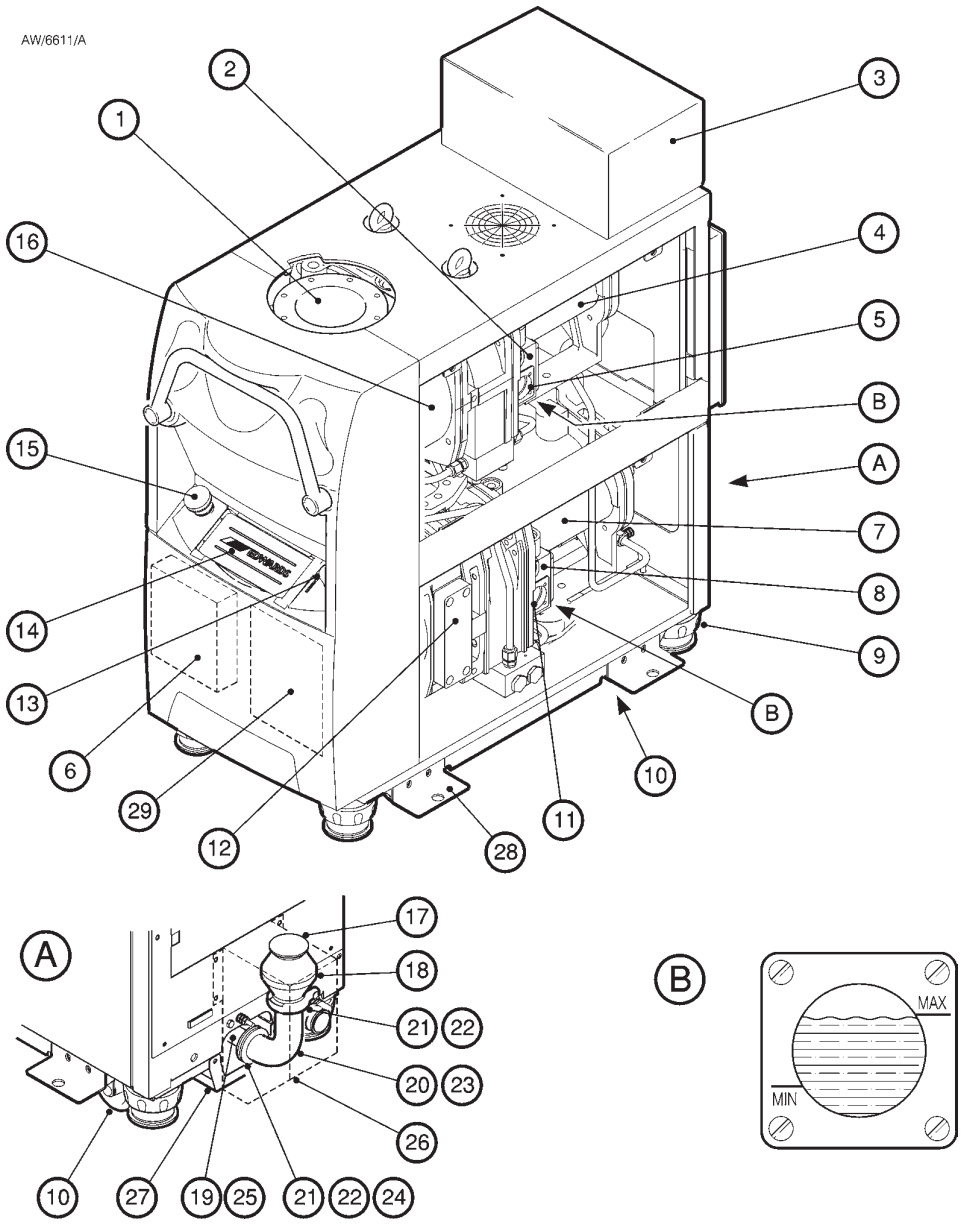
The dashboard has three pressure status LEDs (Figure 1-7, items 3, 5 and 6). These LEDs show whether the nitrogen supply pressure is too high, too low or is in the acceptable range: refer to Section 5.7.

1.7 The HCMB mechanical booster pump (iH600/iH1000 only)

The HCMB pump is a positive displacement roots vacuum pump. The pump mechanism is driven directly by a three-phase electric motor. The HMCB is fitted with a pressure relief valve which decreases the differential pressure between the inlet and outlet of the booster during inlet transients, thereby enhancing the robustness of the iH system. The HCMB1000 pump in the iH1000 system is driven through an electrical inverter, which increases the speed of the motor to 6000 $r.min^{-1}$.

The HCMB pump is backed by the HCDP pump:

- The HCMB600 pump in an iH600 system operates at inlet pressures of 5 mbar (5×10^2 Pa) and below; when you start the HCDP pump, the iH system delays the start of the HCMB pump for a preset time, to allow the HCDP pump to reduce the pressure in the process system to below the maximum inlet pressure for the HCMB pump.
- The HCMB pump in an iH1000 system operates between atmospheric pressure and ultimate vacuum; when you start the HCDP pump, the HCMB pump is also started.



1.	Inlet	13.	Nitrogen pressure regulator	20.	Elbow
2.	HCMB oil filler-plug *	14.	Pump Display Terminal	21.	NW40 trapped 'O' ring
3.	Inverter enclosure †	15.	Emergency stop switch	22.	NW40 clamping ring
4.	HCMB pump-motor *	16.	HCMB pump *	23.	Elbow insulation jacket
5.	HCMB oil-level sight-glass *	17.	Outlet	24.	Clamps insulation jacket
6.	Gas Module	18.	Check-valve	25.	Exhaust pipe insulation jacket
7.	HCDP pump-motor	19.	Exhaust-pipe	26.	Exhaust enclosure
8.	HCDP oil filler-plug			27.	Drip tray
9.	Levelling-foot	* iH600/iH1000 only		28.	Seismic bracket
10.	Castor	† iH1000 onlyInlet		29.	Electronics Module
11.	HCDP oil-level sight-glass				
12.	HCDP pump				

Figure 1-1 - The iH system (iH1000 shown, with side panels removed)

1.8 Temperature control system

1.8.1 HCDP pump temperature control system

The headplate and the fourth stage of the HCDP pump have a direct cooling system in which water flows around these parts of the pump. All other stages of the pump are air-cooled by natural convection and radiation.

The pump-motor is cooled by water which flows through a cooling jacket which surrounds the motor. The cooling-water supply and return pipelines are connected to the iH system by connectors at one end of the iH system (Figure 1-5, items 2 and 3).

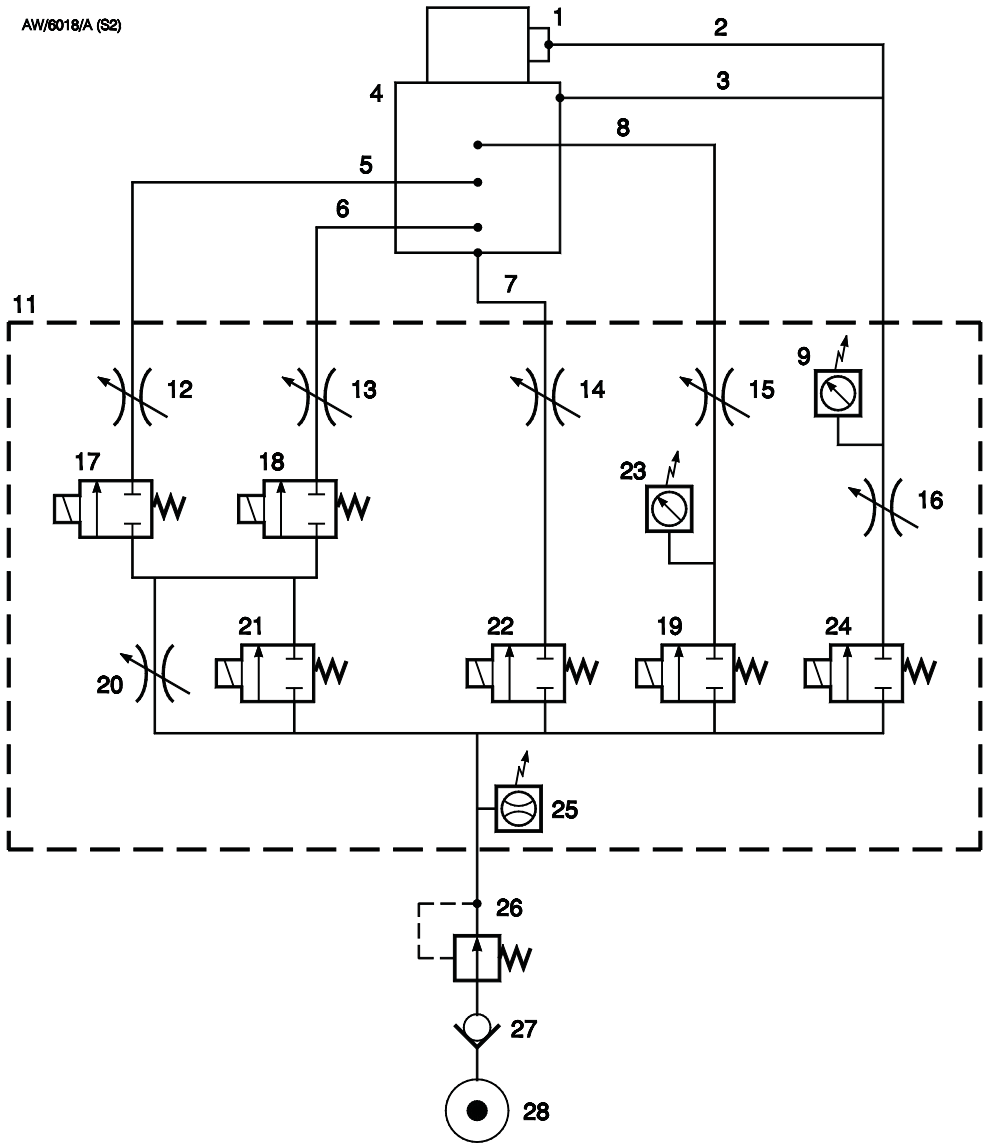
The cooling-water manifolds on the pump distribute the cooling-water to the pump cooling circuit and to the pump-motor cooling circuit (and to the HCMB pump-motor cooling circuit, on an iH600, and iH1000 system). The manifold on the pump headplate also houses a control plug and a blanking plug, which are used to configure the cooling water system for optimal operating temperature. (See Section 3.5)

A surface temperature sensor (Figure 1-6, item 11) is fitted to the pump-body to measure the temperature of the pump-body. The output of the thermocouple is monitored by the iH control system: see Section 1.10.3.

For safety reasons, a shut down thermistor is fitted to the pump headplate manifold block. The thermistor is a solid state device, which has a resistance that changes with temperature. The thermistor is connected to the iH control system and is used to provide warning of cooling system failure. It is also connected to the relay interlock circuit and will cause the iH system to be shut down if the temperature exceeds 60° C.

A motor - protection thermistor is fitted to the pump-motor. This thermistor is a solid-state device which has an electrical resistance of less than 750 Ω at normal pump-motor operational temperature. If the pump-motor is too hot, the electrical resistance rises quickly to 4000 Ω or more. The thermistor is connected to the relay interlock circuit and will cause the system to be shut down if the pump-motor is too hot.

A water flow-switch is fitted in the pump-motor water manifold. The output of the flow-switch is monitored by the iH control system and provides an indication of low water flow through the pump.



1. Two-way gearbox vent-valve
2. Gearbox vent pipeline
3. Exhaust-purge pipeline
4. HCDP pump
5. 3/4-interstage purge pipeline
6. 2/3-interstage purge pipeline
7. Inlet-purge pipeline
8. Shaft-seals purge pipeline
9. Pressure transducer (exhaust-purge)
10. Not used
11. Gas Module manifold
12. Variable restrictor (3/4-interstage purge)
13. Variable restrictor (2/3-interstage purge)
14. Variable restrictor (inlet-purge)
15. Variable restrictor (shaft-seals purge)
16. Variable restrictor (exhaust-purge)
17. Solenoid-valve (3/4-interstage purge)
18. Solenoid-valve (2/3-interstage purge)
19. Solenoid-valve (shaft-seals purge)
20. Variable restrictor (2/3 and 3/4-interstage purges)
21. Solenoid-valve (2/3 and 3/4-interstage purges)
22. Solenoid-valve (inlet-purge)
23. Pressure transducer (shaft-seals purge)
24. Solenoid-valve (exhaust-purge)
25. Mass flow transducer
26. Pressure regulator
27. Check-valve
28. Nitrogen supply inlet

Figure 1-2 - Schematic diagram of the HCDP pump gas system

1.8.2 HCMB pump temperature control system (iH600/iH1000 only)

The HCMB600 pump in an iH600 system is cooled by ambient air. The pump-motor is cooled by water which flows through a cooling jacket which surrounds the pump-motor. The pump-motor cooling-water supply and return pipelines are connected to the cooling-water manifold on the HCDP pump.

The headplate of the HCMB1000 pump in an iH1000 system is directly cooled by water which flows around this part of the pump. The pump-motor is cooled by water which flows through a cooling jacket which surrounds the pump-motor. The headplate and pump-motor cooling-water supply and return pipelines are connected to the cooling-water manifold on the HCDP pump.

A motor-protection thermistor is fitted to the HCMB600 and HCMB1000 pump-motors. This thermistor is identical to that fitted to the HCDP pump (see Section 1.8.1). The thermistor is connected to the relay interlock circuit and will cause the system to be shut down if the pump-motor is too hot.

A temperature sensor probe (Figure 1-6, item 14) is fitted in the stator of the pump. The output of the sensor is monitored by the iH control system: on the iH600, the output is used to provide a warning that the pump has been operating at maximum inlet pressure for longer than the specified time (see Table 2-1) and is overheating; on the iH1000 system, the output is used to control the speed of the HCMB pump, to prevent overheating at high inlet pressures.

1.9 Exhaust system

The outlet of the HCDP pump is connected to an exhaust-pipe, which is below the pump. The outlet also has a port which allows gearbox vent gases to join the main exhaust stream (see Figure 1-2). The final stage of the HCDP pump is a positive displacement Roots stage, which attenuates the gas pressure pulses from the claw stages in the pump. This pump configuration reduces pump-induced resonance in your exhaust-extraction system and removes the need for an exhaust silencer.

An elbow is fitted to the outlet of the exhaust pipe. The outlet of the elbow has a check-valve which prevents the suck-back of exhaust vapours after the iH system is shut down. The check-valve also provides additional attenuation of the pulses in the exhaust pressure. If required, you can remove the elbow and/or check-valve for your specific process (see Section 3.10); or connect the exhaust pipe directly to an exhaust treatment system (such as a BOC Edwards Exhaust Gas Management). The exhaust pipe, elbow and joint between pipe and elbow are fitted with insulation jackets to reduce heat loss from the exhaust system.

You can fit an exhaust temperature sensor accessory to the end of the exhaust pipe (between the elbow and the check-valve, if fitted): see Section 8.4.1. When fitted, the output of the sensor is monitored by the iH control system and is used to provide an indication of exhaust gas temperature.

1.10 Electrical system

Refer to Figures 1-3 and 1-4 which show schematic diagrams of the electrical and control systems of the iH80, iH600 and iH1000 systems.

1.10.1 Introduction

Refer to Figures 1-3 and 1-4. The iH system has an Electrics Box (1), Electronics Module (3), a Gas Module (2) and a Pump Display Terminal (4). The iH1000 system also has an inverter (50). Optionally, your iH system may have an iH Interface Module, an iH Communications Module, an HCMB pump and other accessories, such as an exhaust temperature sensor (30) and a Pump Display Module (10).

All of these Modules communicate through a serial data network. Each Module on the network has a microprocessor, which controls the network communications and also contains the default setpoints for the sensors in or connected to the Modules (see Section 2).

1.10.2 Electrics box

Refer to Figures 1-3 and 1-4. The external electrical supply (5) is connected to the electrical supply connector (6) on the Electrics Box (1). The Electrics Box switches the electrical supplies to the HCDP pump and to the HCMB pump (on an iH600 system). The Electrics Box also provides the electrical supplies to the other Modules in the iH system. The electrical supply to the HCMB1000 pump in an iH1000 system is provided by the inverter (50).

The Electrics Box has contactors for the HCDP pump and the HCMB pump (on an iH600/iH1000 system), pump power and current consumption sensors and short-circuit protection. The Electrics Box also has a transformer and fuses for the 24 V control circuits and fuses for the following supplies: iH Interface Module (11) and d.c. electrical supply (47). Three thermal-type, self-resetting fuses in the Electrics Box protect the d.c. electrical supplies to the network.

Refer to Figure 1-5 detail D. The rear panel of the Electrics Box has the following lamp and connections:

Power on lamp (7)	This lamp is on when the electrical supply to the Electrics Box is on.
Tool Interface Module connector (8)	Use this to connect an iH Tool Interface Module to the iH system (see Section 8.5.3); or to connect an external emergency stop circuit to the iH system (see Section 3.15); or to connect a Disconnect Box to the iH system (see Section 3.21).
LON Interface Connector (9)	Use this to connect the iH system to a network.
Electrical supply connector (10)	Use this to connect your external electrical supply to the iH system: refer to Section 3.16.3.

Protective earth (ground) stud (11)	If required, use this to make additional protective earth (ground) connections: refer to Section 3.16.3.
Exhaust Gas Management interface (12)	If required, use this connector to connect the iH system to a BOC Edwards Exhaust Gas Management.
Fuse holder F7 (13)	This fuse protects the d.c. electrical supply.
Fuse holder F9 (14)	This fuse protects the emergency stop circuit.
Fuse holder F8 (15)	This fuse protects the iH Interface Module (if fitted).

Refer to detail E. Fuses inside the Electrics Box (16 to 21) protect the internal circuits of the Electrics Box. Note that you cannot change these fuses; a BOC Edwards service engineer must change these fuses.

Refer to detail C. The rear panel of the iH system has the following connections:

Active gauge connector (5)	This connector is only available if you have fitted an Active Gauge Connection Kit (see Section 8.4.3). Use this to connect the active gauge to the iH system.

1. Electrics Box
2. Gas Module
3. Electronics Module
3A. Control SMA
4. Pump Display Terminal
5. External electrical supply
6. Electrical supply connector
7. Protective earth (ground) stud
8. Exhaust Gas Management interface
9. Tool Interface Module connector
10. Pump Display Module *
11. iH Tool Interface Module fuse holder
12. Emergency stop fuse holder
13. HCDP electrical supply
14. HCDP motor terminal-box
15. HCDP motor thermistor cable
16. HCMB electrical supply †
17. HCMB motor terminal-box †
18. HCMB motor thermistor cable †
19. RF earth (ground) stud
20. Cooling-fan connector
21. iTIM
22. iTIM connector
23. Pump shut-down thermistor
24. Not used
25. Emergency stop switch
26. RJ12 connector for PDT
27. Not used
28. HCMB temperature sensor †
29. Not used
30. Exhaust temperature sensor *
31. HCDP pump-body temperature sensor
32. Control PL3 connector
33. Gas Module PL4 connector
34. Water flow-switch
35. Not used
36. Dashboard PL1 connector
37. Sensors PL2 connector
38. Not used
39. Solenoid-valves (6 off)
40. Pressure transducers (2 off)
41. Mass flow transducer
42. Dashboard LEDs
43. Not used
44. 4-way XLR connector for PDM
45. Active Gauge connector *
46. Lower rear bulkhead panel
47. d.c. electrical supply fuse holder
48. Active gauge cable connector
49. Sensor connector

* Optional accessory

† iH600 only

Figure 1-3 - Schematic diagram of the iH80/iH600 electrical systems: key

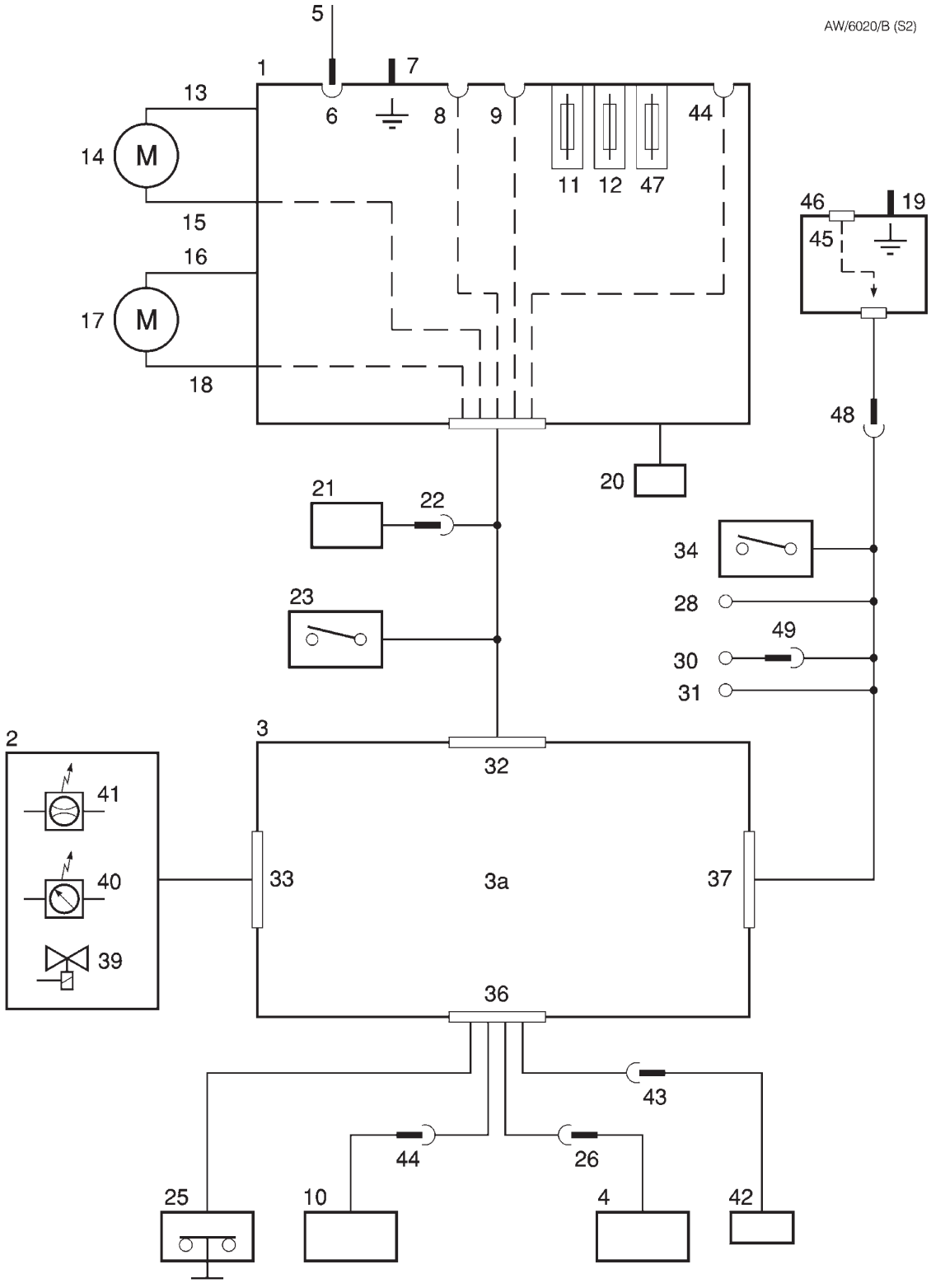


Figure 1-3 - Schematic diagram of the iH80/iH600 electrical systems

RF earth (ground) stud (6)	If required, use this to make additional RF earth (ground) connections: refer to Section 3.16.4.

Refer to Figure 1-6, detail A or B. The bottom panel of the Electrics Box has the following cables and connectors:

Electrics and Control Loom (17)	This is used to provide power, measurement signals and control signals to the Electronics Module.
HCDP electrical supply cable (18)	This is used to connect the electrical supply from the Electrics Box to the HCDP pump.
HCDP thermistor cable (19)	This is used to connect the output of the thermistor in the HCDP pump to the Electrics Box.

1. Electrics Box
2. Gas Module
3. Electronics Module

3A. Control SMA

4. Pump Display Terminal
5. External electrical supply
6. Electrical supply connector
7. Protective earth (ground) stud
8. Exhaust Gas Management interface
9. Tool Interface Module connector
10. Pump Display Module *
11. iH Tool Interface Module fuse holder
12. Emergency stop fuse holder
13. HCDP electrical supply
14. HCDP motor terminal-box
15. HCDP motor thermistor cable
16. HCMB electrical supply
17. HCMB motor terminal-box
18. HCMB motor thermistor cable
19. RF earth (ground) stud
20. Cooling-fan connector
21. iTIM
22. iTIM connector
23. Pump shut-down thermistor
24. Not used
25. Emergency stop switch
26. RJ12 connector for PDT
27. Not used
28. HCMB temperature sensor
29. Not used
30. Exhaust temperature sensor *
31. HCDP pump-body temperature sensor
32. Control PL3 connector
33. Gas module PL4 connector
34. Water flow-switch
35. RS485
36. Dashboard PL1 connector
37. Sensors PL2 connector
38. Not used
39. Solenoid-valves (6 off)
40. Pressure transducers (2 off)
41. Mass flow transducer
42. Dashboard LEDs
43. Not used
44. 4-way XLR connector for PDM
45. Active Gauge connector *
46. Lower rear bulkhead panel
47. d.c. electrical supply fuse holder
48. Active gauge cable connector
49. Sensor connector
50. Inverter

* Optional accessory

Figure 1-4 - Schematic diagram of the iH1000 electrical system: key

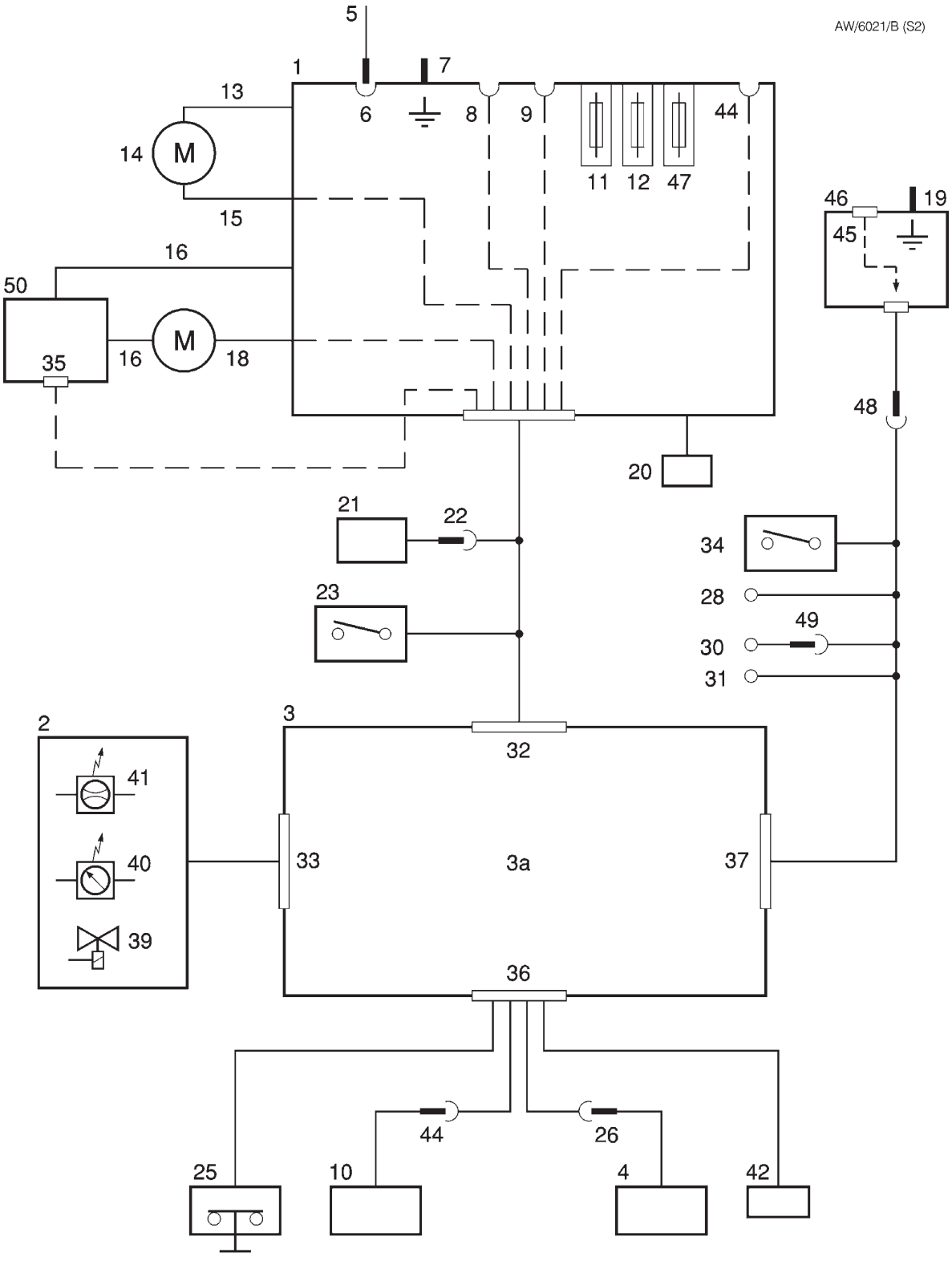

AW/6021/B (S2)
5
1
7
13
6
8
9
44
14
M
11
12
47
15
46
19
45
16
50
M
35
16
18
48
20
21
22
34
23
28
49
30
31
2
3
32
41
40
33
3a
37
39
36
44
26
25
10
4
42

Figure 1-4 -

HCMB thermistor cable (21)	On an iH600/iH1000 system, this is used to connect the output of the thermistor in the HCMB pump to the Electrics Box.
HCMB electrical supply cable (22)	On an iH600/iH1000 system, this is used to connect the electrical supply from the Electrics Box to the HCMB pump.

1.10.3 Electronics module

This Module communicates with the Gas Module, the Pump Display Terminal and the optional Interface Module accessories. The following sensors are connected to the Electronics Module:

- HCDP pump-body and pump-motor water manifold temperature sensors
- HCMB pump temperature sensor (iH600/iH1000 systems only)
- Exhaust temperature sensor (if fitted)
- Water flow-switch.

The Module has a microprocessor which:

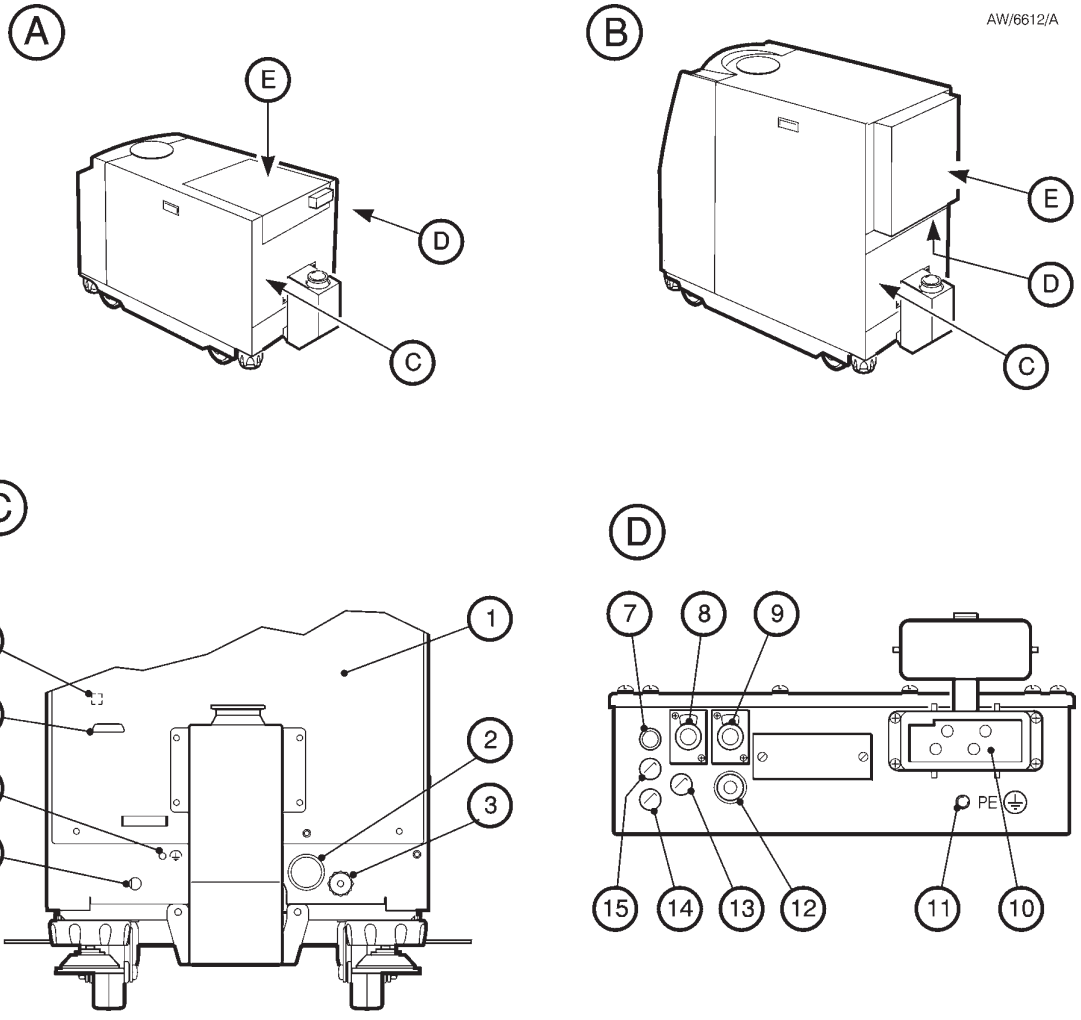
- Monitors the status of the system.
- Sends warning and alarm messages (see Section 1.12.2) to other Modules connected to the iH system.
- Monitors the control inputs (from the Pump Display Terminal or the Interface Module accessory) and switches the pumps on and off as requested.
- Shuts down the iH system if a sensor reading is outside the specified alarm range: see Section 1.12.2.

The Module also communicates with and controls the operation of the Gas Module.

Internal clocks and counters in the module measure the operating time of the iH system and keep count of the number of iH system switch-on/switch-off and process cycles.

1.10.4 Gas module

The Gas Module communicates with and is controlled by the Electronics Module. The operation of the nitrogen purge supply solenoid-valves in the Gas Module is described in Section 1.6.



1. Rear cover
2. Cooling-water outlet
3. Cooling-water inlet
4. Nitrogen inlet
5. Position of Active Gauge connector
6. RF earth (ground) stud
7. Power on lamp
8. Tool Interface Module connector
9. LON interface connector
10. Electrical supply connector
11. Protective earth (ground) stud
12. Exhaust Gas Management interface
13. d.c. electrical supply fuse holder (F7)
14. Emergency stop fuse holder (F9)
15. Tool Interface Module fuse holder (F8)
16. Fuse F6
17. Fuse F5
18. Fuse F4
19. Fuse F1
20. Fuse F2
21. Fuse F3
22. iTIM connector

A iH80
B iH600/iH1000
C Rear panel
D, E Detail of Electrics box

Figure 1-5 - Services and electrical connections on the rear of the iH system

1.11 Controls and indicators

Refer to Figure 1-7. The controls and indicators on the dashboard of the iH system are as follows:

Emergency stop switch (1)	Press this to immediately shut down the iH system in an emergency: refer to Section 5.12.
Pump Display Terminal (2)	Use this to control the iH system: refer to Section 1.13.
Shaft-seal purge pressure warning LED (3)	This yellow LED is on when the shaft-seals purge nitrogen pressure is too high or too low.
Nitrogen supply pressure regulator (4)	Use this to adjust the nitrogen supply pressure.
Shaft-seal purge pressure high and low LEDs (5, 6)	These green LEDs are both on when the shaft-seals purge nitrogen pressure is acceptable. The pressure high LED (5) is off when the pressure is too low, and the pressure low LED (6) is off when the pressure is too high.
Power OK LED (7)	This green LED is on when the 24 V electrical supply to the Electronics Module is on.
Running LED (8)	This green LED is on when the iH pumps are operating.
Alarm LED (9)	This red LED is on when an alarm condition exists: see Section 1.12.
Warning LED (10)	This yellow LED is on when a warning condition exists: see Section 1.12.

A iH80 Electrics Box detail

1. HCMB pump *
2. Inverter enclosure ▲
3. HCMB pump-motor terminal-box *
4. IH600/iH1000 Electrics Box
5. HCDP pump-motor terminal-box
6. Not Used
7. HCDP pump shut-down thermistor
8. HCDP pump water flow-switch
9. Gas Module
10. iH80 Electrics Box
11. HCDP pump-body temperature sensor

B iH600/iH1000 Electrics Box detail

12. HCDP pump
13. Electronics Module
14. HCMB pump-motor *
15. HCMB pump temperature sensor *
16. HCMB Pressure Relief Valve *
17. Electrics and Control Loom
18. HCDP pump electrical supply cable
19. HCDP pump-motor thermistor cable
20. Not used
21. HCMB pump-motor thermistor cable *
22. HCMB pump electrical supply cable (iH600) * or inverter electrical supply cable (iH1000)▲

* iH600/iH1000 only

▲ iH1000 only

Figure 1-6 - Electrical components: key

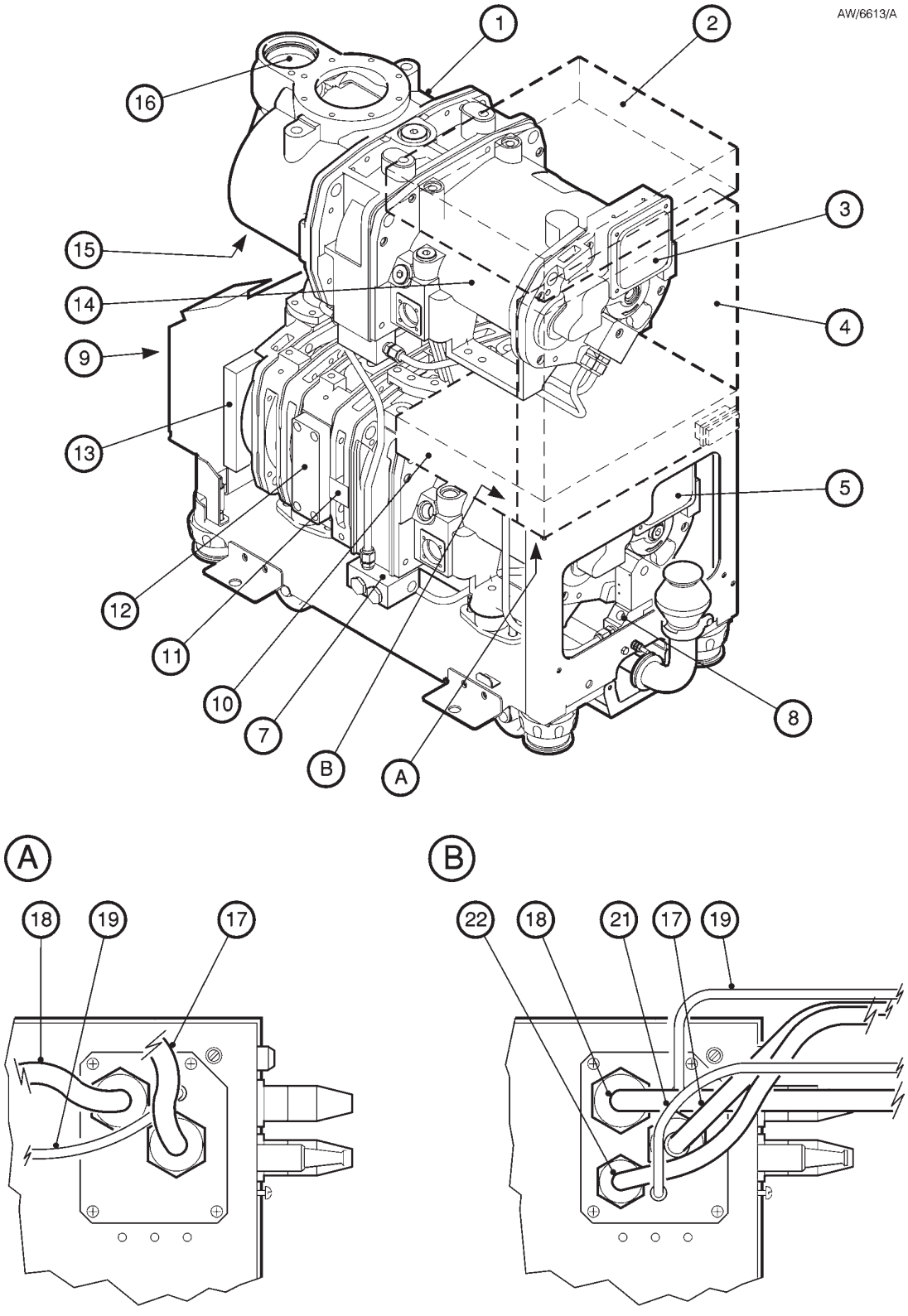


Figure 1-6 - Electrical components (shown without enclosure for clarity)

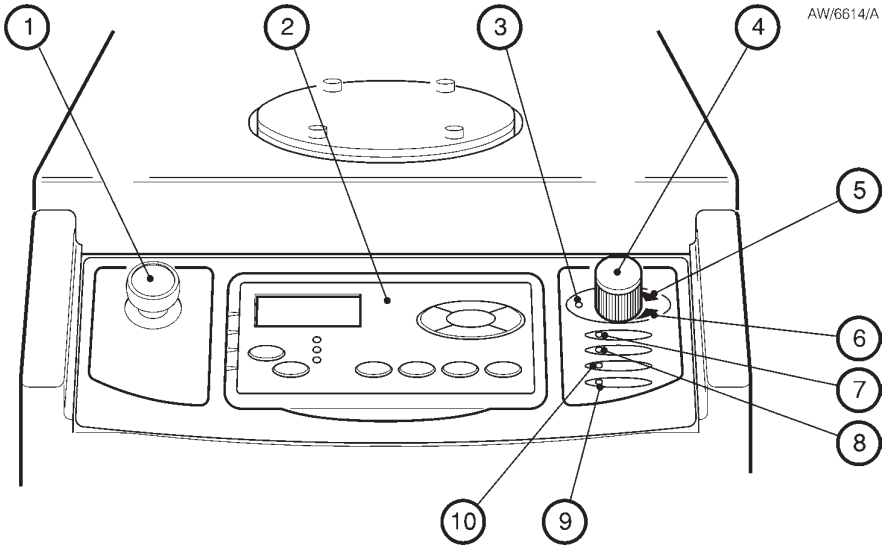
1.12 Control functions

1.12.1 Priority of control

The iH system can be controlled by a number of modules: the Pump Display Terminal (see Section 1.13); an iH Interface Module (see Section 8.5.3); or the iH Single Equipment Monitor (see Section 8.5.4). Only one module can have control of the iH system at any one time. That is, once a module has control of the iH system, control requests from another Module are denied.

To allow another Module to control the iH system:

- The Module which currently has control must 'release' control (that is, you must send the appropriate message on the network or press the appropriate button to release control).
- Any Module which requires control must then 'take' control (that is, you must send the appropriate message to the iH system or press the appropriate button to take control).



1. Emergency stop switch
2. Pump Display Terminal
3. Shaft-seals purge pressure warning LED (yellow)
4. Nitrogen pressure regulator
5. Shaft-seals purge pressure high LED (green)
6. Shaft-seals purge pressure low LED (green)
7. Power OK LED (green)
8. Running LED (green)
9. Alarm LED (red)
10. Warning LED (yellow)

Figure 1-7 - Controls and indicators on the dashboard

Note that when you first switch-on the electrical supply, no Module will initially have control of the iH system. The Module which you want to control the iH system must take control as described above.

1.12.2 Setpoints, warning and alarm conditions

Note: Sensors which generate alarm and warning messages are not safety sensors: see Section 1.12.3.

Each Module which monitors sensors has a microprocessor. Each monitored sensor (except for switch-type sensors, such as the oil monitors, which have only two output states: error or no error) has four associated setpoints. The setpoints are: the low warning setpoint, the high warning setpoint, the low alarm setpoint and the high alarm setpoint. The microprocessor compares the sensor data to the setpoints to determine if an alarm or warning condition exists:

- If the sensor data is below the low warning setpoint or above the high warning setpoint, a warning condition exists. A warning condition means that some aspect of the operation of the iH system is abnormal. The iH system will continue to operate.
- If the sensor data is below the low alarm setpoint or above the high alarm setpoint, an alarm condition exists. An alarm condition means there is a serious fault which results in the shut-down of the iH system to prevent damage to the iH system. However, note that for some of the alarm conditions, you may be able to continue to operate the iH system if you have configured the iH system to 'run til crash': see Section 5.11.

If an alarm or warning condition exists, an appropriate alarm or warning message is displayed on the Pump Display Terminal and an appropriate alarm or warning indication is sent to other Modules on the network. Refer to Tables 6-1 and 6-2 for a full list of the Pump Display Terminal warning and alarm messages.

You can use the default setpoints or you can use a Single Equipment Monitor to adjust the setpoints to suit your application: refer to Section 5.3. Refer to Section 2 for the default setpoints.

1.12.3 Safety sensors

The iH system has a number of safety sensors, which are connected to the relay interlock circuit. If any of the safety sensors cause the interlock relay to operate, the iH system is immediately shut down.

The iH system can also be fitted with a photohelic switch accessory. If it operates, all electrical power to the iH system is removed via the disconnect box. (See Section 1.18 and 1.19)

Table 1-1 shows the safety sensors and the shut down conditions.

Safety sensor	Shut-down condition
HCDP pump-motor thermistor	When the thermistor in the HCDP pump-motor indicates that the temperature of the pump-motor is nominally 150 ^{o}C.
HCMB pump-motor thermistor *	When the thermistor in the HCMB pump-motor indicates that the temperature of the pump-motor is nominally 150 ^{o}C.
HCDP pump shut-down thermistor	When the thermistor indicates that the temperature of the HCDP pump-headplate manifold is 60 ^{o}C or higher.
Exhaust pressure transducer	When the pressure in the exhaust pipeline is 9 psig or higher.
Photohelic switch$^{\#}$	When the pressure in the enclosure exceeds the setpoint.

* iH600/iH1000 only.

$^{\#}$ Accessory

Table 1-1 - Safety sensors

1.13 Pump display terminal

The Pump Display Terminal allows you to manually control the iH system and to display the status of the iH system. Refer to Figure 1-8 which shows the front panel of the Pump Display Terminal.

Use the On button (1) to switch on the iH system (refer to Section 5.6). The On button has a green LED which is illuminated when the iH system is on. Use the Off button (10) to switch off the iH system (refer to Section 5.10).

The display (2) shows two lines of text; each line is 16 characters long. In normal operation, the Normal display is shown; the Normal display has two pages, and each page has two lines. Each page of the Normal display shows the current status of one or more iH system sensors or internal clocks and counters.

As supplied the first page of Normal display shows HCDP pump power consumption and HCDP pump body temperature, and the second page shows HCMB pump power consumption and HCMB pump-motor temperature. You can change the information shown on the Normal display: refer to Section 5.4.

At any time, you can press one of the four menu buttons (7) to select a new menu. You can then use the up (5), down (3), ENTER (6) and CANCEL (4) buttons to move through the menu. The appropriate menu selected LED (8) is on when the corresponding menu is in use.

Use the menu (7), up (5), down (3), CANCEL (4) and ENTER (6) buttons as described below. Refer to Section 4 for a full definition of the menu structures and the display formats.

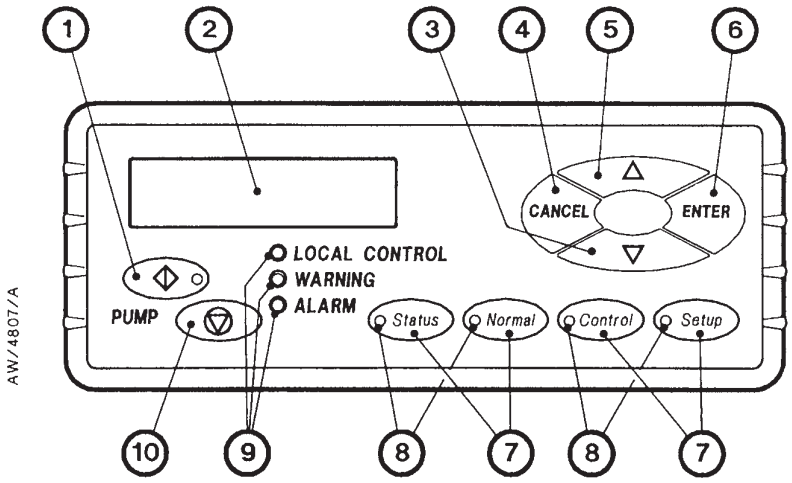
Button	**LED colour**	**Button use**
Normal	Green	Press this button to select the Normal display (see above).
Control	Green	Press this button to select the Control menu. You can then take control or release control of the iH system (see Section 5.5).
Status	Green	Press this button to select the Status menu. In this menu, you can display the current values of all iH system sensors.
Setup	Green	Press this button to select the Setup menu. In this menu you can: manually control the operation of iH gas purges and gate valves fitted to the vacuum system (and connected to the iH through an iH Interface Module with an Auxiliary Interface Card); select 'Run til Crash'; change other display parameters (such as the pressure units used when pressures are displayed and the timeout time). The Setup menu also allows you to select the Service menu; in this menu, you can zero the Gas Module flow transducer and manually operate the components of the iH system.
ENTER	-	Use this button to select a currently displayed menu option or to enter a currently displayed parameter.
CANCEL	-	Use this button to cancel the currently displayed menu or option and return to the previous menu or option.
Up/down	-	Use these buttons to move up or down menu options or to increase or decrease a displayed parameter.

The status LEDs (9) show the current status of the iH system and the Pump Display Terminal:

LED	LED colour	Meaning
ALARM	Red	This LED shows when an alarm condition exists.
WARNING	Amber	This LED shows when a warning condition exists.
LOCAL CONTROL	Green	This LED is on when the Pump Display Terminal has control of the iH system.

The ALARM and WARNING LEDs flash when the corresponding alarm or warning condition first occurs. When you acknowledge the condition (refer to Section 5.9), the corresponding LED goes on permanently. For most alarms and warnings, if the condition clears (that is, the fault which caused the condition is no longer present), the corresponding LED goes off; see Tables 6-1 and 6-2 for the warnings and alarms whose LEDs do not automatically reset in this way.

If remote operation in excess of 25m is expected, a Pump Display Module should be used. The functionality of the Pump Display Module is the same as that of the Pump Display Terminal. Refer to Section 8.5.8 for ordering information.



1. On button
2. Display
3. Down button
4. CANCEL button
5. Up button
6. ENTER button
7. Menu buttons
8. Menu selected LEDs
9. Status LEDs
10. Off button

Figure 1-8 - Front panel of the pump display terminal

1.14 Drip tray

The drip tray is fitted to the bottom of the iH frame (see Figure 1-1) and allows the collection of potentially spilled liquids from the iH system, thereby satisfying SEMI S2 requirements.

1.15 Seismic brackets

The four seismic brackets, which are also used to secure the iH system to a pallet during transit (see Figure 3-1), are fitted to the side of the iH frame. These brackets can be used to protect the iH system during zone 4 earthquake conditions, thereby satisfying SEMI S2 requirements.

1.16 Labels

The labels provided warn against potential hazards, thereby satisfying SEMI S2 requirements.

The labels are placed on the iH system to: identify components; state required operating procedures; and warn of residual risks. Figures 1-10 and 1-11 show the position and text of these labels.

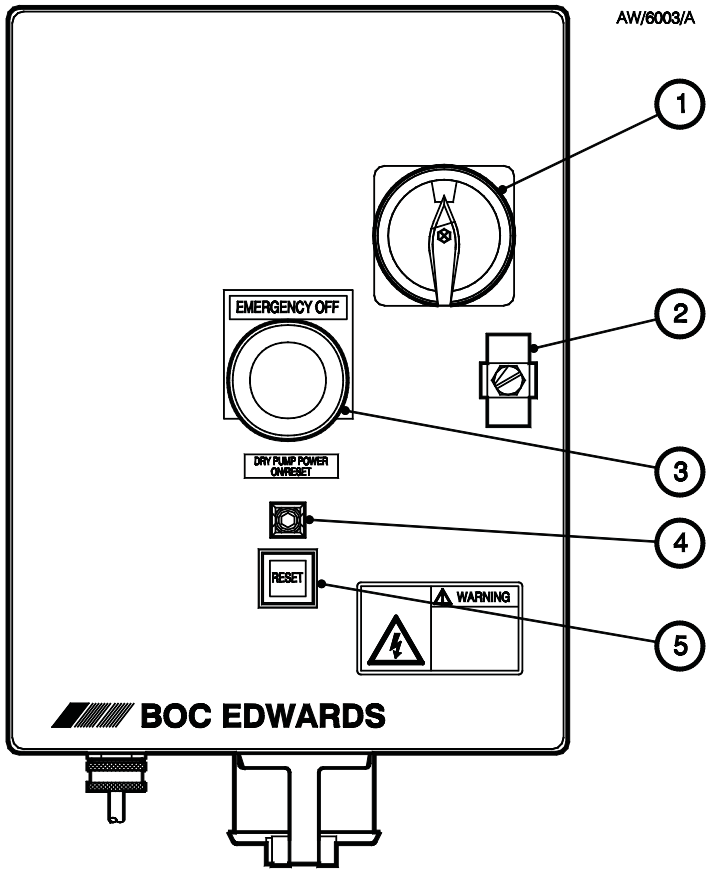
1.17 Exhaust enclosure

The exhaust enclosure fits around the exhaust pipe and check valve(see Figure 1-1), and provides a means of extracting the enclosure in the event of an exhaust leak from the system, thereby satisfying SEMI S2 requirements.

1.18 iH Disconnect box (accessory)

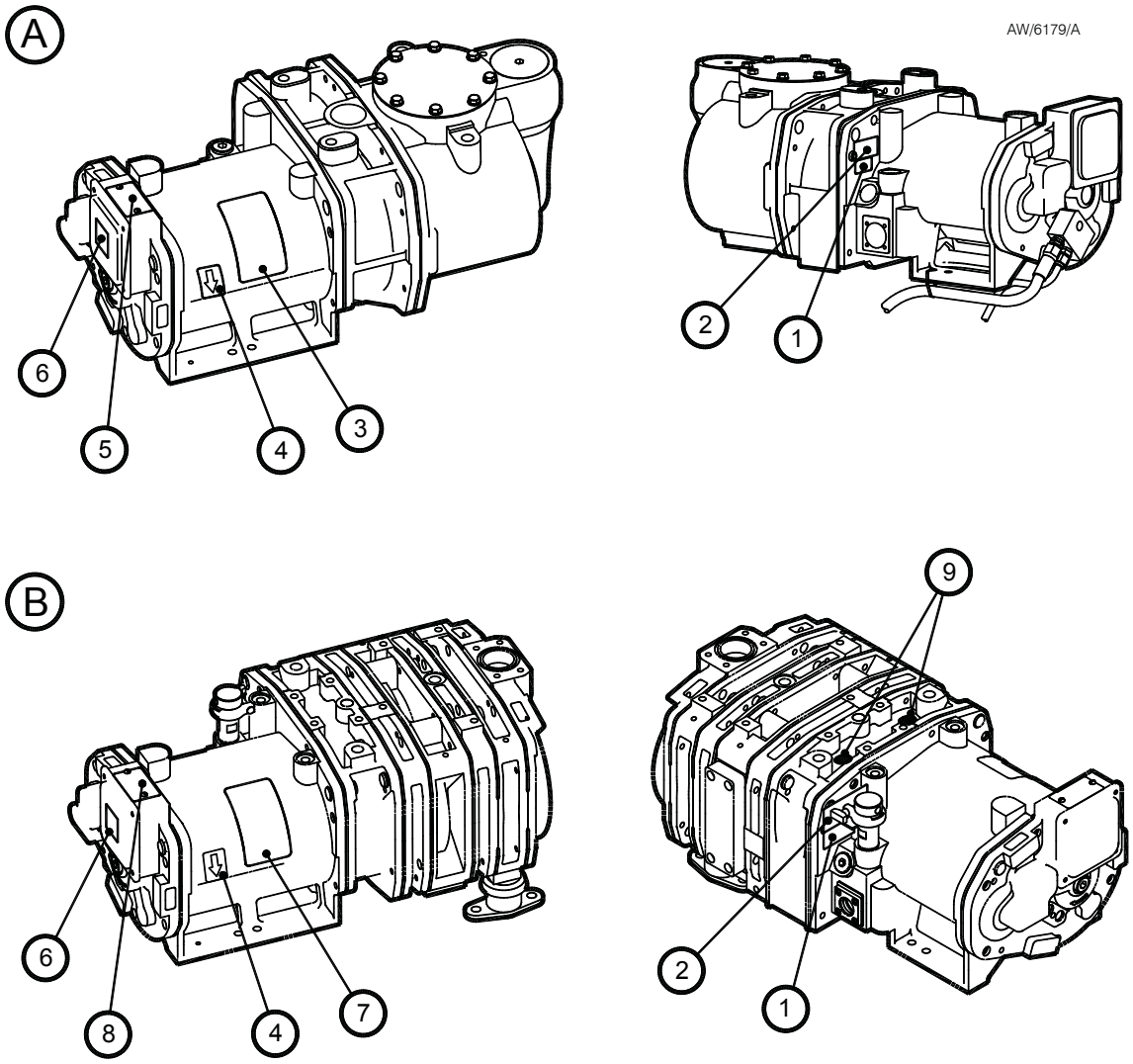
The iH disconnect box accessory is used to energise and isolate the power supply to the iH system. It also allows the isolation of the electrical supply during emergency, and for maintenance and troubleshooting the system, thereby satisfying SEMI S2 requirements. Refer to Section 8 for ordering information.

The functions of the disconnect box are described in the following sections. The disconnect box control panel is shown in Figure 1-9.



1. Isolation switch
2. Door Lock
3. Emergency off button
4. Dry pump power On/Reset indicator lamp
5. Dry pump power On/Reset push button

Figure 1-9 - Disconnect box general arrangement


A
AW/6179/A
6
5
4
3
2
1
B
9
6
8
4
7
2
1

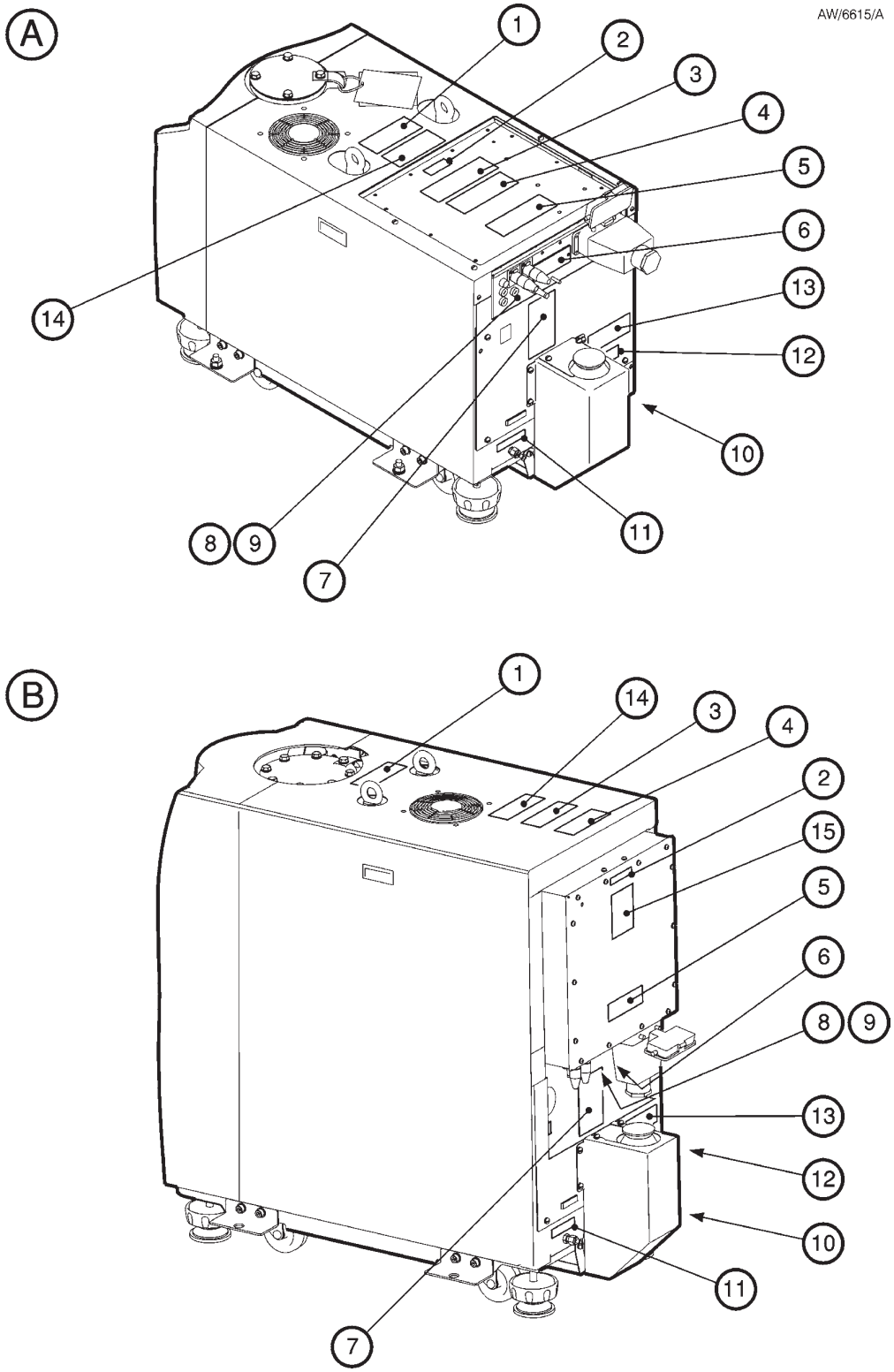
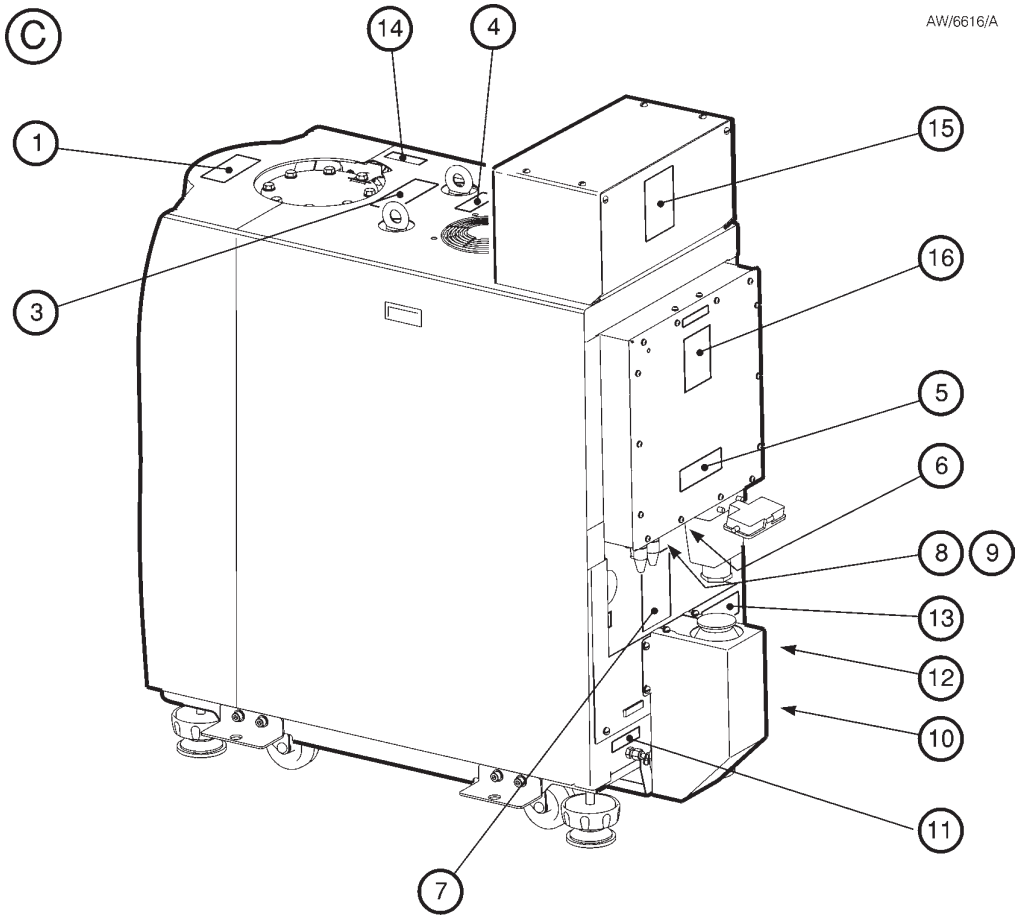


Figure 1-11 - Label positions on iH system enclosures



A. iH80
B. iH600
C. iH1000

1. Warning! Moving Parts Present
2. Voltage variant
3. Caution! Heavy Object
4. Warning! Hazardous Chemicals Enclosed
5. Warning! Disconnect mains supply before removing Electric Box covers
6. Warning! Risk of Electric Shock
7. System Information/ Warning! Risk of High Temperature Symbol
8. Protective Earth symbol
9. External Protective Earth Conductor symbol
10. $H_2O \leq 100$ PSIG (≤ 6.9 bar)
11. N_2 20-100 PSIG (1.4-6.9 bar)
12. Warning! Switch off before disconnecting
13. ETL Listing Label
14. Caution! Hot Surface
15. Set voltage - Do not adjust
16. This equipment must have a second protective earth. See manual.

Figure 1-11 - Label positions on iH system enclosures (continued...)

1.18.1 Start control

The disconnect box has a DRY PUMP POWER ON/RESET push button for operational control of the iH system power supply.

1.18.2 Emergency off control

If an emergency condition arises, the pump system can be shut down in two ways: red EMERGENCY OFF button located on the control panel, or: EMO signal through 6-way XLR connector from the pump. If the EMERGENCY OFF push button is used, the button must be reset by twisting the button until it releases back out, prior to restarting the system with the use of the DRY PUMP POWER ON/RESET push button.

1.18.3 Brownout protection

The disconnect box is equipped with a time delay relay which enables the system to continue running as normal if a brownout occurs (of 3 seconds or less). If the brownout lasts over 3 seconds the disconnect box will shutoff power to the system. If this occurs, it will be necessary to restart the system by using the DRY PUMP POWER ON/RESET push button after the condition is corrected.

1.18.4 Circuit protection

The disconnect box circuits are protected by circuit breakers and fuses (refer to Figure 3-13).

The supply voltage to the box is protected by a 35 amp fused mains disconnect. If any of the fuses fail (F1-F3), the power to the disconnect box will be disabled and the iH system will be shut down.

The transformer primary is protected by two (2) fuses, F4 and F5. If either of these fuses fail, the 24 VAC control circuit is shut down and the pump system is switched off.

The 24 VAC system is protected by a single fuse, F6. If this fuse fails, the control circuit is shut down and the system is switched off.

Circuit breaker CB1 protects the supply to the photohelic gauge (see Section 1.19). If this breaker trips, the photohelic gauge will not operate.

1.19 iH photohelic switch/gauge (accessory)

The iH photohelic switch/gauge accessory allows monitoring for loss of extraction from the enclosure, thereby satisfying SEMI S2 requirements. Refer to Section 8 for ordering information.

1.20 Accessories

A number of accessories are available to configure the iH system for your specific application. Refer to Section 8 for descriptions of these accessories.

2 TECHNICAL DATA

Notes: Unless otherwise specified, data in the following sections applies to all models of iH system.

2.1 General

Dimensions	See Figures 2-1 to 2-4
Inlet and outlet	See Table 2-1
Warm-up time to nominal pumping performance	15 min
Minimum warm-up time to process gas pumping	4 hours
Vacuum system maximum leak-rate	1 x 10^{-5} mbar.ls^{-1} (1 x 10^{-3} Pa.ls^{-1})
Exhaust system maximum leak-rate	1 x 10^{-5} mbar.ls^{-1} (1 x 10^{-3} Pa.ls^{-1})
Ambient operating temperature range	5 to 40 °C
Maximum ambient operating humidity	90% RH
Noise level measured at 1 m from the pump (with enclosure panels fitted)	See Table 2-1
Mass	See Table 2-1
Centre of mass/mass distribution	See Figure 2-5

2.2 Performance

Pumping speed range	See Figures 2-6 to 2-10
Power curves	See Figures 2-6 to 2-10
Peak pumping speed	See Table 2-1
Ultimate vacuum	See Table 2-1
Maximum pressure differential between HCMB inlet and outlet*	See Table 2-1
Maximum inlet pressure *	See Table 2-1
Maximum operating time at maximum inlet pressure *	See Table 2-1

2.3 Temperature control system

HCDP pump shut-down thermistor	
Type	Negative Temperature Coefficient thermistor
"Opening" temperature	60 +/-3 °C
"Closing" temperature	50+/-4 °C
Thermocouples	K type class 1
HCDP and HCMB motor-protection thermistors	
Type	Positive temperature coefficient
Reference temperature	150 °C
Compliant with	IEC 34-11 (BS4999 part III)
Water flow-switch	Closed when flow ≥ 2 l.min^{-1} (iH80) Closed when flow ≥ 4 l.min^{-1} (iH600/iH1000)

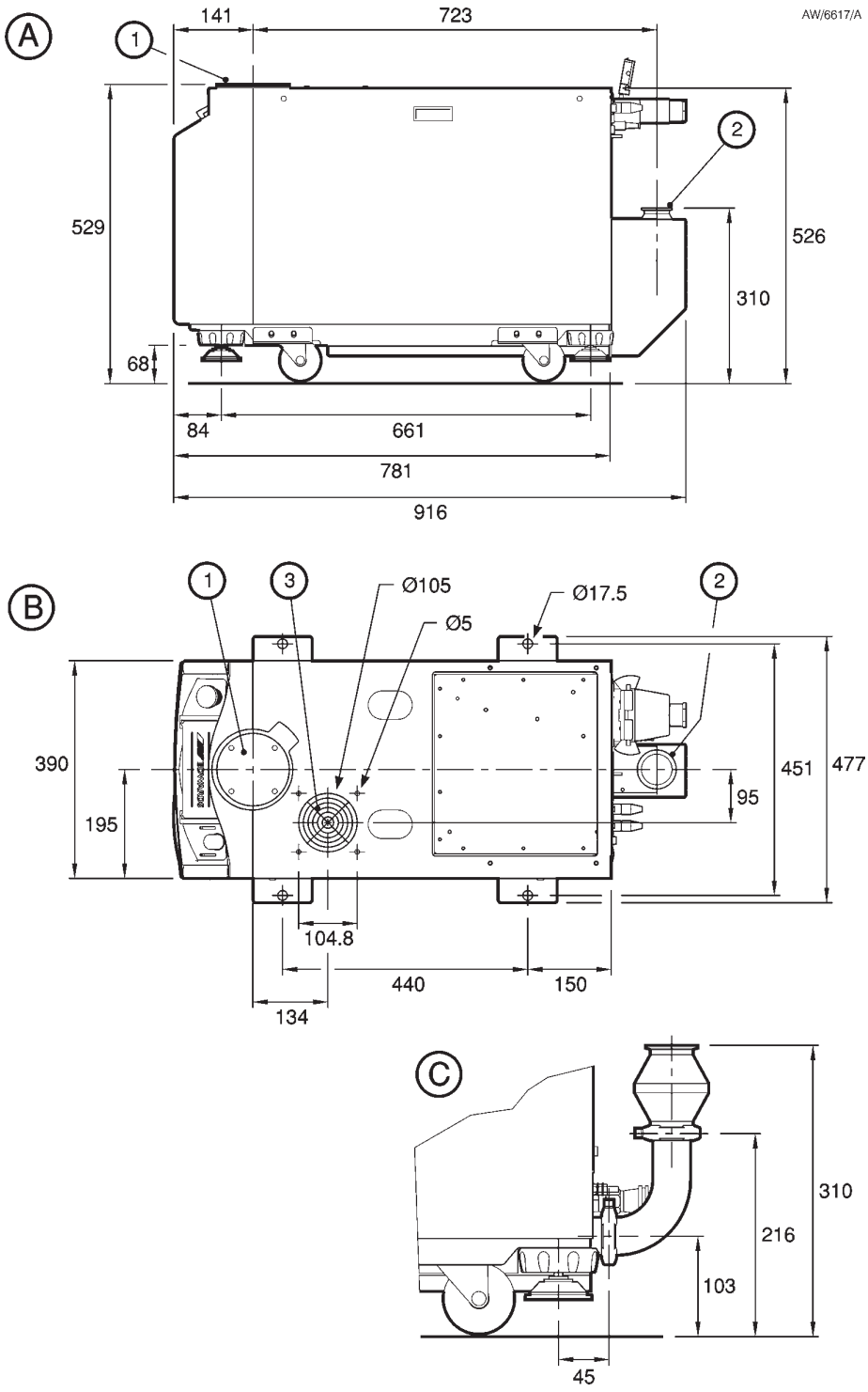
* iH600/iH1000 systems only

Parameter		Units	iH80	iH600	iH1000
Typical peak pumping speed	50 Hz	m^3h^{-1}	86	518	950
	60 Hz	m^3h^{-1}	103	600	1000
Typical ultimate vacuum with shaft-seals purge only	50 Hz	mbar	3×10^{-2}	2×10^{-3}	2×10^{-3}
		Pa	3	2×10^{-1}	2×10^{-1}
	60 Hz	mbar	1×10^{-2}	7×10^{-4}	1×10^{-3}
		Pa	1	7×10^{-2}	1×10^{-1}
Maximum pressure differential across HCMB pump *	50 Hz	mbar	-	90	90
		Pa	-	9×10^3	9×10^3
	60 Hz	mbar	-	90	90
		Pa	-	9×10^3	9×10^3
Maximum inlet pressure	50 Hz	mbar	See Figure 2-6	See Figure 2-7	See Figure 2-9
		Pa	See Figure 2-6	See Figure 2-7	See Figure 2-9
	60 Hz	mbar	See Figure 2-6	See Figure 2-8	See Figure 2-10
		Pa	See Figure 2-6	See Figure 2-8	See Figure 2-10
Maximum operating time at maximum inlet pressure	50 Hz	hour	Continuous	1	Continuous
	60 Hz	hour	Continuous	1	Continuous
Inlet connection		-	ISO63 bolted	ISO100 bolted	ISO100 bolted
Outlet connection		-	NW40	NW40	NW40
Mass		kg	240	415	430
Noise level †		dB(A)	< 64	< 67	<69

* iH600/iH1000 only.

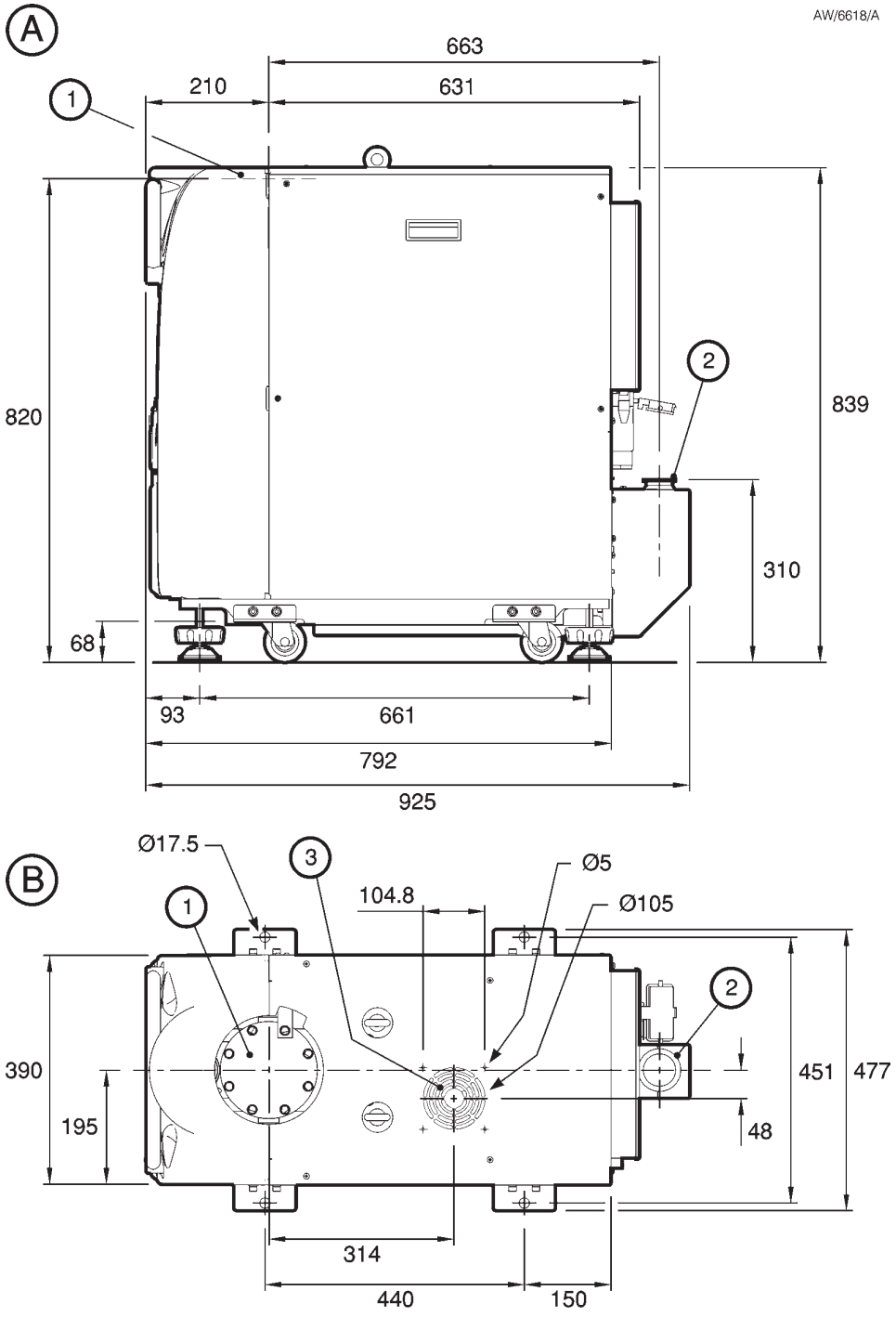
† Measured at 1 metre from the pump, with enclosure panels fitted.

Table 2-1 - Technical data



A	Side view	1.	Inlet
B	Plan view	2.	Outlet (as supplied)
C	Outlet Dimensions	3.	Air-extraction port

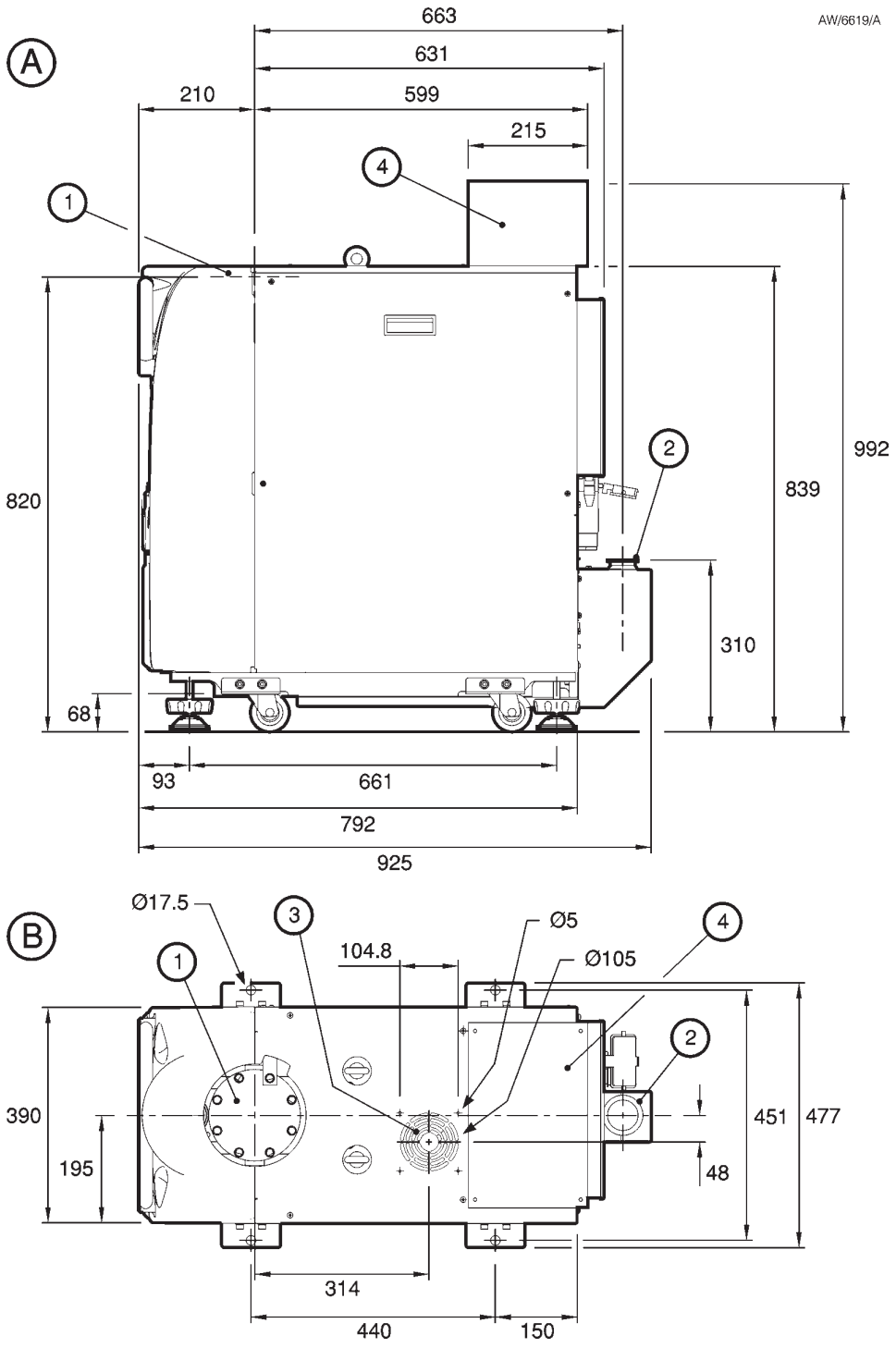
Figure 2-1 - iH80 dimensions (mm)



A Side view
B Plan view

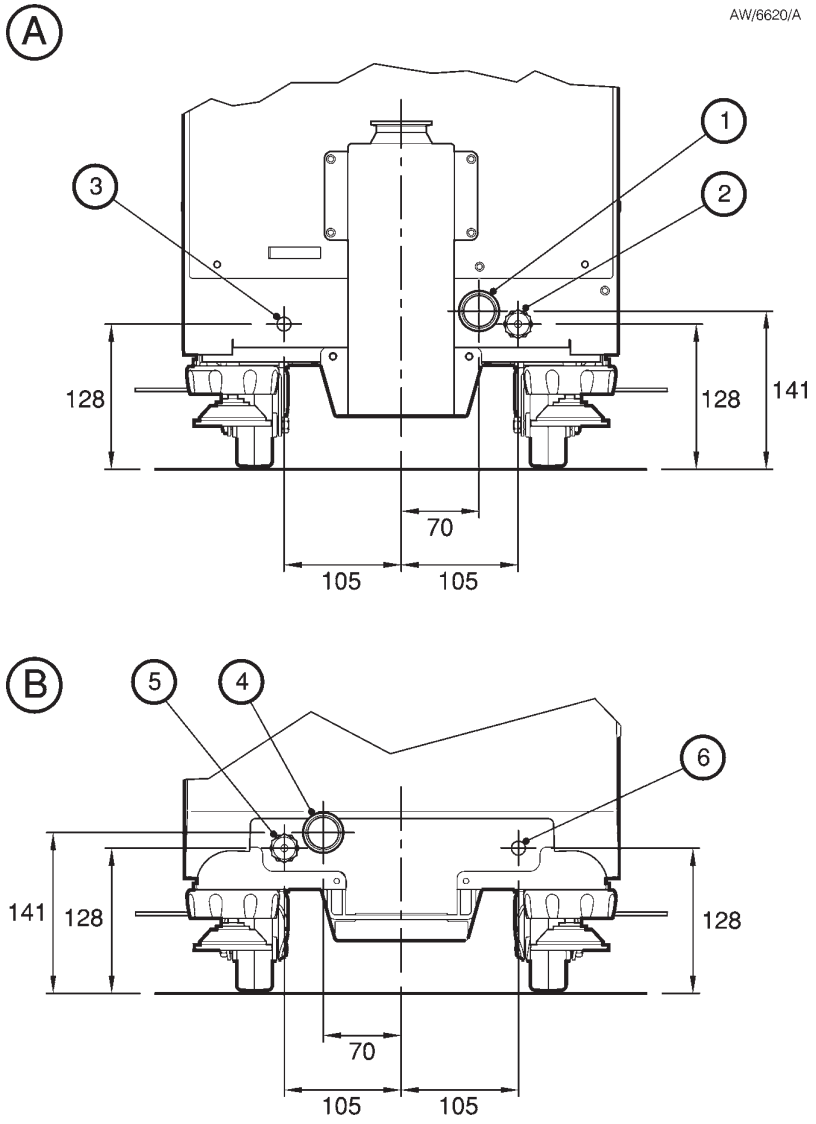
1. Inlet
2. Outlet (as supplied)
3. Air-extraction port

Figure 2-2 - iH600 dimensions (mm)



A	Side view	1.	Inlet	3.	Air-extraction port
B	Plan view	2.	Outlet (as supplied)	4.	Inverter enclosure

Figure 2-3 - iH1000 dimensions (mm)



A As supplied

B Alternative positions

1. Cooling-water outlet (as supplied)
2. Cooling-water inlet (as supplied)
3. Nitrogen inlet (as supplied)
4. Cooling-water outlet (alternative position)
5. Cooling-water inlet (alternative position)
6. Nitrogen inlet (alternative position)

Figure 2-4 - Services connections dimensions (mm)

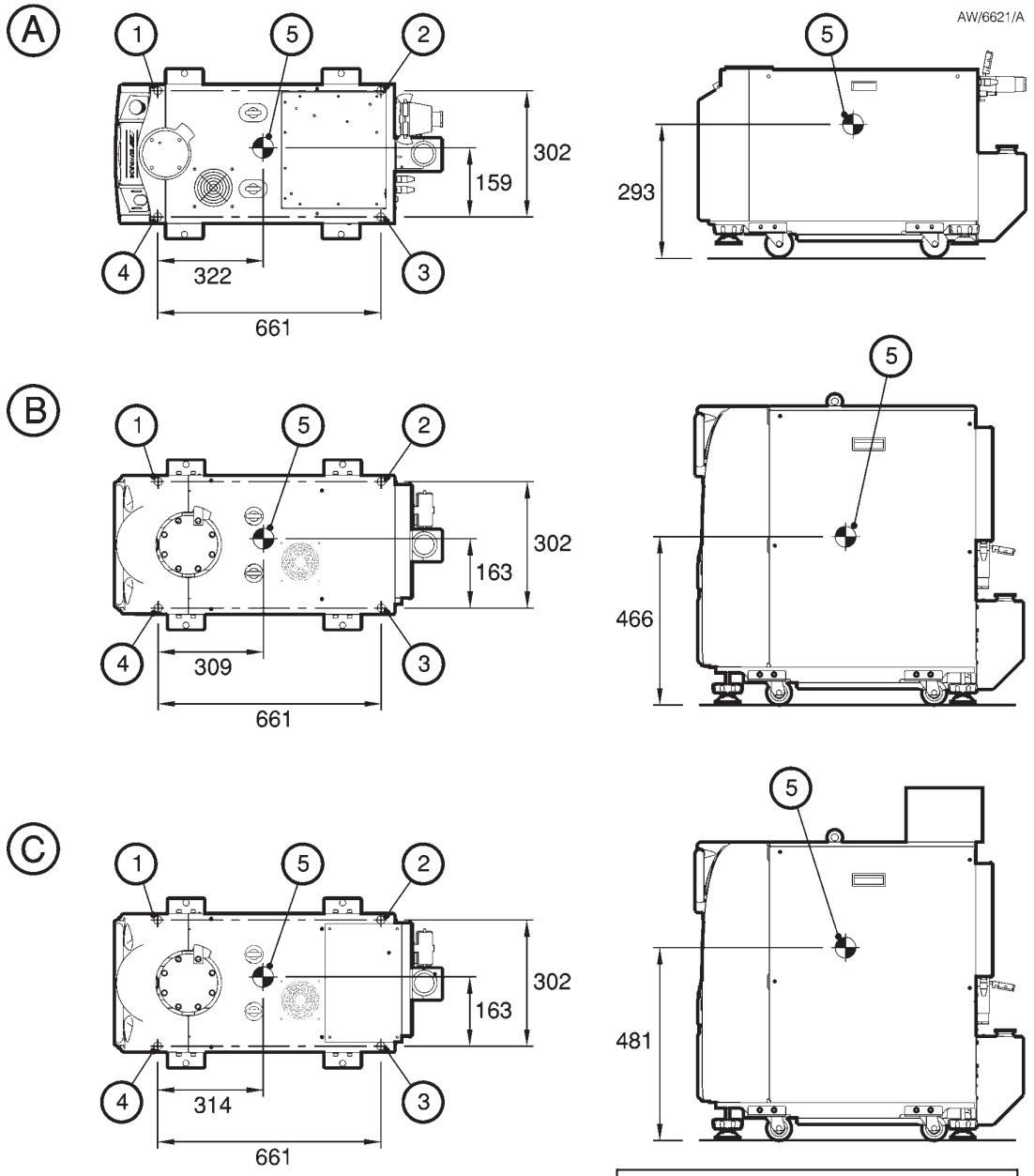
2.4 Cooling-water supply

Notes. Use treated water or non-corrosive industrial water to cool the iH system.

Maximum supply pressure	100 psig (6.9 bar, 6.9 x 10^5 Pa)
Typical pressure differential across supply and return *	
iH80	15 psi (1.03 bar, 1.03 x 10^5 Pa)
iH600/iH1000	15 psi (1.03 bar, 1.03 x 10^5 Pa)
Minimum flow rate required for reliable iH system operation	
iH80	2 $l.min^{-1}$
iH600/iH1000	4 $l.min^{-1}$
Typical heat removed from iH system	
iH80	2.5 kW
iH600	3.2 kW
iH1000	3.2 kW
Maximum particle size in supply	0.03 mm^2
Water supply quality	
Acidity	6.5 to 8.0
Hardness	< 100 p.p.m
Resistivity	> 1 $k\Omega.cm^{-1}$

Solids (turbidity)< 100 p.p.m

* With cooling-water supply temperature of 20 ^oC and flow rate of 3 $l.min^{-1}$.

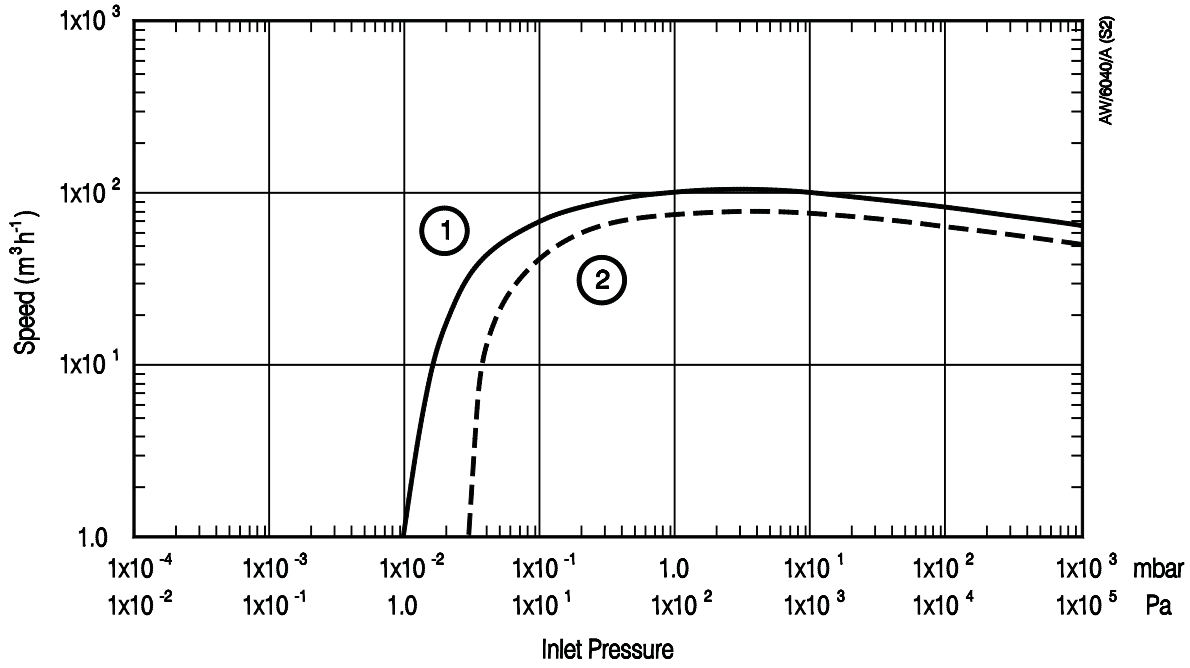


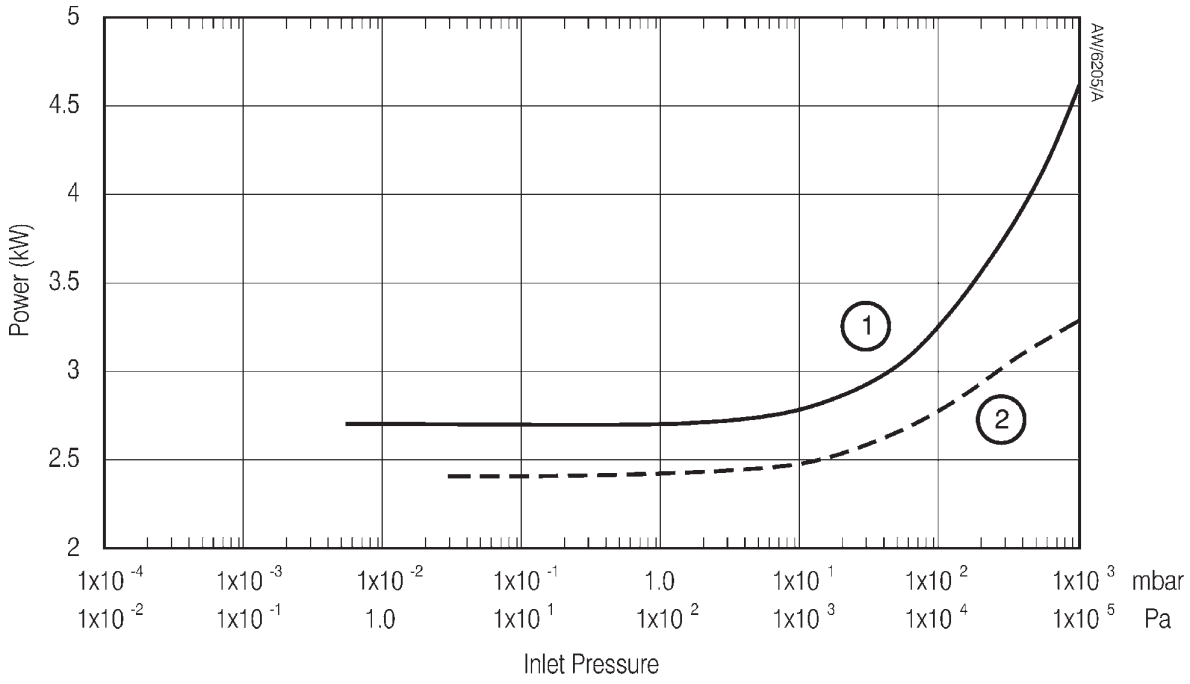
A iH80
B iH600
C iH1000

1. Levelling-foot
2. Levelling-foot
3. Levelling-foot
4. Levelling-foot
5. Centre of mass

	Mass distribution on levelling-feet			
	1	**2**	**3**	**4**
iH80	75 kg	66 kg	51 kg	48 kg
iH600	103 kg	119 kg	75 kg	118 kg
iH1000	118 kg	115 kg	90 kg	107 kg

Figure 2-5 - Centres of mass dimensions (mm) and mass distribution

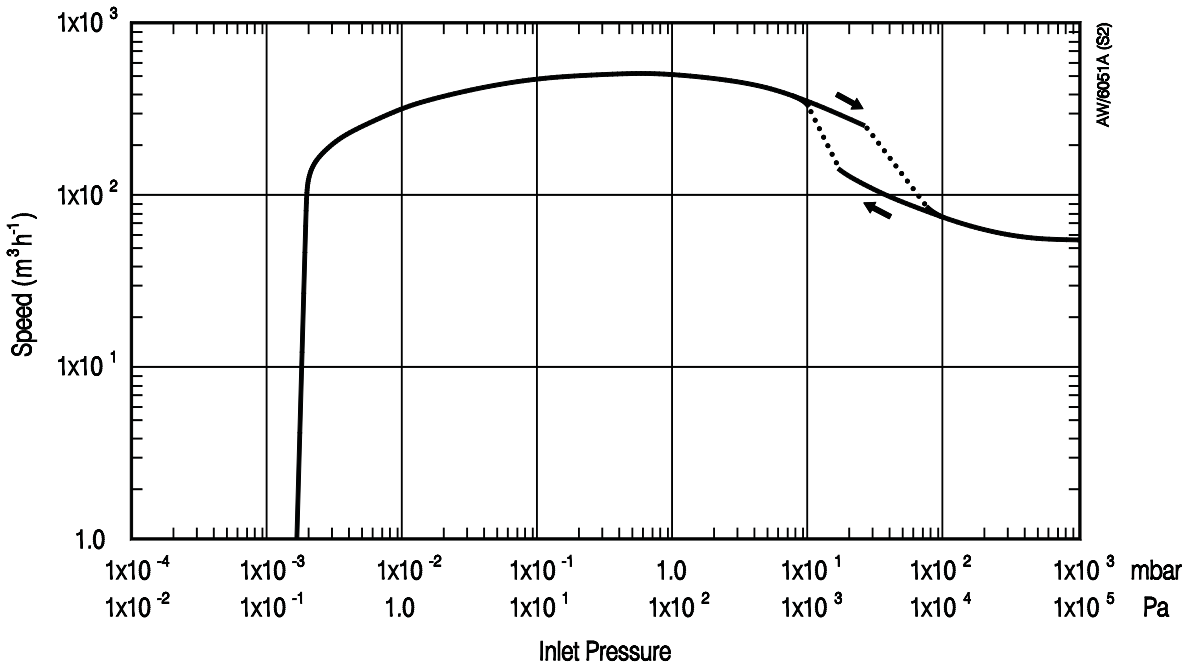


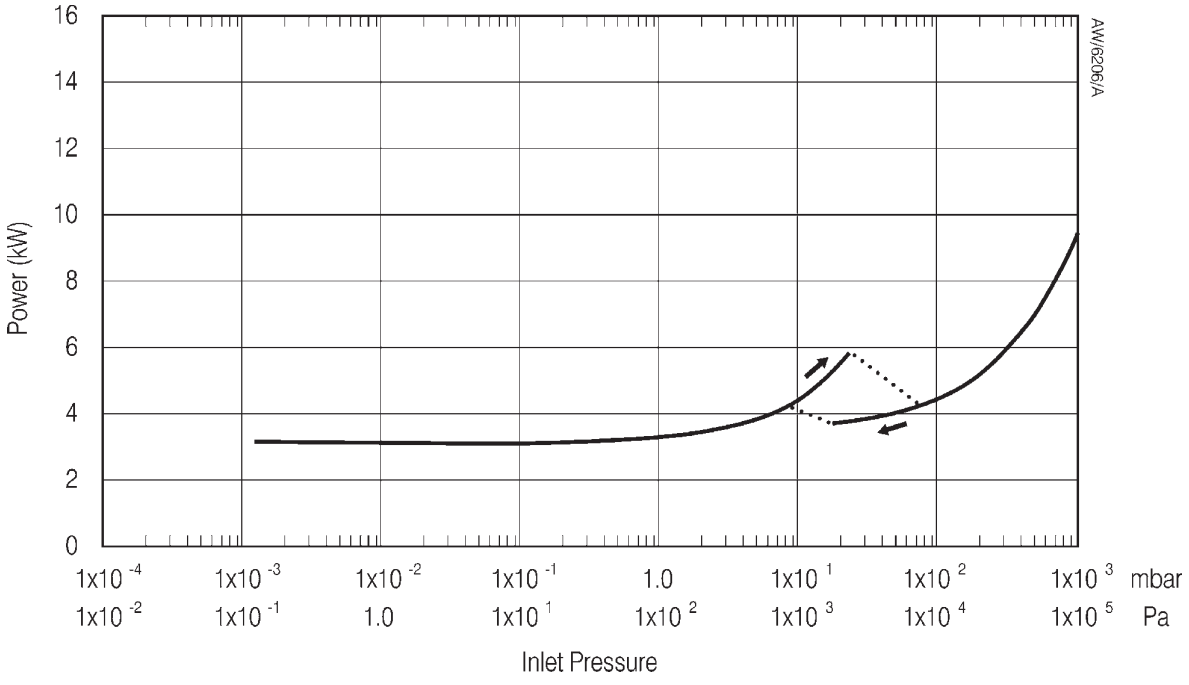


1. 60Hz

2. 50Hz

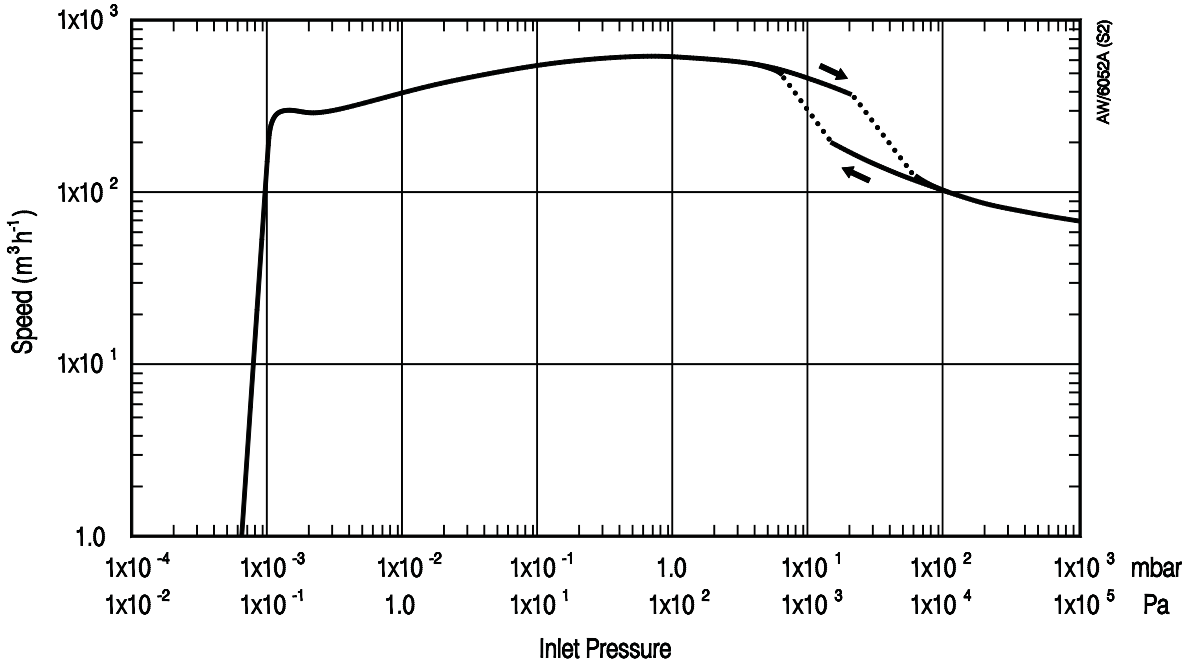
Figure 2-6 - Typical pumping speed and pump power curves for an iH80

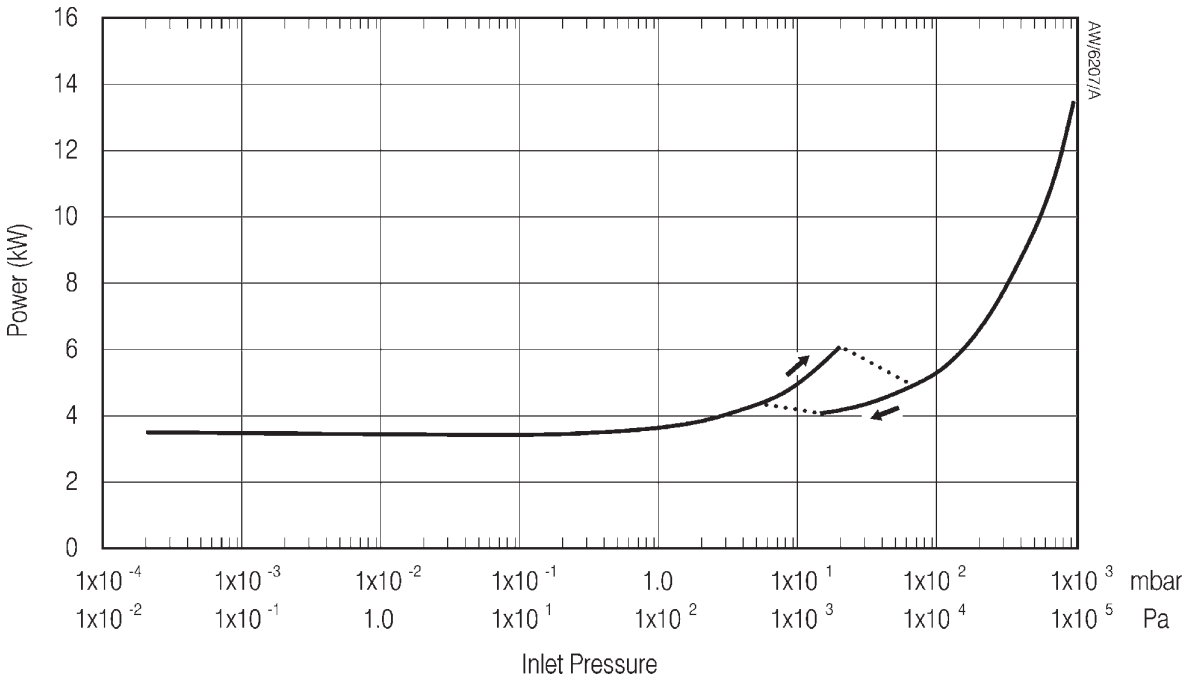




Note: Discontinuity in curves are as a result of the HCMB pressure relief valve opening and closing

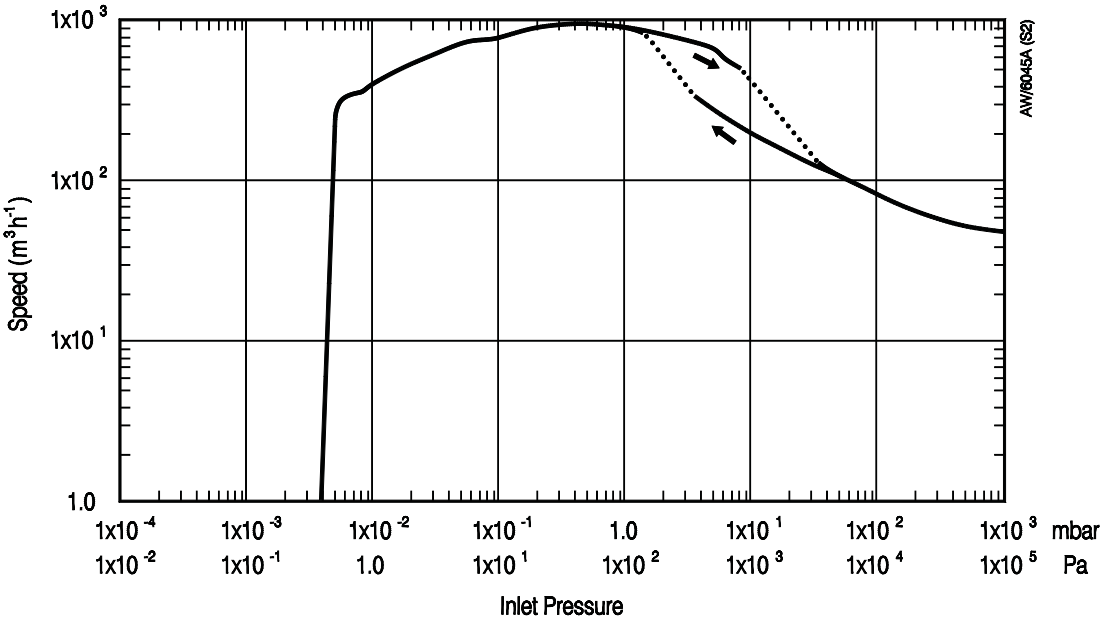
Figure 2-7 - Typical pumping speed and pump power curves for an iH600 at 50Hz

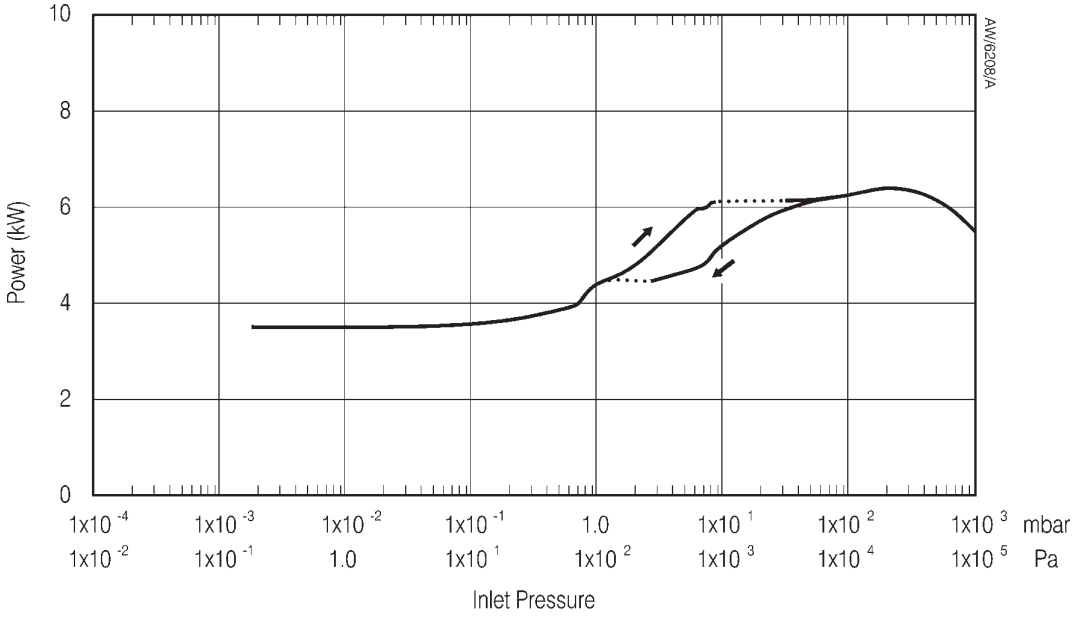




Note: Discontinuity in curves are as a result of the HCMB pressure relief valve opening and closing

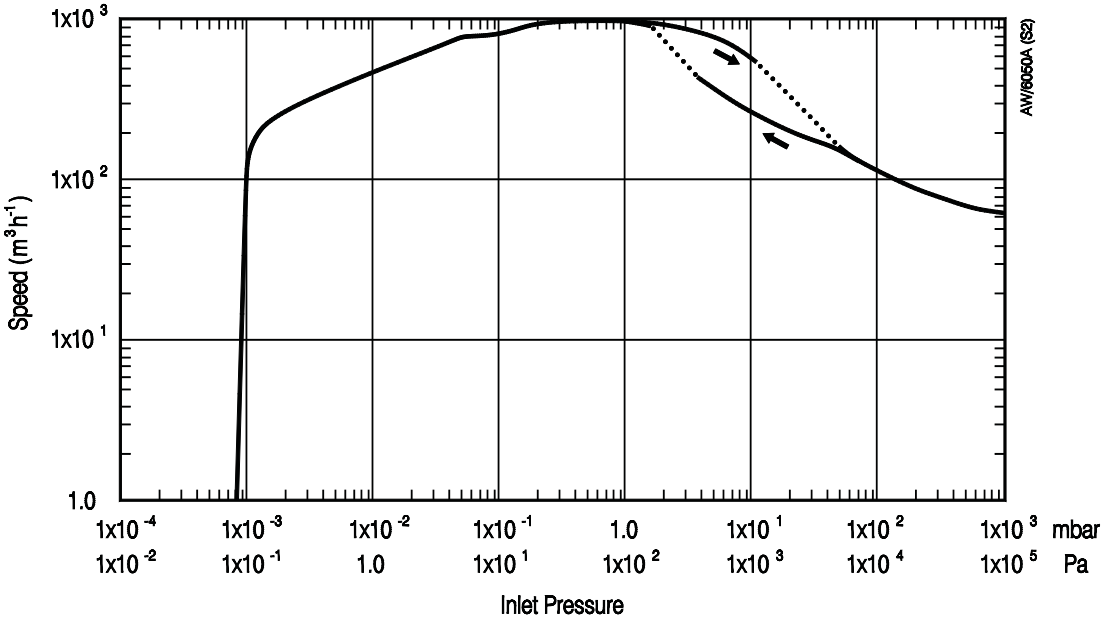
Figure 2-8 - Typical pumping speed and pump power curves for an iH600 at 60Hz

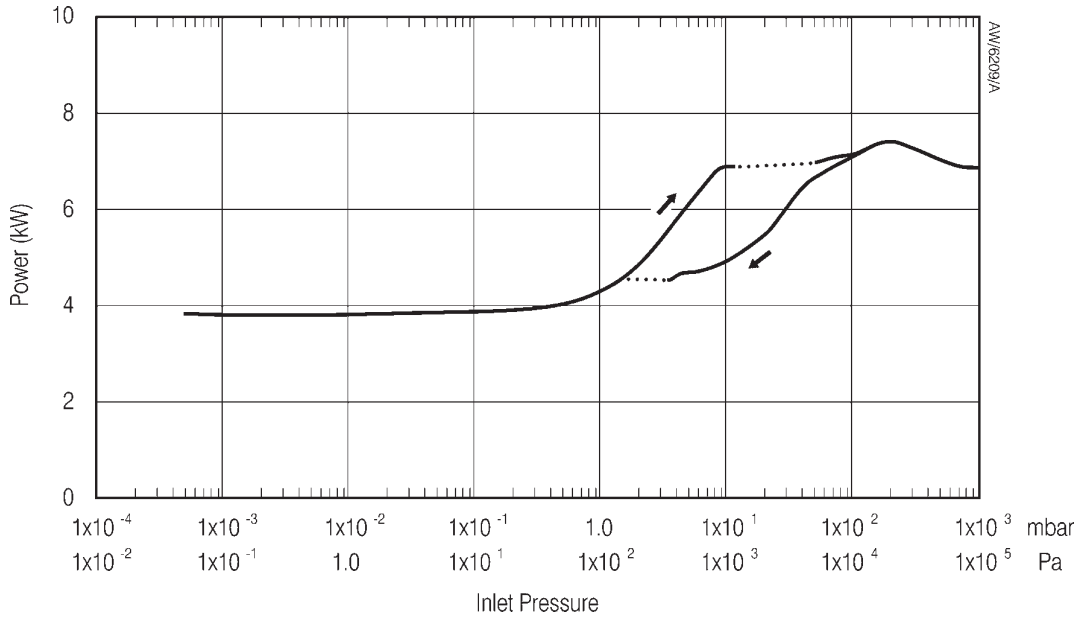




Note: Discontinuity in curves are as a result of the HCMB pressure relief valve opening and closing

Figure 2-9 - Typical pumping speed and pump power curves for an iH1000 at 50Hz





Note: Discontinuity in curves are as a result of the HCMB pressure relief valve opening and closing

Figure 2-10 - Typical pumping speed and pump power curves for an iH1000 at 60Hz

2.5 Lubrication

Note: BOC Edwards Material Safety Data Sheets for the oils referenced in the following sections are available on request. (Refer to Section 1.1 for contacts).

2.5.1 HCDP pump

Gearbox	
Oil charge	0.75 litres (typical)
Grade of oil	SAE 40
ISO viscosity grade	150
Recommended perfluoropolyether oils	Fomblin 25/6, Krytox 1525, Drynert 25/6

2.5.2 HCMB pump (iH600/iH1000 only)

Gearbox	
Oil charge	0.73 litres (iH600), 0.78 litres (iH1000)
Grade of oil	SAE 40
ISO viscosity grade	150
Recommended perfluoropolyether oils	Fomblin 25/6, Krytox 1525, Drynert 25/6

2.6 Electrical data

Electrical supply	
Supply voltage	200-208/380-415 V at 50 Hz, 3-phase 200-208/230/460 V at 60 Hz, 3-phase
Voltage tolerance	±10% (except for 208 V and 415 V at 50 Hz, which are +6% and -10%)
Installation Category	Category 2 (IEC 664)
Full load current ratings	See Table 2-2
Fuse types and ratings	
F1 †	30 A, 600 V, Class J
F2 †	30 A, 600 V, Class J
F3 †	30 A, 600 V, Class J
F4 †	20 A, 600 V, Class J
F5 †	20 A, 600 V, Class J
F6 †	20 A, 600 V, Class J
F7	1.6 A, 250 V
F8	1.6 A, 250 V
F9	3.15 A, 250 V
Emergency stop switch rating	24 V a.c./d.c., 5 A max
External emergency stop switch	
Rating	24 V a.c., 5 A
Load	700 mA (inductive)

† These fuse rating are included for information only. You cannot change these fuses; a BOC Edwards service engineer must change these fuses

Supply voltage and frequency →		200-208 V 50 Hz	200-208 V 60 Hz	230 V 60 Hz	380-415 V 50 Hz	460 V 60 Hz
iH80	Full load (A)	14.4	14.9	14.4	7.2	7.2
	HCDP motor rating (kW)	2.9	3.5	3.5	2.9	3.5
	Maximum power input to pump motor (kW)	3.65	4.48	4.48	3.65	4.48
iH600	Full load (A)	26.2	26.7	26.1	13.1	13.0
	HCMB motor rating (kW)	2.2	2.6	2.6	2.2	2.6
	Maximum power input to both pump motors (kW)	6.51	7.8	7.8	6.51	7.8
iH1000	Full load (A)	26.2	26.7	26.1	13.1	13.0
	HCMB motor rating (kW)	2.2	2.6	2.6	2.2	2.6
	Maximum power input to both pump motors (kW)	6.51	7.8	7.8	6.51	7.8

Table 2-2 - Full load current ratings

2.7 Gas system

Note: Once you have connected your nitrogen supply and adjusted the nitrogen supply pressure, for optimum performance of the pressure regulator, we recommend that the stability of your nitrogen supply is such that the supply pressure remains within ± 20 psi of the adjusted pressure.

Nitrogen supply pressure range	20 to 100 psig (2.4 to 7.9 bar absolute, 2.4×10^5 to 7.9×10^5 Pa)
Nitrogen supply quality	Clean, dry, particles < 0.01µm
Flow rates (with nitrogen supply capacity of 100 slm)	See Table 2-3
Pressure transducer accuracy	± 0.6 psi (± 4.1×10^{-2} bar, ± 4.1×10^3 Pa) at 6 psig (1.4 bar absolute, 1.4×10^5 Pa)
Flow transducer accuracy	± 3.0 slm (± 5×10^3 Pa.ls^{-1})

Purge flows		Flow rates	
		slm	$Pa.ls^{-1}$
Typical nitrogen flow rates (high gas configuration: factory set)	2/3-interstage purge *	5	8.44×10^3
	3/4-interstage purge *	30	5.06×10^4
	Shaft-seals purge	4	6.76×10^3
	Exhaust-purge	5	8.44×10^3
	Maximum total flow without inlet-purge	44	7.44×10^4
	Inlet-purge	25	4.22×10^4
	Maximum total flow with inlet-purge	44	7.44×10^4
Maximum nitrogen flow rates	2/3-interstage purge *	10	1.69×10^4
	3/4-interstage purge *	30	5.06×10^4
	Shaft-seals purge	10	1.69×10^4
	Exhaust-purge	10	1.69×10^4
	Maximum total flow without inlet-purge	60	1.01×10^5
	Inlet-purge	30	5.06×10^4
	Maximum total flow with inlet-purge	60	1.01×10^5

* With inlet purge off. When inlet purge is on, these flow rates will be lower.

Table 2-3 - Nitrogen purge flow rates: high gas configuration

2.8 Materials in contact with process gases

Pump, shafts and rotors	Cast iron, steel, SG iron
Internal and external shaft-seals	
HCDP pump	PTFE (polytetrafluoroethylene)
HCMB pump (iH600/iH1000 only)	PTFE and fluoroelastomer
HCDP pump nitrogen pipelines	Stainless steel
Gas module nitrogen components (pipelines, manifolds, valves, pressure transducers and so forth)	Brass, stainless steel, aluminium, Viton, nickel

2.9 Fire safety

The iH pump series has been assessed to UL3101, CSA22.1 and EN61010 standards for fire safety. The use of combustible materials has been minimised, potential ignition sources have been contained within sealed metal enclosures and engineering controls have been used to avoid ignition or over temperature situations.

2.10 Resource conservation

Measures have been taken in the design of the iH system to conserve the environment, as advised by ISO14001 - Environmental management systems.

Packaging materials may be recycled.

Power consumption has been minimised.

Lubrication for life has been incorporated into the pump design.

No pump parts require cleaning for maintenance.

Materials used in manufacture of the pump may be recycled on completion of its useful life.

2.11 Default setpoints

The default setpoints are shown in Tables 2-4 to 2-6. Where there is an 'ADJ' (adjust) entry in these tables, this specifies that the setpoints are usually not used and the default setpoint is preset so that no warning or alarm condition could result from sensor readings. If required you can adjust these 'ADJ' setpoints for your application, so that suitable warnings and alarms can be generated: refer to Section 5.3.

Parameter	Unit	Default setpoint values			
		Low alarm	Low warning	High warning	High alarm
HCDP power consumption	kW	ADJ	0.0	4.0	4.7
HCMB power consumption	kW	ADJ	0.0	2.9	3.6

Table 2-4 - Electrics box default setpoints

Parameter	Unit	Default setpoint values			
		Low alarm	Low warning	High warning	High alarm
HCDP pump temperature	^{o}C	ADJ	ADJ	168	177
HCDP motor cooling-water return temperature	^{o}C	ADJ	ADJ	45	ADJ
HCMB600 pump temperature	^{o}C	ADJ	ADJ	115	125
HCMB1000 pump temperature	^{o}C	ADJ	ADJ	165	170
Exhaust gas temperature	^{o}C	ADJ	ADJ	220	ADJ

Table 2-5 - Electronics module default setpoints

Parameter		Unit †	Default setpoint values			
			Low alarm	Low warning	High warning	High alarm
Total nitrogen flow (high gas configuration: factory set)	Shaft-seals purge on, Exhaust-purge on, 2/3-interstage purge off, 3/4-interstage purge off, Inlet-purge off	slm	ADJ	3	18	ADJ
	Shaft-seal purge on, Exhaust-purge on, 2/3-interstage purge on, 3/4-interstage purge on, Inlet-purge off	slm	ADJ	38.0	59.4	ADJ
	Shaft-seal purge on, Exhaust-purge on, 2/3-interstage purge on, 3/4-interstage purge on, Inlet-purge on	slm	ADJ	38.0	60.0	ADJ
Exhaust pressure		psig	ADJ	ADJ	5.0	8.0
Shaft-seals purge pressure		psig	ADJ	ADJ	12.5	ADJ

† Only slm gas flow values are given in the table, because only slm values can be entered in the Pump Display Terminal. To convert slm values to $Pa.ls^{-1}$, multiply by $(1.013 / 60) \times 10^5$.

Table 2-6 - Gas module default setpoints: high gas configuration

2.12 Connections

Inlet and outlet	See Table 2-1
Electrical supply connector	
Type	Harting HAN-K-4/2
Cable outside diameter range	18 to 27 mm
Maximum conductor cross-sectional area	16 mm^2
Pump Display Module connector	XLR type 4-way
Network communications connector	XLR type 4-way
Exhaust Gas Management interface	6-pin DIN [3-Common; 4-Normally Closed; 5-Normally Open]
iH Tool Interface Module connector	XLR type 6-way
Nitrogen supply connector	$^1/_4$ inch Tube fitting
Water inlet connector *	$^3/_8$ inch BSP male quick-disconnect
Water outlet connector *	$^3/_8$ inch BSP female quick-disconnect
Active gauge connector	SCC68 socket
Pump Display Terminal connector	RJ12
Tool interface adaptor (iTIM)	15-way D-type

* Connector mating-halves to connect your cooling-water supply and return pipes are supplied with the iH system: refer to Section 3.18.

2.13 Tracer gas analysis

IH600 pumping system tracer gas test results are as follows (see Tables 2-7 through 2-8): Note that because the iH600 has the largest iH enclosure size, these results qualify the iH80 and iH1000 enclosures.

Test Parameters	
Tracer gas	SF_6
Tracer gas concentration	4.00%
Tracer gas release rates	28 slpm
Tracer gas release point	Exhaust check valve
Tracer release direction	Toward top of pump
Process gas	Nitrogen
Exhaust flow rate (m_3/h)	180.0
Volume of enclosure (m_3)	0.256
Free volume of enclosure (m_3)	0.158
Air changes per minute	19
Enclosure modifications	142mm duct connected to top of enclosure

Table 2-7 - Test parameters

Gas Name	**Max Flow (slm)**	**TLV (ppm)**	**25% TLV (ppm)**	**Value Obtained (ppm)**	**ERC**	**Pass/Fail***
DCS	6	5	1.25	0.03	0.090	Pass
HCL	10	5	1.25	0.03	0.150	Pass
HF	10	3	0.75	0.03	0.150	Pass
NF_3	15	10	2.50	0.03	0.225	Pass
SiH_4	6	5	1.25	0.03	0.090	Pass
SF_6	12	1000	250	0.03	0.180	Pass
CIF_3	1.6	0.1	0.025	0.03	0.024	Pass
TEOS	0.7	20	5	0.03	0.0105	Pass
AsH_3	0.5	0.05	0.0125	0.03	0.0075	Pass
PH_3	0.5	0.3	0.075	0.03	0.0075	Pass
WF_6	0.5	10	2.5	0.03	0.0075	Pass
CO	1	50	12.5	0.03	0.015	Pass
H_2	2	4000	1000	0.03	0.03	Pass
* Pass indicates acceptable enclosure (satisfies SEMI S2 criteria of less than 25.0 % of the TLV)						

Table 2-8 - Test results

2.14 Disconnect box (accessory)

2.14.1 General

Dimensions: 406mm (16.0″) x 305mm (12.0″) x 203mm (8.0″)

Mass: 17kg (38.0lbs)

2.14.2 Operating conditions

Temperature Range

Operating: +10°C to +40°C (+50°F to +104°F)

Storage: -45°C to +55°C (-113°F to + 131°F)

Relative Humidity: 10% to 90%

Maximum Operating Altitude: 2000m

2.14.3 Electrical data

Input Voltage Range:

200-208/380-415 V at 50 Hz, 3-phase

200-208/230/460 V at 60 Hz, 3-phase

Full Load Current Rating: See Table 2-2

Fuse Rating

F1, F2, F3(Mains Disconnect): 35.0A

F4, F5(Primary Fuses): 0.5A

F6(Secondary Fuse): 3.0A

Main Disconnect Devices Rated: 30.0A, 600V, 300,000 AIC

2.15 Item numbers

Electrical Supply	iH80	iH600	iH1000
460V, 60Hz, 3-phase	A533-50-908	A533-51-908	A533-52-908
200/208V, 50/60Hz, 3-phase	A533-50-945	A533-51-945	A533-52-945
380/415V, 50Hz, 3-phase	A533-50-946	A533-51-946	A533-52-946
230V, 60Hz, 3-phase	A533-50-957	A533-51-957	A533-52-957

3 INSTALLATION

3.1 Safety

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

- Only BOC Edwards engineers may install the iH pump series. Users can be trained by BOC Edwards to conduct the tasks described in this manual, contact your local service centre or BOC Edwards for more information.
- Ensure that the installation technician is familiar with the safety procedures which relate to the products pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components. Dismantle and clean contaminated components inside a fume-cupboard.
- Do not remove the temporary cover or blanking plate from the iH system inlet until you are ready to connect the iH system to your vacuum system. Do not operate the iH system unless the inlet blanking plate is fitted or the iH system is connected to your vacuum system.
- Do not remove the temporary cover or blanking plate from the iH system exhaust until you are ready to connect the iH system to your exhaust-extraction system. Do not operate the iH system unless the exhaust is connected to your exhaust-extraction system.
- Vent and purge the process system (if the iH system is to replace an existing pumping system) with nitrogen for 15 minutes before you start installation work.
- Disconnect the other components in the process system from the electrical supply so that they cannot be operated accidentally.
- Do not reuse any 'O' ring or 'O' ring assembly and do not allow debris to get into the iH system during installation.
- Wipe up any water or oil spilt during installation to avoid possible risk of slips.
- Route and secure cables, hoses and pipe-work during installation to avoid possible risk of trips.
- Obey all national and local rules and safety regulations when you install the iH system.
- Consult BOC Edwards publication P300-20-000 (Vacuum Pump and Vacuum System Safety) before you pump hazardous materials. This publication is available on request: contact your supplier or BOC Edwards.

3.2 Installation checklist

The operations required to install the iH system and the sections of this instruction manual which describe those operations are shown in Table 3-1.

Installation operation	Section
Unpack and inspect	3.3
Remove the enclosure panels	3.4
Reconfigure the nitrogen and water connections (if required)	3.5
Locate the iH system	3.6
Check the pump oil-level(s)	3.7
iH80 systems	3.7.1
iH600/iH1000 systems	3.7.2
Install or replace the Pump Display Terminal and optional accessories (if necessary)	3.8
Install the Pump Display Terminal	3.8.1
Install optional accessories	3.8.2
Connect the iH inlet to your vacuum system	3.9
Connect the iH exhaust outlet to your exhaust extraction system	3.10
Connect to your factory extraction system (optional)	3.11
Connect the nitrogen supply	3.12
Leak test the system	3.13
Install additional safety equipment (optional)	3.14
Connect to your emergency stop circuit (optional)	3.15
Electrical supply and RF earth (ground) connections	3.16
Reconfigure the iH system for your electrical supply (if necessary)	3.16.1
Reconfigure the pump(s) for your electrical supply (if necessary)	3.16.2
Connect the electrical supply to the iH system	3.16.3
Connect an additional RF earth (optional)	3.16.4
Refit the enclosure panels	3.17
Connect the cooling-water pipelines	3.18
Adjust the interstage purge flow rates if necessary	3.19
Commission the iH system	3.20
Switch on an iH80/iH1000 system	3.20.1
Configure and switch on an iH600 system	3.20.2
Install Disconnect Box (accessory)	3.21
Unpack and Inspect	3.21.1

Table 3-1 - Installation checklist

Mounting	3.21.2
Electrical Installation	3.21.3
Main Electrical Supply	3.21.4
Cable Connections	3.21.5
Install Photohelic Switch/Gauge (accessory)	3.22
Unpack and Inspect	3.22.1
Mounting	3.22.2
Piping Connections	3.22.3
Cable Connections	3.22.4

Table 3-1 - Installation checklist (...continued)

3.3 Unpack and inspect

WARNING

You must use suitable lifting equipment to move the iH system. It is too heavy to lift by hand.

WARNING

Ensure that the maximum angle between paired slings used to lift the iH system is 45^{o}.

The iH system is supplied sealed in a foil bag. To prevent contamination of the iH system, before you unpack and inspect the iH system we recommend that you move the pallet as close as possible to the clean area in which you will install the system. Remove the foil bag carefully; use the bag as a dust cover while you wheel the iH system to its final operating position.

Use the following procedure to unpack and inspect the iH system.

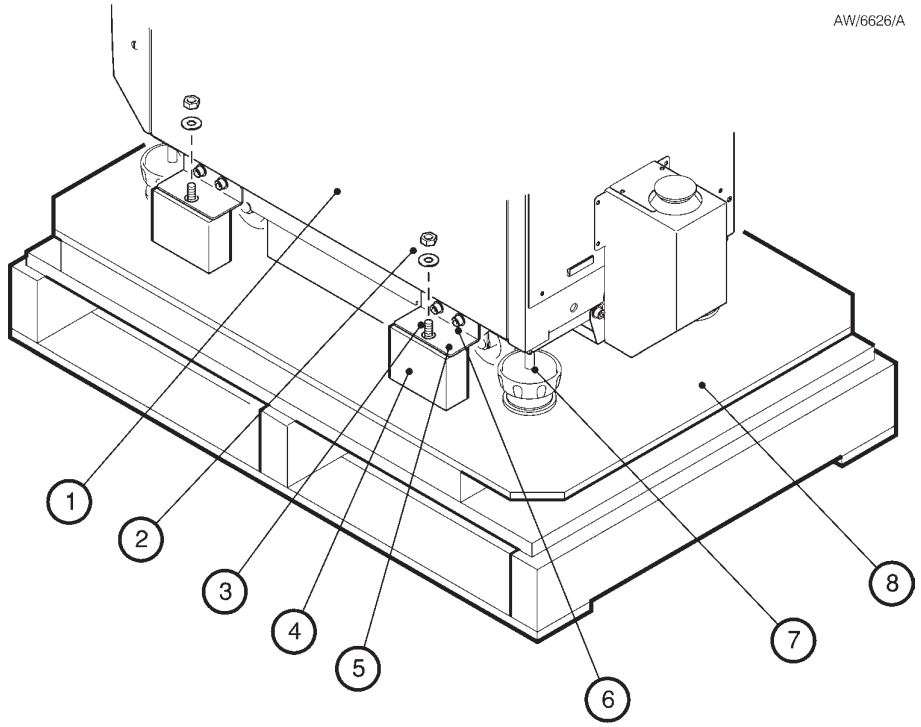
1. Place the pallet in a convenient position with a fork-lift truck or a pallet truck.
2. Remove the staples which secure the cardboard box to the pallet, then remove the cardboard box. Open the top of the foil bag which encloses the iH system.
3. Check that you have received the items listed in Table 3-2. If any of these are missing, notify your supplier within three days.

Qty	Description	Check (✓)
1	iH dry pumping system	❑
1	Pump Display Terminal	❑
Fitting-kit which contains the following:		
1	Inlet 'O' ring †	❑
1	Cooling-water quick-release connectors (pair)	❑
1	NW40 trapped 'O' ring	❑
1	NW40 clamp	❑
1	Nitrogen pipeline fitting	❑
1	Module connector terminator plug	❑
1	Emergency stop switch guard *	❑
1	Electrical supply connector	❑
2	Lifting Bolt Hole Plugs#	❑

* If required, fit this over the emergency stop switch to prevent inadvertent operation of the switch.
† Supplied with the iH80 only.
# Supplied with iH80 and iH600 only

Table 3-2 - Checklist of components

4. Refer to Figure 3-1. Remove the nut and washer (2) which secures each of the four seismic brackets (5) to the blocks (4) on the pallet. Retain the nuts and washers for future use.
5. Refer to Figure 3-2. Use suitable lifting-equipment attached to the lifting bolts (1) to remove the iH system from its pallet. Do not try to lift the iH system by hand (see Section 2 for the mass of the iH system).
6. Inspect the iH system. If the iH system or any other item is damaged, notify your supplier and the carrier in writing within three days; state the Item Number of the iH system together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the iH system if it is damaged.
7. If the iH system is not to be used immediately, replace the packing materials. Store the iH system in suitable conditions as described in Section 7. If you will use the iH system immediately, continue at Step 8.
8. Refer to Figure 3-1. If you do not want to use the seismic brackets to prevent inadvertent movement of the iH system (see Section 3.6), undo and remove the two cap -head screws and washers (6) which secure each of the four brackets (5) to the sides of the iH system, then remove the brackets. Retain the brackets, cap-head screws and washers for future use.

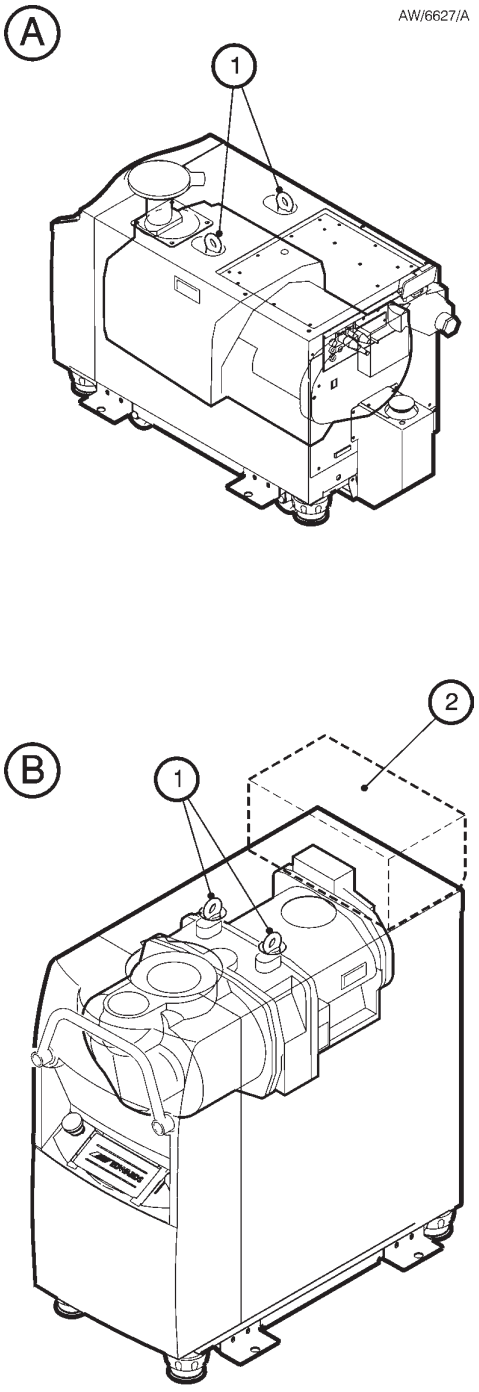


1. iH system
2. Nut and washer
3. Stud
4. Block
5. Seismic Bracket
6. Cap-head screw and washer
7 Levelling foot
8. Pallet

Figure 3-1 - Remove the iH system from the pallet

3.4 Remove the enclosure panels

1. Refer to Figure 3-3.
2. Remove the right-hand side panel from the iH system:
   - Place your hand against the top of the right-hand side panel (4) to support it and use a posidrive screwdriver to release the two or four M5 screws.
   - Swing the top of the panel out slightly and lift out the panel so that the holes in the bottom of the panel disengage from the pins (5) on the frame.
   - Fully remove the panel and place it in a safe location.
3. Remove the left-hand side panel: use the method in Step 2 above.



A iH80
B iH600
C iH1000

1. Lifting-bolts
2. Inverter enclosure (iH1000 only)

Figure 3-2 - Lifting-bolt positions

3.5 Reconfigure the nitrogen and/or water connections (if required)

CAUTION

Ensure that the cooling-water system of your iH system is correctly configured for your electrical supply frequency. If it is incorrectly set at 50Hz, the system will run above optimum operating temperature. If it is incorrectly set at 60Hz, the system will run below optimum operating temperature.

As supplied, the nitrogen and cooling-water connections are at the rear of the iH system (as shown in Figure 1-5) and the cooling water is configured for operation at 60 Hz (as shown in Fig 3-4). If required, you can reconfigure the iH system so that the nitrogen and/or cooling-water connections are at the front of the iH system (see point 1 below) or for operation at 50 Hz (see point 2 below).

1. You will need an Alternative Nitrogen and Cooling-Water Connections Kit if you want to reconfigure the nitrogen and/or cooling-water connections (see Section 8). Reconfigure the connections as described in the instruction manual supplied with the kit.
2. See Figure 3-4. If the iH system will be operating at 50 Hz, switch the positions of the control plug (3) and the blanking plug (2) in the HCDP headplate manifold (1) to ensure optimal temperature. The control plug (marked with an 'X') should now be in the 50 Hz port and the blanking plug in the 60 Hz port.

3.6 Locate the iH system

WARNING

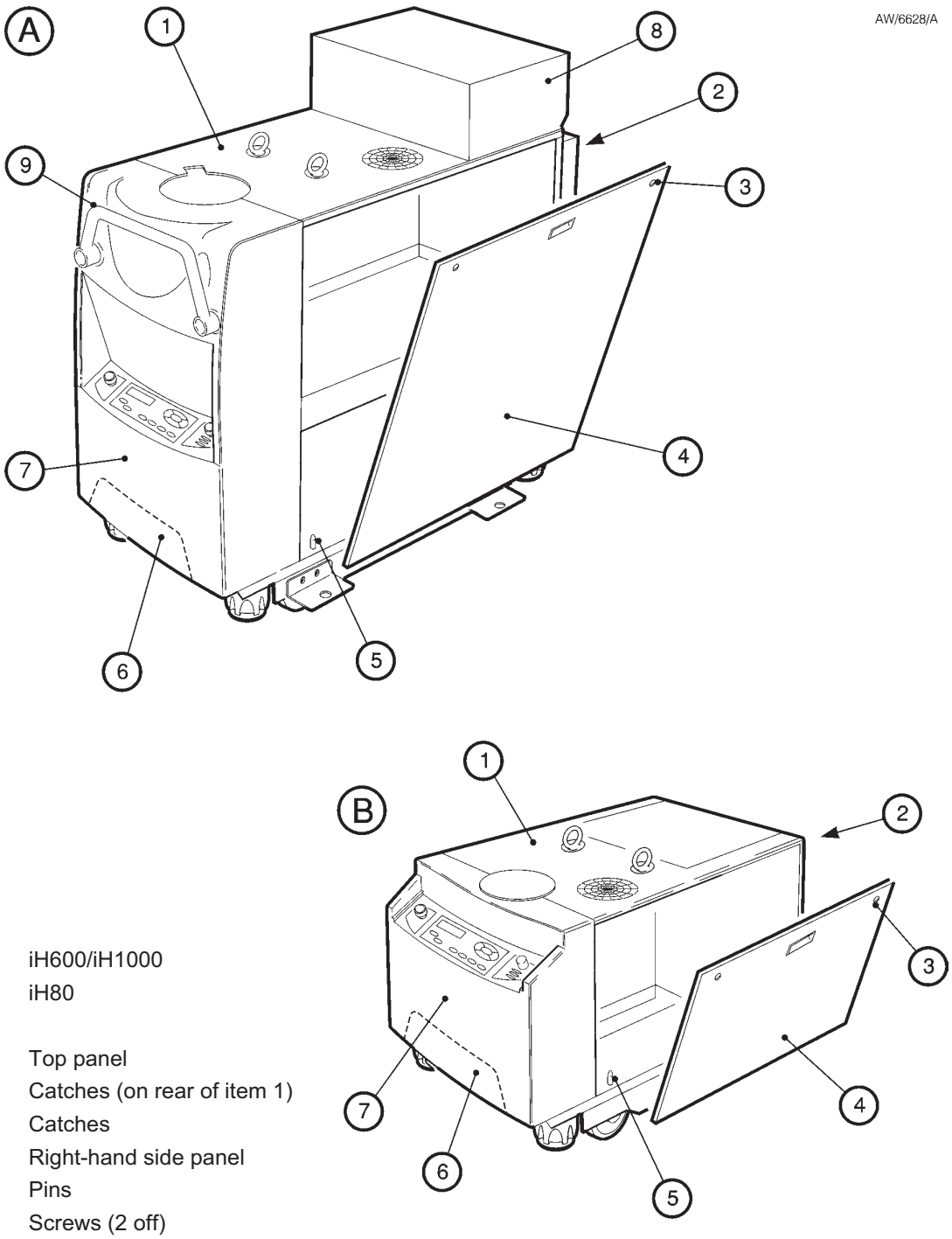
You must use suitable lifting equipment to move the iH system. It is too heavy to lift by hand.

WARNING

Ensure that the maximum angle between paired slings used to lift the iH system is 45^{o}.

Use the following procedure to locate the iH system in its operating position. The iH system must be located on a firm, level surface.

1. Use suitable lifting equipment attached to the lifting bolts to move the iH system close to its final operating position.



A iH600/iH1000
B iH80

1. Top panel
2. Catches (on rear of item 1)
3. Catches
4. Right-hand side panel
5. Pins
6. Screws (2 off)
7. Lower cover
8. Inverter enclosure (iH1000 only)
9. Handle

Figure 3-3 - Remove/refit the enclosure panels

2. Wheel the iH system on its castors to move it into its operating position.
3. Adjust the levelling feet to make sure that the iH system is level and is not supported by the castors.
4. If you want to secure the iH in place to prevent inadvertent movement (for example, during an earthquake), take note of the following
   - the iH system can be secured to the floor by fitting suitable bolts or studs (not supplied) through the 17.5mm hole in the seismic brackets (Figure 3-1, item 5).
   - if vibration transmission to the floor is a concern, suitable vibration isolators (not supplied) should be fitted between the seismic brackets and the bolt or stud.
   - although the iH system is supplied with four seismic brackets, two brackets are capable of protecting the system during an earthquake. The system can therefore be secured as shown in Figure 3-5 for example, to reduce the effective system footprint if required.
   - if all four seismic brackets are to be used, ensure that the bolt spacing is adequate for the floor strength and loads anticipated.
5. If preferred, the lifting bolts can be removed and replaced with the lifting bolt hole plugs supplied with the systems.

3.7 Check the pump oil-level(s)

CAUTION

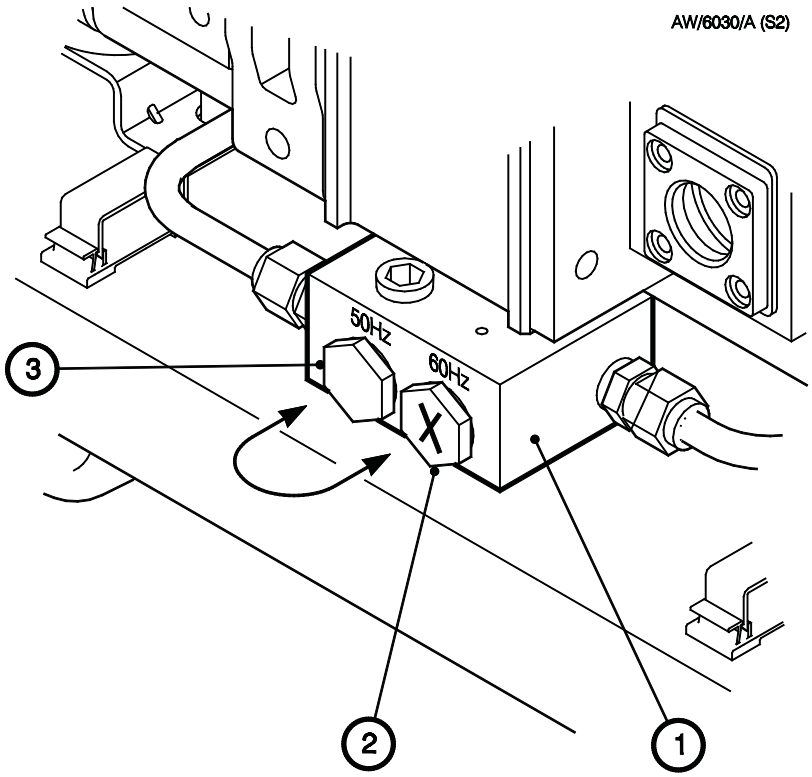
Ensure that the oil-levels in the HCDP pump and the HCMB pump (in an iH600 system) are correct. If a pump oil-level is incorrect, pump performance may be affected and the pump may be damaged.

3.7.1 iH80 systems

The iH80 system is supplied with the HCDP pump filled with oil. However, we recommend that you check the oil-level before you operate the iH system; use the method described below.

Refer to Figure 1-1. Check that the oil-level is between the MAX and MIN marks on the bezel of the HCDP oil-level sight-glass (10):

- If the oil-level is above the MAX mark, drain excess oil from the pump as described in Section 6.9 until the oil-level is correct.
- If the oil-level is below the MIN mark, fill the pump with oil until the oil-level is correct, as described in Section 6.8.



1. HCDP headplate manifold
2. Control Plug
3. Blanking Plug

Figure 3-4 - HCDP headplate cooling - water manifold (as supplied)

3.7.2 iH600/iH1000 systems

The iH600 and iH1000 systems are supplied with both the HCDP and HCMB pumps filled with oil. However, we recommend that you check the HCDP and HCMB oil-levels as described below.

1. Check the HCDP pump oil-level: refer to Section 3.7.1.
2. Refer to Figure 1-1. Check that the oil-level is between the MAX and MIN marks on the bezel of the HCMB oil-level sight-glass (5):
   - If the oil-level is above the MAX mark, drain excess oil from the pump as described in Section 6.10 until the oil-level is correct.
   - If the oil-level is below the MIN mark, fill the pump with oil until the oil-level is correct, as described in Section 6.10.

3.8 Install or replace the pump display terminal and optional accessories (if necessary)

3.8.1 Install the pump display terminal

> CAUTION
>
> It is imperative that the Pump Display Terminal is stored in the recess after installation or use. Placing it on a hot surface such as on top of the enclosure may adversely affect the long-term reliability of the terminal.

1. Unpack and inspect the Pump Display Terminal.
2. Refer to Figure 3-6. Remove the blanking panel (1) from the dashboard (2).
3. Fit the connector (4) on the end of the cable (7) to the Pump Display Terminal connector (6) in the recess (5) in the dashboard.

Note: The Pump Display Terminal connector (6) is intended for use by the Pump Display Terminal only, and should not be mistaken for a Portable Personal Computer port .

4. Place the coiled cable (7) in the recess, then place the Pump Display Terminal(8) in position in the recess (5).

3.8.2 Install optional accessories

Note: Some accessories can only be factory fitted (see Section 8): you will have ordered these accessories when you ordered your iH system, and the accessories will be supplied fitted to your iH system.

Install optional accessories (listed in Section 8) as described in the instructions supplied with the accessory.

3.9 Connect the iH inlet to your vacuum system

Note: If required (that is, if you will use the iH system in an area subject to high RF (radio frequency) emissions), connect the end of the iH earth (ground) cable to one of the bolts that you use to connect the inlet-flange of the iH system to your process system. See Section 3.16.4 for more information.

When you connect your iH system to your vacuum system, take note of the following:

- To get the best pumping speed, ensure that the pipeline which connects the vacuum system to the iH system is the minimum length possible and has an internal diameter not less than the iH system inlet-port.
- Ensure that all components in the vacuum pipeline have a maximum pressure rating which is greater than the highest pressure that can be generated in your system.
- Incorporate flexible pipelines in the vacuum pipeline to reduce the transmission of vibration and to prevent loading of coupling-joints. We recommend that you use BOC Edwards braided flexible pipelines.
- Adequately support vacuum pipelines to prevent the transmission of stress to pipeline coupling-joints.
- On very dusty applications, use a low-impedance inlet-filter to minimise damage to the pump.
- Incorporate a pressure gauge in the inlet pipeline, so that you determine that the iH system operates correctly and (on iH600 systems) so that you can determine the correct booster start delay (see Section 3.20.2). You can fit an Active Gauge Connection Kit accessory (see Section 8.4.2) or an iH600 Pressure Control Kit accessory (see Section 8.4.3) for this purpose.
- You must be able to isolate the iH system inlet from the atmosphere and from your vacuum system if you have pumped or produced corrosive chemicals.

Use the following procedure to connect the inlet of the iH system to your vacuum inlet pipeline:

1. Remove the temporary cover or blanking plate from the inlet of the iH system. Retain the nuts, bolts, washers and blanking plate for future use. Retain the temporary cover for future use on non-contaminated pumps only.
2. Use the 'O' ring supplied and suitable nuts, bolts and washers (not supplied) to connect the inlet-flange of the iH system to your vacuum system.

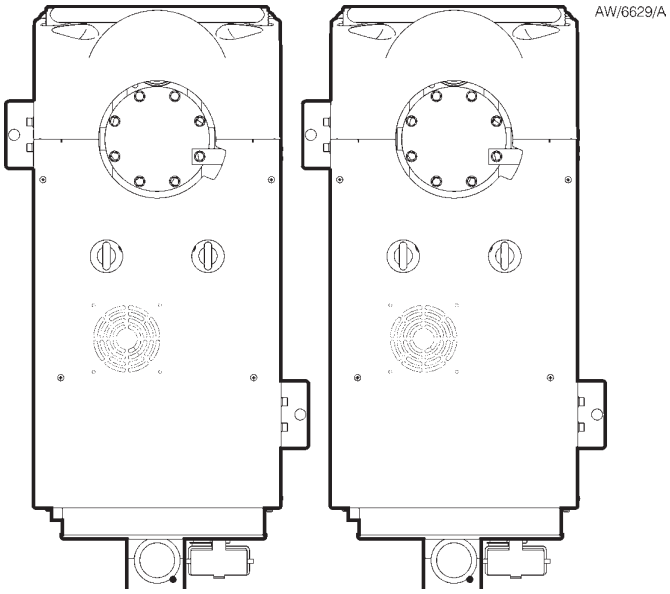


Figure 3-5 - System arrangement to reduce effective footprint (if required)

3.10 Connect the iH exhaust outlet to your exhaust-extraction system

WARNING

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

WARNING

Do not operate the iH system with the exhaust pipeline blocked. If the exhaust pipeline is blocked, the iH system can generate exhaust pipeline pressures up to 7 bar (7 x 10^5 Pa).

CAUTION

Use a catchpot to prevent the drainage of condensate back into the iH system. Condensate which drains back into the iH system could damage the HCDP pump.

When you connect to your exhaust-extraction system, take note of the following:

- Ensure that all components in the exhaust pipeline have a maximum pressure rating which is greater than the highest pressure that can be generated in your system.
- Incorporate flexible pipelines in the exhaust pipeline to reduce the transmission of vibration and to prevent loading of coupling-joints. We recommend that you use BOC Edwards braided flexible pipelines.
- You must be able to isolate the exhaust-outlet from the atmosphere if you have pumped or produced corrosive chemicals.
- Adequately support exhaust pipelines to prevent the transmission of stress to pipeline coupling-joints.

Use the following procedure to connect the iH system to your exhaust-extraction system: refer to Figure 1-1.

1. If the check valve (18) is not required on your application:
   - remove the exhaust enclosure (26) by removing the screws connecting to the rear bulkhead cover and exhaust enclosure top plate.
   - undo and remove the clamp and 'O' ring (22 and 21) which secures the check valve to the elbow (20).
   - retain the check valve for possible future use.
2. If neither the check valve (18) nor elbow (20) is required on your application, or if the elbow is required in a different orientation:
   - remove the exhaust enclosure (26) by removing the screws connecting to the rear bulkhead cover and exhaust enclosure top plate.
   - remove the clamps insulation jacket (24) and retain.
   - undo, or remove, the clamped 'O' ring that secures the elbow to the exhaust pipe (19).
   - reposition, or remove, the elbow (retain both elbow and check valve for possible future use if removed).
3. Remove the temporary cover or blanking plate from the exhaust outlet. Retain blanking plate for future use. Retain temporary cover for future use on non-contaminated pumps only. Use the NW40 trapped 'O' ring and clamp supplied to connect the exhaust outlet on the check valve (18), or elbow (20), or exhaust pipe (19), to your exhaust extraction system.
4. If the check valve was removed or elbow was removed or reorientated:
   - refit the clamps insulation jacket (if removed) on the NW40 joint to your exhaust extraction system. Use Figure 6-3 as a guide.
   - refit the exhaust enclosure (if possible) using the screws connecting to the rear bulkhead cover and exhaust enclosure top plate.

3.11 Connect to your factory extraction system (optional)

As supplied, the temperature control system fitted is sufficient to maintain the iH system at the correct operating temperature; you do not need to connect an air-extraction system to the iH system. However, if required you can connect your factory extraction system to the air-extraction port on the top of the main enclosure (see Figure 2-1).

Note: The iH system is supplied with a finger guard punched into the top enclosure.

3.12 Connect the nitrogen supply

CAUTION

Ensure that your nitrogen supply conforms to the requirements given in Section 2. If it does not, the flow sensors may not operate correctly, the gas pipelines may become blocked or the iH system may be damaged.

Connect your nitrogen supply to the iH system through the nitrogen inlet on the rear of the iH system (Figure 1-5, item 4).

Use rigid metal supply pipelines (such as stainless steel). We recommend that the nitrogen supply pipeline to the iH system has an outside diameter of $^{1}/_{4}$ inch, and that the pipeline is designed and constructed so that large pressure drops are not introduced into the nitrogen supply.

Use the Tube fittings in the fitting-kit to connect your nitrogen pipeline to the iH system: use the Tube fittings as described in Section 6.2.

3.13 Leak test the system

WARNING

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

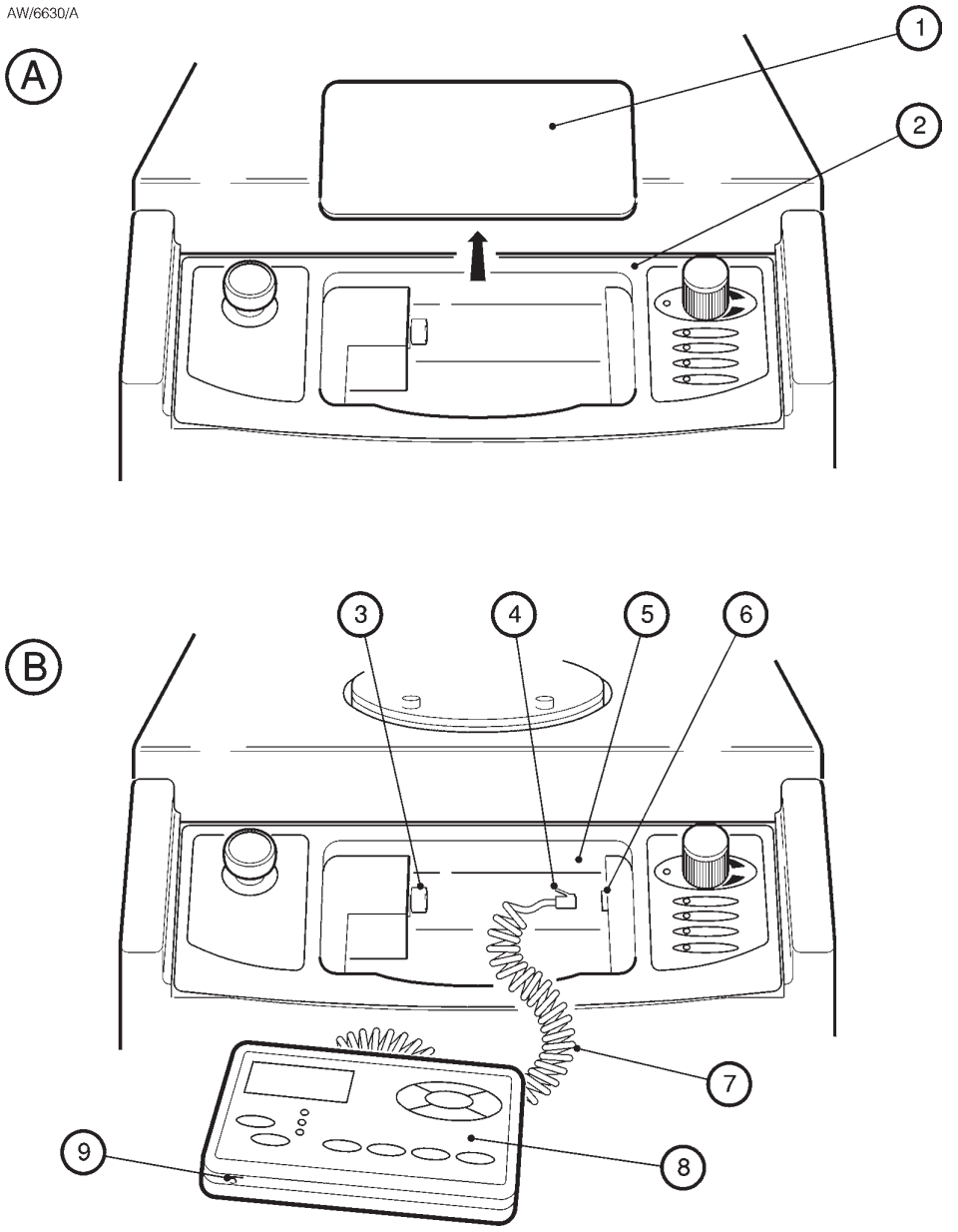
Note: If you need further information on leak testing, contact your supplier or BOC Edwards for advice.

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

Use a pump down test with helium to leak test the pump. We recommend that the leak rate is 1×10^{-5} mbar.ls^{-1} (1×10^{-3} Pa.ls^{-1}) helium or less for the complete system, or 1×10^{-6} mbar.ls^{-1} (1×10^{-4} Pa.ls^{-1}) helium or less for any individual leak.

The iH system is supplied with a blanked leak-test port, as shown in Figure 3-7. To connect to this port:

1. Refer to Figure 3-7. Remove the $^{3}/_{8}$ inch BSP blanking plug from the port (2 or 5).
2. Fit a suitable NW25 klein adaptor and 'O' ring and (if required) an elbow to the port, then connect your leak test equipment to the adaptor or elbow.



A Remove the blanking panel

B Fit the Pump Display Terminal

1. Blanking panel
2. Dashboard
3. Pump Display Module connector
4. Connector
5. Recess
6. Pump Display Terminal connector
7. Cable
8. Pump Display Terminal
9. Viewing angle adjuster

Figure 3-6 - Fit the pump display terminal

3.14 Install additional safety equipment (optional)

WARNING

If your Process Tool/control system needs to know the total flow rate of nitrogen to the iH system for safety reasons, install suitable measurement equipment in the nitrogen supply pipeline.

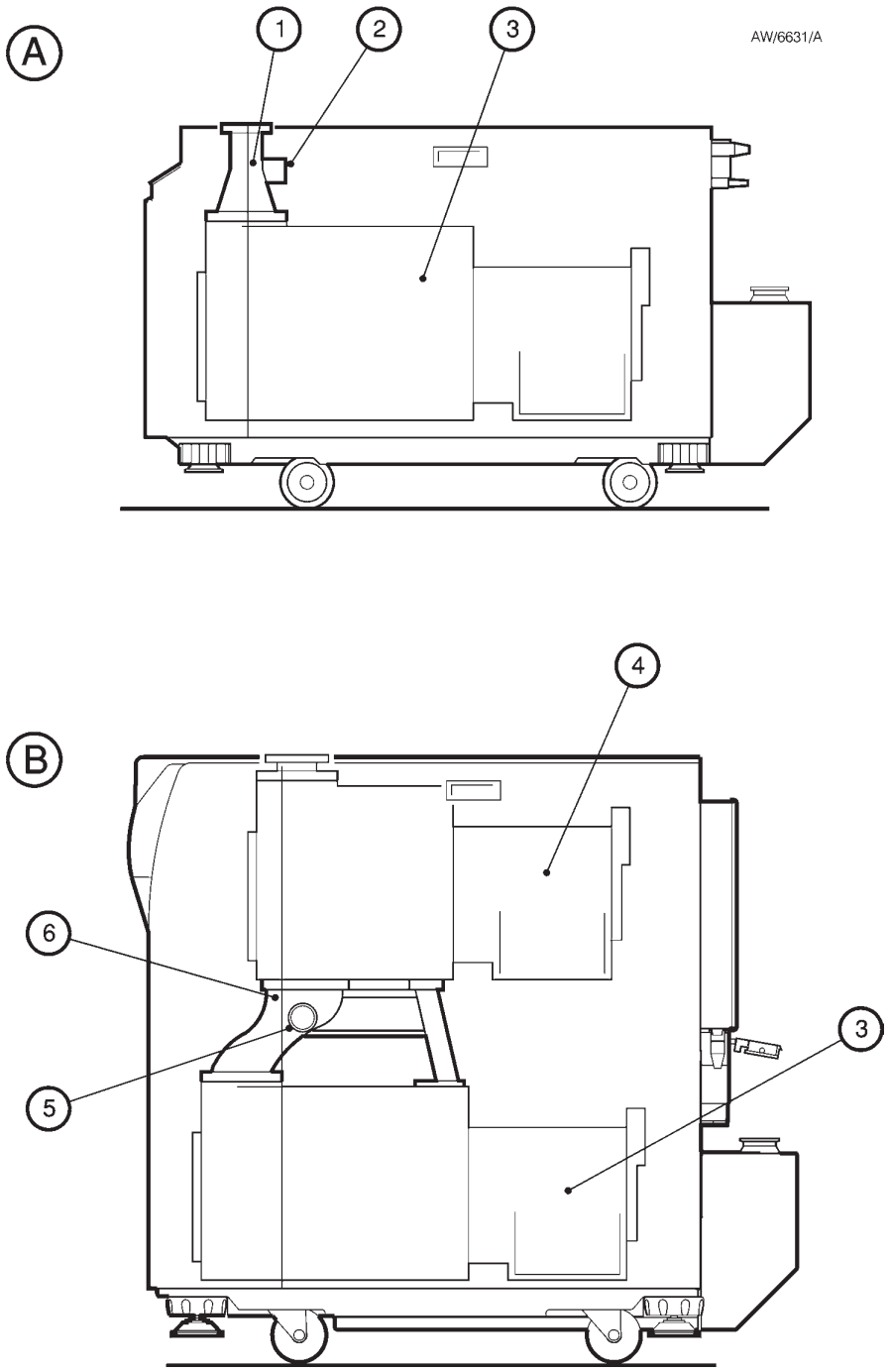
WARNING

If you use the nitrogen purges to dilute dangerous gases to a safe level, ensure that the system shuts down if the nitrogen supply to the iH system fails.

If the sensors or microprocessor fail, the total flow rate of nitrogen displayed or output by the iH system may be incorrect. If you need to know the total flow rate of nitrogen to the HCDP pump for safety reasons, you should therefore fit suitable measurement equipment in the nitrogen supply pipeline. If you fit a rotameter, ensure that it is suitable for use with nitrogen and that it is correctly calibrated.

If the nitrogen supply to the iH system fails, a warning message will be shown on the Pump Display Terminal and will be sent to the Interface Module(s) connected to the iH system. Ensure that your installation is configured so that it remains safe if there is a failure of the nitrogen supply to the iH system.

If an alarm condition is detected (and the iH system is not configured to 'run til crash': see Section 5.11) the iH system will shut down automatically. You must ensure that your installation remains safe if the iH system shuts down automatically.



A	iH80	1.	Inlet spool piece	4.	HCMB pump
B	iH600/iH1000	2.	Leak-test port (blanked)	5.	Leak-test port (blanked)
		3.	HCDP pump	6.	Support manifold

Figure 3-7 - Leak-test port positions

3.15 Connect to your emergency stop circuit (optional)

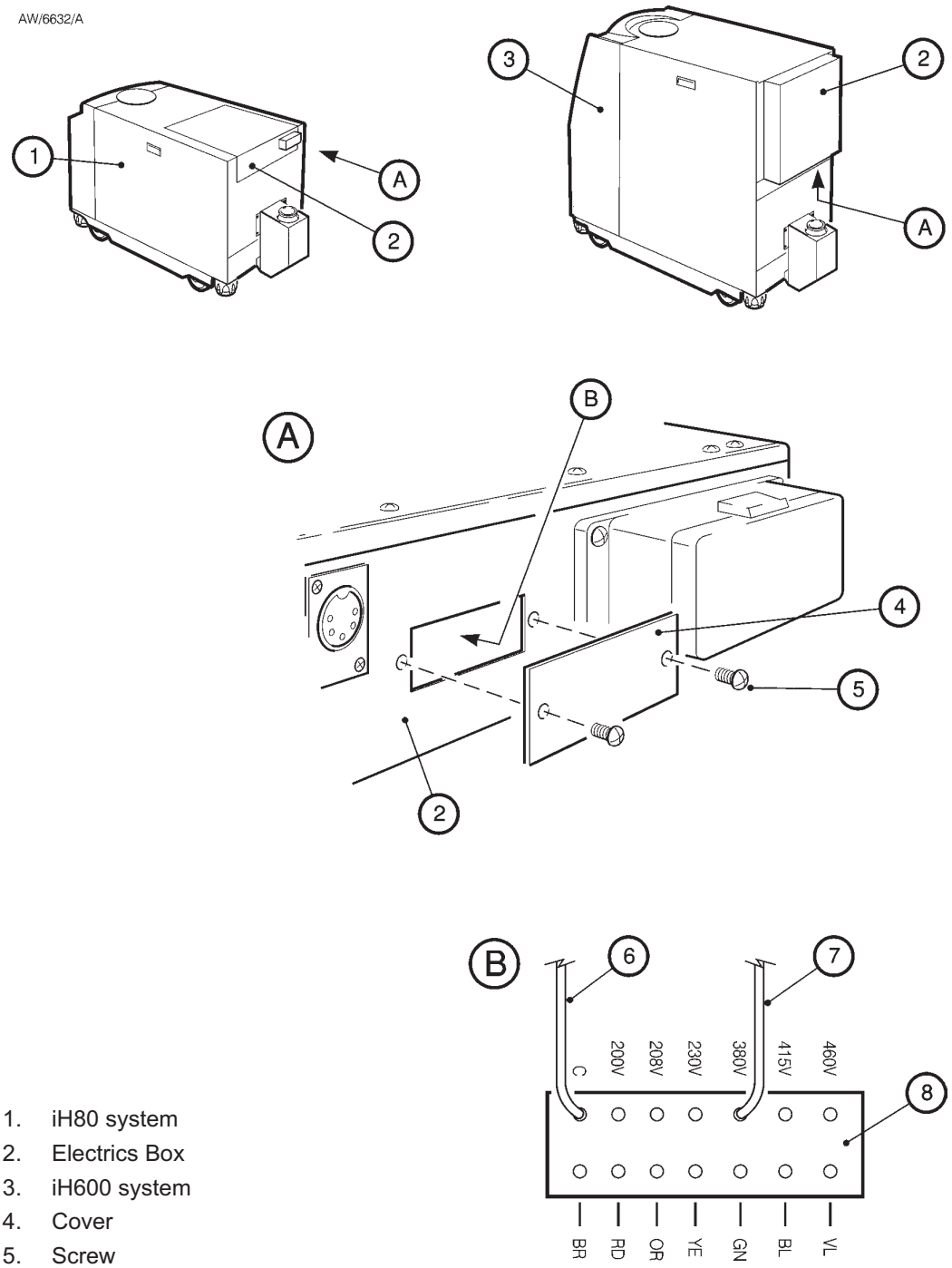
Note: If you do not connect to your own control equipment, you must fit the iH Tool Interface Module plug supplied to the iH Tool Interface Module connector on the rear of the iH system (Figure 1-5, item 8). If you do not, you will not be able to operate the iH system.

If required, you can connect your own control equipment to the iH system to shut down the iH system in an emergency. Use the following procedure

1. Remove the link between pins 1 and 2 of the iH Tool Interface Module connector plug supplied.
2. Connect a suitable cable to the plug; Table 3-3 shows the use of the pins in the plug.
3. Refer to Figure 1-5. Fit the plug to the iH Tool Interface Module connector (8) on the rear of the iH system.

Pin(s)	Use
1 and 2	Linked as supplied. Remove the link and connect these pins to your normally-closed, isolated external emergency stop circuit.
3 and 4	Isolated auxiliary contacts of the emergency stop switch on the Electrics Box.
5	24 V a.c. continuous output; maximum current 625 mA
6	0 V return

Table 3-3 - Pins in the iH tool interface module connector plug



1. iH80 system
2. Electrics Box
3. iH600 system
4. Cover
5. Screw
6. Common cable
7. Voltage select cable
8. Terminal-block

Figure 3-8 - Reconfigure the iH system for your electrical supply (iH80/iH600 only)

3.16 Electrical supply and RF earth (ground) connections

3.16.1 Reconfigure the iH system for your electrical supply (if necessary)

CAUTION

iH1000 systems are supplied already configured for your electrical supply. If you have an iH1000 system, do not try to reconfigure the iH system. If you do, you may damage the iH system.

Note: You cannot reconfigure an iH1000 system. If you want to use an iH1000 system with a different electrical supply to that specified on the rating plate (Figure 3-9, item1), contact your supplier or BOC Edwards.

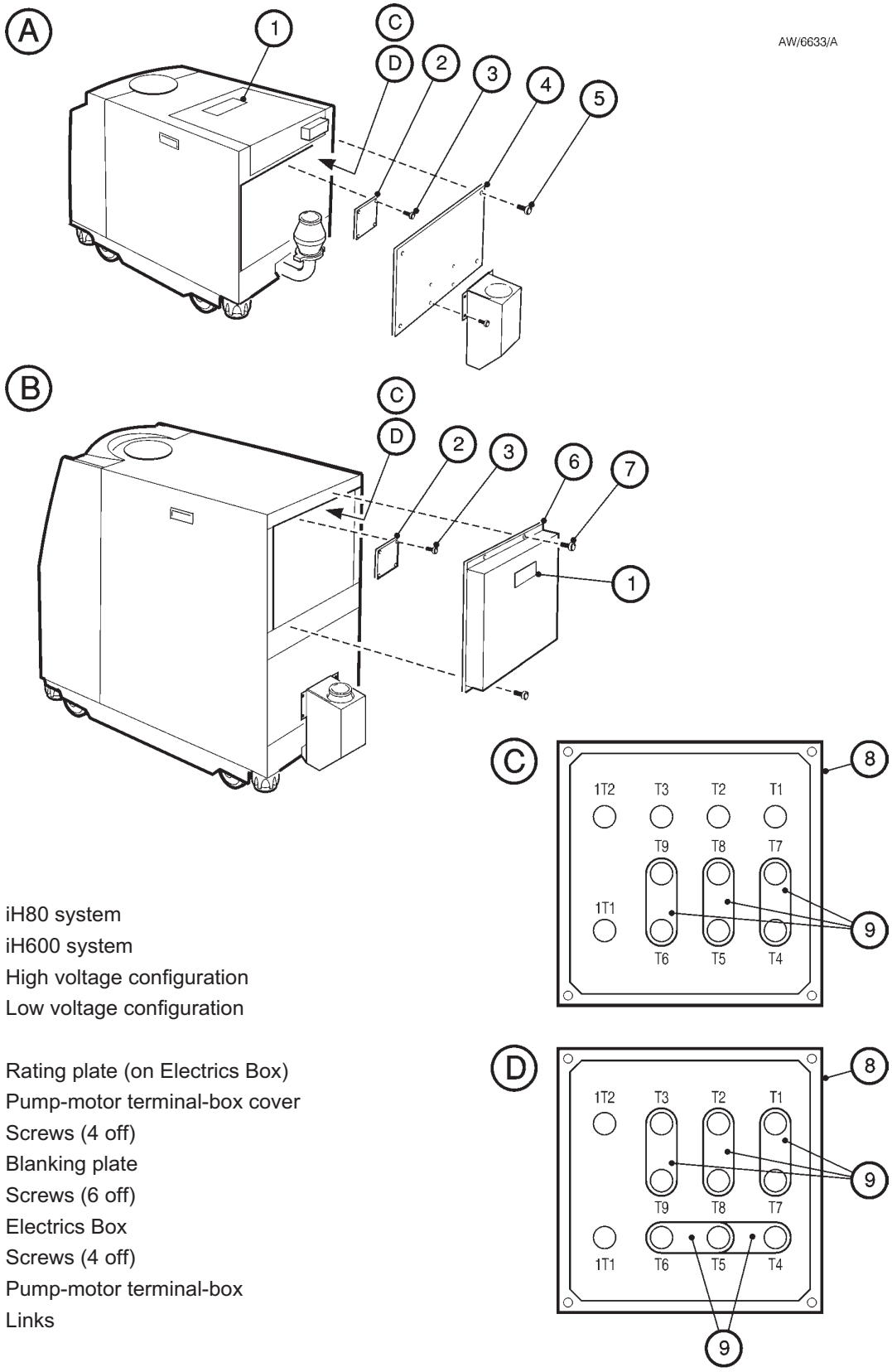
CAUTION

Ensure that the cooling-water system of your iH system is correctly configured for your electrical supply frequency. If it is incorrectly set at 50Hz, the system will run above optimum operating temperature. If it is incorrectly set at 60Hz, the system will run below optimum operating temperature.

Your iH system will be supplied correctly configured for your electrical supply; the Item Number of the iH system (shown on the rating plate: Figure 3-9, item 1) specifies how the system is configured: refer to Section 2.13.

If you want to use an iH80 or iH600 system with a different electrical supply, ensure that the correct transformer primary tapping is selected before you connect the electrical supply to the iH system; refer to Figure 3-8 and use the following procedure:

1. Undo the screws (5) which secure the cover (4) to the Electrics Box (2) and remove the cover.
2. Ensure that the common cable (6) is correctly connected to the common terminal on the terminal-block (8).
3. Ensure that the voltage select cable (7) is connected to the correct voltage terminal of the terminal-block (8) for your electrical supply.
4. Refit the cover (4) and secure with the two screws (5).



A iH80 system
B iH600 system
C High voltage configuration
D Low voltage configuration

1. Rating plate (on Electrics Box)
2. Pump-motor terminal-box cover
3. Screws (4 off)
4. Blanking plate
5. Screws (6 off)
6. Electrics Box
7. Screws (4 off)
8. Pump-motor terminal-box
9. Links

Figure 3-9 - Reconfigure the pump-motor terminal-boxes (iH80/iH600 only)

3.16.2 Reconfigure the pump(s) for your electrical supply (if necessary)

CAUTION

iH1000 systems are supplied already configured for your electrical supply. If you have an iH1000 system, do not try to reconfigure the pumps. If you do, you may damage the iH system.

Note: You cannot reconfigure an iH1000 system. If you want to use an iH1000 system with a different electrical supply to that specified on the rating plate (Figure 3-9, item 1), contact your supplier or BOC Edwards.

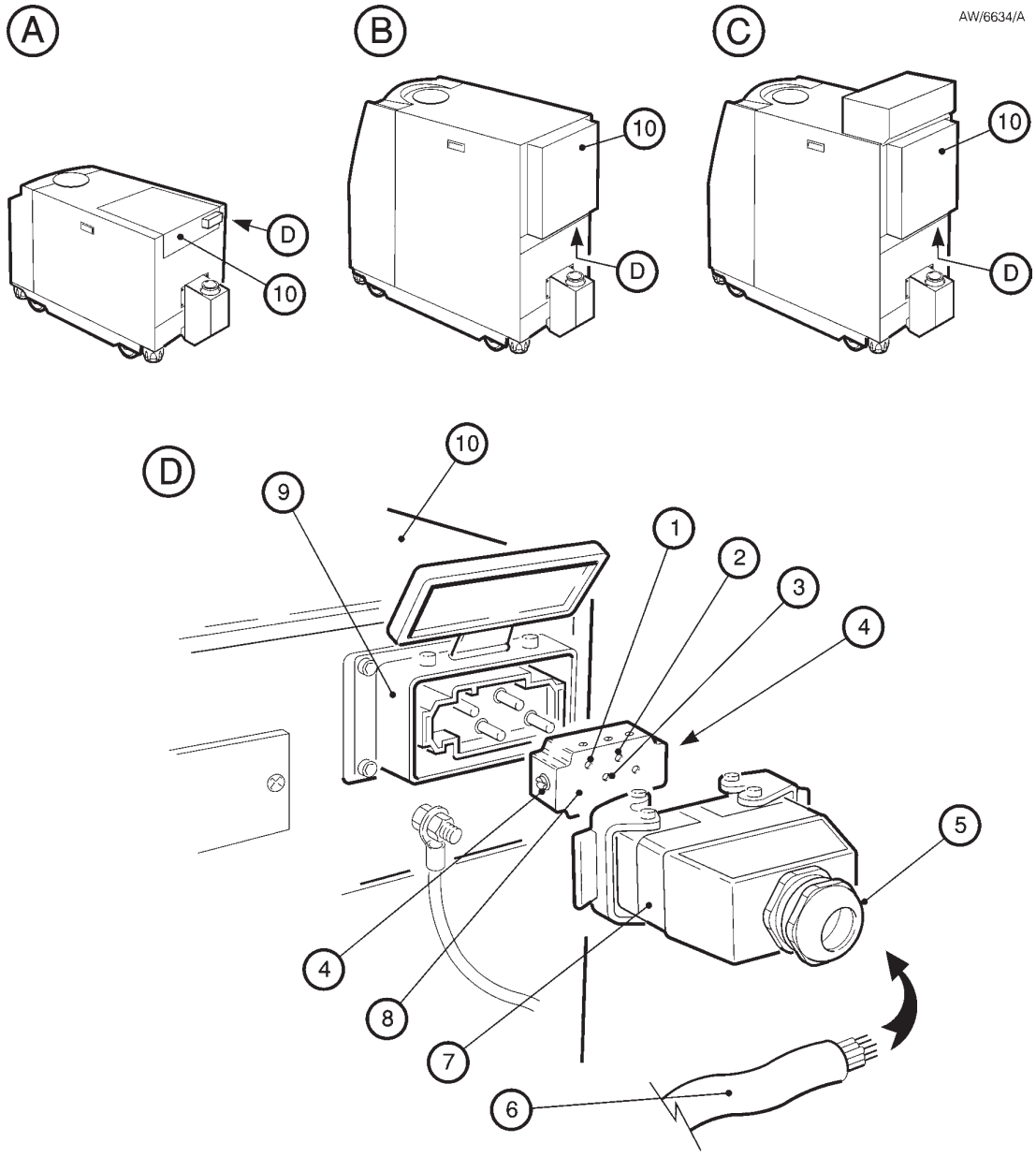
CAUTION

Ensure that the cooling-water system of your iH system is correctly configured for your electrical supply frequency. If it is incorrectly set at 50Hz, the system will run above optimum operating temperature. If it is incorrectly set at 60Hz, the system will run below optimum operating temperature.

Your iH system will be supplied correctly configured for your electrical supply; the Item Number of the iH system (shown on the rating plate: Figure 3-9, item 1) specifies how the system is configured: refer to Section 2.13.

If you want to use an iH80 or iH600 system with a different electrical supply, use the following procedure:

1. Refer to Figure 3-9 detail A. Undo and remove the six screws (5) which secure the blanking plate (4) over the HCDP pump-motor, and remove the blanking plate.
2. Undo and remove the four screws (3) which secure the cover (2) to the HCDP pump-motor terminal-box.
3. Look at the links in the terminal-box (8):
   - For high voltage operation (380-415 V at 50 Hz or 460 V at 60 Hz), ensure that the links (9) are in the positions shown in detail C.
   - For low voltage operation (200-208 V at 50 Hz or 200-230 V at 60 Hz), ensure that the links (9) are in the positions shown in detail D.
4. Refer to detail A. Refit the cover (2) to the HCDP pump-motor terminal-box and secure with the four screws (3).
5. Refit the blanking plate (4) and secure with the six screws (5).
6. If you have an iH600, continue at Step 7, otherwise continue at Section 3.16.3.
7. Refer to detail B. Undo and remove the four screws (7) which secure the Electrics Box (6) to the rear of the iH system, then carefully lower and support the Module. Ensure that you do not disconnect, break or damage any of the cables connected to the Module.



A	iH80	1.	Pin 1 (phase 1)	6.	Electrical supply cable
B	iH600	2.	Pin 2 (phase 2)	7.	Cover
C	iH1000	3.	Pin 3 (phase 3)	8.	Connector block
		4.	Earth (ground) screw	9.	Electrical supply connector
		5.	Strain relief bush	10.	Electrics Box

Figure 3-10 - Connect the electrical supply cable to the connector mating-half

8. Undo and remove the four screws (3) which secure the cover (2) to the HCMB pump-motor terminal-box, then remove the cover (through the access hole in the rear cover-plate).
9. Look at the links in the terminal-box (8):
   - For high voltage operation (380-415 V at 50 Hz or 460 V at 60 Hz), ensure that the links (9) are in the positions shown in detail C.
   - For low voltage operation (200-208 V at 50 Hz or 200-230 V at 60 Hz), ensure that the links (9) are in the positions shown in detail D.
10. Refit the cover (2) to the pump-motor terminal-box and secure with the four screws (3).
11. Refit the Electrics Box (6) to the rear of the iH system and secure with the four screws (7): ensure that you do not trap any of the cables connected to the Electrics Box.

3.16.3 Connect the electrical supply to the iH system

WARNING

This equipment is suitable for Installation Category 2 as defined in IEC 664 (EN61010-1). Connect the iH system to the electrical supply through a suitably rated isolator/contactor for your iH system (refer to Section 2 and the Notes below).

WARNING

Ensure that the iH system and your electrical supply cable are suitably protected against earth (ground) faults and that the earth (ground) conductor of the electrical supply cable is longer than the phase conductors in the connector. On an iH1000 system, you must fit a second protective earth (ground) conductor (with a cross-section of at least 10 mm^2) to the protective earth (ground)stud on the Electrics Box

CAUTION

This is an industrial (class A) product as defined by EN 61326. To ensure compliance with European Electromagnetic Compatibility (EMC) requirements for harmonics and flicker, please note that it is not intended for use in domestic buildings, or in properties directly connected to a electricity supply network which also supplies domestic buildings.

Notes: On an iH1000 system, the earth (ground) installation must ensure that there is an equipotential zone around the iH system: the voltage between the protective earth (ground) stud on the iH system and any other conducting surface within 2 metres of the iH system must be < 30 V r.m.s.

If you connect the electrical supply to an iH1000 system through ELCB relays, they must be suitable for the protection of equipment with a d.c. component in the fault current, and suitable for short-duration switch-on surges, and for high leakage current (for example, type B, according to prEN50178).

Use the following procedure to connect the electrical supply to the iH system. When you make your electrical supply cable, ensure that the earth (ground) conductor is longer than the phase conductors. This will ensure that if the cable is accidentally dragged and the strain relief bush on the electrical supply connector mating-half fails, the earth (ground) conductor will be the last conductor to be pulled from the connector.

1. Refer to Figure 3-10. Remove the connector block (8) from the cover (7) of the mating-half supplied for the electrical supply connector, then pass a suitable cable (6) through the strain relief bush (5) on the cover (7). Refer to Section 2 for suitable cable sizes.
2. Connect the cable phase wires to the pins in the connector block (8) as shown in Table 3-4.
3. Connect the earth (ground) wire of the cable to one of the two earth (ground) screws (4) on the side of the connector block (8).
4. Refit the cover (7) to the connector block (8), then tighten the strain relief bush (5).
5. Fit the mating-half to the electrical supply connector (9) on the Electrics Box (10).
6. Connect the other end of the electrical supply cable to your electrical supply through a suitable isolator, or via the disconnect box (see Section 3.21).
7. On iH80 and iH600 systems, we recommend that you fit a second protective earth (ground) conductor to the protective earth (ground) stud on the Electrics Box (Figure 1-5, item 11) and connect the other end of this conductor to your factory earth (ground). On an iH1000 system, you must fit a second protective earth (ground) conductor.

Wire	Pin number (Figure 3-10 key)
Phase 1 (R)	1
Phase 2 (S)	2
Phase 3 (T)	3

Table 3-4 - Pins in the electrical supply connector

3.16.4 Connect an additional RF earth (optional)

An earth (ground) cable is connected to the rear of the M6 RF earth (ground) stud on the rear panel of the iH system (Figure 1-5 item 6). If you will operate the iH system in an area subject to high RF (radio frequency) emissions, in accordance with good RF installation practise, we recommend that you:

- Use a star washer to connect the end of the earth (ground) cable connected to the iH inlet to one of the bolts that you use to secure the inlet-flange (see Section 3.9).

- Connect an additional earth (ground) cable to the M6 RF earth (ground) stud. You must use a suitable low-impedance cable (for example, use braided cable).

3.17 Refit the enclosure panels

1. Refer to Figure 3-3. Refit the right hand and left hand side panels use the following method for each side panel.
   - Hold the panel (4) and fit it to the side of the iH system, so that the pins (5) on the frame engage in the holes at the bottom of the panel (4).
   - Lower the panel fully down, then swing the top of the panel into place against the frame.
   - Use a posidrive screwdriver to secure the two or four M5 screws (3).

3.18 Connect the cooling-water hoses

WARNING

Do not leave the cooling-water supply turned on until after you complete the electrical installation of the pump. If you do, condensation may form inside the motor terminal-box and there may be a risk of electric shock.

CAUTION

Drain the cooling-water from the iH system, if you will transport or store it in conditions where the cooling-water could freeze. If you do not, cooling-water may freeze in the iH system and damage the pump(s) and/or the cooling-water pipelines.

Notes: For optimum water-cooling, ensure that your cooling-water supply and return hoses are free of restrictions which would reduce the cooling-water flow rate. If you need to connect more than one iH system to the water supply, you must connect them in parallel and not in series.

For minimum water consumption, regulate the cooling-water flow to the iH system.

The positions of the cooling-water connectors are shown in Figure 1-5. Connect the cooling-water supply as follows:

1. Use $^{3}/_{8}$ inch BSP male pipe fittings (which you must supply) to fit the female quick-release connector to the cooling-water supply hose and to fit the male quick-release connector to the cooling-water return hose.
2. Refer to Figure 1-5. Remove the dust-caps from the cooling-water inlet and outlet (2, 3).
3. Connect your water return hose to the cooling-water outlet (2) and connect your water supply hose to the cooling-water inlet (3).
4. Turn on the cooling-water supply.

5. Inspect the water hoses, pipelines and connections and check that there are no leaks.
6. Turn off the water supply while you complete the remainder of the installation procedures.

3.19 Adjust the interstage purge flow rates if necessary

The 2/3-interstage purge and 3/4-interstage purge flow rates are preset for correct operation. If necessary, these purge flow rates can be adjusted: contact your supplier or BOC Edwards for advice.

3.20 Commission the iH system

WARNING

Do not operate the iH system with the exhaust pipeline blocked. If the exhaust pipeline is blocked, the iH system can generate exhaust pipeline pressures up to 7 bar (7 x 10^5 Pa).

WARNING

Do not operate the iH system with any enclosure panels removed and do not touch any parts of the pump(s) when the iH system is on. Surfaces of the pump(s) are very hot and can cause injury to people.

3.20.1 Switch on an iH80/iH1000 system

Note: Operation of the iH system with high inlet pressure may result in shaft-seal pressure warnings (refer to Table 6-1): the operation of the iH system will not be affected, and you can ignore these warnings.

1. Switch on the external electrical supply and check that the power ok LED (Figure 1-7, item 7) goes on. If the LED does not go on, refer to Section 6 to determine the cause of the fault.
2. Switch on the cooling-water and nitrogen supplies.
3. Ensure that the exhaust-extraction system is not blocked (for example, that valves in the exhaust-extraction system are open).
4. Ensure that all openings to atmospheric pressure in the foreline vacuum system are closed, then switch on the iH system.
5. If the iH system starts and continues to operate, continue at Step 6. If a warning or alarm condition is indicated (for example, a warning or alarm message is shown on the Pump Display Terminal):
   - Shut down the iH system: refer to Section 5.10.

- Refer to Section 6 to determine the cause of the fault and to rectify the fault.

6. Look at the pressure gauge in your inlet pipeline:
   - If the pressure is increasing, the HCDP pump-motor terminal-box (and/or if you have an iH1000 system, the HCMB pump-motor terminal-box) is incorrectly wired: immediately shut down the iH system, correct the electrical wiring (refer to Section 3.16.2), then repeat this procedure from Step 3 again.
   - If the pressure is decreasing, continue at Step 7.
7. After you have commissioned the iH system:
   - If you want to continue to operate the iH system, refer to Section 5.
   - Otherwise, shut down the system,: refer to Section 5.10.

3.20.2 Configure and switch on an iH600 system

CAUTION

Ensure that the booster start delay is correctly adjusted for your installation. If it is not, you may damage the iH when you start it up.

CAUTION

You can only switch on and configure an iH600 system if you have a Single Equipment Monitor (SEM) connected to the iH system. If you do not have SEM, do not use the following procedure; contact your supplier or BOC Edwards for advice.

CAUTION

Do not operate an iH600 system with the maximum inlet pressure for longer than the maximum time specified in Table 2-1. If you do, the HCMB pump may overheat

Notes: You will need a stop-watch to do the following procedure, which assumes that you are familiar with the operation of the SEM; where necessary, refer to the manual supplied with the SEM.

You can only adjust the iH booster start delay up to a maximum of 255 seconds. If your required delay is longer than 255 seconds, you must fit an iH600 Pressure Control Kit accessory: refer to Section 8.4.3.

Operation of the iH system with high inlet pressure may result in shaft-seal pressure warnings (refer to Table 6-1): the operation of the iH system will not be affected, and you can ignore these warnings.

When you switch on an iH600 system, the HCDP pump starts immediately, but there is a delay before the HCMB pump is started. This ensures that the vacuum system and vacuum inlet pipelines are partially evacuated by the HCDP pump, so that the maximum inlet pressure for the HCMB pump is not exceeded (see Section 2). As supplied, this delay (the booster start delay) between HCDP pump switch-on and HCMB pump switch-on is preset to 30 seconds.

You must use the following procedure to determine whether the booster start delay is suitable for your installation.

1. Switch on the external electrical supply and check that the power ok LED (Figure 1-7, item 7) goes on. If the LED does not go on, refer to Section 6 to determine the cause of the fault.
2. Logon to the SEM.
3. Use the SEM to:
   - Upload the configuration set from the iH system, and store it with a suitable file name (for example, "iH600").
   - Edit the configuration to identify that an HCMB pump is not fitted, and save the new edited configuration set with a suitable new file name (for example, "iH80/600").
   - Download the edited configuration set to the iH system.
4. Switch on the cooling-water and nitrogen supplies.
5. Ensure that the exhaust-extraction system is not blocked (for example, that valves in the exhaust-extraction system are open).
6. Ensure that all openings to atmospheric pressure in the foreline vacuum system are closed, then switch on the iH system and simultaneously start the stop-watch.
7. If the iH system starts and continues to operate, continue at Step 8. If a warning or alarm condition is indicated (for example, a warning or alarm message is displayed on the SEM or shown on the Pump Display Terminal):
   - Shut down the iH system: refer to Section 5.10.
   - Refer to Section 6 to determine the cause of the fault and to rectify the fault, then repeat this procedure from Step 7.
8. Look at the pressure gauge in your inlet pipeline:
   - If the pressure is increasing, the HCDP pump-motor terminal-box is incorrectly wired: immediately shut down the iH system, correct the electrical wiring (refer to Section 3.16.2), then repeat this procedure from Step 7 again.
   - If the pressure is decreasing, leave the iH system to operate and take note of the time taken to pump down to 5 mbar (5×10^2 Pa), then continue at Step 9.
9. Stop the iH system and isolate it from the electrical supply.
10. Add 10% to the time noted in Step 8, to give the required booster start delay for your installation.
11. If the required booster start delay is less than or equal to 30 seconds, continue at Step 13.

12. If the required booster start delay is greater than 30 seconds, use the SEM to edit and save the original configuration set uploaded from the iH (the set saved as, for example, "iH600"): set the BOOSTER START DELAY to the required booster start delay time.
13. Use the SEM to download the original configuration set (with file name, for example, of "iH600") to the iH system.
14. Start up the iH system again and at the same time start the stop-watch. Watch the pressure gauge in your inlet pipeline. The HCDP pump will start and the pressure will start to reduce. After the booster start delay time, the HCMB pump will start (at an inlet pressure of approximately 5 mbar, 5 x 10^2 Pa):
    - If the pressure increases or does not decrease any further when the HCMB pump starts, the HCMB pump-motor terminal-box is incorrectly wired: immediately shut down the iH system, correct the electrical wiring (refer to Section 3.16.2), then repeat this procedure from this step (Step 14) again.
    - If the pressure continues to decrease after the HCMB pump starts, continue at Step 15.
15. After you have commissioned the iH system:
    - If you want to continue to operate the iH system, refer to Section 5.
    - Otherwise, shut down the system: refer to Section 5.10.

3.21 Install the disconnect box (accessory)

The following sections provide the installation of the disconnect box to your system. The disconnect box general arrangement is shown in Figure 1-9.

3.21.1 Unpack and inspect

Remove all packing materials and protective covers and check the controller. If the controller is damaged, notify the supplier and carrier in writing within three days; state the item number of the controller together with the order number and suppliers invoice number. Retain all packing materials for inspection. Do not use the controller if damaged. Check that the package contains the following items:

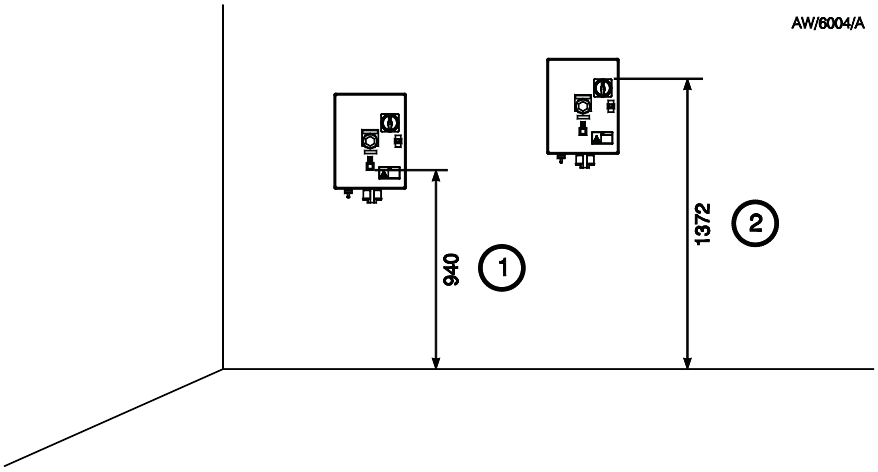
Inspection Check List		
Quantity	**Description**	**Check (✓)**
1	Disconnect Box	❑
2	EMO Shroud	❑
3	Pump Power Cable	❑

If the disconnect box is not used immediately, store in suitable conditions, as described in Section 7.1.

3.21.2 Mounting

The disconnect box is a wall mount unit which utilises the four mounting holes on the back wall of the box. Height requirements for the mounting box are shown in Figure 3-11.

Note: The Disconnect box must be mounted in close proximity to the iH system.



1. Minimum mount height to bottom of reset push button
2. Maximum mount height to top of disconnect switch

Figure 3-11 - Disconnect box mounting height requirements

3.21.3 Electrical installation

The electrical schematic is shown in Figure 3-12. The electrical connections between the disconnect box, incoming electrical supply and pump are described in the following sections. Refer to Figure 3-13 for electrical supply connections, and Figure 3-14 for cable connections.

All hardware required to install the disconnect box is provided in the loose parts package.

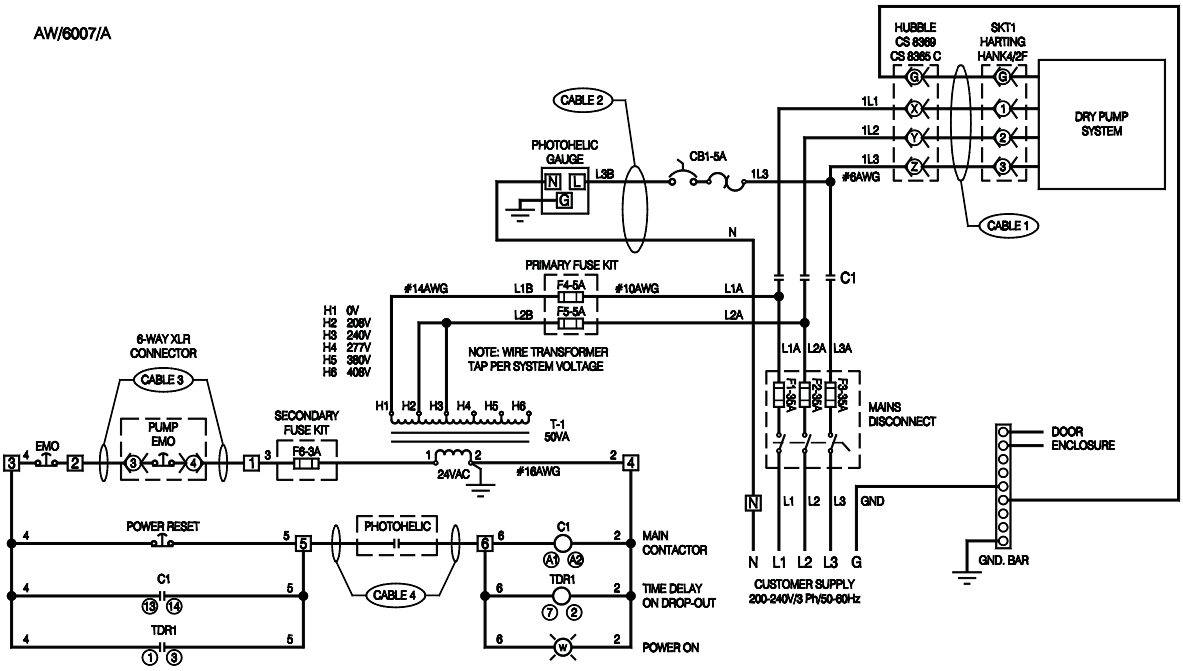


Figure 3-12 - Disconnect box electrical schematic

3.21.4 Main electrical supply

Connect the power supply to the disconnect box using the following steps:

1. Punch out the power supply inlet hole plug on the top of the disconnect box.
2. Tie in the customer power to the supply side of the fused mains disconnect as shown in Figure 3-13.
3. Tie in dedicated grounding and neutral conductors to an open position on the grounding bar and neutral terminal respectively.
4. If the photohelic gauge is installed, ensure that the circuit breaker CB1 is reset.

3.21.5 Cable connections

Connect the cables from the disconnect box to the appropriate locations as follows:

1. Punch out the EMO cable outlet hole (2) on the bottom of the disconnect box. See Figure 3-14.
2. Connect the cable cores to terminals 1 and 2 of the disconnect box. See Figures 3-12 and 3-13.
3. Plug the six way XLR connector into the Tool Interface Module of the iH system. See Figure 1-5.
4. See Section 3.22 for photohelic switch/gauge connections.
5. Close the Disconnect box door and secure it using a flat bladed screwdriver.

1. From customer supply
2. Neutral terminal
3. Ground bar
4. Main Contactor C1
5. 3 Second Brown-Out time delay relay TDR1
6. Terminals 1-6
7. Photohelic Gauge circuit breaker CB1
8. Fused mains disconnect F1 through F3
9. 24 VAC control circuit transformer T-1 and fuses F4 through F6

Figure 3-13 - Disconnect box sub-panel general arrangement: key

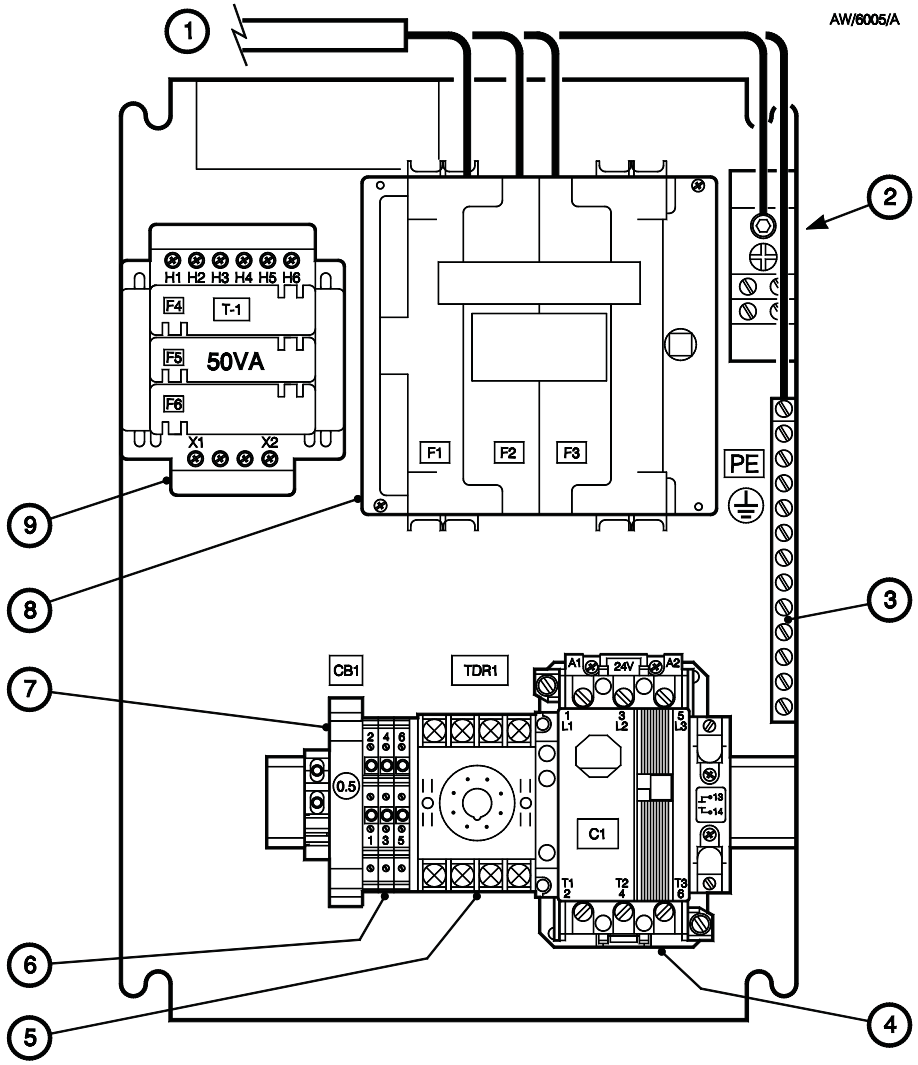
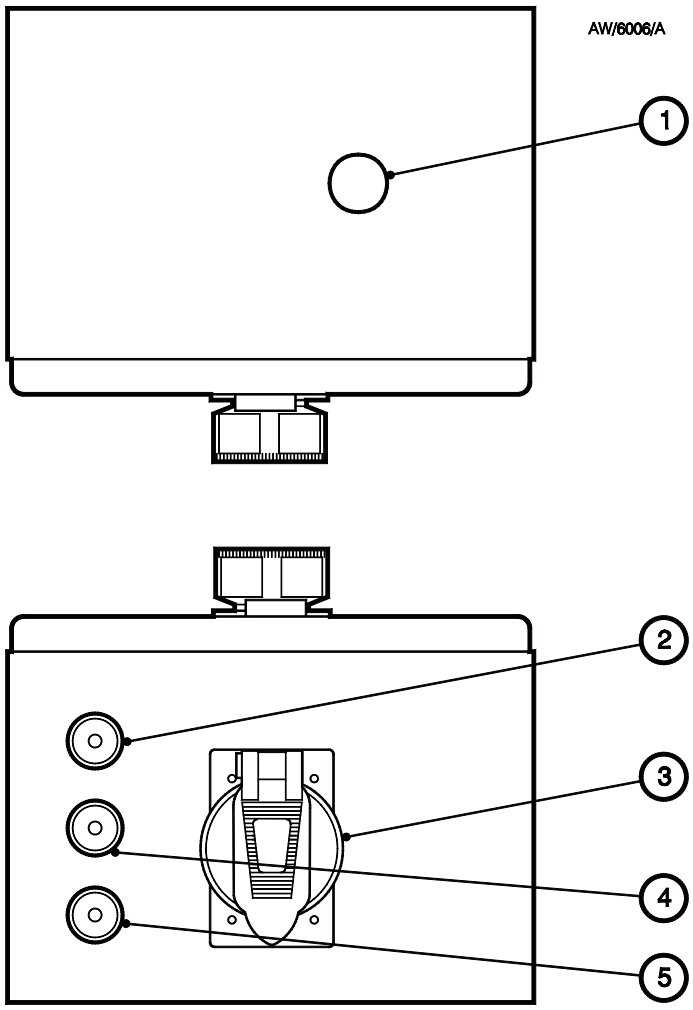


Figure 3-13 - Disconnect box sub-panel general arrangement



1. Customer supply: 1.36 inch diameter hole
2. EMO cable
3. Dry pump power
4. Photohelic gauge signal cable
5. Photohelic power cable

Figure 3-14 - Disconnect box cable connections

3.22 Install photohelic switch/gauge (accessory)

The following sections provide the installation of the photohelic switch/gauge to your system. Note that the installation of the photohelic gauge is only possible if the disconnect box has been installed.

3.22.1 Unpack and inspect

Remove all packaging materials and protective covers and check the switch/gauge. If the switch/gauge is damaged, notify the supplier and carrier in writing within three days; state the item number of the switch/gauge together with the order number and suppliers invoice number. Retain all packing materials for inspection. Do not use the switch/gauge if damaged. Check that the package contains the following items:

Inspection Check List		
Quantity	**Description**	**Check (✓)**
1	Photohelic Switch/Gauge complete with Power and Signal Cables	❑
2	Photohelic Mounting Bracket	❑
3	Braided ¼" Hose complete with Tube Fittings	❑
4	Photohelic Spoolpiece	❑

If any items are missing, notify the supplier in writing within three days.

If the photohelic switch/gauge is not used immediately, store in suitable conditions, as described in Section 7.1.

Remove the finger guard from the pump enclosure air-extraction port (refer to Figures 2-1 to 2-3) and replace it with the photohelic spoolpiece shown in Figure 3-15.

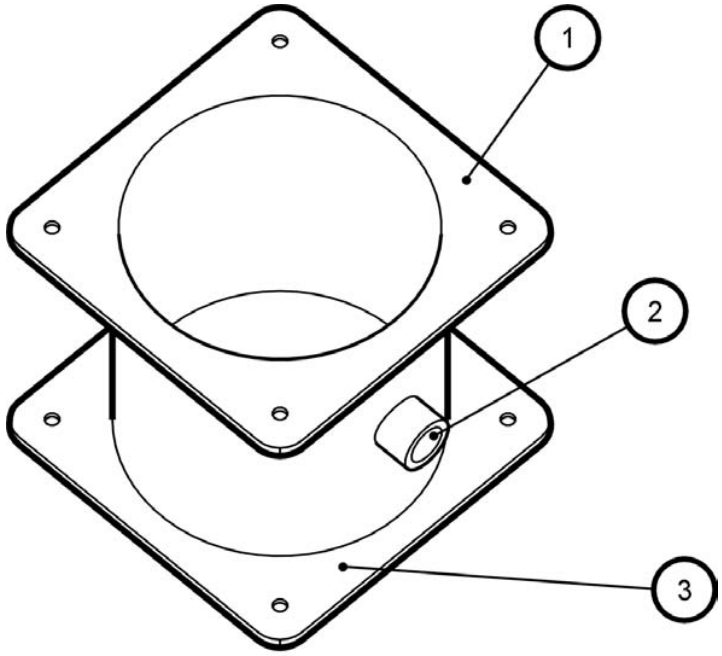
3.22.2 Mounting

The photohelic switch/gauge is a wall mount unit. The mounting instructions are described in the accessories manual.

3.22.3 Piping connections

Connect the piping between the photohelic switch/gauge and the iH exhaust enclosure using the following steps:

1. Connect the male connector to the photohelic monitoring port on the photohelic spoolpiece (Figure 3-15, item 2). Refer to Section 6.2 for guidelines.
2. See Figure 3-16. Connect the braided hose to the male connector and gasket (1) on the photohelic spoolpiece and to the photohelic gauge port as shown. (See Section 6.2 for guidelines)



1. Outlet to be connected to factory extraction system
2. Photohelic monitoring port
3. Inlet to be connected to pump enclosure extraction port

Figure 3-15 - Photohelic spoolpiece

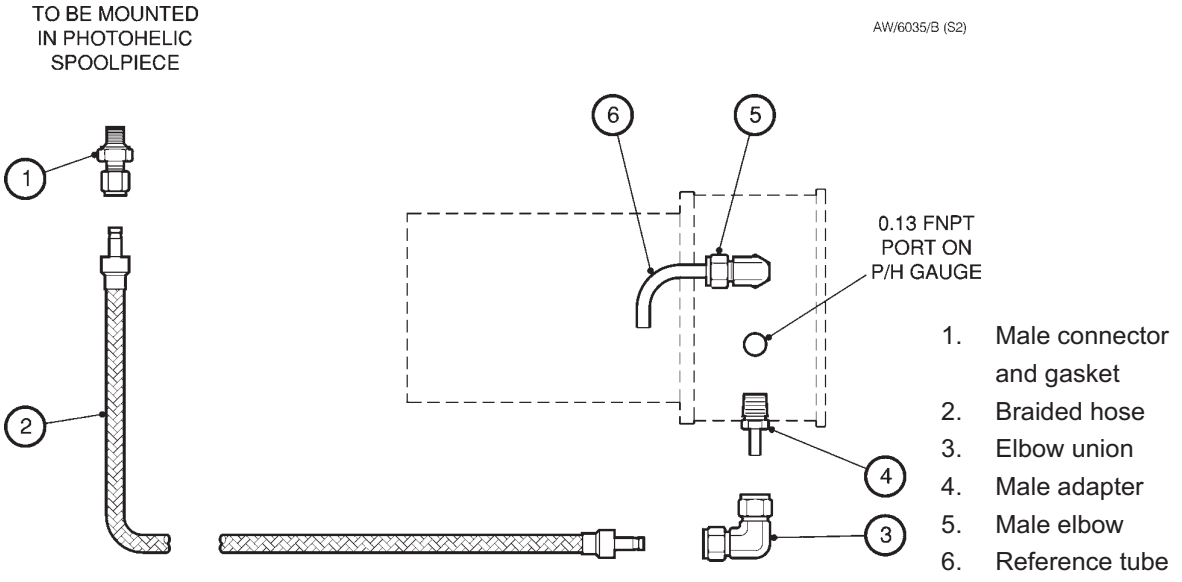


Figure 3-16 - Photohelic gauge piping connections

3.22.4 Cable connections

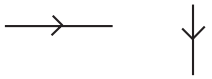
Connect the cabling between the photohelic switch/gauge and the disconnect box as follows:

1. Using a flat screwdriver, open the disconnect door by turning the lock.
2. Ensure power to the disconnect box is isolated and that CB1 is open.
3. Punch out the photohelic gauge signal and power cable holes on the bottom of the disconnect box (Items 4 and 5 on Figure 3-14)
4. Connect the photohelic switch/gauge signal cable to terminals 5 and 6 (See Figures 3-12 and 3-13)
5. Connect the photohelic switch/gauge power cable to CB1, the Neutral Terminal and the Ground Bar. (See Figures 3-12 and 3-13)
6. Restore power to the disconnect box and close CB1
7. Using a flat screwdriver, secure the disconnect door by turning the lock

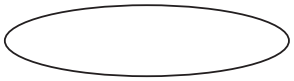
4 PUMP DISPLAY TERMINAL MENUS AND DISPLAY FORMATS

4.1 Introduction

The menus used and the display messages shown on the Pump Display Terminal are described in the menu diagrams in Figures 4-2 to 4-19. The following symbols and conventions are used in the menu diagrams:



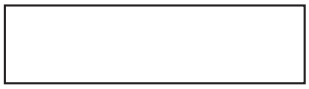
These are flow lines. Arrows on the lines show the direction of flow through a menu.



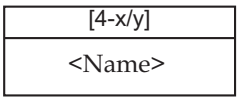
This symbol is used to connect different menus and shows the starting point (or continuation point) of a menu. The symbol is shown with the menu name and, where applicable, a reference of the form [4-x/y]. This reference specifies that the menu continues on (or is continued from) a menu shown on sheet y of Figure 4-x. The sheet reference (/y) is omitted where it is not necessary.

This symbol is used for the ENTER and CANCEL buttons and the four menu buttons: Normal, Status, Control and Setup.

This symbol is used for the up (▲) and down (▼) buttons and for the on (⏼) and off (⏻) buttons.



This symbol is used for the two-line display on the Pump Display Terminal. With the exception of variable text (see Section 4.4), the text shown in the symbol is the text that will be shown on the display.



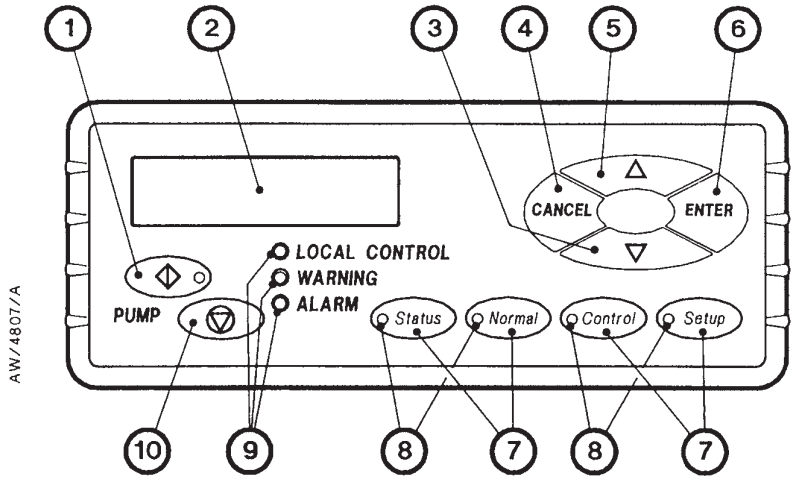
This symbol is a subroutine box and is used to represent a 'subroutine call'; a subroutine is a series of menu steps which are used in a number of different menus or used in different parts of one menu. The [4-x/y] reference (used as described above) shows where the subroutine is expanded.

In a menu which 'calls' a subroutine, where a menu flow line meets the left hand side of a subroutine box, this means that flow continues at the start connector (identified by <name>) of the subroutine. At the 'exit' connector of the subroutine, flow continues in the (calling) menu along the flow line to the right of the subroutine box.

☞ This symbol shows additional text which is not part of the menu, but which further describes the operation of the menu.

4.2 General operation

When you first switch on the iH system, the normal display is shown: see Figure 4-5. Refer to Figure 4-1. You can then press the On or Off button (1 or 10) or any of the four menu buttons (7) to enter the corresponding menu. Then, regardless of the current menu and display status, when you press any of these buttons, you exit the current menu and enter the corresponding new menu. Figure 4-2 shows this menu control logic.



1. On button
2. Display
3. Down button
4. CANCEL button
5. Up button
6. ENTER button
7. Menu buttons
8. Menu selected LEDs
9. Status LEDs
10. Off button

Figure 4-1 - Front panel of the pump display terminal

4.3 The CANCEL button

You can press the CANCEL button at any time during menu operation. For this reason, we have not shown the use of the CANCEL button on all of the menu diagrams, but we have shown specific uses where there is no other obvious way to cancel the current menu option and enter the previous menu option. In general, when you press the CANCEL button, the current menu option is cancelled and the previous menu option is displayed.

Other specific uses of the CANCEL button are as follows:

- In the Switch On and Switch Off menus (Figures 4-3 and 4-4), when you press CANCEL, the menu is exited and the normal display is shown.
- In the Status menu (Figure 4-6), when you press CANCEL the display shows the first two status parameters (the defaults are HCDP current consumption and power consumption).
- When you change passwords in the Setup and Service menus (Figures 4-8 and 4-13) and before you press the ENTER button, if you press CANCEL, the menu moves back to entry of the first digit of the password or serial number.

4.4 Display text and variable text

In the menu diagrams in Figures 4-2 to 4-19, text shown without chevron brackets in the two-line display symbol is the actual text that will be shown on the display. In this text, the 'Δ' symbol is used to show where a digit will be shown; the value of the digit depends on the sensor data or information you enter into the Pump Display Terminal.

Text enclosed in chevron brackets (for example, <status>) defines variable text; what is shown on the display depends on the menu or the status of the iH system and data entered by the user. The following variable text markers are used on the menu diagrams:

<status> This specifies the status of a sensor in the iH (a Water Flow-Switch). <status> can be any of the following:

- OK indicates that the status is acceptable.
- CHECK or LOW indicates that the reading from the sensor is low.
- NP (not present) indicates that the sensor is not fitted.
- NR (not reading) indicates that the sensor is disconnected, faulty or not switched on.

<serial no./tag> This specifies a serial number or the user tag. The user tag is a number which you can use to identify the iH system in the installation.

<parameter> This is a previously selected parameter or menu option.

<message> This specifies a warning, alarm or advisory message.

<e.no> This specifies an error number: refer to Section 6.

<units> This specifies setpoint units, for example kW or slm.

<config> This specifies the gas system configuration and can be any of the following: "low", "medium", "med+exh", or "high".

4.5 Wrap-around

When you use the up and down buttons to change a digit or character on the display, the digit or character will 'wrap-around' between its minimum and maximum values. For example, when you enter a password digit, if the digit is '0' and you press the down button, the digit will change to '9'; if the digit is '9' and you press the up button, the digit will change to '0'.

4.6 Timeout

As supplied, after you have entered a menu (other than the Normal menu), if you do not press a button for five minutes, the Pump Display Terminal will automatically exit the current menu and enter the Normal menu. This facility (known as timeout) is available so that if the setup or service menu is entered and then the iH system is accidentally left unattended for a specified time, the menu is exited to prevent unauthorised use of the menu options.

4.7 Menu structure

The menu structure is shown in Table 4-1. Note that if a particular system component or accessory is not fitted, the corresponding menu option or parameter is not shown or is shown as 'NP' (not present). For example, in the Status menu (Figure 4-6), if a component is not fitted, 'NP' (not present) is shown in the corresponding display line; an oil monitor is not fitted to the HCMB pump, so where Figure 4-6 shows the 'MB OIL' status display, the actual display line will be 'MB OIL NP'.

4.8 Example

Here is an example of how to interpret the menu diagrams. The following procedure describes how to change the units displayed for pressures (you can select kPa or psi).

1. Press the Setup button to enter the Setup menu (Figure 4-8).
2. Use the up and down buttons to change the first digit of the setup password to the correct value, then press the ENTER button.
3. Use the up and down buttons to change the second digit of the setup password to the correct value, then press the ENTER button.
4. Use the up and down buttons to change the third digit of the setup password to the correct value, then press the ENTER button.
5. If you have entered the correct password, the display will then show 'SETUP MENU' on the top line and 'Inlet Purge' on the bottom line.
6. Press the down button six times or press the up button five times; the display will then show 'SETUP MENU' on the top line and 'Units' on the bottom line.
7. Press the ENTER button; the display will then show 'Units Select' on the top line and 'Pressure' on the bottom line (see Figure 4-11).

8. Press the ENTER button; the display will then show 'Pressure' on the top line and the currently selected pressure units on the bottom line.

9. Press the up or down buttons to change the units displayed to the required units, then press the ENTER button. Pressures will now be displayed in the units you selected.

Menu	Figure
Switch on	4-3
Switch off	4-4
Normal	4-5
Status	4-6
Control	4-7
Setup	4-8
Inlet purge	4-8
Gas Ballast	4-8
Gate Valve 1	4-8
Run Til Crash	4-9
Units	4-10
Normal display	4-11
Service	4-12
Serial Numbers	4-13
Zero sensors	4-14
Gas Valve Control	4-15
Manual	4-16
View Status	4-17
Messages	4-18
Warning and alarm messages	4-19

Table 4-1 - Menu structure

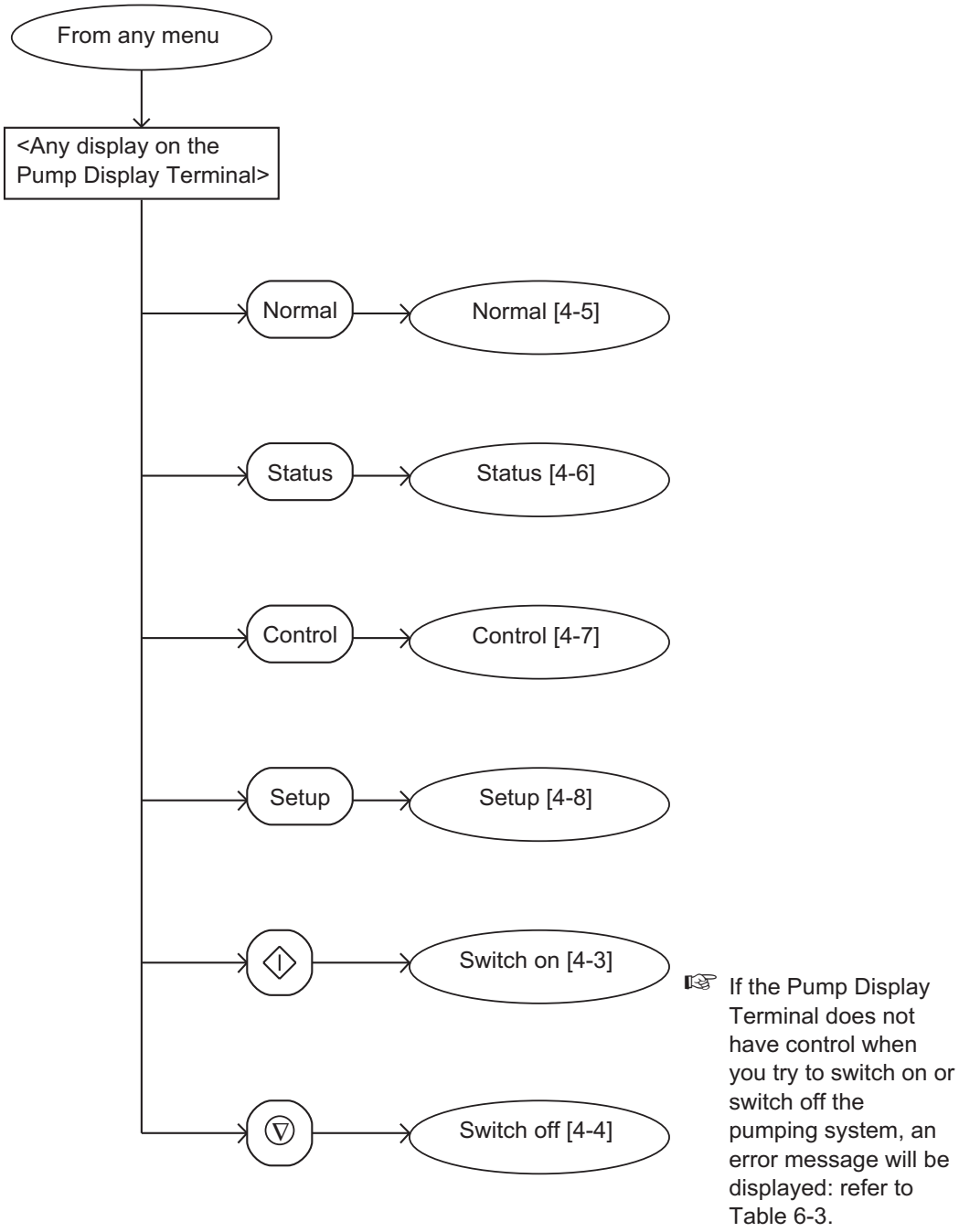


Figure 4-2 - Menu logic

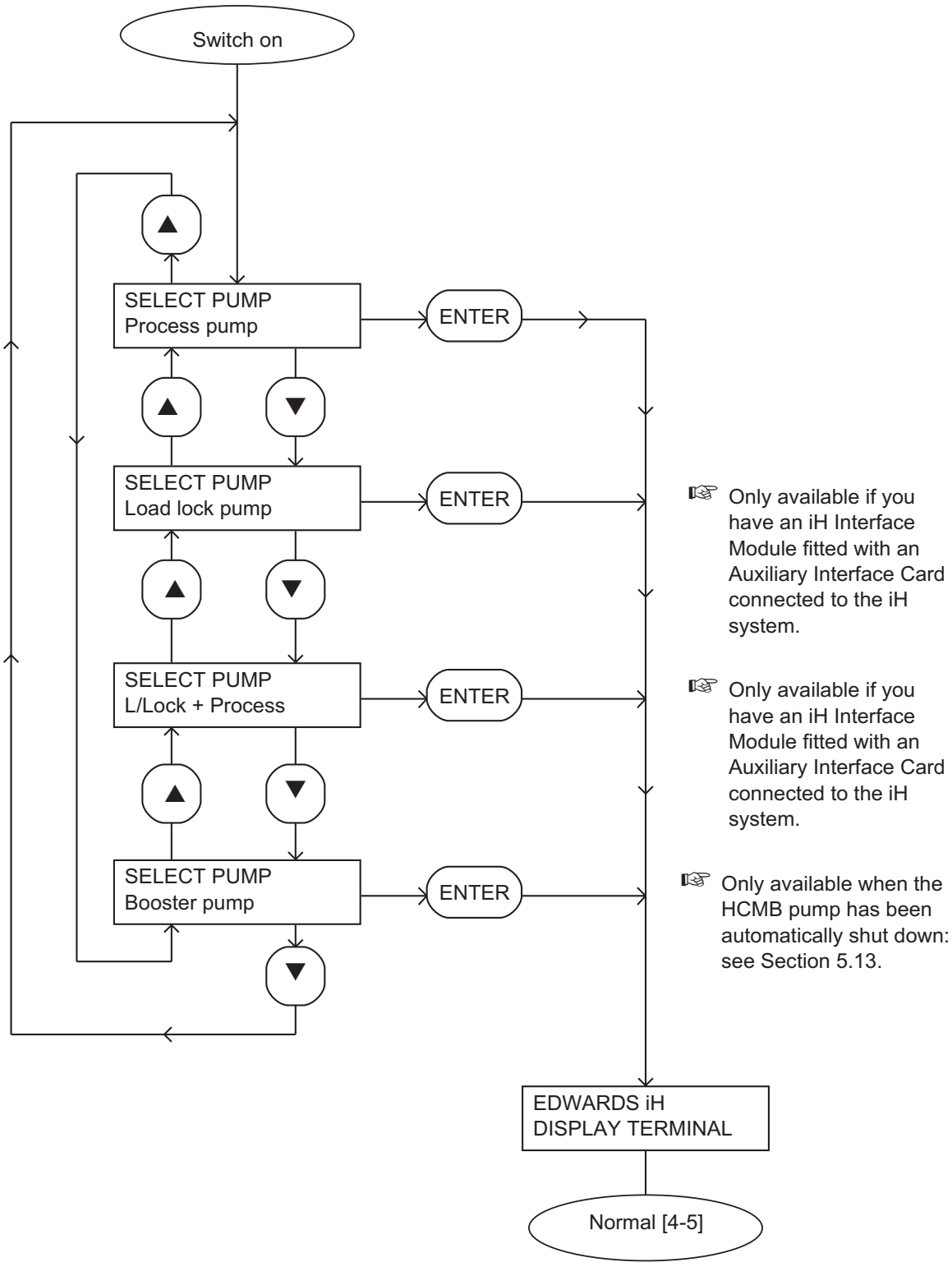


Figure 4-3 - Switch on menu

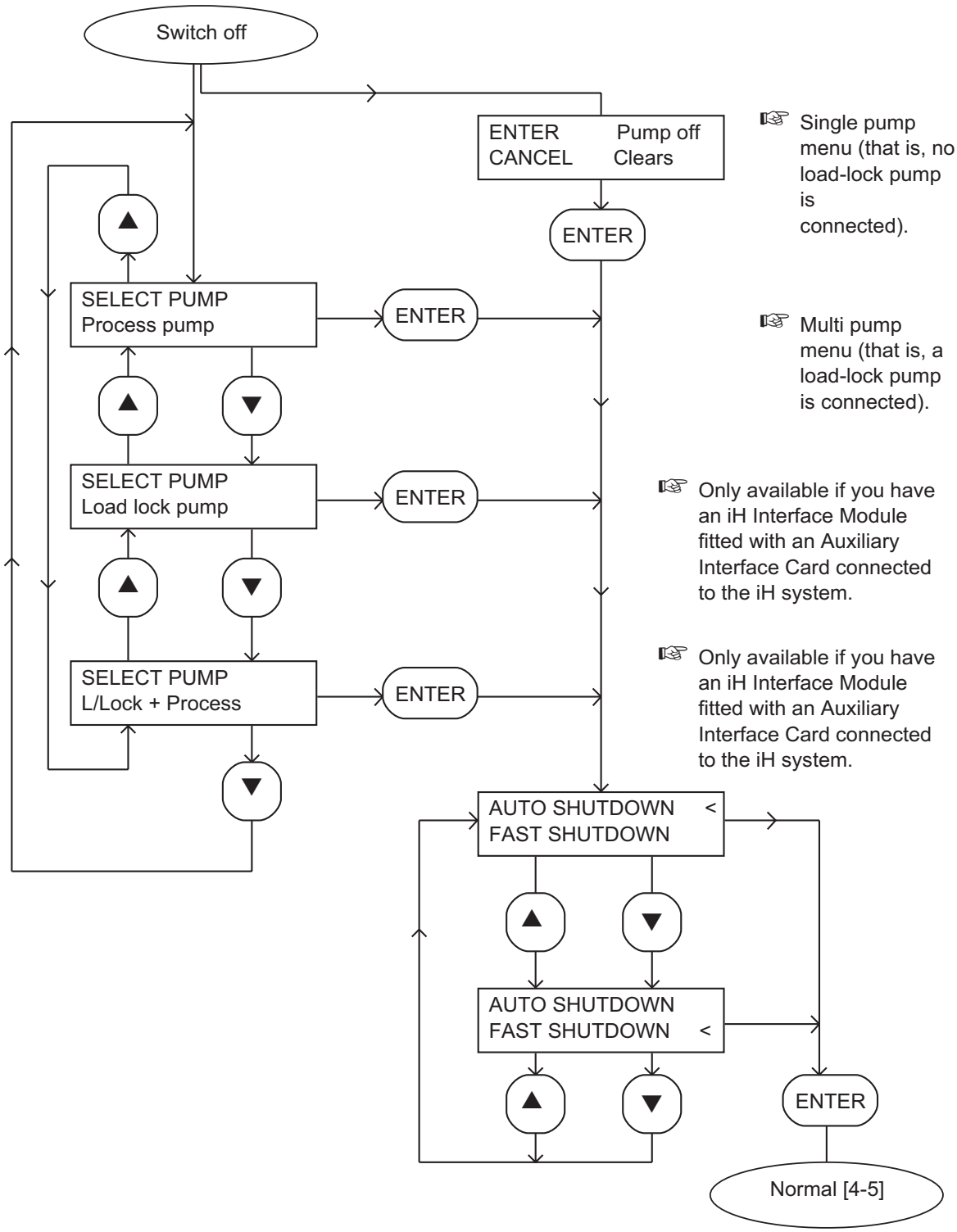
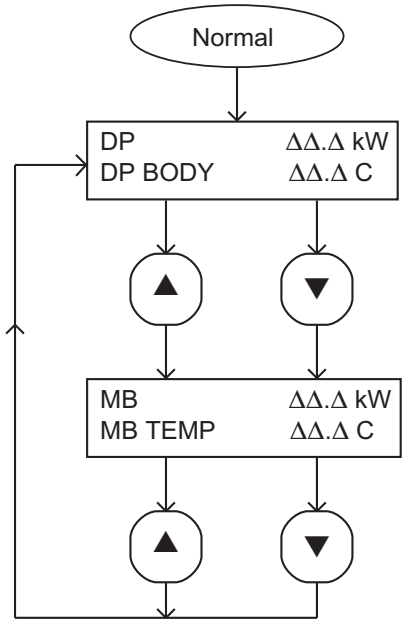


Figure 4-4 - Switch off menu



☞ First page of the normal display

☞ Second page of the normal display

☞ To change the information shown on the two pages, refer to Section 5.

Figure 4-5 - Normal menu

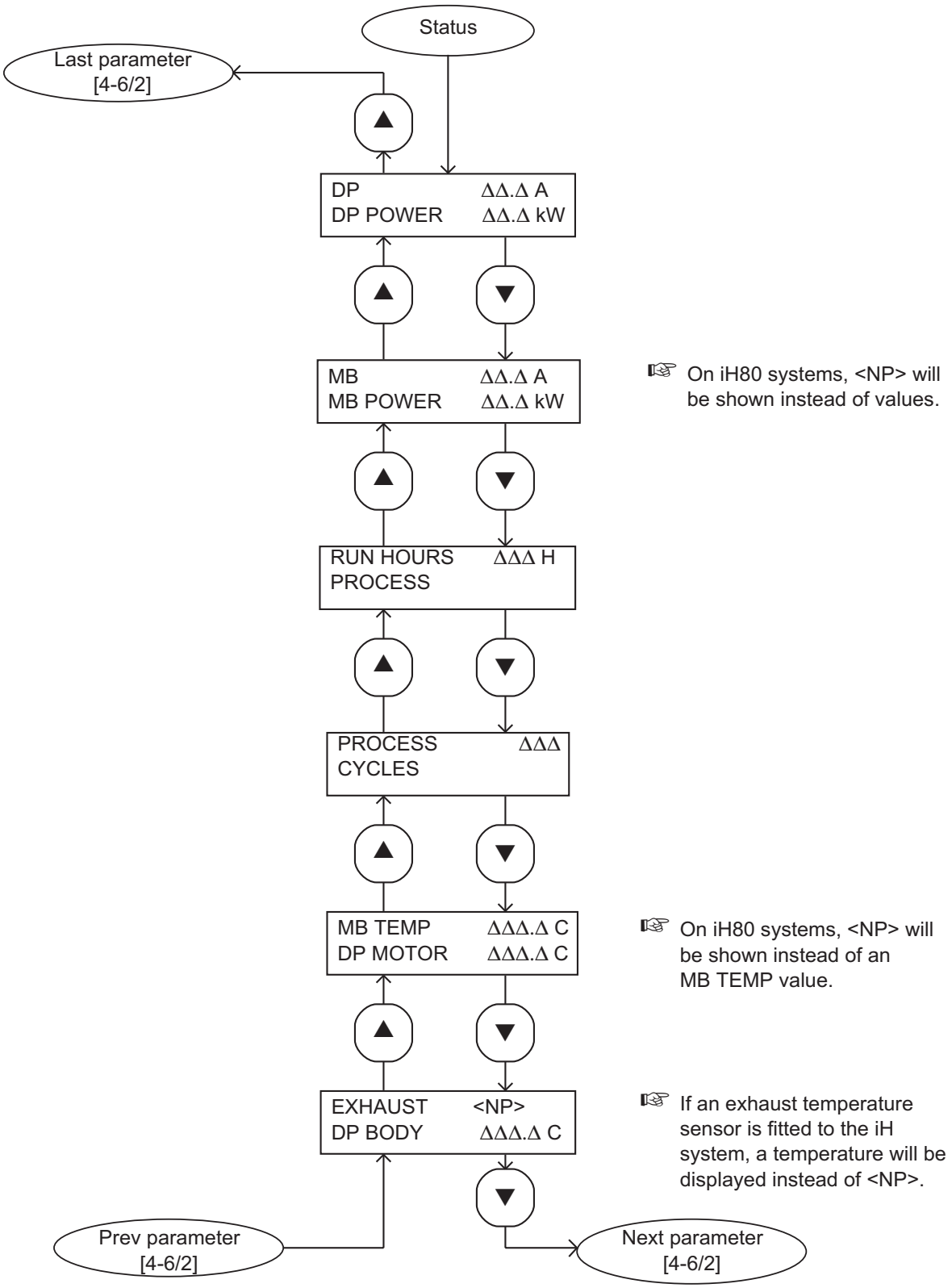


Figure 4-6 - Status menu: sheet 1 of 2

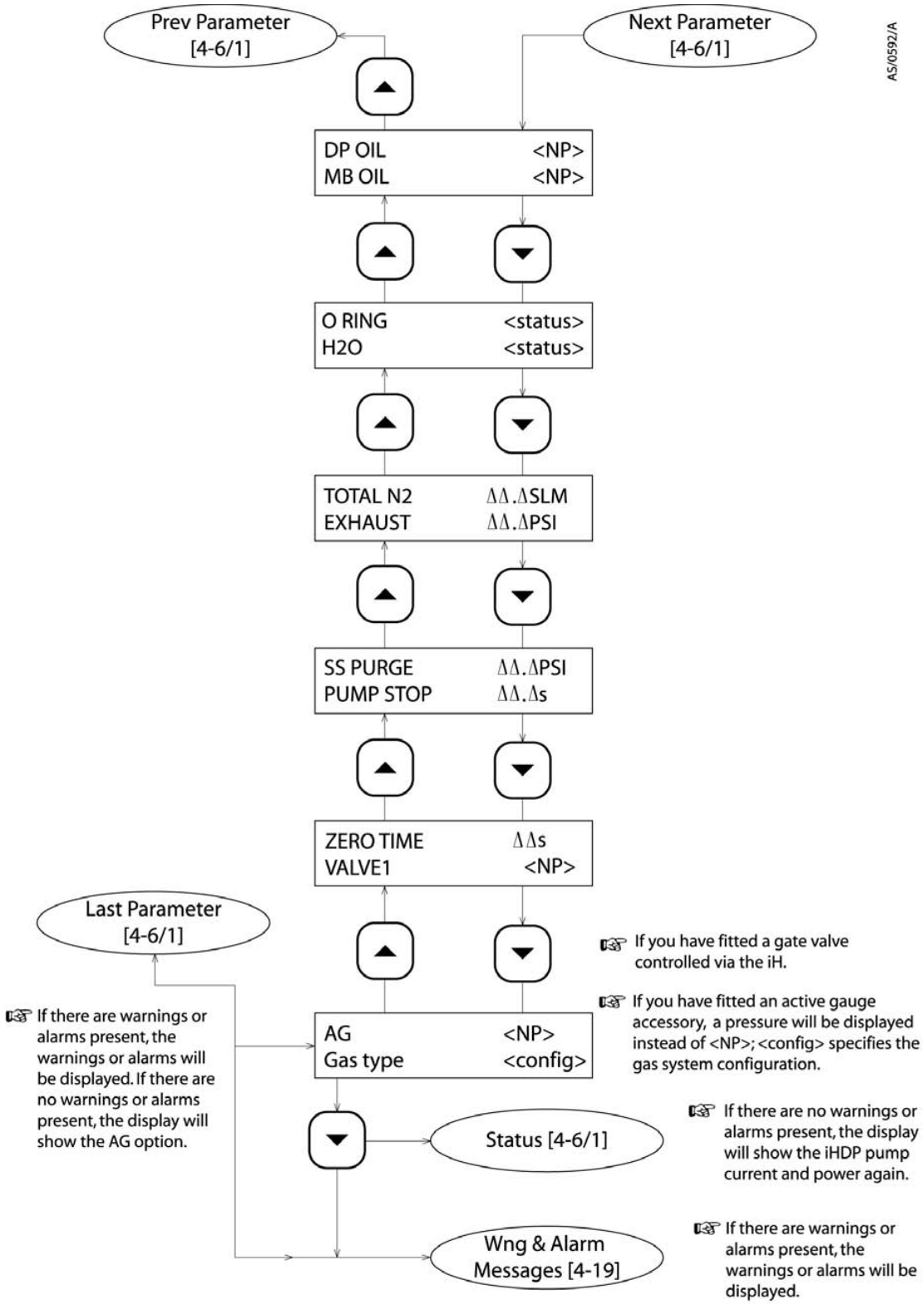


Figure 4-6 - Status menu: sheet 2 of 2

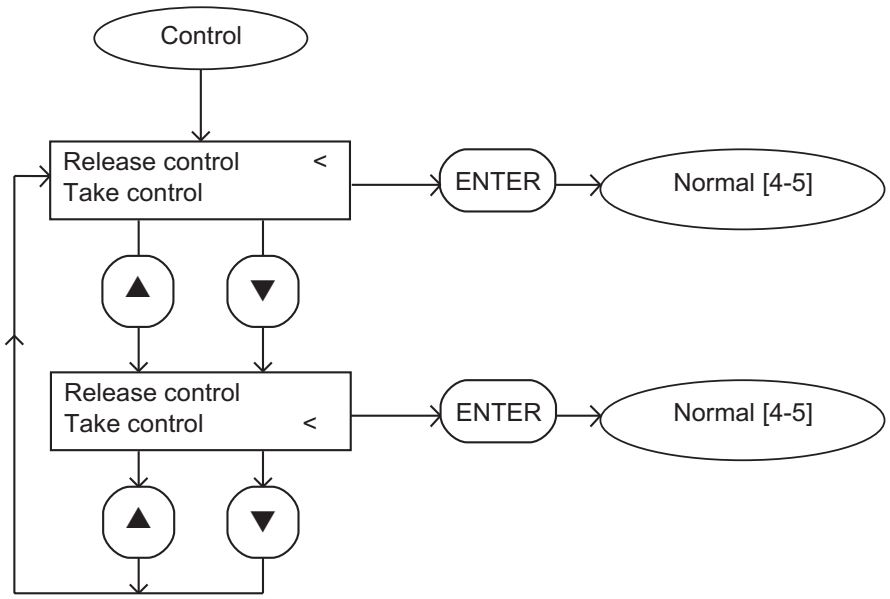


Figure 4-7 - Control menu

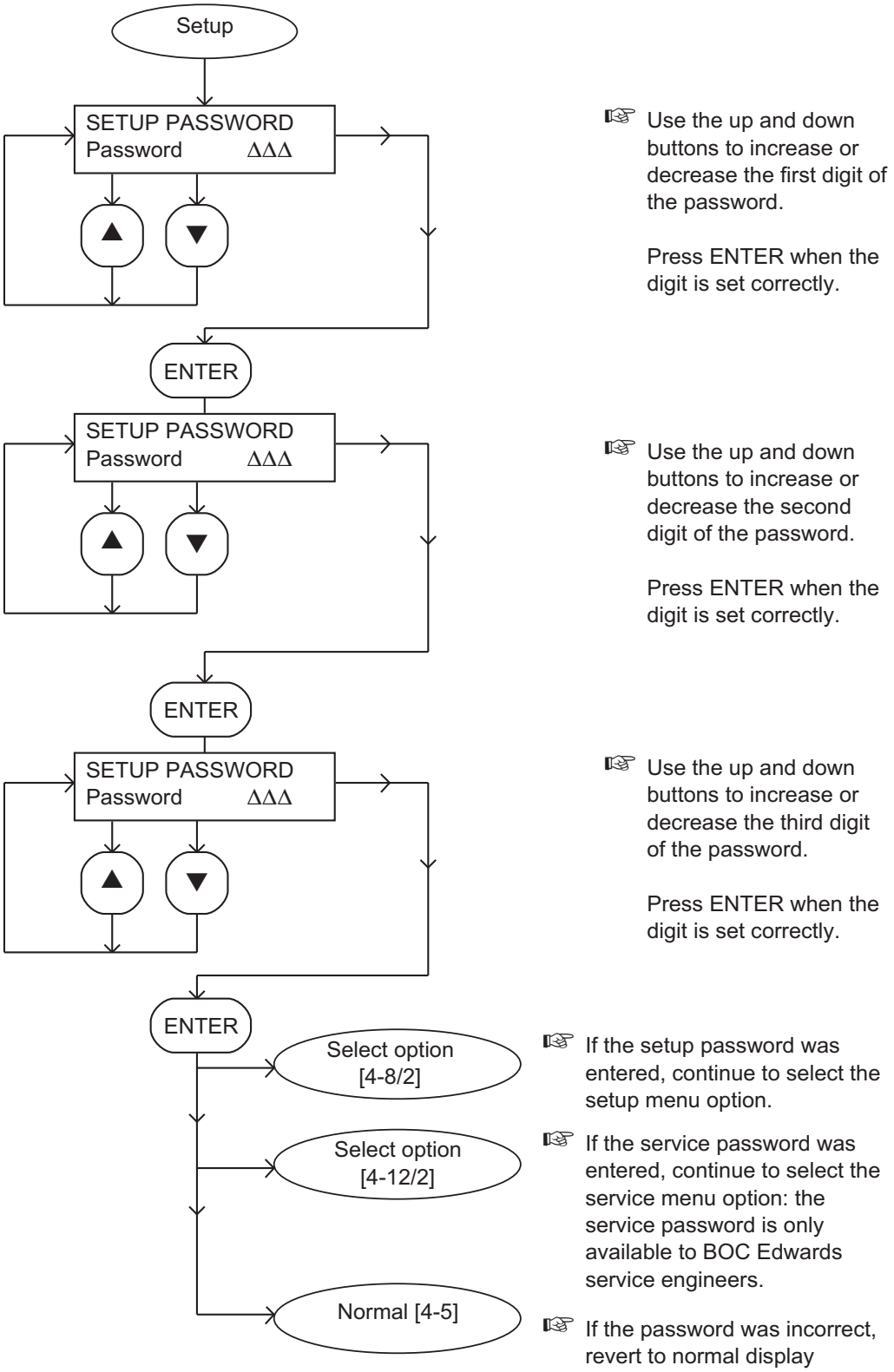


Figure 4-8 - Setup menu: sheet 1 of 3

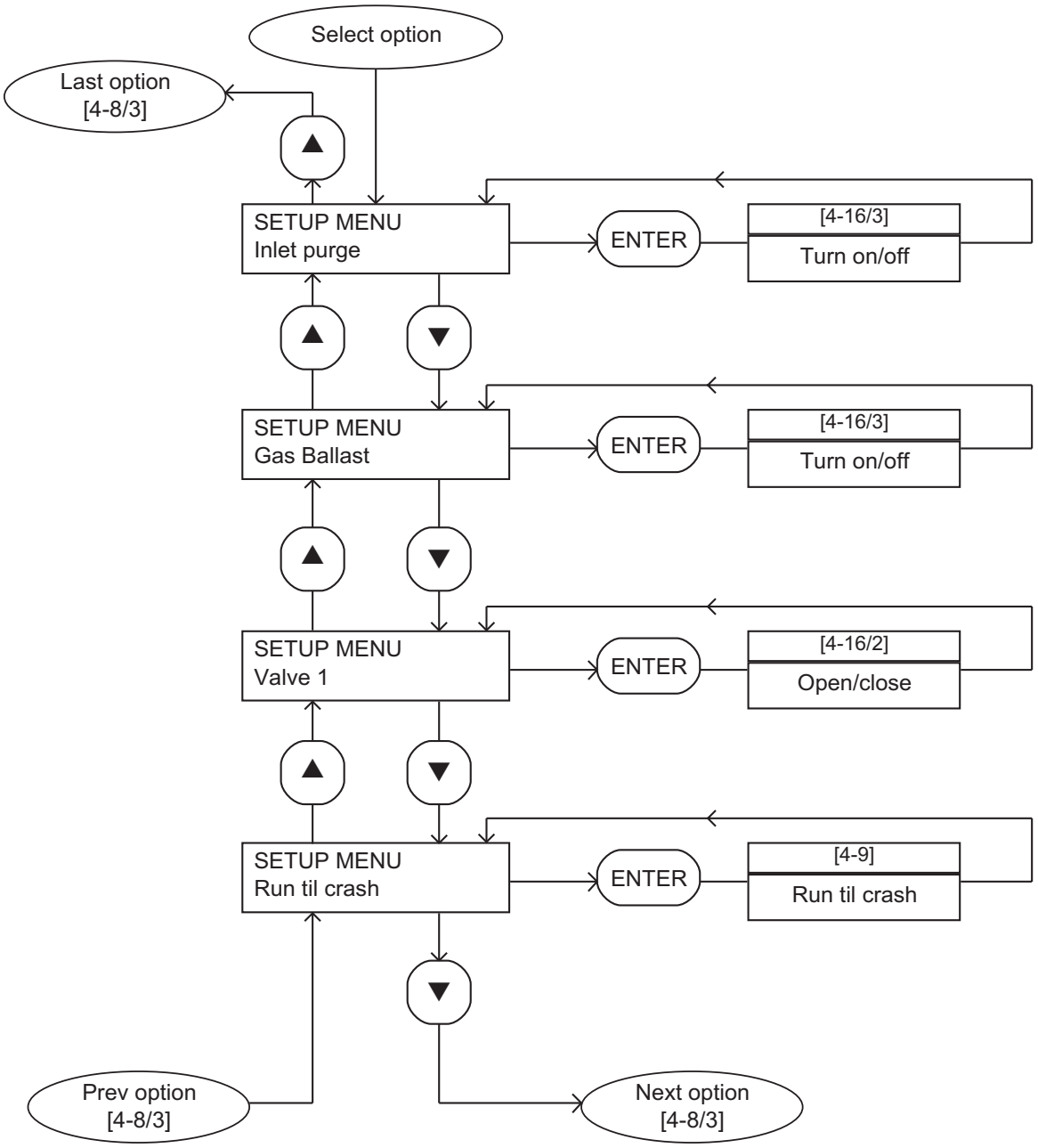


Figure 4-8 - Setup menu: sheet 2 of 3

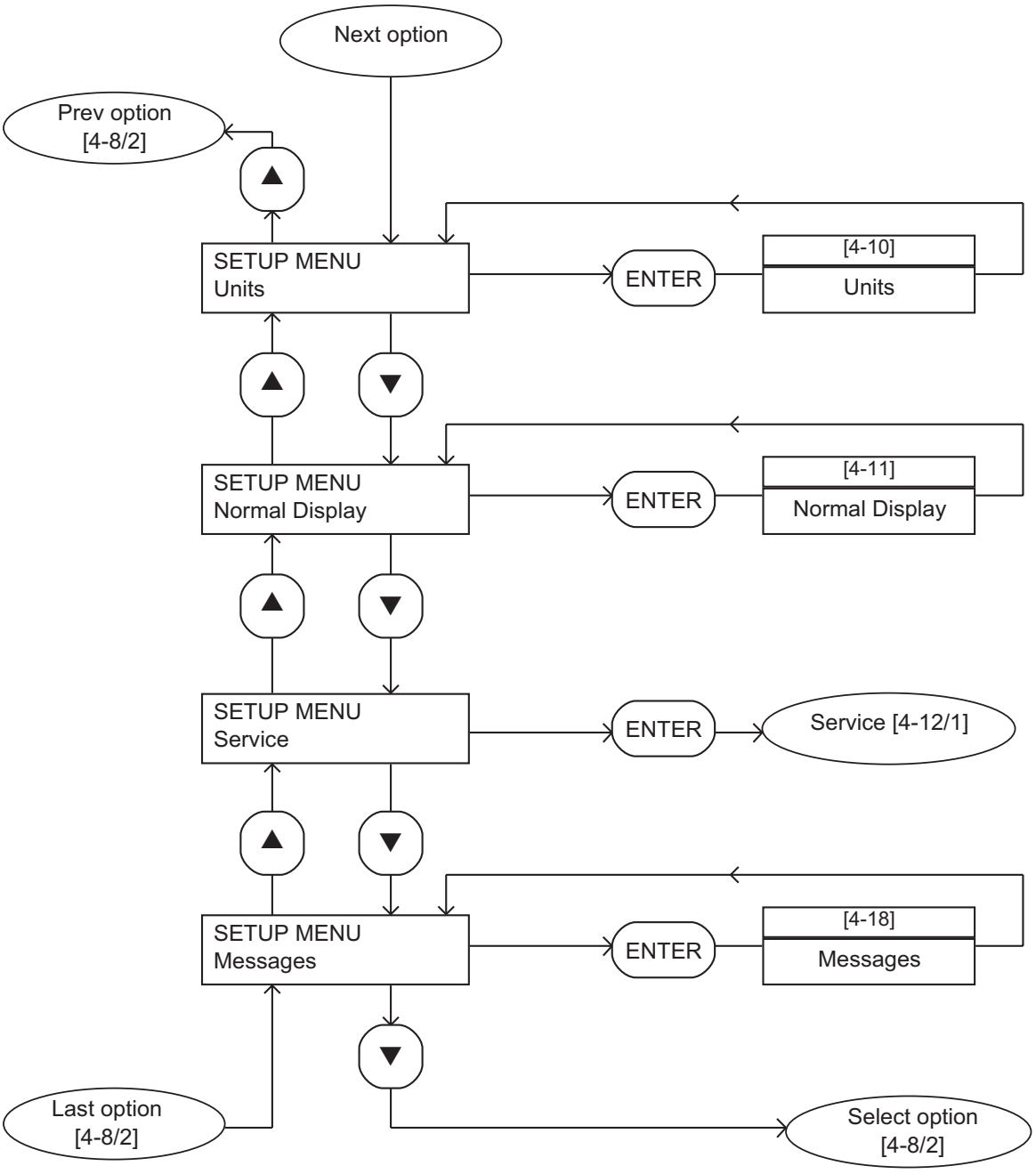


Figure 4-8 - Setup menu: sheet 3 of 3

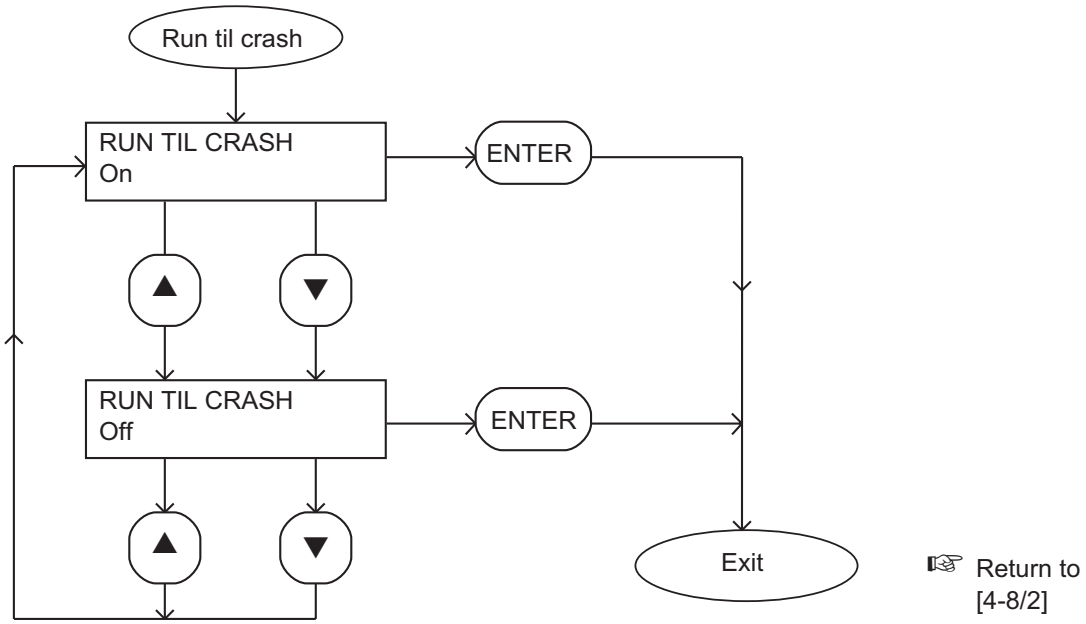


Figure 4-9 - Run til crash menu

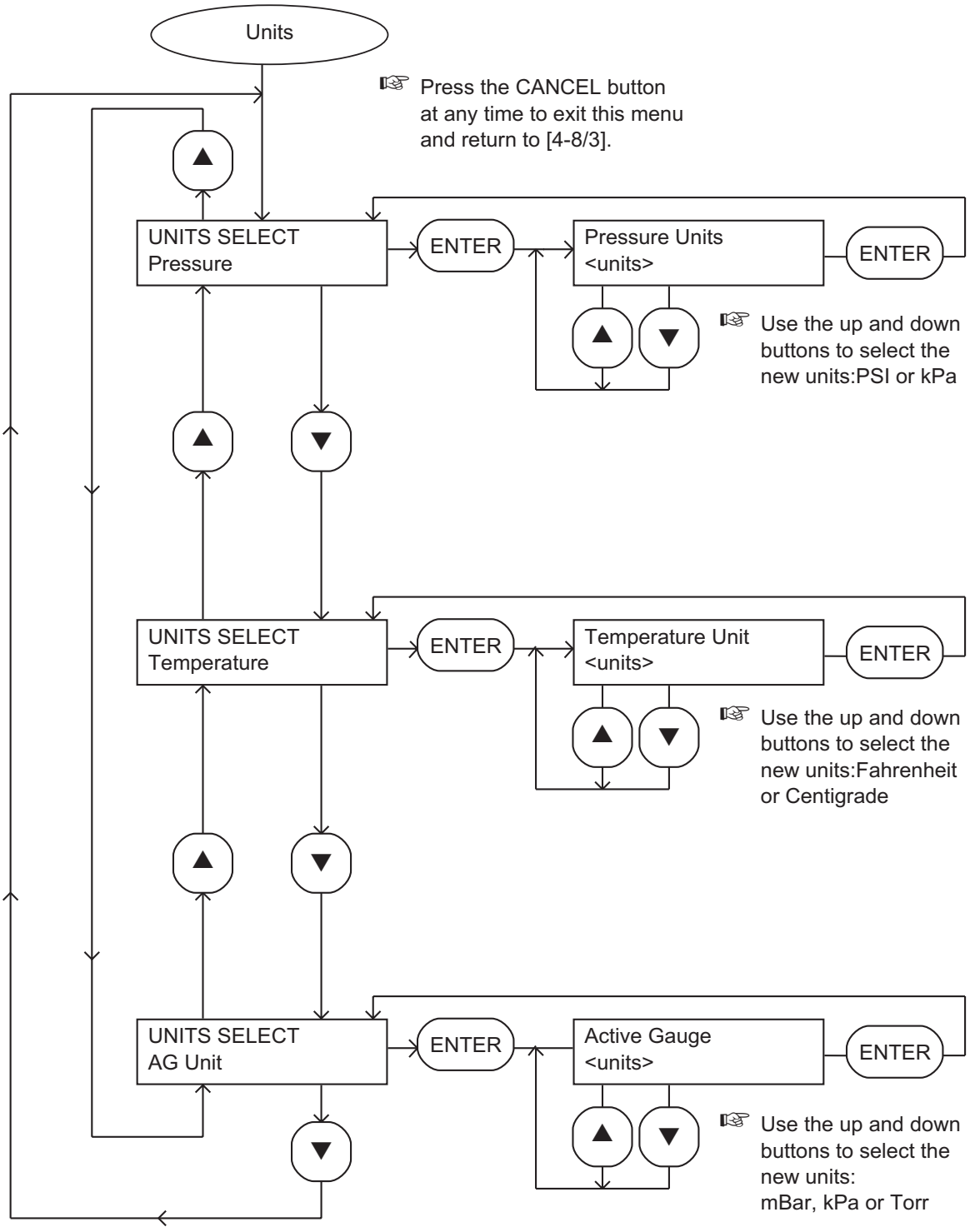


Figure 4-10 - Units menu

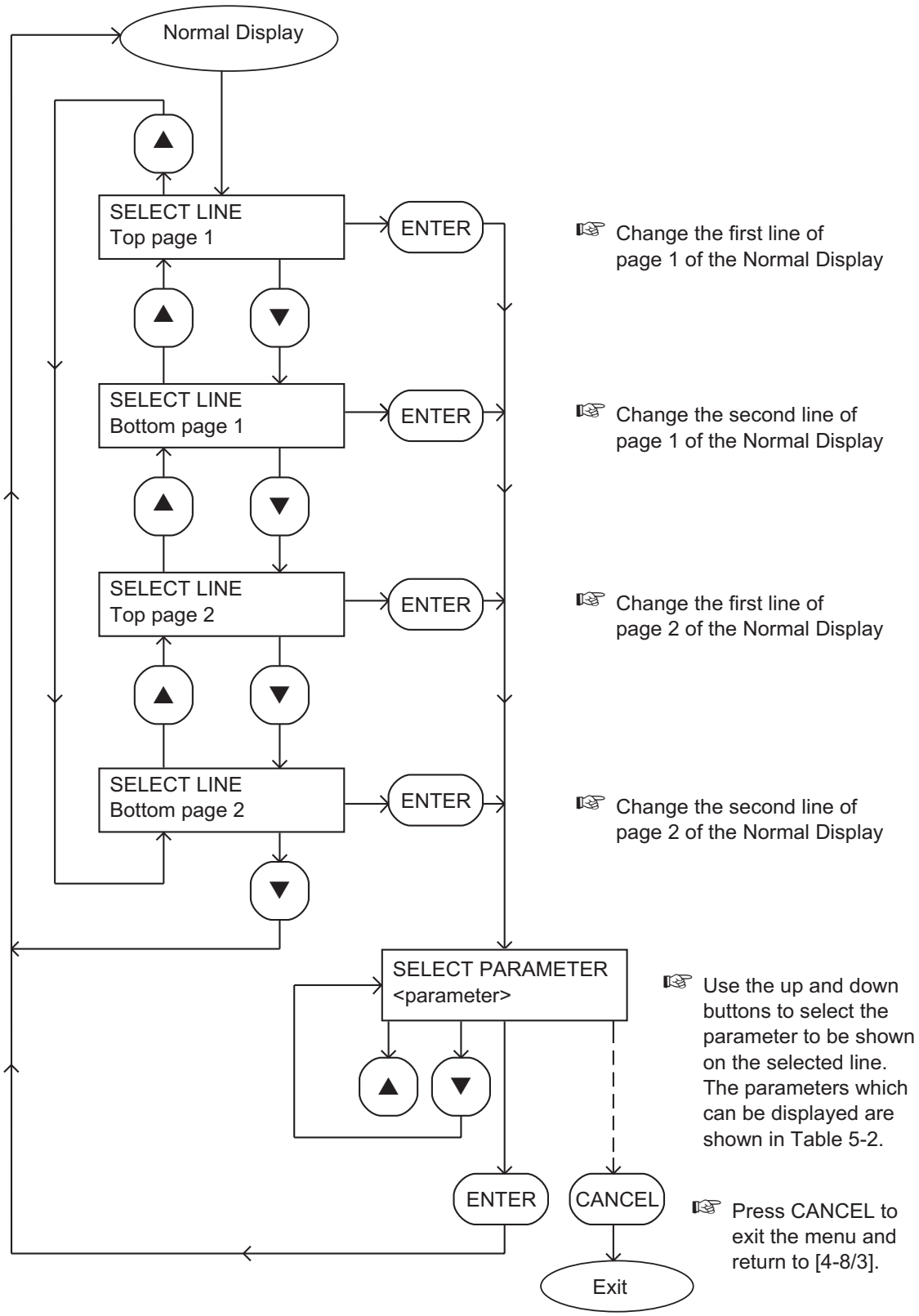


Figure 4-11 - Normal display menu

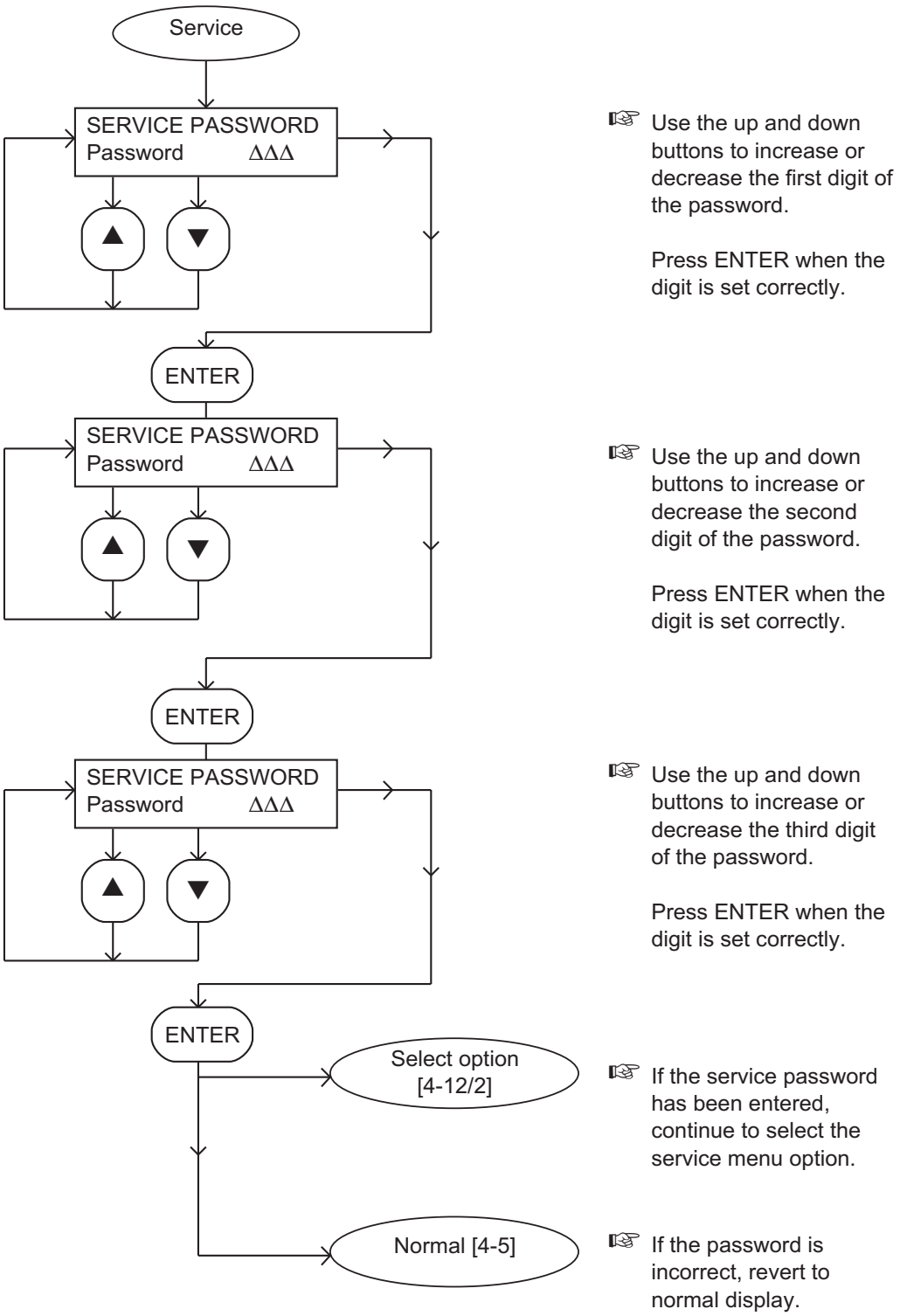


Figure 4-12 - Service menu: sheet 1 of 2

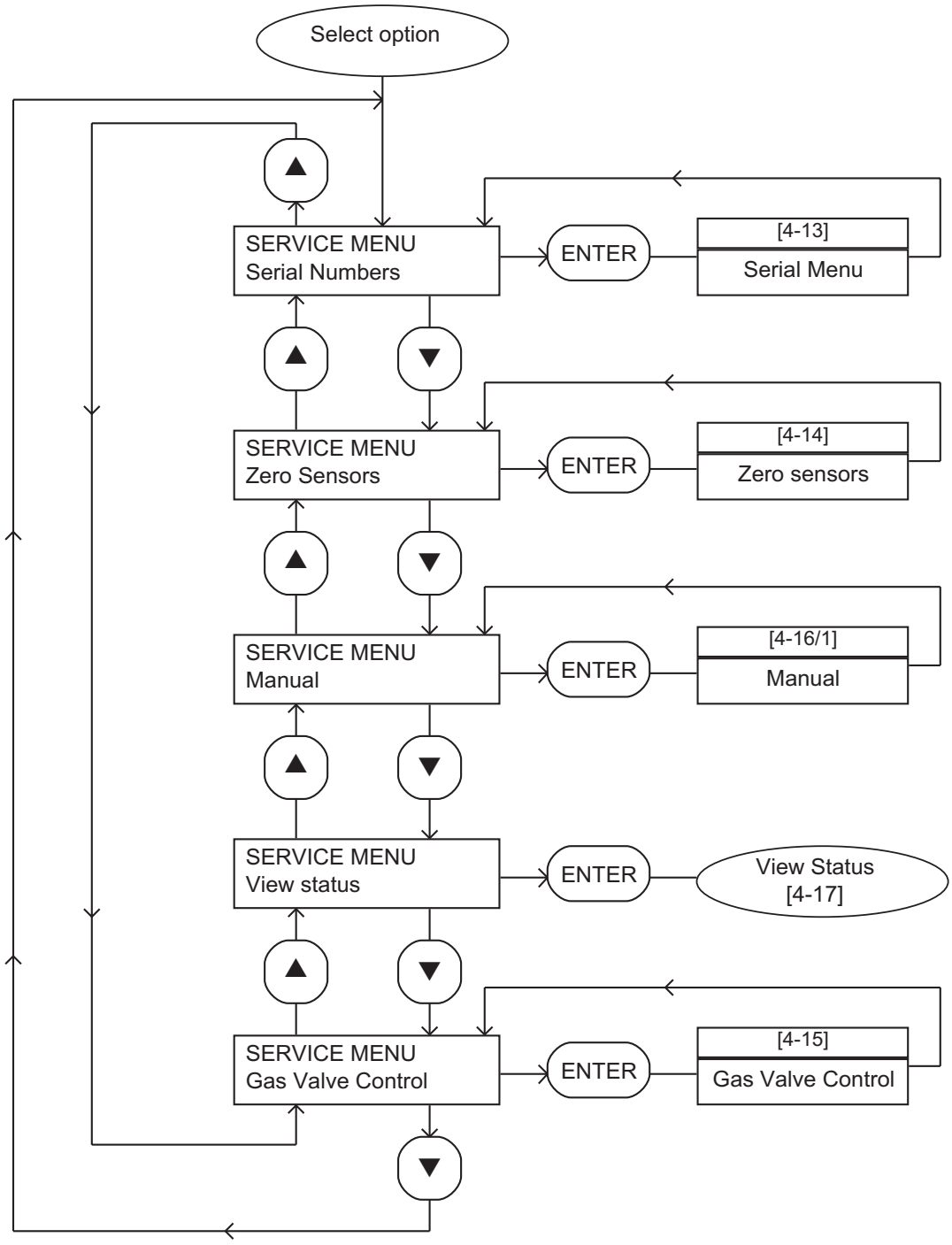


Figure 4-12 - Service menu: sheet 2 of 2

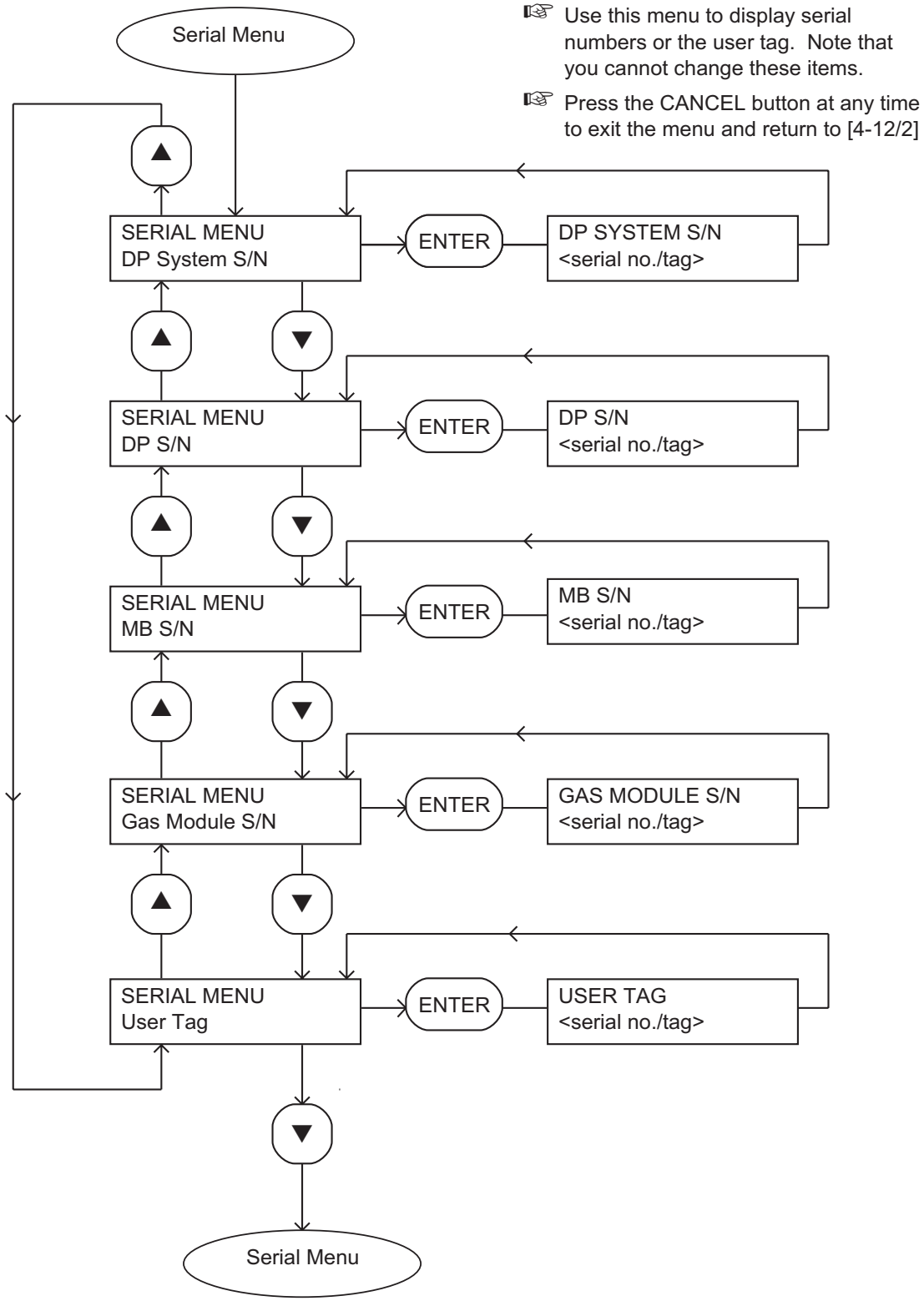
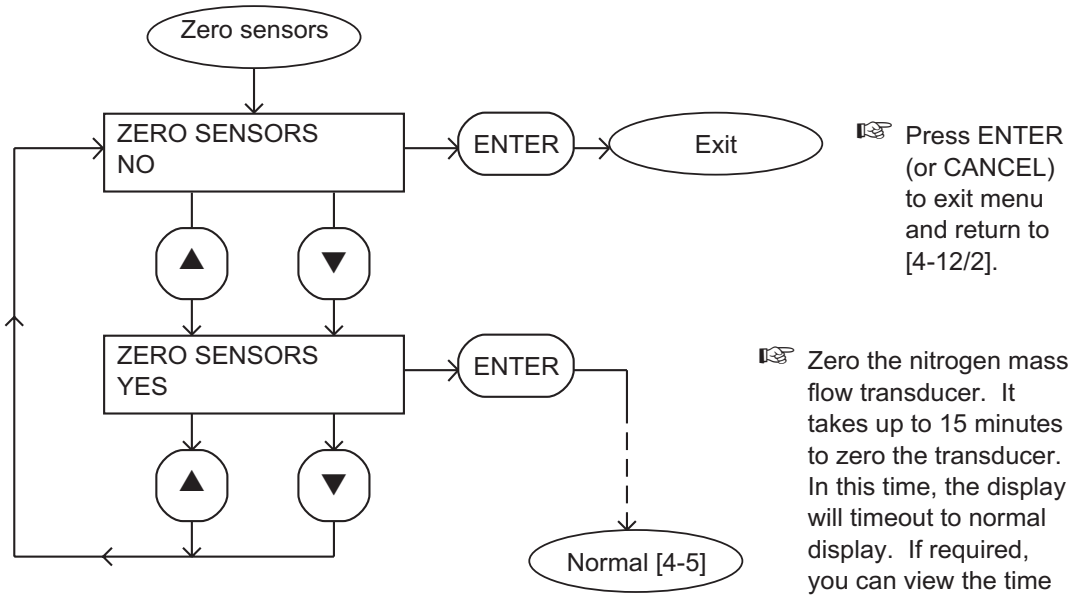


Figure 4-13 - Serial menu



☞ Press ENTER (or CANCEL) to exit menu and return to [4-12/2].

☞ Zero the nitrogen mass flow transducer. It takes up to 15 minutes to zero the transducer. In this time, the display will timeout to normal display. If required, you can view the time remaining before the sensors are zeroed: refer to Section 6.11.

Figure 4-14 - Zero sensors menu

Notes: ***You should only use this menu if you have been suitably trained by BOC Edwards Service Personnel. If necessary, contact BOC Edwards or your supplier to arrange suitable training.***

The actual values displayed depend on the build standard of your system (as identified by its serial number). Contact BOC Edwards if you are unsure what values should be displayed for your system.

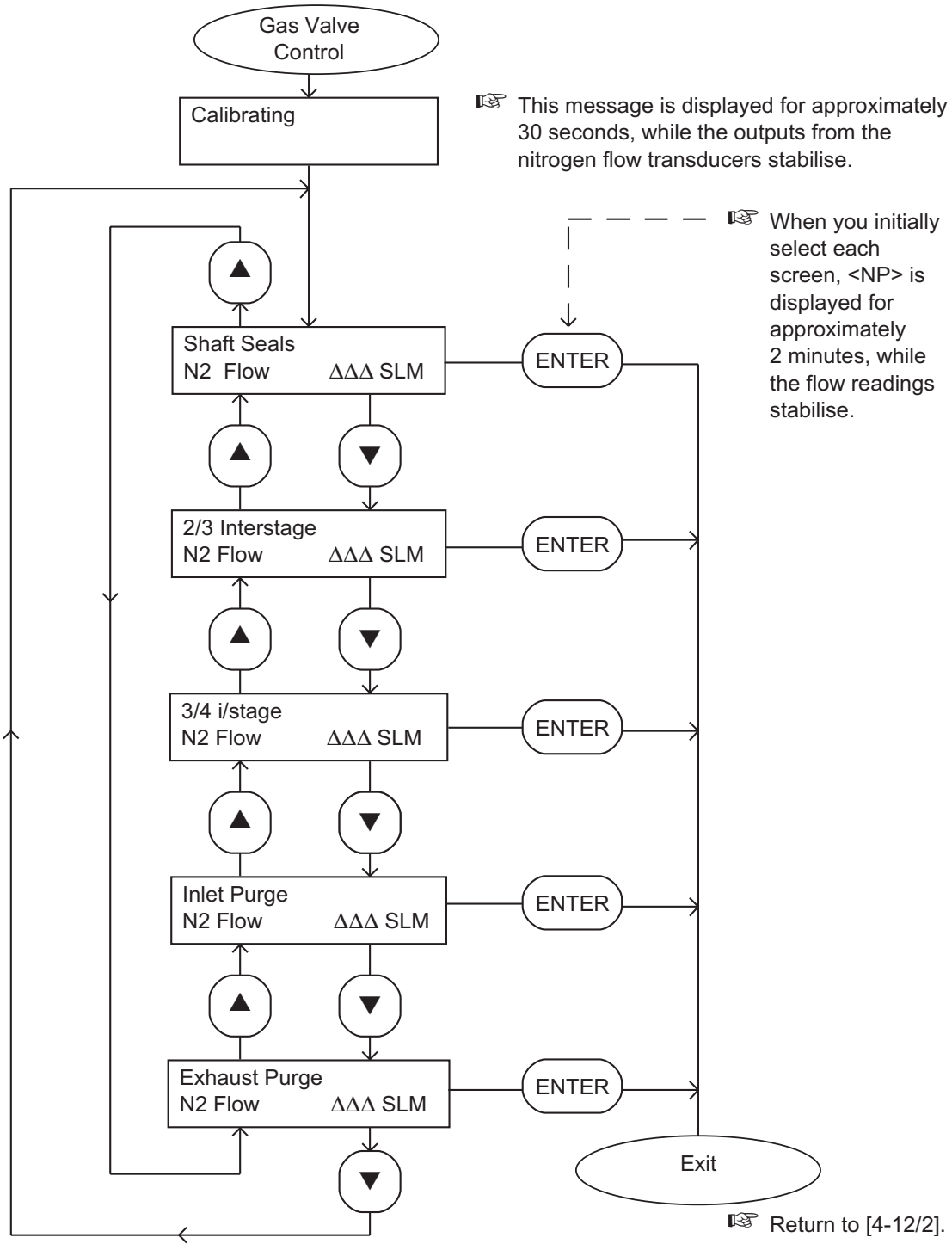


Figure 4-15 - Gas valve control menu

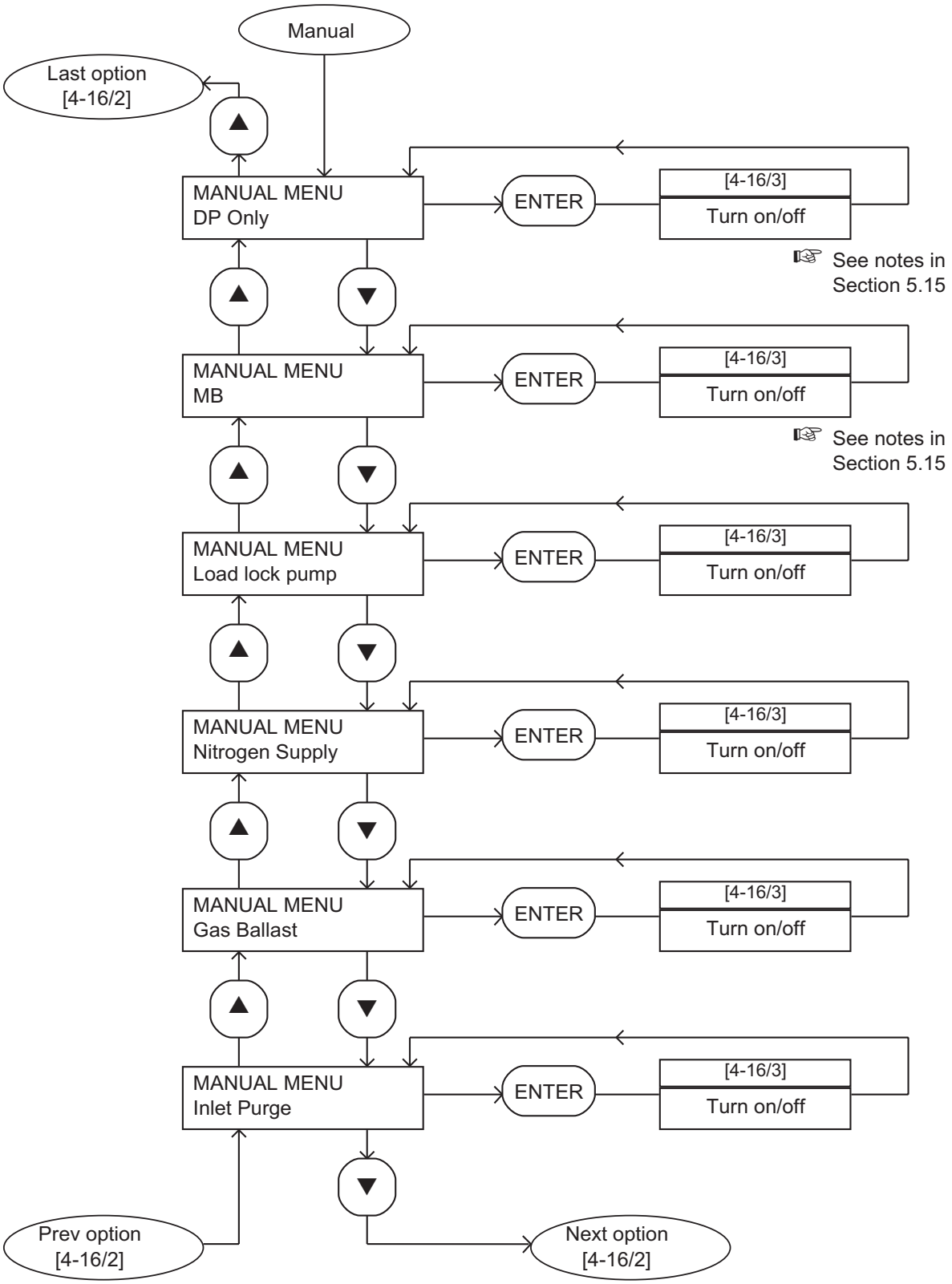


Figure 4-16 - Manual menu: sheet 1 of 3

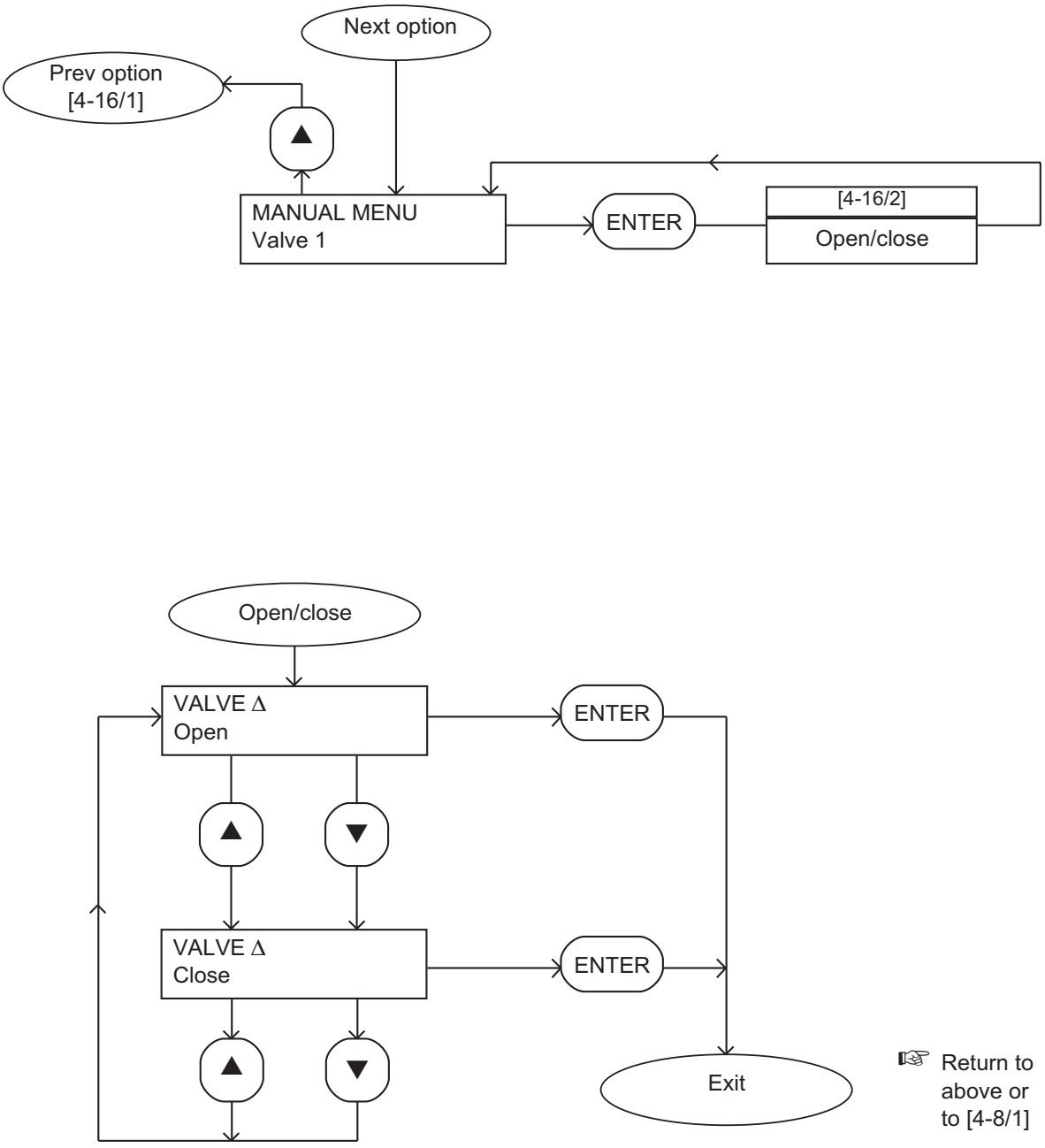


Figure 4-16 - Manual menu: sheet 2 of 3

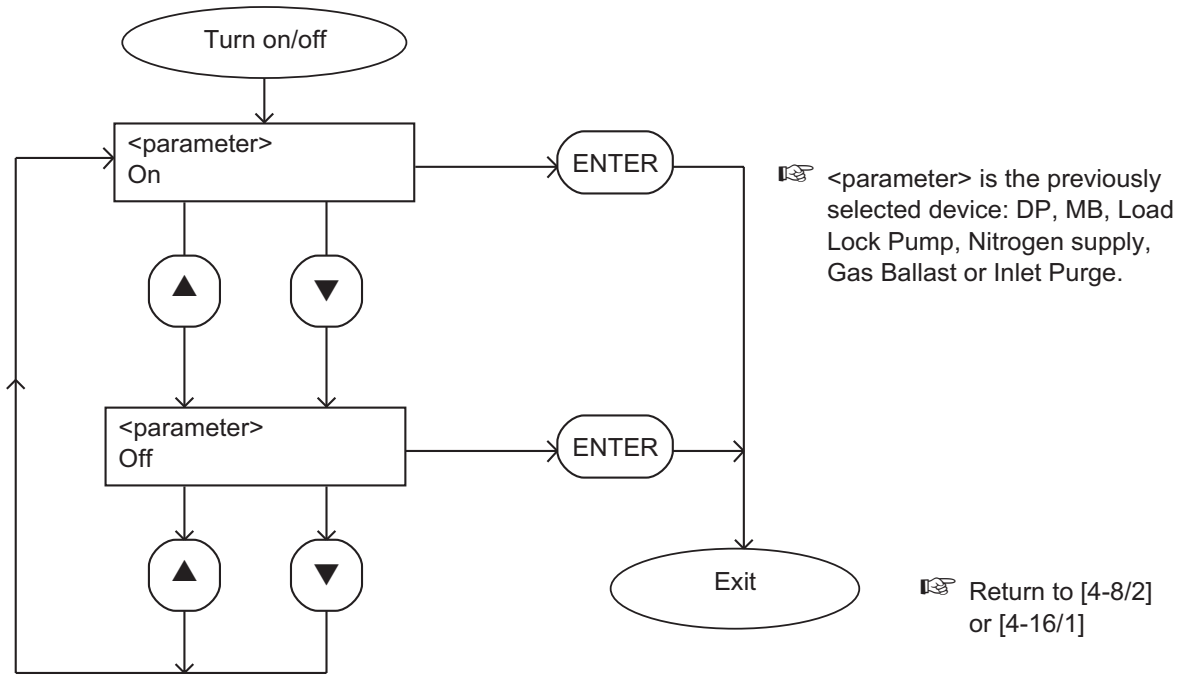


Figure 4-16 - Manual menu: sheet 3 of 3

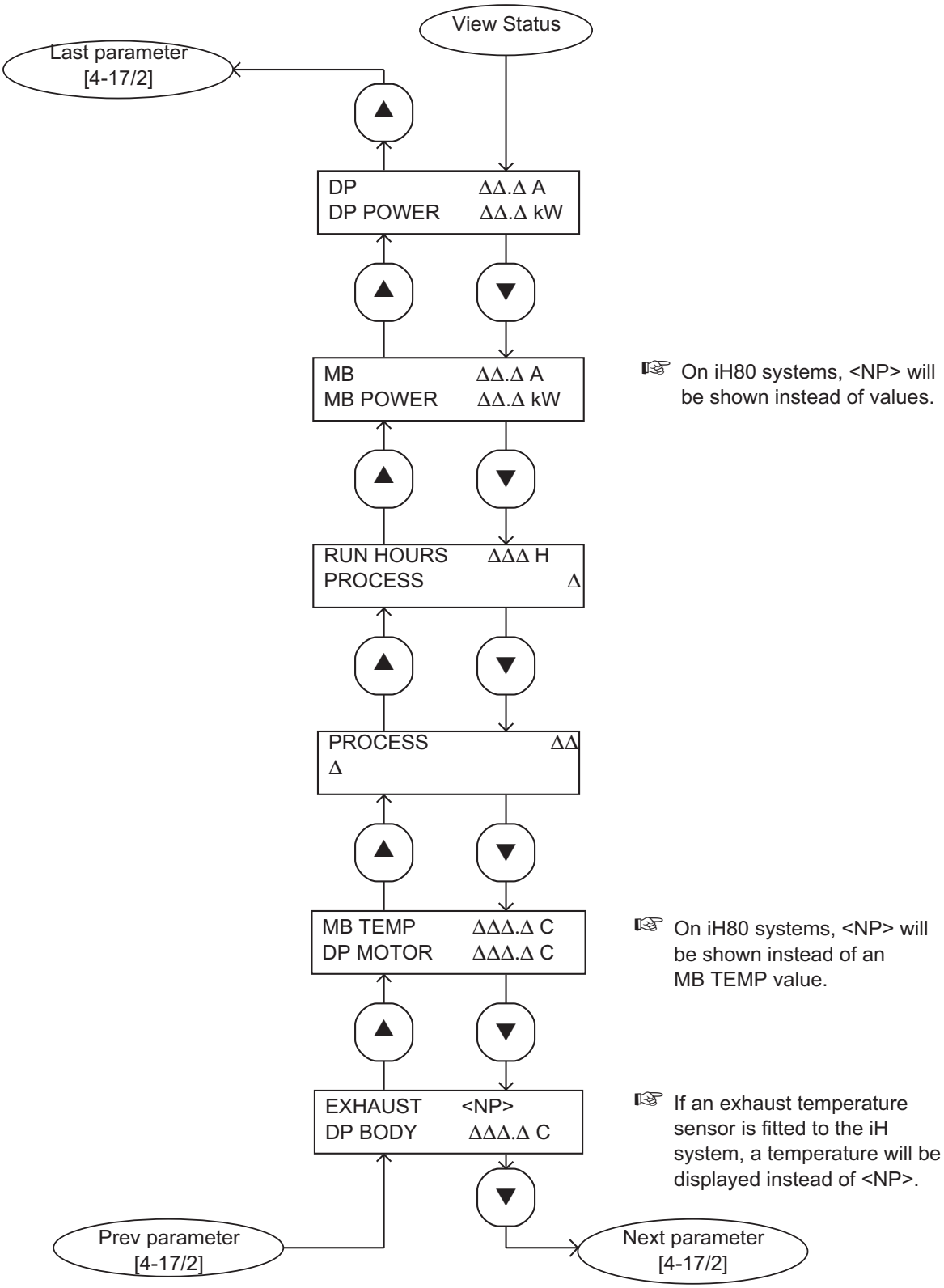


Figure 4-17 - View Status menu: sheet 1 of 2

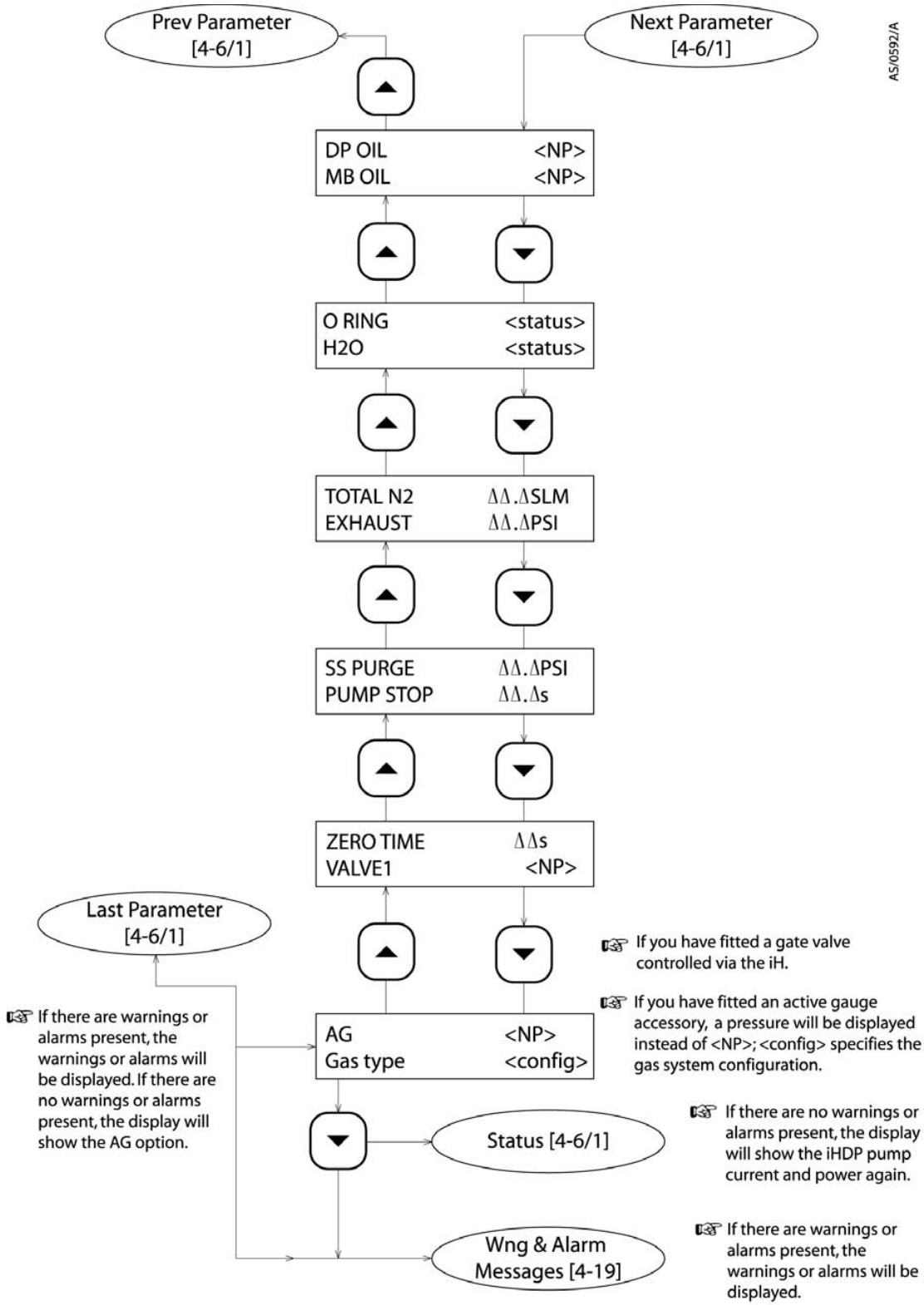


Figure 4-17 - View Status menu: sheet 2 of 2

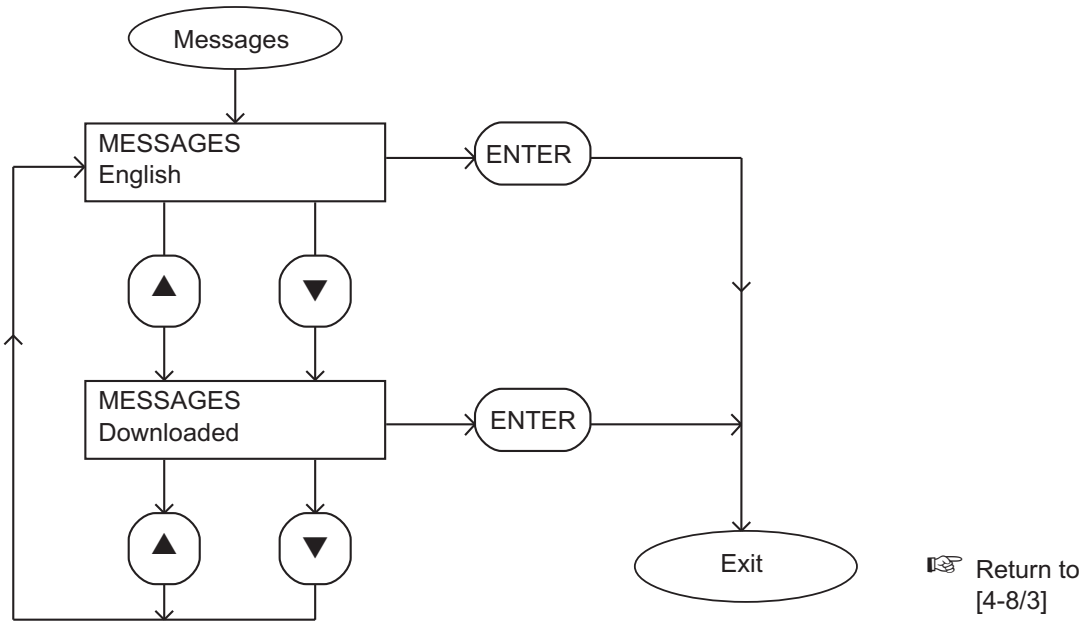


Figure 4-18 - Messages menu

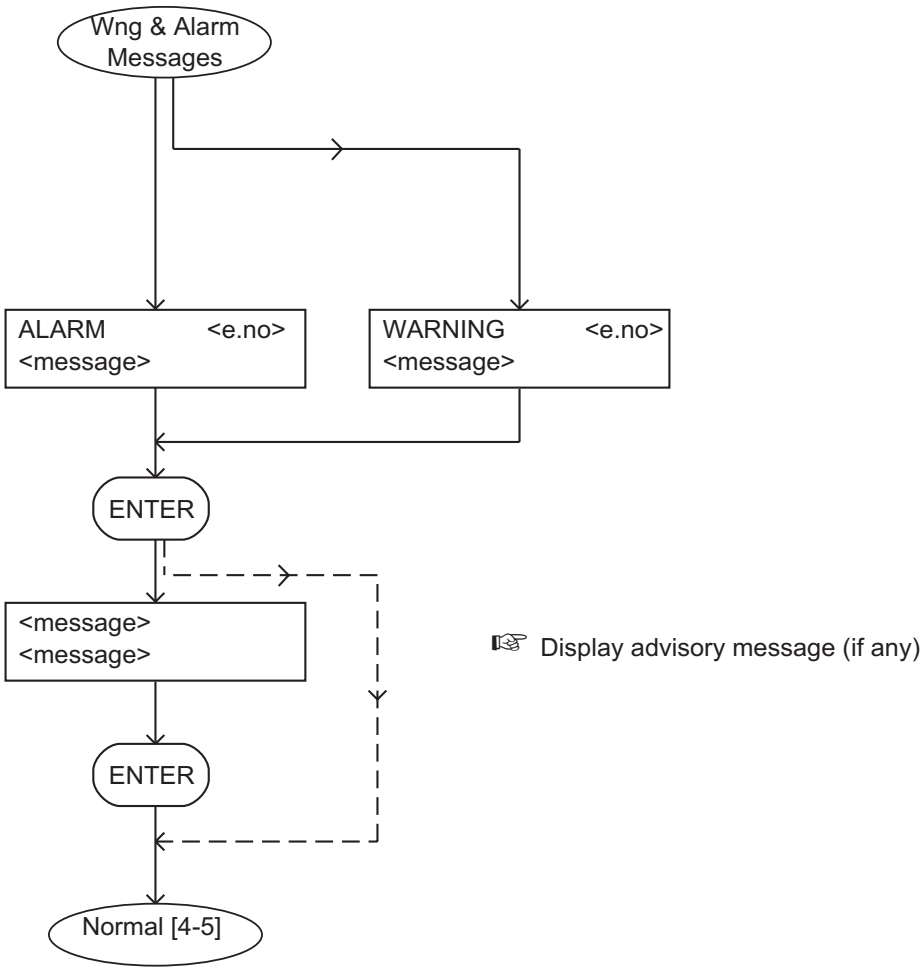


Figure 4-19 - Warning and alarm messages menu

5 OPERATION

5.1 Introduction

The following sections describe the use of the Pump Display Terminal to operate the iH system. For a description of the use of an Interface Module or Communications Module accessory to operate the iH system, refer to the instruction manual supplied with the Module. For a description of the operation of the load-lock pump (if you have connected the iH system to the load-lock pump through an Interface Module), refer to Section 5.16.

The following sections summarise the use of the menus in the Pump Display Terminal . We refer to menus such as 'the Setup/Service/Configuration menu'. Refer to Figure 1-8 or 4-1: this means that you:

- Press the Setup button (7) to select the Setup menu.
- Use the up and down buttons (5, 3) to show the Service option and press ENTER (6) to select the Service menu.
- Use the up and down buttons (5, 3) to show the Configuration option and press ENTER (6) to select the Configuration menu.

We recommend that you fully understand the use of the Pump Display Terminal menus and buttons before you operate the iH system. Refer to Section 4 which fully defines the menus, the use of the buttons and the display formats.

Note that you must switch on the electrical supply to the iH system before you can use the Pump Display Terminal.

5.2 ATEX directive implications

5.2.1 Introduction

This equipment is designed to meet the requirements of Group II Category 3 equipment in accordance with Directive 94/9/EC of the European Parliament and the Council of 23rd March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. (The ATEX Directive)

The ATEX Category 3 applies in respect of potential ignition sources internal to the equipment. An ATEX Category has not been assigned in respect of potential ignition sources on the outside of the equipment as the equipment has not been designed for use where there is an external potentially explosive atmosphere.

There is no potential source of ignition within the pump during normal operation but there may be potential sources of ignition under conditions of predicted and rare malfunction as defined in the Directive. Accordingly, although the pump is designed to pump flammable materials and mixtures, operating procedures should ensure that under all normal and reasonably predicted conditions, these materials and mixtures are not within explosive limits. Category 3 is considered appropriate for the avoidance of ignition in the case of a rare malfunction which allows flammable materials or mixtures to pass through the pump while within their explosive limits.

5.2.2 Flammable/pyrophoric materials

WARNING

You must obey the instructions and take note of the precautions given below, to ensure that pumped gases do not enter their flammable ranges.

When flammable or pyrophoric materials are present within the equipment you must:

- Not allow air to enter the equipment.
- Ensure the system is leak tight.
- Use an inert gas purge (for example, a nitrogen purge) to dilute any flammable gases or vapours entering the pump inlet, and/or use an inert gas purge to reduce the concentration of flammable gases or vapours in the pump and in the exhaust pipeline to less than one quarter of the gases' published lower explosive limits (LEL).
- Use an inert gas purge in to the pump gas ballast connection to prevent the condensation of flammable vapours within the pump mechanism and exhaust pipeline.

5.2.3 Gas purges

WARNING

If you use inert gas purges to dilute dangerous gases to a safe level, ensure that the iH pump is shut down if an inert gas supply fails.

WARNING

You must obey the instructions and take note of the precautions given below, to ensure that pumped gases do not enter their flammable ranges.

Switch on the inert gas purge to remove air from the pump and the exhaust pipeline before the process starts. Switch off the purge flow at the end of the process only after any remaining flammable gases or vapours have been purged from the pump and exhaust pipeline.

If liquids that produce flammable vapours could be present in the pump foreline, then the inert gas purge to the iH pump should be left on all the time this liquid is present. Flammable liquids could be present in the foreline as a result of condensation, or may be carried over from the process.

When you calculate the flow rate of inert gas required for dilution, consider the maximum flow rate for the flammable gases/vapours that could occur. For example, if a mass flow controller is used to supply flammable gases to the process, you should assume a flow rate for flammable gases that could arise if the mass flow controller is fully open.

Continually measure the inert gas purge flow rate: if the flow rate falls below that required, you must stop the flow of flammable gases or vapours into the pump.

Note: We recommend that you obtain and read the Vacuum Pump and Vacuum System Safety manual (publication number P300-20-000), available from BOC Edwards or your supplier.

5.3 Configure the system (optional)

CAUTION

Ensure that you use the correct configuration setpoints for your application. If you do not, the iH system may be damaged during operation.

Note: If you download a configuration set to the iH system, a BOC Edwards engineer must adjust the variable restrictors in the gas system (see Section 1.6) to suit the application. Contact your nearest BOC Edwards Service Centre to arrange this.

If you have a Single Equipment Monitor connected to the iH system, the Monitor contains three configuration sets which contain preset configuration values (for example setpoints) for the iH system, for light, medium and process duty applications. Table 5-1 shows the nominal flow rates associated with each of these configuration stores.

You can use the Single Equipment Monitor to download one of these configuration sets to the iH system. Ensure that you use the correct configuration set for your application; contact your supplier or BOC Edwards for advice before you download a configuration set.

Purge gas flow	Nominal flow rates (slm)			
	Low gas configuration store	**Medium gas configuration store**	**Medium gas + exhaust configuration store**	**High gas configuration store**
Shaft-seals purge	4	4	4	4
2/3-interstage purge	-	10	10	5
3/4-interstage purge	-			30
Exhaust-purge	-	-	5	5
Total purge	4	14	19	44

Table 5-1 - Configuration store nominal gas flows

5.4 Change the display format

5.4.1 Change the normal display

During normal operation (or whenever the Normal menu is selected), the Pump Display Terminal will show the first page of the normal display. The normal display has two pages and each page can show the readings of one or more sensors or internal clocks or counters. As supplied, the information shown on the first page is:

- HCDP pump power consumption
- HCDP pump-body temperature.

If you press the up or down button, the Pump Display Terminal will then show the second page of normal display; as supplied, the information shown on the second page is:

- HCMB pump power consumption
- HCMB pump temperature.

If required, you can use the Setup/Normal display menu to change the information shown on the two normal display pages.

5.4.2 Change the display units

If required, you can change the Pump Display Terminal display units:

- Pressures shown on the Pump Display Terminal can be displayed in either kPa or psi. Use the Setup/Units/Pressure menu to change the pressure display units.
- Temperatures shown on the Pump Display Terminal can be displayed in either ^{o}C or ^{o}F. Use the Setup/Units/Temperature menu to change the temperature display units.
- Pressures measured by an optional Active Gauge connected to the iH system, can be shown on the Pump Display Terminal in either mbar, kPa or Torr. Use the Setup/Units/AG menu to change the Active Gauge pressure display units.

5.5 Take and release control

To use the Pump Display Terminal to control the operation of the iH system, the Local control LED on the Pump Display Terminal (Figure 1-8, item 9) must be on. If the LED is not on, use the Control menu to take control. You cannot take control with the PDT if another module already has control.

If you need to use another module (for example, the iH Interface Module) to operate the iH system, the Local control LED on the Pump Display Terminal (Figure 4-1, item 9) must be off. If the LED is on, use the Control menu to release control.

If you use the Pump Display Terminal to start up the iH system and you then disconnect the Terminal from the iH for 150 seconds or more, the iH system will automatically assume that the Pump Display Terminal has released control; you will then have to use one of the following methods to shut down the iH system:

- Take control with the Pump Display Terminal again, then shut down the iH system as described in Section 5.10.
- Take control with another module and use that module to shut down the iH system.
- Use the emergency stop switch, as described in Section 5.12.

5.6 Start-up

WARNING

Do not operate the iH system with any enclosure panels removed and do not touch any parts of the pump(s) when the iH system is on. Surfaces of the pump(s) are very hot and can cause injury to people.

WARNING

Ensure that it is safe to start the iH system. If you do not (and, for example, maintenance is being performed on components downstream of the iH system), you could cause injury to people.

Notes: *When you use the Pump Display Terminal to start up the iH system, we recommend that you do not disconnect the Terminal from the iH system; if you do, you will not be able to use the Terminal to instantly shut down the iH system: see Section 5.5.*

Operation of the iH system with high inlet pressure may result in shaft-seal pressure warnings (refer to Table 6-1): the operation of the iH system will not be affected, and you can ignore these warnings.

Use the following procedure to start up the iH system:

1. Switch on the cooling-water supply, the nitrogen supply and the external electrical supply (if not already on).
2. Ensure that the exhaust-extraction system is not blocked and that valves in the exhaust-extraction system are open.
3. Ensure that the Pump Display Terminal has control of the iH system: refer to Section 5.5.
4. Refer to Figure 4-1. Look at the display (2) on the Pump Display Terminal:
   - If there are any warnings or alarms, take the necessary corrective action (refer to Section 6); do not start the iH system.
   - If there are no alarms or warnings displayed, use the Switch On menu to switch on the iH system.

When you switch on, the following actions will occur (with a small time delay between each action):

- The LED on the On button on the Pump Display Terminal will start to flash.
- The HCDP pump will be switched on.
- The LED on the On button on the Pump Display Terminal will stay permanently on.

- The solenoid-valve(s) in the Gas Module will open to switch on the nitrogen supplies to the HCDP pump.
- On iH600/iH1000 systems, after the booster start delay, the HCMB pump will be switched on.

5.7 Check the nitrogen pressure and adjust if necessary

Note: You must only check and adjust the nitrogen pressure after the iH system has been operating for at least four hours, so that the HCDP pump is at its correct operating temperature.

You **must** check and adjust the nitrogen pressure when you first use the iH system. Thereafter, we recommend that you regularly check and adjust the nitrogen pressure, to ensure optimum shaft-seals performance and to maximise the life of the shaft-seals.

When you need to adjust the nitrogen pressure:

- Turn the pressure regulator clockwise to increase the pressure.
- Turn the pressure regulator anticlockwise to decrease the pressure.

Use the following procedure to check and adjust the nitrogen pressure:

1. Use the Setup/Inlet Purge menu to turn off inlet-purge.
2. Use the Setup/Gas ballast menu to turn on gas-ballast.
3. Refer to Figure 1-7. If the pressure low LED (6) and the pressure high LED (5) are both on and the pressure warning LED (3) is off, the nitrogen pressure is correct, otherwise continue at Step 4.
4. Pull up the top of the pressure regulator (4) to unlock it.
5. Adjust the pressure regulator (4) until the pressure high and pressure low LEDs (5, 6) are both on and the pressure warning LED (3) is off. Alternatively, use the Status/SS purge menu to display the nitrogen flow, and adjust the pressure regulator (4) until a pressure of 6.0 psi is displayed.
6. Push down the top of the pressure regulator (4) to lock it.

5.8 Monitor the status of the iH system

Notes: If you have selected the Status menu and then do not press any button for five minutes, the display will change to the Normal display: refer to Section 5.4.

If a sensor is not fitted, the corresponding display line will show 'NP' (not present).

Use the Status menu or the Setup/Service/View Status menu to display sensor readings and the values of internal clocks and counters. The information that can be displayed (up to two items of information at a time) is shown in Table 5-2.

5.9 Warning and alarm indications

Notes: Refer to Section 6 for a full list of the warning and alarm messages and their meanings.

Unless you have changed the corresponding setpoints (see Section 5.3), nitrogen purge flow and pressure warning conditions will occur if an iH80 system is operated for extended periods with the inlet pressure close to atmospheric pressure.

If a warning or alarm condition exists:

- The top line of the display on the Pump Display Terminal will change to 'WARNING' or 'ALARM', together with an error number.
- The bottom line of the display will show the warning or alarm message or (for some errors) will be blank.
- The warning or alarm LED on the Pump Display Terminal will flash.

To acknowledge the warning or alarm, press the ENTER button. If the warning or alarm condition has cleared, the warning or alarm LED will go off. If the warning or alarm condition is still present:

- The warning or alarm LED will stay on.
- If the warning or alarm condition does not have an advisory message (see Section 6.17), the display will then change to normal display: see Section 5.4.
- If the warning or alarm condition has an advisory message (see Section 6.17), the display will show two lines which describe a simple check which you can make to identify the cause of the fault and to rectify the fault. When you have read the message, press the ENTER button again; the display will then change to normal display: see Section 5.4.

5.10 Manual shut-down

WARNING

If you intend to do maintenance on the iH system after you have shut it down and you will not isolate the iH system from the electrical supply, do not disconnect the Pump Display Terminal or release control from the Pump Display Terminal (see Section 5.5). If you do, the iH system could be started by another Module.

Notes: Press the Cancel button on the Pump Display Terminal to cancel a shut-down request. The purge time for the Auto shut-down option is preset to 15 minutes as supplied. This purge time can be configured for your application.

Ensure that it is safe to shut down the iH system before you select shut-down.

Use the Switch Off menu to shut down the iH system. Note that the menu has two shut-down options: Fast and Auto. We recommend that you use the Auto shut-down option. This ensures that the iH system is purged with nitrogen for 15 minutes before it is shut down.

When you select Auto shut-down, the following actions will occur (with a small time delay between each action):

- On an iH600 or iH1000 system, the HCMB pump is switched off.
- The LED on the On button on the Pump Display Terminal (Figure 1-8, item 1) starts to flash.
- If not already open, the gas solenoid-valves are opened to switch on the nitrogen purges to the iH system.
- After 15 minutes, the gas solenoid-valves are closed to switch off the nitrogen purges to the HCDP pump, and at the same time the HCDP pump is switched off.
- The LED on the On button on the Pump Display Terminal goes off.

Sensor data	Units	Notes ▼
HCDP pump current consumption	A	
HCDP pump power consumption	kW	
HCMB pump current consumption *	A	
HCMB pump power consumption *	kW	
Total running time	hours	Total run-time of the iH system.
Process running time †	hours	Total run-time on process.
Process cycles †	-	Process cycles.
iH cycles	-	The number of times the iH system has been switched on/off.
HCMB pump temperature *	°C/°F	
HCDP pump-motor water manifold surface temperature	°C/°F	
Exhaust temperature ▲	°C/°F	
HCDP pump body temperature	°C/°F	
Water flow	-	OK indicates the cooling-water flow is acceptable; CHECK indicates that the flow is too low, or that the water flow-switch is faulty or disconnected: see Section 6.
Total nitrogen flow	slm	Total nitrogen flow rate through the Gas Module.
Exhaust pressure	kPa/psi	
Shaft-seals purge pressure	kPa/psi	
Pump stop time	seconds	
Pump zero time	seconds	
Valve 1*	-	The open/closed state of the gate valve (if an iH interface controlling a gate valve is fitted).
Active gauge pressure ▲	mbar/kPa/Torr	
Gas system configuration	-	"low", "medium", "med+exh" or "high".
Warning/alarm messages #	-	Refer to Section 6 for a list of the messages.

* iH600/iH1000 only.

† These display items require signals from the process tool to indicate when the process is on and off, hence these items are only available if you have an iH Interface Module.

▲ Only available for display if the appropriate optional accessory is fitted to the iH system.

These messages cannot be manually selected to be displayed on the Normal display, but will be automatically displayed on the Normal display when a warning or alarm condition exists.

▼ NP or NR can also be displayed to identify the status of a sensor: refer to Section 4.4.

Table 5-2 - Status menu sensor reading displays

If you need to shut down the iH system quickly, use the Fast shut-down option. When you select Fast shut-down, the following actions will occur (with a small time delay between each action):

- On an iH600 or iH1000 system, the HCMB pump is switched off.
- The gas solenoid-valves are opened to switch on the nitrogen purges to the HCDP pump.
- After approximately 15 seconds (for an iH80/iH600 system) or approximately 30 seconds (for an iH1000 system), the gas solenoid-valves are closed to switch off the nitrogen purges to the HCDP pump, and at the same time the HCDP pump is switched off.
- The LED on the On button on the Pump Display Terminal (Figure 1-8, item 1) goes off.

5.11 Automatic shut-down

CAUTION

If you select 'Run til crash', the pump(s) can be damaged and you may invalidate any warranties on the iH system equipment

Notes: The emergency stop button, the emergency stop signal from your control equipment (if fitted) and the safety sensors (see Section 1.12.3) will still shut down the iH system, even if you have selected 'Run til crash'.

Use the Setup/Run Til Crash menu to select 'run til crash'.

'Run til crash' is automatically reset to 'off' when the iH system is disconnected from the electrical supply, or the electrical supply is switched off.

Normally, if an alarm condition exists, the iH control system will shut-down the iH system. If required, you can request 'run til crash' operation. In this mode of operation, most alarm conditions will be ignored and the pump(s) will continue to operate. Note however that for safety reasons the following alarms will shut down the iH system even if you have selected 'run til crash':

- HCDP CURRENT HIGH/LOW (error numbers 310 and 312).
- HCDP THERMISTOR HIGH (error number 512).
- EXHAUST PRESSURE (error number 3912).

On an iH600 or iH1000 system, the following alarms will cause only the HCMB pump to shut down, provided 'run til crash' is not selected:

- HCMB POWER HIGH/LOW (error numbers 810 and 812).
- HCMB PHASE IMBALANCE (error number 1012).

On an iH600 or iH1000 system, the following alarms will cause only the HCMB pump to shut down, whether 'run til crash' is selected or not:

- HCMB CURRENT HIGH/LOW * (error numbers 710 and 712).
- HCMB THERMISTOR HIGH (error number 912).
- - (error number 701) †.

5.12 Emergency stop

Notes: The emergency stop switch is not an electrical isolator, unless the disconnect box accessory is fitted (See Section 5.17).
The use of emergency stop will not automatically shut down the load lock pump (if fitted); you must shut down the load lock pump separately.

To shut down the iH system in an emergency, press the emergency stop switch (Figure 1-7, item 1) on the dashboard. Alternatively, you can operate the emergency stop controls in your own control system if you have connected your emergency stop circuit to the iH system as described in Section 3.15.

When emergency stop is selected:

- The HCDP pump (and the HCMB pump, on iH600 and iH1000 systems) is switched off.
- The solenoid-valve(s) in the Gas Module close, to switch off the supply of nitrogen to the HCDP pump.
- The Pump Display Terminal will display 'STOP ACTIVATED'.
- The LED on the On button on the Pump Display Terminal (Figure 1-8, item 1) will go off.

5.13 Restart the HCMB pump after automatic pump shut-down (iH600/iH1000 only)

WARNING

If a pump is automatically shut down, ensure that it is safe to restart before you restart the pump

If the HCMB pump has been automatically shut down due to an alarm (see Section 5.11), use the Switch On/Booster Pump menu to restart the HCMB pump after the alarm condition has cleared.

5.14 Restart the iH system after emergency stop or automatic shut-down

Note: If the iH system has automatically shut down because of high HCDP pump power (alarms 412 and 512), check that the HCDP pump is free to rotate before you restart the iH system: refer to Section 6.17.

If you have used the emergency stop switch on the dashboard to shut down the iH system, you must reset the emergency stop switch before you can restart the iH system. Turn the emergency stop switch to reset it, then restart the iH system as described in Section 5.6. Note that the 'STOP ACTIVATED' alarm message (see Table 6-2) will stay on the Pump Display Terminal until you restart the pumping system. See Section 5.17 for details of starting the system if the disconnect box is fitted.

If the iH system has been automatically shut down because of an alarm condition, the alarm condition must be rectified before you can restart the iH system. For example, if the iH system has been shut down because the HCDP pump-body is too hot, the pump-body must be allowed to cool before you can restart the iH system. Restart the iH system as described in Section 5.6.

5.15 Operation of iH system components

WARNING

Ensure that it is safe to start the iH system. If you do not (and, for example, maintenance is being performed on components downstream of the iH system), you could cause injury to people.

CAUTION

On an iH600 system, do not operate the HCMB pump unless the HCDP pump is on and has been operating for longer than the booster start delay. If you do, you may damage the iH system.

CAUTION

Ensure that you do not over-pressurise the vacuum system if you switch on purge gas flow when the pumps are not on.

Notes: *The gate valve must be connected to the iH system through an iH Interface Module with an Auxiliary Interface Card.*

When you manually start the HCDP pump or (on an iH600 or iH1000 system) the HCMB pump, the pump will only operate for 10 seconds and will then automatically be switched off again.

Although you can select and use the Setup/Service/Manual/MB menu, this will have no effect on the HCMB pump; that is, you cannot use the menu to manually switch the HCMB pump on and off.

In normal operating conditions, the components of the iH system are operated automatically.

If necessary (for example, for fault finding purposes), you can control the operation of iH system components separately:

- Use the Setup/Service/Manual/Gas Module menu to control the operation of the Gas Module (that is, turn the nitrogen supply, gas-ballast and inlet-purge flows on and off).
- Use the Setup/Service/Manual/Valve menu to control the operation of the gate valve (that is open or close the valve).
- Use the Setup/Service/Manual/DP Only menu to control the operation of the HCDP pump (that is, switch the HCDP pump on and off).

5.16 Operation of the load-lock pump

Note: Operation of the iH system with high inlet pressure may result in shaft-seal pressure warnings (refer to Table 6-1): the operation of the iH system will not be affected, and you can ignore these warnings.

If you have connected a load-lock pump to the iH system through an Interface Module, you can use the following menus to control the operation of the load-lock pump:

- Switch On.
- Switch Off.
- Setup/Service/Manual/Load lock pump.

5.17 Disconnect box and photohelic switch/gauge (accessories)

Operation of the pumping system with the disconnect box and photohelic switch/gauge is described in the following sections. If the photohelic switch/gauge is not installed, all references to it should be ignored.

The following sections assume that the disconnect box and photohelic switch/gauge (if fitted) have been correctly installed and that the pump and accessories have been installed with reference to their own instruction manuals.

5.17.1 Normal startup

- Ensure that the door is closed and secured before operating the disconnect box.
- Press the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.
- Control and monitoring of the system is now enabled through the Pump Display Terminal.

5.17.2 Restart after fault

WARNING

The disconnect box will remain live even with the door open. Do not attempt any servicing in the box before you have isolated the incoming electrical supply

Press the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.

5.17.3 Shutdown

The system can be shutdown in four ways through the disconnect box: local EMO; remote EMO; photohelic gauge in warning state, or; brownout condition over 3 seconds. The following sections describe each of the shutdown methods.

5.17.4 Local EMO

Press the EMO push button on the control panel to shut the system down. It will be necessary to reset the push button by twisting until it releases, prior to system restart. The system power can be enabled by pressing the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.

5.17.5 Remote EMO

The system can be shutdown by a remote EMO signal generated from the pump through the 6-way XLR connector. The system power can be enabled by pressing the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.

5.17.6 Photohelic gauge

The system can be shut down if the photohelic gauge registers a warning condition. The system power can be enabled by pressing the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.

5.17.7 Brownout

The system can be shut down if a brownout occurs for greater than 3 seconds. For brownouts of less then 3 seconds, the system will continue running normally (time delay relay TDR1). The system power can be enabled by pressing the DRY PUMP POWER ON/RESET push button on the disconnect box control panel.

6 MAINTENANCE

6.1 Safety

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

WARNING

Hazardous chemicals are located within the pumps and piping. Use of suitable protective gloves and clothing along with a respirator is recommended if contact with substances is anticipated.

- A suitably trained and supervised technician must maintain the iH system.
- Ensure that the maintenance technician is familiar with the safety procedures which relate to the products pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components. Dismantle and clean contaminated components inside a fume-cupboard.
- Fit a suitable blanking plate on the iH system inlet and your vacuum system as soon as you disconnect the iH system from your vacuum system. Do not operate the iH system unless the inlet blanking plate is fitted or the iH system is connected to your vacuum system.
- Fit a suitable blanking plate on the iH system exhaust and your exhaust-extraction system as soon as you disconnect the iH system from your exhaust-extraction system. Do not operate the iH system unless the exhaust is connected to your exhaust-extraction system.
- Allow the pumps to cool to a safe temperature before you fit lifting bolts or start maintenance work.
- Vent and purge the iH system with nitrogen before you start any maintenance work.
- Isolate the iH system and other components in the process system from the electrical supply so that they can not be operated accidentally. Note that the emergency stop switch on the iH system is **not** an electrical isolator, unless a Disconnect Box accessory is installed.
- On an iH1000 system:
  - Wait for at least four minutes after you have switched off the electrical supply before you touch any electrical component on the iH system.
  - Never operate the iH system (even for test purposes) unless a second protective earth (ground) is fitted: refer to Section 3.16.3.

- Recheck the pump rotation direction if the electrical supply has been disconnected.
- 'O' ring replacement intervals vary depending on your application - your local BOCE office can provide assistance.
- Do not reuse 'O' rings.
- Dispose of components, grease and oil safely (see Section 7.2).
- Take care to protect sealing-faces from damage.
- Do not touch or inhale the thermal breakdown products of fluorinated materials which may be present if the iH system has been overheated to 260 ^{o}C and above. These breakdown products are very dangerous. Fluorinated materials in the iH system may include oils, greases and seals. The iH system may have overheated if it was misused, if it malfunctioned or if it was in a fire. BOC Edwards Material Safety Data Sheets for fluorinated materials used in the pump are available on request: contact your supplier or BOC Edwards. (See Section 1.1 for contact numbers)
- Leak-test the system after maintenance work is complete if you have connected or disconnected any vacuum or exhaust joints; seal any leaks found.
- Wipe up any water or oil spilt during maintenance to avoid possible risk of slips.
- Route and secure cables, hoses and pipe-work during maintenance to avoid possible risk of trips.

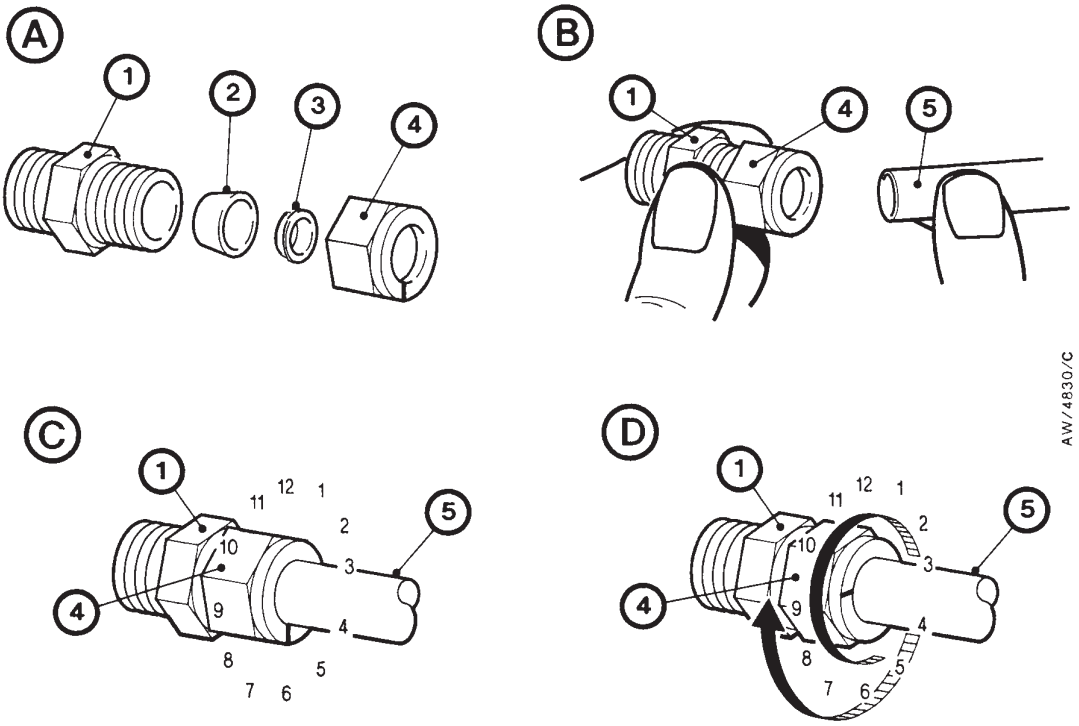
6.2 Correct use of tube fittings

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

You must know how to correctly fit and tighten tube fittings in order to prevent gas leaks; use the procedures in the following sections.

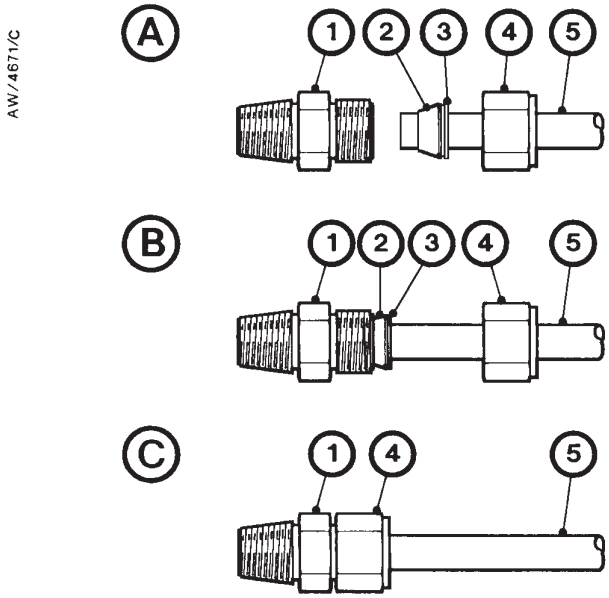
6.2.1 Fit a tube fitting

1. Refer to Figure 6-1 detail A. Undo and remove the nut (4) from the tube fitting (1). Ensure that the front (tapered) ferrule (2) and the rear ferrule (3) are correctly orientated as shown in detail A, then loosely refit the nut (4) to the tube fitting (1).
2. Refer to detail B. Insert the tube (5) through the nut (4) and into the tube fitting (1). Ensure that the tube rests firmly on the shoulder inside the fitting, and that the nut (4) is finger tight.
3. Tighten the nut (4) until you cannot rotate the tube (5). If you cannot turn the tube because of how it is installed, tighten the nut by $^{1}/_{8}$th of a turn.
4. Refer to detail C. Mark the nut (4) at the six o'clock position.
5. Refer to detail D. Hold the body of the connector steady, then turn the nut (4) by $1^{1}/_{4}$ turns (to the nine o'clock position) to fully tighten the connection.



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

Figure 6-1 - Fit a tube fitting



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

Figure 6-2 - Retighten a tube fitting

6.2.2 Reconnect a tube fitting

You can disconnect and reconnect a tube fitting many times and still obtain a correct leak-proof seal. Refer to Figure 6-2 detail A which shows a tube fitting after you have disconnected it. Use the following procedure to reconnect it:

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

6.3 Maintenance frequency

The iH system requires little user maintenance. The maintenance operations you can carry out are described in the following sections. The frequency of maintenance operations depends on your process. Adjust the frequency of maintenance operations according to your experience.

When you maintain the iH system, use BOC Edwards maintenance and service kits. These contain all of the necessary seals and other components necessary to complete maintenance operations successfully.

6.4 Inspect the connections, pipelines, cables and fittings

Note: Refer to Section 6.2 if you have to connect, disconnect or tighten Tube fittings.

1. Remove the enclosure side and top panels: refer to Section 3.4.
2. Check that all the cooling-water connections are secure; tighten any loose connections. Inspect all cooling-water pipelines, hoses and connections and check that they are not corroded or damaged and do not leak; repair or replace any pipelines, hoses and connections that are corroded or damaged, or which leak.
3. Check that all the nitrogen connections are secure; tighten any loose connections. Inspect all nitrogen pipelines and connections and check that they are not corroded or damaged and do not leak; repair or replace any pipelines and connections that are corroded or damaged, or which leak.
4. Check that all electrical connections are secure; tighten any loose connections. Inspect all electrical cables and connectors for damage; replace any cables and connectors that are damaged.
5. Check that all process and exhaust connections are secure; tighten any loose connections. Inspect all process and exhaust pipelines and fittings and check that they are not corroded or damaged; replace any pipelines or fittings that are corroded or damaged.
6. Refit the enclosure side and top panels: refer to Section 3.17.

6.5 Check the purge gas flow rates

Use the Service/Gas valve control menu to regularly check the purge gas flow rates against the nominal flow rates shown in Table 5-1.

6.6 Inspect and clean the exhaust-pipe, elbow and check-valve

WARNING

The substances which accumulate in the exhaust-pipe, elbow and check-valve can be dangerous. Do not allow these substances to come into contact with your skin or eyes. Do not inhale vapours from these substances. Fit blanking caps to the inlet and outlet flanges when you move the exhaust-pipe, elbow or check-valve around your workplace.

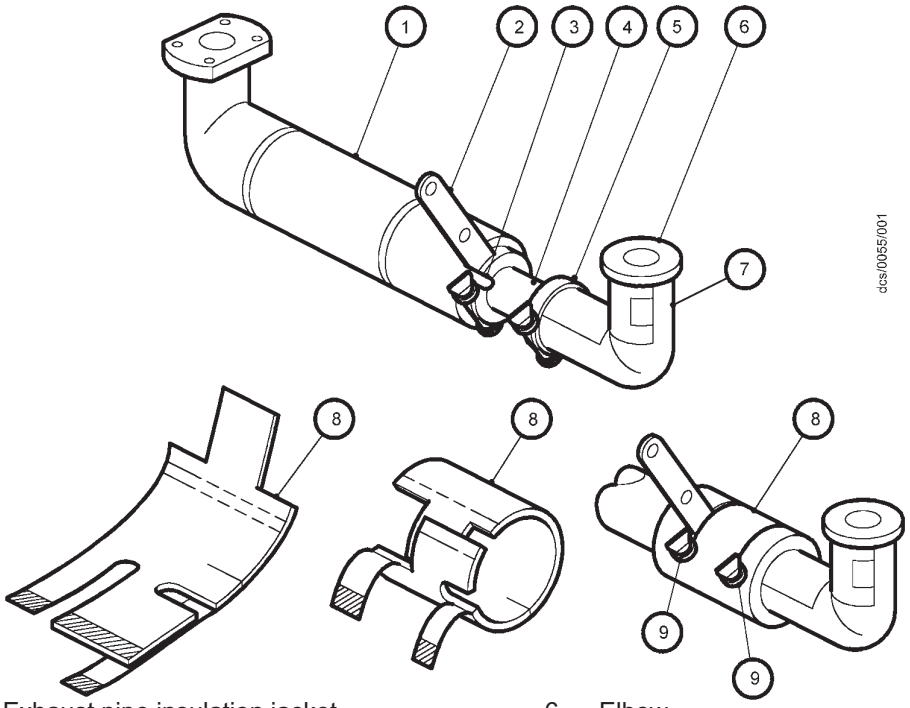
6.6.1 Dismantle, clean and refit the exhaust-pipe and elbow

Note: This requires an iH exhaust service kit (Refer to Section 8.3)

Use the following procedure to dismantle, clean and refit the exhaust-pipe and elbow. Refer to Figure 1-1.

1. Remove the NW40 clamp and trapped 'O' ring on the outlet flange of the check-valve (18) to disconnect the iH system from your exhaust-extraction pipeline. Dispose of the trapped 'O' ring.
2. Remove the exhaust enclosure (26) by removing the screws connecting to the rear bulkhead cover and exhaust enclosure top plate.
3 Remove the elbow insulation jacket (23) and clamp insulation jacket (24) and retain.
4. Remove the NW40 clamp and trapped 'O' ring which secures the check-valve (18) to the elbow (20) and remove the check-valve. Dispose of the trapped 'O' ring.
5. Remove the NW40 clamp and trapped 'O' ring which secures the elbow to the exhaust pipe (19). Dispose of the trapped 'O' ring.
6. Inspect the exhaust-pipe (19). If you do not need to remove the exhaust-pipe from the pump to clean it, use a suitable tool (for example a long bottle brush) and a cleaning solution suitable for the deposits to clean the exhaust pipe and continue at Step 17. If you need to remove the exhaust-pipe from the pump to clean it, continue at Step 7.
7 Use a hexagonal key to remove the cap screws, which secure the drip tray (27) to the iH system. Remove and retain the drip tray.
8 Remove and retain the exhaust insulation jacket (25). Dispose of the stainless steel cable ties.
9. Undo and remove the bracket which secures the exhaust-pipe to the iH system. Retain the bracket.

10. Use a hexagonal key to remove the four M8 cap-head screws and washers which secure the exhaust pipe (19) to the HCDP pump, then remove the metal 'O' ring and the exhaust-pipe from the HCDP pump. Dispose of the 'O' metal ring.
11. Empty all loose deposits from the exhaust-pipe (19), then use a suitable tool (for example, a long bottle-brush) and a cleaning solution suitable for the deposits to clean the exhaust-pipe.
12. Check that the mating surfaces of the HCDP pump outlet and the inlet flange on the exhaust pipe (19) are not scratched or damaged: if necessary refinish the surfaces. Refit the exhaust pipe insulation jacket to the pipe and secure with new stainless steel cable ties (in kit). Use Figure 6-3 as a guide.
13. Fit a new metal 'O' ring (supplied with kit) to the 'O' ring groove on the flange on the exhaust pipe (19).
14. Use the screws and washers (retained in Step 10) to secure the flange to the HCDP pump outlet and tighten by hand; ensure that the 'O' ring remains correctly in place.
15. Use a torque wrench to alternately and evenly tighten the four screws to a torque of 30 Nm.
16. Use the bracket assembly (removed in Step 9) to secure the exhaust pipe (19) to the iH system.
17. Inspect the elbow (20). If you do not need to clean the elbow, continue at Step 19. If you do need to clean the elbow, continue at Step 18.
18. Empty all loose deposits from the elbow, then use a suitable tool (for example a long brush) and a cleaning solution suitable for the deposits to clean the elbow.
19. Fit a new NW40 trapped 'O' ring and the NW40 clamp to secure the elbow to the exhaust pipe.
20. Refit the elbow insulation jacket and clamps insulation jacket. Use Figure 6-3 as a guide.
21. Use the cap screws and washers (retained in Step 7) to secure the drip tray (27) to the iH system.
22. Continue at Section 6.6.2 to clean and refit the check-valve.



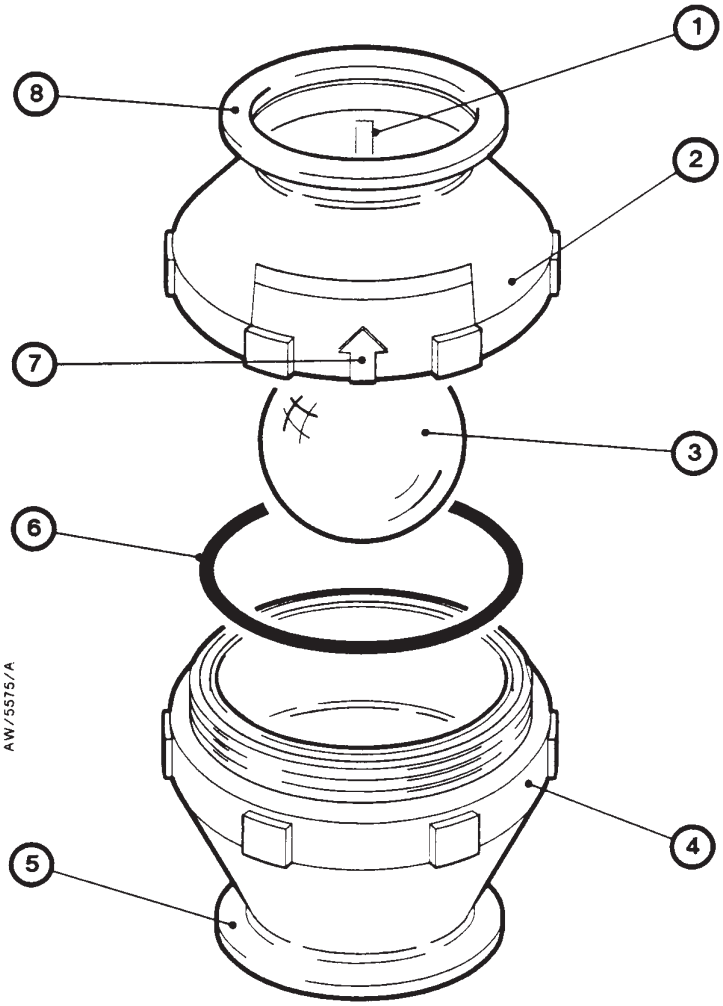
1. Exhaust pipe insulation jacket
2. Support bracket assembly
3. Insulation jacket tab
4. Exhaust pipe
5. NW40 clamp
6. Elbow
7. Elbow insulation jacket
8. Clamps insulation jacket
9. Plastic wing nut

Figure 6-3 - Fit insulation jackets

6.6.2 Clean and refit the check-valve (if fitted)

Note: This requires a check valve service kit. Refer to Section 8.3.

1. Refer to Figure 6-4. Unscrew the two halves (2, 4) of the check-valve body (if necessary, use a strap wrench, then remove the ball (3) and the 'O' ring (6).
2. Use a cleaning solution suitable for the deposits to clean the valve body and the ball. If necessary, replace the fluoroelastomer ball.
3. Inspect the 'O' ring groove and the flange sealing-faces for damage; refinish if necessary.
4. Position the new 'O'ring in its groove in the valve body.
5. Ensure that the ball (3) is correctly positioned in the valve body, then screw the two halves of the valve body (2, 4) together.
6. Refer to Figure 1-1. Use a new trapped 'O' ring (not supplied) and clamp (removed in Section 6.6.1) to secure the check-valve (18) to the elbow (20). Ensure that the flow arrow on the check valve (Figure 6-4, item 7) points away from the elbow towards the exhaust extraction system.
7. See Figure 1-1. Refit the exhaust enclosure (26) using the screws connecting to the rear bulkhead cover, drip tray (27) and exhaust enclosure top plate.
8. Use a new trapped 'O' ring (not supplied) and the NW40 clamp (removed in Section 6.6.1) to secure the check-valve outlet to the exhaust-extraction system.



1. Spider leg
2. Valve body (female)
3. Fluoroelastomer ball*/
   Perfluoroelastomer (Fluorine resistant) ball*
4. Valve body (male)
5. Inlet-flange
6. 'O' ring
7. Flow direction arrow
8. Outlet-flange

* The ball in check valve could be either of these materials

Figure 6-4 - Clean the exhaust check-valve

6.7 Check the HCMB pump oil-level (iH600/iH1000 only)

WARNING

Do not remove the oil filler-plug while the pump is operating. If you do, hot oil may be ejected from the pump.

WARNING

The majority of synthetic oils/grease can cause inflammation of the skin (dermatitis). Safety precautions must be taken to prevent prolonged skin contact with these substances. Use of suitable protective gloves and clothing along with respirator is recommended if contact with substances is anticipated.

CAUTION

Do not check the oil-level when the iH system is operating. The correct oil-level may not be shown when the pump is operating.

CAUTION

Ensure that the oil-level in the HCMB pump is correct. If the pump oil-level is incorrect, pump performance may be affected and the pump may be damaged.

Note: If there is a significant loss of oil from the pump, the shaft-seals may have failed. You cannot replace the shaft-seal. Contact your supplier or a BOC Edwards Service Centre for advice.

Use the following procedure to check the oil-level.

1. Shut down the iH system (refer to Section 5.10) and allow it to cool.
2. Remove the right-hand side enclosure panel from the iH system: refer to Section 3.4.

3. Refer to Figure 1-1. Check that the oil-level is between the MAX and MIN marks on the bezel of the HCMB oil-level sight-glass (5):
   - If the oil-level is above the MAX mark, drain excess oil from the pump as described in Section 6.10 until the oil-level is correct.
   - If the oil-level is below the MIN mark, fill the pump with oil until the oil-level is correct, as described in Section 6.10.
4. Refit the right-hand side enclosure panel: refer to Section 3.17.

6.8 Check the HCDP pump oil-level

WARNING

Do not remove the oil filler-plug while the pump is operating. If you do, hot oil may be ejected from the pump.

WARNING

The majority of synthetic oils/grease can cause inflammation of the skin (dermatitis). Safety precautions must be taken to prevent prolonged skin contact with these substances. Use of suitable protective gloves and clothing along with respirator is recommended if contact with substances is anticipated.

CAUTION

Do not check the oil-level when the iH system is operating. The correct oil-level may not be shown when the pump is operating.

CAUTION

Ensure that the oil-level in the HCDP pump is correct. If the pump oil-level is incorrect, pump performance may be affected and the pump may be damaged.

Use the following procedure to check the oil-level.

1. Shut down the iH system (refer to Section 5.10) and allow it to cool.
2. Remove the right-hand side enclosure panel from the iH system: refer to Section 3.4.

3. Refer to Figure 1-1. Check that the oil-level is between the MAX and MIN marks on the bezel of the HCDP oil-level sight-glass (11):
   - If the oil-level is above the MAX mark, drain excess oil from the pump as described in Section 6.9 until the oil-level is correct.
   - If the oil-level is below the MIN mark, fill the pump with oil until the oil-level is correct, as described in Section 6.9.
4. Refit the right-hand side enclosure panel: refer to Section 3.17.

6.9 Change the HCDP pump oil

WARNING

Do not remove the oil filler-plug while the pump is operating. If you do, hot oil may be ejected from the pump.

WARNING

The majority of synthetic oils/grease can cause inflammation of the skin (dermatitis). Safety precautions must be taken to prevent prolonged skin contact with these substances. Use of suitable protective gloves and clothing along with respirator is recommended if contact with substances is anticipated.

CAUTION

Do not check the oil-level when the iH system is operating. The correct oil-level may not be shown when the pump is operating.

CAUTION

Ensure that the oil-level in the HCDP pump is correct. If the pump oil-level is incorrect, pump performance may be affected and the pump may be damaged.

1. Shut down the iH system (refer to Section 5.10) and allow it to cool.
2. Remove the right-hand side enclosure panel from the iH system: refer to Section 3.4.
3. Refer to Figure 1-1. Remove the HCDP oil filler-plug (8).

4. Use a suitable pump or syringe to suck the oil out of the pump.
5. Dispose of the old 'O' ring on the oil filler-plug (8) and replace it with a new 'O' ring (available as a spare: refer to Section 8.3).
6. Fill the pump through the filler hole with the correct grade and quantity of oil. Allow the oil to drain into the pump, then check the oil-level on the sight-glass: refer to Section 6.8.
7. Ensure that the new 'O' ring is correctly positioned on the oil filler-plug (8), then refit the filler-plug to the HCDP pump.
8. Refit the right-hand side enclosure panel: refer to Section 3.17.

6.10 Change the HCMB pump oil (iH600/iH1000 only)

WARNING

Do not remove the oil filler-plug while the pump is operating. If you do, hot oil may be ejected from the pump.

WARNING

The majority of synthetic oils/grease can cause inflammation of the skin (dermatitis). Safety precautions must be taken to prevent prolonged skin contact with these substances. Use of suitable protective gloves and clothing along with respirator is recommended if contact with substances is anticipated.

CAUTION

Do not check the oil-level when the iH system is operating. The correct oil-level may not be shown when the pump is operating.

CAUTION

Ensure that the oil-level in the HCMB pump is correct. If the pump oil-level is incorrect, pump performance may be affected and the pump may be damaged.

1. Shut down the iH system (refer to Section 5.10) and allow it to cool.
2. Remove the right-hand side enclosure panel from the iH system: refer to Section 3.4.
3. Refer to Figure 1-1. Remove the HCMB oil filler-plug (2).
4. Use a suitable pump or syringe to suck the oil out of the pump.
5. Dispose of the old 'O' ring on the oil filler-plug (2) and replace it with a new 'O' ring (available as a spare: refer to Section 8.3).
6. Fill the pump through the filler hole with the correct grade and quantity of oil. Allow the oil to drain into the pump, then check the oil-level on the sight-glass: refer to Section 6.7.
7. Ensure that the new 'O' ring is correctly positioned on the oil filler-plug (2), then refit the filler-plug to the HCMB pump.
8. Refit the right-hand side enclosure panel: refer to Section 3.17.

6.11 Zero the gas module flow transducer

Note: The flow transducer is zeroed by the software in the control system; you do not need to physically adjust any part of the iH system.

The accuracy of the mass flow transducer in the Gas Module may drift slightly and we recommend that it is 'zeroed' (that is, calibrated for zero gas flow) once a year.

You must zero the transducer with the electrical supply on, the iH system switched off and your nitrogen supply off and disconnected from the iH system. This ensures that the transducer is correctly zeroed when there is no nitrogen flow (if you zero the transducer with the nitrogen supply connected, small nitrogen leaks through the solenoid-valves could affect the calibration).

Use the Setup/Service/Zero Sensors menu to start to zero the transducer, then use the Status menu to display the gas flows; the gas flow displayed will be zero when the transducer has been correctly zeroed. Note that it will take approximately 15 minutes to zero the transducer; if required, you can use the Status/Zero time menu to view the time remaining before the transducer is zeroed.

6.12 Adjust the pump display terminal display viewing angle

If the display (Figure 1-8, item 2) is difficult to see, use the following procedure to adjust the display viewing angle.

1. Refer to Figure 3-6. Remove the Pump Display Terminal (8) from the recess (5) in the dashboard.
2. Place or hold the Pump Display Terminal in its normal operating orientation.
3. Turn the display adjuster (9) clockwise or anticlockwise until the display is easy to read.
4. Refit the Pump Display Terminal (8) in the recess (5) in the dashboard.
5. If necessary, repeat Steps 1 to 4 until the display is easy to see.

6.13 Replace a fuse

WARNING

Ensure that you replace a fuse with a new fuse of the correct rating. If you do not, the iH system will not be adequately protected and you can damage the iH system or cause injury to people.
Do not remove the cover from the Electrics Box. High voltages exist in the Electrics Box when it is connected to the electrical supply. There are no spare parts which you can service in the Electrics Box.

Note: You can only change the fuses in fuse holders F7, F8 and F9. A BOC Edwards service engineer must change fuses F1 to F6 in the Electrics Box (see Figure 1-5).

You can only change the low voltage fuses F7 to F9 for the d.c. electrical supply, the iH Interface Module and the emergency stop circuit. If any of the internal fuses F1 to F6 have failed, you must contact your supplier or BOC Edwards for advice. Only change a fuse if you have identified and rectified the cause of the failure.

To change a fuse, refer to Figure 1-5 and use the following procedure. If the fuse immediately fails when you replace it, there may be an electrical fault: contact your supplier or BOC Edwards for advice.

1. Use a flat-bladed screwdriver to undo the fuse holder (13, 14 or 15) by a 1/4 of a turn, then remove the fuse holder from the Electrics Box.
2. Remove the failed fuse from the fuse holder.
3. Fit a new fuse of the correct rating in the fuse holder. Refer to Section 2 for the fuse ratings.
4. Refit the fuse holder in the Electrics Box, then use a flat-bladed screwdriver to turn the fuse holder clockwise by a $^{1}/_{4}$ of a turn to secure it in place.

6.14 Replace the pump display terminal

Use the following procedure to replace the Pump Display Terminal . Note that you do not need to switch off the iH system to replace the Pump Display Terminal .

1. Refer to Figure 3-6. Remove the Pump Display Terminal (8) from the recess (5) in the dashboard.
2. Remove the connector (4) on the cable (7) from the terminal connector (6) in the recess of the dashboard.
3. Fit the new Pump Display Terminal as described in Section 3.8.1.

6.15 Relocate the iH system for maintenance

WARNING

Use suitable lifting equipment to move the iH system.

WARNING

System process gases and residue can be highly toxic. Take all necessary precautions when handling components that have, or could have, come into contact with them, including 'O' rings, lubricants, and all exhaust accessories.

If you want to remove the iH system from its operating location and move it to another location where you will do maintenance, use the following procedure.

1. Purge the iH system and shut down the iH system as described in Section 5.10 and allow the iH system to cool down.
2. Refer to Figure 3-10. Disconnect the mating-half from the electrical supply connector (9) on the Electrics Box.
3. Refer to Figure 1-5. Switch off your nitrogen and cooling-water supplies, then disconnect the nitrogen supply pipeline from the nitrogen inlet (4) and disconnect the cooling-water supply and return pipelines from the cooling-water inlet and outlet (3, 2).
4. Refer to Figure 1-1. Disconnect the inlet (1) from your vacuum system and disconnect the outlet (17) from your exhaust-extraction system. Fit blanking caps to your vacuum and exhaust-extraction pipelines and to the iH inlet and outlet (1, 17).
5. If necessary, disconnect the iH air-extraction port (see Figures 2-1 to 2-3) from your factory extraction system.
6. Refer to Figure 1-1. Adjust the levelling feet (9) so that the iH system rests on the castors (10).
7. Move the iH system to the location where you will do maintenance.
8. If necessary (depending on the maintenance you will do), disconnect any accessories from the iH system.

After maintenance is complete, re-install the iH system as described in Section 3.

6.16 Check for free rotation of the HCDP pump

WARNING

Hazardous chemicals are located within the pumps and piping. Use of suitable protective gloves and clothing along with a respirator is recommended if contact with substances is anticipated.

If the iH has automatically shut down because of excessive HCDP pump-motor power (that is, alarms 412 or 512 are displayed), use the following procedure to check that the pump is free to rotate before you restart the iH system:

1. Refer to Figure 3-10. Disconnect the mating-half from the electrical supply connector (9) on the Electrics Box.
2. Refer to Figure 1-5. Undo and remove the four screws which secure the rear cover (1), then remove the cover.
3. Refer to Figure 6-5. Use a 100 mm A/F hexagonal key to remove the $^{3}/_{8}$ BSP plug and 'O' ring (2) from the motor shaft.
4. Fit the hexagonal key to the end of the motor shaft and try to turn the shaft clockwise (in the direction shown by the arrow, 3):
   - If the shaft is free to turn, remove the hexagonal key and continue at Step 5.
   - If the shaft is not free to turn, contact your supplier or BOC Edwards: do not try to restart the iH system.
5. Refit the plug and 'O' ring (2) to the motor shaft.
6. Refer to Figure 1-5. Refit the rear cover (1) and secure with the four screws.
7. Refer to Figure 3-10. Refit the mating-half to the electrical supply connector (9) on the Electrics Box.

   You can now restart the iH system: refer to Section 5.14.

6.17 Fault finding

WARNING

Only personnel specially trained to perform electrical maintenance should attempt troubleshooting inside electrical enclosures. These enclosures contain hazardous voltages and are not operator areas.

Before performing any maintenance or trouble shooting it is recommended that you follow the lockout/tagout procedures according to the Control of Hazardous Energy (Lockout/Tagout) in Volume 29 of the Code of Federal Regulation (29CFR) Section 1910.147 for the customer supply. (See Section 6.18 if the disconnect box accessory is installed).

6.17.1 Warning and alarm message fault finding

When a warning or alarm message is generated, you can display the message and (for some of the messages) two lines of text (the advisory message) which identify possible checks you can make to identify the cause of the fault and to rectify the fault.

The first line of a message specifies the fault condition (warning or alarm) and shows the error number. Error numbers are of the form PFF, PPFF or PPPFF, where:

- P, PP, or PPP specifies the fault parameter associated with the alarm or warning: refer to Table 6-4. Note that Table 6-4 defines all of the possible sources; some of these may not be fitted to your iH system.
- FF specifies the fault type: refer to Table 6-5.

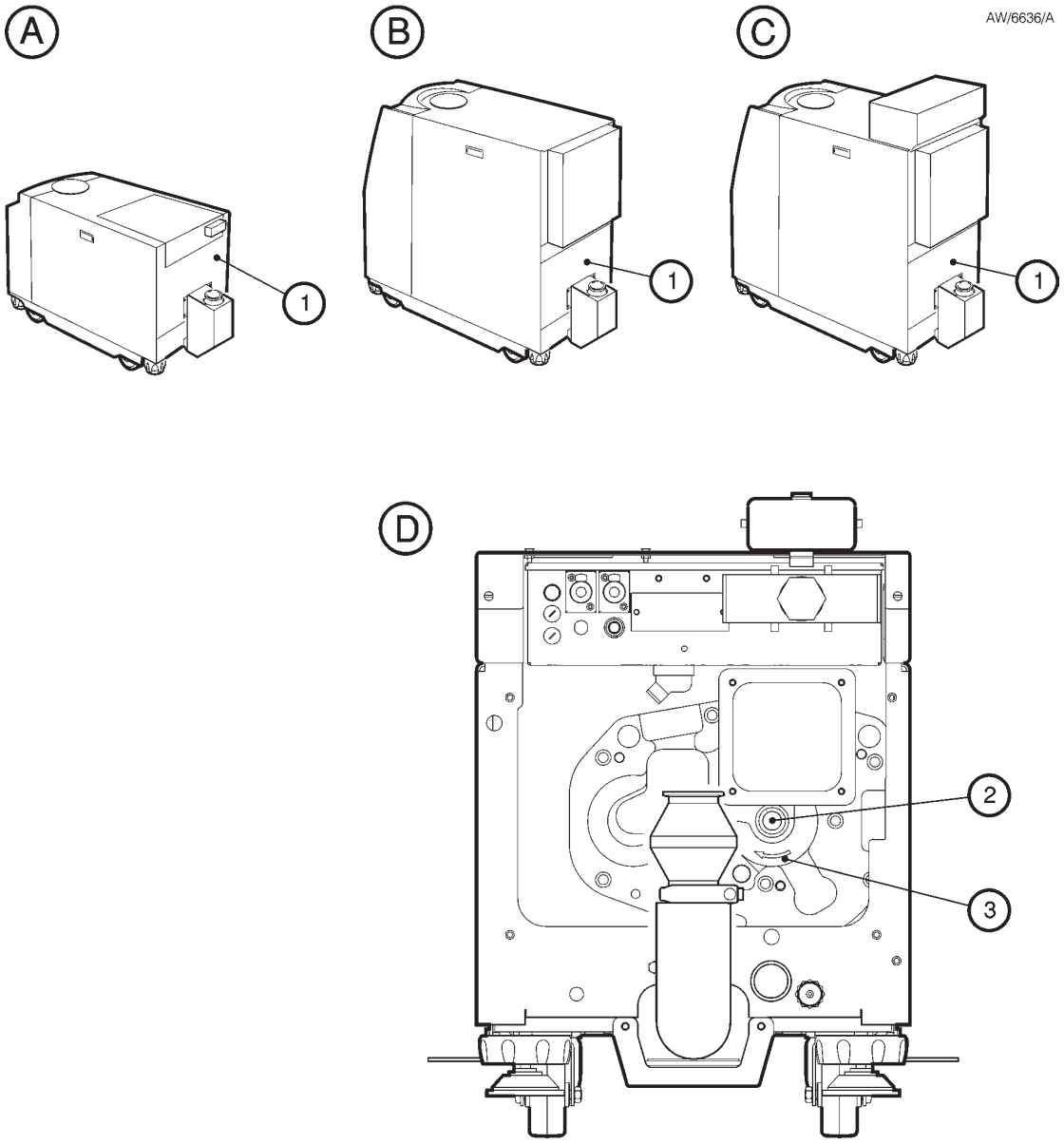
Table 6-1 shows all of the warning messages, the corresponding lines of advisory text (if any) and the meaning of the error/recommended actions. The warning messages are given in error number order in this table.

Table 6-2 shows all of the alarm messages, the corresponding lines of advisory text (if any) and the meaning of the error/recommended actions. The alarm messages are given in error number order in this table.

Note that Tables 6-1 and 6-2 show all of the possible warning and alarm messages, however some of these messages may not be displayed: this depends on how you have adjusted the setpoints.

6.17.2 Other fault finding

Fault messages will be shown on the Pump Display Terminal to identify that the action you have selected cannot be carried out. The messages which can be displayed and their meanings are shown in Table 6-3.



A iH80
B iH600
C iH1000

1. Rear cover
2. Plug and 'O' ring: $^{3}/_{8}$ BSP
3. Correct direction of rotation arrow

Figure 6-5 - Try to turn the HCDP pump

6.18 Disconnect box and photohelic switch/gauge (accessories)

WARNING

Only personnel specially trained to perform electrical maintenance should attempt troubleshooting inside electrical enclosures. These enclosures contain hazardous voltages and are not operator areas.

Before performing any maintenance or troubleshooting it is recommended that you follow the lockout/tagout procedures according to the Control of Hazardous Energy (Lockout/Tagout) in Volume 29 of the code of federal Regulation (29CFR) section 1910.147 for the customer supply. Lockout/tagout for the disconnect box are shown in Figure 6-6.

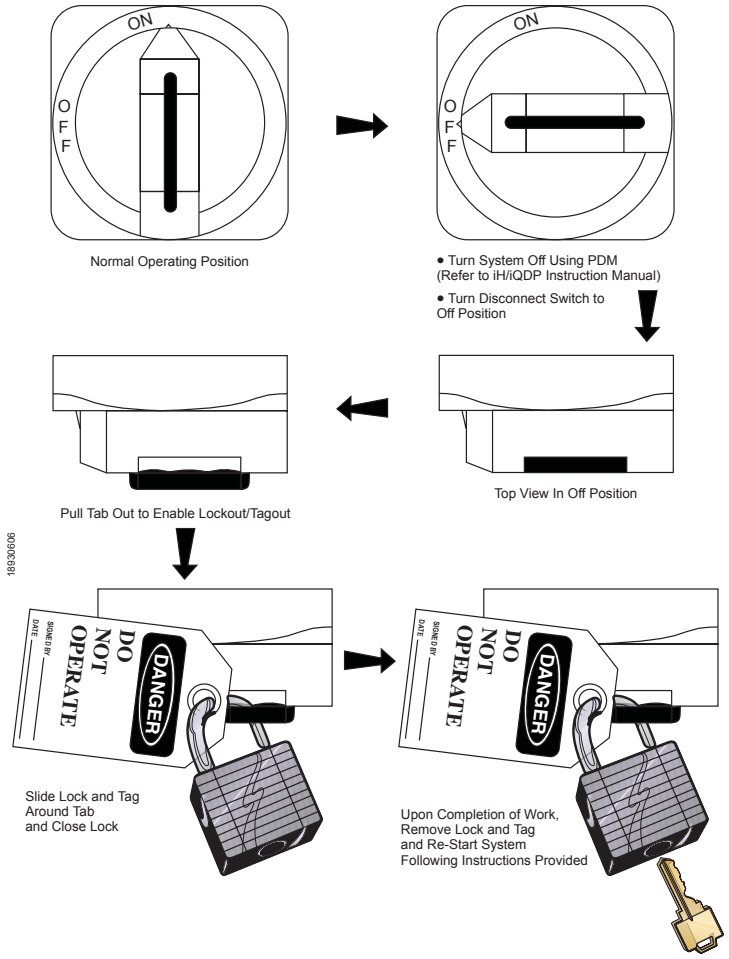


Figure 6-6 - System lockout/tagout procedures

6.18.1 Introduction

Perform the following checks when you maintain your pumping system:

- Check that the disconnect box is securely fitted on the wall.
- Check that all electrical connections are secure and that electrical cables are not damaged.

The disconnect box and photohelic switch/gauge contains no serviceable parts. Repair of faults by the user is limited to replacement of fuses, and resetting of the circuit breakers.

If any other repairs are required, contact your supplier or your nearest BOC Edwards Service Centre for advice.

6.18.2 Fault finding

If you suspect that a fault exists in the disconnect box, check the possible causes and carry out the remedial actions described in the following table before returning the disconnect box to a Service Centre.

Symptom	Probable Cause	Recommendations
The disconnect box will not power up	A fuse has blown	Check fuses F1 through F6 and replace if required
	Incoming electrical supply has failed	Check the electrical supply
	Photohelic gauge in warning state	Rectify situation and reset CB1
	Brownout condition over 3 seconds	Rectify situation and restart system
Photohelic gauge will not operate	Circuit breaker CB1 tripped	Rectify situation and reset CB1

6.18.3 Fuse replacement

The fuses are mounted in standard fuse holders. The use of a fuse puller is recommended when checking or replacing blown fuses.

If fuses blow regularly, this indicates a probable fault in the disconnect box or electrical connections. Isolate and rectify the fault before reusing the disconnect box.

Warning message	Advisory message	Meaning/recommended action
WARNING 101		(a) there is a fault in the Control SMA, or (b) the emergency stop button has been pressed to shut down the iH system, or (c) there has been a transient electrical supply failure (longer than the hold-up time of the iH power supply).
WARNING 113		There is a fault in the ADC (analogue-to-digital convertor) in the Control SMA; the Control SMA must be replaced.
WARNING 209	SEE MANUAL	The electrical supply voltage is too low. Check the electrical supply and the connections to the iH system and rectify as necessary.
WARNING 211	SEE MANUAL	The electrical supply voltage is too high. Check the electrical supply and the connections to the iH system and rectify as necessary.
WARNING 309 DP CURRENT LOW	OPEN CIRCUIT CHECK CONNECTION	The electrical current drawn by the HCDP pump is less than normal. Check that the electrical connections are correct and rectify as necessary. If the electrical connections are correct, a fuse in the Electrics Box may have failed.
WARNING 311 DP CURRENT HIGH	LEAK/DEBRIS SERVICE PUMP	The electrical current drawn by the HCDP pump is higher than normal. There may be a leak in the system or process debris in the pump, or the pump motor may have failed. Inspect the pipelines and service the pump.
WARNING 409 DP POWER LOW	OPEN CIRCUIT CHECK CONNECTION	The electrical power consumption of the HCDP pump is less than normal. Check that the electrical connections are correct and rectify as necessary. If the electrical connections are correct, a fuse in the Electrics Box may have failed.
WARNING 411 DP POWER HIGH	LEAK/DEBRIS SERVICE PUMP	The electrical power consumption of the HCDP pump is higher than normal. There may be a leak in the system or process debris in the pump, or the pump motor may have failed. Inspect the pipelines and service the pump.
WARNING 412 DP POWER HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 411 in this table.

Table 6-1 - Warning messages

Warning message	Advisory message	Meaning/recommended action
WARNING 509	SEE MANUAL	The HCDP motor thermistor Is short circuited. Check the thermistor connections inside the HCDP pump motor terminal-box and check the connections between the HCDP pump and the Electrics Box.
WARNING 611	SEE MANUAL	There is a phase imbalance in the electrical supply to the HCDP pump. Check the electrical supply and the connections to the iH system. If the electrical supply and connections are correct, the pump motor may be faulty.
WARNING 709 MB CURRENT LOW	OPEN CIRCUIT CHECK CONNECTION	The electrical current drawn by the HCMB pump is lower than normal. Check that the electrical connections are correct and rectify as necessary. If the electrical connections are correct, a fuse in the Electrics Box may have failed.
WARNING 711 MB CURRENT HIGH	LEAK/DEBRIS SERVICE PUMP	The electrical current consumption of the HCMB pump is higher than normal. There may be a leak in the system or process debris in the pump, or the pump motor may have failed. Inspect the pipelines and service the pump.
WARNING 809 MB POWER LOW	OPEN CIRCUIT CHECK CONNECTION	The electrical power consumption of the HCMB pump is lower than normal. Check that the electrical connections are correct and rectify as necessary. If the electrical connections are correct, a fuse in the Electrics Box may have failed.
WARNING 811 MB POWER HIGH	LEAK/DEBRIS SERVICE PUMP	The electrical power consumption of the HCMB pump is higher than normal. There may be a leak in the system or process debris in the pump or the pump motor may have failed. Inspect the pipelines and service the pump.
WARNING 812 MB POWER HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 811 in this table.
WARNING 909	SEE MANUAL	The HCMB motor thermistor is short circuited. Check the thermistor connections inside the HCMB pump motor terminal-box and check the connections between the HCMB pump and the Electrics Box.

Table 6-1 - Warning messages (continued)

Warning message	Advisory message	Meaning/recommended action
WARNING 1011	SEE MANUAL	There is a phase imbalance in the electrical supply to the HCMB pump. Check the electrical supply and the connections to the iH system. If the electrical supply and connections are correct, the pump motor may be faulty.
WARNING 1201		When started, no electrical current was drawn by the HCDP pump. Check whether the pump motor is open circuit. If not, the current sensor may have failed.
WARNING 1401 SERVICE DUE (R)	xxxxx HRS RUN SINCE SERVICE	The iH system has operated for xxxxx hours since it was last serviced. Service the iH system.
WARNING 1601 SERVICE DUE (P)	xxxxx HRS RUN SINCE SERVICE	The iH system has operated for xxxxx hours since it was last serviced. Service the iH system.
WARNING 1801 SERVICE DUE (P)	xxxxx CYCLES SINCE SERVICE	The iH system has been operated for xxxxx process cycles since it was last serviced. Service the iH system.
WARNING 2001 SERVICE DUE (C)	xxxxx CYCLES SINCE SERVICE	The iH system has been operated for xxxxx switch-on/off cycles since it was last serviced. Service the system.
WARNING 3113		There is a fault in the ADC (analogue-to-digital convertor) in the Control SMA; the Control SMA must be replaced.
WARNING 3501		(a) the gas module mass flow transducer has drifted outside the valid range allowed for zeroing, or (b) you cannot zero the transducer because the nitrogen purge is switched on or the HCDP pump is on.
WARNING 3509 TOTAL N2 FLOW LO	FLOW LOW CHECK GAS MODULE	The total nitrogen flow is too low. There may be a fault in the Gas Module.
WARNING 3511 TOTAL N2 FLOW HI	FLOW HIGH CHECK GAS MODULE	The total nitrogen flow is too high. There may be a fault in the Gas Module.
WARNING 3911 EXHAUST PRESSURE	EXHAUST BLOCKED SERVICE PUMP	The pressure in the exhaust pipeline is too high. There may be process debris or condensation in the exhaust pipeline, or a valve in the pipeline may be shut. You may have too many pumping systems connected to the exhaust pipeline.

Table 6-1 - Warning messages (continued)

Warning message	Advisory message	Meaning/recommended action
WARNING 3913		The exhaust pressure transducer is not fitted, or is disconnected or has failed. Check and rectify as necessary.
WARNING 4009 SS PURGE LOW	ADJUST REGULATOR INCREASE PRESS.	The shaft-seals purge pressure is too low. Check that the nitrogen supply is as specified in Section 2 and that you have correctly adjusted the pressure: refer to Section 5.7.
WARNING 4010 SS PURGE LOW	PRESSURE LOW ADJUST REGULATOR	Refer to the recommended actions for error number 4009 in this table.
WARNING 4011 SS PURGE HIGH	PRESSURE HIGH CHECK GAS MODULE	The shaft-seals purge pressure is too high. Check that you have correctly adjusted the pressure: refer to Section 5.7. If you cannot correctly adjust the pressure, the regulator may be faulty.
WARNING 4012 SS PURGE HIGH	PRESSURE HIGH CHECK GAS MODULE	Refer to the recommended actions for error number 4011 in this table.
WARNING 4013		The shaft-seals pressure transducer is not fitted, or is disconnected or has failed. Check and rectify as necessary.
WARNING 5113		There is a fault in the ADC (analogue-to-digital convertor) in the Control SMA; the Control SMA must be replaced.
WARNING 5411 MB TEMP		The temperature of the HCMB pump is too high. Check the pumping system inlet pressure; has the pumping system been operating with inlet pressure > 5 mbar (5×10^2 Pa) for 1 hour or more. If the maximum inlet pressure has not been exceeded, or if the pumping system has not been operated at the maximum inlet pressure for longer than the specified time, the cooling-circuit of the pump maybe blocked.
WARNING 5413		Check that the HCMB pump temperature sensor is fitted and is correctly connected. If the sensor is correctly fitted and connected, it may have failed. Check the operation of the sensor and replace it if it has failed.
WARNING 5511 DP MOTOR TEMP	MOTOR WATER LOW CHECK WATER	The temperature of the HCDP pump- motor is too high. Check the cooling-water connections in the iH system and check that the cooling-water supply is on and is as specified in Section 2. If the connections and supply are correct, the cooling-circuit of the pump maybe blocked.

Table 6-1 - Warning messages (continued)

Warning message	Advisory message	Meaning/recommended action
WARNING 5513		The HCMB pump-motor surface temperature sensor is not fitted, or is disconnected or has failed.
WARNING 5609 EXHAUST TEMP LOW	EXHAUST TEMP LOW CHECK EXHAUST	The temperature of the exhaust is too low for the process.
WARNING 5613		You have configured the iH to have an exhaust temperature sensor fitted, but the sensor is not fitted, or is disconnected or has failed. Check and rectify as necessary.
WARNING 5709 DP TEMP LOW	DP TEMP LOW SEE MANUAL	The operating temperature of the HCDP pump is too low:.
WARNING 5711 DP TEMP HIGH	DP TEMP HIGH SEE MANUAL	The operating temperature of the HCDP pump is too high: there may be process debris in the pump or the pump may be damaged.
WARNING 5713		The HCDP pump-body temperature sensor is not fitted, or is disconnected or has failed. Check and rectify as necessary.
WARNING 6001 WATER FLOW LOW	CHECK COOLING WATER SUPPLY	The flow of cooling-water through the iH system is too low. Refer to the recommended actions for error number 5411.
WARNING 7801 O RING	O RING LEAK - CHECK	The secondary seal is breached. You are now depending on the primary seal mechanism.
WARNING 11101		There is a fault in the NIM (Network Interface Module): refer to the instruction manual supplied with the NIM.
WARNING 12101		There is a fault in the Tool Interface Card in the iH Interface Module. Refer to the instruction manual supplied with the iH Interface Module.
WARNING 15101		There is a fault in the Auxiliary Interface Card in the iH Interface Module. Refer to the instruction manual supplied with the iH Interface Module.
WARNING 15201		The gate valve connected to the iH Interface Module has failed to close.
WARNING 15301		The gate valve connected to the iH Interface Module has failed to open.

Table 6-1 - Warning messages (continued)

Warning message	Advisory message	Meaning/recommended action
WARNING 17601	SEE MANUAL	The inverter on an iH1000 system has experienced a transient power supply problem, or there is a recoverable fault.
WARNING 17701	SEE MANUAL	The HCMB pump stator temperature is > 165 °C, and the HCMB pump speed has been reduced to 1200 $r.min^{-1}$. The warning condition will be removed and the HCMB pump speed will increase to 6000 $r.min^{-1}$ again when the pump stator temperature has fallen to 150 °C.

Table 6-1 - Warning messages (continued)

Alarm message	Advisory message	Meaning/recommended action
ALARM 101 STOP ACTIVATED		The emergency stop switch has been pressed or a safety sensor connected to the emergency stop circuit has operated (or your remote emergency off circuit has operated) to shut down the iH system. Note that the message will remain on the display until you restart the pumping system.
ALARM 101		Refer to the recommended actions for error number 101: see Table 6-1.
ALARM 210		Refer to the recommended actions for error number 209: see Table 6-1.
ALARM 212		Refer to the recommended actions for error number 211: see Table 6-1.
ALARM 310 DP CURRENT LOW	OPEN CIRCUIT CHECK CONNECTION	Refer to the recommended actions for error number 309: see Table 6-1.
ALARM 312 DP CURRENT HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 311: see Table 6-1.
ALARM 410 DP POWER LOW	OPEN CIRCUIT CHECK CONNECTION	Refer to the recommended actions for error number 409: see Table 6-1.
ALARM 412 DP POWER HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 411: see Table 6-1.
ALARM 512		The pump-motor has tripped out because the motor windings are too hot: either the cooling-system has failed or the motor overloaded. Either of these faults should have been identified before shut-down, so either there are two separate faults (for example, cooling-water supply failure and thermocouple circuit failure) or the thermistor circuit has failed: contact your supplier or Edwards.

Table 6-2 - Alarm messages

Alarm message	Advisory message	Meaning/recommended action
ALARM 612		Refer to the recommended actions for error number 611: see Table 6-1.
ALARM 710 MB CURRENT LOW	OPEN CIRCUIT CHECK CONNECTION	Refer to the recommended actions for error number 709: see Table 6-1.
ALARM 712 MB CURRENT HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 711: see Table 6-1.
ALARM 810 MB POWER LOW	OPEN CIRCUIT CHECK CONNECTION	Refer to the recommended actions for error number 809: see Table 6-1.
ALARM 812 MB POWER HIGH	LEAK/DEBRIS SERVICE PUMP	Refer to the recommended actions for error number 811: see Table 6-1.
ALARM 912		Refer to the recommended actions for error number 512 in this table.
ALARM 1012		Refer to the recommended actions for error number 1011: see Table 6-1.
ALARM 1101		(a) the electrical supply is not connected to the HCDP pump-motor, or (b) the HCDP pump has started, but has then immediately stopped again, because the phase sequence of the electrical supply to the pump is incorrect: reverse two of the phases in the electrical supply connector: refer to Section 3.16.3.
ALARM 3912 EXHAUST PRESSURE	EXHAUST BLOCKED SERVICE PUMP	Refer to the recommended actions for error number 3911: see Table 6-1.
ALARM 5412 MB MOTOR TEMP	MOTOR WATER LOW CHECK FILTER	Refer to the recommended actions for error number 5411: see Table 6-1.
ALARM 5512 DP MOTOR TEMP	MOTOR WATER LOW CHECK FILTER	Refer to the recommended actions for error number 5511: see Table 6-1.
ALARM 5610 EXHAUST TEMP LOW	EXHAUST TEMP LOW CHECK EXHAUST	Refer to the recommended actions for error number 5609: see Table 6-1.
ALARM 5710 DP TEMP LOW	TCV SET LOW ADJUST TCV	Refer to the recommended actions for error number 5709: see Table 6-1.
ALARM 5712 DP TEMP HIGH	TCV SET HIGH ADJUST TCV	Refer to the recommended actions for error number 5711: see Table 6-1.
ALARM 17410	SEE MANUAL	The inverter on an iH1000 system has been operating at less than 10 Hz for more than three minutes. There is a mechanical fault (possible a pump rotor has locked): contact your supplier or BOC Edwards for advice.

Table 6-2 - Alarm messages (continued)

Alarm message	Advisory message	Meaning/recommended action
ALARM 17601	SEE MANUAL	The inverter on an iH1000 system has experienced a significant power supply problem and the HCMB pump has been stopped, or the HCMB pump in the iH1000 system has stopped because of a mechanical or electrical fault. You must manually restart the HCMB pump (refer to section 5.13). If the alarm condition persists after several attempts to restart the HCMB pump, contact your supplier or BOC Edwards for advice.

Table 6-2 - Alarm messages (continued)

Message	Meaning
CONTROL failed Press CANCEL	You have requested that the Pump Display Terminal takes control of the iH system, but the attempt to take control has failed. Press the CANCEL button to return to normal display.
CONTROL REMOTE Press CANCEL	(a) You have requested that the Pump Display Terminal takes control of the iH system, but another module still has control. Press the CANCEL button to return to normal display, release control from the module which currently has control and then try again. (b) You have requested some action, but the Pump Display Terminal does not have control of the iH system. Press the CANCEL button, take control and then try again.
PUMP failed to respond (CANCEL)	(a) You have requested that the iH system is switched on or off, but the pump(s) has failed to start or stop: press the CANCEL button to cancel the request, identify and rectify the cause for the failure of the pump(s) to start or stop, then try again. (b) You have tried to open or close one of the gate valves (if fitted), but the valve has failed to respond. Identify and rectify the cause for the failure of the valve to open or close, then try again. (c) A valve (for example, a setpoint) has been requested from the iH system, but the iH system has not been responded. (d) The emergency stop switch has been pressed and released: restart the pumping system.
PUMP RUNNING Press CANCEL	You have requested that the iH system is switched on, but it is already on. Press the CANCEL button to return to normal display.

Table 6-3 - Fault messages

Message	Meaning
PUMP STOPPED Press CANCEL	You have requested that the iH system is switched off, but it is already off. Press the CANCEL button to return to normal display.
EDWARDS DISPLAY MODULE	If this message is displayed when the iH system is switched on and the display does not change to normal display, this means that the Pump Display Terminal cannot correctly communicate with the iH system.
None (the display is blank)	One or both fuses FS6 and FS8 may have tripped. Switch off the electrical supply to the iH system, then switch it on again to reset the fuse(s).

Table 6-3 - Fault messages (continued)

Parameter †	Source/cause of error
1	iH system status
2	Electrical supply voltage
3	HCDP pump current consumption
4	HCDP pump power consumption
5	HCDP pump-motor thermistor
6	Phase imbalance in HCDP pump current consumption
7	HCMB pump current consumption
8	HCMB pump power consumption
9	HCMB pump-motor thermistor
10	Phase imbalance in HCMB pump current consumption
11	HCDP pump status
12	HCMB pump status
14	Total run hours (since last service)
16	Total run hours (on process, since last service)
18	Process cycles (since last service)
20	Switch-on/off cycles (since last service)
31	Gas Module status
35	Gas Module flow transducer: total nitrogen purge flow

Table 6-4 - Fault parameters

39 **Parameter** †	Exhaust pressure sensor **Source/cause of error**
40	Shaft-seals purge pressure transducer
51	Electronics Module status
53	Active Gauge (optional accessory)
54	HCMB pump temperature sensor
55	HCDP pump-motor water manifold surface temperature sensor
56	iH exhaust temperature sensor (optional accessory)
57	HCDP pump-body thermocouple
111	Network Interface Module status (optional accessory)
121	Tool Interface Card status (optional accessory)
151	Auxiliary Interface Card status (optional accessory)
152	Gate Valve Closed status
153	Gate Valve Open status
174	Inverter speed(iH1000 only)
176	Inverter status (iH1000 only)
177	HCMB pump over-temperature monitor (iH1000 only)

† First digit of a three-digit error number, first two digits of a four-digit error number, or first three digits of a five-digit error number.

Table 6-4 - Fault parameters (continued)

Fault type ▲	**Meaning**
01	Digital alarm condition *
09	Low warning condition
10	Low alarm condition
11	High warning condition
12	High alarm condition
13	Device error †

▲ Last two digits of the error number.

* For example, the gas module flow transducer has drifted outside the valid range allowed for zeroing.

† For example, sensor is not fitted, or is disconnected.

Table 6-5 - Fault types

7 STORAGE AND DISPOSAL

7.1 Storage

CAUTION

Drain the cooling-water from the iH system, if you will transport or store it in conditions where the cooling-water could freeze. If you do not, cooling-water may freeze in the iH system and damage the pump(s) and/or the cooling-water pipelines.

Store the iH system as follows :

1. If applicable, ensure that the pumps have been shut down as described in Section 5.10 and disconnect all services, process and exhaust connections.
2. Fit blanking-plates to all vacuum inlets and exhaust outlets. Place protective covers over the iH services connection points.
3. Store the iH system in clean dry conditions until required.
4. When required for use, prepare and install the iH system as described in Section 3 of this manual.

7.2 Disposal

Dispose of the iH system and any components safely in accordance with all local and national safety and environmental requirements.

Take particular care with the following:

- Fluoroelastomers and Perfluoroelastomers which may have decomposed as the result of being subjected to high temperatures
- Components which have been contaminated with dangerous process substances.

7.3 Transportation

WARNING

Do not drain the oil from the pump(s) if you know that dangerous substances have been pumped, or if you are unsure whether dangerous substances have been pumped or not.

WARNING

If you have to transport the iH system with the pump(s) filled with oil, you must fit blanking plates to seal all vacuum inlet and outlet ports (to prevent possible oil leakage).

CAUTION

Drain the cooling-water from the iH system, if you want to transport it in conditions where the cooling-water could freeze. If you do not, cooling-water may freeze in the iH system and damage the pump and/or the cooling-water pipelines.

Notes: *The HCDP pump (and on iH600 and iH1000 systems, the HCMB pump) is supplied fitted with a transit seal. This seal has a finite serviceable life. If the iH system is transported with the pump(s) full of oil when the transit seal is no longer serviceable, oil may leak into the swept volume of the pump(s).*

You must provide a correctly completed Return of Equipment Declaration (form HS2) if you return the iH system to BOC Edwards: refer to Section 8.2.

If the iH system is to be returned to BOC Edwards, ensure the iTIM module is first removed from the system (as detailed in the iTIM instruction manual) for use with the replacement pump. iH pumps returned from BOC Edwards after service will not include an iTIM module.

If you want to transport the iH system (either for onward shipment to your own customer, or for return to BOC Edwards for repair), before you transport it:

1. If applicable, ensure that the iH system has been purged and shut down (see Section 5.10) and disconnect all services, process and exhaust connections.

2. If the HCDP pump and HCMB pump (on an iH600 and iH1000 system) have been filled with oil:
   - If you know that dangerous substances have been pumped, or if you are unsure whether dangerous substances have been pumped or not, leave the oil in the pump(s). Do **not** drain the oil.
   - Drain the oil from the pump(s) (as described in Section 6.9 or 6.10) **only** if you are certain that dangerous substances have not been pumped.
3. Fit blanking-plates to seal all vacuum inlet and outlet ports. Place protective covers over the iH services connection points.

8 SERVICE, SPARES AND ACCESSORIES

8.1 Introduction

BOC Edwards products, spares and accessories are available from BOC Edwards companies in Belgium, Brazil, Canada, China, France, Germany, Israel, Italy, Japan, Korea, Singapore, Switzerland, United Kingdom, U.S.A and a world-wide network of distributors. The majority of these centres 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.

8.2 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 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.

8.3 Spares

Spare	**Item Number**
iH Pump Display Terminal	D372-72-800
Krytox 1525 oil (1 kg)	H113-09-018
Fomblin 25/6 oil (1 kg)	H113-12-019
Drynert 25/6 oil (1 kg)	H113-12-021
Exhaust check-valve servicing kit	A440-03-820
Exhaust check-valve servicing kit (Fluorine resistant)	A440-08-820
iH Exhaust Service Kit	A505-92-000
Teminator plug (4 way)	A532-20-050
Exhaust-pipe (with metal 'O' ring)	A505-52-000
Metal 'O' ring (for HCDP outlet to exhaust-pipe connection): pack of 10	H021-15-001
Oil filler-plug 'O' ring: pack of 10	H021-06-110

8.4 Ordering accessories

Note: All of the accessories in Section 8.4.1 to 8.4.4 must be ordered when you order your iH system. The accessories you have ordered will be supplied fitted to your iH system.

8.4.1 Exhaust Temperature Sensor

The Exhaust Temperature Sensor monitors the temperature in the iH exhaust outlet. When fitted, the output of the Sensor is monitored by the iH system. If required, you can configure the iH system to generate a warning if the exhaust temperature is too low or too high.

Accessory	Item Number
Exhaust Temperature Sensor	A532-07-000

8.4.2 Active Gauge Connection Kit

The Active Gauge Connection Kit allows the iH system to monitor the pressure measured by an Active Gauge fitted in the inlet pipeline to the iH system. Note that the Active Gauge Connection Kit cannot be fitted if you have ordered an iH Pressure Control Kit: see Section 8.4.3.

The Connection Kit is suitable for use with any of the following BOC Edwards Active Gauges:

- ATC-M Active Thermocouple Gauge
- ASG (1000 mbar) Active Strain Gauge
- APG-MP Active Pirani Gauge
- APG-L Active Pirani Gauge (Heated)
- Barocel Capacitance Manometers (10 to 1000 mbar or torr).

When supplied, the Active Gauge Connection Kit is configured for use with an APG-MP Active Pirani Gauge. You will need to fit an iH PC Interface Kit if you want to reconfigure the iH system for use with another gauge type (see Section 8.5.4).

Accessory	Item Number
Active Gauge Connection Kit	D372-41-000

8.4.3 iH600 Pressure Control Kit

The iH600 Pressure Control Kit can be fitted to an iH600 system, to enable the HCMB pump to be automatically started at a preset inlet pressure. Note that the Active Gauge Connection Kit accessory (see Section 8.4.2) cannot be fitted if you have ordered an iH Pressure Control Kit.

Accessory	Item Number
iH Pressure Control Kit	A505-40-000

8.4.4 iH Enclosure Extraction Fan Kit

When fitted, an iH Enclosure Extraction Fan Kit provides air-extraction of the iH enclosure at a rate of 2.8 m^3min^{-1} (100 cfm). The Kit is suitable for both iH80 and iH600 systems.

Accessory	Item Number
iH Enclosure Extraction Fan Kit	A505-39-000

8.5 Other accessories

8.5.1 iTIM

An iTIM may be used to provide control and monitoring of the pump by your Process Tool, using a parallel digital interface. The iTIM has a number of advanced features.

- Digital connections for up to 3 different types of tool interface on each iTIM.
- Convenient mounting on the rear of the pump, rapid two point fixing.
- Configurable connectivity to enable AUC functionality to be readily customised.
- Gate valve control is included in this module as standard.
- The iTIM has a set point store, which allows pump set points relating to a particular process or recipe to be saved. These set points are automatically to be loaded into pump on power up, including new pumps when one is replaced.
- RS232C option to allow serial communications with your Process Tool or PC-based software.

Accessory	Item Number
E73+A1+T1 iTIM	D374-20-000
E73+A1+T1+Serial iTIM	D374-21-000
MCM+L1 iTIM	D374-22-000
MCM+L1+Serial iTIM	D374-23-000

Contact your supplier or BOC Edwards for further information on interface solutions.

8.5.2 iM Interface and Communications Modules

Where these modules already exist they may be utilised to provide control and monitoring of the pump by your Process Tool or other control equipment. For example a pump may be upgraded from an iH to an iHs without changing the interface module.

However the iTIM provides improved performance over the iM modules, for example full AUC functionality is only available using the iTIM. The iTIM is recommended on all new installations.

8.5.3 iH Single Equipment Monitor and iH Fabworks

The iH Single Equipment Monitor allows you to monitor pump parameters and configure the iH system. The iH Fabworks allows you to network together all of the iH systems in your installation, and to use a PC to centrally monitor the iH systems. Contact your supplier or BOC Edwards if you want to network your iH systems.

8.5.4 iH PC Interface Kits

The iH PC Interface Kit allows you to directly connect the iH system to a laptop PC or to a desktop PC and to use the PC to switch the iH system on and off, and to monitor the status of the iH system. The Kit is supplied with all necessary cables and with the iH Single Equipment Monitor software.

Accessory	**Item Number**
Desktop PC Interface Kit	D372-18-100
Laptop PC Interface Kit (USA)	D372-18-200
Laptop PC Interface Kit (Europe)	D372-18-300
Laptop PC Interface Kit (UK)	D372-18-400
Laptop PC Interface Kit (Japan)	D372-18-500
PCMCIA Laptop PC Interface Kit	D372-17-000

8.5.5 iH Alternative Connections Kits

Use this kit to reconfigure the iH system to use the alternative nitrogen inlet and/or cooling-water inlet and outlet connection positions (see Section 3.5).

Accessory	**Item Number**
Alternative Nitrogen and Cooling-Water Connections Kit	A505-34-000

8.5.6 iH Alternative Exhaust Kit

This kit provides the user with O-rings and insulation jackets to fit to the exhaust pipe in the reversed position.

Accessory	**Item Number**
iH Alternative Exhaust Kit	A505-33-000

8.5.7 iH Nitrogen Flow Switch

When installed, the Flow Switch enables the iH communications Module to monitor the flow of nitrogen purge gas to the dry pumping system, and shut down the dry pumping system if the flow is too low.

Accessory	**Item Number**
iH Nitrogen Flow Switch	A532-54-000

8.5.8 iH Pump Display Module

When fitted, the iH Pump Display Module allows the operator to manually control the pump (as with the Pump Display Terminal), but with the option of communicating over distances in excess of 25m.

Accessory	Item Number
iH Pump Display Module	D372-37-000

8.5.9 iH Pump Display Module Extension Cables

If required, you can use an extension cable to allow you to use the Pump Display Module further away from the iH system.

Accessory	Item Number
Extension cable (display/interface), 3 m	D372-07-591
Extension cable (display/interface), 5 m	D372-07-592
Extension cable (display/interface), 10 m	D372-07-595
Extension cable (display/interface), 15 m	D372-07-596
Extension cable (display/interface), 25 m	D372-07-597

8.5.10 iH Pump Display Terminal Extension Cables

If required, you can use an extension cable to allow you to use the Pump Display Terminal further away from the iH system.

Accessory	Item Number
Extension cable (display/interface), 3 m	D372-72-801
Extension cable (display/interface), 5 m	D372-72-802
Extension cable (display/interface), 10 m	D372-72-803
Extension cable (display/interface), 15 m	D372-72-804
Extension cable (display/interface), 25 m	D372-72-805

8.5.11 iH Disconnect Box

When fitted, the iH disconnect box allows the isolation of the electrical supply for an emergency, maintenance or troubleshooting of the system.

Accessory	Item Number
iH Disconnect Box	U20000445

8.5.12 iH Photohelic Switch/Gauge Kit

When fitted, the iH photohelic switch/gauge kit will isolate the electrical supply to the system, via the disconnect box, should the pressure in the enclosure exceed a certain setpoint.

Accessory	Item Number
iH Photohelic Switch/Gauge Kit	U30004021

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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