Instruction Manual

TCS, TPU and Kronis Systems *

TCS Thermal Conditioning Systems

TPU Thermal Processing Units

Kronis Systems

CE
73/023/EEC
89/336/EEC

BOC EDWARDS

* *Incorporating Alzeta Corporation combustor technology*

Declaration of Conformity

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

declare under our sole responsibility that the product(s)

TCS Thermal Conditioning Systems

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

EN61010-1	Electrical Safety Standard. Generic Standard Class: Laboratory, Measurement and Control Equipment; including Amendment A2:1995.
EN61326 (Industrial environment, Class A emissions)	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements. General Requirements.
NFPA-79 (1997)	National Electrical Code - Electrical Safety: Machines.
UL3101-1	Electrical Equipment for Measurement, Control and Laboratory Use. Part 1: General Requirements.
SEMI S2-93A	Safety Guidelines for Semiconductor Manufacturing Equipment.

following the provisions of

73/023/EEC	Low Voltage Directive.
89/336/EEC	Electromagnetic Compatibility Directive.

Y 0 7 0 - X X - X X X

Model/voltage:
- **1** 'E' model: 230 V, 50 Hz, 1-phase, with Services Module
- **2** 'S' model: 120 V, 60 Hz, 1-phase, with Services Module
- **3** 'J' model: 100 V, 50 Hz, 1-phase, with Services Module
- **4** 'J' model: 100 V, 60 Hz, 1-phase, with Services Module
- **A** 'E' model: 230 V, 50 Hz, 1-phase, with WRU
- **B** 'S' model: 120 V, 60 Hz, 1-phase, with WRU
- **C** 'J' model: 100 V, 50 Hz, 1-phase, with WRU
- **D** 'J' model: 100 V, 60 Hz, 1-phase, with WRU

Number of inlets:
- **1** 1 inlet
- **2** 2 inlets
- **4** 4 inlets

Fuel gas type:
- **0** Methane; 36.9 to 42.3 $MJ.m^3$
- **1** Propane/LPG; 92.5 to 105.75 $MJ.m^3$
- **2** 6B (Japanese specification)

Installation options:
- **0** None (standard unit)
- **1** TMS (Temperature Management System)
- **2** Bypass nitrogen dilution
- **3** Options 1 and 2 above

Other installation options:
- **0** None (standard unit)
- **4** Internal bypass-valves
- **5** Remote Bypass Module
- **6** Secondary containment kit
- **7** Options 4 and 6 above
- **8** Options 5 and 6 above

J D Watson

Dr. J. D. Watson, Senior Technical Manager, VED

4 DECEMBER 2002 CLEVEDON

Date and Place

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

BOC EDWARDS

Declaration of Conformity

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

declare under our sole responsibility that the product(s)

TPU Thermal Processing Unit Systems

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

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Fuel gas type:
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- **1** Propane/LPG; 92.5 to 105.75 $MJ.m^3$

Installation options:
- **0** None (standard unit)
- **1** TMS (Temperature Management System)
- **2** Remote Bypass Module
- **3** TMS and Remote Bypass Module

Other installation options:
- **0** None (standard unit)
- **1** Bypass nitrogen dilution
- **2** High CF_4 abatement
- **3** Options 1 and 2 above
- **6** Secondary containment kit
- **7** Options 1 and 6 above
- **8** Options 2 and 6 above
- **9** Options 3 and 6 above

Dr. J. D. Watson, Senior Technical Manager, VED

4 December 2002 Crewkerne

Date and Place

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

BOC EDWARDS

Declaration of Conformity

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

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Kronis Systems

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

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Date and Place

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BOC EDWARDS

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1 INTRODUCTION

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the following BOC Edwards exhaust abatement systems:

- TCS Thermal Conditioning Systems.
- TPU Thermal Processing Units.
- Kronis Systems.

You must use the abatemement system as described in this manual.

Read this manual before you install, operate and maintain the abatement system.

Note that detailed service instructions are described in the TCS/TPU/Kronis service manual, which is available to suitably trained technicians.

Important safety information is highlighted as WARNING and CAUTION instructions; you must obey these instructions. The use of WARNINGs and CAUTIONs is defined below.

WARNING

Warnings are given where failure to observe the instruction could result in injury or death to people.

CAUTION

Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment and process.

Throughout this manual a reference in square brackets, for example [TE-508], is a 'component tag' and denotes the label used on the corresponding component in the system.

The units used conform to the SI international system of units of measurement.

The term 'inches wg' is used to mean 'inches of water (gauge)'.

Where gas flow rates are specified, the term 'slm' is used to mean 'standard l min^{-1}'; this is a flow of 1 l min^{-1} at an ambient temperature of 0 °C and at a pressure of 1013 mbar (1.013×10^5 Pa).

1.2 Symbols and labels

The warning labels on the system are shown in Figures 1 and 2.

The warning labels on the system identify potential safety hazards, thereby satisfying SEMI S1 requirements.

The following symbols appear on the abatement systems:

Start

Stop

Locked

Unlocked

Temperature controller

Protective conductor terminal

(continued on page 4)

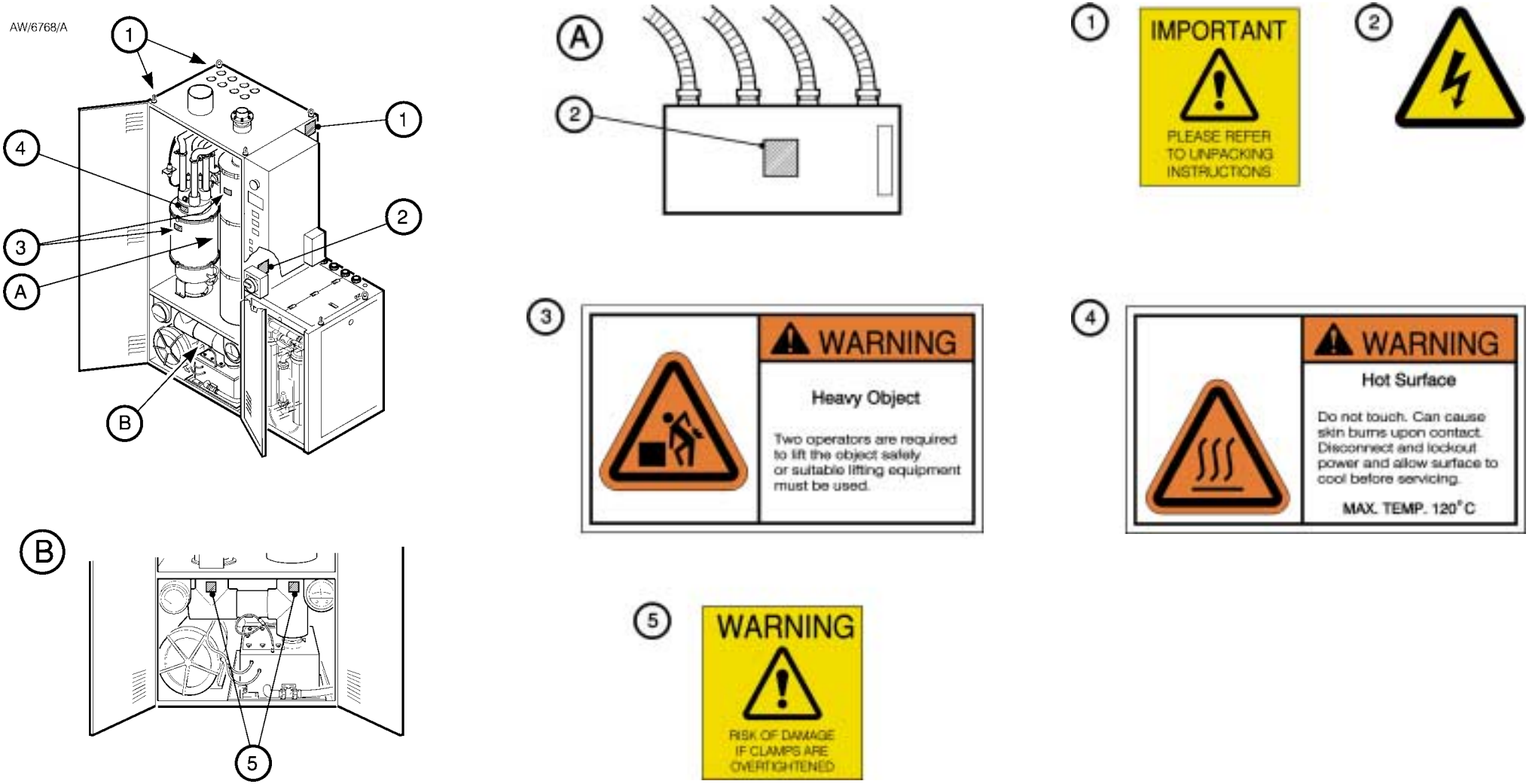
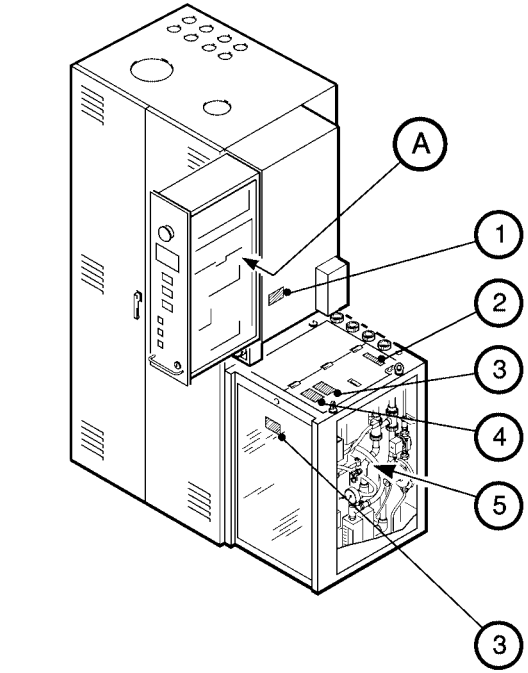
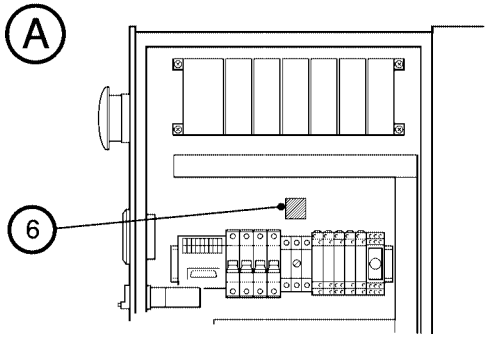


Figure 1 - Abatement system enclosure warning labels





1

WARNING

Hazardous Voltage Enclosed

Voltage or current hazard sufficient to cause shock, burn or death. Disconnect and lockout power before servicing.

2

CAUTION

WATER SUPPLY TO THIS UNIT MUST BE IN ACCORDANCE WITH BOCE SPECIFICATION TPUIN 9-1 H2O. FAILURE TO MEET THIS SPECIFICATION WILL CAUSE IRREPARABLE DAMAGE AND WILL VOID WARRANTY

3

WARNING

HAZARDOUS CHEMICALS LOCATED WITHIN THIS ENCLOSURE, USE OF SUITABLE PROTECTIVE GLOVES AND CLOTHING ALONG WITH RESPIRATOR IS RECOMMENDED IF CONTACT WITH SUBSTANCES IS ANTICIPATED

4

WARNING

Moving Parts Present

Can result in serious injury to hands or fingers if placed in machine. Disconnect and lockout power before servicing.

5

6

CAUTION

BEFORE SERVICING DISCONNECT POWER

Figure 2 - Control unit and WRU warning labels

Arrows on the pipelines in the system identify the direction of flow in the pipelines. Labels on the pipelines identify the substances in the pipelines, as follows:

ACID DRAIN	Black text on yellow background
COLD WATER	White text on green background
FUEL GAS	Black text on yellow background
AMBIENT AIR	Black text on green background
NITROGEN	Black text on green background

1.3 Overview of the systems

The TCS, TPU and Kronis systems are designed to treat the hazardous exhaust gases from semiconductor applications such as LPCVD, PECVD, MOCVD and dielectric etch.

Each of the systems uses an inward fired combustor coupled with a three-stage wet scrubber system, to ensure a high destruction rate efficiency together with the effective removal of by-products and the capture of powder deposits, which are removed to acid drain.

The TCS is suitable for all CVD applications and will treat the by-products of NF_3 chamber cleans, but is not suitable for the abatement of PFC gases themselves.

The TPU is suitable for all CVD and many etch applications, particularly those which use PFC perfluorinated compound gas species or ClF_3.

The Kronis is suitable for low K dielectric CVD applications, where precursors such as trimethyl-silane $(CH_3)_3SiH$, tetramethylsilane $(CH_3)_4Si$ and dimethyldimethoxysilane $(CH_3O)_2Si(CH_3)_2$ are used. The by-products of PFC species (C_3F_8) and NF_3 chamber clean processes will also be abated.

All of the systems are supplied as an abatement system enclosure (see Section 1.4), together with a WRU (Water Recirculation Unit: see Section 1.5), or a Services Module (see Appendix A8).

You must install and use the WRU or Services Module (as described in this manual), to condition your services supplies to meet the system enclosure requirements, as specified in Section 2.

Three types of each of the abatement systems are available (the E, J and S models), configured for use with European, Japanese and US electrical supplies. Also, your system can be supplied with four inlets, two inlets or a single inlet.

Note that your system may be supplied with a number of ordering options (see Section 1.11). The main part of this manual describes a basic abatement system with a WRU but without other ordering options; refer to Appendices A4 onwards for descriptions of the ordering options.

Note: The TMS (Temperature Management System) ordering option for TCS and TPU systems is described in Appendix A4.

A TMS is supplied fitted as standard to Kronis systems, to prevent the condensation of the precursors or by-products in the Kronis inlet pipelines. The Kronis TMS differs from the TCS and TPU TMS option, and is described in Appendix A5.

1.4 The abatement system enclosure

Refer to Figure 3. The abatement system enclosure has the following major components:

- A combustor (15). During normal system operation (that is, when the bypass valves are on-line: see Section 1.8.4), process gas flows from the pumping systems directly into the combustor, which provides thermal destruction of the gases.
- A three-stage wet scrubber system. The scrubber system consists of the cyclone scrubber (12), the quench/weir (13), and the packed tower (4) which remove the combustion by-products such as HF and SiO_2.

The treated gases then flow into the exhaust gas outlet (1). You will connect the exhaust gas outlet to your exhaust-extraction system.

When a bypass valve is off-line (see Section 1.8.4), the gases from a pumping system do not pass into the combustor but are routed directly to the pumping system bypass outlet. You must configure the bypass outlets as described in Section 3.3.4.

You must provide an electrical supply and nitrogen supplies (for combustor purge and for actuation of valves) to the abatement system enclosure.

On a TPU or Kronis system, you must also provide an oxygen supply to the abatement system enclosure.

You must provide other services supplies for the WRU (see Section 1.5) or Services Module (see Appendix A8).

You must connect the abatement system enclosure to a suitable cabinet-extraction system.

You will connect control signals from your pumping systems and from your Process Tool to the abatement system enclosure (through the interface module: Figure 16, item 9), to identify when a pumping system is on, and to identify when PFC gas is flowing into the abatement system.

1.5 The WRU (Water Recirculation Unit)

Note: The WRU will be supplied with the abatement system enclosure. Alternatively, you can order the system to be supplied with a Services Module (refer to Appendix A8). If you require another installation configuration, contact BOC Edwards at the address given in Section 1.13.

You must provide the following services for the WRU:

- Fuel gas supply, for the combustor in the abatement system enclosure.
- Make-up water supply, which is filtered and used to provide a scrubber water supply for the scrubber system in the system enclosure.
- Cooling-water supply, to cool the scrubber water supply to the system enclosure.

The WRU contains all of the devices necessary to regulate the pressures of the scrubber water and fuel gas services supplies, to monitor supply pressures and flows, and to pump the acid waste water from the abatement system enclosure, into your unpressurised acid drain outlet.

(continued on page 6)

The electrical supply and the nitrogen supplies for the components in the WRU are supplied from the abatement system enclosure.

You will connect the fuel gas, make-up water and cooling-water supplies to the inlets on the WRU (see Figure 15).

The WRU has flexible fuel gas and scrubber water outlet pipes which you will connect to the inlets in the abatement system enclosure; you will also connect the water return pipe (from the acid water drain tank) to the WRU: refer to Section 3.9.

1.6 Principle of abatement system operation

1.6.1 Introduction

Refer to Figure 4. During normal operation, process gases from the pumping systems enter the inlets, then pass through the bypass valves [YV-113 to YV-116]. The gases then pass into the combustor (see Section 1.6.2), then through to the three-stage scrubber (refer to Sections 1.6.3 to 1.6.5).

Treated gas passes through the exhaust outlet and into your exhaust-extraction system. Acid waste water from the drain tank is recycled (by the WRU: see Section 1.7.3), and pumped to a non-pressurised outlet to your acid drain system.

A General view of the enclosure
B Standard inlet configuration
C High CF_4 abatement option inlet configuration (TPU systems only)

1. Exhaust gas outlet
2. Fuel gas detector (optional)
3. Control unit
4. Packed tower
5. Ventilation grill
6. WRU
7. Right-hand door
8. Acid water drain tank
9. Water leak detector
10. Drip tray
11. Air blower
12. Cyclone scrubber
13. Quench/weir
14. Left-hand door
15. Combustor
16. Inlet head
17. Combustor sight-glass
18. Inlet pipelines
19. Elbow
20. 'T' piece and spool
21. Bypass valve actuator

Figure 3 - Key

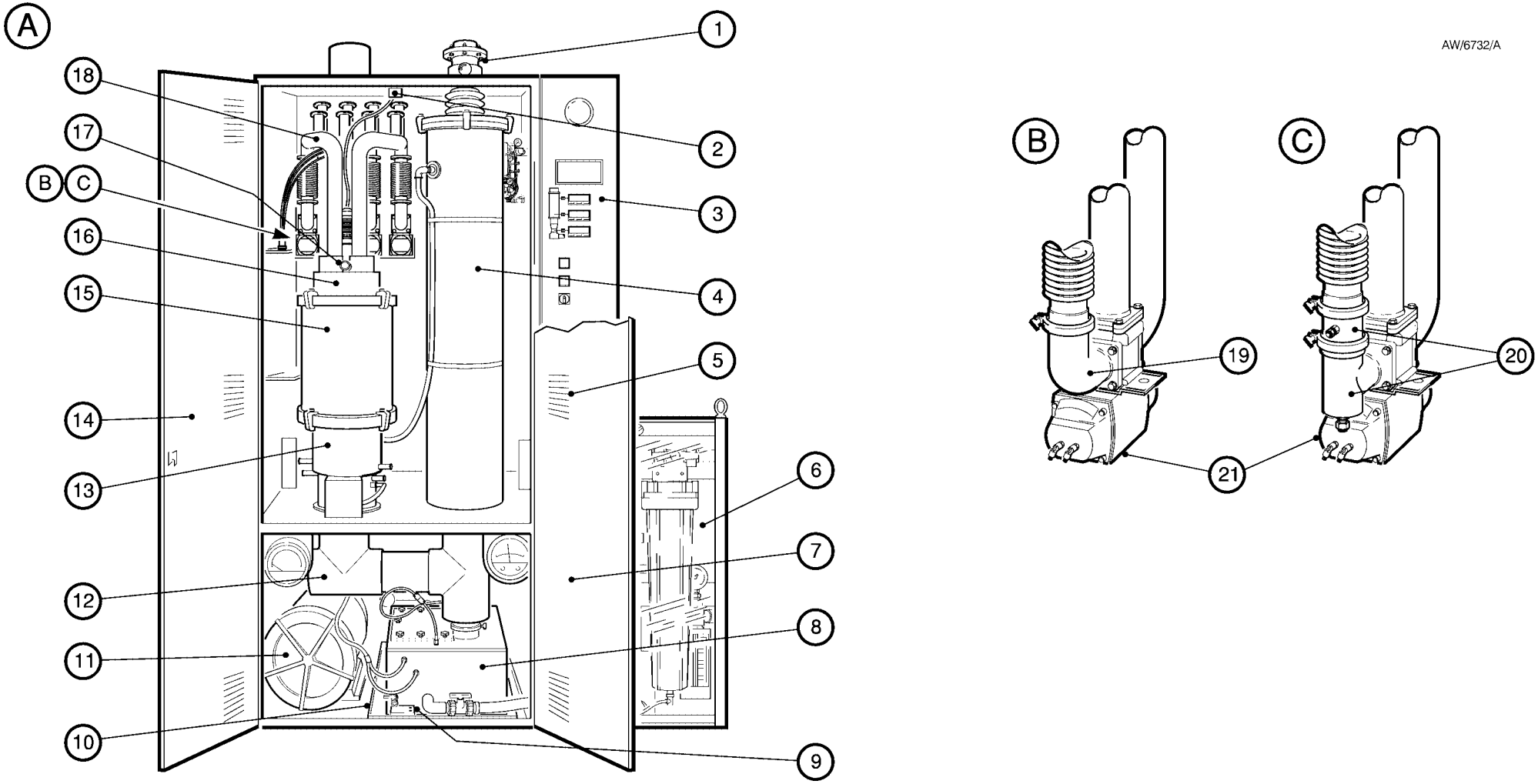


Figure 3 - The abatement system enclosure

1.6.2 Combustor operation

Refer to Figure 4. The combustor in the abatement system enclosure is an Alzeta Corporation high efficiency, automatic forced-draft radiant combustor.

TCS combustor operation

In normal operation (when your pumping systems indicate that process gas is flowing into the abatement system):

- Process gas enters the inlet head and passes into the combustion chamber. A mixture of air (from the blower [BR-300]) and fuel gas is fed into the annular plenum chamber. This mixture than passes through the perforated plate and then through the porous ceramic combustor liner.
- The spark igniter [BX-402] and the pilot assembly ignite the gases in the combustor, and combustion of the fuel gas, air and process gas then takes place. No flame is visible, although the surface of the combustor liner becomes incandescent (a bright orange colour). You can see the liner through the combustor sight-glass (Figure 3, item 17).
- After combustion, the gas stream passes into the three-stage wet scrubber system: see Section 1.6.3.

TPU combustor operation

The combustor has two modes of operation:

- **Low fire**
  This is the normal mode of operation, and is automatically selected when your pumping systems indicate that process gas is flowing into the abatement system and your Process Tool indicates that no PFC gas is flowing into the abatement system.
- **High fire**
  High fire mode is automatically selected when your pumping systems indicate that process gas is flowing into the abatement system and your Process Tool indicates that PFC gas is flowing into the abatement system.

In low fire operation, the TPU operates in the same way as the TCS.

In high fire operation, the combustor operates as in low fire mode, but oxygen is also drawn into the process gas inlet pipeline, additional fuel gas is drawn into the inlet head, and a higher flow of fuel gas is drawn into the plenum chamber.

Kronis combustor operation

The combustor in the Kronis has three modes of operation:

- **Low fire**
  This mode of operation is automatically selected whenever all of the bypass valves are off-line (that is, your pumping systems indicate that no process gas is flowing into the abatement system).
- **High fire (deposition)**
  This mode is automatically selected when your pumping systems indicate that process gas is flowing into the abatement system and your Process Tool indicates that no PFC gas is flowing into the abatement system.

- **High fire (clean)**
  This mode is automatically selected when your pumping systems indicate that process gas is flowing into the abatement system and your Process Tool indicates that PFC gas is flowing into the abatement system.

In low fire operation, the Kronis operates in the same way as the TCS: see page 8.

In high fire (deposition) operation, the combustor operates in the same way as the TCS (see page 8), but oxygen is drawn into the inlet head, and a higher flow of fuel gas is drawn into the plenum chamber.

In high fire (clean) operation, the combustor operates as described for the high fire (deposition) mode, except that:

- Oxygen is drawn into the process gas inlet pipeline.
- A mixture of nitrogen (to purge any residual oxygen) and fuel gas is drawn into the inlet head.

1.6.3 Quench

Immediately after combustion, the hot gases enter the quench (Figure 3, item 13). Two scrubber water spray jets provide a finely atomised water spray across the hot gas stream. Scrubber water is also piped directly to the quench wall, to cool the wall and to provide a protective weir effect to prevent corrosion of the wall by the hot gases. In this part of the scrubber, the hot gases cool to < 80 °C.

As they cool, the gases become saturated with water vapour and drop through the quench towards the cyclone scrubber.

Particulates in the gases are entrained in the water vapour, which condenses as water at the bottom of the quench.

1.6.4 Cyclone scrubber operation

In the cyclone scrubber (Figure 3, item 12), the inertia of the gases, the inertia of the scrubber water from the water jet and the internal structure of the scrubber force the gas stream to rotate rapidly.

The gases and water vapour enter the cyclone scrubber at a speed of approximately 5 m s^{-1}; this results in a gas rotational speed of 1350 r min^{-1} (equivalent to a centripetal acceleration of 150 g).

The action of the water jet ensures that the scrubber water and gases flow towards the acid water drain tank and the base of the packed tower.

Any fine particulate not entrained in the quench stage will be entrained in the water which forms on the scrubber walls.

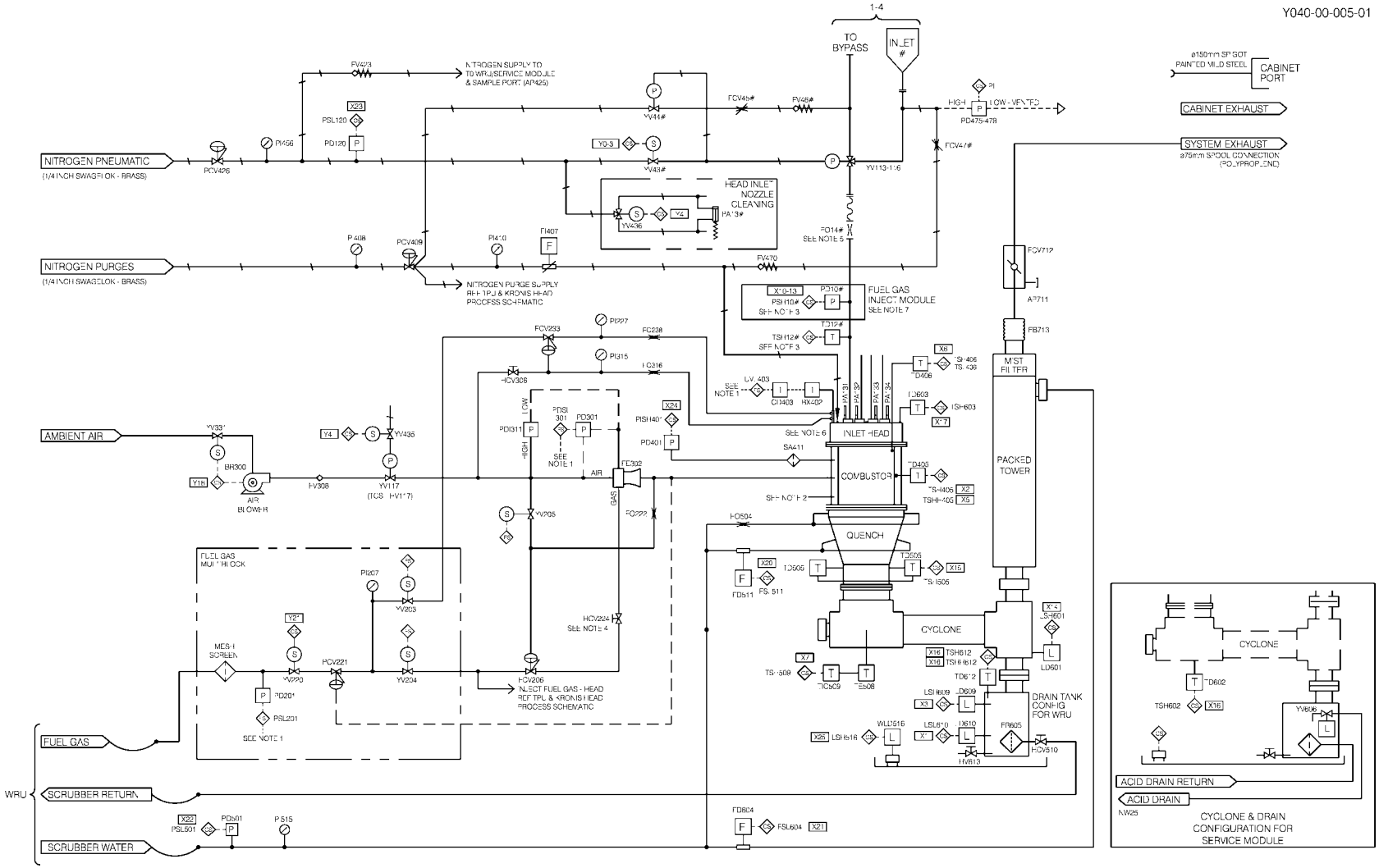


Figure 4 - Abatement system enclosure piping and instrumentation diagram (sheet 1): abatement system enclosure

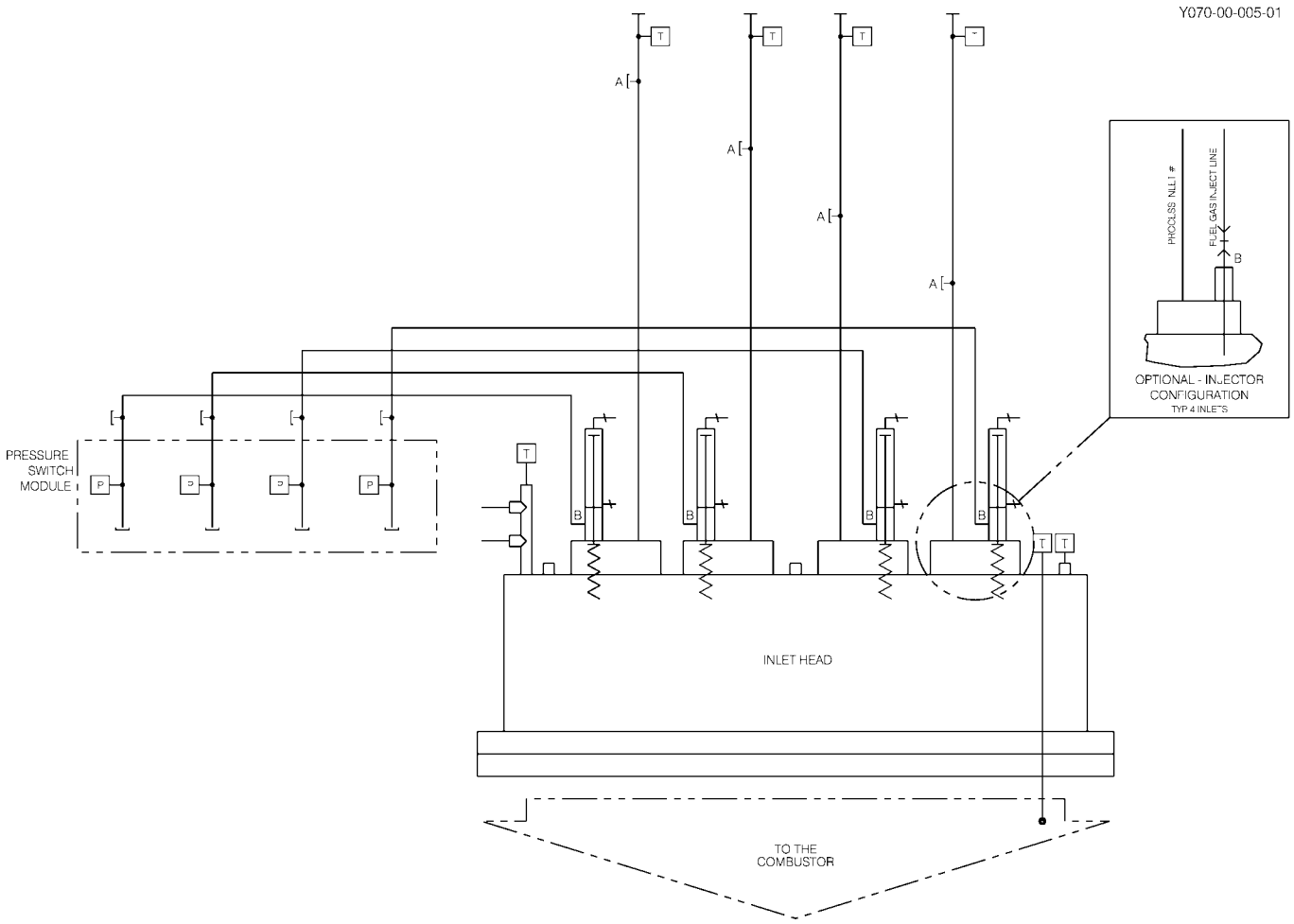


Figure 4 - Abatement system enclosure piping and instrumentation diagram (sheet 2): TCS inlet head

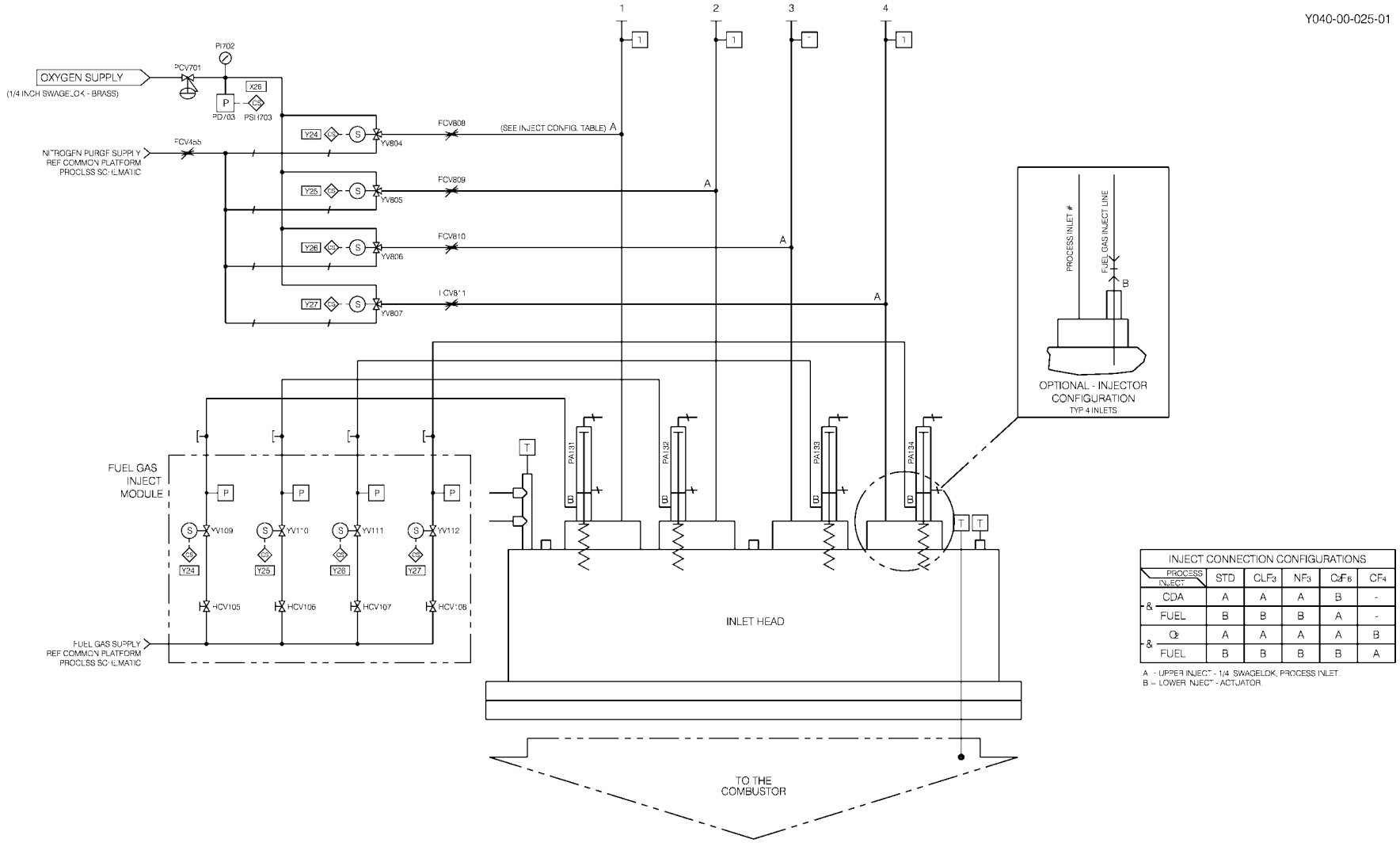


Figure 4 - Abatement system enclosure piping and instrumentation diagram (sheet 3): TPU inlet head

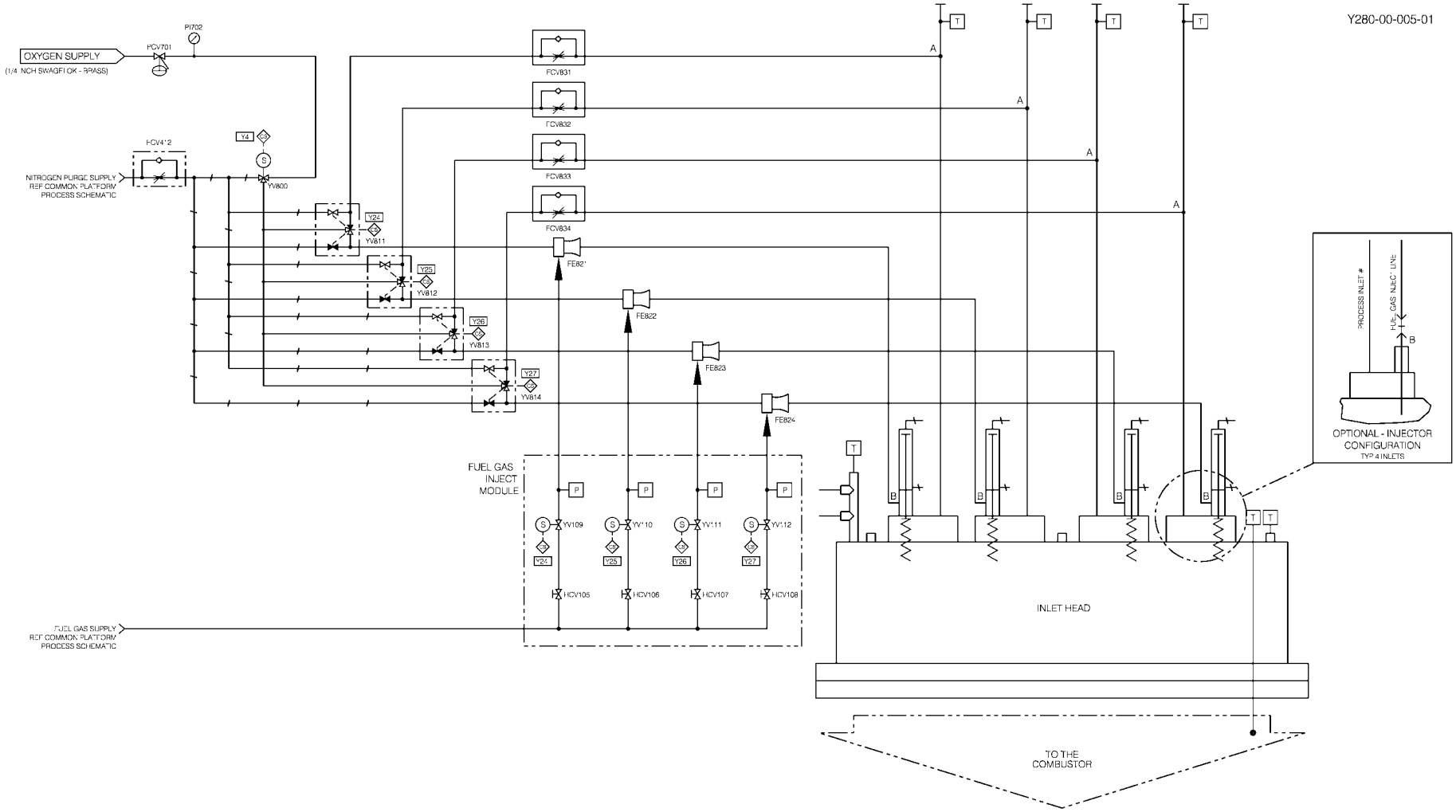


Figure 4 - Abatement system enclosure piping and instrumentation diagram (sheet 4): Kronis inlet head

Device abbreviations:

AP#	Sample port
BR#	Blower
BX#	Flame scanner
FB#	Flexible bellows
FCV#	Flow control valve
FD#	Flow device
FE#	Mixer assembly
FI#	Flow indicator
FO#	Flow orifice
FR#	Filter
FV#	Flow check valve
HCV#	Hand control valve
HV#	Hand valve
ICD#	Ignition control device
LD#	Level device
PA#	Pressure actuator
PCV#	Pressure control valve
PD#	Pressure device
PDI#	Differential pressure indicator
PI#	Pressure indicator
SA#	Spark arrestor
TD#	Temperature device
TE#	Thermocouple
TIC#	Temperature controller
WLD#	Water leak detector
YV#	Control valve

Process interlock abbreviations:

FSL#	Flow switch low
LSH#	Level switch high
LSL#	Level switch low
PDSL#	Pressure switch low (differential)
PISH#	Pressure indicator switch high
PSH#	Pressure switch high
PSL#	Pressure switch low
TSH#	Temperature switch high
TSHH#	Temperature switch high high
TSL#	Temperature switch low
UVL#	UV low

Legend:

X#	PLC I/O reference (X = input; Y = output)
FS	Flame management system
CS	Control system
F	Flow device
L	Level device
P	Pressure device
T	Thermal device
P	Pneumatic actuator
S	Electrical solenoid

Figure 4 - Abatement system enclosure piping and instrumentation diagram (sheet 5): key

1.6.5 Packed tower operation

Refer to Figure 3. The gases pass from the cyclone scrubber (12) into the base of the packed tower (4). The tower is a high efficiency, counter-current tower, which contains high conductance/high surface area packing. Gas rises through the packing, which scrubs remaining acid/HF components from the gases.

A constant spray of scrubber water from the water jet entrains any remaining particulate and falls to the acid water drain tank. The cleaned gas stream finally passes through two mist filter elements which trap any water droplets, then out through the exhaust gas outlet and into your exhaust-extraction system.

1.7 Principle of WRU operation

1.7.1 Scrubber water supply conditioning

Refer to Figure 5. The WRU requires two separate water supplies, as follows:

- **Cooling-water supply**
  You will connect your cooling-water supply to the cooling-water supply inlet (Figure 15, item 9). This is a 'clean' supply, which does not come into contact with any of the treated process gases. This supply passes through the heat exchanger [HX-903] and is used to cool the recycled scrubber water from the abatement system enclosure (see below).

- **Make-up water supply**
  You will connect your make-up water supply to the make-up water supply inlet (Figure 15, item 8). The supply passes through a filter ([FL-505 or FL-507], see below) and is then used as scrubber water in the abatement system enclosure, as described in the other sections of this manual.

  Used scrubber water (acid waste water) is then recycled (see Section 1.7.3): it passes through the heat exchanger ([HX-903], cooled by the cooling-water supply), is mixed with the incoming make-up water supply and then passes through a filter [FL-505 or FL-507] and into the abatement system enclosure again.

The make-up water supply pipeline in the WRU has two water filters [FL-505, FL-507]. During normal operation, one of these filters is 'on line' (that is, filters the scrubber water supply to the system enclosure), and the other filter is isolated. When the on-line filter becomes blocked, you can configure the WRU so that the other (isolated) filter becomes the on-line filter, and isolate and change the blocked filter, without the need to shut down the system.

1.7.2 Fuel gas supply conditioning

Refer to Figure 5. The fuel gas passes from the inlet through the pressure regulator [PCV-203]. The pressure gauge [PI-205] indicates the pressure of the fuel gas supply to the abatement system enclosure. A flow indicator [FI-204] indicates the flow rate of fuel gas to the system enclosure.

A solenoid-valve [YV-201] isolates the fuel gas supply from the WRU and from the abatement system enclosure when the system shuts down, when the system is disconnected from the electrical supply, or when the WRU is electrically disconnected from the system enclosure.

A filter in the fuel gas multiblock traps any particulate greater than 0.5 mm diameter.

1.7.3 Water recirculation and pumped drain operation

Refer to Figure 5. The used scrubber water (acid waste water) from the system enclosure passes from the outlet of the acid water drain tank in the abatement system enclosure, into the WRU and through the heat exchanger [HX-903], where it is cooled by the cooling-water supply. The acid water drain tank in the system enclosure has two level switches [LSH-609, LSL-610]:

- When the level of acid waste water in the drain tank is below the upper level-switch [LSH-609], the acid waste water is mixed with the incoming make-up water supply, and then passes through a filter [FL-505 or FL-507] and into the abatement system enclosure again.
- When the level of acid waste water in the drain tank reaches the upper level-switch [LSH-609], the water is recirculated for a preset time, and then the pneumatically operated acid drain isolation valve [YV-608] is opened, to allow used scrubber water (acid waste water) out of the WRU and into your acid drain system.

Device abbreviations:

AP#	Sample port
BP#	Booster pump
FCV#	Flow control valve
FI#	Flow indicator
FL#	Filter
FO#	Flow orifice
HCV#	Hand control valve
HX#	Heat exchanger
PCV#	Pressure control valve
PI#	Pressure indicator
WLD#	Water leak detector
YV#	Control valve

Legend:

A	Actuator device
F	Flow device

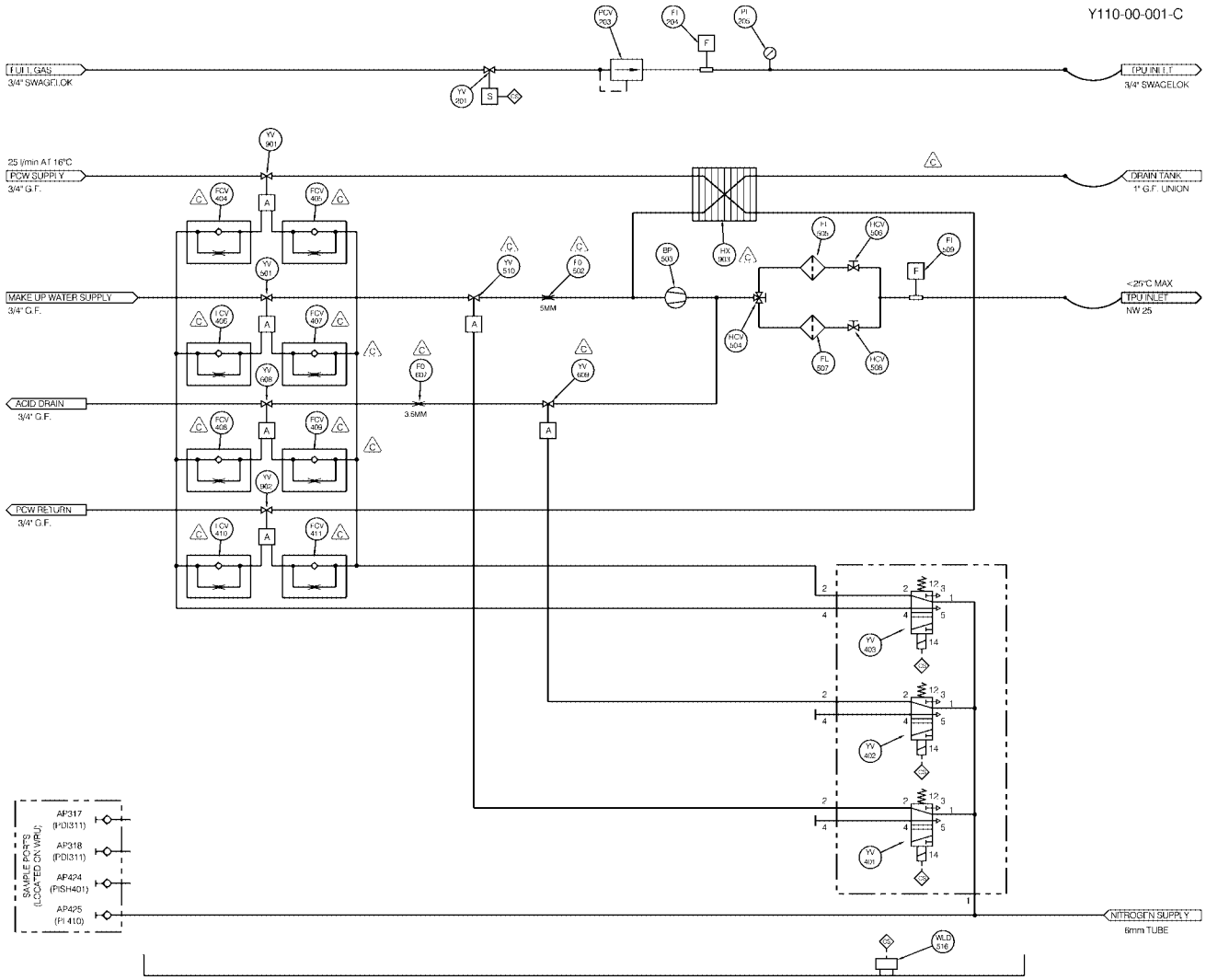


Figure 5 - WRU piping and instrumentation diagram

1.8 Control system

1.8.1 Introduction

The control system in the abatement system enclosure has the following main components:

- A PLC (Programmable Logic Controller).
- An FMS (Flame Management System).

In accordance with the requirements of the U.S. NFPA (National Fire Protection Association), the PLC is the master controller in the system and the FMS is a slave controller to the PLC.

1.8.2 Master controller PLC (Programmable Logic Controller)

The master controller is a PLC, which controls the overall operation of the system and:

- Monitors the process interlocks (see Section 1.10.3).
- Monitors the operation of the FMS (see Section 1.8.3).
- Actuates the pneumatically operated valves in the system enclosure.
- Displays status and fault messages on the status display (see Sections 4.9 and 5.14).
- Provides system warnings and alarms through the Interface Module (see Section 3.24)

1.8.3 FMS (Flame Management System)

The FMS is an electrical control unit, approved for combustion systems which use gaseous fuels. The FMS is connected to the master controller (the PLC), which requests the FMS to start or shut down the combustor, as appropriate.

When the master controller (PLC) initiates FMS 'combustor on', the FMS:

- Checks the process interlocks (see Section 1.10.3).
- Purges the combustor.
- Ignites the pilot flame, then allows fuel gas into the combustor.

During system operation:

- The FMS monitors the flame in the combustor until it is requested to turn off the main flame. If necessary (that is, if there is a flameout during operation), the FMS will try to relight the main flame: refer to Section 4.8.
- If one of the three FMS process interlocks operate (refer to Section 1.10.3), the FMS automatically closes the main fuel gas valve [YV-204] and initiates master controller (PLC) shut-down.

When the master controller (PLC) initiates 'combustor off', the FMS closes the main fuel gas valve.

1.8.4 Process gas flow control

Refer to Figure 4. The bypass valves [YV-113 to YV-116] have two positions: on-line and off-line. When the system start-up procedure has been completed and the signal from a pumping system indicates that the pumping system is operating, the PLC will actuate the corresponding bypass valve on the pump inlet pipeline to the on-line position, to allow process gases from the pumping system into the inlet head, then into the combustor.

The PLC will actuate the bypass valve to the off-line position (so that any process gas passes through the bypass pipe directly to your back-up treatment system), when any of the following occurs:

- The Process Tool indicates that no PFC gas is flowing (see Note 3) and the pumping system has not operated for approximately 40 seconds.
- The pressure switch [PSH-101 to PSH-104] indicates a high pressure in the inlet pipeline for more than 20 seconds.
- A bypass alarm or system alarm condition exists (see Section 1.10.3).
- The abatement system is switched to stand-by or off.
- The Process Tool indicates that PFC gas is flowing (see Note 3) and the pumping system is not operating.

Note 1: The system provides signals available to your Process Tool through the interface module, to identify when an abatement system bypass alarm condition exists (see Section 3.25). On receipt of a bypass alarm signal, your Process Tool must be configured to isolate the process gases at source, to reduce the flow of untreated process gases into your back-up treatment system, connected to the system bypass outlets.

Note 2: When a bypass alarm condition exists and the alarm output signal (for the Process Tool) is set, there is a small delay before the bypass valve goes off-line, to allow for the abatement of any residual process gas flows from the pumping system/vent line.

Note 3: 'PFC gas flowing' is as defined by the Process Tool signals connected to the PFC INTERFACE terminals in the interface module (see Sections 3.3.3 and 3.25). Note that on the TCS, you may not have connected signals from your Process Tool to the interface module.

1.8.5 Low and high fire control

TPU low and high fire control

In the TPU, if the pumping systems indicate that PFC gas is flowing into one of the system process gas inlets, the combustor is automatically switched to operate in high fire mode.

In high fire mode:

- For each inlet into which PFC gas is flowing:

  The PLC opens the appropriate inject valve [YV-109 to YV-112], to allow fuel gas to be pre-mixed (in the inlet pipeline) with the process gases from the pumping system.

  The PLC opens the appropriate inject valve [YV-804 to YV-807], to allow oxygen to flow in with the process gases from the pumping system.

- The PLC opens the combustor high fire valve [YV-117].

These actions ensure that the combustor operates at a suitable temperature to thermally destroy the PFC gases: see Section 1.6.2.

Kronis low and high fire control

In the Kronis, if the pumping systems indicate that process gas is flowing into one of the system process gas inlets (but the Process Tool indicates that no PFC gas is flowing into the abatement system), the combustor is automatically switched to operate in high fire (deposition) mode.

In high fire (deposition) mode:

- The PLC opens the oxygen isolation valve [YV-800] to make oxygen available for the inject system.
- For each inlet into which process gas is flowing:

  The PLC operates the appropriate inject valve [YV-811 to YV-814], to allow a nitrogen purge to be introduced into the process gas inlet pipeline, and to allow oxygen to be introduced through the inlet head into the combustor.
- The PLC opens the combustor high fire valve [YV-117].

If the pumping systems indicate that process gas is flowing into one of the system process gas inlets and the Process Tool indicates that PFC gas is flowing into the abatement system, the combustor is automatically switched to operate in high fire (clean) mode. In high fire (clean) mode:

- For each inlet into which PFC gas is flowing:

  The PLC opens the appropriate inject valve [YV-109 to YV-112], to allow fuel gas to be pre-mixed (with nitrogen) before being introduced through the inlet head into the combustor, for mixing with the process gases from the pumping system.

  The PLC operates the appropriate inject valve [YV-811 to YV-814], to allow oxygen to be introduced into the process gas inlet pipeline for mixing with the process gases from the pumping system, and to allow nitrogen to be pre-mixed (with fuel gas) before being introduced through the inlet head into the combustor, for mixing with the process gases from the pumping system.

Note 1: The oxygen isolation valve [YV-800] remains open in high fire (clean) mode, to make oxygen available for the inject system.

Note 2: The combustor high fire valve [YV-117] remains open in high fire (clean) mode, to allow a higher flow of fuel gas to be drawn into the plenum chamber.

1.9 Controls and displays

1.9.1 Abatement system enclosure controls and displays

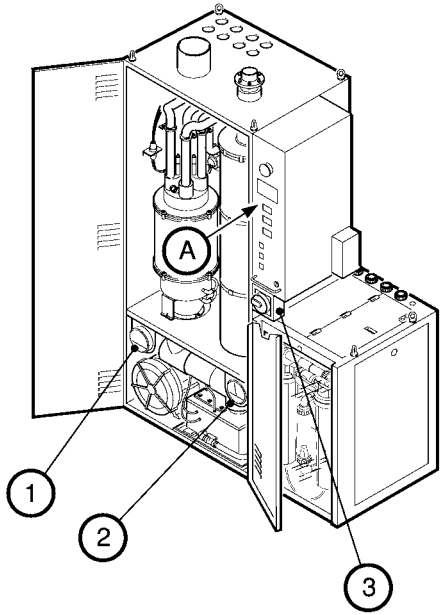
Refer to Figure 6. The abatement system enclosure has the following controls and displays:

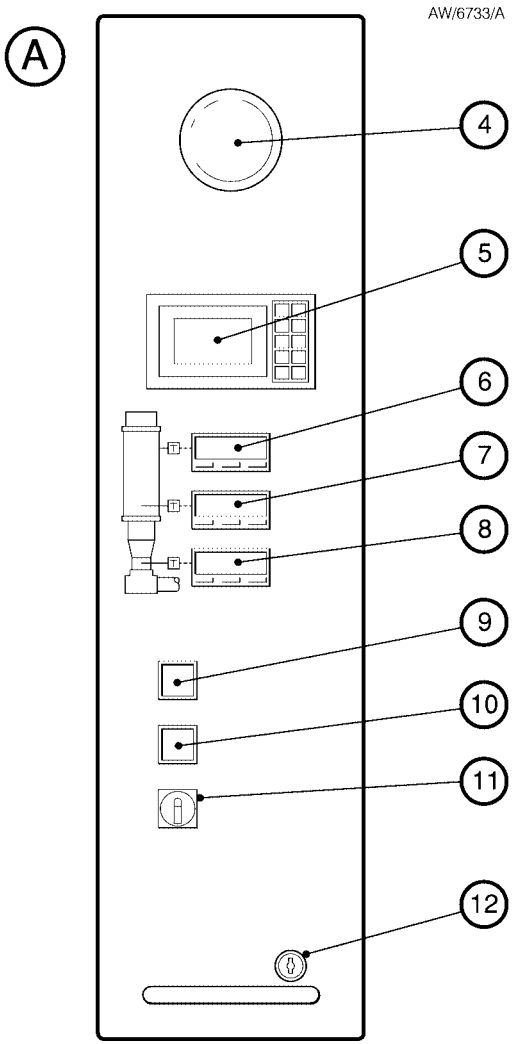
Fuel/air differential pressure gauge (1)
This gauge shows the differential pressure of the fuel and air across the venturi air/fuel gas mixer.

Plenum chamber pressure gauge (2)
This gauge shows the pressure in the plenum chamber.

Electrical supply isolator (3)
Use this to isolate the abatement system from the electrical supply. The isolator can be padlocked in the 'off' position for electrical safety during maintenance or servicing.

(continued on page 22)





1. Fuel/air differential pressure gauge
2. Plenum chamber pressure gauge
3. Electrical supply isolator *
4. Emergency stop switch
5. Status display
6. Plenum chamber temperature display
7. Combustion chamber temperature display
8. Quench outlet temperature display
9. Status lamp
10. Reset button
11. Start/stop switch
12. Keylock

* Or breaker disconnect: see Section 3.26.1

Figure 6 - Abatement system enclosure controls and indicators

Emergency stop switch (4)
Use this switch to shut down the abatement system in an emergency: refer to Section 4.6.

Status display (5)
This is a four line, back-lit LCD display, with 16 characters per line. During normal operation, the display shows the status of the abatement system (see Section 4.9). If the system shuts down, the display will show fault messages which identify the cause of the shutdown (refer to Section 5.14).

Plenum chamber temperature display (6)
This digital display is part of the plenum chamber temperature controller, and shows the temperature of the fuel gas mixture in the plenum chamber.

Combustion chamber temperature display (7)
This digital display is part of the combustion chamber temperature controller, and shows the temperature of the gases in the combustion chamber.

Quench outlet temperature display (8)
This digital display is part of the quench outlet temperature controller, and shows the temperature of the gases at the quench outlet.

Status lamp (9)
This lamp is on when the abatement system is connected to the electrical supply and the electrical isolator (3) is on.

Reset button (10)
Use this to set the abatement system into a ready state before start-up, or to restart the abatement system after an emergency shutdown: refer to Section 4.7.

Start/stop switch (11)
Use this to start up or shut down the abatement system (see Sections 4.1 and 4.4).

Keylock (12)
Use this to lock or unlock the control unit in the enclosure.

1.9.2 WRU controls and indicators

Refer to Figure 7, detail B. The controls and indicators on the WRU are as follows:

Filter 1 isolation valve (5)
Use this valve to isolate water filter 1 from the make-up water supply when you need to change the filter: refer to Section 5.10.

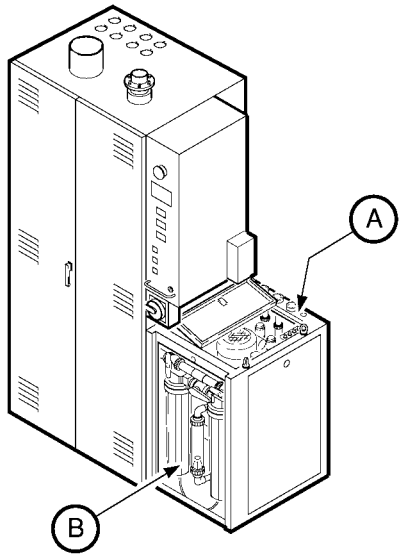
Filter changeover valve (6)
Use this valve to direct the make-up water supply to filter 1 or to filter 2 (for example, when you change a filter: refer to Section 5.10) An arrow on the valve indicates the 'on-line' filter.

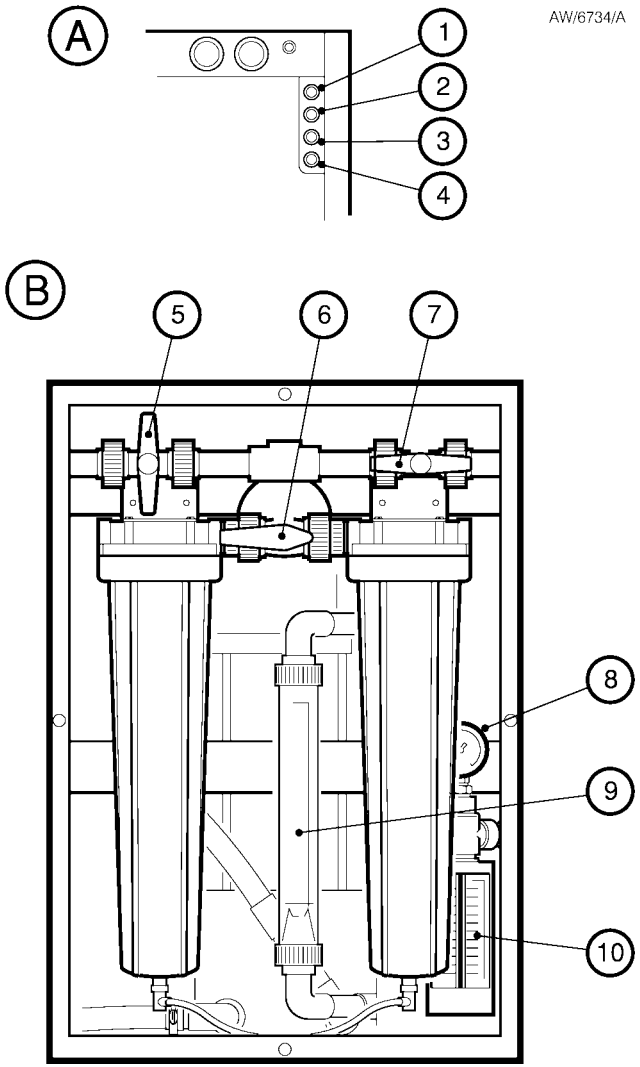
Filter 2 isolation valve (7)
Use this valve to isolate water filter 2 from the make-up water supply when you need to change the filter: refer to Section 5.10.

Fuel gas pressure gauge (8)
The shows the pressure of the regulated fuel gas supply to the abatement system enclosure.

Water flowmeter (9)
This shows the scrubber water flow rate to the abatement system enclosure.

Fuel gas flowmeter (10)
This shows the regulated fuel gas flow rate to the abatement system enclosure.





1. Fuel/air differential pressure sample port (AP317)
2. Fuel/air differential pressure sample port (AP318)
3. Plenum chamber pressure sample port (AP424)
4. Nitrogen pressure sample port (AP425)
5. Filter 1 isolation valve
6. Filter changeover valve
7. Filter 2 isolation valve
8. Fuel gas pressure gauge
9. Scrubber water flowmeter
10. Fuel gas flowmeter

Figure 7 - WRU controls and indicators

1.10 Safety features

1.10.1 Introduction

The abatement system uses two sets of interlocks:

- System safety interlocks
- Process interlocks

These interlocks and their associated fault levels are described in the following Sections.

In addition there are interlocks associated with some of the ordering options: refer to the corresponding Appendix for each ordering option for details.

1.10.2 System safety interlocks

Note: The Cabinet-Extraction Interlock is an accessory. To meet SEMI-S13 requirements, you must install this accessory.

The abatement system has four system safety interlocks to meet SEMI-S13 requirements:

- Emergency stop
- Process gas high temperature switch
- Nitrogen supply low pressure switch
- Cabinet-extraction warning/shut-down

The system safety interlocks (and the setpoints at which they operate) are shown in Table 1 and are described below.

The operation of these interlocks will be verified by a service engineer during scheduled maintenance operations, as defined by the maintenance schedule applicable to your installation.

Emergency stop [EMS]

The abatement system has an emergency stop switch on the front of the control unit. Use of the switch will cause an alarm fault condition and a controlled shut-down of the system.

Process gas high temperature switch [TSH121-124]

Each abatement system process gas inlet is fitted with a temperature snap-switch, linked to the PLC. If the setpoint of a temperature snap-switch is reached, the PLC will shut down the abatement system in an alarm condition.

Nitrogen supply low pressure switch [PSL-120]

The abatement system enclosure is fitted with a low pressure switch on the nitrogen supply, linked to the PLC. If the setpoint of the nitrogen supply low pressure switch is reached, the PLC will cause the system to enter a system warning condition.

Cabinet-extraction warning/shut-down

To meet SEMI-S13 requirements, you must install the Cabinet-Extraction Interlock accessory (see Appendix A12).

The accessory provides warning and shut-down signals, which indicate that the extraction rate is less than the rate required to meet SEMI-F15 requirements.

You must connect the shut-down signal to the Process Tool to shut down the abatement system when the cabinet-extraction system has failed.

Interlock	Tag	Setpoint	Fault level	Alarm timeout *	Monitored by
Emergency stop	EMS	-	System alarm	-	PLC
Process gas high temperature switch	TSH121-124 †	180 °C	Bypass alarm	-	PLC
Cabinet-extraction low pressure	PSL-715	+0.4 inches wg	System warning	-	PLC
Nitrogen low pressure switch	PSL-120	3 bar gauge	System warning	-	PLC

Table 1 - System safety interlocks

* The alarm timeout is the time that the abatement system will monitor the alarm condition before initiating abatement system shut down.

† TSH-121 is the interlock for inlet 1, TSH-122 is the interlock for inlet 2, and so on. Each of the TSH interlocks is connected in series with the corresponding PSH process system interlock (and with the corresponding 'PUMP INTERFACE' control input signal: see Table 24). If any of the interlocks operate (and the corresponding 'PUMP INTERFACE' control signal indicates that the pumping system/vent line connected to the inlet is operating), a 'BYPASS LOCKOUT' message will be displayed.

1.10.3 Process interlocks and Process Tool fault outputs

The system has 29 process interlocks; these interlocks (and the setpoints at which they operate) are shown in Table 2 (see page 27). The PLC monitors 26 of these interlocks, and the FMS monitors 3 hardwire interlocks. Each interlock has an associated fault level (system warning, system alarm or bypass alarm). The meanings of the fault levels are as follows:

- **Bypass alarm** means that the abatement system will continue to operate, but warns that one or more of the bypass valves are in the off-line position.
- **System warning** means that there is a fault which may become serious; the abatement system will continue to operate until a shut-down condition occurs. The system warning remote fault output is set when a system warning fault exists.

  Note that system warning faults are not 'latched'; if a system warning fault condition occurs (and the system warning remote fault output is set), the system warning remote fault output will be reset if the fault condition then clears.
- **System alarm** means that there is a serious fault. When a system alarm fault condition exists, all of the bypass valves are set to the off-line position and the abatement system will automatically initiate shut down.

The abatement system provides remote fault outputs, which you can connect to your Process Tool (see Section 3.25). If the PLC detects that the abatement system is in a fault condition, the remote fault outputs will identify the fault level (that is, bypass alarm, system warning or system alarm).

1.10.4 Failure of your services

If any of your services fail, the abatement system will respond to the appropriate process interlocks which operate. If a system alarm condition results, the bypass valves will be actuated to the off-line position, so that process gas will be routed directly to the bypass outlets and will not be treated in the abatement system.

If the failure of your services causes a system alarm fault (see Table 2), the abatement system will automatically initiate shut down.

When the process interlocks operate, appropriate fault messages will be shown on the status display and the remote fault outputs will identify the fault level to your Process Tool (see Section 1.10.3).

Interlock	Tag	Setpoint	Fault level	Alarm timeout	Monitored by
Process gas high pressure switch *	PSH-101 to 104	+2 inches wg	Bypass alarm	-	PLC
Scrubber water supply low pressure switch	PSL-501	3 bar gauge	System warning #	#	PLC
Combustor gas low temperature switch	TCH-406	400 °C †	System warning	-	PLC
Oxygen high pressure switch Ø	PSH-703	12 psi	System warning	-	PLC
Quench wall high temperature switch	TSH-505	70 °C	System alarm	30 seconds	PLC
Quench low water flow switch	FSL-511	3 l min^{-1}	System alarm	30 seconds	PLC
Inlet head high temperature switch	TSH-603	120 °C	System alarm	30 seconds	PLC
Packed tower low water flow switch	FSL-604	3 l min^{-1}	System alarm	30 seconds	PLC
Quench outlet high temperature switch	TCH-509	80 °C	System alarm	5 seconds	PLC
Drain water high level switch	LSH-601	-	System alarm	1.5 seconds	PLC
Combustor gas high temperature switch	TCH-406	1150 °C	System alarm	5 seconds	PLC
Plenum chamber high pressure switch	PISH-401	+4 inches wg	System alarm	1.5 seconds	PLC
Pre-mix fuel gas high temperature switch	TCH-405	150 °C	System alarm	5 seconds	PLC
Fuel gas low pressure switch	PSL-201	7.5 mbar	System alarm	2 seconds	FMS
Air flow differential low pressure switch	PDSL-301	+2.5 inches wg	System alarm	2 seconds	FMS
Flame monitor (flame detector)	BE-403	<1 µA for > 1 sec	System alarm	2 seconds	FMS
Water leak detector	WLD-516	-	System alarm	1.5 seconds	PLC

Table 2 - Process interlocks

Interlock	Tag	Setpoint	Fault level	Alarm timeout	Monitored by
Water temperature alarm §	TSH-612	60 °C	System alarm	1 second	PLC
Water temperature warning §	TSH-612	55 °C	System warning	-	PLC
Water level switch failure §	LSH-609	-	System alarm	1 second	PLC
Water level switch failure §	LSL-610	-	System alarm	1 second	PLC
Acid drain fail §	‡	‡	System warning	‡	PLC
Water in low §	‡	‡	System warning	‡	PLC
Water leak detector §	WLD-516	-	System alarm	1.5 seconds	PLC
Fuel gas detector (optional)	FGD-230	-	System alarm	0 seconds	PLC
Remote level $	-	-	System alarm	0 seconds	PLC
Remote on/off $	-	-	System alarm	0 seconds	PLC
Remote gas $	-	-	System alarm	0 seconds	PLC
TMS temperature low Ω	-	-	System warning	-	PLC

Table 2 - Process interlocks (Continued)

* PSH-101 is the interlock for inlet 1, PSH-102 is the interlock for inlet 2, and so on. Each of the PSH interlocks is connected in series with the corresponding TSH safety interlock (see Table 1) and with the corresponding 'PUMP INTERFACE' control input signal: see Table 24. If any of the interlocks operate (and the corresponding 'PUMP INTERFACE' control input signal indicates that the pumping system/vent line connected to the inlet is operating), a 'BYPASS LOCKOUT' message will be displayed.

\# On start-up, if the scrubber water supply low pressure system warning fault condition persists continuously for 10 seconds, the abatement system will then automatically shut down in a system alarm fault condition. Once the abatement system has started up correctly and is operating with the bypass valves on-line, if the scrubber water supply low pressure system warning fault condition persists continuously for a preset timeout time, the abatement system will then automatically shut down in a system alarm fault condition. The default timeout time is 24 hours, but can be adjusted by a BOC Edwards Service Engineer.

Ø Only applicable to TPU systems. The abatement system will not enter high fire mode if this interlock is in the warning condition.

† 400 °C is the normal factory setting, but during commissioning, a BOC Edwards engineer can adjust this setpoint in the range 400 to 600 °C, to suit your installation.

§ These interlocks are in/generated by the WRU.

‡ These faults are derived from interlock tags LSH-609 and LSH-610. If either of these faults persist, after 4 minutes the abatement system enters a system alarm fault condition.

$ Remote control input signals: see Section 3.25.

Ω Kronis only: see Appendix A5.

Table 2 - Process interlocks: notes

1.10.5 Sample ports

CAUTION

The sample ports are only provided for use by qualified service engineers, with the correct equipment.

Refer to Figure 7, detail A. The WRU has four sample ports (1 to 4) under the top cover. At any time, these sample ports can be used as described below to monitor pressures in the abatement system enclosure, without the need to open the enclosure:

- The fuel/air differential pressure sample ports (AP317 and AP318) (1, 2) can be used to monitor the fuel/air differential pressure. These sample ports are connected directly to the sample ports in the abatement system enclosure (Figure 14, items 15 and 14).
- The plenum chamber pressure sample port (AP424) (3) can be used to monitor the pressure in the combustor plenum chamber. This sample port is connected directly to the sample port in the abatement system enclosure (Figure 14, item 10).
- The nitrogen pressure sample port (AP425) (4) can be used to monitor the pressure of the nitrogen supply from the abatement system enclosure.

1.11 Ordering options

Note 1: TMS is supplied fitted as standard to Kronis systems. Refer to Appendix A5 for a description of the Kronis TMS.

Note 2: The High CF_4 Abatement option is not available on TCS or Kronis systems.

You can order the abatement system with one or more of the following ordering options:

TMS (Temperature Management System) for TCS and TPU systems
This option is recommended for TEOS, W-CVD and metal etch processes, and other processes which generate condensable by- products. Refer to Appendix A4 for a description of this option.

Remote Bypass Module
Select this option if you want the bypass valves to be outside the abatement system enclosure. Refer to Appendix A6 for a description of this option.

Bypass Nitrogen Dilution
This option is essential for ClF_3 applications, and is recommended for SiH_4 applications. Refer to Appendix A7 for a description of this option.

High CF_4 Abatement
This option is required to achieve high abatement efficiency on CF_4 applications. When you order the system with this option, the inlet configuration differs from the standard configuration: see Figure 3, details B and C.

Fuel Gas Detector
If you select this option, the abatement system is supplied with a detector (Figure 3, item 2) fitted in the system enclosure. The detector is connected to the control system and will shut down the system if fuel gas is detected in the enclosure.

Services Module
With this option, the abatement system is supplied with a Services Module, instead of a WRU. The Services Module has separate scrubber water supply booster and acid drain pumps, and is less water efficient than a WRU. Refer to Appendix A8 for a description of the Services Module.

Acid Drain Tank Filter
This option is only available if you also order the Services Module option. If you select this option, the abatement system is supplied with a filter (Figure A11, item 6) fitted in the acid water drain tank.

Spring Return Bypass
Select this option to provide additional safety in the event of an electrical supply failure or a nitrogen supply failure. Refer to Appendix A10 for a description of this option.

Secondary Containment Kit
This Kit comprises a secondary containment tray and an additional water leak detector. The abatement system enclosure and WRU (or Services Module) are mounted on the tray, which will contain any water leaks from the enclosure or WRU/Services Module. Refer to Appendix A11 for a description of this option.

1.12 Accessories

A number of accessories are available for the abatement system.

Refer to Section 7.4 for a description of these accessories and their Item Numbers.

1.13 Contact information

If you require any information further to that contained in this manual, contact the BOC Edwards Exhaust Management Group at the following address:

BOC Edwards
Exhaust Management Group
Kenn Business Park
Kenn Road
CLEVEDON
North Somerset
BS21 6TH
United Kingdom

Phone:+44 (0) 1275 337100
Fax:+44 (0) 1275 337200
Email:support.clevedon@edwards.boc.com

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2 TECHNICAL DATA

CAUTION
With respect to European Electromagnetic Compatibility (EMC) requirements for harmonics and flicker, the abatement system should be treated as Class A (industrial) as defined by EN 61326. In this context the abatement system is not intended for use in domestic buildings, or in properties directly connected to an electrical supply network which also supplies domestic buildings.

Note: Refer to Appendices A4 onwards for additional technical data for ordering options.

2.1 Operating and storage conditions

Operating environment	Suitable for indoor use only
Operating/storage ambient temperature range	5 to 40 °C
Operating/storage ambient humidity range	30 to 95% RH, non-condensing
Maximum operating altitude	2000 m
Installation category	Class 2
Pollution category	2

Table 3 - Operating and storage conditions

2.2 Mechanical data

Dimensions	See Figures 8 and 9
Mass	
Abatement system enclosure	410 kg
WRU: 'E' model	101.5 kg
WRU: 'S' and 'J' models	103.5 kg
Centre of mass	See Figure 8

Table 4 - Mechanical data

2.3 Process gas flow rates

WARNING

You must not operate vacuum pump and abatement systems with gas mixtures in the flammable zone.

You must not introduce liquids, either fuels or oxidants, into abatement systems and you must prevent flammable vapours condensing in pump exhaust pipework leading to abatement systems.

Failure to follow the above requirements may result in uncontrolled thermal reactions, which may give rise to a hazardous situation.

If flammable gases and/or vapours are introduced into the exhaust management system, then the pump mechanism and abatement systems must be considered an ignition source in the hazard analysis undertaken by the user and, as a minimum, the following actions must be taken:

1. Ensure that the system is leak tight.
2. Ensure that gas dilution is provided by using an inert gas (for example, N_2) inlet purge and/or gas ballast purge to:
   - Reduce the concentration of flammable gases or vapours within the pump and exhaust line (refer to Tables 6 to 9 for the dilution standards for for individual gas species); this is the 'dilution requirement'. Only if the inlet or gas ballast purges are not sufficient should additional purge at the pump exhaust be used to achieve the dilution requirement.
   - Prevent condensation of flammable vapours within the pump mechanism and exhaust line.
3. When calculating the purge flow rate required to achieve the dilution requirement, the total maximum continuous gas flow rate should be considered: refer to Tables 6 to 9. In addition, where a failure mode may result in higher gas flows, for example when a mass flow controller (mfc) fails to the fully open state, you must take measures to detect and stop this flow immediately. Failure to stop flows higher than those detailed in Tables 6 to 9 may cause the abatement system to shut down.
4. You must not introduce liquids, either fuels or oxidants, into the abatement system. The purge flow, and/or the use of TMS, must be sufficient to prevent the condensation of vapours within the pump mechanism and exhaust line.
5. The purge flow must be switched on before the process starts and the flow must continue beyond the end of the process, in order to purge the system of reactive gases or vapours. The purge flow should be monitored and interlocked to the Process Tool, so that the flow of gases is stopped if the purge flow fails.

BOC Edwards recommend that you obtain and read "Vacuum Pump and Vacuum System Safety" (publication number P300-20-000) available from BOC Edwards or your local supplier.

Note: There must be no significant pulsations in the process gas flows into the abatement system. We therefore recommend that check-valves are fitted to the pumping system outlets.

Total gas flow rates per inlet (all abatement systems) *	Minimum		Maximum: TCS	Maximum: TPU & Kronis
	With propane or LPG † fuel gas	With methane fuel gas		
Single inlet abatement system	140 l min^{-1}	80 l min^{-1}	280 l min^{-1}	200 l min^{-1}
Two inlet abatement system	70 l min^{-1}	40 l min^{-1}	140 l min^{-1}	100 l min^{-1}
Four inlet abatement system	35 l min^{-1}	20 l min^{-1}	70 l min^{-1}	50 l min^{-1}

Table 5 - Total gas flow rates (per inlet)

* The total gas flow rates into the abatement system inlets must be in the ranges specified above. When you calculate your total gas flow rates into the inlets, you must take account of not only the process gases, but also of any pump purge gas flows and any other additional safety purge gas flows into the pipelines connected to the inlets.

† Liquefied petroleum gas.

WARNING

The total maximum continuous gas flow rates given below are flow rates that ensure safe operation of the TCS. These flow rates will not necessarily provide optimum abatement of the gases. If you require further information contact BOC Edwards for advice.

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
AsH_3	Arsine	Contact BOC Edwards †	Cl_2	Chlorine	Contact BOC Edwards †
BCl_3	Boron Trichloride	Contact BOC Edwards †	ClF_3	Chlorine Trifluoride	Contact BOC Edwards †
BF_3	Boron Trifluoride	400	CO	Carbon Monoxide	8000
B_2H_6	Diborane	2000	F_2	Fluorine	12000
CF_4	Carbon Tetrafluoride	Contact BOC Edwards †	GeH_4	Germane	2000
C_2F_6	Hexafluoroethane	Contact BOC Edwards †	H_2	Hydrogen	50000 ‡
C_3F_8	Perfluoropropane	Contact BOC Edwards †	HBr	Hydrogen Bromide	4000
C_4F_8	Octofluorocyclobutane	4000	HCl	Hydrogen Chloride	40000
CH_4	Methane	16000	HF	Hydrogen Fluoride	38400
CHF_3	Trifluoromethane	6000	NF_3	Nitrogen Trifluoride	6000
CH_2F_2	Difluoromethane	4000	NH_3	Ammonia	20000
CH_3F	Fluoromethane	4000	NO	Nitrogen Oxide	10000

Table 6 - TCS continuous process gas flow rates (sheet 1 of 2)

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
N_2O	Nitrous Oxide	10000	$SiCl_4$	Silicon Tetrachlororide	5000
O_2	Oxygen	20000	SiF_4	Silicon Tetrafluoride	5000
O_3	Ozone	20000	SiH_4	Silane	2000 **
PH_3	Phosphine	2000	$Si(O(C_2H_5))_4$	Tetraethylorthosilicate (TEOS)	4 g min^{-1} ††
SF_6	Sulphur Hexafluoride	Contact BOC Edwards †	$TiCl_4$	Titanium Tetrachloride	4000
$SiCl_2H_2$	Dichlorosilane (DCS)	2000	WF_6	Tungsten Hexafluoride	1600
$SiHCl_3$	Trichlorosilane	2000			

Table 6 - TCS continuous process gas flow rates (sheet 2 of 2)

* The total maximum continuous gas flow rate is the gas flow across all four TCS inlets. The maximum continuous gas flow rate to an individual inlet is this total gas flow divided by the number of inlets.

† Contact BOC Edwards for further advice on these applications.

‡ BOC Edwards H_2 dilution standard is < 4% in N_2, for inherent system safety.

** BOC Edwards SiH_4 dilution standard is < 1% in N_2, for inherent system safety.

†† You must not introduce liquids, either fuels or oxidants, into the abatement system: refer to the warning in Section 2.3.

WARNING

The total maximum continuous gas flow rates given below are flow rates that ensure safe operation of the TPU. These flow rates will not necessarily provide optimum abatement of the gases. If you require further information contact BOC Edwards for advice.

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
AsH_3	Arsine	Contact BOC Edwards †	Cl_2	Chlorine	2000
BCl_3	Boron Trichloride	400	ClF_3	Chlorine Trifluoride	8000
BF_3	Boron Trifluoride	400	CO	Carbon Monoxide	8000
B_2H_6	Diborane	2000	F_2	Fluorine	12000
CF_4	Carbon Tetrafluoride	6000	GeH_4	Germane	2000
C_2F_6	Hexafluoroethane	6400	H_2	Hydrogen	50000 ‡
C_3F_8	Perfluoropropane	4000	HBr	Hydrogen Bromide	4000
C_4F_8	Octofluorocyclobutane	4000	HCl	Hydrogen Chloride	40000
CH_4	Methane	16000	HF	Hydrogen Fluoride	38400
CHF_3	Trifluoromethane	6000	NF_3	Nitrogen Trifluoride	6000
CH_2F_2	Difluoromethane	4000	NH_3	Ammonia	20000
CH_3F	Fluoromethane	4000	NO	Nitrogen Oxide	10000

Table 7 - TPU continuous process gas flow rates (sheet 1 of 2)

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
N_2O	Nitrous Oxide	10000	$SiCl_4$	Silicon Tetrachlororide	5000
O_2	Oxygen	20000	SiF_4	Silicon Tetrafluoride	5000
O_3	Ozone	20000	SiH_4	Silane	2000 **
PH_3	Phosphine	2000	$Si(O(C_2H_5))_4$	Tetraethylorthosilicate (TEOS)	4 g min^{-1} ††
SF_6	Sulphur Hexafluoride	12000	$TiCl_4$	Titanium Tetrachloride	4000
$SiCl_2H_2$	Dichlorosilane (DCS)	2000	WF_6	Tungsten Hexafluoride	1600
$SiHCl_3$	Trichlorosilane	2000			

Table 7 - TPU continuous process gas flow rates (sheet 2 of 2)

* The total maximum continuous gas flow rate is the gas flow across all four TPU inlets. The maximum continuous gas flow rate to an individual inlet is this total gas flow divided by the number of inlets.

† Contact BOC Edwards for further advice on these applications.

‡ BOC Edwards H_2 dilution standard is < 4% in N_2, for inherent system safety.

** BOC Edwards SiH_4 dilution standard is < 1% in N_2, for inherent system safety.

†† You must not introduce liquids, either fuels or oxidants, into the abatement system: refer to the warning in Section 2.3.

WARNING

The total maximum continuous gas flow rates given below are flow rates that ensure safe operation of the Kronis. These flow rates will not necessarily provide optimum abatement of the gases. If you require further information contact BOC Edwards for advice.

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
AsH_3	Arsine	Contact BOC Edwards †	Cl_2	Chlorine	Contact BOC Edwards †
BCl_3	Boron Trichloride	Contact BOC Edwards †	ClF_3	Chlorine Trifluoride	Contact BOC Edwards †
BF_3	Boron Trifluoride	400	CO	Carbon Monoxide	8000
B_2H_6	Diborane	2000	F_2	Fluorine	12000
CF_4	Carbon Tetrafluoride	Contact BOC Edwards †	GeH_4	Germane	2000
C_2F_6	Hexafluoroethane	Contact BOC Edwards †	H_2	Hydrogen	50000 ‡
C_3F_8	Perfluoropropane	Contact BOC Edwards †	HBr	Hydrogen Bromide	4000
C_4F_8	Octofluorocyclobutane	4000	HCl	Hydrogen Chloride	40000
CH_4	Methane	16000	HF	Hydrogen Fluoride	38400
CHF_3	Trifluoromethane	6000	NF_3	Nitrogen Trifluoride	6000 **
CH_2F_2	Difluoromethane	4000	NH_3	Ammonia	20000
CH_3F	Fluoromethane	4000	NO	Nitrogen Oxide	10000

Table 8 - Kronis continuous process gas flow rates (sheet 1 of 2)

Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *	Chemical symbol	Process gas	Total maximum continuous gas flow rate (sccm) *
N_2O	Nitrous Oxide	10000	$SiCl_4$	Silicon Tetrachlororide	5000
O_2	Oxygen	20000	SiF_4	Silicon Tetrafluoride	5000
O_3	Ozone	20000	SiH_4	Silane	2000 ††
PH_3	Phosphine	2000	$Si(O(C_2H_5))_4$	Tetraethylorthosilicate (TEOS)	4 g min^{-1} ‡‡
SF_6	Sulphur Hexafluoride	Contact BOC Edwards †	$TiCl_4$	Titanium Tetrachloride	4000
$SiCl_2H_2$	Dichlorosilane (DCS)	2000	WF_6	Tungsten Hexafluoride	1600
$SiHCl_3$	Trichlorosilane	2000			

Table 8 - Kronis continuous process gas flow rates (sheet 2 of 2)

* The total maximum continuous gas flow rate is the gas flow across all four Kronis inlets. The maximum continuous gas flow rate to an individual inlet is this total gas flow divided by the number of inlets.

† Contact BOC Edwards for further advice on these applications.

‡ BOC Edwards H_2 dilution standard is < 4% in N_2, for inherent system safety.

** A flow of 2000 sccm is allowable per inlet, up to a maximum of three inlets. The total flow into the Kronis must never exceed 6000 sccm.

†† BOC Edwards SiH_4 dilution standard is < 1% in N_2, for inherent system safety.

‡‡ You must not introduce liquids, either fuels or oxidants, into the abatement system: refer to the warning in Section 2.3.

WARNING

The total maximum continuous gas flow rates given below are flow rates that ensure safe operation of the Kronis. These flow rates will not necessarily provide optimum abatement of the gases. If you require further information contact BOC Edwards for advice.

Chemical symbol	Precursor	Total allowable continuous gas flow rate per inlet (sccm)	Total maximum continuous gas flow rate into the Kronis (sccm)
3MS	Trimethylsilane	500 to 1500	4500
4MS	Tetramethylsilane	500 to 1500 *	3000
DMDMOS	Dimethyldimethoxyorthosilane	200 to 1500	6000
TMCTS	Tetramethylcyclotetrasiloxane	2 to 8 g min^{-1}	20 g min^{-1}
OMCTS	Octomethylcyclotetrasiloxane	2 to 8 g min^{-1}	20 g min^{-1}

Table 9 - Kronis continuous precursor flow rates

* 2-inlet Kronis only

2.4 Fuel gas supply

WARNING

Your fuel gas supply pressure must not exceed 1 bar gauge. If it does, you will damage the abatement system and there may be a fuel gas leak.

CAUTION

Do not use hydrogen as a fuel gas. If you do, you will damage the abatement system.

Note 1: The fuel gas flow rates specified below assume that the calorific value of the fuel gas is as specified below. If your abatement system is configured to operate with fuel gas which has a different calorific value, the fuel gas flow rate will also be different.

Note 2: If your fuel gas supply pressure is below the minimum pressure specified below, contact your supplier or BOC Edwards.

Note 3: Your fuel gas supply must not contain any particulate with a diameter greater than 0.5 mm.

Fuel gas type		
Methane: calorific value	36.9 to 42.3 MJ m^{-3}, 972 to 1114 btu s^{-1} ft^{-3}	
Propane/LPG: calorific value	92.5 to 105.75 MJ m^{-3}, 2436 to 2785 btu s^{-1} ft^{-3}	
Supply pressure (see Note 2 above)	0.021 to 0.7 bar gauge, 1.021 x 10^5 to 1.7 x 10^5 Pa, 0.3 to 10.1 psig	
Flow rates (see Note 1 above)	**Methane**	**Propane/LPG**
TCS	37 l min^{-1}	15 l min^{-1}
TPU/Kronis: low fire	37 l min^{-1}	15 l min^{-1}
TPU/Kronis: high fire (on all 4 inlets)	65 l min^{-1}	27 l min^{-1}

Table 10 - Fuel gas supply data

2.5 Nitrogen supplies

Note: Your nitrogen supplies must be clean and dry. The nitrogen requirements given below apply to abatement systems without the Bypass Nitrogen Dilution option. If you have ordered the Bypass Nitrogen Dilution option, refer to Appendix A7.

Purge nitrogen supply	
Supply pressure	4 to 8 bar gauge, 5×10^5 to 9×10^5 Pa
Flow rate	15 l min^{-1}
Pneumatics nitrogen supply	
Supply pressure	6 to 8 bar gauge, 7×10^5 to 9×10^5 Pa

Table 11 - Nitrogen supplies data

2.6 Oxygen supply

Note: The following data is only applicable to TPU and Kronis systems.

Supply pressure	30 to 45 psi, 2.07 to 3.1 bar gauge, 3.07×10^5 to 4.1×10^5 Pa
Nominal regulated pressure	10 psi
Flow rate (for each process gas inlet)	
TPU	16 l min^{-1}
Kronis	15 l min^{-1}
Supply quality	Commercial grade (>90% purity)

Table 12 - Oxygen supply data

2.7 Cooling-water supply

Note 1: Use treated or non-corrosive industrial water for your cooling-water supply.

Note 2: Refer to Appendix A3 for information on how to determine the RSI of your cooling-water supply.

Minimum supply pressure	4.1 bar gauge, 5.1 x 10^5 Pa, 60 psig
Maximum supply pressure	6.9 bar gauge, 7.9 x 10^5 Pa, 100 psig
Minimum flow rate	
Supply temperature of 5 °C	32 l min^{-1}
Supply temperature of 10 °C	40 l min^{-1}
Supply temperature of 15 °C	54 l min^{-1}
Supply temperature of 18 °C	68 l min^{-1}
Pressure differential across heat exchanger	0.23 bar (minimum) to 0.87 bar (maximum), 3.3 to 12.6 psi
RSI (Ryznar Stability Index: see Note 2 above)	6.5 to 7
Maximum particle size	30 µm
Acidity	6.5 to 8.0 pH
Hardness	< 100 ppm
Resistivity	> 1 kΩ cm^{-1}
Solids (turbidity)	< 100 ppm
Typical heat removal from abatement system/WRU	25 kW

Table 13 - Cooling-water supply data

2.8 Make-up water supply and acid waste water drain

CAUTION
Your make-up water supply must comply with the requirements specified below. If it does not, you will invalidate the warranty on your abatement system.

Note 1: Calcium and magnesium will always deposit on wetted components in the presence of HF, and the necessary abatement system servicing frequency will depend on the calcium and magnesium content of the make-up water supply. The use of water softeners is an effective way to reduce calcium and magnesium levels, and can reduce calcium content to < 0.1 mg l^{-1}. BOC Edwards recommends that your make-up water supply has the lowest calcium level economical for your installation, with a maximum level of 3 p.p.m.

Note 2: The acid waste water outlet must be connected to a non-pressurised outlet.

Note 3: Do not use deionised water. If you do, the water leak detectors will not operate correctly.

Minimum supply pressure	1.5 bar gauge, 2.5 x 10^5 Pa, 22 psig
Maximum supply pressure	4.0 bar gauge, 5.0 x 10^5 Pa, 58 psig
Maximum temperature	30 °C
Acidity (see Note 1 above)	5 to 10 pH
Resistivity	> 5 µS
Calcium content	<3 mg l^{-1}
Magnesium content	<3 mg l^{-1}
Maximum particulate size	100 µm
Total solid content	< 100 ppm
Time average consumption	8 l min^{-1} (max) to 0.5 l min^{-1} (min)
Acid waste pumping head capability	10 psi (see Note 2 above)

Table 14 - Make-up water supply and waste water drain data

2.9 Exhaust-extraction system

Note 1: BOC Edwards recommends that your exhaust-extraction system is of non-metallic construction, and is suitable for the extraction of moist acid gas.

Note 2: The pressure differential specified below is the pressure differential between your exhaust-extraction system and the abatement system, as measured by the plenum chamber pressure gauge in the abatement system. If your exhaust-extraction system cannot provide the required pressure differential or flow rate, contact your supplier or BOC Edwards for advice.

Note 3: During abatement system operation, there is a pressure drop of 2 inches between the abatement system inlets and the packed tower outlet.

Pressure differential range	0 to -5 inches wg, 7.5 mbar, 7.5 x 10^2 Pa
Maximum flow rate	1000 l min^{-1}
HF concentration in exhaust gas	< 3 p.p.m.
Mist filtration	> 50 µm

Table 15 - Exhaust-extraction system data

2.10 Cabinet-extraction system

Note: The extraction rate must comply with all local and national safety requirements.

Recommended cabinet-extraction rate	100 m^3 h^{-1}
Burst plate	See Figure 8, detail D

Table 16 - cabinet-extraction system data

2.11 Electrical data

Note: The WRU incorporates an overload protection (current limiting) device which operates at 125% of full load current.

	'E' model	**'S' model**	**'J' model (50 Hz)**	**'J' model (60 Hz)**
Electrical supply				
Voltage	230 V a.c.	120 V a.c.	100 V a.c.	100 V a.c.
Tolerance	± 10%	± 10%	± 10%	± 10%
Phases	1	1	1	1
Frequency	50 Hz	60 Hz	50 Hz	60 Hz
Conductor size required	4 mm^2 (12 AWG)	10 mm^2 (8 AWG)	10 mm^2 (8 AWG)	10 mm^2 (8 AWG)
Full load current rating				
Abatement system enclosure and WRU (with no TMS or other ordering options)	8.7	20.3 A	20.1 A	23.6 A
Largest motor ampere rating (drain pump in WRU)	0.75 kW	0.75 kW	0.75 kW	0.75 kW
Ampere interrupt capacity (AIC)	10 kA	10 kA	10 kA	10 kA
Fuse ratings				
F1: control unit	2 A, 'T' type	2 mA, 'T' type	2 A, 'T' type	2 A, 'T' type
F2: FabWorks connector	500 mA, 'T' type	500 m A, 'T' type	500 mA, 'T' type	500 mA, 'T' type
F3: FMS transformer	-	-	1 A, 'T' type	1 A, 'T' type
F4: power supply (primary)	1 A, 'T' type	1 A, 'T' type	1 A, 'T' type	1 A, 'T' type
F5: power supply (secondary)	2.5 A, 'T' type	2.5 A, 'T' type	2.5 A, 'T' type	2.5 A, 'T' type
PLC relay module	6.3 A, 'T' type	6.3 A, 'T' type	6.3 A, 'T' type	6.3 A, 'T' type
Circuit breaker ratings: abatement system enclosure				
CB1: air blower	4 A	6 A	10 A	10 A
CB2: water drain pump	4 A	6 A	6 A	6 A
CB3: water supply booster pump	6 A	10 A	10 A	10 A
CB4: TMS	6 A	6 A	6 A	6 A

Table 17 - Electrical data (sheet 1 of 2)

	'E' model	**'S' model**	**'J' model (50 Hz)**	**'J' model (60 Hz)**
Circuit breaker ratings: breaker disconnect (if fitted)				
SW1: master circuit breaker	32 A	32 A	32 A	32 A
CB1: abatement system enclosure	16 A	16 A	16 A	16 A
CB2: WRU	16 A	16 A	16 A	16 A
Conductor colours used				
> 100 V a.c.	Black	Black	Black	Black
a.c. line neutral	Blue	White	White	White
24 V a.c.	Red	Red	Red	Red
24 V a.c. return	Red	White	White	White
24 V d.c. positive	Blue	Blue	Blue	Blue
24 V d.c. negative	Blue	Blue	Blue	Blue
Signal return	Blue	Blue	Blue	Blue
Earth (ground)	Green / Yellow	Green / Yellow	Green / Yellow	Green / Yellow

Table 17 - Electrical data (sheet 2 of 2)

2.12 Connections

Process connections	
Process gas inlets	NW40 stainless steel
Bypass outlet	NW40 stainless steel
Abatement system exhaust outlet	75 mm diameter polypropylene
Cabinet extraction outlet	150 mm diameter x 150 mm deep, painted mild steel
Services connections	
Purge nitrogen inlet	1/4 inch Swagelok, brass
Pneumatics nitrogen inlet	1/4 inch Swagelok, brass
Oxygen inlet *	1/4 inch Swagelok, brass
Fuel gas inlet	3/4 inch Swagelok, brass
Cooling water inlet	3/4 inch nominal bore uPVC pipe
Cooling water return	3/4 inch nominal bore uPVC pipe
Make-up water inlet	3/4 inch nominal bore uPVC pipe
Acid waste water outlet	3/4 inch nominal bore uPVC pipe
Electrical connections	
Electrical supply cable gland	Suitable for 3-core double insulated cable, 14 mm cable diameter
Pump/process/tool/control system interface	Screw terminals

Table 18 - Connections

* TPU or Kronis only.

2.13 Manufacturing materials

The following materials are in contact with the process gases:

Stainless steel, sheathed nickel alloy, polypropylene, viton, PFPE (perfluoropolyether).

The materials used for the process and services connections are listed in Section 2.12. Other materials used in the abatement system are listed in Table 19.

Fuel gas and nitrogen pipelines	Copper, brass, PTFE, nylon
Oxygen pipelines *	PTFE, nylon
Internal scrubber water supply pipelines	PVC, polypropylene
Pumped acid drain pipeline	Polypropylene, PVC

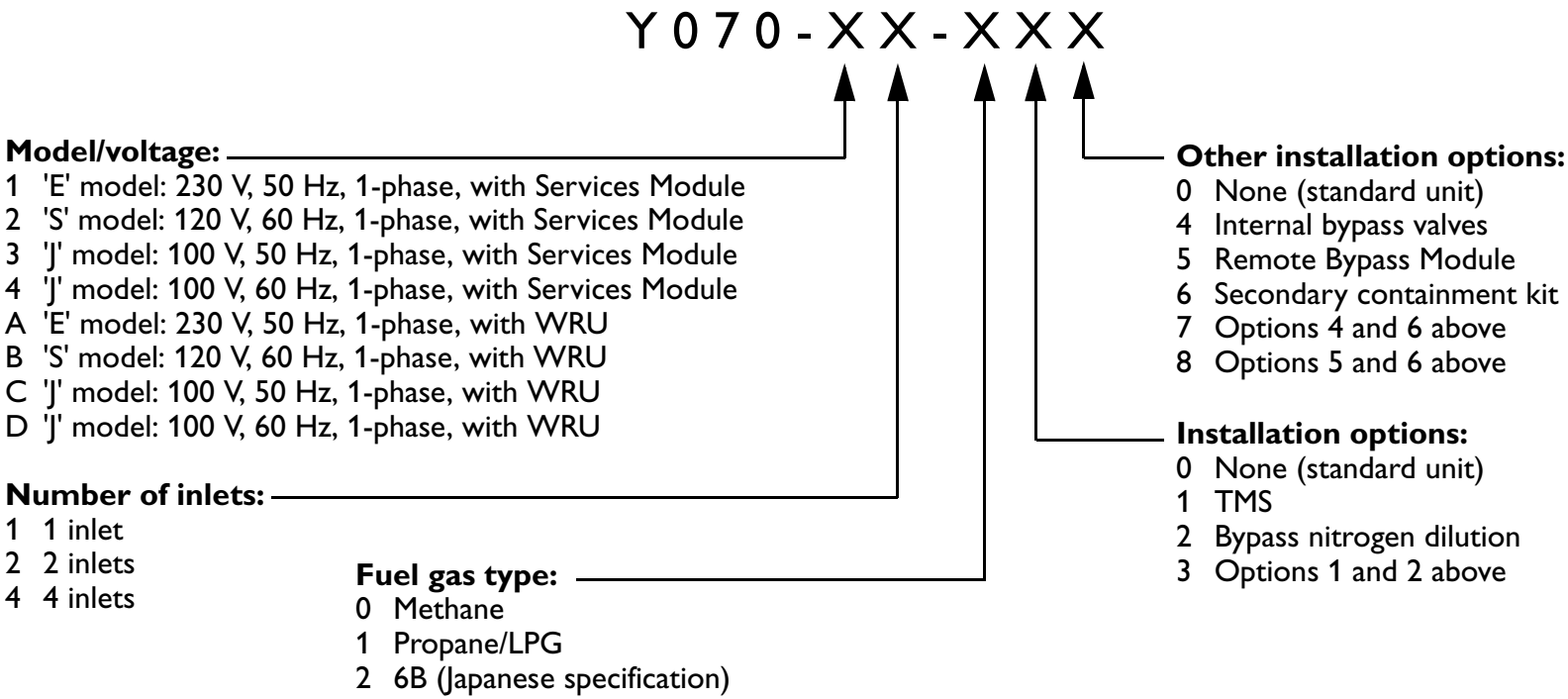
Table 19 - Manufacturing materials

* TPU or Kronis only.

2.14 Item Numbers

2.14.1 TCS Item Numbers

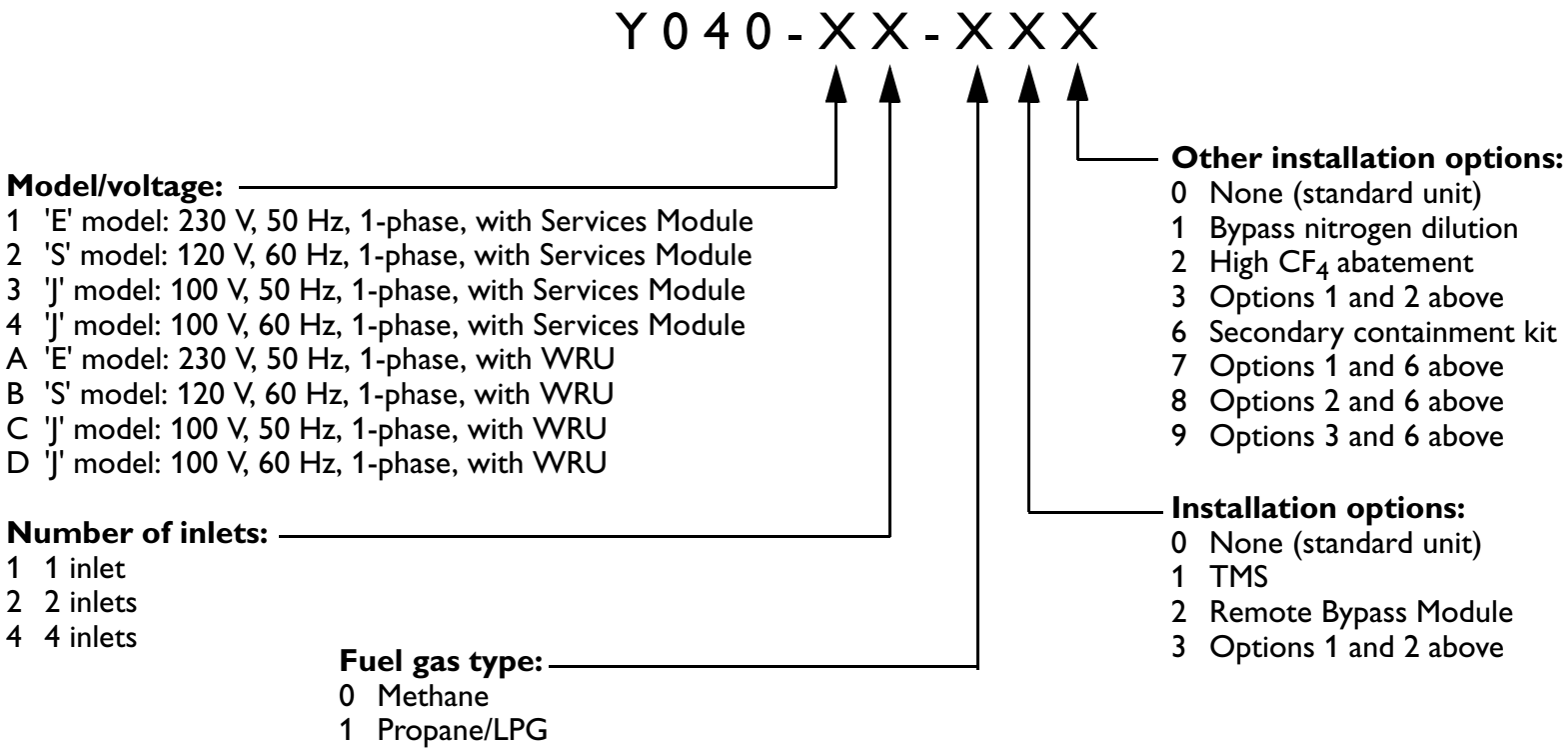
The Item Number for your TCS depends on the TCS model, the number of inlets, and the ordering options, in accordance with the following matrix structure:



For example, the Item Number for a 4-inlet 'E' model TCS for use with a 230 V, 50 Hz 1-phase electrical supply, with a Services Module, with propane fuel gas, with the Remote Bypass Module, and with the TMS and bypass nitrogen dilution options is: Y070-14-135.

2.14.2 TPU Item Numbers

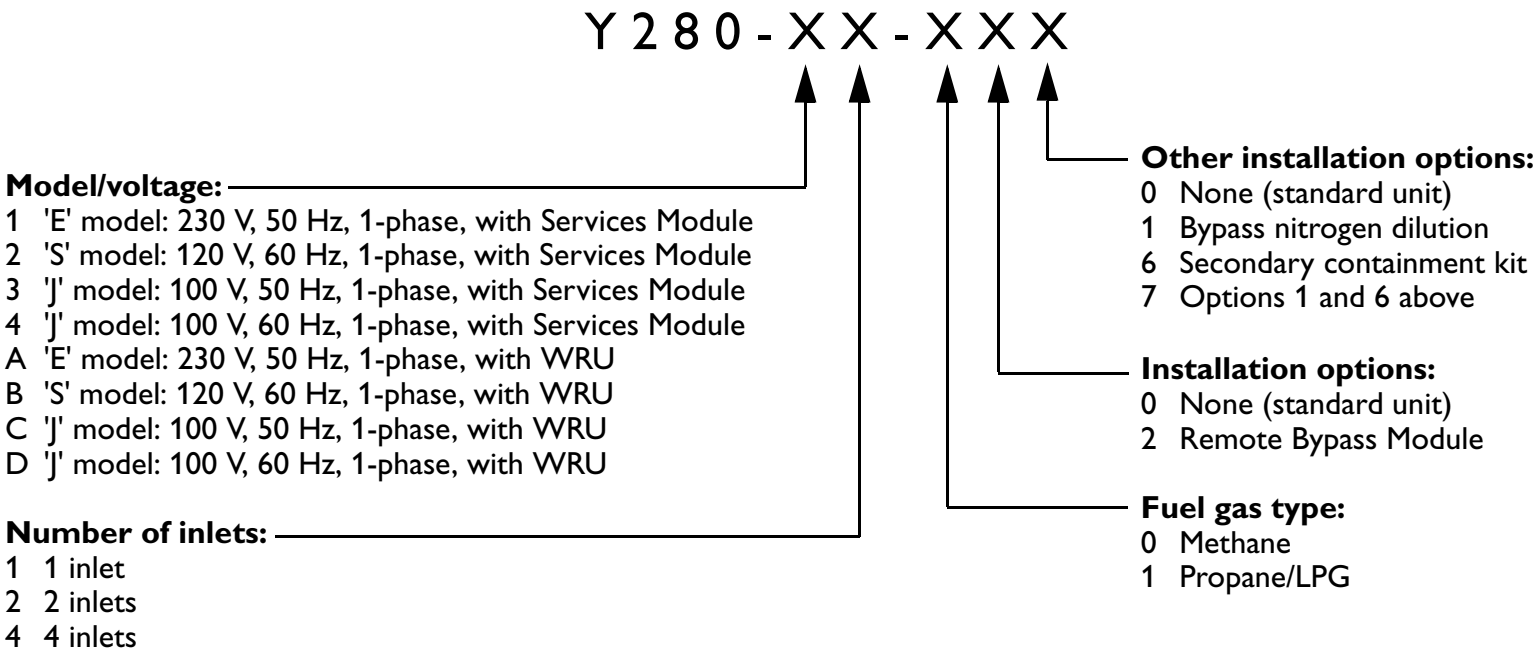
The Item Number for your TPU depends on the TPU model, the number of inlets, and the ordering options, in accordance with the following matrix structure:



For example, the Item Number for a 2-inlet 'J' model TPU for use with a 100 V, 50 Hz electrical supply, with a WRU, with methane fuel gas, with the TMS and High CF_4 abatement options is: Y040-C2-012.

2.14.3 Kronis Item Numbers

The Item Number for your Kronis depends on the Kronis model, the number of inlets, and the ordering options, in accordance with the following matrix structure:



For example, the Item Number for a 1-inlet 'S' model Kronis for use with a 120 V, 60 Hz electrical supply, with a WRU, with methane fuel gas, with no additional options is: Y280-B1-000.

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2.15 Summary of facilities connections

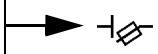
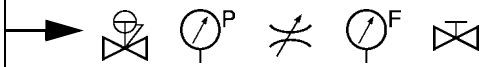
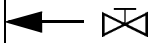
Facility	Recommendations	Requirements	Connection
Electrical supply		230 V a.c., 1 ~, 50 Hz, 12 AWG ('E' model) 120 V a.c., 1 ~, 60 Hz, 8 AWG ('S' model) 100 V a.c., 1 ~, 50/60 Hz, 8 AWG ('J' model)s	Ø 14 mm gland
Purge nitrogen supply		4 to 8 bar gauge, 5 x 10^5 to 9 x 10^5 Pa, 15 l min^{-1}	$^1/_4$ inch Swagelok
Pneumatics nitrogen supply		6 to 8 bar gauge, 7 x 10^5 to 9 x 10^5 Pa	$^1/_4$ inch Swagelok
Oxygen supply (TPU and Kronis only)		2.07 to 3.1 bar gauge, 3.07 x 10^5 to 4.1 x 10^5 Pa, 30 to 45 psi, 15 l min^{-1} (TPU), 16 l min^{-1} (Kronis)	$^1/_4$ inch Swagelok
Fuel gas supply		Methane: 36.9 to 42.3 MJ m^{-3}, 972 to 1114 btu s^{-1} ft^{-3} , 37 l min^{-1} (TCS/TPU/Kronis low fire), or 65 l min^{-1} (TPU/Kronis high fire). Propane/LPG: 92.5 to 105.75 MJ m^{-3}, 2436 to 2785 btu s^{-1} ft^{-3}, 15 l min^{-1} (TCS/TPU/Kronis low fire), or 27 l min^{-1} (TPU/Kronis high fire). 0.021 to 0.7 bar gauge, 1.021 x 10^5 to 1.7 x 10^5 Pa, 0.3 to 10.1 psig.	$^3/_4$ inch Swagelok
Cooling-water supply		4.1 to 6.9 bar gauge, 5.1 x10^5 to 7.9 x10^5 Pa, 60 to 100 psig, 6.5 to 8 pH, > 1 kΩ cm^{-1}, 68 l min^{-1} at 18 °C, < 30 µm	$^3/_4$ inch uPVC pipe
Cooling-water return			$^3/_4$ inch uPVC pipe

Table 20 - Summary of facilities connections (sheet 1 of 2)

Facility	Recommendations	Requirements	Connection
Make-up water supply		1.5 to 4 bar gauge, 2.5 x10^5 to 5 x10^5 Pa, 22 to 58 psig, 30 °C, 5 to 10 pH, 23.5 l min^{-1} (max), < 100 µm	$^3/_4$ inch uPVC pipe
Acid water drain		Non-pressurised outlet, 10 psi	$^3/_4$ inch uPVC pipe
Process gas		Refer to Section 2.3	NW40 stainless steel
Exhaust gas		0 to -5 inches wg, 7.5 mbar, 7.5 x 10^2 Pa, 1000 l min^{-1}	Ø 75 mm polypropylene
Bypass outlet			NW40 stainless steel
Cabinet extraction		100 m^3 h^{-1}	Ø 150 mm mild steel, painted

KEY:

Fused isolator

Pressure regulator

Pressure gauge

Isolation valve

Flow regulator

Flowmeter

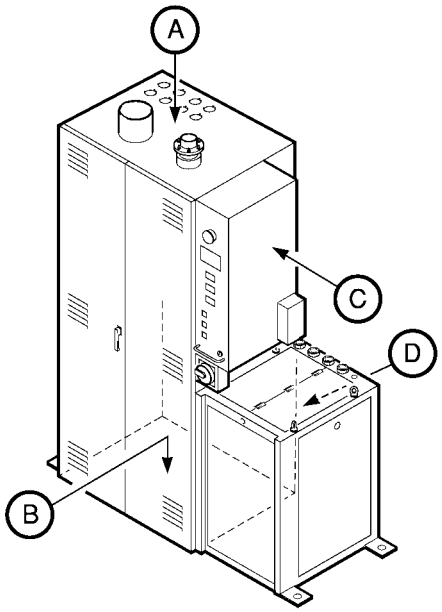
Filter

Gravity drain

Flexible bellows

Sample port

Table 20 - Summary of facilities connections (sheet 2 of 2)



Note: The area above the WRU must be kept free for access: refer to Section 3.4

Mass distribution (kg)	
E	86
F	107
G	120
H	97

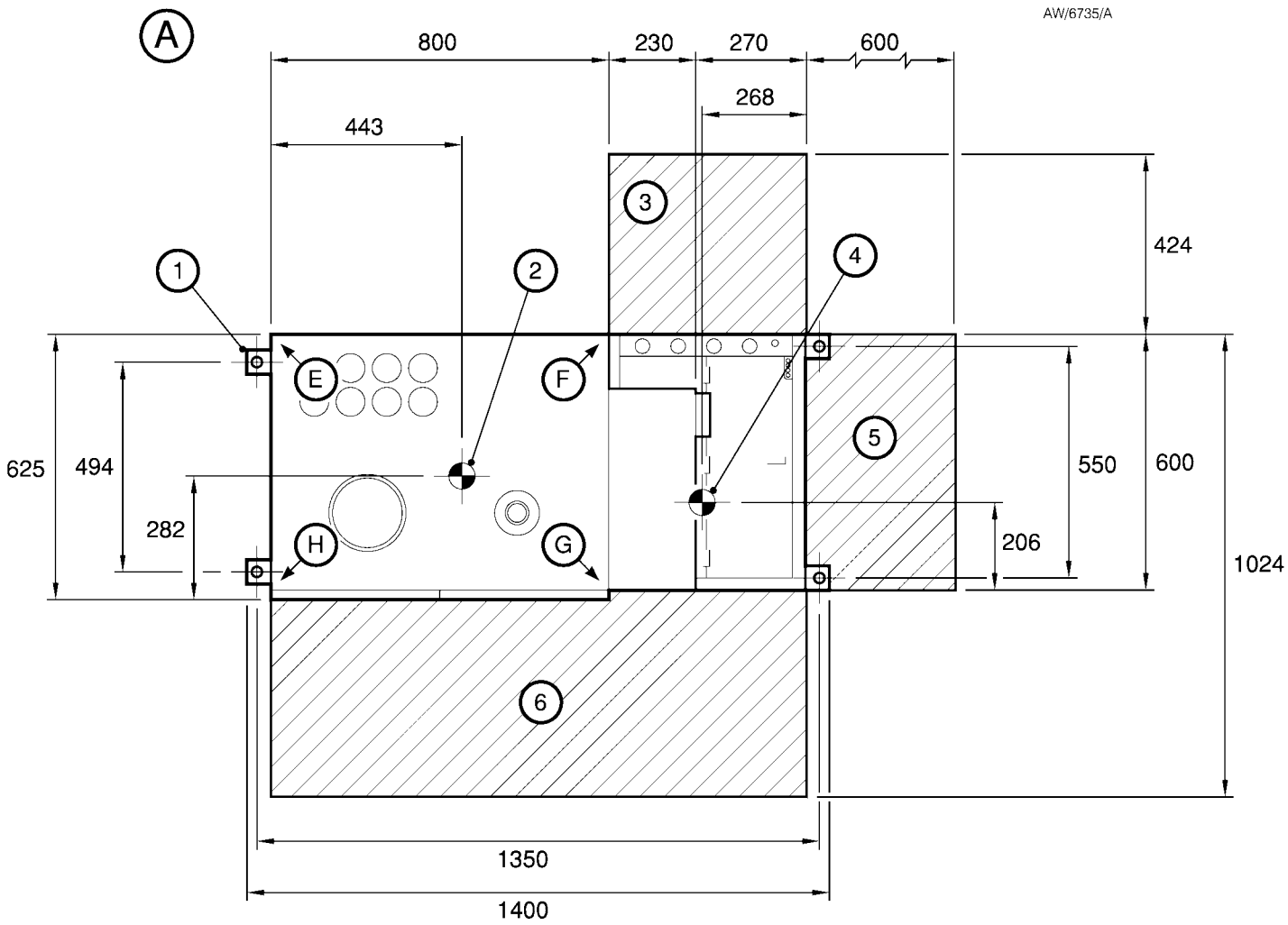
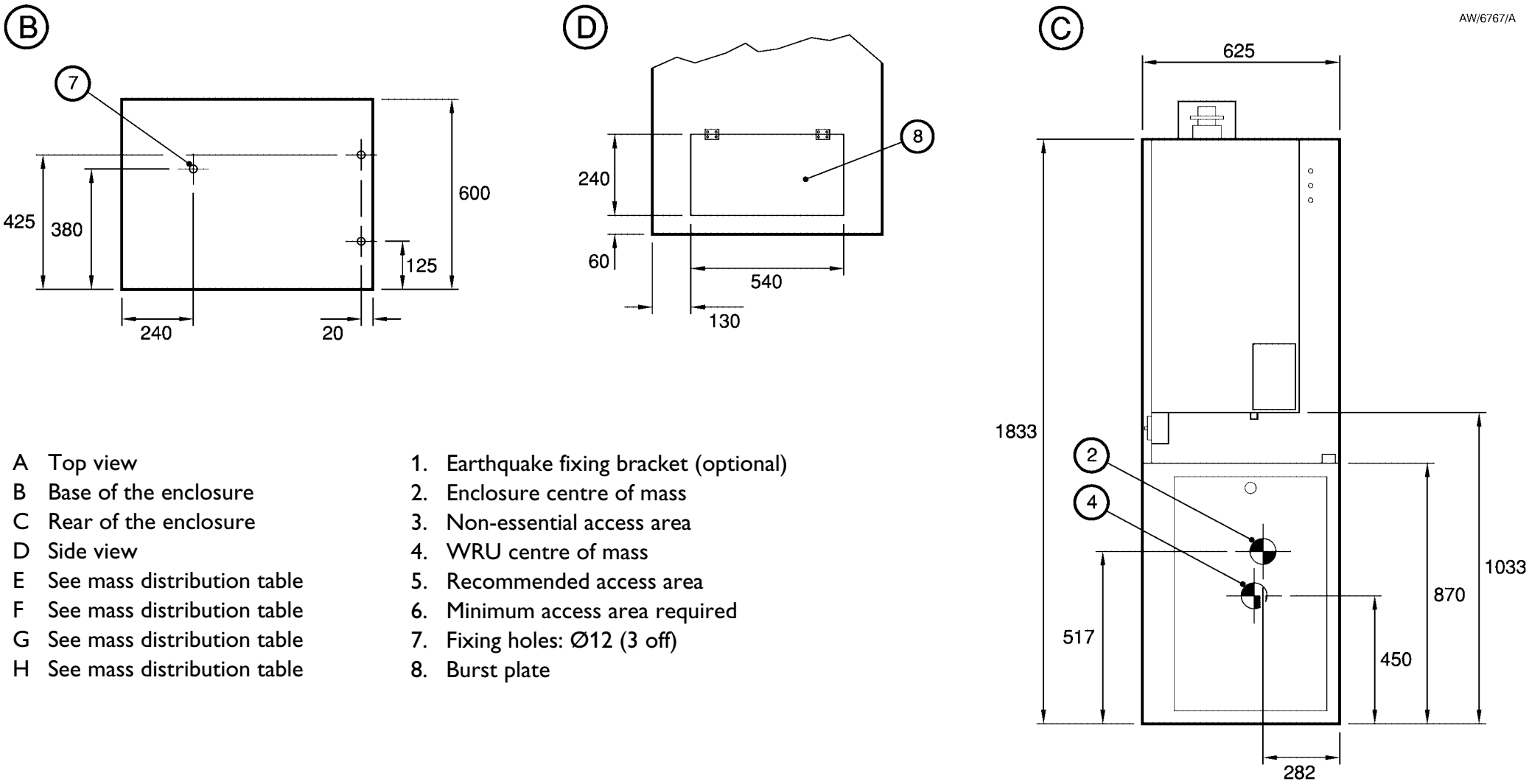


Figure 8 - Installation dimensions (mm) and centre of mass (sheet 1 of 2)



A Top view
B Base of the enclosure
C Rear of the enclosure
D Side view
E See mass distribution table
F See mass distribution table
G See mass distribution table
H See mass distribution table

1. Earthquake fixing bracket (optional)
2. Enclosure centre of mass
3. Non-essential access area
4. WRU centre of mass
5. Recommended access area
6. Minimum access area required
7. Fixing holes: Ø12 (3 off)
8. Burst plate

Figure 8 - Installation dimensions (mm) and centre of mass (sheet 2 of 2)

A Top view of abatement system enclosure
B Top view of WRU
C Side view of abatement system enclosure
D Inlet/outlet details

1. Bypass outlets
2. Process gas inlets
3. Cabinet-extraction outlet: Ø150
4. Exhaust gas outlet: Ø75
5. Fuel gas inlet
6. Cooling-water supply inlet
7. Make-up water supply inlet
8. Acid drain outlet
9. Cooling-water return outlet
10. Rating plate
11. Abatement system enclosure

Figure 9 - Connection dimensions (mm): key

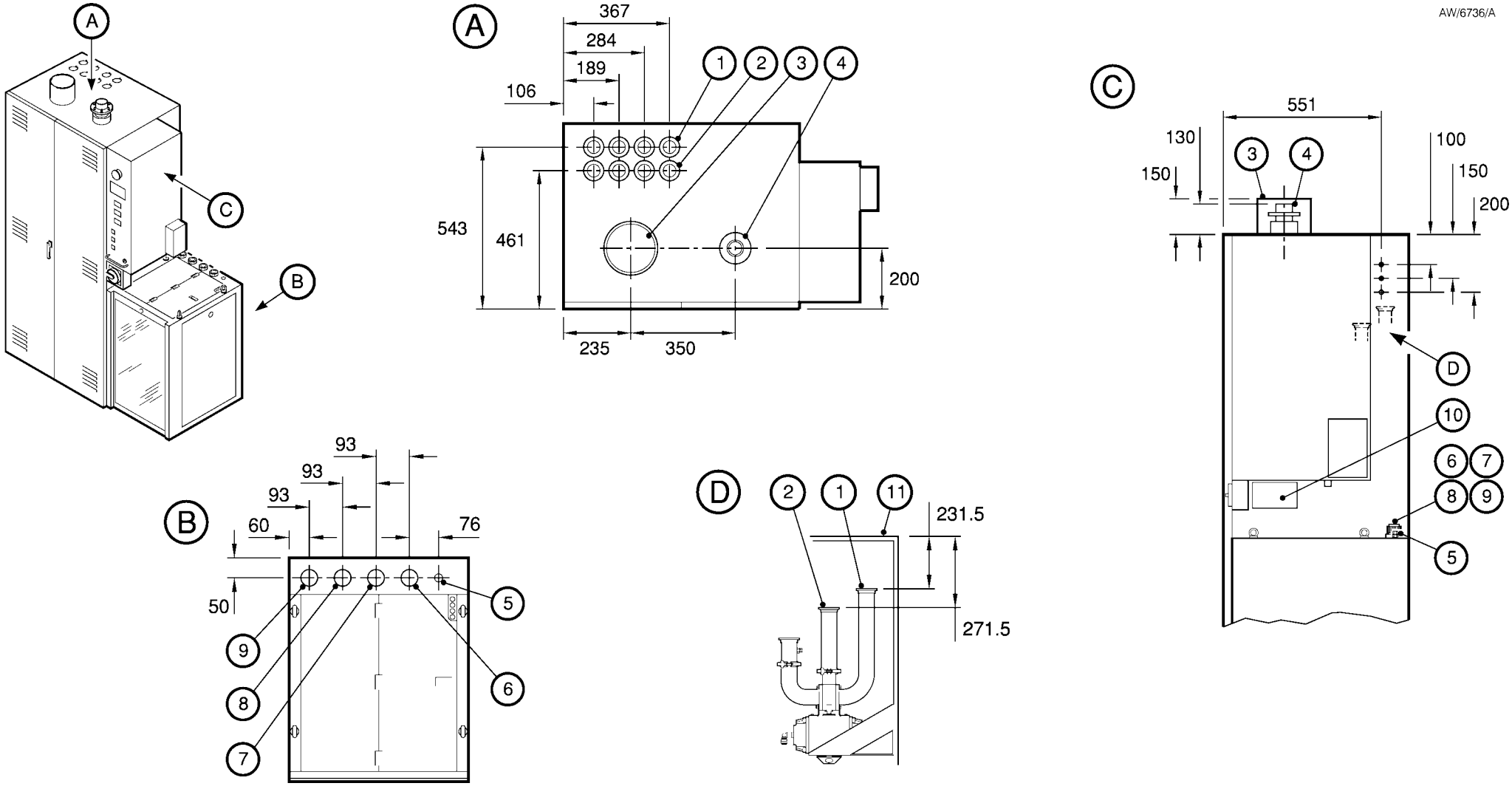


Figure 9 - Connection dimensions (mm)

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3 INSTALLATION

3.1 General safety

WARNING

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

- A suitably trained and supervised technician must install the abatement system.
- Ensure that the installation technician is familiar with and complies with the safety procedures which relate to the fuel gas (see Section 3.2), process gases, nitrogen supply, and (on the Kronis) oxygen supplies.
- Vent and purge the pumping systems before you start installation.
- Check that all of the required components are available and of the correct type before you start work.
- Disconnect the pumping systems from the electrical supply so that they cannot be operated accidentally.
- Helium leak test the abatement system after installation and seal any leaks found, as described in Section 3.16.

3.2 Fuel gas safety

WARNING

To ensure the safety of the fuel gas supply pipelines installation, you must comply with the following requirements.

- Suitably trained and registered technicians must install the fuel gas supply pipelines, to ensure that the pipelines are correctly installed, leak tested and purged, and have fuel gas available in the pipelines. For example, in the UK, installation technicians must be registered with the Council Of Registered Gas Installers (CORGI).
- The fuel gas supply pipelines must incorporate suitable flexible pipes and sleeving, particularly in installations where earthquakes are likely to occur.
- The fuel gas supply pipeline(s) must incorporate lockable gas isolation valves.
- All fuel gas supply pipelines and valves must be clearly labelled.
- Full supporting documentation for the pipelines installation must be available for inspection by BOC Edwards engineers. This documentation must include a schematic diagram showing all of the components in the supply pipelines, their physical locations and how they are labelled.
- Your cabinet-extraction rate must comply with the requirements of Section 2.10, to ensure sufficient air exchange in the unlikely event of a fuel gas leak into the abatement system enclosure.

(continued on page 64)

- After installation, you must obtain a suitable installation certificate. This certificate will provide documentary evidence that the fuel gas supply pipelines have been correctly installed, leak tested and purged. You may not be able to get your abatement system commissioned (see Section 3.27) unless such a certificate is available.
- Ensure that the abatement system cannot be switched on and used until it has been inspected and commissioned (see Section 3.27).

We recommend that you maintain a system file in which you can retain all installation certificates and other documentation. You can also use this file to hold records of subsequent maintenance or servicing operations on the abatement system and the services supply pipelines.

3.3 System design and safety

3.3.1 Introduction

CAUTION

If the abatement system is not installed in accordance with our recommendation, BOC Edwards will accept no liability or warranty claims in accordance with our standard terms and conditions.

In order to ensure that your installation is safe, you must configure your Process Tool to correctly interface with the abatement system, and your system must be designed for safe operation, particularly in the event of a bypass valve opening.

Refer to the following sections for more detailed information on these requirements.

Note: BOC Edwards engineers will not commission the abatement system unless it has been installed in accordance with the requirements of this manual.

3.3.2 Pipeline design and construction

Take note of the following when you design and construct your pipelines to be connected to the abatement system:

- Suitably trained and registered technicians must install the pipelines, to ensure that the pipelines are correctly installed, leak tested and purged.
- The pipelines must incorporate suitable flexible pipes and sleeving, particularly in installations where earthquakes are likely to occur.
- Appropriate construction materials must be used for all pipelines and connections. For example: all flexible pipes and bellows downstream of the pumping systems/chamber must be of braided construction; all seals must be trapped 'O' ring types.
- Where possible, do not install valves in the pipelines. If you do fit valves in the pipelines (for example, to assist in servicing), ensure that they can be locked in the open position.

- Ensure that each process chamber, each pumping system and each pipeline is clearly labelled. This will help to ensure that accidental 'cross-over' does not occur during construction.
- If required, you can connect a chamber vent line to an abatement system inlet, as long as you comply with the Process Tool interfacing requirements (see Section 3.3.3).
- After construction, perform helium leak testing of all the pipelines up- and down-stream of the system and seal any leaks found.
- Full supporting documentation for the pipelines installation must be available for inspection by BOC Edwards engineers. This documentation must include a schematic diagram showing all of the components in the pipelines, their physical locations and how they are labelled.

3.3.3 Process tool interfacing

WARNING

The Process Tool connections must be made, and the interface signals must be used, as described in this manual. If they are not, the system will not operate correctly.

The abatement system requires a number of interface signals from your Process Tool in order for the system to operate correctly. In addition, the abatement system provides interface status signals for your Process Tool, which must be configured to operate correctly on receipt of a fault indication. The use of these signals is described below.

Pump interface signals

The Process Tool **must** provide a 'PUMP INTERFACE' signal for each abatement system inlet in order for the bypass valves to operate correctly, as follows:

- The signal must be open when the pumping system connected to the inlet is off (or, if you have connected a vent line to the inlet, the vent line isolation valve is closed); that is, no gas is flowing into the abatement system inlet.
- The signal must be closed when the pumping system connected to the inlet is on (or, if you have connected a vent line to the inlet, the vent line isolation valve is open); that is, gas is flowing into the abatement system inlet.

You must connect the signals to the abatement system through the interface module (see Section 3.25). If these signals do not operate correctly, the abatement system bypass valves will not open/close correctly, and untreated process gas may pass into the outlet or bypass pipelines.

(continued on page 66)

Note 1: Your Process Tool must be configured to open the PUMP INTERFACE signal if the pumping system fails, or if it has been shut down for maintenance/servicing.

Note 2: If a pumping system is removed when the bypass valve for the system inlet is on-line, the system will indicate a fault and shut down, or process gases may back-migrate from the combustor.

Note 3: If BOC Edwards pumping systems are used, the abatement system can be directly connected to the 6-way DIN plugs on the pumping system control modules: refer to the pumping system instruction manual or contact BOC Edwards for advice.

PFC interface signals

The 'PFC INTERFACE' signals are optional for TCS systems, and may be required (depending on the flow of clean gases into the TCS) in order to reduce the acidity of the waste water in the abatement system. Note that on the TCS, these signals are only used to automatically adjust the water consumption (see Section 3.28).

On TPU and Kronis systems, the Process Tool **must** provide a 'PFC INTERFACE' signal for each system inlet, to identify when PFC gas is flowing from a pumping system/vent line (and so to select combustor high fire mode of operation).

Your Process Tool must set the PFC INTERFACE signal for each inlet, so that it is:

- Open when no PFC gas is flowing into the inlet.
- Closed when PFC gas is flowing into the inlet.

You must connect these signals to the abatement system through the interface module (see Section 3.25). If these signals do not operate correctly, the abatement system will not operate correctly, and PFC gases will not be abated correctly.

Note: A number of devices can be used to provide the PFC INTERFACE signals from your Process Tool, depending on the make and type of valves used in your Process Tool's gas module. If necessary, contact your supplier or BOC Edwards for advice on how to provide these signals from your Process Tool. Section 7.4.1 lists accessories suitable for provision of these signals.

Alarm interface signals

Note: When a system alarm condition arises, all of the bypass valves will go off-line, and each of the abatement system inlet 'REMOTE BYPASS' signals will identify a bypass alarm condition.

The abatement system provides a 'REMOTE BYPASS' status signal for each system inlet, and an 'ALARM BEACON' status signal, which identifies a system alarm condition.

You **must** connect these signals to your Process Tool, which must be configured to operate correctly on receipt of an alarm indication (see Section 3.3.4).

You will connect these signals to your Process Tool through the interface module (see Section 3.25).

Warning interface signal

The abatement system provides a 'SYSTEM WARNING' status signal, which identifies when a system warning condition exists (refer to Section 1.10.3).

For additional safety, we recommend that you connect this signal to your Process Tool to provide advance warning of a possible system shut-down.

You will connect this signal to your Process Tool through the interface module (see Section 3.25).

3.3.4 Bypass pipeline safety

WARNING

Ensure that your bypass pipelines configurations are safe in the event that a bypass valve opens and untreated process gases pass into a bypass pipeline.

If a bypass valve opens during abatement system operation, untreated process gas may pass into your bypass pipelines. You must ensure that your bypass pipeline configuration is safe in these circumstances.

There are a number of methods you can use to ensure that your installation will operate safely; we recommend that you use one of the two methods described below.

1. **Initiate a 'soft' shut-down and introduce dilution purge**

   Configure your Process Tool so that, immediately on detection of an alarm indication from the abatement system:

   - A 'soft' shut-down is initiated, to prevent the further flow of process gas into the abatement system.
   - A dilution purge gas supply is switched on: a suitable flow of dilution gas must be introduced into the bypass pipeline from the abatement system, to sufficiently dilute any process gases in the pipeline; for example, to dilute any residual flammable process gas in the system to below its LEL (lower explosive limit).

2. **Use gas scrubbers**

   Connect the bypass pipelines to stand-by gas scrubbers that can treat the flows of gases detailed in Section 2.3.

   The scrubbers must be interfaced in such a way that, if a scrubber is not available when a bypass valve opens, a 'soft shut-down and dilution purge' is initiated (as described above).

3.3.5 Services safety

To comply with SEMI-S2 requirements you must incorporate an isolation valve in each of your fuel gas supply, cooling-water supply, cooling-water return, make-up water supply, nitrogen supply, and (on the TPU and Kronis only) oxygen supply pipelines, so that you can switch off the supplies and isolate the pipelines for maintenance. These valves must be suitable for the pressures and flows specified in Section 2.

3.3.6 Gas detection

We recommend that your installation incorporates gas detectors, to monitor both the abatement system and the pumping system installation:

Use suitable gas detectors to monitor the abatement system enclosure cabinet-extraction pipeline, and the area in which the pumping systems are installed, for process gas leaks.

Use fuel gas detectors to monitor the abatement system enclosure cabinet-extraction pipeline for fuel gas leaks into the system enclosure.

Connect the installed gas detectors in series to the 'REMOTE GAS' input in the interface module (refer to Section 3.25). Your Process Tool must be configured to isolate the process gases at source and to shut down the pumping systems in the event of gas detection.

3.4 Prepare the installation site

Before you install the abatement system, ensure that suitable services are available for the system (refer to Section 2) and that there is sufficient room for access to the system as shown in Figure 8.

Note also that:

- The area above the WRU (to a height level with the top of the abatement system enclosure) must be kept free for access.
- For a system with a burst plate, you must leave a suitably sized area free behind the abatement system enclosure.

The base must be firm and level. There must be no more than a 10 mm difference in height between one side of the abatement system enclosure and the other side. Similarly, there must be no more than a 10 mm difference in height between the front of the system enclosure and the rear of the system enclosure.

Install the abatement system as close as possible to the pumping systems, to ensure the immediate treatment of the process gases.

If the pipelines which connect the pumping systems to the abatement system are long, there will be large volumes of pipeline in which solids can be deposited and corrosion can occur.

We recommend that you use pipes with a diameter of 40 mm or less for the pipelines between the pumping systems and the abatement system. See Table 21 which lists the gas residence times in pipelines of different diameters. Your design should ensure that gas residence times are as short as possible.

Nominal pipe Ø (mm)*	Nitrogen gas flow (l min^{-1})									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
40	6.0	3.0	2.0	1.5	1.2	1.0	0.8	0.7	0.6	0.6
50	9.6	4.8	3.2	2.4	1.9	1.6	1.4	1.2	1.1	1.0
60	14.4	7.2	4.8	3.6	2.9	2.4	2.0	1.8	1.6	1.4
70	20.0	10.0	6.6	5.0	4.0	3.3	2.9	2.5	2.2	2.0
80	26.8	13.4	8.8	6.7	5.3	4.4	3.8	3.3	3.0	2.7
90	34.4	17.2	11.4	8.6	6.8	5.7	4.9	4.3	3.8	3.4
100	42.8	21.4	14.2	10.7	8.5	7.1	6.1	5.3	4.8	4.3

Table 21 - Gas residence times (seconds per metre) for different pipeline diameters

* Nominal Wall Thickness Schedule 5 10S Average used 2.4 mm.

For example, if your pipe diameter is 60 mm, and the gas flow is 40 l min^{-1}, the gas residence time will be 3.6 seconds per metre.

If the total pipe length from the process chamber to the abatement system inlet is 10 m, then:

Gas residence time = 10 x 3.6 = 36 seconds

3.5 Unpack and inspect the abatement system enclosure

CAUTION

Use suitable lifting equipment and a lifting frame to move the abatement system enclosure. If you do not, you can damage the enclosure. Refer to Section 2.2 for the mass of the enclosure.

The abatement system enclosure is supplied on a large pallet enclosed by protective packaging which is secured by spring clips and steel bands. Use the following procedure to unpack the enclosure.

1. Use a pallet truck or fork-lift truck to locate the pallet close to where you will install the system.
2. Remove the steel bands which secure the package.
3. Use an appropriate tool to release the spring clips and remove the top panel of the package.
4. Release the spring clips on the side panels (remove the centre spring clips last) and remove the side panels.
5. Remove the plastic wrapping from the enclosure and open the doors.
6. Remove the packing materials and cartons from the enclosure, then unpack the cartons (which contain, for example, the clamps and trapped 'O' rings).
7. Inspect the enclosure and the components in the cartons. If any of the equipment is damaged, notify your supplier and the carrier in writing within three days; state the Item Number and Serial Number of the system, together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the system if it is damaged.
8. Check that you have received the items listed in Table 22. If any of these items is missing, notify your supplier in writing within three days.

   (Refer also to Appendices A4 onwards for any other items which may be supplied if your system has ordering options.)

Quantity	Description	Refer to Section	Check (✓)
1	Abatement system enclosure	3.7	❑
2	Control unit keys	5.8	❑
1	Temperature controller instruction manual	5.14	❑
1	Cabinet-extraction flange	3.17	❑
1	Flange fittings kit	3.17	❑
1	Interface module (with cable)	3.24	❑
1	Outlet spool	3.14	❑
1	Pipe clip (to fit the outlet spool)	3.14	❑
*	NW40 clamps	3.11/3.12	❑
*	NW40 trapped 'O' rings	3.11/3.12	❑
1	Enclosure fixing hole drilling template	3.7	❑
1	Spare fuses kit	5.8	❑

Table 22 - Checklist of items for the abatement system enclosure

* You will receive two clamps and two trapped 'O' rings for each inlet on your system.

9. Check that the abatement system is suitable for use with your electrical supply. If it is not suitable for your electrical supply, do not continue to install the system; contact your supplier or BOC Edwards.

If the system is not to be used immediately, replace the protective covers and packaging and store in suitable conditions, as described in Section 6.1.

3.6 Unpack and inspect the WRU

> CAUTION
>
> Use suitable lifting equipment to move the WRU. If you do not, you can damage the WRU. Refer to Section 2.2 for the mass of the WRU.

The WRU is supplied on a pallet enclosed by protective packaging; this packaging consists of a number of panels secured together by spring clips and steel bands. Unpack the WRU as follows:

1. Use a pallet truck or fork-lift truck to locate the pallet close to its final installation location.
2. Remove the steel bands which secure the package, then remove the fixing screws which secure the top panel to the package and remove the top panel.
3. Release the fixing screws which secure the side panels (remove the centre fixing screws last) and remove the side panels.
4. Remove the plastic wrapping from the WRU.
5. Remove the packing materials and carton(s) and unpack the carton(s).
6. Inspect the WRU and the components in the carton(s). If any of the equipment is damaged, notify your supplier and the carrier in writing within three days; state the Item Number and Serial Number of the equipment, together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the WRU if it is damaged.
7. Check that you have received the items listed in Table 23. If any item is missing, notify your supplier in writing within three days.
8. Check that the WRU model (E, S or J) is the same as your model of abatement system. If it is not, do not continue to install the abatement system; contact your supplier or BOC Edwards.

If the WRU is not to be used immediately, replace the protective covers and packaging and store in suitable conditions, as described in Section 6.1.

Quantity	Description	Refer to Section	Check (✓)
1	WRU	3.8	❑
1	WRU fittings kit (to fit the WRU to the enclosure)	3.8	❑
1	Filter spanner (to change a water filter)	5.10	❑
1	Connector (to connect the WRU to the enclosure)	3.9	❑
2	Pipe clamps (to connect the WRU to the enclosure)	3.9	❑

Table 23 - Checklist of items for the WRU

3.7 Locate the abatement system enclosure

CAUTION

Use suitable lifting equipment and a lifting frame to move the abatement system enclosure. If you do not, you can damage the enclosure. Refer to Section 2.2 for the mass of the enclosure.

CAUTION

Ensure that the abatement system enclosure is sufficiently level (see Section 3.4). If it is not, the system may be damaged and fail during operation.

Note: We recommend that you fit restraints to secure the abatement system enclosure in the event of an earthquake. Refer to Section 7.4.3 for a suitable earthquake restraint accessory.

1. Refer to Figure 10. Attach suitable lifting equipment to a lifting frame (2) to distribute the load, and connect the frame to the lifting bolts (1) on the top of the abatement system enclosure, as shown in detail B. Do not attach the lifting equipment directly to the lifting bolts (as shown in detail A); if you do, you may damage the enclosure when you move it.
2. Undo and remove the three bolts (3) which secure the enclosure to the mini-pallet (4).
3. Use the lifting equipment to move the enclosure to its operating location.
4. Ensure that the enclosure is sufficiently level (refer to Section 3.4). If the enclosure is not level, uneven water flow through the system during operation can result in damage and failure of the quench unit. If necessary, place plates under the base of the enclosure to level it.
5. Use three suitable bolts through the fixing holes (Figure 8, items 7) to secure the enclosure to its base.

   Note that a template is supplied to enable you to drill suitable fixing holes in the base/floor on which you will locate the enclosure.

A Incorrect method of lifting
B Correct method of lifting
C Remove the pallet

1. Lifting bolt
2. Lifting frame
3. Fixing bolt
4. Mini-pallet

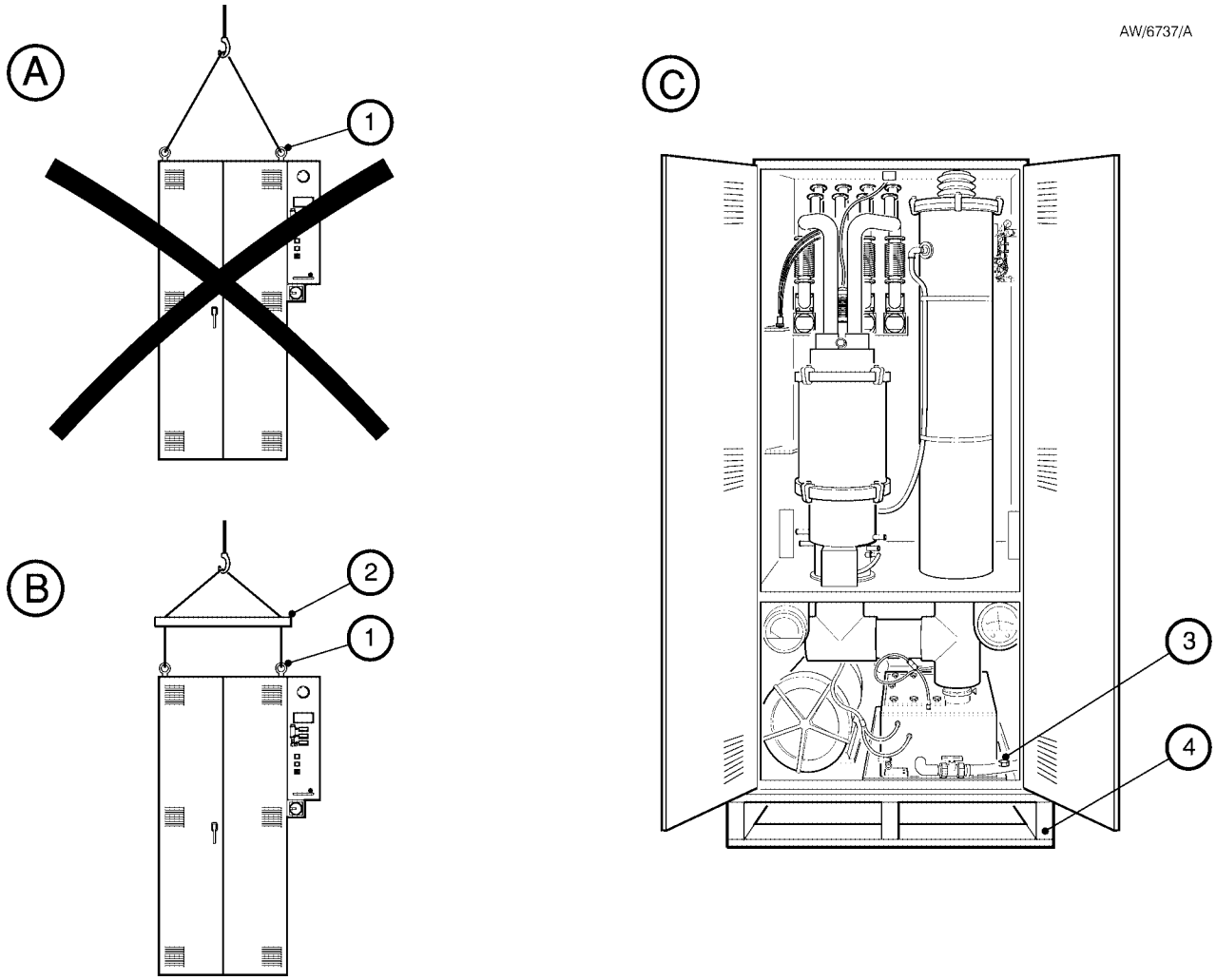

Figure 10 - Remove the abatement system enclosure from the pallet

3.8 Locate the WRU and fit the water leak detector

WARNING

Ensure that you correctly bolt the WRU to the abatement system enclosure. If you do not, the gas and other pipeline connections may be stressed, and may leak.

CAUTION

Use suitable lifting equipment to move the WRU. If you do not, you can damage the WRU. Refer to Section 2.2 for the mass of the WRU.

1. Refer to Figure 11, detail A. Undo the catch (5) then remove the transparent front cover (4) from the WRU.
2. Attach suitable lifting equipment to the lifting-bolts (2) on the top of the WRU and move the WRU into its operating location, next to the abatement system enclosure.
3. Ensure that the drain tank outlet leadthrough hole (detail C, item 11) on the WRU aligns with the leadthrough hole in the system enclosure (detail B, item 6).
4. From inside the abatement system enclosure, fit the three bolts and washers (1, supplied in the WRU fittings kit) to secure the WRU to the enclosure.
5. Remove all packing materials from the WRU water leak detector (supplied in the abatement system enclosure).
6. Refer to Figure 14. Pass the water leak detector through the cabinet extract leadthrough hole (11) in the side of the abatement system enclosure and into the WRU.
7. Refer to Figure 11. Secure the water leak detector (13) under the bracket (12) in the WRU.

Note: If required, you can fit additional water leak detectors (in series) by using the spare water leak detector socket in the abatement system enclosure. The water leak detectors can be used for any secondary containment device.

1. Bolts and washers (3 off)
2. Lifting-bolts
3. WRU
4. Transparent cover
5. Catch
6. Leadthrough hole
7. Drain tank outlet
8. Tank outlet isolation valve
9. Sample/drain valve
10. Water return pipe
11. Leadthrough hole
12. Bracket
13. Water leak detector
14. Pneumatic pipes
15. Scrubber water supply pipe
16. Fuel gas connector
17. Top cover
18. Electrical cable *
19. Electrical connectors

* 'J' and 'S' model WRUs only

Figure 11 - Fit the WRU to the abatement system enclosure: key

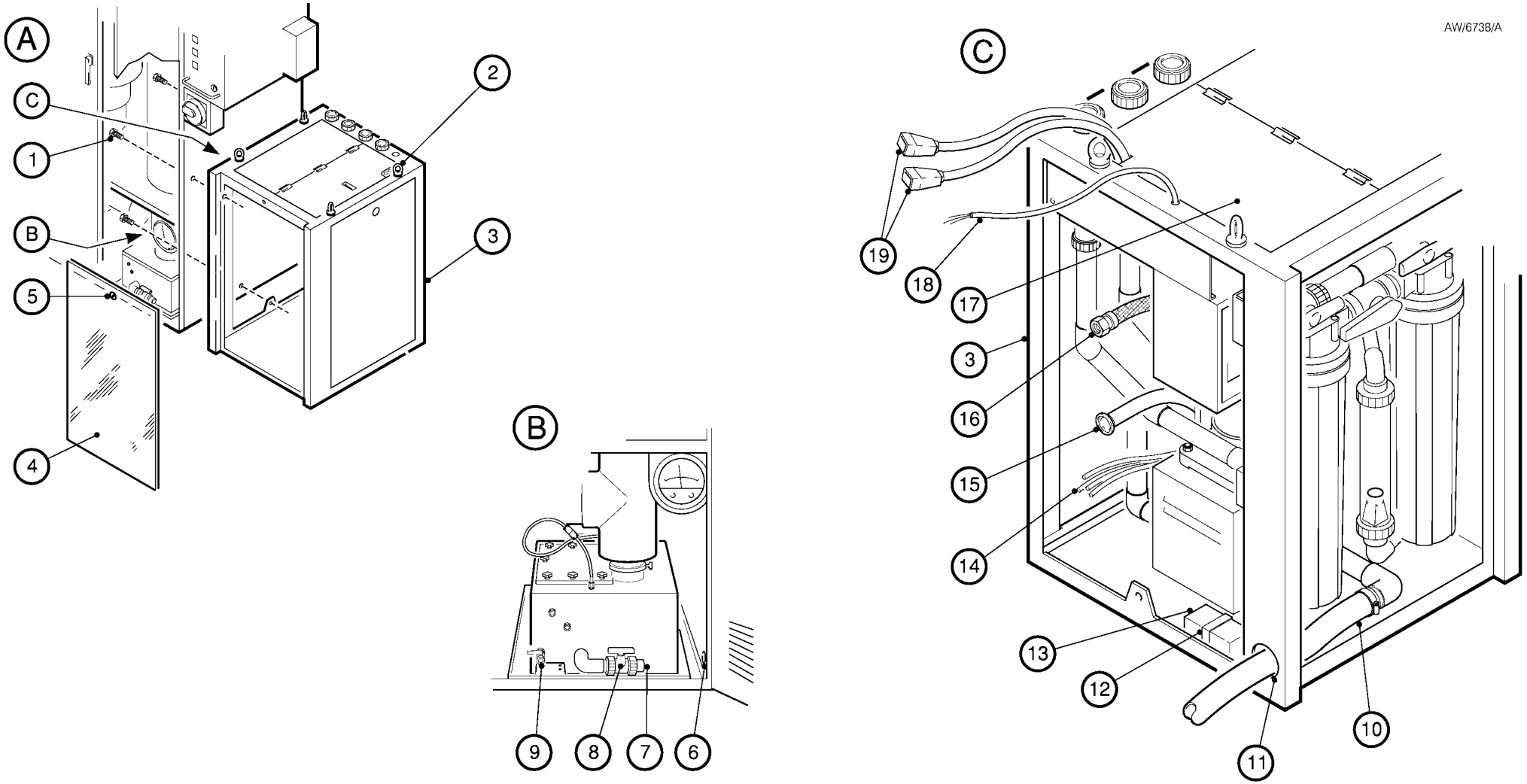

Figure 11 - Fit the WRU to the abatement system enclosure

3.9 Connect the WRU to the abatement system enclosure

WARNING

The electrical supplies for the WRU are supplied from the abatement system enclosure. Do not connect external electrical supplies to the WRU. If you do, you may damage the enclosure or the WRU, and the system will not operate correctly.

Use the following procedure to connect the WRU to the abatement system enclosure.

1. Refer to Figure 11, detail C. Pass the fuel gas connector (16) through the fuel gas leadthrough hole (Figure 14, item 6) in the side of the abatement system enclosure, and fit the connector to the fuel gas inlet on the fuel gas multiblock, which is in-line with the fuel gas leadthrough hole.
2. Remove the blanking cap and clamp (if fitted) from the scrubber water supply pipe (15).
3. Pass the end of the scrubber water supply pipe (15) through the water supply leadthrough hole (Figure 14, item 7) on the side of the abatement system enclosure and into the enclosure.
4. Fit the connector supplied (see Table 23) to the end of the scrubber water supply pipe (15) and secure with one of the pipe clamps supplied.
5. Refer to Figure 14. Remove the blanking cap (if fitted) from the enclosure water supply inlet, which is in-line with the water supply leadthrough hole (7).
6. Fit the connector on the end of the scrubber water supply pipe to the enclosure water supply inlet.
7. Refer to Figure 11, detail C. Remove the blanking cap and clamp (if fitted) from the end of the water return pipe (10).
8. Pass the end of the water return pipe (10) through the leadthrough hole (11) in the WRU, through the leadthrough hole (detail B, item 6) on the side of the abatement system enclosure and into the enclosure.
9. Remove the blanking cap and clamp (if fitted) from the drain tank outlet (detail B, item 7), then fit the end of the water return pipe (10) to the drain tank outlet and secure with the other pipe clamp supplied.
10. Fit the pneumatic and sample pipes (14) to the connectors on the side of the abatement system enclosure; refer to Figure 14:
    - Fit the pipe labelled "YV507" to the YV507 nitrogen supply connector (8).
    - Fit the pipe labelled "YV622" to the YV622 nitrogen supply connector (9).
    - Fit the pipe labelled "AP424" to the AP424 sample pipe connector (10).
    - Fit the pipe labelled "AP318" to the AP318 sample pipe connector (14).
    - Fit the pipe labelled "AP317" to the AP317 sample pipe connector (15).
11. Refer to Figure 11, detail C. Lift up the top cover (17) and pass the free end of the electrical cable with the two connectors (19) out of the top of the WRU.

12. Lower the top cover back into place, so that the electrical cable passes through the leadthrough cut-out in the top cover.
13. Fit the two connectors (19) on the electrical cable to the two electrical connectors (Figure 16, items 12 and 13) under the control unit; note that the connectors (19) on the cable are keyed, so that you cannot fit them incorrectly to the connectors on the abatement system enclosure.

3.10 Remove the inlet and bypass centring plates from the abatement system enclosure (systems without the Remote Bypass Module)

1. Refer to Figure 12, detail D. Undo and remove the three bolts (21), nuts and washers (20) which secure the bypass centring plate (19) to the top of the abatement system enclosure (5), then remove the centring plate.
2. Undo and remove the three bolts (21), nuts and washers (20) which secure the inlet and bypass centring plate (25) to the top of the enclosure (5), then remove the centring plate.
3. Undo and remove the three bolts (21), nuts and washers (20) which secure the inlet centring plate (24) to the top of the enclosure (5), then remove the centring plate.

3.11 Connect the bypass outlets to your bypass pipelines

WARNING

Ensure that a hazardous situation cannot arise due to the mixing of different process gases in the bypass pipelines.

WARNING

Ensure that your bypass pipelines configurations are safe in the event that a bypass valve opens and untreated process gases pass into a bypass pipeline: refer to Section 3.3.4.

CAUTION

Ensure that moisture or condensation cannot drain back through a bypass pipeline into the abatement system enclosure. If it does, there will be a risk of blockage or corrosion in the enclosure.

Note: If you have ordered the Remote Bypass Module option, you must fit the Module before you connect the bypass outlet pipelines to the abatement system enclosure: refer to Appendix A6.

The design of your bypass pipelines must prevent the drainage of moisture or condensation in the pipelines back into the abatement system enclosure (for example, route each bypass outlet pipe from the enclosure into the top of your back-up treatment system, as shown in Figure 13). Water above the bypass valves will enter the enclosure if one of the valves is in the on-line position, and could react with the process pump gases and cause blockage or corrosion.

Refer to Figure 12 which shows the correct outlet configurations. Note that:

- You must incorporate braided flexible bellows (22) in your bypass outlet pipelines (1 to 4) to prevent the transmission of stress to the abatement system pipelines and coupling joints.
- You must **not** fit a manifold (10) to the bypass outlets, as shown in detail B.

Use the following procedure to connect each bypass outlet on your abatement system:

1. Refer to Figure 12, details C and D. Use one of the clamps and trapped 'O' rings supplied (23) to fit braided flexible bellows (22, not supplied) to the bypass outlet (11, 12, 17 or 18).
2. Use another clamp and trapped 'O' ring (not supplied) to connect your bypass pipeline (1 to 4) to the braided flexible bellows (22).

A Correct installation *
B Incorrect bypass outlet installation *
C Interior of the enclosure
D Correct connection configuration

* 4 inlet system shown

Figure 12 - Detail key

1. Pumping system 1 bypass pipeline
2. Pumping system 2 bypass pipeline
3. Pumping system 3 bypass pipeline
4. Pumping system 4 bypass pipeline
5. Abatement system enclosure
6. Pumping system 4 inlet pipeline
7. Pumping system 3 inlet pipeline
8. Pumping system 2 inlet pipeline
9. Pumping system 1 inlet pipeline
10. Manifold (do not use !)
11. Bypass outlet 3
12. Bypass outlet 4
13. Process gas inlet 3
14. Process gas inlet 4
15. Process gas inlet 2
16. Process gas inlet 1
17. Bypass outlet 1
18. Bypass outlet 2
19. Bypass centring plate
20. Nuts and washers
21. Bolts
22. Braided flexible bellows
23. Clamp and trapped 'O' ring
24. Inlet centring plate
25. Inlet and bypass centring plate

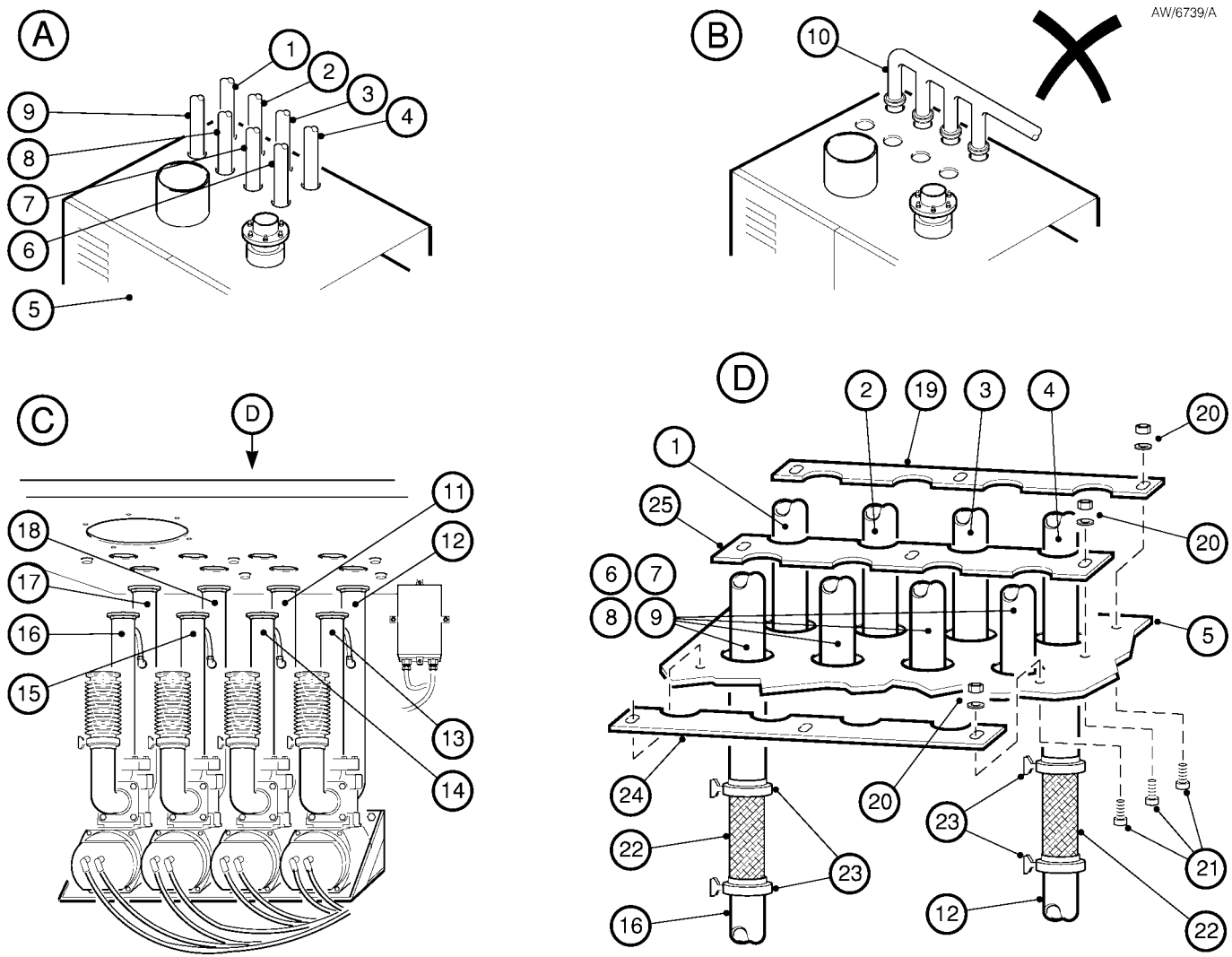

Figure 12 - Inlet and bypass outlet configurations

3.12 Connect the pumping systems/vent lines to the abatement system inlets

WARNING

You must ensure that any unused abatement system inlet (that is, any inlet to which a pumping system is not connected), or any inlet to which a gas cabinet is connected (see Note 1 below), is continuously purged with 20 l min^{-1} of dry nitrogen.

Note 1: If required, you can connect a gas cabinet to an abatement system inlet, as long as it is continuously purged (see the warning above). However, you must not connect a gas cabinet to the abatement system and manually purge large volumes of gas (or repeatedly and rapidly purge smaller quantities of gas) from the cabinet, for example when you change a gas bottle. If you want to connect a gas cabinet to the abatement system, contact your supplier or BOC Edwards for advice.

Note 2: If you have a Kronis system, or if you have ordered the TMS option on a TCS or TPU system, you must fit suitable TMS accessories to the pipelines between the pumping systems and the abatement system inlets, to heat the pipelines: refer to Appendix A4.

Refer to Figure 12 which shows the correct inlet configurations. Note that:

- You must incorporate braided flexible bellows (22) in your inlet pipelines (6 to 9) to prevent the transmission of stress to the abatement system pipelines and coupling-joints.
- You must not connect more than one pumping system to a single inlet (as the mixing of different process gases could be hazardous).
- You must continuously purge unused inlets with dry nitrogen: refer to the warning above.
- Your design must ensure that the gas flow into each inlet does not exceed the flow rates specified in Section 2.3.

1. Refer to Figure 12, details C and D. Use one of the clamps and trapped 'O' rings supplied (23) to fit braided flexible bellows (22, not supplied) to the process gas inlet (13 to 16).
2. Use another clamp and trapped 'O' ring (not supplied) to connect the pipeline from a pumping system/vent line (6 to 9), or a nitrogen purge pipeline, to the braided flexible bellows (22).

3.13 Refit the inlet and bypass centring plates to the abatement system enclosure (systems without the Remote Bypass Module)

1. Refer to Figure 12, detail D. Fit the inlet and bypass centring plate (25) to the top of the abatement system enclosure (5), and loosely secure with the three bolts (21) and the nuts and washers (20).
2. Adjust the position of the centring plate (25) so that your process inlet pipelines (6 to 9) and bypass outlet pipelines (1 to 4) are vertical and are located in the cut-outs in the centring plate, then tighten the nuts (20) to secure the centring plate in position.

3. Fit the bypass centring plate (19) to the top of the abatement system enclosure (5) and loosely secure with the three bolts (21) and the nuts and washers (20).
4. Adjust the position of the centring plate (19) so that your bypass outlet pipelines (1 to 4) are securely held in place by the cut-outs in the centring plate, then tighten the nuts (20) to secure the centring plate in position.
5. Fit the inlet centring plate (24) to the top of the abatement system enclosure (5) and loosely secure with the three bolts (21) and the nuts and washers (20).
6. Adjust the position of the centring plate (24) so that your inlet pipelines (6 to 9) are securely held in place by the cut-outs in the centring plate, then tighten the nuts (20) to secure the centring plate in position.

3.14 Fit the outlet spool to the abatement system enclosure

1. Refer to Figure 13, detail C. Place the outlet spool (6) in position, so that the bottom of the spool passes through the leadthrough hole on the top of the abatement system enclosure (7): orientate the spool so that you can access the damper (11).
2. Use the pipe clip supplied (14) to secure the flexible bellows (15) to the bottom of the outlet spool (6).

3.15 Connect the exhaust gas outlet to your exhaust-extraction system

CAUTION

The exhaust gas outlet pipe should be of suitable non-metallic materials. If you use galvanised steel materials, the pipe could corrode and leak.

CAUTION

Ensure that moisture or condensation in the main header of your exhaust-extraction system cannot drain back into the abatement system. If it does, there will be a risk of blockage or corrosion in the system.

CAUTION

Ensure that the damper is adjusted so that no back-pressure will occur when the abatement system operates with full process gas flows.

Refer to Figure 13, which shows a typical exhaust installation configuration. Use a suitable pipe clip to connect your exhaust gas outlet pipe to the outlet spool (6).

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We recommend that your exhaust gas outlet pipe is polypropylene with a diameter of 75 mm or larger. Do not use a metal pipe, as this may be corroded by the mildly acidic exhaust gas vapour. Note that if compliance with FM4910 is required, PTFE/PFA lined stainless steel pipework is recommended.

The design of your exhaust-extraction system must prevent the drainage of moisture or condensation from the main header back into the abatement system. However, if you connect to a spur of the exhaust-extraction system, you must ensure that condensation in the outlet gas stream from the abatement system can drain back into the abatement system. For example (refer to Figure 13):

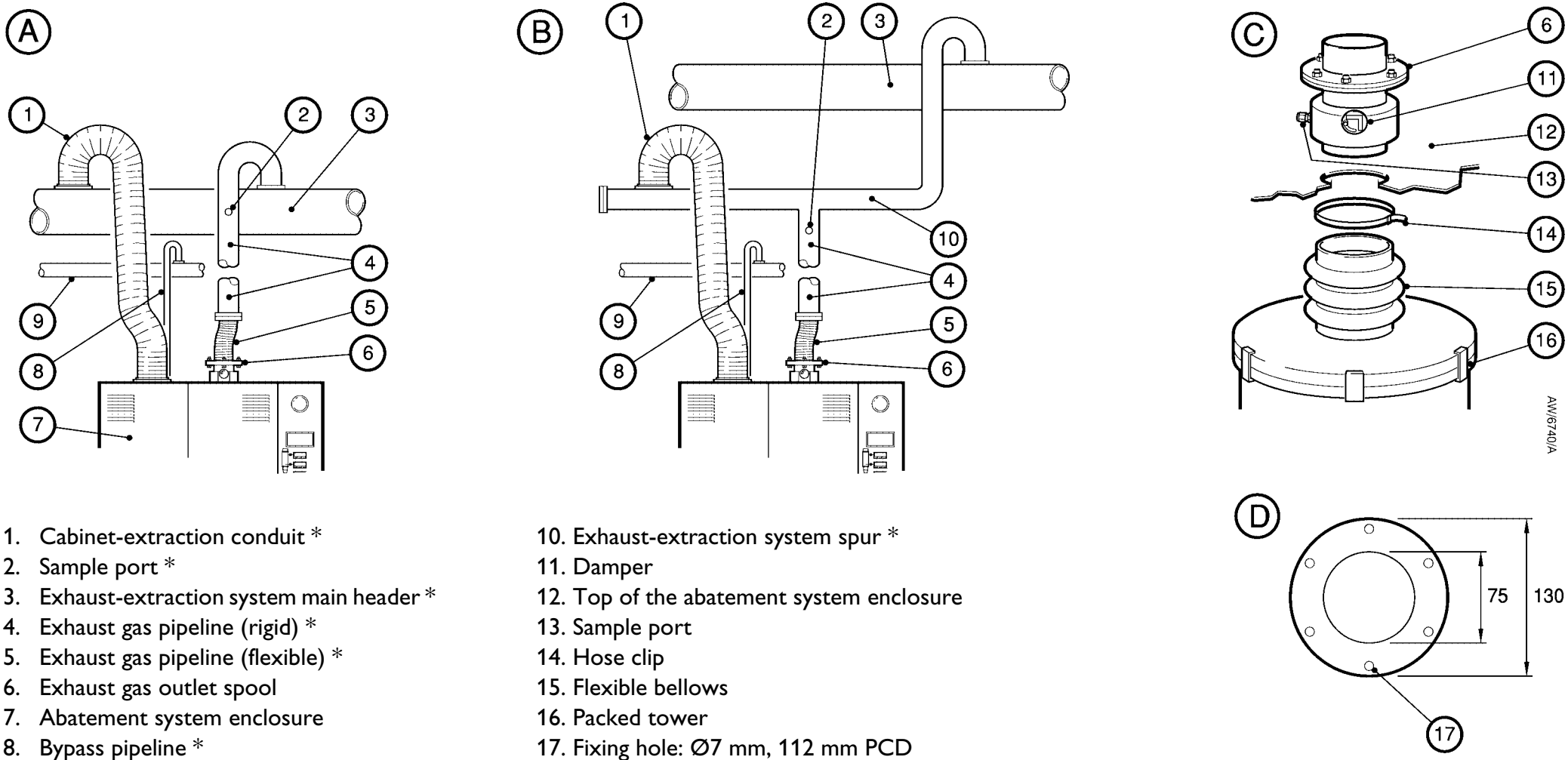
- Refer to detail A. If you connect directly to the main header of your exhaust-extraction system, you must route the exhaust gas outlet pipe (4) into the top of the main header (3).
- Refer to detail B. If you connect to a spur (10) off of the main header (3) of your exhaust-extraction system, you must connect the exhaust gas outlet pipe (4) directly to the bottom of the spur.

When you connect the gas exhaust outlet to your exhaust-extraction system:

- Connect a flexible pipeline (5) to the exhaust gas outlet spool (6), to ensure that you can easily disconnect the pipeline for maintenance purposes, and so that stress is not transmitted to the abatement system pipelines and coupling-joints.
- If required, you can connect your exhaust gas outlet pipe to the outlet spool using a mating flange: refer to detail D for the dimensions of the flange and the securing points (17).
- We recommend that you incorporate a sample port (2) in the exhaust gas outlet pipe. The sample port must be at least 3 m from the exhaust gas outlet.

A Typical connection configuration: to exhaust-extraction system main header
B Typical connection configuration: to exhaust-extraction system spur
C Fit the outlet spool
D Outlet spool details

Figure 13 - Detail key



1. Cabinet-extraction conduit *
2. Sample port *
3. Exhaust-extraction system main header *
4. Exhaust gas pipeline (rigid) *
5. Exhaust gas pipeline (flexible) *
6. Exhaust gas outlet spool
7. Abatement system enclosure
8. Bypass pipeline *
9. Back-up treatment system *
10. Exhaust-extraction system spur *
11. Damper
12. Top of the abatement system enclosure
13. Sample port
14. Hose clip
15. Flexible bellows
16. Packed tower
17. Fixing hole: Ø7 mm, 112 mm PCD

* Customer supplied

Figure 13 - Typical exhaust gas and cabinet-extraction installation configurations

3.16 Leak test the installation

WARNING

Leak test the system after installation and seal any leaks found to prevent the leakage of gases from the system and the leakage of air into the system.

Uncontrolled air leaks may lead to flammable mixtures in the process gas pipelines. BOC Edwards will accept no liability or warranty claims resulting from flammable mixtures caused by air leaks.

Leak test the system after installation and after any invasive maintenance, and seal any leaks found. Process gases which leak from the system will be dangerous to people and there may be a danger of explosion or fire if air leaks into the system. Suitable leak test equipment and full instructions are available from BOC Edwards.

Note that a leak test certificate must be provided for inspection by the BOC Edwards engineer during the commissioning procedure.

3.17 Connect to your cabinet-extraction system

WARNING

Failure of your cabinet-extraction system must be detected by your building management system, and you must not allow process gases to flow into the abatement system unless the cabinet-extraction system can provide the necessary air flow (see Section 2.10). If it does not, the enclosure will not provide double containment of the process gases in the event of a leak in the abatement system or the connecting pipelines.

CAUTION

Ensure that moisture or condensation cannot drain back from your cabinet-extraction system into the abatement system. If it does, there will be a risk of corrosion in the system.

Note: The Cabinet-Extraction Interlock accessory (see Appendix A12) can provide the necessary interface to your building management system.

Use the bolts and washers supplied in the flange fittings kit to secure the cabinet-extraction flange to the cabinet-extraction port on the top of the abatement system enclosure (Figure 9, item 3), then use suitable conduit to connect the cabinet-extraction flange to your cabinet-extraction or exhaust-extraction system. Note that:

- Refer to Figure 13. To prevent the drainage of moisture or condensation back into the abatement system, you must route the cabinet-extraction conduit (1) into the top or side of your cabinet-extraction or exhaust-extraction system.
- Your cabinet-extraction system must provide the extraction flow specified in Section 2.10. This may require the installation of a flow-regulating damper downstream of the abatement system.

3.18 Connect to your acid water drain system

CAUTION

Ensure that your acid waste water is a non-pressurised drain. If the acid waste water cannot be pumped from the abatement system, the system will shut down.

The acid waste water must be pumped into a non-pressurised drain. If it is not, pressure rises in your acid water drain could prevent the water booster/drain pump in the WRU from removing the acid waste water from the abatement system, and so could cause the abatement system to shut down.

Refer to Figure 15. Connect a suitable outlet pipeline between your acid waste water drain and the acid waste water outlet (7) on the WRU.

Note that:

- We recommend that you incorporate a full-bore manual isolation-valve in your acid waste water drain system, so that you can isolate it from the WRU.
- If you have fitted the interface module (15) to the rear of the control unit (13), as shown in detail D, you must incorporate elbows in the pipeline (16), to allow clearance of the vertical parts of the pipeline from the control unit.
- Do not fit non-return valves in this pipeline; these valves will probably become blocked by solid particulates in the waste water.

3.19 Connect the nitrogen supplies

CAUTION

Ensure that your nitrogen supply pressures are as specified in Section 2.5. If a nitrogen supply pressure is too high, you can damage the abatement system.

We recommend that you incorporate an isolation valve in each of the nitrogen supply pipelines (close to the abatement system), so that you can switch off each of the supplies.

1. Refer to Figure 14. Connect your pneumatics nitrogen supply to the pneumatics nitrogen inlet (1) on the side of the abatement system enclosure.
2. Connect your purge nitrogen supply to the purge nitrogen inlet (3) on the side of the abatement system enclosure.

3.20 Connect the oxygen supply (TPU or Kronis systems only)

CAUTION

Ensure that your oxygen supply pressure is as specified in Section 2.6. If the supply pressure is too high, you can damage the abatement system.

We recommend that you incorporate an isolation valve in the oxygen supply pipeline (close to the abatement system), so that you can switch off the supply.

Refer to Figure 14. Connect your oxygen supply to the oxygen inlet (2) on the side of the abatement system enclosure.

3.21 Connect the fuel gas supply

WARNING

Observe all appropriate safety precautions when you install the fuel gas services. If you do not, there is a risk of fire or explosion, or of asphyxiation.

CAUTION

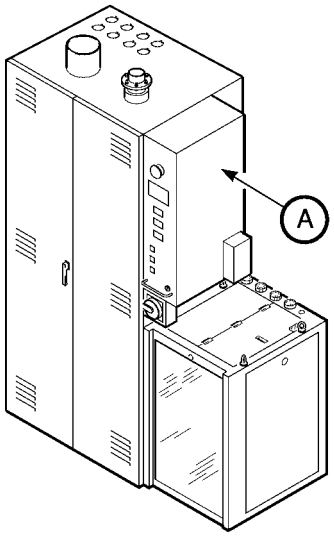
Do not pressurise the fuel gas supply pipeline above 60 inches wg during installation. If you do, you can damage the abatement system.

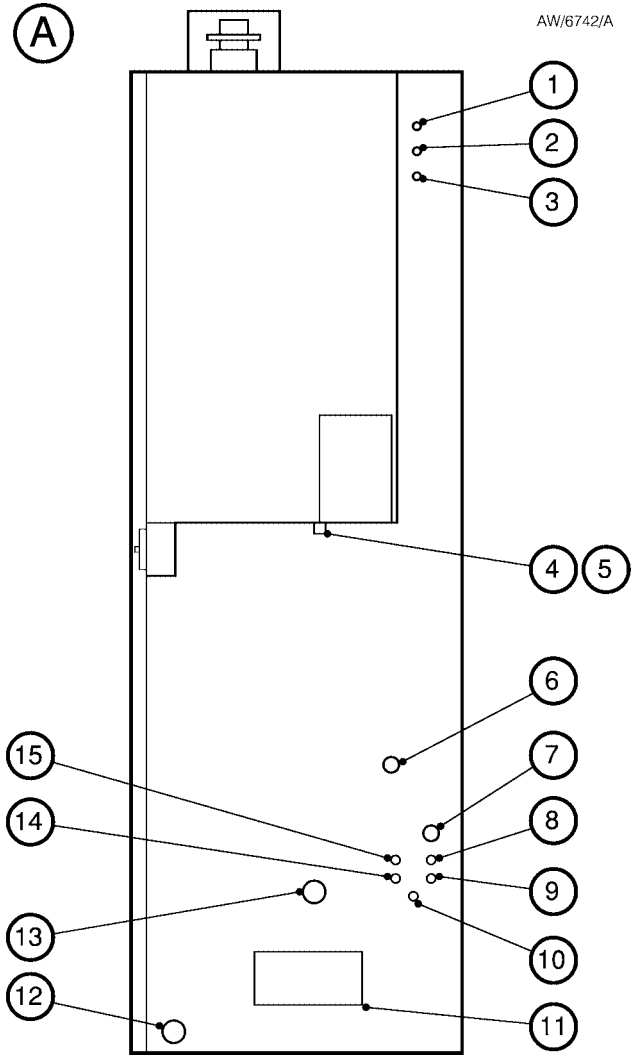
When you connect your fuel gas supply pipeline to the WRU, you must ensure that the pipeline is leak tested and purged before the abatement system is commissioned. Note that you must comply with the requirements of Sections 3.2 and 3.3.2 when you install the gas supply pipelines.

You **must** incorporate an isolation valve in the fuel gas supply pipeline, so that you can switch off the supply for maintenance (for example, if you want to disconnect the WRU). The isolation valve must be close to the WRU, and must be dedicated to the WRU fuel gas supply (that is, it must not control the fuel gas supplies to other equipment).

Refer to Figure 15 and use the following procedure to connect your fuel gas supply pipeline:

1. Undo and remove the four bolts (10), then remove the gas connection enclosure (11) from the WRU.
2. Pass your fuel gas supply pipeline through the leadthrough hole in the gas connection enclosure (11), then connect the pipeline to the fuel gas inlet (12).
3. Refit the gas connection enclosure (11) to the WRU and secure with the four bolts (10).





1. Pneumatics nitrogen inlet
2. Oxygen inlet †
3. Purge nitrogen inlet
4. Electrical connector
5. Electrical connector *
6. Fuel gas pipe leadthrough hole
7. Water supply leadthrough hole
8. Nitrogen supply connector (YV507)
9. Nitrogen supply connector (YV622)
10. Sample pipe connector (AP424)
11. Cabinet extract leadthrough hole
12. Drain tank outlet leadthrough hole
13. Not used (blanked off)
14. Sample pipe connector (AP318)
15. Sample pipe connector (AP317)

† TPU or Kronis only
* Behind item 4

Figure 14 - Abatement system enclosure services connections

3.22 Connect the make-up water supply

CAUTION

Ensure that your make-up water supply complies with the specification in Section 2.8 and does not contain debris (with any dimension larger than 100 µm). If there is debris in the scrubber water, or the supply pressure is too low, you can damage the abatement system/WRU, or cause it to shut down.

Refer to Figure 15. Connect your make-up water supply to the make-up water supply inlet (8) on the top of the WRU. Refer to details C and D:

- We recommend that you incorporate an isolation valve (14) in the make-up water supply pipeline (16) (close to the WRU), so that you can switch off the make-up water supply, and isolate the pipeline for maintenance.
- We recommend that you incorporate a filter in the supply pipeline, to prevent the entry of debris into the WRU and abatement system enclosure.
- If you have fitted the interface module (15) to the rear of the control unit (13), as shown in detail D, you must incorporate elbows in the supply pipeline (16), to allow clearance of the vertical parts of the pipeline from the control unit.

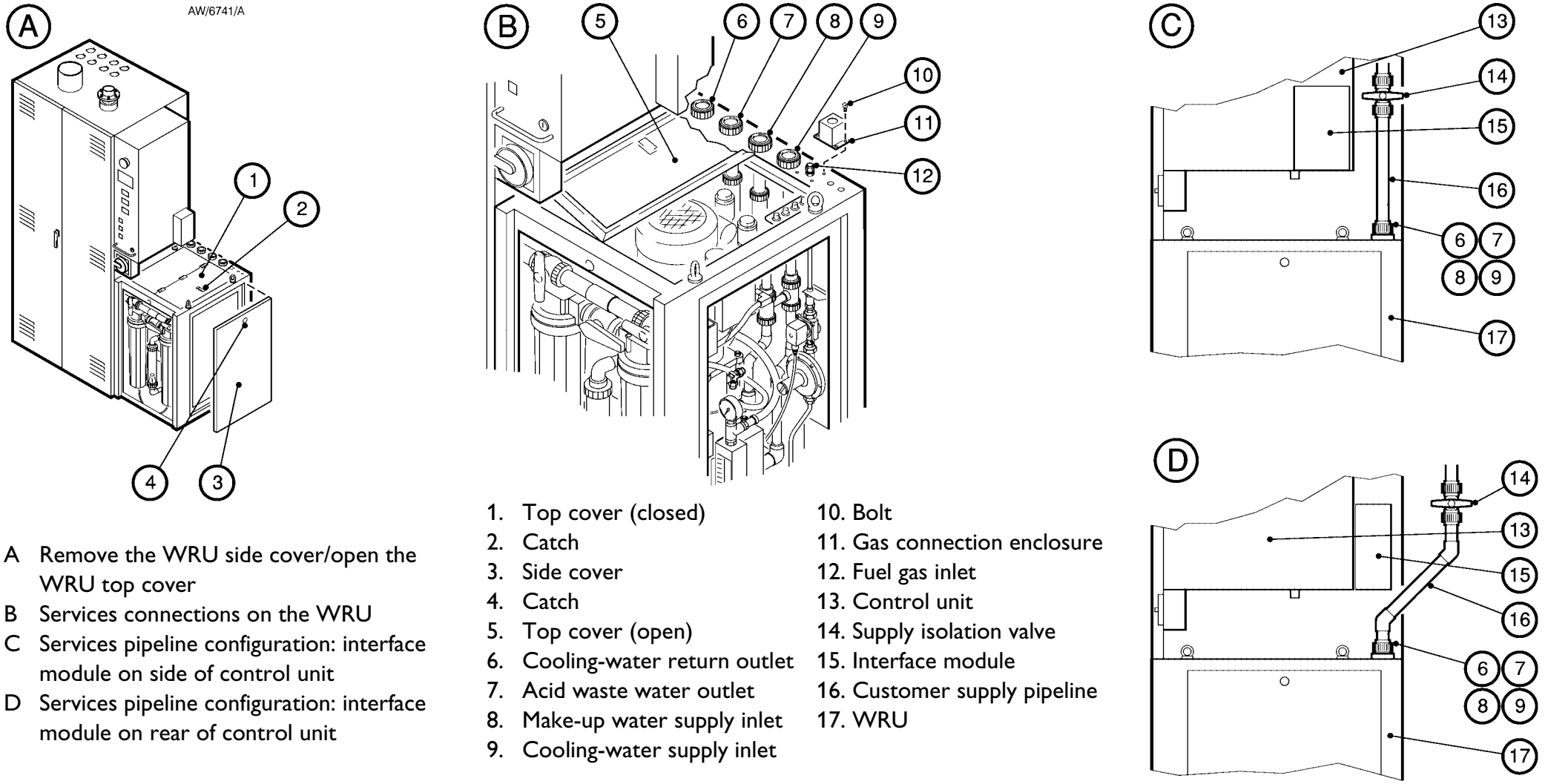
3.23 Connect the cooling-water supply and return pipelines

You must ensure that the cooling-water supply cannot be interrupted during abatement system operation. Refer to Figure 15, details C and D:

- We recommend that you incorporate an isolation valve (14) in each of the supply and return pipelines (16) (close to the WRU), so that you can switch off the cooling-water supply, and isolate the return pipeline for maintenance.
- If you have fitted the interface module (15) to the rear of the control unit (13), as shown in detail D, you must incorporate elbows in the pipelines (16), to allow clearance of the vertical parts of the pipelines from the control unit.

Use the following procedure to connect your cooling-water supply and return pipelines to the WRU.

1. Refer to Figure 15, detail B. Fit your cooling-water return pipeline to the cooling-water return outlet connector (6) on the top of the WRU.
2. Fit your cooling-water supply pipeline to the cooling-water supply connector (9) on the top of the WRU.



A Remove the WRU side cover/open the WRU top cover
B Services connections on the WRU
C Services pipeline configuration: interface module on side of control unit
D Services pipeline configuration: interface module on rear of control unit

1. Top cover (closed)
2. Catch
3. Side cover
4. Catch
5. Top cover (open)
6. Cooling-water return outlet
7. Acid waste water outlet
8. Make-up water supply inlet
9. Cooling-water supply inlet
10. Bolt
11. Gas connection enclosure
12. Fuel gas inlet
13. Control unit
14. Supply isolation valve
15. Interface module
16. Customer supply pipeline
17. WRU

Figure 15 - WRU services connections

3.24 Fit the interface module

Note: We recommend that you fit the interface module to the side of the control unit, as this will make it easier to connect your services supply pipelines to the WRU.

Refer to Figure 16. You can fit the interface module (9) in one of two positions:

- On the rear of the control unit (11), with the cable-glands (3) at the bottom.
- On the side of the control unit (11), with the cable-glands (3) at the rear.

Use the following procedure to fit the interface module:

1. Undo and remove the six bolts (5) and washers (6) which secure the upper and lower covers (7, 4) to the interface module (9) and remove the two covers.
2. Fit the interface module (9) in its required position on the control unit (11), so that the electrical connector (10) in the rear of the interface module mates with the required connector (2) on the rear or side of the control unit.
3. Use the four bolts (8) supplied in the fittings kit to secure the interface module (9) in position on the control unit (11).

Note: Do not refit the covers (4, 7) to the interface module; you will refit the covers after you have made the electrical connections between the abatement system enclosure and the WRU, and between the interface module and your pumping systems and Process Tool.

3.25 Make the electrical connections to the interface module

CAUTION

Ensure that you do not apply a voltage across any of the volt-free input or output terminals in the interface module. If you do, you can damage your equipment.

CAUTION

Do not disconnect the links fitted to terminals 1 to 4 on 1-inlet and 2-inlet systems. If you do, the abatement system will not operate correctly.

Note 1: If you do not connect external remote on/off and remote gas signals, you must link the corresponding terminals. Also, if the remote level terminals are not being used, you must ensure that they are linked. If you do not, you will not be able to start the abatement system.

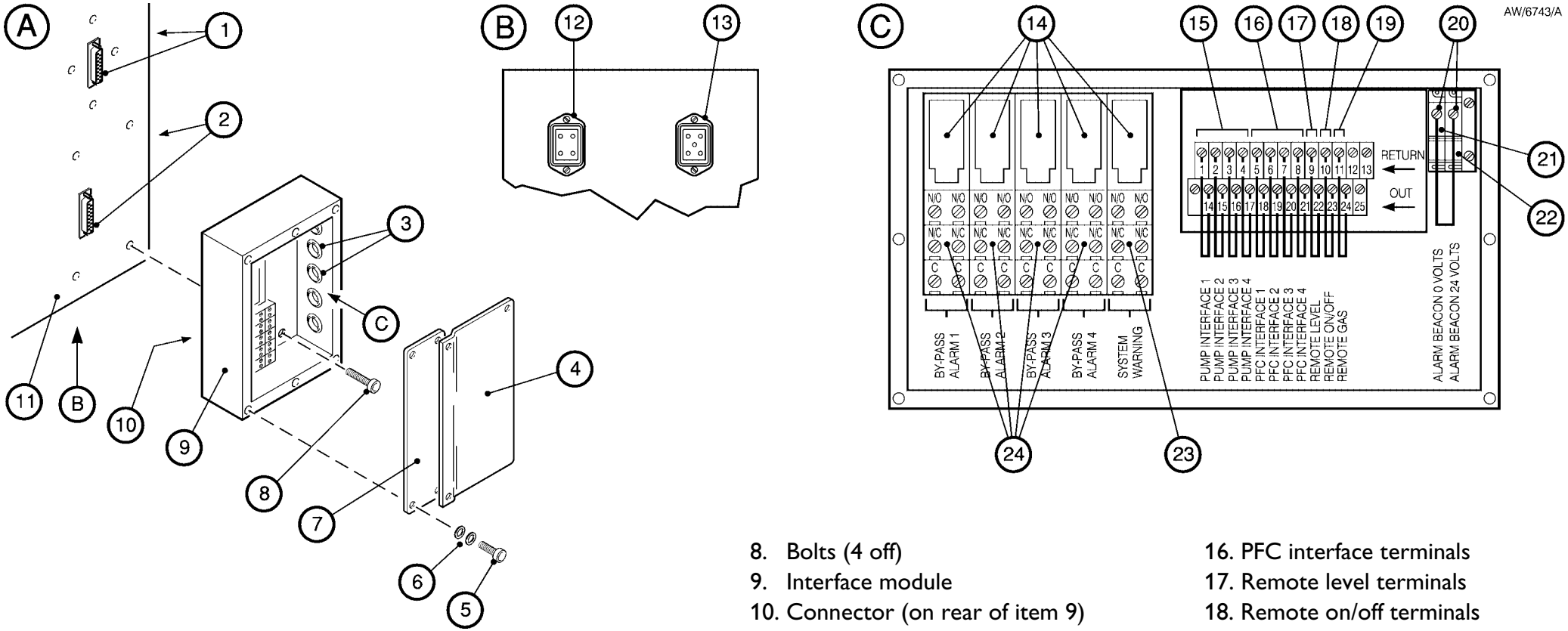
Note 2: Connection of the PFC signals (in Step 2) is optional for TCS systems, but may be required (see Section 3.3.3). Connection of these signals is mandatory for TPU and Kronis systems.

Refer to Figure 16. Use the procedure given on page 92 to make the electrical connections from your Process Tool and/or control system.

Make these electrical connections through the interface module (9): pass each of your cables through a cable-gland (3), make the electrical connections as described in the following procedure, then tighten the cable-gland.

The electrical connections in the interface module are shown in Figure 16 and are summarised in Table 24.

(continued on page 92)



1. FabWorks connector
2. Interface module connector
3. Cable-glands
4. Lower cover
5. Bolts (6 off)
6. Plain and spring washers
7. Upper cover
8. Bolts (4 off)
9. Interface module
10. Connector (on rear of item 9)
11. Side of control unit
12. Water drain pump connector
13. Water booster pump connector
14. Status relays
15. Pumping interface terminals
16. PFC interface terminals
17. Remote level terminals
18. Remote on/off terminals
19. Remote gas terminals
20. Alarm beacon terminals
21. 0 V terminal
22. 24 V terminal
23. System warning output terminals
24. Bypass alarm output terminals

Figure 16 - Fit the interface module

1. Refer to Figure 16, detail C. For each pumping system/vent line, connect a volt-free control signal to the corresponding 'PUMP INTERFACE' terminals (15). These signals must be used as described in Section 3.3.3, to identify when the pumping system is on/off, or the vent line isolation-valve is open/closed.

   Note that for 1-inlet and 2-inlet systems. links are fitted to ensure parallel operation of the manifolded inlets:

   - On 1-inlet systems, terminals 1, 2, 3 and 4 are linked, and you must connect the control signal to terminals 1 and 14.
   - On 2-inlet systems, terminals 1 and 2 are linked, as are terminals 3 and 4, and you must connect the control signals to terminals 1 and 14, and to terminals 4 and 17.

   You must not disconnect the links, otherwise the abatement system will not operate correctly.

2. For each pumping system/vent line, connect a volt-free control signal to the 'PFC INTERFACE' terminals (16). Each of these signals must be used as described in Section 3.3.3, to identify when PFC gas is flowing into the corresponding abatement system inlet.

3. Connect each of the bypass alarm relays (24) to your Process Tool; note that both normally-open and normally-closed output terminals are available on each relay.

   The bypass alarm outputs identify when a bypass alarm fault condition exists for the corresponding pumping system/vent line (see Section 1.10.3), and your Process Tool must be configured to operate as described in Sections 3.3.3 and 3.3.4 in the event of a bypass alarm indication.

4. Connect the alarm beacon terminals (20) to your Process Tool. The alarm beacon outputs identify when a system alarm fault condition exists (see Section 1.10.3), and your Process Tool must be configured to operate as described in Sections 3.3.3 and 3.3.4 in the event of a system alarm indication.

5. If required, connect the system warning relay (23) to your Process Tool; note that both normally-open and normally-closed output terminals are available on the relay. The outputs identify when a system warning fault condition exists.

6. If required, connect a remote level signal (in series with the WRU water leak detector) to the 'REMOTE LEVEL' terminals (17), to shut down the abatement system when necessary as requested by an external device (for example, an external water sensor).

   Note that:

   - A link is fitted to these terminals, and you must remove the link to use a remote level signal.
   - You can fit and connect multiple water leak detectors (refer to Section 3.8) instead of using this input signal.

7. If required, connect a remote on/off signal from your Process Tool to the 'REMOTE ON/OFF' terminals (18), to remotely shut down/switch on the abatement system.

8. If required, connect a remote gas signal to the 'REMOTE GAS' terminals (19), to shut down the abatement system when requested by an external device (for example, a gas detector).

9. Refer to detail A. After you have made the electrical connections, use the six bolts (5) and washers (6) to refit the upper and lower covers (7, 4) to the interface module (9).

Figure 16 key	Signal	Terminal (s)	Use	Signal type
24	BYPASS ALARM 1 - 4	C and N/O	Open to indicate that a bypass alarm fault condition exists.	Volt-free status output †
		C and N/C	Closed to indicate that a bypass alarm fault condition exists.	Volt-free status output †
23	SYSTEM WARNING	C and N/O	Open to indicate that a system warning fault condition exists.	Volt-free status output †
		C and N/C	Closed to indicate that a system warning fault condition exists.	Volt-free status output †
15	PUMP INTERFACE 1	1 and 14	Close to indicate that the pumping system connected to inlet 1 is operating.	Volt-free control input ‡
	PUMP INTERFACE 2	2 and 15	Close to indicate that the pumping system connected to inlet 2 is operating.	Volt-free control input ‡
	PUMP INTERFACE 3	3 and 16	Close to indicate that the pumping system connected to inlet 3 is operating.	Volt-free control input ‡
	PUMP INTERFACE 4	4 and 17	Close to indicate that the pumping system connected to inlet 4 is operating.	Volt-free control input ‡
16	PFC INTERFACE 1	5 and 18	Close to indicate that PFC gas is flowing into inlet 1.	Volt-free control input ‡
	PFC INTERFACE 2	6 and 19	Close to indicate that PFC gas is flowing into inlet 2.	Volt-free control input ‡
	PFC INTERFACE 3	7 and 20	Close to indicate that PFC gas is flowing into inlet 3.	Volt-free control input ‡
	PFC INTERFACE 4	8 and 21	Close to indicate that PFC gas is flowing into inlet 4.	Volt-free control input ‡
17	REMOTE LEVEL *	9 and 22	Open to shut down the abatement system.	Volt-free control input ‡
18	REMOTE ON/OFF *	10 and 23	Open to shut down the abatement system.	Volt-free control input ‡
19	REMOTE GAS *	11 and 24	Open to shut down the abatement system.	Volt-free control input ‡
20	ALARM BEACON	-	On when a system alarm fault condition exists.	24 V d.c. output

Table 24 - Electrical connections in the interface module

* If you do not connect external signals to these terminals, you must link the terminals.

† From the abatement system.
‡ To the abatement system

3.26 Complete the electrical connections

WARNING

Isolate your electrical supply before you make the connections to the abatement system. If you do not, there will be a risk of injury or death by electric shock.

CAUTION

You must fit an overcurrent circuit protection device in the supply to the abatement system, suitable for the system full load current rating: refer to Section 2.11.

CAUTION

Ensure that all electrical connections are made as specified in the following sections. If they are not, you can damage the abatement system.

3.26.1 Introduction

You must use a suitable five-core cable, through a suitably fused isolator, to connect the electrical supply to the abatement system.

Your abatement system may be fitted with either of two types of electrical supply isolator:

- If your system has a 'standard' electrical supply isolator as shown in Figure 17, connect the WRU to the electrical supply isolator as described in Section 3.26.2 (if necessary), then connect the electrical supply to the isolator as described in Section 3.26.3.
- If your system has a 'breaker disconnect' isolator as shown in Figure 18, connect the WRU to the breaker disconnect as described in Section 3.26.4 (if necessary), then connect the electrical supply to the breaker disconnect as described in Section 3.26.5.

3.26.2 Connect the WRU to the electrical supply isolator ('J' and 'S' models only)

1. Refer to Figure 17, detail A. Undo and remove the screws which secure the cover of the electrical supply isolator (2) and remove the cover.
2. Refer to detail B. Pass the electrical cable (Figure 11, item 18) from the WRU through the cable-gland (4) on the rear of the electrical supply isolator (2).
3. Connect the three wires in the electrical cable (8) as shown in detail C:
   - Connect the neutral wire to the lower neutral terminal (7).
   - Connect the live wire to terminal 2/T1 (9).
   - Connect the earth (ground) wire to the lower earth (ground) terminal (10).
4. Continue at Step 2 of Section 3.26.3 (to connect the electrical supply to the electrical supply isolator).

A General view of the abatement system enclosure
B Rear of the electrical supply isolator
C Electrical connections in the isolator
D Lockout position

1. Control unit
2. Electrical supply isolator
3. Cable-gland (electrical supply cable)
4. Cable-gland (WRU cable)
5. Electrical supply cable
6. Electrical supply connections
7. Neutral terminals
8. Electrical cable (from WRU)*
9. Terminal 2 (T1)
10. Earth (ground) terminals
11. Terminal 1 (L1)
12. Electrical supply isolator (in lockout position)

* 'J' and 'S' models only

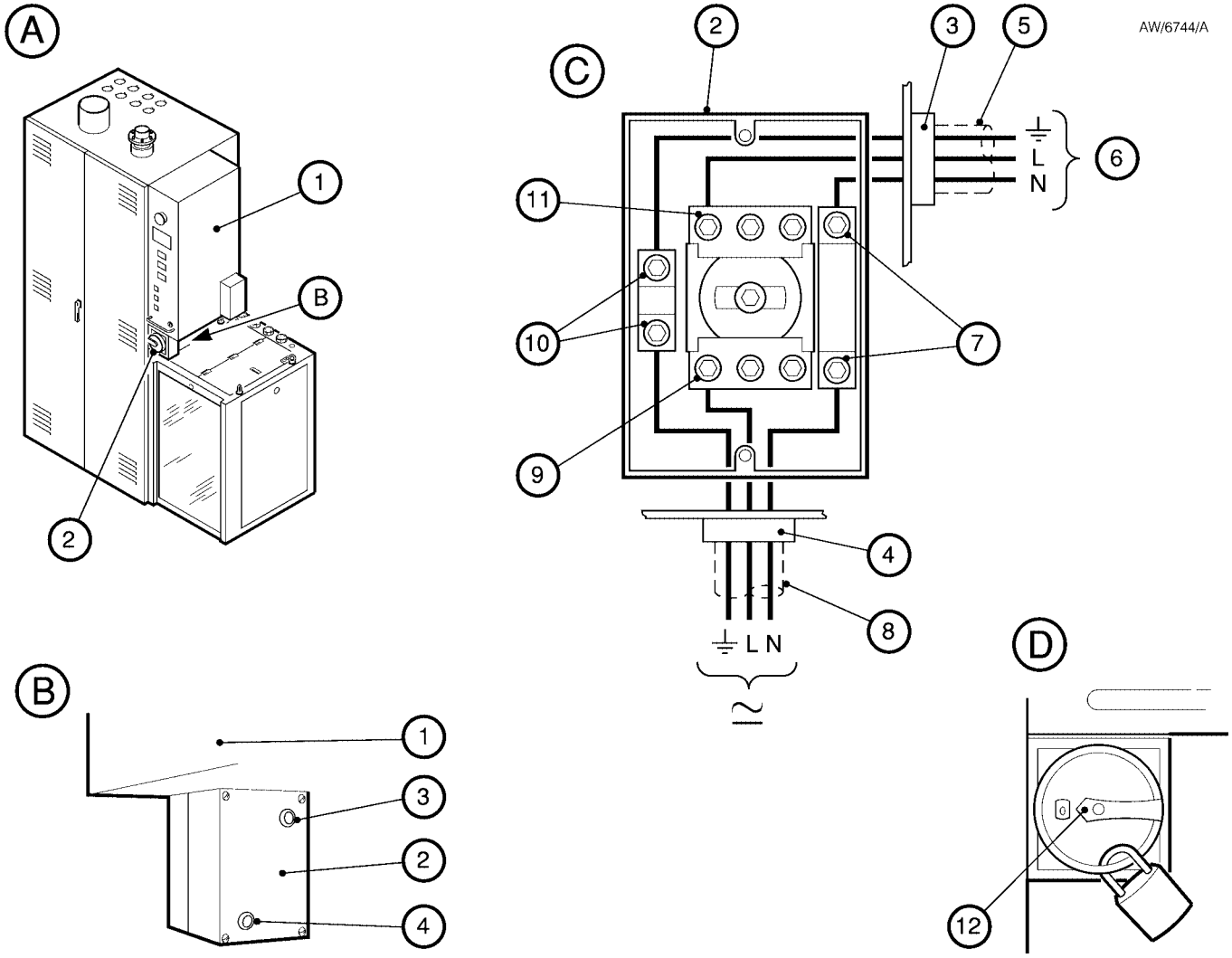


Figure 17 - Electrical connections to the electrical supply isolator

3.26.3 Connect the electrical supply to the electrical supply isolator

Use the following procedure to connect the electrical supply to the electrical supply isolator. Use a suitable three-core cable to connect the electrical supply, through a suitably fused isolator.

1. Refer to Figure 17, detail A. Undo and remove the screws which secure the cover of the electrical supply isolator (2) and remove the cover.
2. Refer to detail B. Pass your electrical supply cable through the cable gland (3) on the rear of the isolator (2).
3. Connect the wires in the electrical supply cable (5) as shown in detail C:
   - Connect the neutral wire to the upper neutral terminal (7).
   - Connect the live wire to terminal 1/L1 (11).
   - Connect the earth (ground) wire to the upper earth (ground) terminal (10).
4. Refer to detail A. Refit the cover to the electrical supply isolator (2) and secure with the screws.
5. Refer to detail B. Tighten the strain-relief screws on the electrical supply cable-gland (3).
6. If you connected a 'J' or 'S' model WRU to the electrical supply isolator in Section 3.26.2, tighten the strain-relief screws on the WRU electrical cable-gland (4).

3.26.4 Connect the WRU to the breaker disconnect ('J' and 'S' models only)

1. Refer to Figure 18, detail F. Undo and remove the screws (16) which secure the front cover (17) to the breaker disconnect (2) and remove the cover. Note that there is an earth (ground) cable connected between the cover and the earth (ground) terminal (5) in the breaker disconnect: leave this cable connected.
2. Undo and remove the screws (18) which secure the bracket (15) and safety cover (14), then remove the bracket and safety cover.
3. Refer to detail B. Pass the electrical cable (Figure 11, item 18) from the WRU through the leadthrough hole (4) on the rear of the breaker disconnect (2).
4. Connect the wires in the electrical supply cable as shown in detail C:
   - Connect the neutral wire to the lower neutral terminal (9).
   - Connect the live wire to circuit breaker CB2 (6).
   - Connect the earth (ground) wire to the earth (ground) terminal (5).
5. Continue at Step 3 of Section 3.26.5 (to connect the electrical supply to the breaker disconnect).

3.26.5 Connect the electrical supply to the breaker disconnect

Use the following procedure to connect the electrical supply to the breaker disconnect. Use a suitable three-core cable to connect the electrical supply, through a suitably fused isolator.

1. Refer to Figure 18, detail F. Undo and remove the screws (16) which secure the front cover (17) to the breaker disconnect (2) and remove the cover. Note that there is an earth (ground) cable connected between the cover and the earth (ground) terminal (5) in the breaker disconnect: leave this cable connected.
2. Refer to detail F. Undo and remove the screws (18) which secure the bracket (15) and safety cover (14), then remove the bracket and safety cover.
3. Refer to detail B. Drill out the pilot leadthrough hole (3) on the rear of the breaker disconnect, so that the hole is of sufficient size for a cable-gland suitable for your electrical supply cable.
4. Fit a suitable cable-gland (not supplied) to the leadthrough hole (3).
5. Refer to detail B. Pass your electrical supply cable through the cable-gland fitted to the leadthrough hole (3).
6. Connect the wires in the electrical supply cable as shown in detail C:
   - Connect the neutral wire to the upper neutral terminal (9).
   - Connect the live wire to terminal 1 of the master breaker (8).
   - Connect the earth (ground) wire to the earth (ground) terminal (5).
7. Refer to detail F. Refit the safety cover (14) and bracket (15) to the breaker disconnect and secure with the screws (18).
8. Refit the front cover (17) and secure with the screws (16).

A General view of the enclosure
B Rear of the breaker disconnect
C Electrical connections in the breaker disconnect
D Normal position
E Lockout position
F Exploded view of the breaker disconnect

1. Control unit
2. Breaker disconnect
3. Electrical supply cable leadthrough hole
4. WRU cable leadthrough hole
5. Earth (ground) terminal
6. Circuit breaker CB2
7. Circuit breaker CB1
8. Master breaker
9. Neutral terminals
10. Guard
11. Electrical supply isolator
12. Lock
13. Spindle
14. Safety cover
15. Bracket
16. Screws
17. Front cover
18. Screws

Figure 18 - Electrical connections to the breaker disconnect: key

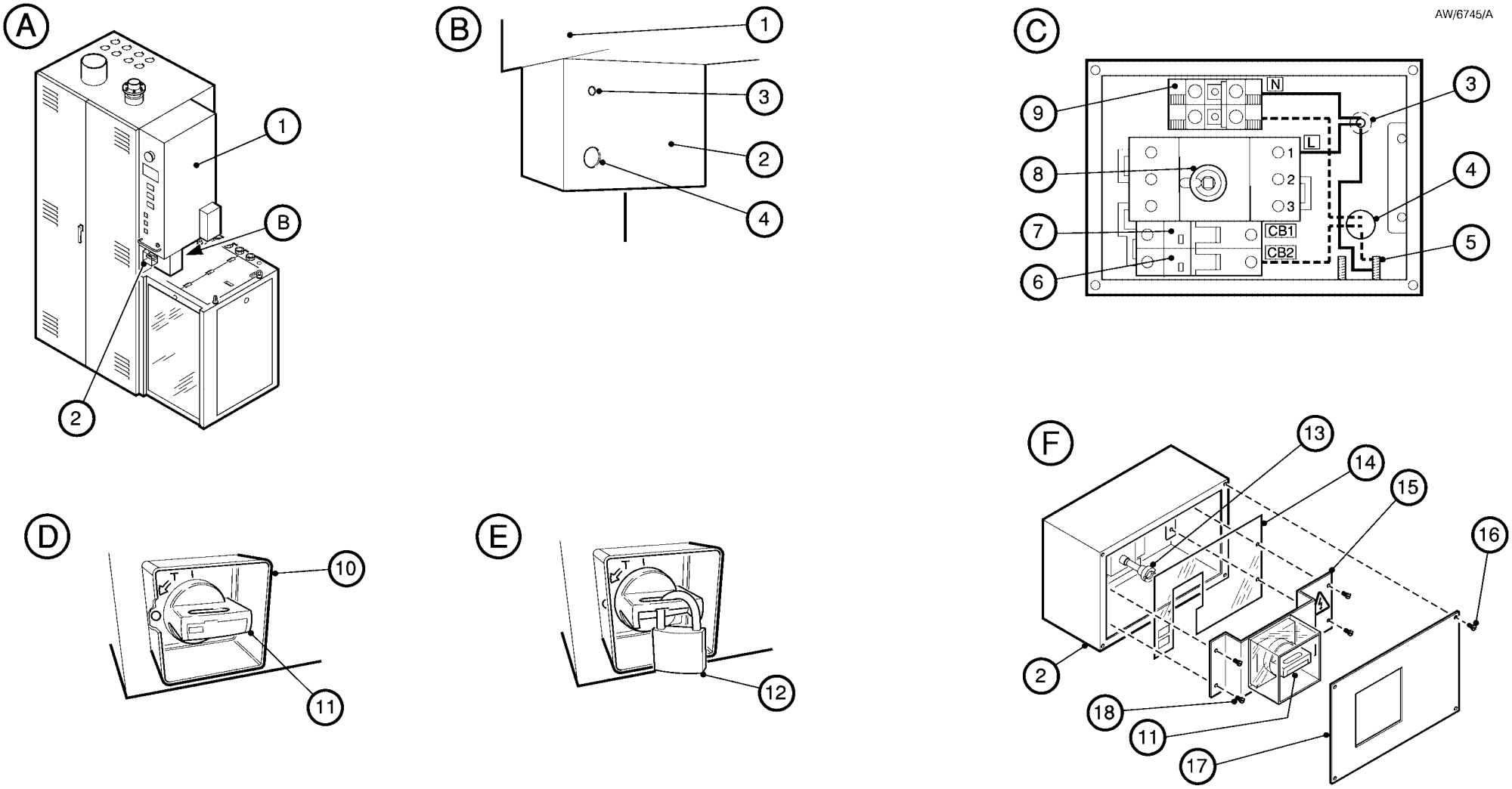


Figure 18 - Electrical connections to the breaker disconnect

3.27 Have the installation inspected and commissioned

WARNING

Ensure that the abatement system cannot be used until it has been inspected and commissioned.

Note 1: We recommend that you complete the installation checklist (form SIC-1, included at the end of this manual) before you request commissioning of the abatement system. This will help you to confirm that you have installed the abatement system correctly.

Note 2: If required, after commissioning the BOC Edwards engineers can perform gas chromatograph conformance testing of TPU or Kronis abatement systems: refer to Appendix A13 for more information.

After you have installed the abatement system, contact your supplier, nearest BOC Edwards company or Service Centre to arrange to have the installation configured, inspected and commissioned.

As part of this procedure, the installation engineer will:

- If necessary, electrically reconfigure the abatement system for your installation.
- Leak test the abatement system internal pipelines.
- Verify that your Process Tool/abatement system interface configuration is correct. Note that your Process Tool must provide interface signals (see Table 24) to the abatement system, for correct operation.
- Complete the commissioning sign-off documentation.

You cannot use the abatement system until it has been inspected and commissioned.

We recommend that you use form CRF-1 (included at the end of this manual) to request that you have the abatement system commissioned.

3.28 Have the make-up water consumption adjusted (optional)

3.28.1 Introduction

WARNING

Do not try to adjust the make-up water consumption yourself. The make-up water consumption must be correctly adjusted by a BOC Edwards engineer.

Note 1: The make-up water consumption must only be adjusted by a BOC Edwards engineer. You cannot adjust the make-up water consumption yourself. The information in this section is therefore provided for guidance only.

Note 2: On a TCS without an operational PFC interface, the make-up water consumption must be manually adjusted as described in Section 3.28.3.

Note 3: Make-up/scrubber water flow when there is no HF present in the incoming process gases will slowly dissolve CaF_2 deposits in the abatement system. Also, the higher the time average consumption of make-up water, the lower the peak quantity of fluorides in the abatement system, which will reduce deposits in the abatement system. The highest peak level of fluorides in the abatement system (and so the highest level of deposits) will occur with the lowest consumption of make-up water (that is, maximum recycling of scrubber water).

After you have had the installation commissioned (as in Section 3.27), if required the BOC Edwards engineer can reduce the time average make-up water consumption. You must ensure that the make-up water consumption is suitable for your installation.

3.28.2 Automatic adjustment

If the Process Tool has been correctly connected to the interface module as described in Section 3.25 so that the PFC interface signals identify when PFC gas is flowing into the abatement system inlets, the make-up water flow is automatically adjusted, in accordance with a preprogrammed minimum water consumption strategy:

- If the PFC signals indicate that no PFC is flowing for a predefined time, make-up water consumption reverts to the minimum consumption figure specified in Section 2.8.
- When PFC signals indicate that PFC is flowing, the PLC in the abatement system automatically adjusts the make-up water consumption, according to the amount of PFC flowing into the system.

3.28.3 Manual adjustment

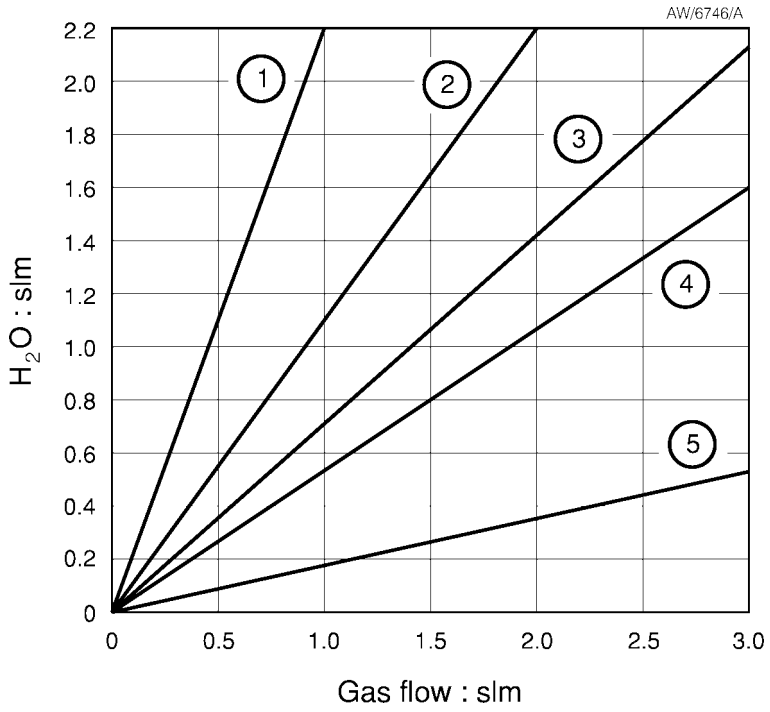
The minimum make-up water consumption can be manually adjusted in accordance with the expected acid gas loading from your process. To determine the recommended make-up water consumption, fill in the appropriate information in Table 25, as follows:

1. Complete the 'Gas flow' column with the expected gas flows for each abatement system inlet.
2. Complete the 'Nominal make-up water consumption' column: for each inlet, determine the nominal make-up water consumption from the graph shown in Figure 19.
3. Complete the 'Process' column with the appropriate process, then complete the 'On-time adjustment' column; this depends on the process as follows:

Process	On-time adjustment
PECVD single wafer	50%
PECVD batch tool	100%
Etch	100%

4. Complete the 'Required make-up water consumption' column: for each inlet, this value is calculated as (Nominal make-up water consumption) x (On-time adjustment).
5. Calculate the 'Total required make-up water consumption': this is the total of the 'Required make-up water consumption' column.

Refer to Table 26 for an example completed make-up water consumption table.



1. C_3F_8/C_4F_8
2. SF_6/C_2F_6
3. ClF_3/CF_4
4. NF_3/CHF_3
5. HCl/HF

Figure 19 - Nominal make-up water consumption (H_2O) against gas flow

Abatement system inlet	Gas flow (l min^{-1})	Make-up water consumption (l min^{-1})	Process	On-time adjustment (%)	Required make-up water consumption (l min^{-1})
1					
2					
3					
4					
Total required make-up water consumption :					

Table 25 - Calculation of required make-up water consumption

Abatement system inlet	Gas flow (l min^{-1})	Make-up water consumption (l min^{-1})	Process	On-time adjustment (%)	Required make-up water consumption (l min^{-1})
1	NF3 1.5	0.8	PECVD S/W	50	0.4
2	NF3 0.75	0.4	PECVD S/W	50	0.2
3	NF3 1.5	0.8	PECVD S/W	50	0.4
4	NF3 0.75	0.4	PECVD S/W	50	0.2
Total required make-up water consumption :					1.2

Table 26 - Example completed make-up water consumption table

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4 OPERATION

4.1 Start-up

4.1.1 Switch on the abatement system

> CAUTION
>
> You must prime the WRU (see Section 4.1.2) if you have just installed the abatement system, or if the system enclosure and/or WRU have been partially or fully drained of water. If you do not, the operational life of the booster pump in the WRU may be reduced, and the WRU may not operate correctly.

Use the following procedure to switch on the abatement system:

1. Refer to Figure 6. Ensure that the electrical supply isolator (3) is in the off position and that the start/stop switch (11) is in the off position.
2. Figure 11. Open the right-hand door of the abatement system enclosure and check that the drain tank outlet isolation valve (8) is in the open position (that is, in-line with the tank outlet pipeline).
3. Refer to Figure 7. Look through the transparent front cover of the WRU:
   - Check that one of the filter isolation valves (5, 7) is open and that the other filter isolation valve is closed.
   - Check that the filter changeover valve (6) is set to direct water to the correct filter (that is, the filter whose isolation valve is open).
4. If necessary, remove the front cover of the WRU and correct the valve positions.
5. Ensure that your cabinet-extraction and exhaust-extraction systems are on and operating.
6. Switch on your services; that is:
   - On all systems: switch on your make-up water, cooling-water, nitrogen, and fuel gas supplies.
   - On TPU and Kronis systems: also switch on your oxygen supply.
7. Ensure that the services pressures are correct: refer to Sections 2.4 to 2.8.
8. Switch on the electrical supply to the abatement system.
9. Refer to Figure 6. Switch on the electrical supply isolator (3) and ensure that the status lamp (9) goes on; if the lamp does not go on, refer to Section 5.14.
10. Press the reset button (10) to initialise the abatement system.
11. If you have just installed the abatement system/WRU, or if the abatement system/WRU has been wholly or partially drained of water, continue at Section 4.1.2 to prime the WRU; otherwise continue at Step 12.
12. Close the door(s) of the abatement system enclosure.
13. Turn the start/stop switch (11) to the start position.

The abatement system will then start its automatic start-up sequence of operations: refer to Section 4.1.3.

4.1.2 Prime the WRU (if necessary)

WARNING

If the abatement system has been in use, acid water may be pumped out of the booster pump when you prime the WRU. Ensure that you wear the correct personal protective equipment when you prime the WRU: refer to Section 5.1.3.

CAUTION

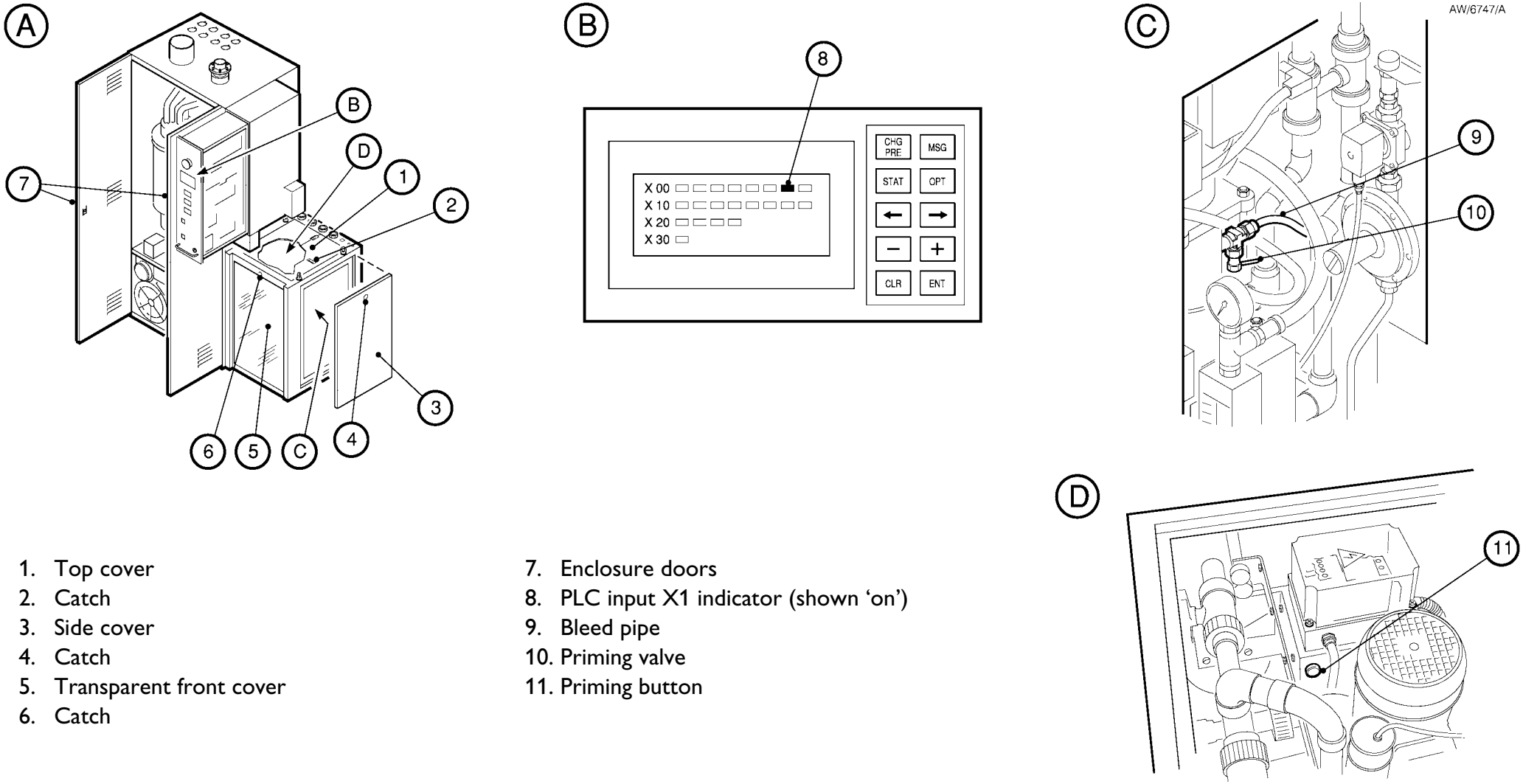
You must prime the WRU if you have just installed the abatement system, or if the abatement system enclosure and/or WRU have been partially or fully drained of water. If you do not, the operational life of the booster pump in the WRU may be reduced, and the WRU may not operate correctly.

1. Refer to Figure 20. Press the STAT button on the status display, so that the PLC I/O status is displayed.
2. Open the abatement system enclosure doors (7).
3. Refer to details C and D. Ensure that you can access both the priming valve (10) and the priming button (11) in the WRU:
   - Undo the catch (2) and open the top cover (1) of the WRU.
   - Undo the catch (4) and remove the side cover (3) from the WRU.
   - Undo the catch (6) and remove the transparent front cover (5) from the WRU.
4. Route the end of the plastic bleed pipe (9) from the WRU into a suitable container.
5. Open the priming valve (10).
6. Watch the end of the bleed pipe (9) while you press and hold in the priming button (11).
7. When there is a steady stream of water coming out of the bleed pipe (9), close the priming valve (10).
8. Look at the PLC inputs on the status display (see detail B). When PLC input X1 (8) goes off:
   - Open the priming valve (10), ensure that all air is fully expelled from the bleed pipe (9), then close the priming valve again.
   - Release the priming button (11).
9. Press the MSG button on the status display, so that abatement system status is shown on the status display.
10. Refer to Figure 6. Turn the start/stop switch (11) to the start position. The abatement system will then start its automatic start-up sequence of operations: refer to Section 4.1.3.
11. Refer to Figure 25. Look at the scrubber water pressure gauge (7). If the gauge does not show a pressure of approximately 4 bar (60 psi) within three seconds of start up:
    - Refer to Figure 6. Turn the start/stop switch (11) to the stop position.
    - Repeat this procedure from Step 5 again.
12. When the abatement system has correctly started up, close the system enclosure doors and refit the WRU covers.

4.1.3 Automatic start-up operations

When you turn the start/stop switch to the start position, the PLC automatically starts up the abatement system.

The sequence of automatic start-up operations is described in Table 27.



1. Top cover
2. Catch
3. Side cover
4. Catch
5. Transparent front cover
6. Catch
7. Enclosure doors
8. PLC input X1 indicator (shown 'on')
9. Bleed pipe
10. Priming valve
11. Priming button

Figure 20 - Prime the WRU

Operation	Control system active	Elapsed time (s)
The status display shows 'BYPASS' or 'BYPASS PUMP OFF' for each pumping system.	PLC	0
The air blower is switched on and the blower inlet isolation valve [YV-331] is opened.	PLC	2
The make-up water isolation valve [YV-501], the acid drain isolation valve [YV-608], the cooling-water supply isolation valve [YV-901] and the cooling-water outlet isolation valve [YV-902] are opened.	PLC	10
The make-up water flow control valve [YV-510] is opened. *	PLC	12
The water booster/drain pump is switched on.	PLC	16
The fuel gas isolation valve [YV-201] is opened.	PLC	16
The gas inlet isolation valve [YV-220] is opened.	PLC	30
The FMS start-up sequence is initiated. The PLC then monitors the abatement system for 40 seconds while the FMS operates the following combustor ignition sequence:		
• The system is purged for five seconds.	FMS	32
• The pilot gas valve [YV-203] is opened.	FMS	32
• The ignition transformer [BX-402] is energised.	FMS	32
• The FMS (through the flame monitor [BE-403]) detects that the pilot flame is present and monitors that the flame is continuously present for 10 seconds. †	FMS	32
• The combustor gas isolation valve [YV-204] is opened.	FMS	34
• The rich start valve [YV-205] is opened.	FMS	34
• The FMS (through the flame monitor [BE-403]) detects that the main flame is present and monitors that the flame is continuously present for 10 seconds. †	FMS	34
• The rich start valve [YV-205] is closed.	FMS	44

Table 27 - Automatic start-up sequence (sheet 1 of 2)

Operation	Control system active	Elapsed time (s)
At the end of the start-up sequence, if no errors have been Detected, the status display will show 'ONLINE', 'BYPASS' or 'BYPASS PUMP OFF'; this depends on the status of the abatement system process gas inlets.	PLC	90

Table 27 - Automatic start-up sequence (sheet 2 of 2)

* The make-up water flow control valve is closed again after 16 seconds. The valve will then open and close, as the acid waste water tank fills and drains, in accordance with the water recirculation operation: refer to Section 1.7.3.

† The elapsed times after 32 seconds assume that no flame failure occurs. The FMS continuously monitors the flame. If there is a flame failure, the abatement system will attempt to establish the pilot flame again, and the FMS will monitor the flame for a further 10 seconds. If a flame failure occurs five times and no pilot flame can be established, the abatement system will then shut down.

4.2 Adjust the PFC residence timers: TPU/Kronis only (if necessary)

WARNING

There are live electrical components in the control unit when the abatement system is switched on. Use an insulated screwdriver and only touch the potentiometers when you adjust the timers; do not touch other components in the control unit.

Note: Refer to Table 21 when you calculate the PFC gas residence times in your installation.

The PLC in the abatement system has four PFC residence timers, one for each pumping system. When the abatement system has been operating in the TPU high fire mode or the Kronis high fire (clean) mode (because PFC gas has been flowing into the abatement system; see Section 1.8.5), the corresponding timer controls how long the abatement system remains in the mode after the Process Tool indicates that PFC gas is no longer flowing.

As supplied, the timers are preset to 30 seconds; the timers can be adjusted up to a maximum of 100 seconds.

If necessary, you must use the following procedure to adjust the timers to suit the residence time of PFC in your installation (that is, the time that PFC gas continues to flow into the abatement system after the PFC gas flow into the pumping system is switched off). Use this procedure the first time you switch on the abatement system, before you use the system to treat process gases. You can only adjust the timers when the abatement system is operating.

1. Refer to Figure 6. Press the CHG/PRE button on the status display (5), then press the → button. The display will then show the current values of the four PFC residence timers (in seconds), in the following form:

   TIMER 1 0030
   TIMER 2 0030
   TIMER 3 0030
   TIMER 4 0030

2. Refer to Figure 22. Use the key supplied to undo the lock (1) on the control unit.
3. Use the handle (2) to pull the control unit rack out of the enclosure.
4. Refer to detail C. Use a small insulated screwdriver to adjust the PFC residence timers (20):
   - Adjust the CH1 potentiometer to adjust the PFC residence timer for pumping system 1.
   - Adjust the CH2 potentiometer to adjust the PFC residence timer for pumping system 2.
   - Adjust the CH3 potentiometer to adjust the PFC residence timer for pumping system 3.
   - Adjust the CH4 potentiometer to adjust the PFC residence timer for pumping system 4.
5. Look at the display to see whether the new timer settings are correct; if necessary, repeat Step 4 to adjust the timers. When the timers are correctly set, continue at Step 6.
6. Push the control unit rack back into the enclosure, then use the key to engage the lock (1).
7. Press the MSG button on the status display. The display will then show the abatement system status again (see Section 4.9).

4.3 Monitor the services pressures and flow rates

Note: When you monitor the fuel gas flow rate, the correct flow rate reading is shown by the top of the float in the flowmeter.

We recommend that you regularly monitor the services pressures and flow rates to the abatement system. You must monitor the pressures and flow rates (and adjust them if necessary) when you first switch on the abatement system, after you have installed the abatement system enclosure and the WRU.

Refer to Figure 7 and use the following procedure:

1. During operation, regularly look at the water flowmeter (9). If the indicated water flow rate is < 15 l min^{-1}, the currently on-line water filter may be blocked: change over to the other filter, as described in Section 5.10.
2. During operation, regularly look at the fuel gas pressure gauge (8) and flowmeter (10) to monitor the fuel gas pressure and flow rate. If the pressure and flow rate are too low or too high, contact your supplier or BOC Edwards for advice.
3. Refer to Figure 25. During operation, regularly look at the pneumatics nitrogen supply pressure gauge (2); if the pressure shown is not approximately 5 bar, use the adjuster on the pneumatics nitrogen supply pressure regulator (3) to adjust the nitrogen supply pressure until it is in the correct range. To adjust the nitrogen supply pressure:
   - Pull out the adjuster on the pressure regulator (3) to unlock it.
   - Turn the adjuster clockwise to increase the regulated pressure, or turn the adjuster anticlockwise to decrease the regulated pressure.
   - Push in the adjuster on the pressure regulator to lock it.
4. On a TPU or Kronis system only: during operation, regularly look at the oxygen supply pressure gauge (5); if the pressure shown is not approximately 10 psi, use the adjuster on the oxygen supply pressure regulator (6) to adjust the oxygen supply pressure until it is in the correct range. To adjust the oxygen supply pressure:
   - Pull out the adjuster on the pressure regulator (6) to unlock it.
   - Turn the adjuster clockwise to increase the regulated pressure, or turn the adjuster anticlockwise to decrease the regulated pressure.
   - Push in the adjuster on the pressure regulator to lock it.
5. During operation, regularly look at the purge nitrogen supply pressure gauge (4); if the pressure shown is not in the range 4 to 8 bar, adjust the pressure of your purge nitrogen supply until it is in the correct range.

4.4 Normal shut-down

4.4.1 Shut down and lock out the Process Tool and pumping system

WARNING

Before you shut down the abatement system, ensure that the Process Tool and pumping systems are correctly purged, shut down and locked out. If you do not, undiluted process gas may continue to flow into your bypass pipelines, or (in the event of a failure) into the abatement system.

Before you shut down the abatement system, you must ensure that the Process Tool and the pumping systems are correctly purged, shut down and locked out.

The operations required are listed below; you must implement suitable procedures to enable these operations to be initiated and carried out safely, and to be notified to other personnel:

- Isolate the process gas supplies from the Process Tool.
- Adequately purge the process chamber with nitrogen.
- Close the process chamber isolation-valve to isolate it from the pumping systems and abatement system.
- Shut down and lock out the Process Tool.
- Operate inlet purge on the pumping systems for at least 15 minutes to purge the pumping systems, the outlet pipelines and the abatement system.
- Shut down and lock out the pumping systems and the services supplies to the pumping systems.

4.4.2 Shut down the abatement system

CAUTION

After you select shut-down, wait at least two minutes before you switch off the make-up water supply to the abatement system. If you do not, you can damage the system.

1. Ensure that the Process Tool and pumping systems have been correctly shut down and locked out, as described in Section 4.4.1.
2. Turn the start/stop switch (Figure 6, item 11) to the off position to shut down the abatement system. The abatement system will then automatically start its shut-down procedure, under control of the PLC.

   The sequence of manual shut-down operations is shown in Table 28.
3. At the end of the automatic shut-down, if the system will be left shut down for a long time:
   - Turn off the electrical supply isolator (Figure 6, item 3) and switch off the electrical supply to the abatement system.
   - Switch off the services to the abatement system; that is, the make-up water, cooling-water, nitrogen and fuel gas supplies, and (if applicable) the oxygen supply.
4. If required, check the positions of the bypass valves: refer to Section 4.6.2.

Operation	Control system active	Elapsed time (s)
The status display shows 'TPU IN OFF MODE'.	PLC	0
The bypass alarm signal output terminals are opened to indicate a bypass alarm for each inlet.	PLC	0
The bypass valves [YV-113 to YV-116] are actuated to the off-line position to divert process gases to the bypass outlets.	PLC	0
FMS shut-down is initiated and the combustor gas isolation valve [YV-204] is closed.	PLC	0
The air blower is switched off and the blower inlet isolation valve [YV-331] is closed.	PLC	0
The inject gas valves [YV109 to YV-112] are closed.	PLC	0
The fuel gas isolation valve [YV-201], the gas inlet isolation valve [YV-220] and the pilot gas valve [YV-203] are closed.	PLC	0
The make-up water isolation valve [YV-501], the acid drain isolation valve [YV-608], the cooling-water supply isolation valve [YV-901] and the cooling-water outlet isolation valve [YV-902] are closed.	PLC	16
The water booster/drain pump is switched off.	PLC	16
The make-up water flow control valve [YV-510] and the acid waste water flow control valve [YV-609] are closed.	PLC	22
Automatic shut-down is complete.	PLC	22

Table 28 - Automatic shut-down sequence

4.5 Standby mode shut-down

Note: When in standby mode, the abatement system will automatically start-up to full operation within 180 seconds of receipt of a pumping system on signal.

The abatement system will enter standby mode and the PLC will initiate automatic shut down if all the pumping systems connected to the abatement system remain off for one minute (that is, all of the pump interface signals are open circuit: see Table 24).

The sequence of standby mode shut-down operations is described in Table 29.

4.6 Emergency shut-down

4.6.1 Abatement system emergency shut-down procedure

Note: If you have pressed the emergency stop switch to shut down the abatement system, you must reset it before you can restart the system: refer to Section 4.7. If you cannot identify the cause of an automatic emergency shut-down, refer to Section 5.14.2.

In an emergency, press the emergency stop switch on the control unit (Figure 6, item 4) to shut down the abatement system. The abatement system will also automatically carry out an emergency shut-down when any of the process interlocks indicate an alarm condition.

Note that because of the heat and acidic output of the abatement system combustor, all of the valves are not closed immediately; instead, the emergency shutdown sequence is as described in Section 4.4.2, except that the status display will show 'EMERGENCY STOP CHECK TPU BEFORE RESET OF EMS'.

Operation	Control system active	Elapsed time (s)
The status display shows 'TPU IN OFF MODE'.	PLC	0
The bypass alarm signal output terminals are opened to indicate a bypass alarm for each inlet.	PLC	20 (2.5*)
The bypass valves [YV-113 to YV-116] are actuated to the off-line position to divert process gases to the bypass outlets.	PLC	20 (2.5*)
FMS shut-down is initiated and the combustor gas isolation valve [YV-204] is closed.	PLC	150
The inject gas valves [YV109 to YV-112] are closed.	PLC	150
The fuel gas isolation valve [YV-201], the gas inlet isolation valve [YV-220] and the pilot gas valve [YV-203] are closed.	PLC	150
The air blower is switched off and the blower inlet isolation valve [YV-331] is closed.	PLC	200
The make-up water isolation valve [YV-501], the acid drain isolation valve [YV-608], the cooling-water supply isolation valve [YV-901] and the cooling-water outlet isolation valve [YV-902] are closed.	PLC	216
The water booster/drain pump is switched off.	PLC	216
The make-up water flow control valve [YV-510] and the acid waste water flow control valve [YV-609] are closed.	PLC	222
Automatic shut-down is complete.	PLC	222

Table 29 - Automatic standby mode shut-down sequence

* These elapsed times apply if you have connected signals from your Process Tool to the PFC INTERFACE signals in the interface module, and the signals indicate that PFC gas is flowing into the abatement system when standby mode shut-down is initiated.

4.6.2 Ensure that the installation is safe

WARNING

Shut down and lock out the Process Tool and pumping systems after an emergency shut-down. If you do not, undiluted process gas may continue to flow into your bypass pipelines, or (in the event of a failure) into the abatement system.

WARNING

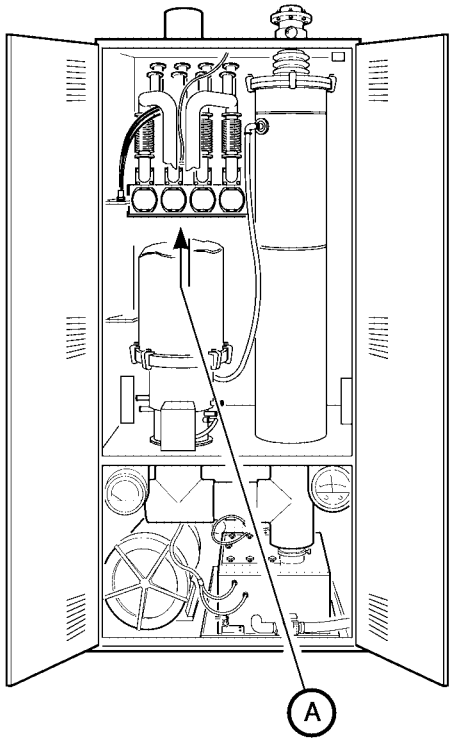
Ensure that you wear the correct personal protective equipment (refer to Section 5.1.3) if you open the abatement system enclosure.

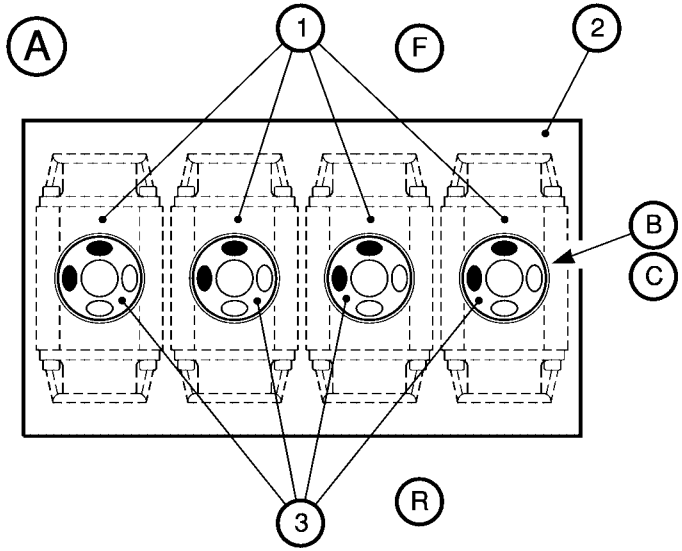
WARNING

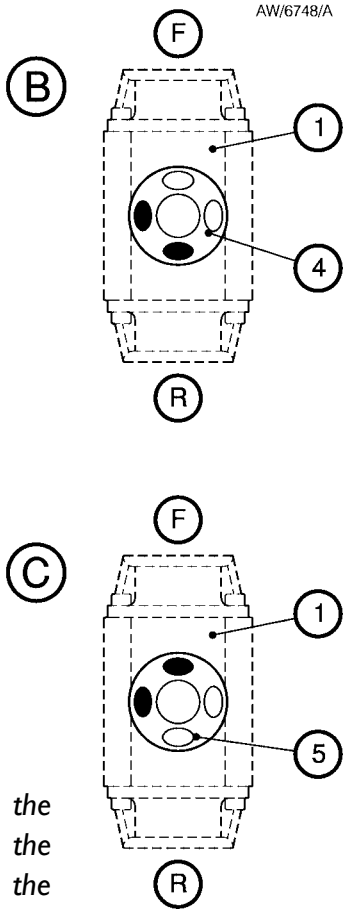
If the abatement system shuts down with any of the bypass valves in the on-line position, contact your supplier or BOC Edwards; do not use the abatement system and do not disconnect any of the pipelines in or connected to the abatement system.

After an emergency abatement system shut-down, you must ensure that the installation is safe. Use the following procedure to check that the installation is safe after an emergency shut-down:

1. Shut-down and lock out the Process Tool and pumping systems: refer to Section 4.4.1.
2. If you think that there may be process gases in the abatement system enclosure, do not open the enclosure or continue with the procedure in this section: contact your supplier or BOC Edwards for advice.
3. Put on the necessary personal protective equipment (refer to Section 5.1.3), to ensure that you are safe in the unlikely event that there is process gas in the abatement system enclosure, then open the doors of the enclosure.
4. Refer to Figure 21. Look at the position indicators (3) on the bypass valves; the orientation of the two white caps identify whether the bypass valve is in the on-line or off-line position:
   - If all of the position indicators are in the off-line position (5, as shown in detail C), the abatement system has shut down correctly. Refer to Section 5.14 for the necessary fault finding procedures.
   - If one or more of the position indicators are in the on-line position (4, as shown in detail B), the abatement system has shut down incorrectly: continue at Step 5.
5. Check the pneumatics nitrogen supply pressure:
   - If the nitrogen pressure is incorrect, the abatement system may have shut down because the pressure was insufficient to operate the valves in the system: ensure that the nitrogen supply pressure is correct before you restart the abatement system.
   - If your nitrogen supply is correct, do not use the abatement system and do not disconnect any of the process or bypass pipelines, or the pipelines in the abatement system enclosure: contact your supplier or BOC Edwards for advice.







A Bottom view of the bypass valves
B Bypass valve in on-line position
C Bypass valve in off-line position
F Front of the enclosure
R Rear of the enclosure

1. Bypass valve actuators
2. Support bracket
3. Position indicators
4. Position indicator (on-line positions)
5. Position indicator (off-line positions)

Note: If your abatement system has the Remote Bypass Module option, the bypass valve actuators and the position indicators are on the top of the abatement system enclosure: refer to Appendix A6*.*

Figure 21 - Check the bypass valve positions

4.7 Restart after manual emergency shutdown

WARNING

Ensure that it is safe to restart the abatement system before you use the following procedure: refer to Section 4.6.2.

Refer to Figure 6 and use the following procedure to restart the abatement system after you have pressed the emergency stop switch to shut down the system:

1. Turn the start/stop switch (11) to the off position.
2. Twist the emergency stop switch (4) to reset it.
3. Press the reset button (10) to reset the abatement system.
4. Turn the start/stop switch (11) to the start position. The abatement system will then automatically start up again, as described in Section 4.1.3.

4.8 Flameouts

Note: The bypass valves will not change position (that is, if a bypass valve is on-line, it will not go off-line) during a flameout.

During abatement system operation (with fuel gas flowing), the FMS constantly monitors the flame in the combustion chamber with the flame monitor. If there is a flameout (that is, if the flame in the combustion chamber is extinguished):

- The combustor gas isolation valve is closed (to shut off the fuel gas/air mixture).
- The PLC instructs the FMS to try to re-ignite the flame.

The PLC will attempt to re-ignite the main flame up to five times in any five minute period. If the main flame cannot be re-ignited in this time, the abatement system will automatically shut down. If the main flame is successfully re-ignited after a flameout, but another flameout occurs within five minutes of the first, the abatement system will automatically shut down.

4.9 Status and fault indications

CAUTION

If a 'PSL 120 LOW NITROGEN PRESSURE FAULT' message is shown, the bypass valves in the abatement system may not operate correctly. Shut down the system (as described in Section 4.4), then check that the system has shut down correctly: refer to Section 4.6.2.

Note: If all of the status display lines show BYPASS PUMP OFF for two minutes, the abatement system will automatically enter standby mode: see Section 4.5.

When the electrical supply isolator is on and before the abatement system has been started up, the status display will show 'OFF'.

When the abatement system has completed its start-up sequence and is in normal operation, each line of the status display will show the status of one of the abatement system process gas inlets (1 to 4), as shown in Table 30.

If a fault condition arises, the appropriate fault message will be shown on the status display: refer to Section 5.14.

Message	Meaning
BYPASS	This indicates that the abatement system is on but is not yet ready to treat process gases. This status is shown during start-up when the bypass valves have not yet moved to the on-line position. *
BYPASS PUMP OFF	This indicates that the bypass valve for the inlet is in the off-line position, and that any process gas from the pumping system will be routed directly to the bypass pipeline and will not be treated by the abatement system (and that the pump interface signal is open circuit: see Table 24). *
BYPASS LOCKOUT	This indicates that the bypass valve for the inlet is in the off-line position because of an over-pressure fault in the inlet pipeline to the abatement system. †
ONLINE <PFC STATUS>	This indicates that the bypass valve is in the on-line position, and that process gas from the pumping system is being treated by the abatement system. <PFC STATUS> will be shown as either "PFC ON" or "PFC OFF" to identify whether PFC gas is flowing into the inlet or not.
REMOTE OFF	This indicates that your control equipment has shut down the abatement system (that is, that your control equipment has opened the remote on/off control input signal: see Table 24).

Table 30 - Status display messages

* When a bypass valve is in the off-line position, the corresponding bypass alarm outputs will indicate that a bypass alarm fault condition exists: see Table 24.

† Once an inlet is in the 'bypass lockout' condition, the bypass valve for the inlet will remain off-line (even if the fault condition clears). You can only cause the bypass valve to go on-line, so that the abatement system treats process gases from the inlet again, by restarting the abatement system.

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5 MAINTENANCE

5.1 Safety

5.1.1 General safety precautions

WARNING

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

- A suitably trained and supervised technician must maintain the abatement system.
- Ensure that the maintenance technician is familiar with the safety procedures which relate to the process products, acid waste water, fuel gas, compressed nitrogen and (if applicable) oxygen supplies.
- Comply with all local site safety and operating procedures.
- Ensure that you wear the correct personal protective equipment suitable for the maintenance operations you will carry out: refer to Section 5.1.3.
- Dispose of components safely: refer to Section 6.2.
- If you need to mechanically dismantle the abatement system or to work on its electrical system:
  - Shut down the system and switch off all of the services as described in Section 4.4 before you start maintenance or servicing.
  - Use a suitable electrical lock-out procedure to prevent accidental injury by electric shock during maintenance or servicing: see Section 5.1.2.
  - Leak test the installation and seal any leaks found after maintenance or servicing, if you have disconnected the process gas inlets, bypass outlets or exhaust gas outlet.
- If you have installed your own hand-operated bypass/isolation valves in the process gas inlet pipelines, ensure that these valves are fully opened (fully on-line) before you restart the abatement system after maintenance.

5.1.2 Electrical and services lockout/tagout

WARNING

If you fail to correctly implement a Process Tool lockout and tagout procedure during maintenance, there may be a risk of a potentially toxic process gas leak.

WARNING

Lockout the abatement system from the electrical supply during maintenance or servicing. If you do not, there will be a risk of injury or death by electric shock.

During maintenance or servicing, you must ensure that the abatement system is isolated from the electrical supply, so that it cannot be switched on and operated accidentally.

(continued on page 122)

In accordance with OHSA requirements, you must implement a suitable electrical lockout procedure. We recommend that you use the following procedure:

1. Notify all affected persons of the shut-down of the abatement system for maintenance or servicing.
2. Identify the person who has locked out the abatement system and the reason for the lockout on a ‘tagout’ sheet or tag.
3. Record the time, date, purpose and authoriser of the lockout in a logbook.
4. Switch off the electrical supply at the lockout location. The electrical supply isolator has a lockout facility for this purpose: see Figure 17 detail D and Figure 18 detail E.
5. Securely attach a 'lockout' device to the electrical supply at this location. Use a lock or other device which cannot be readily removed.
6. Display a 'tagout' notice in an easily seen location.

You must also turn off the supplies and lockout the isolation valves to isolate your fuel gas supply, cooling water supply and return, make-up water supply, nitrogen supply and oxygen supply pipelines.

When you want to return the abatement system to normal use after maintenance or servicing:

1. Ensure that all tools and other equipment have been removed from the abatement system and that the system is fully and correctly reassembled.
2. Ensure that all appropriate persons are notified that the abatement system is to be switched on.
3. Check that all of the abatement system controls are in the correct 'off' position.
4. Remove the lockout devices and turn the isolation valves on your fuel gas supply, cooling water supply and return, make-up water supply, nitrogen supply, and oxygen supply pipelines to the on position.
5. Remove the lockout devices and switch on the electrical supply to the abatement system.
6. Notify all affected persons that the maintenance or servicing is complete and that the abatement system is ready for normal use.
7. Complete the logbook to identify when the lockout was removed and when the abatement system was switched on again.

5.1.3 Invasive safety procedures

WARNING

Before you break any seal in the pipelines connected to the abatement system (or in the process pipelines in the system) check that, in accordance with your site-specific 'permit to work' (or equivalent) working practices, all the pipelines have been sufficiently purged, so that there are no residual process gases present in the pipelines.

WARNING

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

If you need to disconnect, dismantle or repair any of the pipelines connected to the abatement system, before you start work:

- Place tapes or barriers around the equipment to be worked on, to identify that potentially dangerous operations are to take place, and to prevent access by unauthorised people.
- Ensure that the maintenance technician is familiar with the safety procedures which relate to the process gases used.
- Ensure that you have a sufficient number of trapped 'O' rings, blanking plates and clamps or clamping rings to seal (blank off) the pipelines.
- Ensure that you have a sufficient number of air-tight sacks, bags or other containers (of suitable size), to contain components to be disposed of, or to contain contaminated components while you move them to the area where you will work on them.

When you disconnect, dismantle, or reconnect the pumping system outlet pipelines to the abatement system, the bypass pipelines, or your exhaust-extraction system:

- Ensure that you are aware of any process contamination that may have occurred, and comply with all applicable normal site practices.
- Always wear the necessary personal protective equipment: refer to Table 31.
- Disconnect then immediately seal (blank off) exposed pipelines as quickly as possible, to prevent the escape of vapour from the pipelines into the ambient atmosphere.
- Take care not to disturb any particulate trapped in the abatement system or the connecting pipelines. Do not use a brush or compressed air to clean the connecting pipelines in the installation location.

(continued on page 124)

Equipment	Requirement
Body protection	Wear acid-resistant overalls or laboratory apron
Eye protection	Wear safety glasses as a minimum requirement (safety glasses need not be worn if a full-face visor or full-face respiratory mask is worn)
Foot protection	Always wear steel toe-capped acid-resistant safety shoes
Head protection	Hard hats may be required (these will depend on your installation)
Hearing protection	Ear defenders may be required (these will depend on your installation)
Hand protection	Always wear acid resistant gloves
Respiratory protection	Ensure that you comply with your local and national requirements (the exact respiratory protection requirements will depend on the process gases used)

Table 31 - Personal protective equipment requirements for invasive procedures

- Transport contaminated components inside a suitable air-tight bag, sack or other container, to prevent the escape of vapour and particulates into the ambient atmosphere.
- Safely dispose of particulates and contaminated components: refer to Section 6.2.
- Leak test the system after reassembly: refer to Section 3.16.

When you need to open the abatement system enclosure after a fault condition or emergency shut-down (see Section 4.6.2), always wear the necessary personal protective equipment: refer to Table 31.

During normal operation, acid waste water may have an HF concentration of up to 0.5%. When you need to disconnect, dismantle or reconnect the acid waste water pipelines, or when you may come into contact with acid waste water:

- Ensure that you are aware of any process contamination that may have occurred, and comply with all applicable normal site practices.
- Always wear the necessary personal protective equipment: refer to Table 31.

5.2 Maintenance plan

The plan shown in Table 32 details the maintenance activities necessary to maintain the abatement system in normal operation. Instructions for each maintenance operation are given in the section shown.

Maintenance operation	Frequency	Refer to Section
Inspect the services pipelines and connections	Weekly	5.3
Inspect the abatement system pipelines and connections	Weekly	5.4
Inspect the cyclone scrubber	Weekly	5.5
Inspect the WRU pipelines and connections	Weekly	5.6
Inspect the abatement system inlet, bypass and exhaust pipelines and connections	Weekly	5.7
Replace a fuse	When necessary	5.8
Reset a circuit breaker	When necessary	5.9
Replace a water filter element	When necessary	5.10
Inspect the acid waste water tank screen	When necessary	5.11
Replace consumable components	When necessary	5.12

Table 32 - Maintenance plan

5.3 Inspect the services pipelines and connections

WARNING

A suitably trained and registered technician must maintain the fuel gas pipelines.

WARNING

Ensure that you wear the correct personal protective equipment when you maintain the acid waste water pipelines: refer to Section 5.1.3.

Where possible, we recommend that you investigate the cause of any damage or corrosion, and implement corrective measures to prevent any future damage of components.

1. Inspect all of your cooling-water supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
2. Inspect all of your make-up water supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
3. Refer to Figure 7. Look at the scrubber water flowmeter (9). If the indicated water flow rate is < 15 l min^{-1}, the currently on-line water filter may be blocked: change over to the other filter, as described in Section 5.10.
4. Inspect all of your nitrogen supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
5. Check that the nitrogen supply pressures to the abatement system are correct and adjust if necessary.
6. On TPU and Kronis systems only: Inspect all of your oxygen supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
7. On TPU and Kronis systems only: Check that the oxygen supply pressure to the abatement system is correct and adjust if necessary.
8. Inspect all of your fuel gas supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Ensure that any damaged or corroded component is repaired or replaced, and ensure that any leak found is sealed.
9. Look at the fuel gas pressure gauge (8) and flowmeter (10), and check that the fuel gas supply pressure and flow are correct; adjust the pressure if necessary.
10. Inspect your cabinet-extraction system and check that it provides the required extraction flow rate.
11. Inspect the acid waste water outlet pipeline and check that it is not damaged or corroded and that it does not leak. Repair or replace any damaged or corroded component and seal any leak found.
12. Inspect all of your electrical cables to the abatement system and check that they are not damaged and have not overheated. Repair or replace any damaged or overheated cable.

5.4 Inspect the abatement system pipelines and connections

WARNING

A suitably trained and registered technician must maintain the fuel gas pipelines.

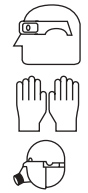
WARNING

Ensure that you wear the correct personal protective equipment when you inspect the abatement system enclosure pipelines and connections: refer to Section 5.1.3.

Use the following procedure to inspect the abatement system enclosure pipelines and connections. If any damaged or corroded component is found, or if a leak is found, contact your supplier or BOC Edwards to arrange an inspection and repair of the abatement system; do not use the abatement system to treat process gases until it has been inspected and repaired.

1. Inspect all of the scrubber water supply and acid waste water pipelines and connections in the abatement system enclosure and check that they are not damaged or corroded and that they do not leak.
2. Inspect the nitrogen supply pipelines and connections in the abatement system enclosure and check that they are not damaged or corroded and that they do not leak.
3. On TPU and Kronis systems only: Inspect the oxygen supply pipelines and connections in the abatement system enclosure and check that they are not damaged or corroded and that they do not leak.
4. Inspect the fuel gas supply pipelines and connections in the abatement system enclosure and check that they are not damaged or corroded and that they do not leak.
5. Inspect all of the electrical cables and connections in the abatement system enclosure and check that they are not damaged and have not overheated.

5.5 Inspect the cyclone scrubber



WARNING

Ensure that you wear the correct personal protective equipment when you inspect the cyclone scrubber: refer to Section 5.1.3.

Refer to Figure 3. Inspect the outside of the cyclone scrubber (12). Shut down the abatement system and contact your supplier or BOC Edwards to arrange for inspection of the system and replacement of the cyclone scrubber, if:

- There are leaks visible at the joints of the cyclone scrubber.
- There are pin-holes or cracks anywhere in the scrubber.
- Any part of the cyclone scrubber is discoloured.
- There are any ripples, dents or bubbles (which may indicate overheating) or any part of the scrubber is distorted.

If the cyclone scrubber needs to be replaced, do not use the abatement system to treat process gases until it has been inspected and repaired.

5.6 Inspect the WRU pipelines and connections

WARNING

A suitably trained and registered technician must maintain the fuel gas pipelines.

WARNING

Ensure that you wear the correct personal protective equipment when you inspect the acid waste water pipelines: refer to Section 5.1.3.

Use the following procedure to inspect the WRU pipelines and connections.

If any damaged or corroded component is found, or if a leak is found, contact your supplier or BOC Edwards to arrange an inspection and repair of the WRU; do not use the abatement system to treat process gases until the WRU has been inspected and repaired.

1. Refer to Figure 20, detail A. Remove the covers from the WRU:
   - Undo the catch (6), then remove the transparent front cover (5).
   - Undo the catch (2), then lift off the top cover (1) from the WRU.
   - Undo the catch (4), then remove the side cover (3).
2. Inspect the cooling-water, make-up water and scrubber water pipelines and connections in the WRU and check that they are not damaged or corroded and that they do not leak.
3. Inspect the water drain outlet pipelines and connections in the WRU and check that they are not damaged or corroded and that they do not leak.
4. Inspect the fuel gas supply pipelines and connections in the WRU and check that they are not damaged or corroded and that they do not leak.
5. Inspect the electrical cables in the WRU and check that they are not damaged and have not overheated.
6. Inspect the nitrogen pipe (from the abatement system enclosure to the pneumatic manifold in the WRU) and check that it is not damaged and that it does not leak.
7. Refit the covers to the WRU:
   - Refit the side cover (3) to the WRU and engage the catch (4) to secure the cover in place.
   - Refit the top cover (1) to the WRU and engage the catch (2) to secure the cover in place.
   - Refit the transparent front cover (5) to the WRU, then engage the catch (6) to secure the cover in place.

5.7 Inspect the abatement system inlet, bypass and exhaust pipelines and connections

WARNING

Ensure that you wear the correct personal protective equipment when you inspect the pipelines and connections: refer to Section 5.1.3.

1. Inspect the pipelines and connections between the pumping system exhausts and the abatement system and check that they are not damaged or corroded and that they do not leak. Ensure that any damaged or corroded component is repaired or replaced, and that any leak found is sealed.
2. Inspect the bypass pipelines and connections and check that they are not damaged or corroded and that they do not leak. Ensure that any damaged or corroded component is repaired or replaced, and that any leak found is sealed.
3. Inspect the exhaust gas outlet pipeline and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
4. Inspect your exhaust-extraction system and check that it provides the required extraction flow rate.

5.8 Replace a fuse (when necessary)

WARNING

Lockout the abatement system from the electrical supply before you start work. If you do not, there will be a risk of injury or death by electric shock.

If you think that a fuse has failed, use the following procedure to check the fuse and replace it, if necessary. Only replace a fuse when you have identified and rectified the cause of the fuse failure. Refer to Table 17 for the fuse designations and ratings.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then electrically lock out the abatement system: refer to Section 5.1.2.
3. Refer to Figure 22. Use the key supplied to undo the lock (1) on the control unit, then use the handle (2) to pull the control unit rack out of the enclosure.
4. Remove fuse F1 (7), fuse F2 (9), fuse F3 (4), fuse F4 (5), or fuse F5 (8); if necessary, remove the fuse from a PLC module as follows:
   - Refer to detail D. Pull out the retaining clips (21, 23), then pull the module from the PLC.
   - Remove the radial fuse (24) from the module.
5. Measure the electrical continuity across the fuse.

6. If there is no continuity, the fuse has failed. Replace it with a new fuse of the correct rating (refer to Table 17). To replace the fuse in a PLC module:
   - Refer to detail D. Fit the new radial fuse (24) to the module.
   - Refit the module to the PLC and push in the retaining clips (21, 23).
7. Push the control unit rack back into the enclosure, then use the key to engage the lock (1).
8. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.1.

If the fuse fails again immediately after you have replaced it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.

5.9 Reset a circuit breaker (when necessary)

WARNING

Lockout the abatement system from the electrical supply before you start work. If you do not, there will be a risk of injury or death by electric shock.

If you think that a circuit breaker has tripped, use the procedures in Sections 5.9.1 and 5.9.2 to check the circuit breaker and to reset it, if necessary. Only reset a circuit breaker when you have identified and rectified the cause of the trip. Refer to Table 17 for the circuit breaker ratings.

5.9.1 Enclosure circuit breakers

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then electrically lock out the abatement system: refer to Section 5.1.2.
3. Refer to Figure 22. Use the key supplied to undo the lock (1) on the control unit, then use the handle (2) to pull the control unit rack out of the enclosure.
4. Reset the tripped circuit breaker (19).
5. Push the control unit rack back into the enclosure, then use the key to engage the lock (1).
6. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.

If the circuit breaker trips again immediately after you have reset it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.

5.9.2 Breaker disconnect circuit breakers

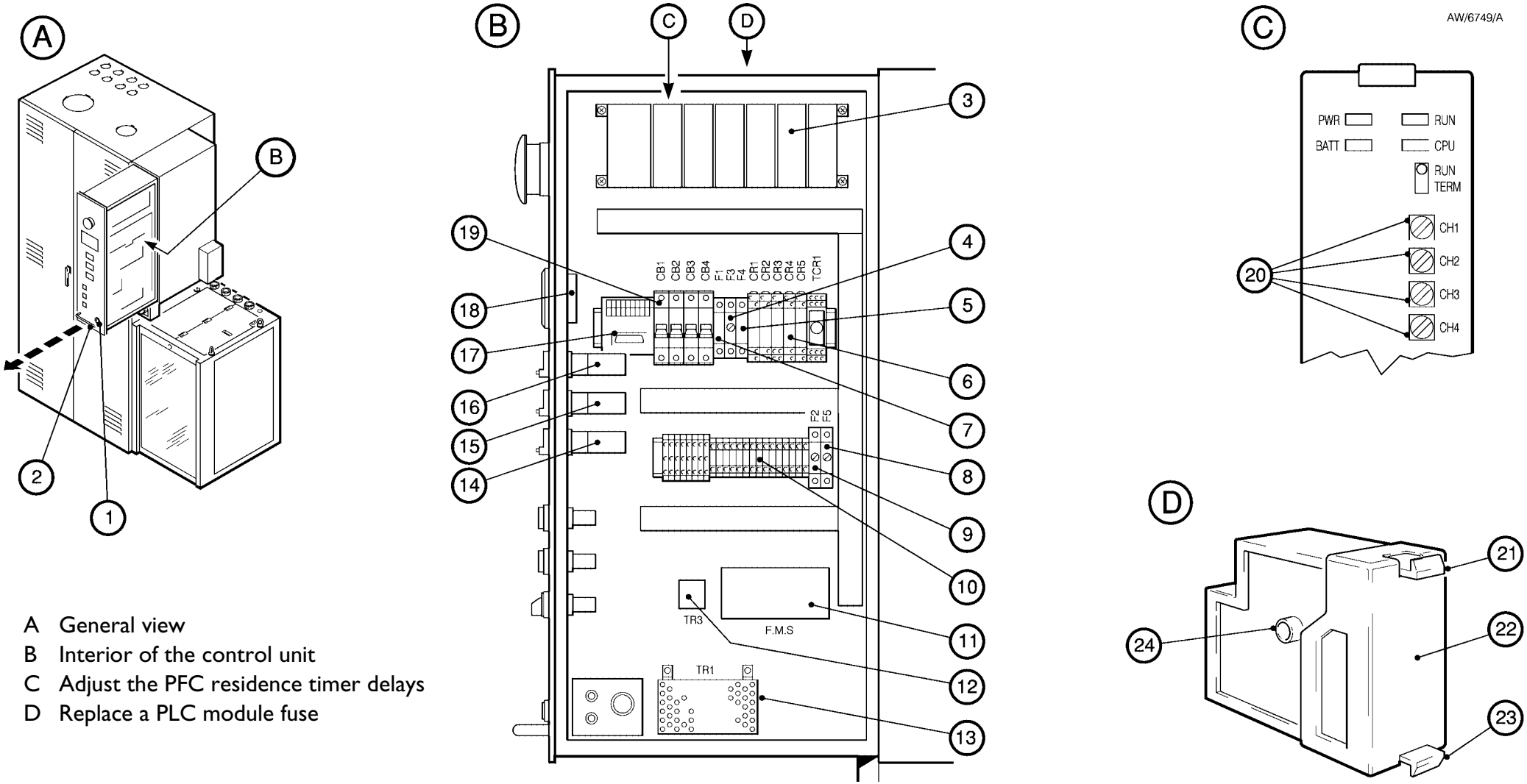
Note: To reset a breaker disconnect circuit breaker, you must lockout the electrical supply to the abatement system; you cannot lockout the breaker disconnect itself.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then electrically lock out the abatement system: refer to Section 5.1.2.
3. Refer to Figure 18. Undo the screws (16) and remove the front cover (17) from the breaker disconnect.
4. Undo and remove the screws (18) and remove the bracket (15) and safety cover (14) from the breaker disconnect.
5. Reset the tripped circuit breaker (6, 7 or 8).
6. Refit the safety cover (14) and bracket (15) and secure with the screws (18).
7. Refit the front cover (17) to the breaker disconnect and secure with the screws (16).
8. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.

If the circuit breaker trips again immediately after you have reset it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.

1. Lock
2. Handle
3. PLC
4. Fuse F3
5. Fuse F4
6. Relays
7. Fuse F1
8. Fuse F5
9. Fuse F2
10. Terminals
11. FMS
12. FMS transformer TR3 ('J' model only)
13. Power supply TR1
14. Quench outlet temperature display
15. Combustion chamber temperature display
16. Plenum chamber temperature display
17. Terminal block
18. Status display and keypad
19. Circuit breakers
20. PFC residence timer potentiometers
21. Clip
22. PLC module
23. Clip
24. Radial fuse

Figure 22 - Interior of the control unit: key



A General view
B Interior of the control unit
C Adjust the PFC residence timer delays
D Replace a PLC module fuse

Figure 22 - Interior of the control unit

5.10 Replace a water filter element

5.10.1 Introduction

Note: You do not need to shut down the abatement system to replace a water filter.

Refer to Figure 23, detail B. One of the two filters (6, 7) will be 'on-line' and the other filter will be 'off-line'. Note that:

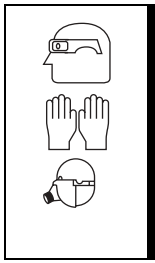
- The isolation valve (3 or 5) for the on-line filter will be in the open position (that is, aligned with the pipeline between the filters).
- The isolation valve (3 or 5) for the 'off-line' filter will be in the closed position (that is, aligned with the filter body).
- The arrow on the filter changeover valve (4) will point to the on-line filter.

When necessary:

- Change over to a new filter element: refer to Section 5.10.2.
- Change the blocked filter element: refer to Section 5.10.3.

When a filter is blocked, you must change over to a new filter element immediately. However, you may replace the blocked filter later, at some convenient time.

5.10.2 Change over to a new filter element



WARNING

Ensure that you wear the correct personal protective equipment when you access the inside of the WRU: refer to Section 5.1.3.

1. Refer to Figure 23, detail A. Undo the catch (1), then remove the transparent front cover (2) from the WRU.
2. Refer to detail B. Turn the filter isolation valve (3 or 5) which is currently in the closed (off-line) position to the open (on-line) position.
3. Turn the (changeover valve (4) to point to the new on-line filter.
4. Turn the other filter isolation valve to the closed (off-line) position.

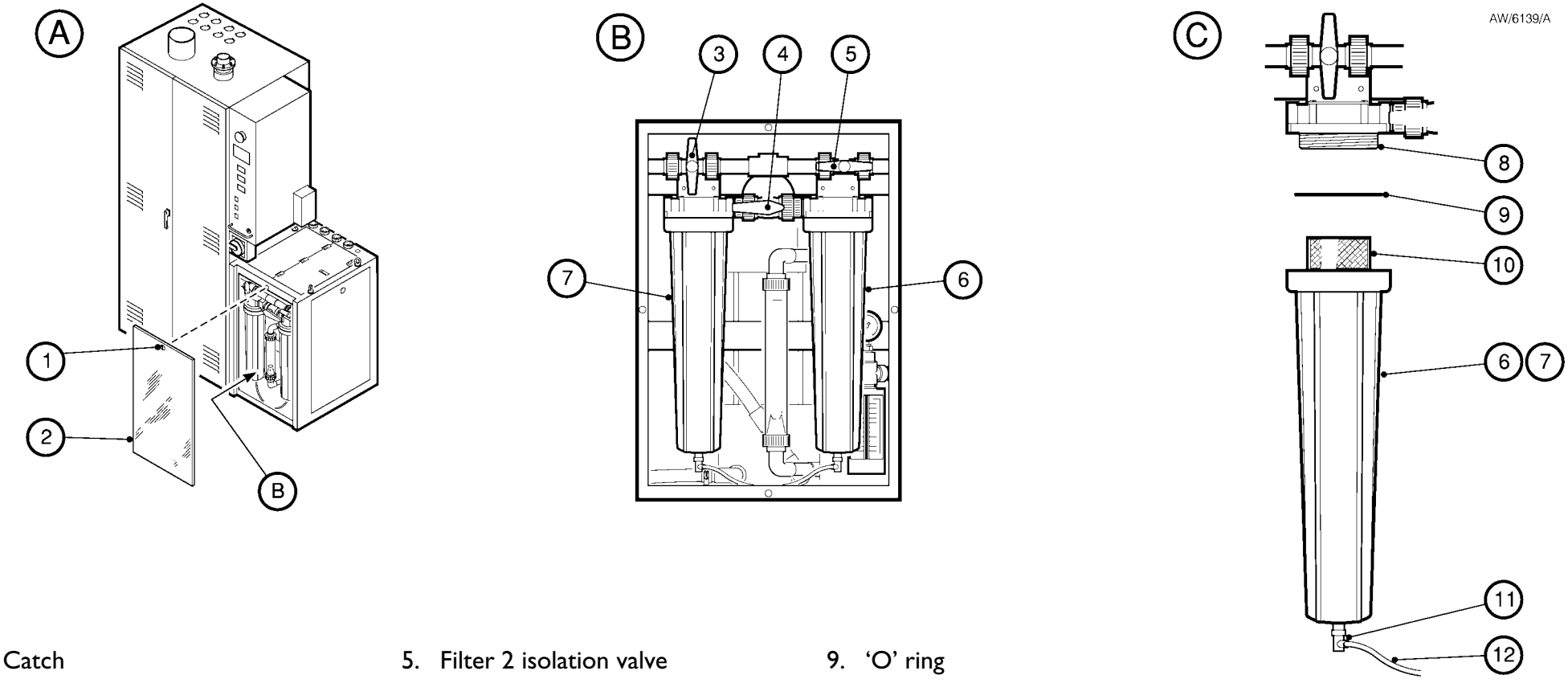
5.10.3 Replace the blocked filter element

WARNING

Ensure that you wear the correct personal protective equipment when you replace the filter element: refer to Section 5.1.3.

1. Put on the required personal protective equipment: see Section 5.1.3.
2. Refer to Figure 23. Place a suitable waste water container (with a capacity of at least 5 litres) next to the currently off-line filter (6 or 7), to catch any spillage of acid waste water from the filter housing.
3. Refer to detail C. Route the end of the drain tube (12) from the off-line filter into the waste water container.
4. Open the drain valve (11), allow any waste water to drain out of the filter housing, then close the drain valve again.

(continued on page 134)

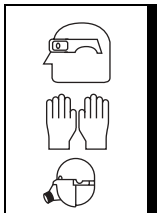


1. Catch
2. Front cover
3. Filter 1 isolation valve
4. Changeover valve
5. Filter 2 isolation valve
6. Filter 2 housing
7. Filter 1 housing
8. Filter mount
9. ‘O’ ring
10. Filter element
11. Drain valve
12. Drain tube

Figure 23 - Change over to a new filter element/change a filter element

5. Use the filter spanner supplied to unscrew and remove the filter housing (6 or 7) of the off-line filter from the filter mount (8); try to ensure that as little water is spilled from the filter housing as possible.
6. Remove the blocked filter (10) from the filter housing (6 or 7); dispose of the filter: refer to Section 6.2.
7. Fit a new filter (10) in the filter housing (6 or 7), then check that the 'O' ring (9) is correctly fitted to the top of the filter housing.
8. If possible, fill the filter housing (6 or 7) with water.
9. Refit the filter housing (6 or 7) to the filter mount (8) and tighten by hand.
10. Use the filter spanner to fully tighten the filter housing (6 or 7).
11. Use a suitable lint-free cloth or sponge to mop up any spillage, then place the cloth or sponge in the waste water container.
12. Refer to detail A. Refit the transparent front cover (2) to the WRU, then engage the catch (1) to secure the cover in place.
13. Dispose of the acid waste water and any cloth or sponge used: refer to Section 6.2.

5.11 Inspect the acid waste water tank screen



WARNING

Ensure that you wear the correct personal protective equipment when you inspect the acid waste water tank screen: refer to Section 5.1.3.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then electrically lock out the abatement system: refer to Section 5.1.2.
3. Refer to Figure 24, detail A. Connect a suitable pipe to the sample/drain valve (2). Route the end of the pipe into a suitable container, to catch any acid waste water drained from the tank.
4. Open the sample/drain valve (2), allow the acid waste water to drain from the tank (4), then close the sample/drain valve.
5. Undo and remove the thumbwheels (1), then take off the top cover (3) from the tank (4).
6. Refer to detail B. Pull the screen (6) out of the tank (4), then clean any loose deposits off the screen.
7. Inspect the screen: if the screen is cracked or warped, or if there any solid deposits which cannot be removed, you must replace the screen: refer to Section 7.3.
8. Refit the screen (6): slide it into the slots in the tank (4)
9. Ensure that the seal (5) is correctly in place, then refit the top cover (3) over the studs (7).
10. Refit the thumbwheels (1) to the studs (7), to secure the top cover (3) to the tank (4).
11. Safely dispose of the acid waste water drained from the tank, and of any deposits removed from the screen: refer to Section 6.2.
12. When required, remove the electrical lockout device(s) (refer to Section 5.1.2) and restart the abatement system as described in Section 4.1.

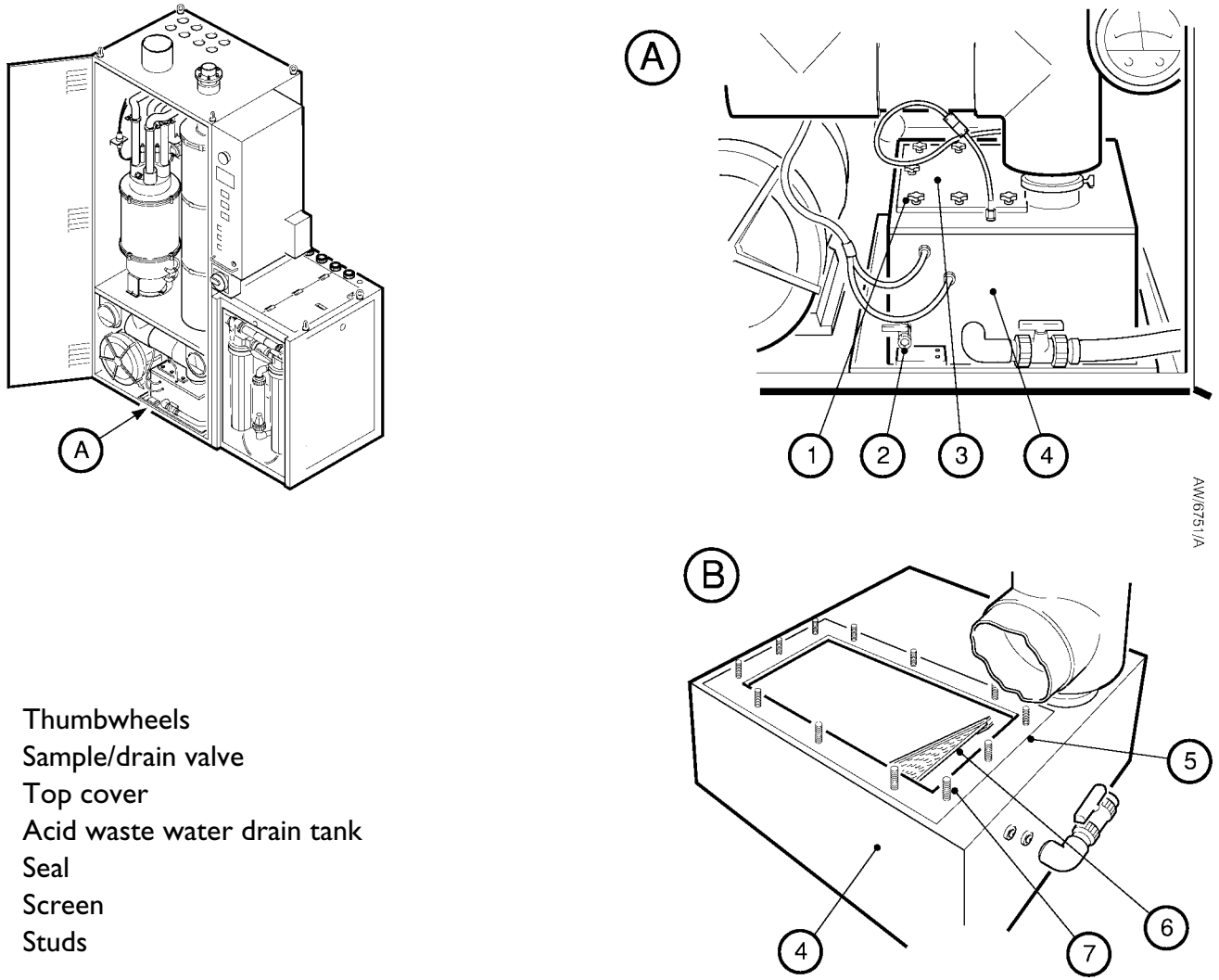
5.12 Replace consumable components

WARNING

Replace consumable components when necessary. If you do not, the abatement system may fail or be damaged, or your cooling-water supply may become contaminated.

You must replace consumable components at a frequency in accordance with your installation. This frequency varies depending on the HF concentration of the scrubber water/acid waste water recirculating in the WRU, and is typically 6 monthly for an HF concentration of 0.5%.

Ensure that you have determined the correct consumable replacement frequency for your installation: if necessary, contact your supplier or BOC Edwards for advice.



1. Thumbwheels
2. Sample/drain valve
3. Top cover
4. Acid waste water drain tank
5. Seal
6. Screen
7. Studs

Figure 24 - Inspect the acid waste water tank screen

5.13 Leaks

There are two types of leak that may occur in the abatement system enclosure:

- Gas leak
- Water leak

Any leak of process gas, exhaust gas or fuel gas will be removed from the enclosure through the cabinet-extraction system.

Any water leak in the abatement system enclosure or in the WRU will be contained in the drip tray in the bottom of the abatement system enclosure or WRU respectively.

If a water leak occurs:

1. Identify the source of the leak and seal the leak.
2. Use a suitable lint-free cloth or sponge to mop up the leak, then place the cloth or sponge in a suitable waste water container.
3. Dispose of the waste water and any cloth or sponge used: refer to Section 6.2.

5.14 Fault finding

5.14.1 Status display fault messages

Note 1: We recommend that you maintain a fault log. If the abatement system shuts down automatically, take note of the fault messages shown on the status display and record these in the log (together with any PLC indications: see Section 5.14.2) before you switch off the system.

Note 2: The PLC in the abatement system retains a fault log of the last 10 faults which have caused system shut-down: refer to Section 5.14.3 to view this shut-down fault log.

If the abatement system shuts down automatically because of a system alarm (that is, one of the system alarm process interlocks has operated), the status display will show a number of messages which will identify the possible causes of the shutdown.

In general, each message has two or more lines:

- The first line identifies the process interlock which has operated.
- The other lines provide an indication of the interlock's function.

Where two or more messages are present, the messages will be shown one after the other, and will continue to be cycled on the display until the abatement system is switched off.

Table 33 shows the messages which can be displayed, their meanings and the actions you should carry out to identify and rectify the fault. Note that the messages are shown in alphabetical order for ease of reference. Refer to Table 34 for other fault finding.

Fault message	Check	Actions
BYPASS LOCKOUT	Is the process gas flow to an abatement system inlet too high ?	Check that the process gas flow is as specified in Section 2.3, and correct as necessary.
	Is an inlet pipeline/nozzle blocked ?	Shut down the abatement system and contact your supplier or BOC Edwards to arrange for an inspection.
	Is a process gas high temperature switch [TSH-121 to TSH-124] or a process gas high pressure switch [PSH-101 to PSH-104] disconnected or faulty ?	Contact your supplier or BOC Edwards.
	Has there been ignition of the process gases in the inlet pipelines ?	Shut down the abatement system and your Process Tool and contact your supplier or BOC Edwards to arrange for an inspection.
EMERGENCY STOP CHECK TPU BEFORE RESET OF EMS	Has the emergency stop switch been pressed to shut down the abatement system ?	Rectify the cause of the shut down, then reset and restart the abatement system: refer to Section 4.7.
	Has the emergency stop 24 V electrical supply failed ?	Look at relay CR1; if the relay is de-energised, the 24 V electrical supply is off. If the 24 V electrical supply is off, check whether fuse F1 in the power supply has failed, and replace if necessary: refer to Section 5.8.
	Is there an electrical fault ?	Check that the wiring to the interface module is correct. If the wiring to the interface module is correct, there may be an electrical fault in the abatement system: contact your supplier or BOC Edwards.
FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL	Is the fuel gas pressure too low ?	Restart the abatement system and take a note of the point where the flame alarm signal occurs. If the flame alarm signal does not appear immediately, but the pilot flame does not appear, check that the fuel gas supply to the abatement system is the correct pressure (8.4 inches).

Table 33 - Status display fault message fault finding (sheet 1 of 15)

Fault message	Check	Actions
FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL (continued)	Has the electrical supply to the fuel gas isolation valve [YV-201] failed ?	Check that circuit breaker CB3 has not tripped; if the circuit breaker has tripped, identify and rectify the cause of the trip, then reset the circuit breaker if necessary: refer to Section 5.9.
	Has the electrical supply to the fuel gas isolation valve [YV-201] failed ? (continued)	If circuit breaker CB3 has not tripped, check that the electrical cables are correctly fitted between the control unit and the WRU: refer to Sections 3.9 and 3.26.2 or 3.26.4.
	Is there a failure in the WRU ?	If the pressure of the fuel gas supply to the WRU is correct, the pressure regulator [PCV-203] or the fuel gas isolation valve [YV-201] may be faulty: contact your supplier or BOC Edwards.
	Is the low gas pressure switch incorrectly set or faulty ?	If the flame alarm signal occurs immediately on abatement system start up, the fuel gas low pressure switch [PSL-201] may not be set correctly, or may be faulty: contact your supplier or BOC Edwards.
	Is the low combustion air pressure switch incorrectly set or faulty ?	Check that the low combustion air pressure switch [PDSL-301] is set to operate at 3 inches. If the switch is correctly set, the switch may be faulty: contact your supplier or BOC Edwards.
	Is there a leak in the mixer system ?	Check that the transparent pipelines between the venturi mixer, the differential pressure indicator [PDI-311] and the pressure switch [PDSL-301] do not leak. If there are leaks, contact your supplier or BOC Edwards to arrange for repair of the abatement system.
	Is the flame monitor faulty ?	If the pilot flame appears correctly, but the flame alarm signal appears, the flame monitor [BE-403] may be faulty: contact your supplier or BOC Edwards.
	Is the internal gas pressure okay ?	If the pilot flame appears correctly, but flame failure occurs as the main gas valve opens to start the combustor light up sequence, check the internal dynamic fuel gas pressure.

Table 33 - Status display fault message fault finding (sheet 2 of 15)

Fault message	Check	Actions
FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL (continued)	Is the internal gas pressure okay ? (continued)	The pressure shown on the fuel gas pressure gauge [PI-207] should be 8.4 inches during the pilot ignition sequence, 5 inches during rich start and 5 inches minus plenum pressure during normal operation (if the plenum pressure is -1 inches, the reading on the pressure gauge [PI-207] will read 4 inches). If the pressure shown on pressure gauge [PI-207] does not correspond with the pressure shown on the differential pressure gauge [PISH-401], the pressure control valve [PCV-221] may be faulty: contact your supplier or BOC Edwards . If the pressure control valve operates correctly, the reference pipe to the top of the venturi mixer may be blocked: contact your supplier or BOC Edwards.
	Is a fuel gas or pilot valve faulty ?	Check that the pilot flame is visible during start up. If there is no pilot flame, the pilot air control valve or the pilot fuel gas valve [YV-203] may be faulty: contact your supplier or BOC Edwards.
	Is there an ignition system failure ?	Check that the spark ignitor cable is correctly connected and is not damaged. If the spark ignitor cable is correctly connected and is undamaged, the ignition transformer may be faulty, or the pilot fuel gas jet orifice may be blocked: contact your supplier or BOC Edwards.
	Has the blower circuit breaker tripped ?	Check that the air blower operates correctly. If the air blower does not operate, check that circuit breaker CB1 has not tripped. If necessary, reset the circuit breaker (refer to Section 5.9).
	Is the blower air filter blocked, is there a leak in the pipelines, is the flame controller disconnected or faulty, or has relay CR4 failed ?	If circuit breaker CB1 has not tripped but the air blower does not operate, the air blower may be disconnected or may be faulty, the blower air filter may be blocked, there may be a leak in the pipelines, the flame controller may be disconnected or may be faulty, or relay CR4 may have failed: contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 3 of 15)

Fault message	Check	Actions
FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL (continued)	Is the gas multiblock filter blocked ?	If there is a differential pressure increase from the WRU fuel gas pressure gauge to the enclosure pressure gauge [PI-201], the fuel gas multiblock filter may be blocked: contact your supplier or BOC Edwards.
FMS CONTROLLER FAIL TO START UP	Has the FMS internal fuse or an electrical component failed ?	Either the internal fuse in the FMS has failed, or the timer unit has failed, or there is an electrical fault: contact BOC Edwards for advice.
FSL 511 QUENCH WATER FLOW FAULT	Has the make-up water supply failed ?	Ensure that the make-up water supply is switched on and that its pressure is as specified in Table 14. During normal operation, the pressure shown on the scrubber water pressure gauge [PSL-501] should be between 3.5 to 4 bar.
	Is the water filter blocked ?	If the pressure of the external make-up water supply is correct, but the internal scrubber water pressure is low, the water filter may be blocked: refer to Section 5.10.
	Does the water isolation valve operate correctly ?	If there is no internal scrubber water pressure, the main water isolation valve [YV-501] may be faulty: contact your supplier or BOC Edwards.
	Is the flow level switch disconnected, or has it failed ?	Check that input X20 on the PLC is on. If the input is off, the flow level switch may be disconnected, or it may be faulty: contact your supplier or BOC Edwards.
	Has circuit breaker CB3 tripped ?	Check that circuit breaker CB3 has not tripped; if the circuit breaker has tripped, identify and rectify the cause of the trip, then reset the circuit breaker: refer to Section 5.9.
	Are the enclosure to WRU electrical cables disconnected ?	If the circuit breaker has not tripped, look at output Y12 on the PLC; this should be on to indicate that the 24 V control signal for the pump is available. If so, check that the electrical cables are correctly connected between the abatement system enclosure and the WRU: refer to Sections 3.9 and 3.26.2/3.26.4.

Table 33 - Status display fault message fault finding (sheet 4 of 15)

Fault message	Check	Actions
FSL 511 QUENCH WATER FLOW FAULT (continued)	Has the WRU water booster/drain pump failed ?	If circuit breaker CB3 has not tripped, PLC output Y12 is on and the electrical cable is correctly connected, but the water booster/drain pump does not operate, it may have failed: contact your supplier or BOC Edwards.
	Is the quench water jet blocked or is it damaged ?	If the water booster/drain pump operates, the water spray jet may be blocked or corroded: contact your supplier or BOC Edwards.
FSL 604 PACKED TOWER WATER FLOW FAULT	Has the make-up water supply failed ?	Ensure that the make-up water supply is switched on and that its pressure is as specified in Table 14. During normal operation, the pressure shown on the scrubber water pressure gauge [PSL-501] should be between 3.5 to 4 bar.
	Is the water filter blocked ?	If the pressure of the external make-up water supply is correct, but the internal scrubber water pressure is low, the water filter may be blocked: refer to Section 5.10.
	Does the water isolation valve operate correctly ?	If there is no internal scrubber water pressure, the main water isolation valve [YV-501] may be faulty: contact your supplier or BOC Edwards.
	Is the flow level switch disconnected or has it failed ?	Check that input X21 on the PLC is on. If the input is off, the flow level switch may be disconnected, or it may be faulty: contact your supplier or BOC Edwards.
	Has circuit breaker CB3 tripped ?	Check that circuit breaker CB3 has not tripped; if the circuit breaker has tripped, identify and rectify the cause of the trip, then reset the circuit breaker: refer to Section 5.9.
	Are the enclosure to WRU electrical cables disconnected ?	If the circuit breaker has not tripped, look at output Y12 on the PLC; this should be on to indicate that the 24 V control signal for the pump is available. If output Y12 is on, check that the electrical cables are correctly connected between the control unit and the WRU: refer to Sections 3.9 and 3.26.2/3.26.4.

Table 33 - Status display fault message fault finding (sheet 5 of 15)

Fault message	Check	Actions
FSL 604 PACKED TOWER WATER FLOW FAULT (continued)	Has the WRU water booster/drain pump failed ?	If circuit breaker CB3 has not tripped, PLC output Y12 is on and the pump electrical supply cable is correctly connected, but the water booster/ drain pump does not operate, it may have failed: contact your supplier or BOC Edwards.
	Is the packed tower water jet blocked or is it damaged ?	If the water booster/drain pump operates, the water spray jet may be blocked or corroded: contact your supplier or BOC Edwards.
GAS SENSOR ALARM	Has the optional abatement system fuel gas detector detected gas in the enclosure ?	Look at the LEDs on the fuel gas detector (Figure 3, item 2). If the red LED on the detector is on, gas has been detected in the enclosure: ensure that the cabinet-extraction system remains on, shut down the abatement system and isolate the fuel gas supply, then contact your supplier or BOC Edwards.
	Has the optional external (customer supplied) gas detector detected gas ?	Ensure that the cabinet-extraction system remains on, shut down the abatement system and isolate the fuel gas supply, then contact your supplier or BOC Edwards.
	Is the optional external gas detector incorrectly connected to the abatement system ?	Ensure that the gas detector is correctly connected to the abatement system: refer to Section 3.25.
	Has the gas detector failed ?	If the previous checks fail to identify a fault, the abatement system fuel gas detector or your optional external gas detector may be faulty: contact your supplier or BOC Edwards.
LSH 601 DRAIN WATER LEVEL ALARM	Is there a blockage in your acid water drain ?	Inspect your acid drain system and remove any blockage as necessary. The drain must be non-pressurised and there must be no restriction to the waste water flow. Restart the abatement system after you have rectified any fault, then check that the high water level switch [LSH-601] goes closed circuit and that input X14 on the PLC is off.

Table 33 - Status display fault message fault finding (sheet 6 of 15)

Fault message	Check	Actions
LSH 601 DRAIN WATER LEVEL ALARM (continued)	Is the WRU water booster/drain pump switched off ?	If the abatement system is off, turn the start switch to the start position to turn on the water booster/drain pump.
	Has the WRU water booster/drain pump decoupled ?	Switch off the abatement system, then switch it on again
	Has the water booster/drain pump circuit breaker tripped ?	If the water booster/drain pump still does not operate, check whether circuit breaker CB3 has tripped and reset it as necessary: refer to Section 5.9. Note that output Y17 on the PLC should be on to indicate that the 24 V control signal for the drain pump is available.
	Is the WRU water booster/drain pump disconnected or has it failed ?	If circuit breaker CB3 has not tripped, and the water booster/drain pump does not operate, it may be misconnected or faulty: contact your supplier or BOC Edwards.
	Is the WRU water booster/drain pump blocked ?	If the water booster/drain pump operates, but does not pump water, it may be blocked: contact your supplier or BOC Edwards.
	Is there a blockage or leak in the pipelines, is the tank damaged or blocked, or is the drain level switch disconnected or has it failed ?	Contact your supplier or BOC Edwards to arrange for an inspection of the abatement system.
LSH 609 SWITCH FAULT OR CONNECTION ERROR	Are the level switches incorrectly fitted ?	Ensure that both level switches are correctly fitted to the acid drain tank.
	Is a level switch faulty ?	Replace the level switch assembly.
LSH 610 SWITCH FAULT OR CONNECTION ERROR	Are the level switches incorrectly fitted ?	Ensure that both level switches are correctly fitted to the acid drain tank.
	Is a level switch faulty ?	Replace the level switch assembly.

Table 33 - Status display fault message fault finding (sheet 7 of 15)

Fault message	Check	Actions
PISH 401 PLENUM GAS PRESSURE ALARM	Has the plenum chamber pressure gauge setpoint been incorrectly adjusted ?	Ensure that the setpoint on the plenum chamber pressure gauge is set to +4 inches wg.
	Does the exhaust-extraction system operate correctly ?	If the pressure shown on the plenum chamber pressure gauge is higher than 4 inches, monitor the exhaust- extraction pressure when the abatement system has shut down.
	Does the exhaust-extraction system operate correctly ? (continued)	If the pressure in the extraction system is above atmospheric pressure, check that valves in the system are open, that the extraction fan is switched on, that the damper has not failed and that the exhaust-extraction system is not blocked.
	Is the plenum chamber pressure gauge out of calibration ?	Disconnect the exhaust-extraction system from the abatement system and check that the plenum chamber pressure gauge shows 0 at atmospheric pressure. If necessary, use the zero adjust screw to recalibrate the gauge.
	Is the packed tower blocked ?	The combustor liner, packed tower packing and mist filter elements may need to be changed: contact your supplier or BOC Edwards.
	Is the water drain system faulty ?	If the waste water is not draining from the abatement system, the water level could rise enough to restrict the cyclone effect. Check that the waste water is correctly draining from the abatement system: refer to the checks and actions for fault message LSH 601.
	Is the plenum chamber pressure gauge [PISH-401] disconnected or incorrectly configured ?	If the above checks fail to identify the cause of the fault, the gas pipe between the combustor and the pressure gauge may be disconnected, or the gauge may have failed: contact your supplier or BOC Edwards.
PSH 703 OXYGEN PRESSURE WARNING * * *TPU/Kronis systems only.*	Is the oxygen supply pressure too high ?	Check that the pressure of your oxygen supply is as specified in Table 12.
	Is there a blockage in the oxygen pipelines in the abatement system, or has the pressure control valve [PCV-701] failed ?	Shut down the abatement system, then contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 8 of 15)

Fault message	Check	Actions
PSL 120 LOW NITROGEN PRESSURE FAULT	Has the pneumatics nitrogen supply failed ?	Ensure that the pneumatics nitrogen supply is switched on; look at the nitrogen pressure gauge [PI-410] and check that the pressure is as specified in Table 11.
	Is the supply pipeline disconnected from the pressure regulator [PCV-409], or is the nitrogen pressure switch [PSL-120] disconnected or has it failed?	Contact your supplier or BOC Edwards to arrange for an inspection of the abatement system.
PSL 501 LOW WATER PRESSURE FAULT	Has the make-up water supply failed ?	Ensure that the make-up water supply is switched on and that its pressure shown on the pressure gauge [PSL-501] is above 3 bar.
	Is the water filter blocked ?	If the water flowmeter (Figure 7, item 9) shows a flow < 15 l min^{-1}, the water filter may be blocked: refer to Section 5.10.
	Is the water pressure switch [PSL-501] disconnected or has it failed ?	Look at input X22 on the PLC; the input should be on when the pressure switch is closed circuit. If the input is not on, the water pressure switch may be disconnected or it may be faulty: contact your supplier or BOC Edwards.
	Is the WRU water booster/drain pump disconnected or has it failed ?	Inspect circuit breaker CB3 and reset it if it has tripped. Output Y12 on the PLC should be on to indicate that the 24 V control signal for the pump is available. If output Y12 is on, but the pump does not operate, the pump may be disconnected or it may be faulty: contact your supplier or BOC Edwards.
	Has the water isolation-valve [YV-501] failed ?	If the water booster/drain pump operates correctly, look at output Y22 on the PLC; the output should be on when the valve should be open. If the output is on, but the valve does not open, the valve may be disconnected, or it may be faulty: contact your supplier or BOC Edwards.
REMOTE ALARM	Has the Process Tool or control system shut down the abatement system ?	Identify and rectify the cause of the remote alarm shut down, then restart the abatement system: refer to Section 4.7.
	Are the electrical connections to the interface module incorrectly wired ?	Check that the Process Tool and control system have been correctly wired to the interface module: refer to Section 3.25.

Table 33 - Status display fault message fault finding (sheet 9 of 15)

Fault message	Check	Actions
REMOTE ALARM (continued)	Is there an electrical fault ?	If the wiring to the interface module is correct, there may be an electrical fault in the abatement system: contact your supplier or BOC Edwards.
TCH 405 PLENUM BURNER TEMPERATURE ALARM	Is the thermocouple disconnected ?	If the plenum chamber temperature display shows InPt FAIL, the combustor thermocouple [TCH-405] may be disconnected: ensure that the connector attached to the thermocouple is fitted to the connector in the abatement system enclosure.
	Is the thermocouple misconnected ?	If the plenum chamber temperature display shows AL/LO, the thermocouple [TCH-405] may be misconnected. Ensure that the thermocouple connector is fitted to the connector in the enclosure so that the + and - pins and sockets are correctly aligned.
	Is the thermocouple faulty, or has the temperature controller failed, or does the combustor liner need to be replaced ?	If the above checks fail to identify the cause of the fault, the thermocouple [TCH-405] may be faulty, the temperature controller may have failed, or the combustor liner may need to be replaced: contact your supplier or BOC Edwards.
TCH 406 COMBUSTOR OVER TEMPERATURE	Is the process gas flow too high ?	Ensure that the total gas flow into the abatement system is as specified in Section 2.3.
	Is the thermocouple disconnected ?	If the combustor chamber temperature display shows InPt FAIL, the combustor thermocouple [TCH-406] may be disconnected: ensure that the connector attached to the thermocouple is fitted to the connector in the abatement system enclosure.
	Is the thermocouple misconnected ?	If the combustor chamber temperature display shows AL/LO, the thermocouple [TCH-406] may be misconnected. Ensure that the thermocouple connector is fitted to the connector in the enclosure so that the + and - pins and sockets are correctly aligned.

Table 33 - Status display fault message fault finding (sheet 10 of 15)

Fault message	Check	Actions
TCH 406 COMBUSTOR OVER TEMPERATURE (continued)	Is the fuel gas supply faulty ?	Check that the fuel gas supply pressure is correct, and that the calorific value of the fuel gas is as specified in Table 10.
	Is the thermocouple faulty, or has the temperature controller failed, or is the calorific value of the fuel gas too high ?	If the above checks fail to identify the cause of the fault, the thermocouple [TCH-406] may be faulty, the temperature controller may have failed, or the calorific value of the fuel gas may be too high: contact your supplier or BOC Edwards.
TCH 406 COMBUSTOR UNABLE TO REACH RUNNING TEMPERATURE	Refer to the checks and actions for the TCH 406 COMBUSTOR OVER TEMPERATURE fault message.	
TCH 509 QUENCH ZONE OVER TEMPERATURE	Has the make-up water supply failed ?	If the scrubber water does not cool the quench, check that the make-up water supply is switched on and that its temperature and pressure are as specified in Table 14.
	Is the thermocouple disconnected ?	If the quench outlet temperature display shows InPt FAIL, the cyclone scrubber thermocouple [TCH-509] may be disconnected. Check that the thermocouple connector is correctly fitted to the connector in the enclosure.
	Is the thermocouple misconnected ?	If the quench outlet temperature display shows AL/LO, the thermocouple [TCH-509] may be misconnected. Ensure that the thermocouple connector is fitted to the connector in the enclosure so that the + and - pins and sockets are correctly aligned.
	Is a thermocouple faulty, or has the temperature controller failed ?	If the above checks fail to identify the cause of the fault, the thermocouple [TCH-509] may be faulty, or the temperature controller may have failed: contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 11 of 15)

Fault message	Check	Actions
TSH 505 TRANSITION TEMPERATURE ALARM	Has the make-up water supply failed ?	Ensure that the make-up water supply is switched on and that its temperature and pressure are as specified in Table 14.
	Has the water isolation-valve [YV-501] failed or is there a blockage in the abatement system ?	Look at the scrubber water pressure gauge [PI-515] in the abatement system enclosure. If the water pressure is too low, the water isolation-valve [YV-501] may have failed, or there may be a blockage: contact your supplier or BOC Edwards.
	Are the water temperature snap-switches disconnected or have they failed ?	If the above checks fail to identify the cause of the fault, one or both of the quench temperature snap-switches [TSH-505] may be disconnected or they may have failed: contact your supplier or BOC Edwards.
TSH 603 INLET HEAD TEMPERATURE ALARM	Has the inlet head overheated ?	Make the following checks and rectify any defect found: • Check that the dry pumps have exhaust silencers fitted. • Check that unused inlets are purged with the correct flow rate of nitrogen. • Check that the nitrogen purge to the inlet head is correct. • Check that the gas flow rate into each inlet is correct. • Check that the pump running signal for each inlet is only on when the pump is operating.
	Is the temperature snap-switch disconnected or has it failed ?	If the above check fails to identify the cause of the fault, the inlet head temperature snap-switch [TSH-603] may be disconnected or it may have failed: contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 12 of 15)

Fault message	Check	Actions
TSH 612 WATER TEMPERATURE ALARM	Is the cooling-water supply correct ?	Ensure that the cooling-water supply is on, and is the correct pressure and temperature.
	Is there a water leak in the WRU or enclosure ?	Ensure that none of the water pipelines in the WRU and enclosure are leaking, and that the heat exchanger in the WRU does not leak.
	Has the heat exchanger failed ?	If you have checked all of the above and cannot identify the fault, the heat exchanger may have failed: contact your supplier or BOC Edwards.
WARNING ACID DRAIN FAIL	Has a circuit breaker tripped ?	Check that the circuit breaker in the WRU and circuit breaker CR3 in the enclosure have not tripped. If a circuit breaker has tripped, identify and rectify the cause of the trip, then reset the circuit breaker.
	Are the enclosure to WRU electrical cables disconnected ?	If the circuit breaker has not tripped, look at output Y12 on the PLC; this should be on to indicate that the 24 V control signal for the water booster/ drain pump is available.
		If output Y12 is on, check that the electrical cables are correctly connected between the control unit and the WRU: refer to Sections 3.9 and 3.26.2/3.26.4.
	Has the WRU water booster/drain pump failed, or is there a blockage in the orifice in the WRU ?	If circuit breaker CB3 has not tripped, PLC output Y12 is on and the electrical cable is correctly connected, but the water booster/drain pump does not operate, it may have failed: contact your supplier or BOC Edwards.
WARNING WATER IN LOW	Has the make-up water supply failed ?	Ensure that the external make-up water supply is on, and that its pressure is correct.
	Are the filter isolation and changeover valves correctly selected ?	Ensure that the filter isolation valve for the on-line filter is open, and that the changeover valve is correctly positioned to select the on-line filter.
	Is the WRU water filter blocked ?	Changeover to use the other water filter, then change the blocked filter.
	Does the water isolation valve operate correctly ?	If there is no internal water pressure, the water isolation valve in the WRU may be faulty: contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 13 of 15)

Fault message	Check	Actions
WARNING WATER IN LOW (continued)	Has a circuit breaker tripped ?	Check that the circuit breaker in the WRU and circuit breaker CR3 in the enclosure have not tripped. If a circuit breaker has tripped, identify and rectify the cause of the trip, then reset the circuit breaker.
	Are the WRU electrical cables disconnected ?	If the circuit breaker has not tripped, look at output Y12 on the PLC; this should be on to indicate that the 24 V control signal for the pump is available. If output Y12 is on, check that the electrical cables are correctly connected between the control unit and the WRU: refer to Sections 3.9 and 3.26.2/3.26.4.
	Has the WRU water booster/drain pump failed ?	If circuit breaker CB3 has not tripped, PLC output Y12 is on and the pump electrical supply cable is correctly connected, but the water booster/ drain pump does not operate, it may have failed: contact your supplier or BOC Edwards.
WATER LEAK DETECTOR ALARM	Has the enclosure water leak detector detected water in the drip tray as the result of a leak in the water supply pipelines ?	Inspect the drip tray in the enclosure. If there is water in the drip tray, inspect the enclosure for water leaks in the scrubber water supply pipelines in the enclosure: if there are leaks, contact your supplier or BOC Edwards.
	Is the water in the drip tray as a result of a leak in the cyclone scrubber ?	If there is water in the drip tray and there are no leaks in the scrubber water supply pipelines in the enclosure, inspect the cyclone scrubber for leaks: if there are leaks, contact your supplier or BOC Edwards.
	Is the enclosure water leak detector incorrectly connected, or has it failed ?	If there is no water in the drip tray, look at the LEDs on the leak detector (Figure 3, item 9). If both LEDs are off, or if the fail LED is on and the power LED is off, the water leak detector may be incorrectly connected to the control system, or it may be faulty: contact your supplier or BOC Edwards.
	Has the WRU water leak detector detected water in the base of the WRU as the result of a leak in the water pipelines ?	Inspect the make-up water, cooling-water and scrubber water supply and acid waste water drain pipelines, connectors and other components in the WRU: if there are leaks, contact your supplier or BOC Edwards.

Table 33 - Status display fault message fault finding (sheet 14 of 15)

Fault message	Check	Actions
WATER LEAK DETECTOR ALARM (continued)	Is the WRU water leak detector incorrectly connected, or has it failed ?	Look at the LEDs on the leak detector (Figure 11, item 13). If both LEDs are off, or if the fail LED is on and the power LED is off, the water leak detector may be incorrectly connected to the enclosure, or it may be faulty: contact your supplier or BOC Edwards.
	Has an additional water leak detector detected water as the result of a leak in the water supply pipelines or the cyclone scrubber in the abatement system enclosure, or as the result of a leak from the pipelines, connectors or components in the WRU or Services Module ?	If you have fitted a Secondary Containment Kit (as in Appendix A11) or have fitted any additional water leak detectors (see Section 3.8), inspect the secondary containment tray or other drip tray where the water leak detector is fitted. If there is water in the secondary containment tray or other drip tray: • Inspect the abatement system enclosure for water leaks in the scrubber water supply pipelines or the cyclone scrubber: if there are leaks, contact your supplier or BOC Edwards. • Inspect the make-up water, cooling-water and scrubber water supply and acid waste water drain pipelines, connectors and other components in the WRU (or Services Module, if fitted: see Appendix A8): if there are leaks, contact your supplier or BOC Edwards.
	Is an additional water leak detector incorrectly connected, or has it failed ?	If there is no water in the secondary containment tray or other drip tray, look at the LEDs on the additional leak detectors fitted. If both LEDs are off, or if the fail LED is on and the power LED is off, the water leak detector may be incorrectly connected to the enclosure, or it may be faulty: contact your supplier or BOC Edwards.
-	-	If you have carried out all of the recommended actions and you still cannot identify the cause of a fault, or you cannot rectify a fault, contact the BOC Edwards Exhaust Management Group (refer to Section 1.13).

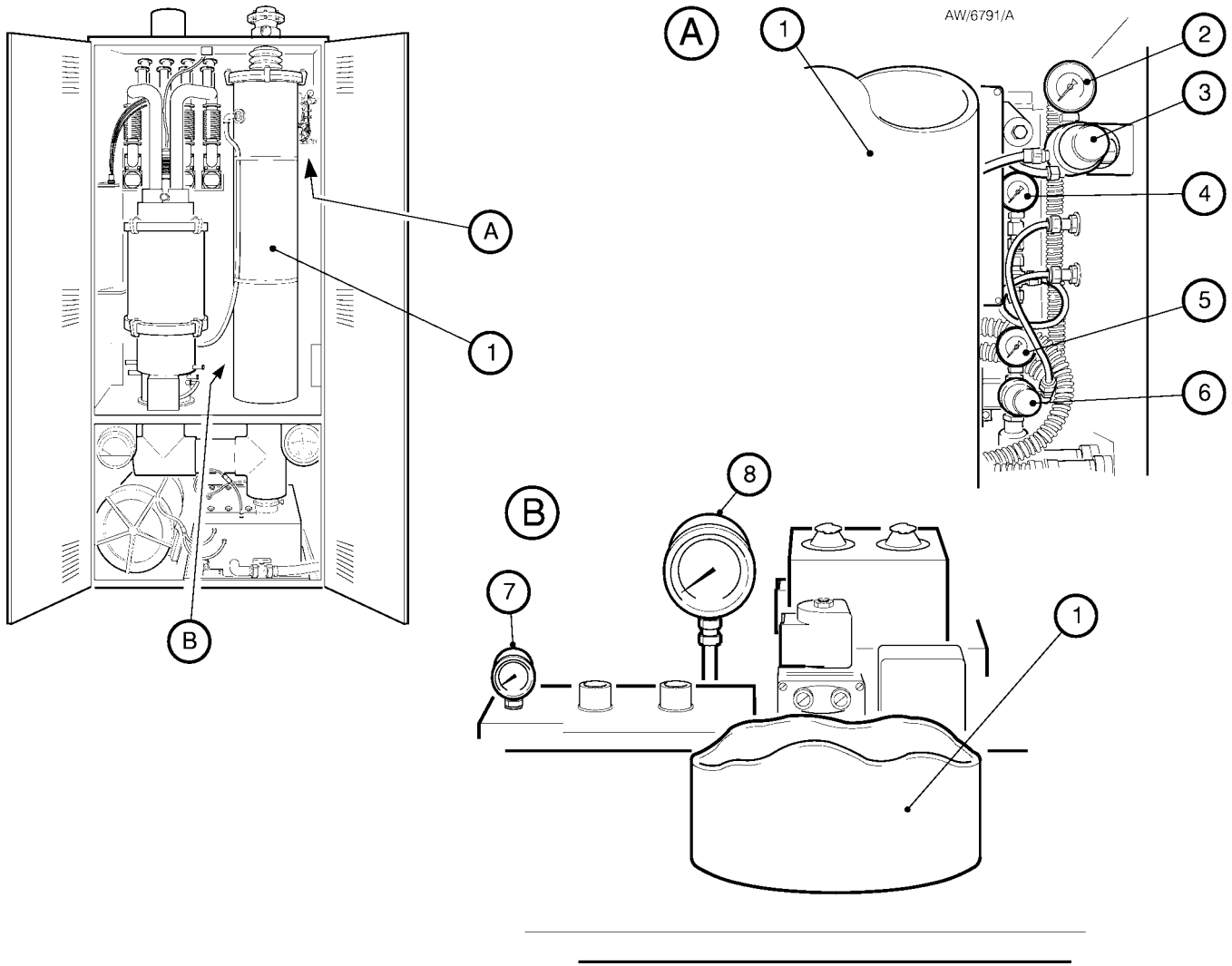
Table 33 - Status display fault message fault finding (sheet 15 of 15)

Symptom	Check	Actions
The display is blank and all lamps are off (with the electrical supply isolator switched on).	Has the electrical supply failed?	Check the external electrical supply and rectify any fault found.
	Has the system circuit breaker tripped?	If circuit breaker CB1 has tripped, identify and rectify the cause of the fault, then reset the circuit breaker (refer to Section 5.9) and restart the abatement system (refer to Section 4.1).
	Has the abatement system enclosure fuse failed?	Inspect the fuse. If the fuse has failed, identify and rectify the cause of the fault, then replace the fuse (refer to Section 5.8) and restart the abatement system (refer to Section 4.1).
	Is there an electrical fault?	If the above checks fail to identify the cause of the fault, there may be an electrical fault in the abatement system: contact your supplier or BOC Edwards.
During normal operation, the plenum chamber temperature is > 50 °C.	Is the combustor liner cracked?	Contact your supplier or BOC Edwards to arrange for an inspection of the abatement system.
The temperature shown on a temperature display is increasing rapidly, or InPt FAIL is displayed.	Is the temperature sensor disconnected?	The corresponding temperature sensor may be incorrectly connected to the control module: contact your supplier or BOC Edwards.
	Is the temperature sensor faulty?	If the temperature sensor is correctly connected, it may have failed: contact your supplier or BOC Edwards.
A negative temperature is shown on a temperature display.	Is the temperature sensor incorrectly connected?	Check that the temperature sensor is correctly connected (for example, that thermocouple connectors are correctly connected, so that the '+' and '-' indicators on the male and female connectors match.

Table 34 - Other fault finding (sheet 1 of 2)

Symptom	Check	Actions
InPt nOnE is shown on a temperature display.	Have the temperature controller operating parameters been lost or corrupted?	Contact your supplier or BOC Edwards to arrange for the re-entry of the correct operating parameters into the temperature controller.
-	-	If you have carried out all of the recommended actions and you still cannot identify the cause of a fault, or you cannot rectify a fault, contact the Exhaust Management Group at Clevedon (refer to Section 1.13).

Table 34 - Other fault finding (sheet 2 of 2)



1. Packed tower
2. Pneumatics nitrogen supply pressure gauge
3. Pneumatics nitrogen supply pressure regulator
4. Purge nitrogen supply pressure gauge
5. Oxygen pressure gauge *
6. Oxygen pressure regulator *
7. Scrubber water pressure gauge
8. Fuel gas pressure gauge

* TPU and Kronis systems only

Figure 25 - Locations of the pressure gauges in the abatement system enclosure

5.14.2 Unexplained shutdowns

If the abatement system shuts down automatically and there is no apparent cause for the shut-down, there may be a failure in the control system. We therefore recommend that you:

- Refer to Figure 22. Use the key supplied to undo the lock (1) on the control unit.
- Use the handle (2) to pull the control unit rack out of the enclosure.
- Take note of the state of the LED indicators on the PLC (3).
- Contact your supplier or BOC Edwards for advice: advise them of any fault messages which were displayed and of the state of the PLC indicators.

5.14.3 View the shut-down fault log

The PLC in the control unit retains a fault log of the last 10 faults which caused abatement system shut-down.

To aid in fault finding, you can use the procedure given below to view this fault log, whenever the electrical supply isolator is in the 'on' position.

In the procedure, note that:

- The buttons referred to are the buttons on the status display (Figure 6, item 5).
- In general, when a list of options is shown on the status display, press the + button to move the cursor down the list, and press the - button to move the cursor up the list.

Use the following procedure to view the shut-down fault log:

1. Press the OPT button. The status display will then show a number of options.
2. Use the + and - buttons to move the cursor so that 'ERR/MSG' flashes on the display.
3. Press the ENT button. The status display will then show the following information:

SHOW ERR/MESG
1 ERROR LIST
2 MESSAGE LIST

4. Use the + and - buttons to move the cursor so that option '2' flashes on the display.
5. Press the ENT button; the status display format will then be as shown below, where:

ΔΔΔΔ
<date>
<time>

- ΔΔΔΔ is a four-digit fault code defining the last detected shut-down fault: refer to Table 35 for the fault codes and their associated fault messages.
- <date> and <time> specify the date and time at which the fault was detected, where:

  <date> is in the form 'month/day/year'.

  <time> is in the form 'hours : minutes : seconds : milliseconds'.

(continued on page 156)

6. To scroll the display through the fault log:
   - Press the + button to scroll down the fault log, to view earlier detected shut-down faults.
   - Press the - button to scroll up the fault log, to view more recently detected shut-down faults.
7. When you have finished viewing the fault log, press the MSG button; the status display will then show normal display, as described in Section 4.9.

Fault code	Associated fault message(s): see Table 33
0004	LSH609 SWITCH FAULT OR CONNECTION ERROR LSH610 SWITCH FAULT OR CONNECTION ERROR
0005	FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL
0006	TCH 405 PLENUM BURNER TEMPERATURE ALARM
0007	TCH 406 COMBUSTOR OVER TEMPERATURE
0008	TCH 509 QUENCH ZONE OVER TEMPERATURE
0009	WARNING WATER IN LOW
0010	WARNING ACID DRAIN FAIL
0013	LSH 601 DRAIN WATER LEVEL ALARM
0014	TSH 505 TRANSITION TEMPERATURE ALARM
0015	TSH 612 WATER TEMPERATURE ALARM
0016	TSH 603 INLET HEAD TEMPERATURE ALARM
0017	FSL 511 CYCLONE WATER FLOW FAULT
0018	FSL 604 PACKED TOWER WATER FLOW FAULT
0019	PSL 501 LOW WATER PRESSURE FAULT
0021	PISH 401 PLENUM GAS PRESSURE ALARM
0022	WATER LEAK DETECTOR ALARM
0024	FMS CONTROLLER FAIL TO START UP
0030	REMOTE WATER LEAK ALARM
0032	GAS SENSOR ALARM

Table 35 - Shut-down fault log codes

6 STORAGE AND DISPOSAL

6.1 Storage

6.1.1 Prepare the abatement system

WARNING

Ensure that the abatement system is locked out from the electrical supply. If you do not, there will be a risk of injury or death by electric shock.

WARNING

Ensure that you wear the correct personal protective equipment when you disconnect the pipelines from the abatement system: refer to Section 5.1.3.

1. Shut down the abatement system as described in Section 4.4.
2. If applicable, ensure that the pumping systems have been shut down and disconnect the pumping system(s) from the abatement system inlet(s).
3. Switch off the fuel gas, nitrogen, oxygen, make-up water and cooling-water services supplies and disconnect them from the abatement system enclosure and from the WRU.
4. Ensure that the abatement system is locked out from the external electrical supply: the electrical supply must be locked out at the external contactor/circuit breaker, not at the abatement system (as described in Section 5.1.2).

   If your system has a standard electrical supply isolator continue at Step 5. If your system has a breaker disconnect, continue at Step 9.
5. Refer to Figure 17. Undo and remove the screws which secure the cover to the electrical supply isolator (2) on the abatement system enclosure, and remove the cover.
6. Loosen the cable-gland (3), disconnect the wires in the electrical supply cable (5) from the electrical supply isolator (2), and remove the electrical supply cable from the isolator.
7. If you have a 'J' or 'S' model WRU: loosen the cable-gland (4), disconnect the wires in the WRU electrical cable (8) from the electrical supply isolator (2), and remove the electrical cable from the isolator.
8. Refit the cover to the electrical supply isolator (2) and secure with the screws. Continue at Step 15.
9. Refer to Figure 18. Undo and remove the screws (16) which secure the front cover (17) to the breaker disconnect, then remove the front cover.
10. Undo and remove the screws (18) and remove the bracket (15) and safety cover (14).
11. Loosen the cable-gland fitted to the leadthrough hole (3), disconnect the wires in the electrical supply cable from the breaker disconnect, and remove the cable from the breaker disconnect.
12. If you have a 'J' or 'S' model WRU: loosen the cable-gland (3), disconnect the wires in the WRU electrical cable from the breaker disconnect, and remove the electrical cable.

(continued on page 158)

13. Refit the safety cover (14) and bracket (15) to the breaker disconnect and secure with the screws (18).
14. Refit the front cover (17) to the breaker disconnect and secure with the screws (16).
15. Refer to Figure 16. Undo and remove the six screws (5) and washers (6) and remove the upper and lower covers (7, 4) from the interface module (9).
16. Disconnect all of the electrical connections from the interface module.
17. Refit the upper and lower covers (7, 4) to the interface module (9) and secure with the six screws (5) and the washers (6).
18. Disconnect the bypass outlet(s), the abatement system exhaust outlet and the cabinet-extraction outlet.

6.1.2 Disconnect the acid waste water pipeline and drain the abatement system (if necessary)

WARNING

Ensure that you wear the correct personal protective equipment when you disconnect the acid waste water pipeline (and drain the abatement system): refer to Section 5.1.3.

CAUTION

Ensure that all scrubber water, make-up water, cooling-water and acid waste water is drained from the abatement system enclosure and the WRU if you store the equipment in an area where the ambient temperature can fall close to 0 °C or below. If you do not, the abatement system enclosure or WRU can be damaged if the water freezes in the equipment.

1. Refer to Figure 15. Disconnect the pipelines from the cooling-water supply inlet (9), return outlet (6), make-up water supply inlet (8) and acid waste water outlet (7) connectors.
2. If necessary (that is, if you want to store the equipment in an area where the ambient temperature can fall close to 0 °C or below), drain the scrubber water, cooling-water, make-up water and acid waste water from the abatement system.

   To drain the waste water from the WRU acid water drain tank:

   - Refer to Figure 11, detail B. Ensure that the waste water tank outlet isolation valve (8) is in the 'closed' position (that is, at a right-angle to the outlet, 7).
   - Undo the pipe clamp and disconnect the water return pipe (detail C, item 10) from the drain tank outlet (7)
   - Attach a suitable pump or other extraction mechanism to the drain tank outlet (7).
   - Open the outlet isolation valve (8) (so that the valve handle is in-line with the outlet, 7) and use your pump (or other mechanism) to drain the waste water from the tank.
   - Close the outlet isolation valve (8) again, then disconnect your pump or other mechanism from the valve outlet (7).

3. Safely dispose of the acid waste water: refer to Section 6.2.

6.1.3 Move the abatement system to the storage area (if required)

CAUTION

Use suitable lifting equipment and a lifting frame to move the abatement system enclosure. If you do not, you can damage the enclosure. Refer to Section 2.2 for the mass of the enclosure.

CAUTION

Use suitable lifting equipment to move the WRU. If you do not, you can damage the WRU. Refer to Section 2.2 for the mass of the enclosure.

1. Refer to Figure 14. Disconnect the connectors on the WRU electrical cable from the two connectors (4, 5) under the control unit.
2. Refer to Figure 11, detail A. Undo the catch (5), then remove the transparent front cover (4) from the WRU.
3. Refer to details B and C. Undo and remove the pipe clamp which secures the water return pipe (10) to the waste water tank outlet (7), and disconnect the pipe from the outlet.
4. Disconnect the four nitrogen and sample pipes (14) from the connectors on the side of the abatement system enclosure.
5. Pull the water return pipe (10) through the leadthrough hole (6) in the abatement system enclosure, through the leadthrough hole (11) in the WRU, and into the WRU.
6. Undo and remove the pipe clamp which secures the end of the water supply pipe (15) to the water supply inlet in the abatement system enclosure, then disconnect the pipe from the inlet and pull the pipe out through the leadthrough hole in the abatement system enclosure and into the WRU.
7. Disconnect the WRU fuel gas connector (16) from the fuel gas inlet on the enclosure.
8. Remove the WRU leak detector (13) from under the bracket (12), then pass the leak detector and its cable through the cabinet extract leadthrough hole (Figure 14, item 11) and into the abatement system enclosure.
9. Undo and remove the three bolts (1) which secure the WRU to the abatement system enclosure.
10. Refit the transparent cover (4) to the WRU and engage the catch (5) to secure the cover.
11. Attach suitable lifting equipment to the lifting bolts (2) on the top of the WRU and move the WRU to the storage area.
12. Refer to Figure 10. Attach suitable lifting equipment to a lifting frame (2) to distribute the load, and connect the lifting frame to the lifting bolts (1) on the top of the abatement system enclosure, as shown in detail B. Do not attach the lifting equipment directly to the lifting bolts (as shown in detail A), as you may damage the enclosure when you move it. Move the enclosure to the storage area.

6.1.4 Store the abatement system enclosure and the WRU

1. Fit blanking plates to all inlets and outlets.
2. Place protective covers over the services connection points.
3. Store the abatement system enclosure and WRU in clean, dry conditions until required.
4. When required for use, prepare and install the abatement system enclosure and WRU as described in Section 3.

6.2 Disposal

WARNING

Ensure that you wear the correct personal protective equipment when you handle acid waste water or contaminated components: refer to Section 5.1.3.

Dispose of acid waste water, the abatement system enclosure, the WRU and any components safely in accordance with all local and national safety and environmental requirements.

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

7 SERVICE, SPARES AND ACCESSORIES

7.1 Introduction

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

Order spare parts 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 of the equipment.
- Item Number and description of part.

Note that the above items are to be found on the rating and serial number plate: Figure 9, item 10.

7.2 Service

BOC Edwards products are supported by a world-wide network of BOC Edwards Service Centres. Each Service Centre offers a wide range of options including: equipment decontamination; service exchange; repair; rebuild and testing to factory specifications. Equipment which has been serviced, repaired or rebuilt is returned with a full warranty.

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

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

7.3 Spares

Note 1: Spares for ordering options are listed in Appendices A4 onwards.

Note 2: At maximum HF concentration (in the acid waste water) of 0.5%, consumable spares should be replaced every 6 months. You can adjust this replacement frequency according to the actual HF concentration in your system and your service experience.

The spares for the abatement system are listed in Table 36. Unless otherwise specified, spares are common to all TCS, TPU and Kronis systems. Note that each spare is designated as one of the following types:

- Consumable: you must maintain a stock of these spares, to allow for easy replacement and to minimise abatement system down-time (refer to Note 2 above).
- Essential: you must maintain a stock of these spares.
- Recommended: we recommend that you maintain a stock of these spares.

Spare	Item Number	Type
Enclosure consumables kit: 'E' model	Y041-C0-100	Consumable
Enclosure consumables kit: 'S/J' models	Y041-C0-200	Consumable
WRU consumables kit: 'E' model	Y111-C0-100	Consumable
WRU consumables kit: 'S/J' models	Y111-C0-200	Consumable
ISO63/250 claw clamp/brass nut kit	Y042-10-091	Consumable
Combustor liner kit	A554-05-001	Consumable
Acid drain tank screen	Y116-01-046	Consumable
Acid drain tank level switch assembly	Y112-01-035	Consumable
Acid drain tank thermocouple kit	Y112-01-017	Consumable
WRU heat exchanger	Y112-01-063	Consumable
WRU water booster/drain pump: 'E' model WRU	Y112-01-005	Consumable
WRU water booster/drain pump: 'S' model WRU	Y112-01-058	Consumable
WRU water booster/drain pump: 'J' model (50 Hz) WRU	Y112-01-009	Consumable
WRU water booster/drain pump: 'J' model (60 Hz) WRU	Y112-01-059	Consumable
WRU water filter elements (pack of 5)	Y112-01-007	Consumable
WRU water valve kit	Y042-00-015	Consumable
Enclosure essential spares kit: 'E' model	Y041-E0-100	Essential
Enclosure essential spares kit: 'S/J' models	Y041-E0-200	Essential
WRU essential spares kit: 'E' model	Y111-E0-100	Essential
WRU essential spares kit: 'S/J' models	Y111-E0-200	Essential
Cyclone thermocouple kit, front mounted	Y042-10-173	Essential
Drain level-switch assembly [LSH-601]	A554-01-039	Essential
24 V d.c. relay (double contact)	A554-01-053	Essential
Inlet nozzle inspection kit	A554-02-008	Essential
Full system inspection kit	A554-01-028	Essential
Fuse kit (all models)	A554-02-001	Essential
Cyclone scrubber thermocouple kit	A554-03-001	Essential
Temperature snap-switch kit	A554-01-044	Essential

Table 36 - Spares (sheet 1 of 4)

Spare	Item Number	Type
Enclosure recommended spares kit: 'E' model	Y041-R0-100	Recommended
Enclosure recommended spares kit: 'S/J' models	Y041-R0-200	Recommended
WRU recommended spares kit: 'E' model	Y111-R0-100	Recommended
WRU recommended spares kit: 'S/J' models	Y111-R0-200	Recommended
Bypass assembly: CF_4 option	Y042-10-053	Recommended
Bypass assembly: standard	Y042-10-054	Recommended
Bypass 3-way valve	Y042-10-087	Recommended
Pigtail spring assembly	A554-02-009	Recommended
Pigtail spring assembly (Kronis)	Y282-01-002	Recommended
Ionisation head assembly	Y042-10-092	Recommended
Ionisation head assembly (Kronis)	Y282-01-000	Recommended
Ignition cap and cable assembly	A554-05-004	Recommended
Transformer assembly: 'S' and 'J' models	Y042-10-093	Recommended
Transformer assembly: 'E' model	Y042-10-094	Recommended
Inlet head thermocouple assembly	Y042-00-005	Recommended
Pneumatic assembly kit: 'E' model	Y042-10-095	Recommended
Packed tower mist filter element	A554-01-036	Recommended
Packed tower packing	A554-01-037	Recommended
Water flow-switch assembly [FSL-511, FSL-604]	Y042-10-273	Recommended
Water pressure gauge [PI-515]	A554-01-046	Recommended
Triple water leak detector	Y042-10-167	Recommended
Water hose kit (see Note: at end of this table)	Y042-10-122	Recommended
Water spray jet kit	Y042-10-123	Recommended
Nozzle replacement kit	A554-05-003	Recommended
Nozzle replacement kit (Kronis)	Y282-01-003	Recommended
Acid waste water tank filter: 2.5 mm	A554-01-003	Recommended
Plenum chamber temperature controller	A554-01-050	Recommended
Combustor temperature controller	A554-01-051	Recommended
Quench/weir temperature controller	A554-01-052	Recommended

Table 36 - Spares (sheet 2 of 4)

Spare	Item Number	Type
Bypass valve seals kit	A554-01-032	Recommended
Status display kit	A554-01-047	Recommended
Combustor/quench gasket kit	A554-01-055	Recommended
Combustor head ISO250 trapped 'O' ring	A554-01-023	Recommended
NW40 swing clamp	C105-16-401	Recommended
NW40 trapped 'O' ring	C105-16-490	Recommended
NW40 flexible bellows	C105-16-670	Recommended
NW50 swing clamp	C105-17-304	Recommended
NW25 swing clamp	C105-14-401	Recommended
NW25 trapped 'O' ring	C105-14-490	Recommended
Ignition transformer: 'E' model	A556-55-709	Recommended
Ignition transformer: 'S' and 'J' models	A556-55-715	Recommended
Ceramic cement	A554-01-085	Recommended
Pneumatic ball valve assembly	Y112-01-019	Recommended
Nozzle cleaning service kit	Y042-10-004	Recommended
Nozzle cleaning spring return actuator kit	Y042-10-005	Recommended
Packed tower blanking kit	Y042-10-006	Recommended
Cyclone chamber assembly	Y042-10-028	Recommended
2 inlet crown	Y042-10-029	Recommended
1 inlet crown	Y042-10-031	Recommended
4 inlet crown	Y042-10-032	Recommended
Damper spool flange	Y042-10-037	Recommended
Pilot burner kit: methane	Y042-10-042	Recommended
Pilot burner kit: propane	Y042-10-043	Recommended
Water manifold assembly	Y042-10-044	Recommended
D/A actuator: port 1 or 3	Y042-10-047	Recommended
D/A actuator: port 2 or 4	Y042-10-048	Recommended

Table 36 - Spares (sheet 3 of 4)

Spare	Item Number	Type
System leak test kit	Y042-10-050	Recommended
Gas multiblock kit: 'E' model	Y042-10-051	Recommended
Gas multiblock kit: 'S' and 'J' models	Y042-10-052	Recommended
Cabinet securing bracket	Y042-10-061	Recommended
Air blower assembly: 'E' model	Y042-10-066	Recommended
Air blower assembly: 'S' and 'J' models	Y042-10-067	Recommended
Zero governor assembly	Y042-10-069	Recommended
Combustor assembly	Y042-10-071	Recommended
Pneumatics assembly: 'S' and 'J' models	Y042-10-078	Recommended
Weir assembly	Y042-10-057	Recommended
WRU flexible gas hose kit	Y112-01-020	Recommended
WRU seals kit	Y112-01-027	Recommended
WRU make-up water supply pipe kit	Y112-01-022	Recommended
WRU cooling-water return pipe kit	Y112-01-028	Recommended
WRU cooling-water supply pipe kit	Y112-01-029	Recommended
WRU dual filter pipe kit	Y112-01-032	Recommended
WRU acid drain water pipe kit	Y112-01-033	Recommended
WRU diaphragm valve make-up water supply pipe kit	Y112-01-041	Recommended
WRU diaphragm acid drain water pipe kit	Y112-01-042	Recommended
WRU 5 mm orifice and 'O' ring kit	Y112-01-039	Recommended
WRU 3.5 mm orifice and 'O' ring kit	Y112-01-040	Recommended
WRU diaphragm valve kit	Y112-01-043	Recommended
WRU 3-way valve kit (Viton)	Y112-01-008	Recommended
WRU filter housing kit	Y112-01-023	Recommended
WRU front cover kit	Y112-01-021	Recommended
WRU acid drain tank kit	Y112-01-015	Recommended
WRU acid drain tank thermocouple PCB kit	Y112-01-018	Recommended

Table 36 - Spares (sheet 4 of 4)

Note:The water hose kit (Item Number A554-01-081) is only applicable to abatement systems with serial numbers > 83.

7.4 Accessories

Note: Refer to Table 37 for accessory Item Numbers.

7.4.1 PFC Interface Kits accessories

Versions of the PFC Interface Kit accessory are available suitable for use with BN or BK series miniature air actuated valves, and allow you to fit a microswitch to the PFC admittance valve, and to connect the output of the microswitch (that is, the PFC interface signal) to the abatement system interface module. Full instructions to fit the kit are supplied with the accessory.

7.4.2 Bypass Lock-Out Kit

If required for additional safety, fit the Bypass Lock-Out Kit to prevent movement of the bypass valves while you carry out abatement system maintenance or servicing. Refer to Appendix A9 for a full description of the Kit and its use.

7.4.3 Earthquake Restraint Kit

The Earthquake Restraint Kit consists of brackets which, when fitted to the abatement system enclosure and to the WRU, secure the equipment in place in the event of an earthquake.

7.4.4 Cabinet-Extraction Interlock

The Cabinet-Extraction Interlock provides a signal shut down the abatement system in the event that your cabinet-extraction system fails.

You will fit the Interlock to the cabinet-extraction port instead of the standard cabinet-extraction flange.

Refer to Appendix A12 for a full description of the accessory and its use.

7.4.5 Installation accessories

The Secondary Containment Tray is designed to contain water leaks from the abatement system enclosure/WRU. The Tray is fitted to your floor, and then the enclosure/WRU is installed in the Tray.

Use a Platform Kit to raise the abatement system enclosure and the WRU off of the floor. The Platform Kit has adjustable feet, so that you can adjust the height of the installation, and ensure that it is level.

7.4.6 Tri-Colour Remote Beacon

This accessory consists of a beacon with green, red and amber lamps, which provide an indication of the status of the abatement system.

The accessory is supplied with a 2 m cable, to connect the accessory to the interface module.

7.4.7 Remote Display

This accessory is a status display that can be located remotely from the abatement system enclosure.

The accessory incorporates an emergency stop switch and a 10 m cable to connect the accessory to the abatement system enclosure.

7.4.8 System Leak Check Kit

This Kit contains all the components necessary to leak check the abatement system.

Accessory	Item Number
PFC Interface Kit - BN series valves	A554-01-071
PFC Interface Kit - BK series valves	A554-01-078
PFC Interface Kit - Nupro series valves	A554-20-007
Bypass Lock-Out Kit	Y042-10-059
Earthquake Restraint Kit	Y042-10-061
Cabinet-Extraction Interlock	Y042-10-290
Secondary Containment Tray	Y046-01-174
Platform Kit	Y042-10-075
Tri-Colour Remote Beacon	Y042-10-024
Remote Display	A554-30-001
System Leak Check Kit	Y042-10-050

Table 37 - Accessory Item Numbers

8 ENGINEERING DIAGRAMS

Figure 26 shows an electrical block diagram of the abatement system and is included to assist in fault finding.

When you look at Figure 26, please note the following:

This symbol identifies a connection to the control system (that is, the PLC).

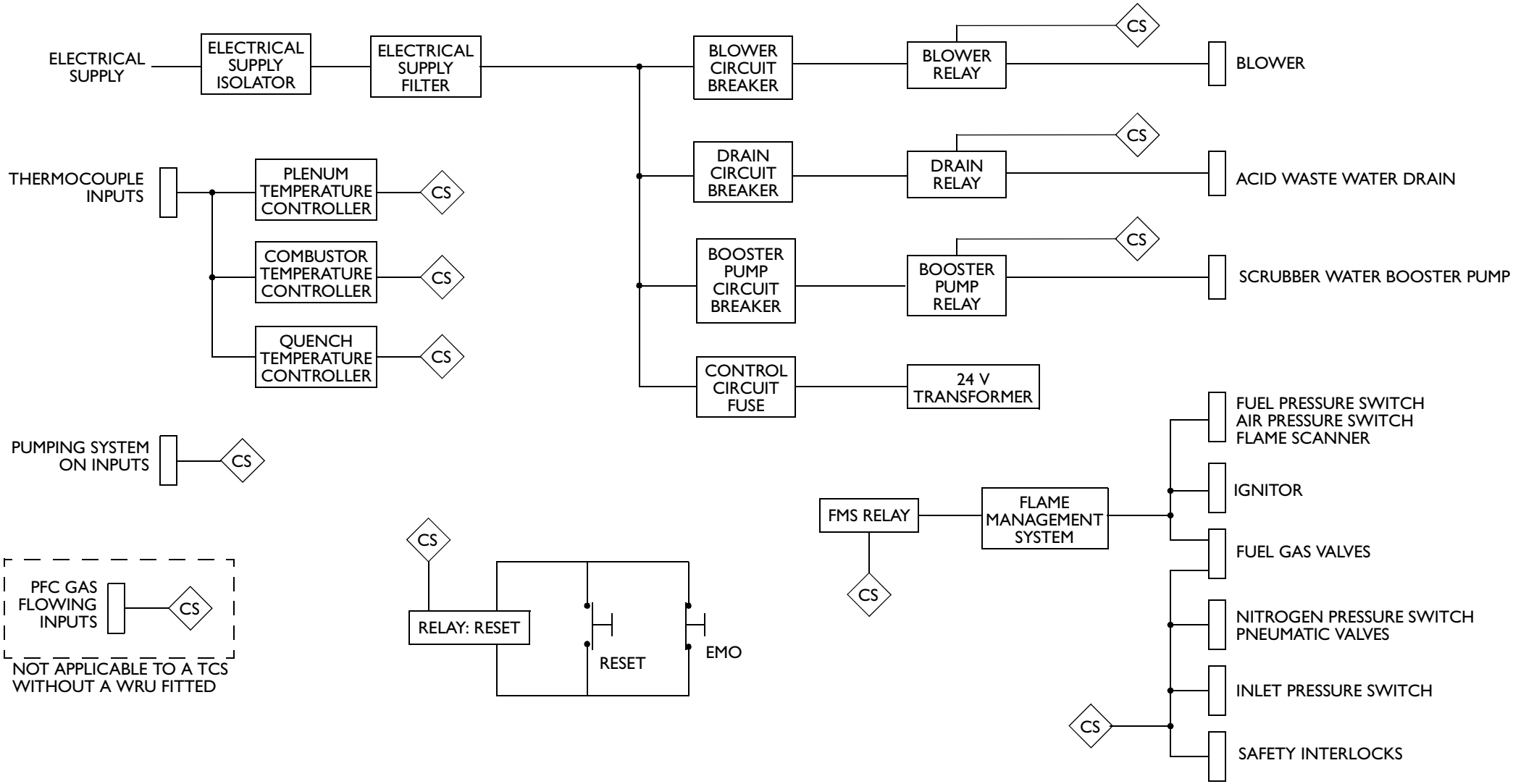


Figure 26 - Electrical block diagram

APPENDIX

A1 CONVERSION TABLES

Refer to Tables A1, A2, A3 and A4 for conversion factors.

	l min^{-1}	ft^3 min^{-1}	m^3 h^{-1}	imp gal h^{-1}	US gal h^{-1}
1 l min^{-1} =	1	0.0353	0.06	16.67	15.85
1 ft^3 min^{-1} =	28.32	1	1.7	3.734	4.486
1 m^3 h^{-1} =	16.67	0.589	1	2.1997	2.642
1 imp gal h^{-1} =	0.076	0.2678	0.4546	1	1.201
1 US gal h^{-1} =	0.063	0.2229	0.3785	0.833	1

Table A1 - Volumetric flow rate unit conversions

	mm	cm	m	in	ft
1 mm =	1	0.1	0.001	0.0394	3.28×10^{-3}
1 cm =	10	1	0.01	0.3937	3.28×10^{-2}
1 m =	1000	10	1	39.37	3.2808
1 in =	25.4	2.54	0.0254	1	8.33×10^{-2}
1 ft =	304.8	30.48	0.305	12	1

Table A2 - Linear unit conversions

Unit/function	Equivalent/formula
British Thermal Unit (BTU)	1 BTU = 0.252 kg.Cal
Calorific value: MJ m^{-3} to kCal	1 kCal = 4.18 x MJ m^{-3}
Centigrade (°C) to Fahrenheit (°F)	$°F = (^9/_5 \times °C) + 32$
Fahrenheit (°F) to Centigrade (°C)	$°C = {}^5/_9 \times (°F - 32)$

Table A3 - Miscellaneous equivalents and formulae

	psi	atm.	inch H_20	mm H_20	cm H_20	oz $inch^{-2}$	kg cm^{-2}	inch Hg	mm Hg (Torr)	cm Hg	mbar	bar	Pa (N m^{-2})	kPa	MPa
1 psi =	1	0.0681	27.71	703.8	70.38	16	0.0704	2.036	51.715	5.17	68.95	0.0689	6895	6.895	0.0069
1 atm. =	14.7	1	407.2	10,343	1,034.3	235.1	1.033	29.92	760	76	1013	1.013	101,325	101.3	0.1013
1 inch H_20 =	0.0361	0.00246	1	25.4	2.54	0.5775	0.00254	0.0735	1.866	0.187	2.488	0.00249	248.8	0.249	0.00025
1 mm H_20 =	0.001421	0.000097	0.0394	1	0.1	0.0227	0.0001	0.00289	0.0735	0.00735	0.098	0.000098	9.8	0.0098	0.00001
1 cm H_20 =	0.01421	0.000967	0.3937	10	1	0.227	0.001	0.0289	0.735	0.0735	0.98	0.00098	98	0.098	0.0001
1 oz $inch^{-2}$ =	0.0625	0.00425	1.732	43.986	4.4	1	0.0044	0.1273	3.232	0.323	4.31	0.00431	431	0.431	0.00043
1 kg cm^{-2} =	14.22	0.968	394.1	100,010	1,001	227.6	1	28.96	735.6	73.56	980.7	0.981	98,067	98.07	0.0981
1 inch Hg =	0.4912	0.03342	13.61	345.7	34.57	7.858	0.0345	1	25.4	2.54	33.86	0.0339	3386	3.386	0.00339
1 mm Hg (Torr) =	0.01934	0.001316	0.536	13.61	1.361	0.310	0.00136	0.0394	1	0.1	1.333	0.001333	133.3	0.1333	0.000133
1 cm Hg =	0.1934	0.01316	5.358	136.1	13.61	3.1	0.0136	0.394	10	1	13.33	0.01333	1333	1.333	0.00133
1 mbar =	0.0145	0.000987	0.4012	10.21	1.021	0.2321	0.00102	0.0295	0.75	0.075	1	0.001	100	0.1	0.0001
1 bar =	14.504	0.987	401.9	10,210	1021	232.1	1.02	29.53	750	75	1000	1	100,000	100	0.1
1 Pa (Nm^{-2}) =	0.000145	0.00001	0.00402	0.102	0.0102	0.00232	0.00001	0.000295	0.0075	0.00075	0.01	0.00001	1	0.001	0.000001
1 kPa =	0.14504	0.00987	4.019	102.07	10.207	2.321	0.0102	0.295	7.05	0.75	10	0.01	1000	1	0.001
1 MPa =	145.04	9.869	4019	102,074	10,207	2321	10.2	295.3	7500	750	10,000	10	1,000,000	1000	1

Table A4 - Pressure unit conversions

APPENDIX

A2 CORRECT USE OF SWAGELOK CONNECTORS

Note: We recommend that you use a second spanner to hold the fitting still when you remove or fit a Swagelok connector.

You must know how to correctly fit and retighten Swagelok connectors in order to prevent gas or water leaks; use the procedures in the following sections.

A2.1 Fit a Swagelok connector

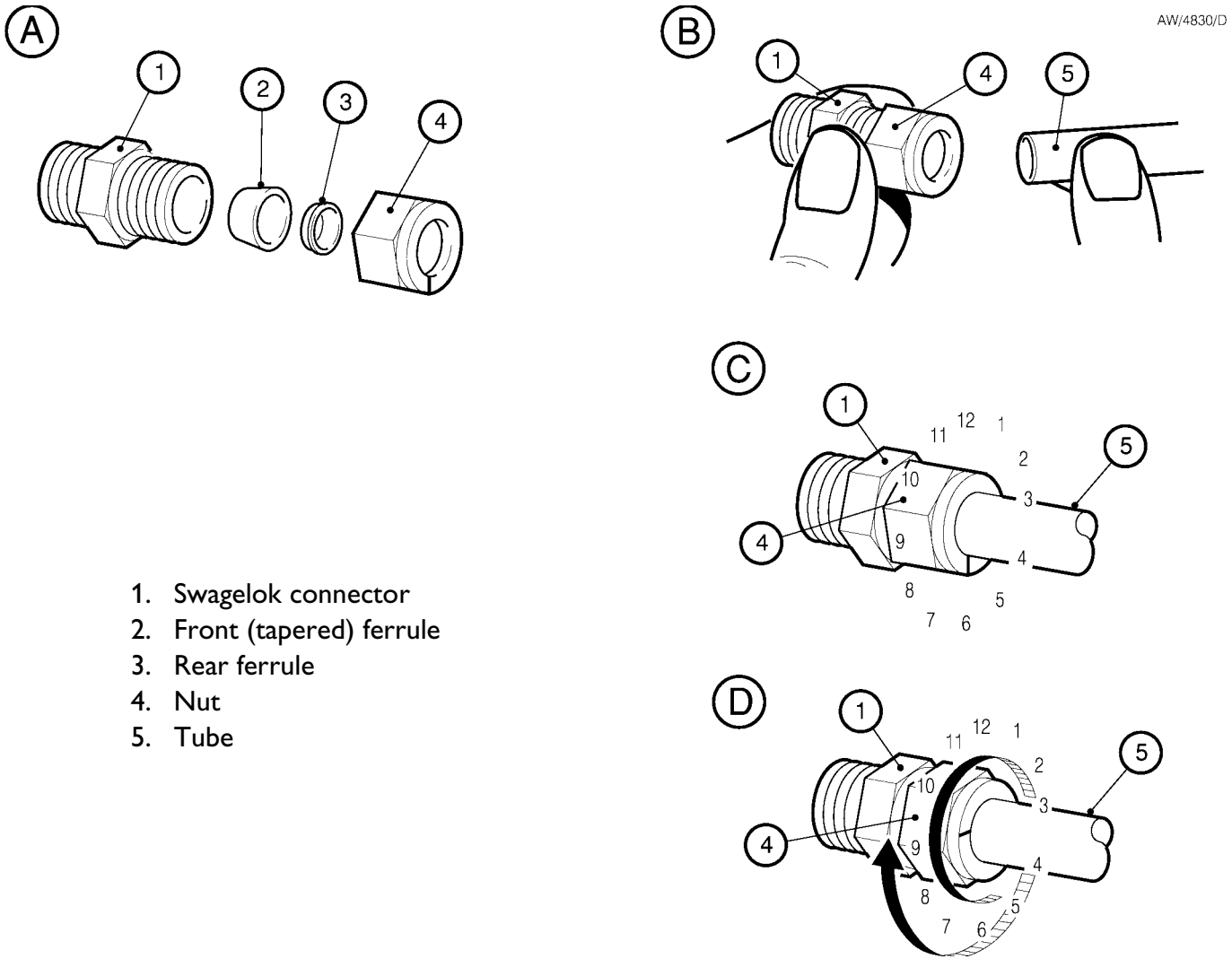
Use the following procedure to fit a Swagelok connector:

1. Refer to Figure A1, detail A. Undo and remove the nut (4) from the Swagelok connector (1). Ensure that the front (tapered) ferrule (2) and the rear ferrule (3) are correctly orientated as shown in detail A, then loosely refit the nut (4) to the connector (1).
2. Refer to detail B. Insert the tube (5) through the nut (4) and into the Swagelok connector (1). Ensure that the tube rests firmly on the shoulder inside the fitting, and that the nut (4) is finger tight.
3. Tighten the nut (4) until you cannot rotate the tube (5). If you cannot turn the tube because of how it is installed, tighten the nut by $^{1}/_{8}$ 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.

A2.2 Reconnect a Swagelok connector

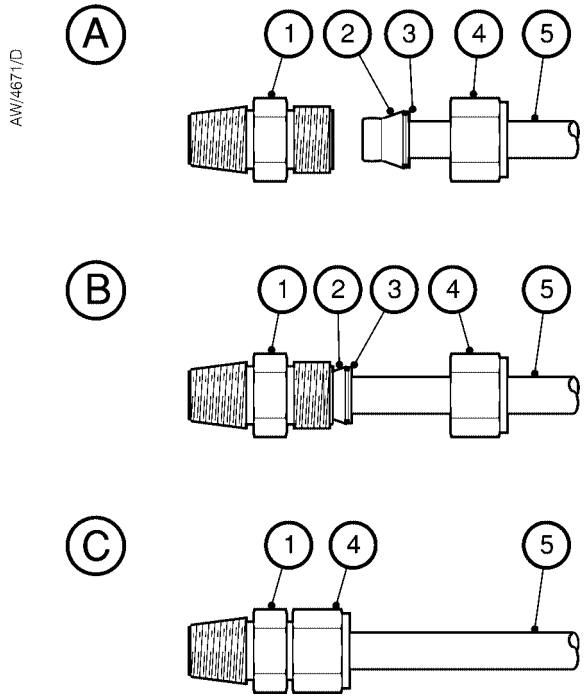
You can disconnect and reconnect a Swagelok connector many times and still obtain a correct leak-proof seal. Refer to Figure A2, detail A which shows a Swagelok connector after you have disconnected it. Use the following procedure to reconnect it:

1. Refer to detail B. Insert the tube (5) with the swaged ferrules (2, 3) into the Swagelok fitting (1), until the front (tapered) 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.



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

Figure A1 - Fit a Swagelok fitting



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

Figure A2 - Retighten a Swagelok fitting

APPENDIX

A3 RYZNAR STABILITY INDEX

A3.1 Introduction

The Ryznar Stability Index (RSI) provides a means of calculating the suitability of the cooling-water supply for use in dry pump and abatement systems.

High water temperature and low flow can cause corrosion with soft water, or cause dissolved salts to be precipitated with hard water.

Follow the procedure in Section A3.2 to calculate the RSI for your cooling-water supply, and check whether the supply is suitable for use. You should contact your local water authority for details of the water quality and, if required, for advice on suitable in-line water treatment.

A3.2 Calculation

The following parameters of the cooling-water supply are necessary to calculate the RSI:

- Total dissolved solids (mg l^{-1})
- On-site supply temperature (°C)
- Calcium hardness, calculated from the total calcium carbonate (mg l^{-1} as $CaCO_3$)
- Total alkalinity, calculated from the total calcium carbonate (mg l^{-1} as $CaCO_3$)
- On-site pH

To calculate the RSI use the following procedure:

1. Use the cooling-water supply parameters to obtain values of A, B, C, and D: use Tables A5, A6, A7 and A8 respectively.
2. Use values A, B, C and D to obtain value pHs:

   pHs = (9.3 + A + B) - (C + D)
3. Use the pHs value, and the pH value of the supply, to obtain the RSI:

   RSI = 2pHs - pH
4. Check whether the cooling-water supply is suitable for use: see Section A3.3.

A3.3 Results

BOC Edwards recommend that your cooling-water supply has an RSI of 6.5 to 7.0.

If the RSI of your cooling-water supply is outside this range, you should incorporate suitable in-line water treatment methods, to ensure that the RSI of the cooling-water supply into your system is in this recommended range.

The following list indicates the amount of deposit or corrosion that can be expected according to the RSI of your cooling-water supply.

4.0 to 5.0	Heavy scale
5.0 to 6.0	Light scale
6.0 to 7.0	Little scale or corrosion
7.0 to 7.5	Significant corrosion
7.5 to 9.0	Heavy corrosion
> 9.0	Unacceptable corrosion

Total solids (ppm)	Value A
50 - 300	0.1
301 - 4000	0.2
4000 - 13000	0.3

Table A5 - Total solids

Temp. (°C)	Value B		Temp. (°C)	Value B
0 - 1	2.6		32 - 36	1.8
2 - 5	2.5		37 - 43	1.7
7 - 9	2.4		44 - 50	1.6
10 - 12	2.3		51 - 55	1.5
14 - 16	2.2		56 - 63	1.4
18 - 21	2.1		64 - 71	1.3
22 - 26	2.0		72 - 81	1.2
27 - 31	1.9			

Table A6 - Temperature

ppm of $CaCO_3$	Value C		ppm of $CaCO_3$	Value C
1 - 3	0.2		88 - 110	1.6
4 - 5	0.3		111 - 138	1.7
6 - 7	0.4		139 - 174	1.8
8 - 9	0.5		175 - 220	1.9
10 - 11	0.6		230 - 270	2.0
12 - 13	0.7		280 - 340	2.1
14 - 17	0.8		350 - 430	2.2
18 - 22	0.9		440 - 550	2.3
23 - 27	1.0		560 - 690	2.4
28 - 34	1.1		700 - 870	2.5
35 - 43	1.2		880 - 1100	2.6
44 - 55	1.3		1100 - 1400	2.7
56 - 69	1.4		>1400	2.8
70 - 87	1.5			

Table A7 - Calcium hardness

ppm of $CaCO_3$	Value D		ppm of $CaCO_3$	Value D
10 - 11	1.0		140 - 176	2.2
12 - 13	1.1		177 - 220	2.3
14 - 17	1.2		230 - 270	2.4
18 - 22	1.3		280 - 350	2.5
23 - 27	1.4		360 - 440	2.6
28 - 35	1.5		450 - 550	2.7
36 - 44	1.6		560 - 690	2.8
45 - 55	1.7		700 - 880	2.9
56 - 69	1.8		890 - 1100	3.0
70 - 88	1.9		1100 - 1400	3.1
89 - 110	2.0		>1400	3.2
111 - 139	2.1			

Table A8 - Alkalinity

APPENDIX

A4 TMS (TEMPERATURE MANAGEMENT SYSTEM) ORDERING OPTION: TCS AND TPU SYSTEMS

A4.1 Introduction

A4.1.1 Description

Note: If you are unsure as to whether you need TMS on your application or not, please contact the BOC Edwards Exhaust Management Group: refer to Section 1.13.

This ordering option (for TCS and TPU systems) is recommended for TEOS, W-CVD and metal etch processes, and other processes which generate condensable by-products.

When fitted, the TMS maintains the inlet pipelines and the inlet head at a temperature in the range of approximately 90 to 120 °C (depending on the application), to prevent deposition of solids in the abatement system.

A4.1.2 Principle of operation

Refer to Figure A3 which shows a system fitted with the TMS option. The following additional items are supplied fitted to the system:

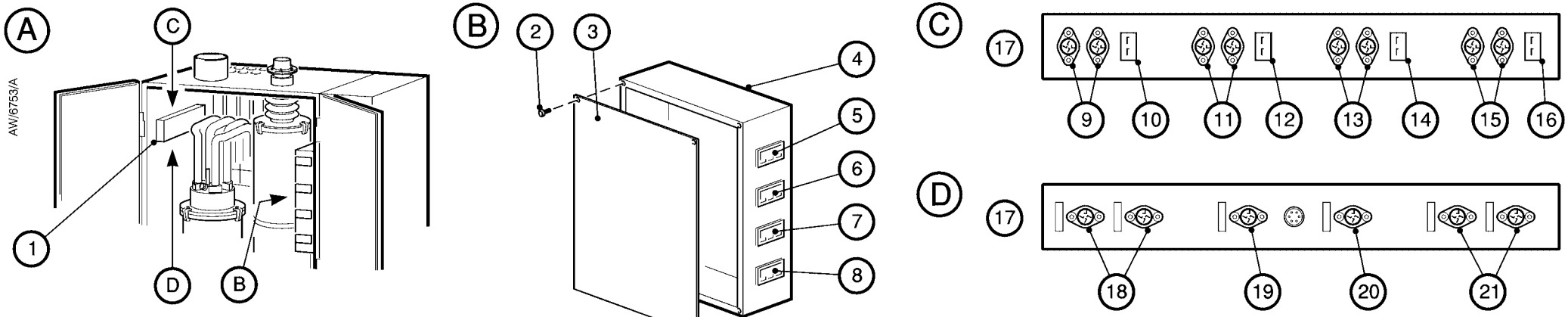
Heaters
Heaters are fitted to the inlet pipe(s) on the inlet crown (see details E to G), to each inlet pipe on the inlet head (see detail H) and to each inlet and bypass pipeline in the abatement system enclosure (see detail J). The electrical supplies for these heaters are provided from the TMS distribution box (1).

Thermal insulation jackets
Thermal insulation jackets are fitted to the inlet pipe(s) on the crown (see details E to G), to each inlet pipe on the inlet head (see detail H) and to each inlet and bypass pipeline in the abatement system enclosure (see detail J).

Thermocouples (45)
See detail J. A thermocouple is fitted to each of the inlet pipelines (53) in the abatement system enclosure, under a heater (52). These thermocouples monitor the temperature of the pipelines and are connected to the TMS distribution box (1).

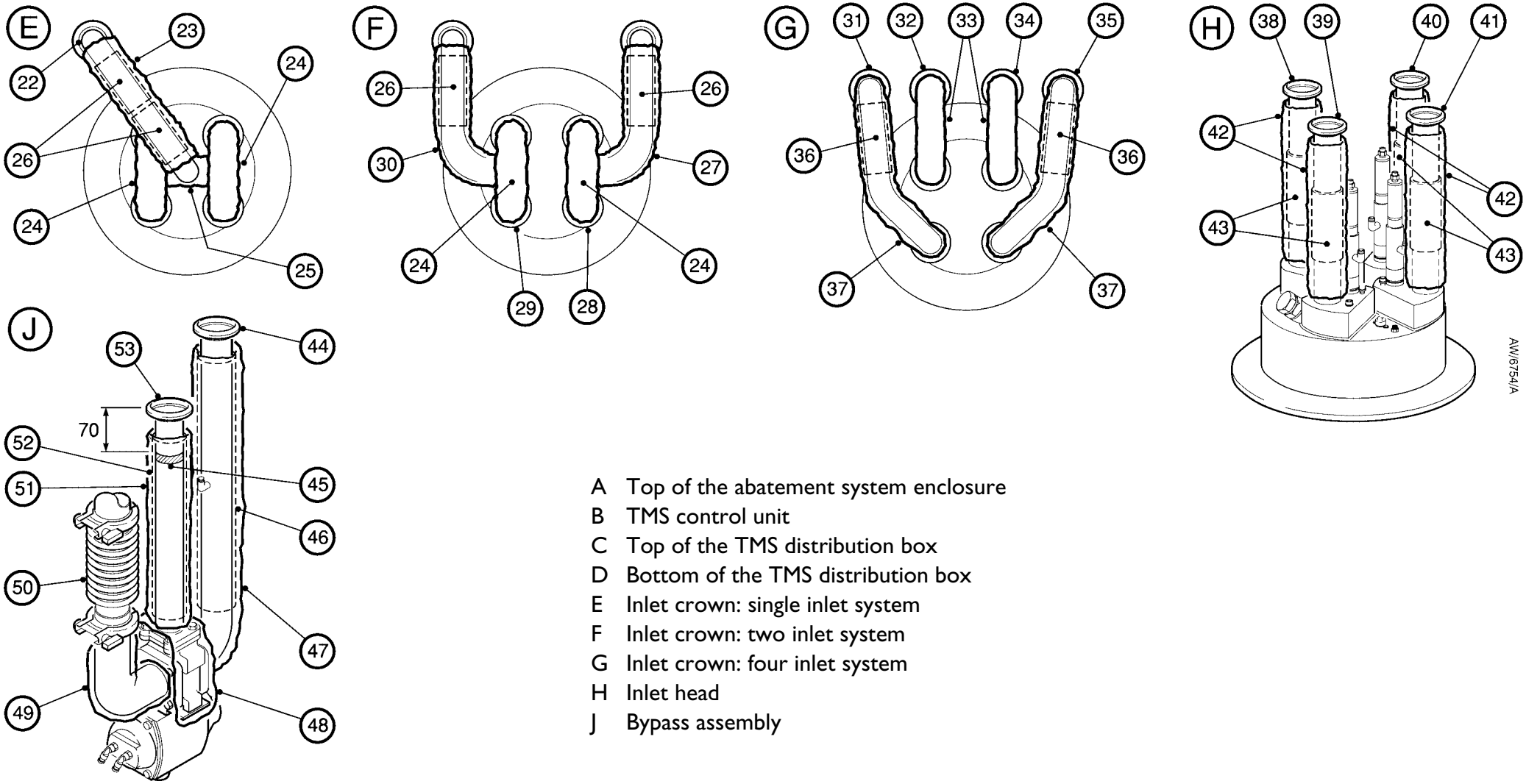
TMS distribution box (1)
The TMS distribution box provides the electrical supplies to the heaters. These electrical supplies are switched on and off, as demanded by the TMS control unit (4).

TMS control unit (4)
This control unit has four temperature controllers (5 to 8), each of which shows the temperature of one of the inlet pipelines (as monitored by the thermocouples). The control unit requests the TMS distribution box (1) to switch the electrical supplies to the heaters on and off, as appropriate, to maintain the inlet pipelines at the required temperature.



1. TMS distribution box
2. Bolt
3. Cover
4. TMS control unit
5. Inlet 1 TMS temperature controller
6. Inlet 2 TMS temperature controller
7. Inlet 3 TMS temperature controller
8. Inlet 4 TMS temperature controller
9. Inlet 1 TMS heater connectors
10. .Inlet 1 TMS thermocouple connector
11. Inlet 2 TMS heater connectors
12. Inlet 2 TMS thermocouple connector
13. Inlet 3 TMS heater connectors
14. Inlet 3 TMS thermocouple connector
15. Inlet 4 TMS heater connectors
16. Inlet 4 TMS thermocouple connector
17. Front of the abatement system
18. Inlet 1 heater connectors
19. Inlet 2 TMS heater connectors
20. Inlet 3 TMS heater connectors
21. Inlet 4 TMS heater connectors
22. 1 inlet system crown
23. Thermal insulation jacket
24. Thermal insulation jacket
25. Thermal insulation jacket
26. Heaters (100 mm)
27. Thermal insulation jacket
28. 2 inlet system crown (inlet 2)
29. 2 inlet system crown (inlet 1)
30. Thermal insulation jacket
31. 4 inlet system crown (inlet 1)
32. 4 inlet system crown (inlet 2)
33. Thermal insulation jacket
34. 4 inlet system crown (inlet 3)
35. 4 inlet system crown (inlet 4)
36. Heaters (100 mm)
37. Thermal insulation jacket
38. Quadrant inlet 1
39. Quadrant inlet 4
40. Quadrant inlet 2
41. Quadrant inlet 3
42. Thermal insulation jacket
43. Heater (100 mm)
44. Bypass pipeline
45. Thermocouple position
46. Heater (180 mm)
47. Thermal insulation jacket
48. Thermal insulation jacket
49. Thermal insulation jacket
50. Flexible bellows
51. Thermal insulation jacket
52. Heater (180 mm)
53. Inlet pipeline

Figure A3 - TCS/TPU TMS components (sheet 1 of 2)



A Top of the abatement system enclosure
B TMS control unit
C Top of the TMS distribution box
D Bottom of the TMS distribution box
E Inlet crown: single inlet system
F Inlet crown: two inlet system
G Inlet crown: four inlet system
H Inlet head
J Bypass assembly

Figure A3 - TCS/TPU TMS components (sheet 2 of 2)

A4.1.3Warning label

When supplied with the TMS option, an additional warning label is fitted in the abatement system enclosure: see Figure A4.

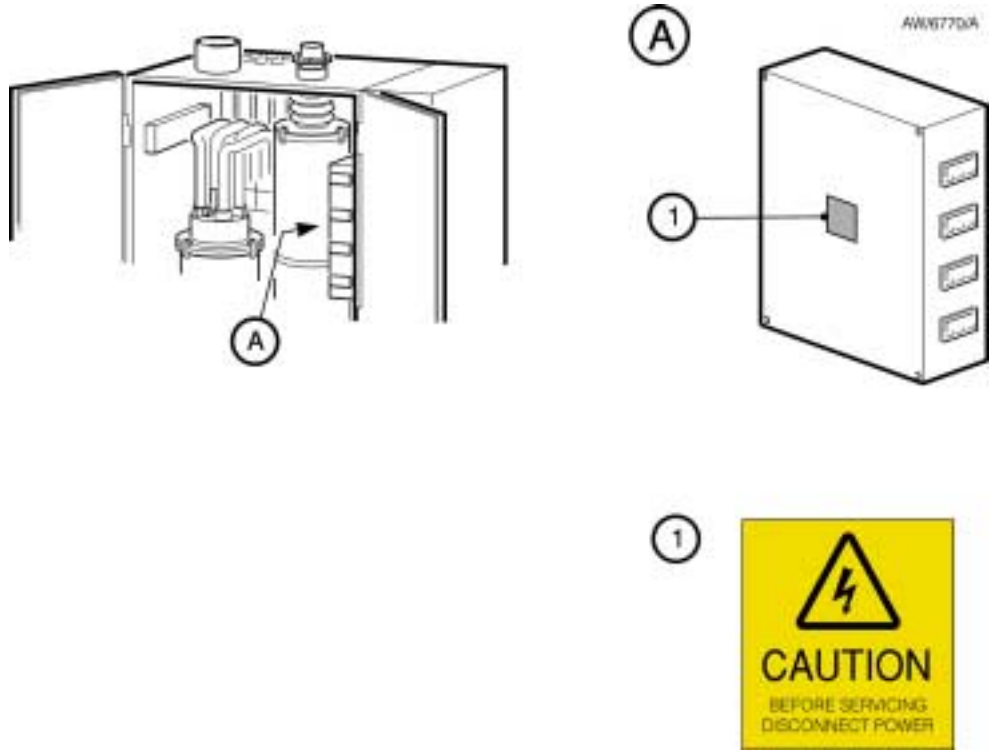


Figure A4 - TCS/TPU TMS warning label

A4.2 Additional technical data

The additional electrical data shown in Table A9 is applicable to a TCS/TPU abatement system fitted with the TMS option.

A4.3 Additional installation requirements

CAUTION

Fit suitable TMS components to the pipelines between the pumping systems and the TPU or TCS. If you do not, the pipelines may become blocked.

As supplied, all of the TMS components in the abatement system enclosure are preset for correct operation.

You **must** fit other suitable TMS components to the pipelines between the pumping systems and the abatement system process gas inlets (including the flexible bellows in the pipelines: see Section 3.12), to maintain the temperature of these pipelines at a temperature in the range of approximately 90 to 120 °C. If you do not, deposits may form in these pipelines, and they may become blocked.

A4.4 Operation

When supplied with this option, the TMS components and the abatement system are configured for correct operation.

Once the abatement system is switched on, the electrical supplies to the TMS heaters are switched on, and the heaters maintain the inlet pipes and the other components at the correct temperature.

A4.5 Maintenance

A4.5.1 Inspect the TMS components

Use the following procedure to regularly inspect the TMS components:

1. Inspect all of the TMS heaters, thermocouples and thermal insulation jackets and check that they are not damaged and are correctly secured in place. Secure or replace any component as necessary.
2. Inspect all of the TMS heater and thermocouple cables and check that they are not damaged and have not overheated. If any cable is damaged or has overheated, replace the corresponding heater or thermocouple.

	'E' model	**'S' model**	**'J50' model**	**'J60' model**
Full load current rating (TMS only)	2.4 A	4.5 A	5.4 A	5.4 A
TMS control unit fuse ratings				
F1	1 A, 'T' type	1 A, 'T' type	1 A, 'T' type	1 A, 'T' type
F2	10 A, 'T' type	10 A, 'T' type	10 A, 'T' type	10 A, 'T' type
F3	4 A, 'T' type	6.3 A, 'T' type	6.3 A, 'T' type	6.3 A, 'T' type

Table A9 - TCS/TPU TMS electrical data

A4.5.2Heater thermal fuse failure

If a heater thermal fuse fails, the heater will not operate and must be replaced.

If you think that a heater thermal fuse has failed, use the following procedure to check the heater and to replace it if necessary.

1. Refer to Figure A3. Remove the connector on the end of the heater cable from the corresponding heater connector on the top or bottom of the TMS distribution box (1).
2. Check the continuity of pins 1 and 3 in the connector on the end of the heater cable:
   - If there is no continuity, the heater has failed: continue at Step 3 to replace the heater.
   - If there is continuity, the heater has not failed: refit the connector on the end of the heater cable to the corresponding heater connector on the top or bottom of the TMS distribution box (1).
3. Remove the insulation jacket(s) which cover the heater to be replaced.
4. Remove and dispose of the failed heater, and fit a new heater in its place.
5. Refit the insulation jacket(s) which cover the replaced heater.
6. Fit the connector on the end of the heater cable to the corresponding heater connector on the top or bottom of the TMS distribution box (1).

A4.5.3Replace a TMS fuse (when necessary)

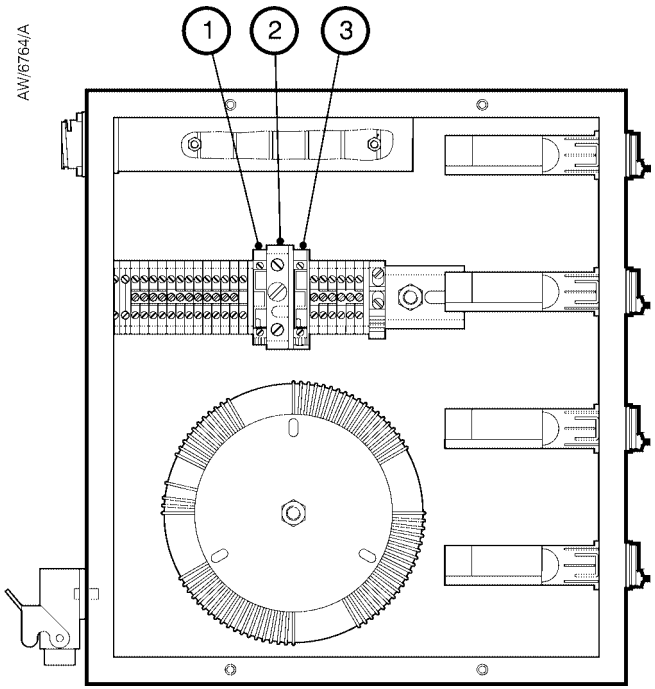
WARNING

Lockout the abatement system from the electrical supply before you start work. If you do not, there will be a risk of injury or death by electric shock.

If you think that a TMS fuse has failed, use the following procedure to check the fuse and replace it, if necessary. Only replace a fuse when you have identified and rectified the cause of the fuse failure. Refer to Table A9 for the fuse designations and ratings.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.2.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then lock out the abatement system: refer to Section 5.1.2.
3. Open the doors of the abatement system enclosure.
4. Refer to Figure A3. Undo and remove the screws (2), then remove the cover (3) from the TMS control unit (4).
5. Refer to Figure A5. Remove the fuse (1, 2 or 3) which you suspect has failed.
6. Check the electrical continuity of the fuse:
   - If there is no continuity, the fuse has failed. Replace it with a new fuse of the correct rating (refer to Table A9).
   - If there is continuity, the fuse has not failed: refit it in the TMS control unit.
7. Refer to Figure A3. Refit the cover (3) to the TMS control unit (4) and secure with the screws (2).
8. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.1.

If the fuse fails again immediately after you have replaced it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.



1. Fuse F1
2. Fuse F2
3. Fuse F3

Figure A5 - TCS/TPU TMS fuses in the TMS control unit

A4.6 TMS spares and accessories

A4.6.1 Introduction

Order TMS spares and accessories as described in Section 7 of this manual.

A4.6.2 TMS spares

See Table A10 for the TMS spares available.

A4.6.3 TMS accessories

A number of BOC Edwards standard TMS accessories have been developed to reduce the formation of deposits in the pipelines from the pumping systems to the abatement system. The accessories you require will depend on the installation configuration of your system; contact your supplier or BOC Edwards for advice.

Spare	Item Number
Pipeline heater (100 mm)	Y140-14-100
Pipeline heater (180 mm)	Y140-14-180
Heater retaining straps	A555-20-549
Thermocouple	A550-01-080
Temperature controller	A551-01-021
Bellows thermal insulation jacket	A550-01-064

Table A10 - TCS/TPU TMS spares

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APPENDIX

A5 TMS (TEMPERATURE MANAGEMENT SYSTEM): KRONIS SYSTEMS

A5.1 Introduction

A5.1.1 Description

TMS is fitted as standard to Kronis abatement systems, to maintain the inlet pipelines and the inlet head at a high temperature, to prevent deposition of solids in the abatement system.

A5.1.2 Principle of operation

Refer to Figure A6, which shows the following TMS components fitted to the Kronis system:

- Pipe and valve heaters.
- Thermal insulation jackets.
- Heater monitors.
- Control unit.

These components are described below.

Pipe and valve heaters

Pipe heaters are fitted to the inlet pipe(s) on the inlet crown (see details D to F), to each inlet pipe on the inlet head (see detail G) and to each inlet and bypass pipeline in the abatement system enclosure (see detail H). Each pipe heater is regulated to 150 °C by a thermal switch, and is protected by an integral thermal fuse that will disable the heater.

Refer to detail H. A valve heater (36) is fitted to each bypass valve in the enclosure. Each valve heater has a heating element consisting of a PTC (positive temperature coefficient) resistor, with a rating of 150 °C.

The pipe heaters and the valve heaters are connected in series in a 'chain'; electrical power is supplied (in parallel) to each heater from the TMS control unit.

Thermal insulation jackets

Thermal insulation jackets are fitted to the inlet pipe(s) on the crown (see details D to F), to each inlet pipe on the inlet head (see detail G), to each inlet and bypass pipeline, inlet elbow and bypass valve in the enclosure (see detail H).

These thermal insulation jackets reduce heat loss from the system, and prevent accidental contact with the hot pipes or valves.

Heater monitors

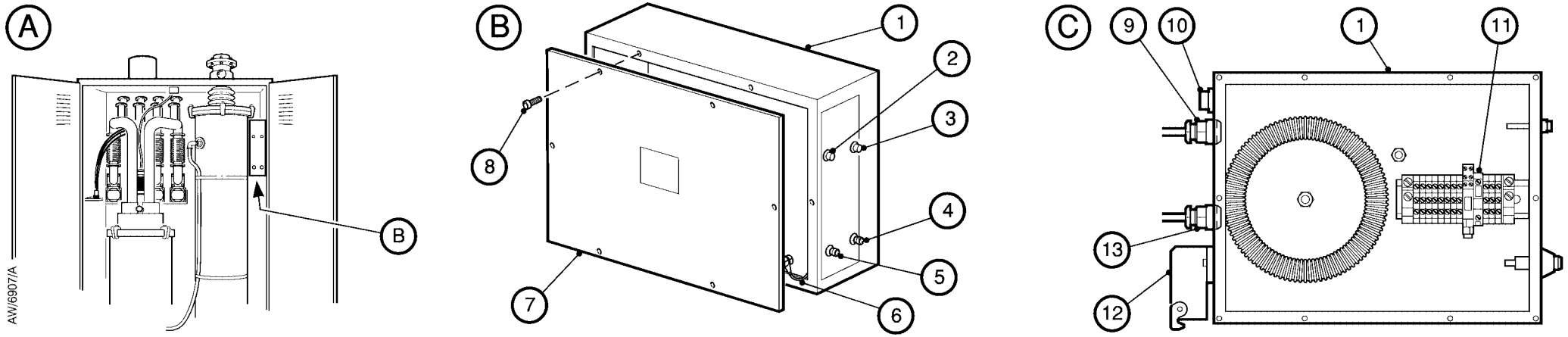
Refer to detail G. A heater monitor is fitted to the heater (33) on each inlet pipe on the inlet head. The heater monitors are connected in series to the control unit (1).

Each monitor incorporates a thermal switch which is normally open, and closes when the temperature rises to 90 °C or above.

Each monitor has a green indicator lamp which is on when the thermal switch is closed, and so indicates when the corresponding heater is at the correct operating temperature.

The heater monitors are connected in series in a 'chain' to the control unit. If one of the heater monitors fails, the indicator lamp on the failed monitor, and on all the heater monitors between the failed monitor and the control unit go off.

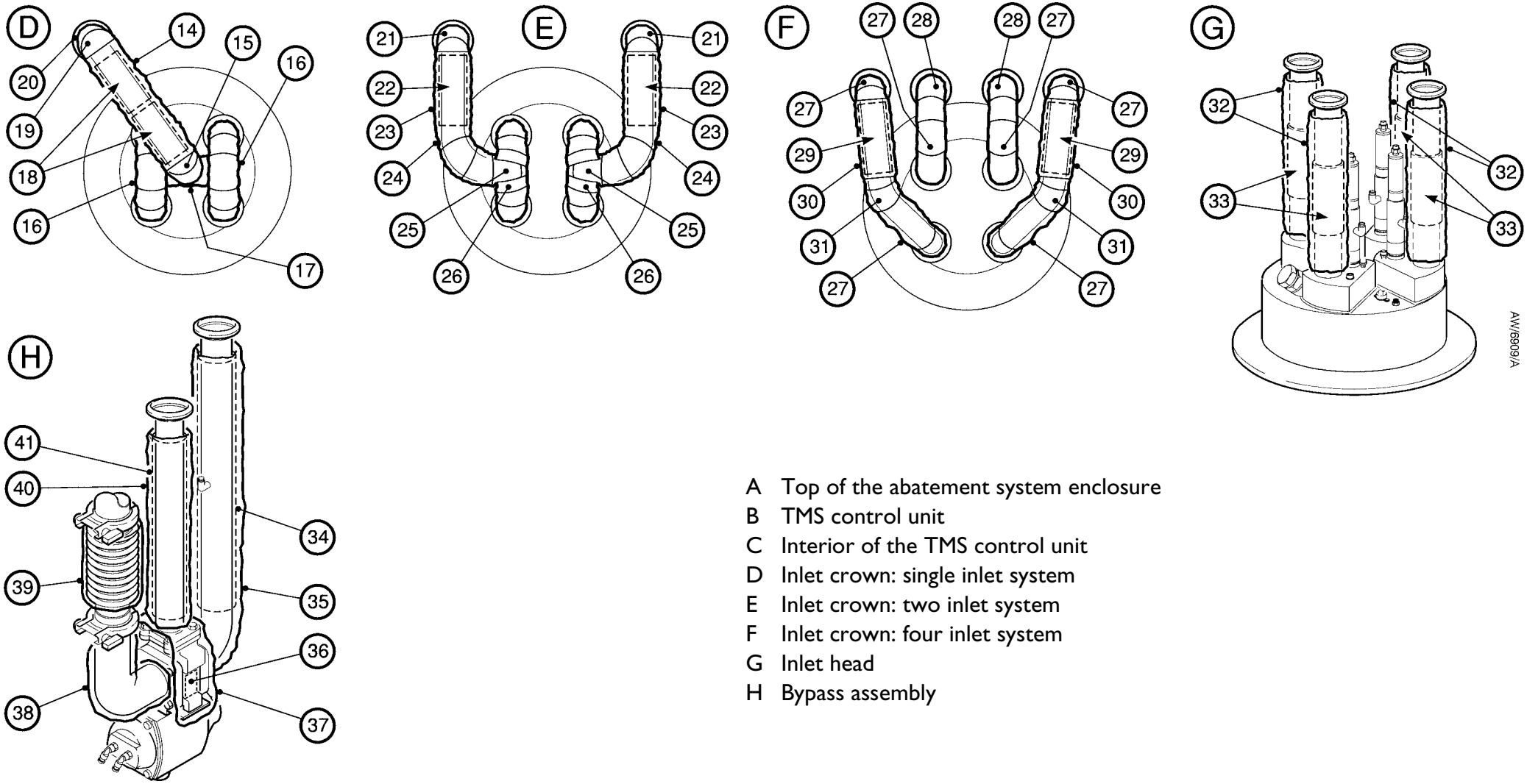
(continued on page 186)



1. TMS control unit
2. Heater power lamp
3. Monitor lamp
4. Secondary fuse F3
5. Secondary fuse F1
6. Earth (ground) wire
7. Cover
8. Bolt
9. Heater connector
10. Remote connector
11. Primary fuse F2
12. Electrical supply connector
13. Monitor connector
14. Thermal insulation jacket
15. Thermal insulation jacket
16. Thermal insulation jacket
17. Thermal insulation jacket
18. Pipe heater (Ø32 x 100 mm) *
19. Thermal insulation jacket
20. Thermal insulation jacket
21. Thermal insulation jacket
22. Pipe heater (Ø32 x 100 mm) *
23. Thermal insulation jacket
24. Thermal insulation jacket
25. Thermal insulation jacket
26. Thermal insulation jacket
27. Thermal insulation jacket
28. Thermal insulation jacket
29. Pipe heater (Ø40 x 100 mm) *
30. Thermal insulation jacket
31. Thermal insulation jacket
32. Thermal insulation jacket
33. Pipe heater (Ø32 x 235 mm) * and heater monitor
34. Pipe heater (Ø40 x 200 mm) *
35. Thermal insulation jacket
36. Valve heater
37. Thermal insulation jacket
38. Thermal insulation jacket
39. Thermal insulation jacket

* And retaining strap(s) if fitted

Figure A6 - Kronis TMS components (sheet 1 of 2)



A Top of the abatement system enclosure
B TMS control unit
C Interior of the TMS control unit
D Inlet crown: single inlet system
E Inlet crown: two inlet system
F Inlet crown: four inlet system
G Inlet head
H Bypass assembly

Figure A6 - Kronis TMS components (sheet 2 of 2)

TMS control unit

Refer to detail B. The TMS control unit (1) provides the electrical supplies to the pipe and valve heaters, and incorporates two indicator lamps, as follows:

- The heater power lamp (2) is on whenever the electrical supplies to the pipe and valve heaters are on.
- The monitor lamp (3) is on when the inlet pipes are at the correct operating temperature. The lamp goes off whenever any of the heater monitor thermal switches opens.

A5.1.3Warning label

A warning label is fitted to the TMS control unit: see Figure A7.

A5.1.4Additional interlock

The TMS control unit provides the additional 'TMS low temperature' interlock: see Table 2.

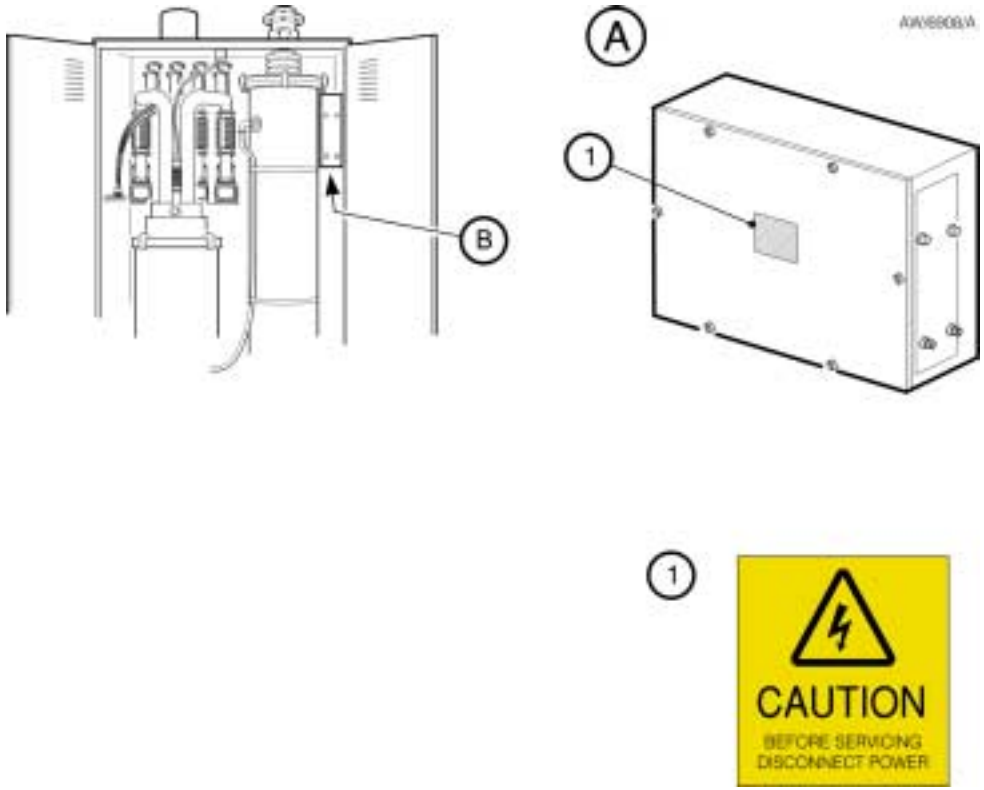


Figure A7 - Kronis TMS control unit warning label

A5.2 Additional technical data

The additional electrical data shown in Table A11 is applicable to the Kronis TMS.

A5.3 Additional installation requirements

> CAUTION
>
> Fit suitable TMS components to the pipelines between the pumping systems and the Kronis. If you do not, the pipelines may become blocked.

As supplied, all of the TMS components in the abatement system enclosure are preset for correct operation.

You **must** fit other suitable TMS components to the pipelines between the pumping systems and the Kronis process gas inlets (including the flexible bellows in the pipelines: see Section 3.12), to maintain the temperature of these pipelines at a temperature in the range of approximately 90 to 150 °C. If you do not, deposits may form in these pipelines, and they may become blocked.

	'E' model	**'S' model**	**'J' models**
Full load current rating	6.25 A	6.25 A	6.25 A
TMS control unit fuse ratings			
Primary fuse F2	2 A, 'T' type	5 A, 'T' type	5 A, 'T' type
Secondary fuse F1	5 A, 'T' type	5 A, 'T' type	5 A, 'T' type
Secondary fuse F3	5 A, 'T' type	5 A, 'T' type	5 A, 'T' type

Table A11 - Kronis TMS electrical data

A5.4 Operation

As supplied, the TMS components fitted to the Kronis system are configured for correct operation.

Once the Kronis system is switched on, the electrical supplies to the TMS heaters are switched on, and the heaters maintain the inlet pipes and the other components at the correct temperature.

A5.5 Maintenance

A5.5.1 Inspect the TMS components

Use the following procedure to regularly inspect the TMS components:

1. Inspect all of the pipe and valve heaters, heater monitors and thermal insulation jackets and check that they are not damaged and are correctly secured in place. Secure or replace any component as necessary.
2. Inspect all of the heater cables and heater monitor cables and check that they are not damaged and have not overheated. If any cable is damaged or has overheated, replace the corresponding heater or heater monitor.

A5.5.2Heater failure

WARNING

Take care that the securing spring does not injure your fingers when you remove/fit a valve heater.

CAUTION

Do not bend a heater excessively or force it flat. If you do, you can damage the heater element and cause the heater to fail.

If you think that a heater has failed, use the following procedure to check the heater and to replace it if necessary.

1. Refer to Figure A3. Remove the plug and socket at each end of the heater cable from the socket and plug on the two adjacent heater cables in the chain.
2. Check the resistance across the two pins in the heater cable plug:
   - A pipe heater has failed if there is no resistance; a valve heater has failed if the resistance > 1 MΩ: continue at Step 5 to replace the heater.
   - If the heater has not failed: continue at Step 3 to check the heater cable.
3. Check the continuity of the two wires in the heater cable, between the plug and the socket:
   - If there is no continuity, the heater cable has failed: continue at Step 4 to replace the heater.
   - If there is continuity, the heater cable has not failed: refit the plug and socket at each end of the heater cable to the socket and plug on the two adjacent heater cables in the chain.
4. Shut down the abatement system (refer to Section 4.4) and allow it to cool to a safe temperature.
5. Lockout the abatement system from the electrical supply (refer to Section 5.1.2) so that it cannot be operated accidentally.
6. Remove the thermal insulation jacket(s) which cover the heater to be replaced.
7. Take note of the location and orientation of the failed heater, then remove and dispose of the heater:
   - Pipe heaters may be secured in place by one or more retaining straps.
   - Valve heaters are secured in place by a spring.
8. Fit a new heater in place on the pipe or valve, and secure with the strap(s) or the spring:
   - Fit the new heater in the same location and in the same orientation as the failed heater.
   - Do not bend the new heater excessively or force it flat. If you do, you can damage the heater element and cause the heater to fail.
9. Refit the insulation jacket(s) which cover the replaced heater.
10. Fit the plug and socket at each end of the heater cable to the socket and plug on the two adjacent heater cables in the chain.

A5.5.3 Replace the TMS primary fuse (when necessary)

WARNING

Lockout the abatement system from the electrical supply before you start work. If you do not, there will be a risk of injury or death by electric shock.

WARNING

Ensure that the earth (ground) cable in the TMS control unit is correctly fitted before you restart the abatement system. If you do not, there will be a risk of injury or death by electric shock.

If you think that the primary TMS fuse has failed, use the following procedure to check the fuse and replace it, if necessary.

Only replace the fuse when you have identified and rectified the cause of the fuse failure. Refer to Table A11 for the fuse designations and ratings.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.2.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then electrically lock out the abatement system: refer to Section 5.1.2.
3. Open the doors of the abatement system enclosure.
4. Refer to Figure A6, detail B. Undo and remove the bolts (8), then remove the cover (7) from the TMS control unit (1).
5. Hold the cover while you remove the nut and washer which secures the earth (ground) cable (6) to the terminal in the control unit (1).
6. Refer to detail C. Remove the primary fuse (11) which you suspect has failed.
7. Check the electrical continuity of the fuse:
   - If there is no continuity, the fuse has failed. Replace it with a new fuse of the correct rating (refer to Table A11).
   - If there is continuity, the fuse has not failed: refit it in the TMS control unit.
8. Refer to detail B. Hold the cover (7) next to the control unit (1), then use the nut and washer to refit the end of the earth (ground) cable (6) to the terminal in the control unit (1).
9. Refit the cover (7) to the TMS control unit (4) and secure with the bolts (8). Ensure that the earth (ground) cable is not trapped when you refit the cover.
10. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.1.

If the fuse fails again immediately after you have replaced it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.

A5.5.4 Replace a TMS secondary fuse (when necessary)

WARNING

Lockout the abatement system from the electrical supply before you start work. If you do not, there will be a risk of injury or death by electric shock.

If you think that a secondary TMS fuse has failed, use the following procedure to check the fuse and replace it, if necessary.

Only replace the fuse when you have identified and rectified the cause of the fuse failure. Refer to Table A11 for the fuse designations and ratings.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.2.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then lock out the abatement system: refer to Section 5.1.2.
3. Open the doors of the abatement system enclosure.
4. Twist the fuse holder anticlockwise, remove the fuse holder and the secondary fuse (4, 5) from the control unit, then remove the fuse from the fuse holder
5. Check the electrical continuity of the fuse:
   - If there is no continuity, the fuse has failed. Dispose of the fuse, fit a new fuse of the correct rating (refer to Table A11) in the fuse holder and refit the fuse holder in the TMS control unit.
   - If there is continuity, the fuse has not failed: refit it in the fuse holder and refit the fuse holder in the TMS control unit.
6. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.1.

If the fuse fails again immediately after you have replaced it, there is an electrical fault in the abatement system: contact your supplier or BOC Edwards for advice.

A5.5.5 Replace a heater monitor

If you think that a heater monitor is damaged or has failed, use the following procedure to replace it, if necessary.

1. If the abatement system has not automatically shut down, shut down the system as described in Section 4.4.2.
2. Refer to Figure 6. Ensure that the start/stop switch (11) and the electrical supply isolator (3) are both in the off position, then lock out the abatement system: refer to Section 5.1.2.
3. Leave the abatement system so that the pipelines and heaters cool down to a safe temperature.
4. Remove the plug and socket at each end of the heater monitor cable from the socket and plug on the two adjacent heater monitor cables in the chain.
5. Undo the securing strap and remove the heater monitor from the heater to which it is fitted.
6. Fit a new heater monitor as close as possible to the centre of the heater, and secure with a strap.

7. Fit the plug and socket at each end of the heater monitor cable to the socket and plug on the two adjacent heater monitor cables in the chain.
8. Remove the electrical lockout device(s) (refer to Section 5.1.2), then restart the abatement system as described in Section 4.1.1.

A5.5.6Additional fault finding

In addition to the fault message fault finding given in Table 33, refer to Table A12 for Kronis TMS fault message fault finding.

Also refer to the fault finding in Table A12 if an indicator lamp on a heater monitor goes off.

Fault message	Check	Actions
WARNING TMS TEMPERATURE LOW	Is the system at operating temperature ?	Ensure that you have allowed 2 hours for the system to reach operating temperature.
	Is there a fault with another heater monitor ?	Check that the indicator lamps on the other heater monitors are on. If they are not, the fault is with the first heater monitor that does not have its indicator lamp on.
	Is there a break in the chain of heaters or heater monitors ?	Check that all the electrical connections in the chain of heaters and of heater monitors are secure.
	Is the heater monitor not fitted securely, or is it not positioned on the heater correctly ?	Check that the heater monitor is installed as described in Section A5.5.5, so that the monitor is as close to the centre of the heater as possible, and that the securing strap is securely tightened.
	Has the heater failed ?	Check that the heater under the heater monitor has not failed: see Section A5.5.2. If necessary replace the heater.
	Has the heater monitor failed ?	There may be a failure in the heater monitor cable or the thermal switch. Replace the heater monitor: refer to Section A5.5.5.

Table A12 - Kronis TMS status display fault message fault finding

A5.6 TMS Spares

Additional spares for the Kronis TMS are listed in Table A13.

Spare	Item Number
Pipe heater: (Ø40 x 200 mm)	Y140-12-200
Pipe heater: (Ø40 x 100 mm)	Y140-12-100
Pipe heater: (Ø32 x 235 mm)	Y140-11-235
Pipe heater: (Ø32 x 100 mm)	Y140-11-100
Valve heater (120 V)	Y140-17-024
Heater monitor (with 300 mm cable)	Y143-00-300
1-inlet crown thermal insulation kit	Y141-09-004
2-inlet crown thermal insulation kit	Y141-09-005
4-inlet crown thermal insulation kit	Y141-09-006
Inlet head thermal insulation kit	Y141-09-008
Bypass assembly thermal insulation kit	Y141-09-009
Bypass valve thermal insulation kit	Y141-01-005
Pipe heater retaining strap	A555-20-549
Valve heater securing spring	B271-01-005

Table A13 - Kronis TMS spares

APPENDIX

A6 REMOTE BYPASS MODULE ORDERING OPTION

A6.1 Introduction

Use this option when you have the TMS option fitted (see Appendix A4), or when you want the bypass valves to be outside the abatement system enclosure. This ensures that you can maintain components in the enclosure, with no possibility of the leakage of dangerous process gases into the enclosure.

Note that when the system is supplied with this option:

- The process gas inlets are on the rear of the Remote Bypass Module.
- The bypass outlets are in the same position on the top of the abatement system enclosure (but higher than) the bypass outlets on the standard abatement system.

Refer to Figures A8 and A9 which show the process gas inlet and bypass outlet configurations and dimensions when the abatement system is supplied with this option.

A6.2 Additional installation requirements

A6.2.1 Unpack and inspect the Module

When the system is supplied with this ordering option, the enclosure is supplied without bypass valves, and the additional items shown in Table A14 are supplied with the system. After you have unpacked and inspected the abatement system enclosure and the WRU (see Sections 3.5 and 3.6), inspect the additional items shown in Table A14, and check that you have received all of these items.

If any item is missing or damaged, notify your supplier and the carrier in writing within three days; state the Item Number and the Serial Number of the system, together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not continue to install the Remote Bypass Module and use the system if any item is damaged.

Quantity	Description	Refer to Section	Check (✓)
1	Remote bypass module	A6.2.2	❑
6	Bolts	A6.2.2	❑
4	'O' rings	A6.2.2	❑
4	Clamps	A6.2.2	❑

Table A14 - Checklist of additional Remote Bypass Module items

A6.2.2 Install the Remote Bypass Module

Install the Remote Bypass Module before you connect the system bypass outlets to your bypass pipelines (see Section 3.11); use the following procedure:

1. Refer to Figure A8, detail A. For each of the four pipelines (10) in the abatement system enclosure:
   - Fit one of the 'O' rings supplied to the top of the inlet pipeline (10).
   - Use one of the clamps supplied to connect one of the spool pieces (9) to the inlet pipeline.
2. Place the Remote Bypass Module (13) in position on top of the enclosure (11), so that the position indicators (12) are towards the front of the enclosure, and so that the outlet flanges (6) on the Remote Bypass Module align with the spool pieces (9) in the enclosure.
3. Use four of the clamps supplied and the remaining four 'O' rings to secure the outlet flanges (6) on the Remote Bypass Module to the spool pieces (9) in the enclosure.
4. Fit the six bolts (5) to secure the Remote Bypass Module (13) to the top of the enclosure.
5. Pass the nitrogen pipelines (7) in the enclosure through the leadthrough hole (8) in the top of the enclosure and through the leadthrough hole(s) in the base of the Remote Bypass Module (13).
6. Fit the nitrogen pipelines to the pneumatic connectors (14) on the bypass valve actuators. Note that there are four sets of two pipelines, that the pipelines are colour coded, and that the pipelines have labels which identify the process gas inlet. Connect the correct pipelines to the correct pneumatic connectors on the actuators.

A6.2.3 Connect the pumping systems to the inlets, and connect the bypass outlets to your bypass pipelines

When you connect the bypass outlets to your bypass pipelines (see Section 3.11) and connect the pumping systems to the abatement system inlets (see Section 3.12):

- Refer to Figure A8 which shows the inlet and bypass outlet configurations for the system with the Remote Bypass Module fitted.
- Refer to Figure A9 which shows the inlet and bypass outlet dimensions.

A6.3 Additional operation actions

WARNING

If the abatement system shuts down with any of the bypass valves in the on-line position, contact your supplier or BOC Edwards; do not use the system and do not disconnect any of the process or bypass pipelines, or the pipelines in the system enclosure.

Refer to Figure A8. When you check that the bypass valves are on-line or off-line after system shut-down (in Section 4.6.2), look at the position indicators (12) on the Remote Bypass Module.

1. Pumping system 1 bypass outlet
2. Pumping system 2 bypass outlet
3. Pumping system 3 bypass outlet
4. Pumping system 4 bypass outlet
5. Bolts
6. Outlet flanges
7. Nitrogen pipelines
8. Leadthrough hole
9. Spool pieces
10. Inlet pipelines
11. Abatement system enclosure
12. Position indicators
13. Remote Bypass Module
14. Pneumatic connectors
15. Pumping system 4 process gas inlet
16. Pumping system 3 process gas inlet
17. Pumping system 2 process gas inlet
18. Pumping system 1 process gas inlet
19. Position indicators (off-line position)
20. Position indicators (on-line position)

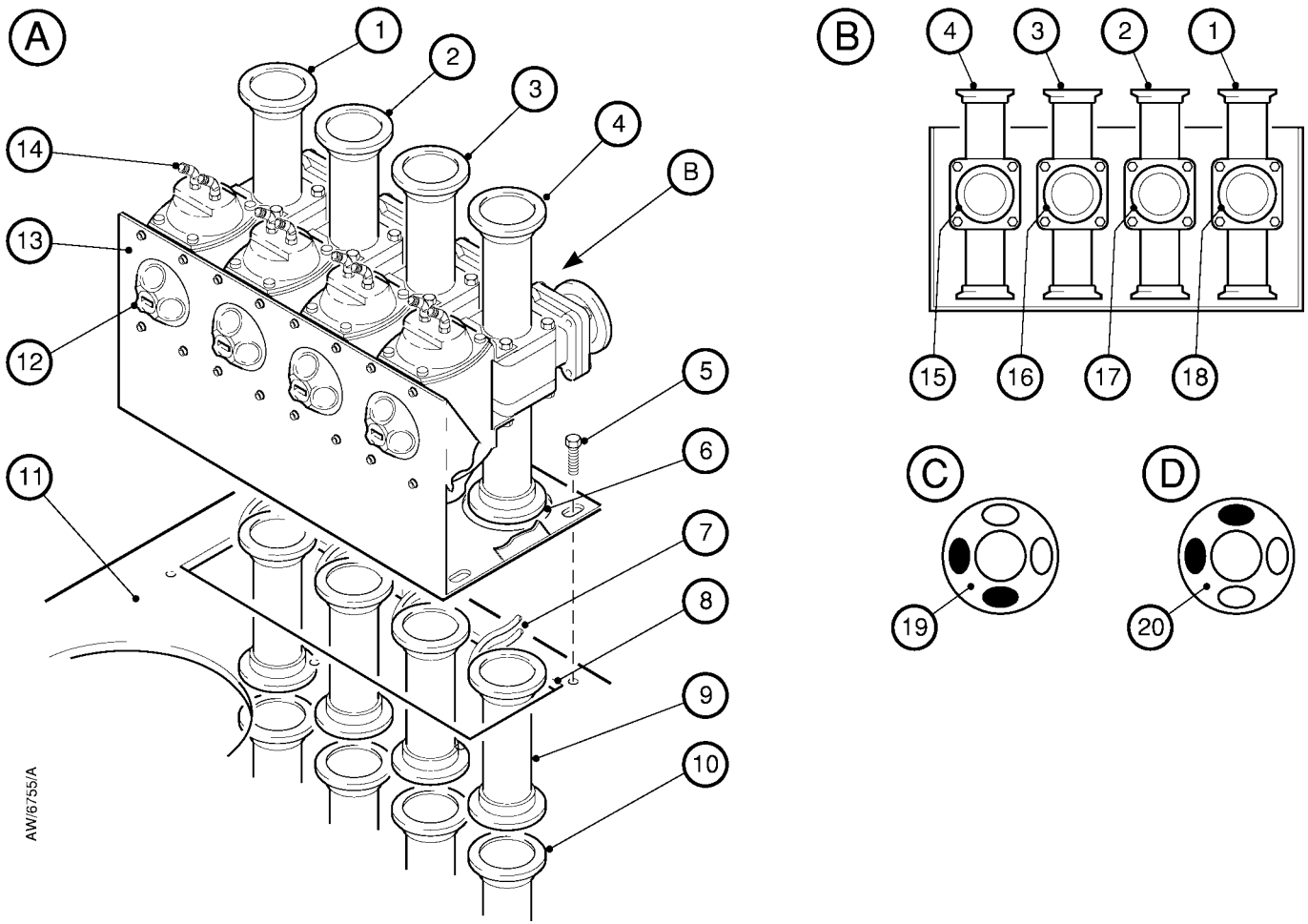


Figure A8 - Fit the Remote Bypass Module

A Top view
B Side view

1. Process gas inlet (4 off)
2. Bypass outlets (4 off)

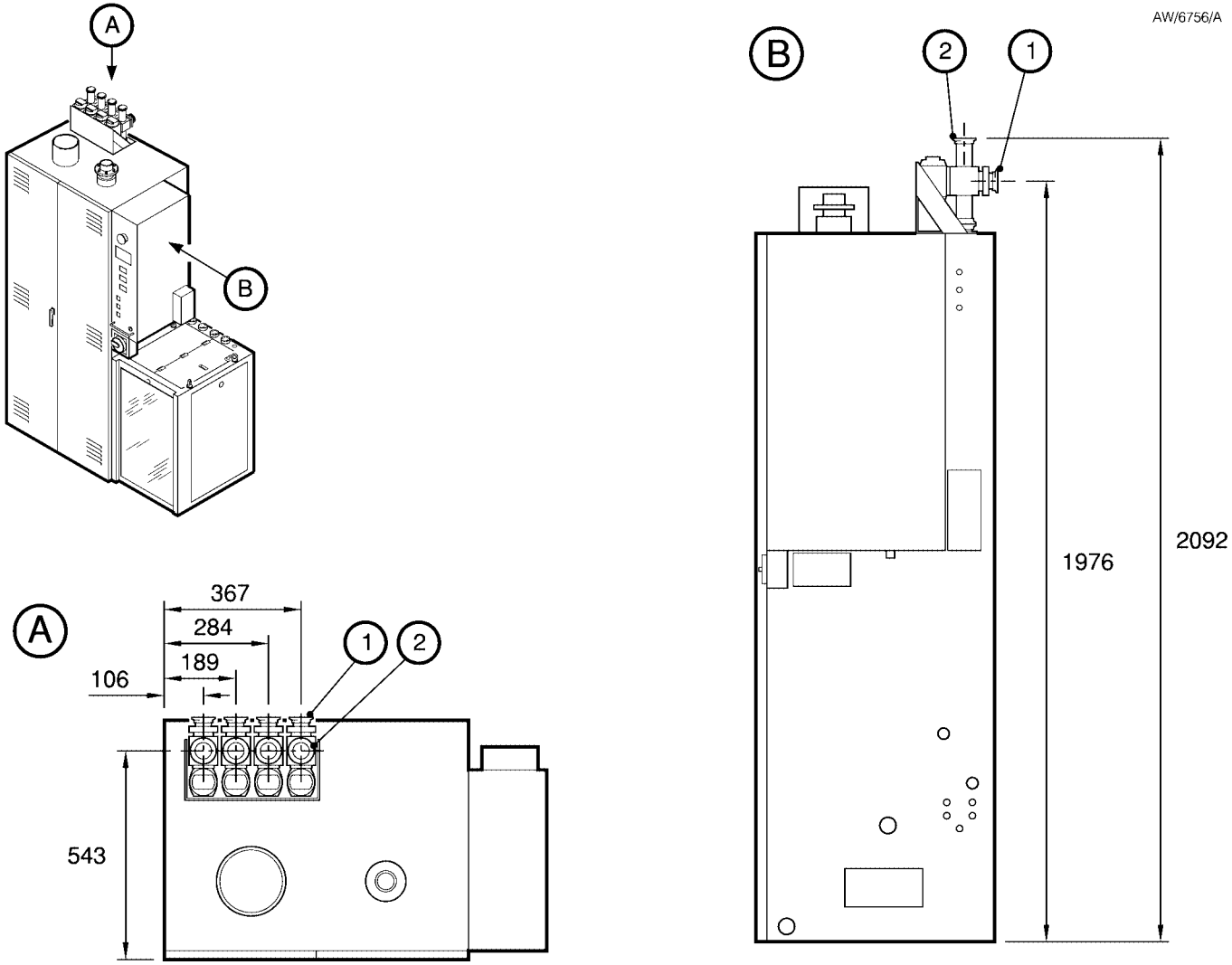


Figure A9 - Inlet and outlet dimensions (mm) for the Remote Bypass Module

APPENDIX

A7 BYPASS NITROGEN DILUTION

A7.1 Introduction

When you order the system with this option, the abatement system enclosure is configured to provide a flow of nitrogen to the corresponding bypass pipeline of any system inlet whose bypass valve is in the off-line position, in order to dilute the process gases which pass through the system and flow into the bypass pipeline.

A7.2 Principle of operation

Refer to Figure A10. Each system inlet/bypass pipeline has a dilution nitrogen pipeline (3) routed from the purge nitrogen pressure regulator (see Figure 25) to the corresponding bypass pipeline (2).

Up to four control valves control the supply of the dilution nitrogen to the corresponding bypass pipeline (2).

These control valves operate as follows:

- During normal operation with the bypass valve in the on-line position, the corresponding control valve is closed, so that no dilution nitrogen flows into the bypass pipeline.
- When the bypass valve for an inlet is in the off-line position, the pneumatic pipeline from the bypass valve actuates the corresponding control valve to the open position, so that dilution nitrogen flows into the bypass pipeline.

Each dilution nitrogen pipeline (3) incorporates a check-valve (1), which prevents any flow of process gases into the dilution nitrogen pipeline

A7.3 Technical data

Note 1: Refer to Section 2.5 for the nitrogen supply requirements.

Note 2: You must use a nitrogen supply pipeline with a diameter of at least $^1/_2$ inch, to ensure that, when full dilution nitrogen is flowing, the pressure available for the valve actuation nitrogen supply is greater than 4 bar (5×10^5 Pa).

Dilution nitrogen flow rate (per inlet) Normal operation Bypass mode	 None 50 l min^{-1}

Table A15 - Dilution nitrogen flow rate for the Bypass Nitrogen Dilution option

1. Check-valves
2. Bypass pipelines
3. Dilution nitrogen pipelines
4. Inlet pipelines

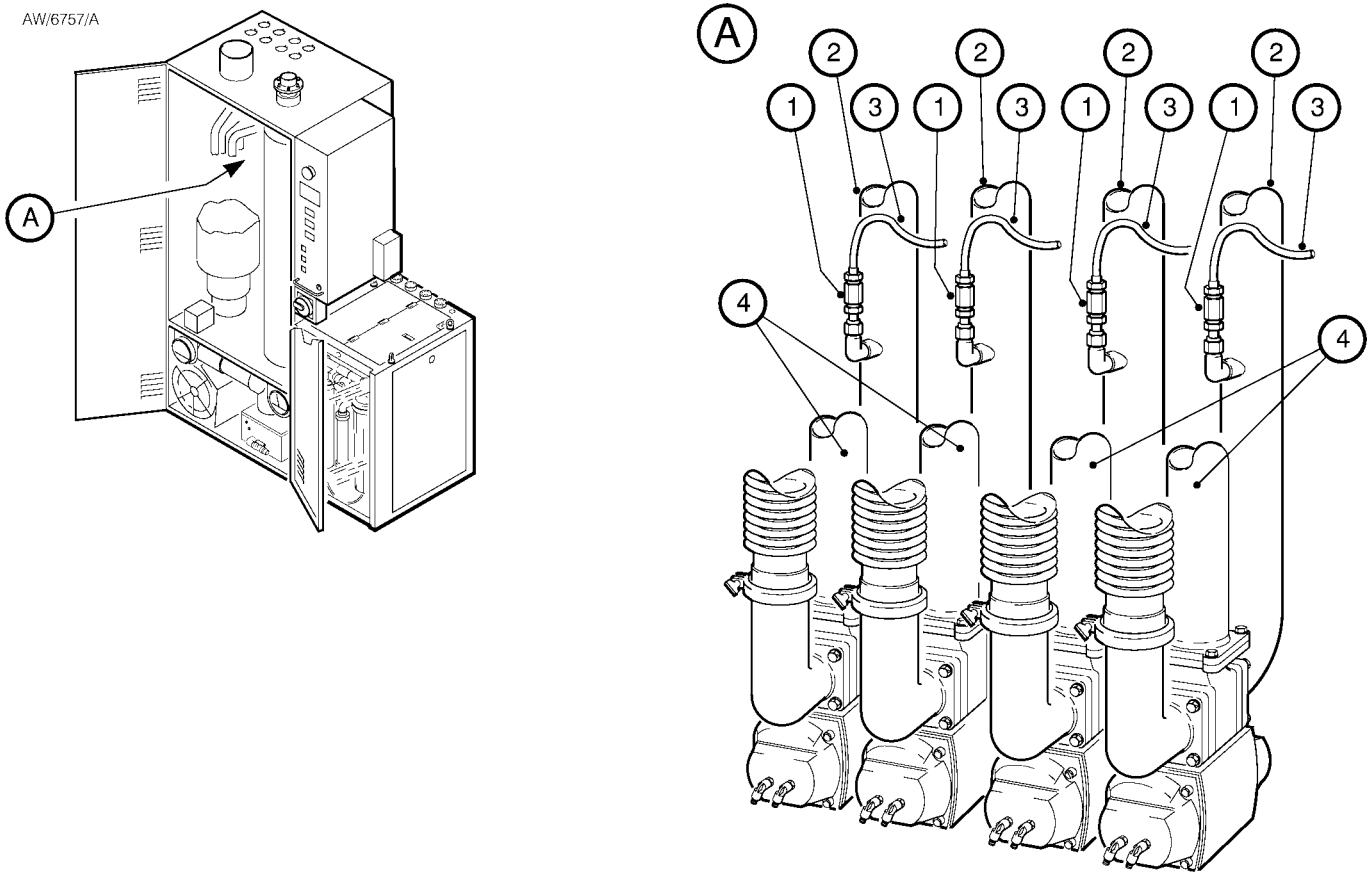


Figure A10 - Bypass Nitrogen Dilution installation

APPENDIX

A8 SERVICES MODULE

A8.1 Introduction

A8.1.1 General

With this option, the abatement system is supplied with a Services Module instead of a WRU.

The Services Module has a similar function to the WRU, however:

- Only a single water supply is required: the scrubber water supply. The scrubber water supply passes into the system enclosure, and is not recirculated (that is, acid waste water from the drain tank is pumped directly to the waste water outlet).
- There are separate scrubber water supply and pumped drain outlet trains, each of which has its own pump.

HAZARDOUS CHEMICALS and MOVING PARTS warning labels are fitted to the Services Module, in the same locations as on the WRU: refer to Figure 2.

A8.1.2 Abatement system enclosure differences

When the system is supplied with a Services Module, a different type of acid water drain tank is fitted in the abatement system enclosure, and a high temperature switch is fitted to the cyclone in the enclosure.

Refer to Figure A11, which shows the drain tank for an abatement system with a Services Module:

- The tank has a recirculation pipe (2) which allows some of the acid waste water to be recirculated from the outlet pipeline and into the acid drain tank (see Section A8.1.6). When the level of waste water in the acid drain tank rises, the float valve in the recirculation pipe closes and no water can enter the tank.
- The tank has a drain valve (4), which allows acid waste water to be drained from the tank (see Section A8.6.2).

A8.1.3 Description of the Services Module

You must provide the following services for the Services Module:

- Fuel gas supply, for the combustor in the abatement system enclosure.
- Scrubber water supply, for the scrubber system in the abatement system enclosure.

The Services Module contains all of the devices necessary to regulate the pressures of the scrubber water and fuel gas services supplies, and to monitor supply pressures and flows. The Services Module has a water booster pump and a drain water pump, to pump the acid waste water from the system, to a maximum height of 5 metres, into your unpressurised acid drain outlet.

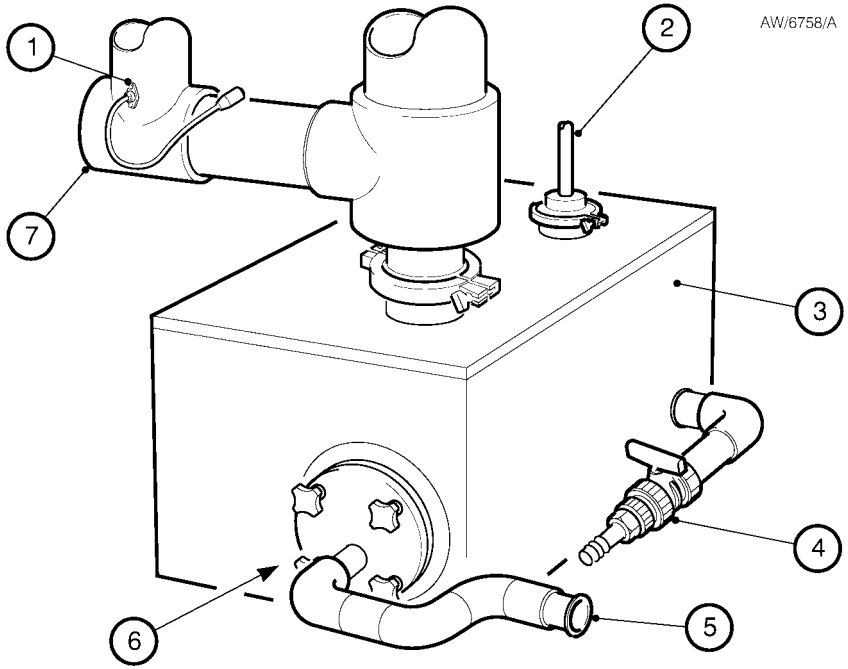
The scrubber water supply pipeline in the Services Module has a water filter with a manual backwash actuator. You must connect the backwash outlet to a suitable drain: refer to Section A8.3.9.

(continued on page 200)

The electrical supply and the nitrogen supply for the components in the Services Module are supplied from the abatement system enclosure.

You will connect the fuel gas and scrubber water supplies to the inlets on the rear of the Services Module (see Figure A17). The Services Module has flexible fuel gas and scrubber water outlet pipes which you will connect to the inlets on the system enclosure (refer to Section A8.3.4).

You will connect the Services Module pumped drain inlet and the recirculation pipe directly to the pumped drain outlet and the water recirculation inlet on the side of the abatement system enclosure: refer to Section A8.3.4.



1. Cyclone high temperature switch
2. Recirculation pipe
3. Acid water drain tank
4. Drain valve
5. Drain tank outlet
6. Filter (inside tank)
7. Cyclone

Figure A11 - Acid water drain tank for an abatement system with a Services Module

A8.1.4Scrubber water supply conditioning

Refer to Figure A12. Your scrubber water supply passes from the inlet through the isolation-valve [YV-507], then through the water booster pump [BP-521] to boost the pressure of the scrubber water supply to the abatement system enclosure.

A flow indicator [FI-522] indicates the scrubber water flow rate to the system enclosure. The isolation-valve [YV-507] automatically isolates the Services Module from your scrubber water supply when the abatement system shuts down, or when the system is disconnected from the electrical supply, or when the Services Module is electrically disconnected from the system enclosure.

The scrubber water supply pipeline incorporates a water filter [FR-525], which filters particulate from the scrubber water supply. A pressure regulator [PCV-526] allows you to control the pressure of the scrubber water supply to the abatement system enclosure. The water filter has two pressure gauges: one gauge [PI-524] shows the pressure of the scrubber water supply into the water filter, and the other gauge [PI-527] shows the regulated pressure of the scrubber water supply to the abatement system enclosure.

The manual backwash valve [HA-529] allows you to backwash the filter: refer to Section A8.5.5.

A8.1.5Fuel gas supply conditioning

Refer to Figure A12. The fuel gas passes from the inlet through the pressure regulator [PCV-224]. The fuel gas supply pipeline has two pressure gauges: one gauge [PI-223] indicates the pressure of the fuel gas supply to the Services Module, and the other gauge [PI-226] shows the regulated fuel gas supply to the system enclosure. A flow indicator [PI-225] indicates the flow rate of fuel gas to the abatement system enclosure.

A solenoid-valve [YV-222] isolates the fuel gas supply from the Services Module and from the system enclosure when the abatement system shuts down, or when the system is disconnected from the electrical supply, or when the Services Module is electrically disconnected from the system enclosure.

A8.1.6Pumped drain

Refer to Figure A12. The acid waste water from the abatement system enclosure passes through the inlet. The waste water drain pump [DP-623] pumps the waste water through the outlet to your waste water system.

Part of the acid waste water is recirculated through the manual recirculation isolation valve [YV-622] then through the outlet to the acid waste water tank in the abatement system enclosure. This recirculation keeps the tank partially filled with acid waste water, ensures that the waste water pump is primed, reduces the build-up of solids in the tank and in the waste water pipelines, and ensures that no gas escapes from the tank.

The acid drain isolation-valve [YV-624/HCV-624] automatically isolates the Services Module from your waste water pipeline when the abatement system shuts down, or when the system is disconnected from the electrical supply, or when the Services Module is electrically disconnected from the system enclosure.

(continued on page 202)

The drain valve [HCV-625] can be opened to allow the drainage of the waste water outlet pipelines for maintenance (for example, when the water drain is blocked).

Device abbreviations:

BP#	Booster pump
DP#	Drain pump
FI#	Flow indicator
FR#	Filter
FV#	Flow check valve
HA#	Hose adaptor
HCV#	Hand control valve
PCV#	Pressure control valve
PI#	Pressure indicator
WLD#	Water leak detector
YV#	Control valve

Legend:

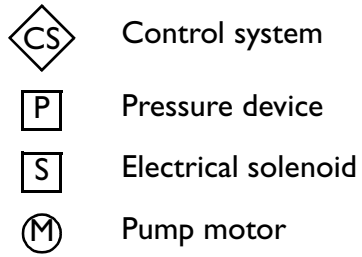


Figure A10 - Services Module piping and instrumentation diagram: key

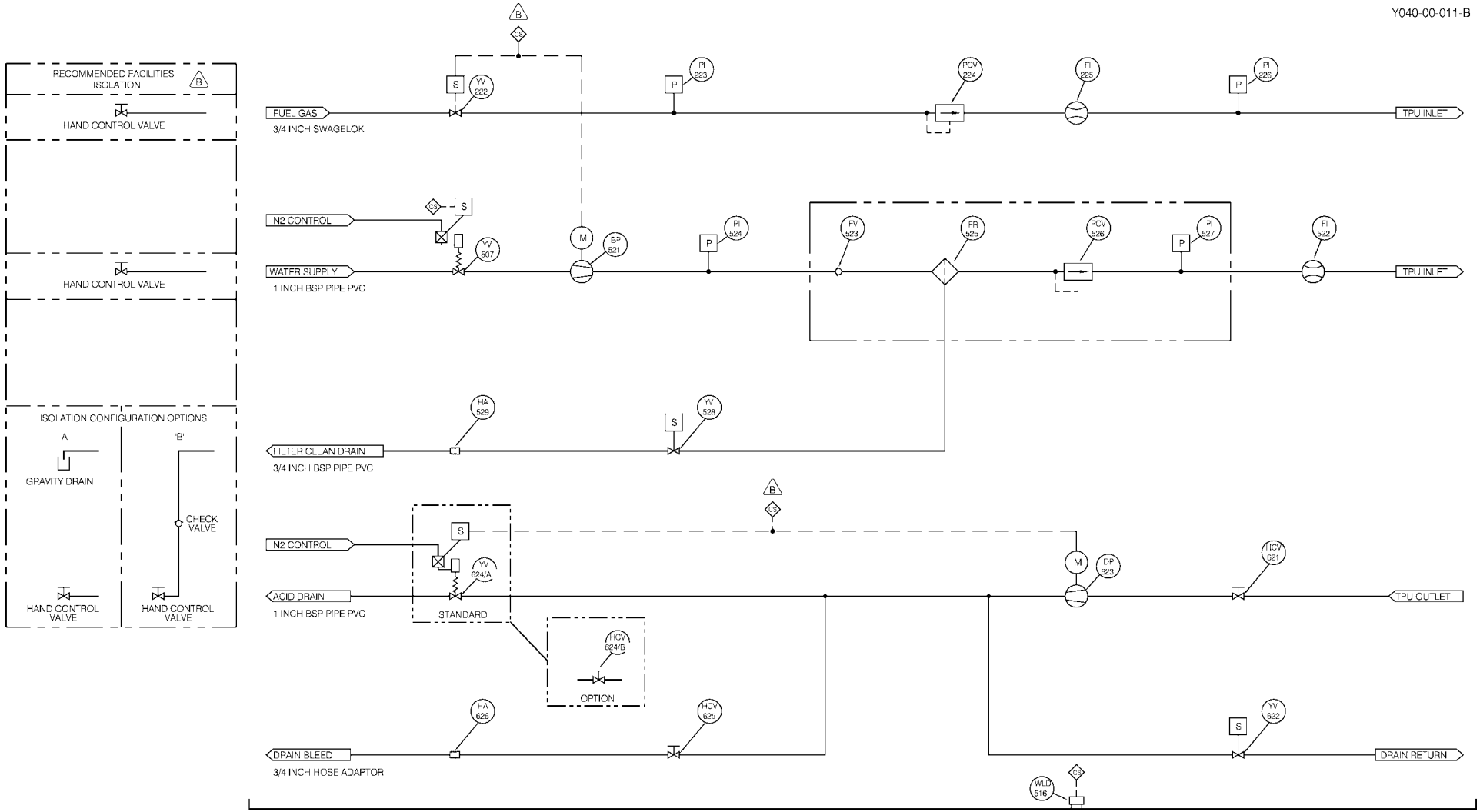


Figure A12 - Services Module piping and instrumentation diagram

A8.1.7Services Module controls and indicators

Refer to Figure A13. The Services Module has the following displays and controls:

Scrubber water supply pressure regulator (1)
Use this to regulate the pressure of the scrubber water supply to the abatement system enclosure.

Regulated fuel gas pressure gauge (2)
This gauge shows the regulated pressure of the fuel gas supply to the abatement system enclosure.

Manual backwash valve (3)
This valve must be open to allow you to backwash the water filter (either automatically or manually).

Fuel gas flowmeter (4)
This gauge shows the flow rate of the fuel gas supply to the abatement system enclosure.

Fuel gas supply pressure gauge (5)
This gauge shows the pressure of the fuel gas supply to the Services Module.

Scrubber water supply pressure gauge (6)
This gauge shows the pressure of the scrubber water supply to the Services Module.

Water drain pump isolation valve (9)
This valve allows you to isolate the Services Module from the waste water outlet in the abatement system enclosure.

Regulated water supply pressure gauge (11)
This gauge indicates the regulated pressure of the scrubber water supply to the abatement system enclosure.

Scrubber water supply flow-meter (12)
This gauge shows the flow rate of the scrubber water supply to the abatement system enclosure.

Refer to Figure A16.

Waste water drain valve (18)
Open this valve to drain the waste water outlet pipeline for maintenance or service purposes.

Water recirculation valve (17)
Use this valve to isolate the Services Module from the recirculation inlet on the abatement system enclosure.

8.1.8 Process interlocks and fault messages

Note that when you have a Services Module:

- The WRU interlocks (see Table 2) will not operate, and the corresponding fault messages (see Table 33) for the WRU interlocks will not be displayed.
- There is an additional interlock, as shown in Table A16 below.

Interlock	Tag	Setpoint	Fault level	Monitored by
Cyclone high temperature switch	TSH-602	50 °C	System alarm	PLC

Table A16 - Additional interlock for the Services Module

1. Scrubber water supply pressure regulator
2. Regulated fuel gas pressure gauge
3. Backwash valve
4. Fuel gas flowmeter
5. Fuel gas supply pressure gauge
6. Scrubber water supply pressure gauge
7. Water leak detector
8. Transparent plastic mounting plate
9. Water drain pump isolation valve
10. Water filter
11. Regulated scrubber water supply pressure gauge
12. Scrubber water supply flowmeter

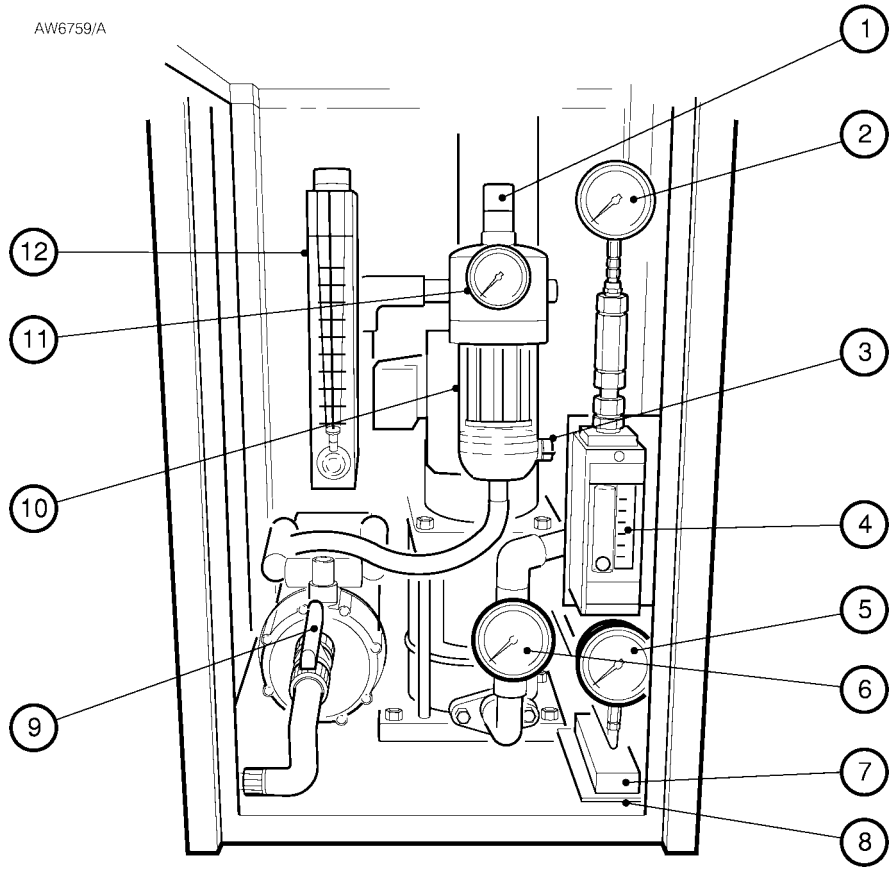


Figure A13 - Services Module controls and indicators

A8.2 Technical data

Note: Unless qualified in the following sections, the technical data in Section 2 of this manual also applies to an abatement system with a Services Module.

A8.2.1 Electrical data

	'E' model	'S' model	'J' model	'J' model
Electrical supply				
Voltage	230 V a.c.	120 V a.c.	100 V a.c.	100 V a.c.
Phases	1	1	1	1
Frequency	50 Hz	60 Hz	50 Hz	60 Hz
Full load current rating (abatement system with Services Module, without TMS ordering option)	8.6 A	18.8 A	12.5 A	12.5 A
Largest motor ampere rating (drain pump)	0.37 kW	0.55 kW	0.55 kW	0.55 kW

Table A17 - Services Module electrical data

A8.2.2 Mechanical data

Dimensions	See Figures A14 and A15
Mass	
Abatement system enclosure	410 kg
Services Module	96.5 kg

Table A18 - Services Module mechanical data

A8.2.3 Connections

	Size	Material
Scrubber water inlet	1 inch NB pipe	PVC
Acid waste water outlet	1 inch NB pipe	PVC
Backwash outlet	$^3/_4$ inch NB pipe	PVC

Table A19 - Services Module connections

A8.2.4Scrubber water supply and waste water drain

CAUTION
Your scrubber water supply must comply with the requirements specified below. If it does not, you will invalidate the warranty on your abatement system.

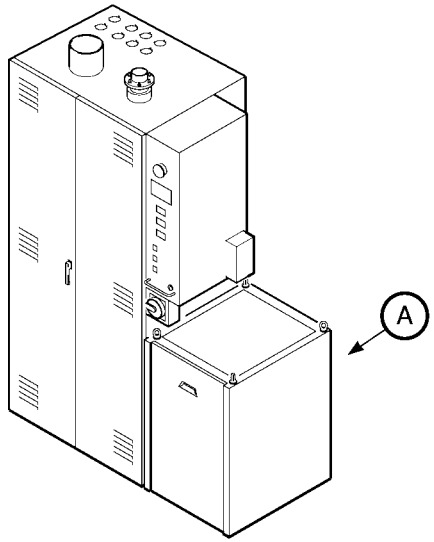
Note 1: Refer to Section 2.13 for the materials used in the water pipelines in the system enclosure. Contact your supplier or BOC Edwards if your scrubber water supply does not comply with the following specifications.

Note 2: The acid waste water drain must be connected to a non-pressurised outlet.

Scrubber water supply	
Minimum supply pressure	1.5 bar gauge, 2.5 x10^5 Pa, 22 psig
Maximum supply pressure	4.0 bar gauge, 5.0 x10^5 Pa, 58 psig
Maximum temperature	30 °C
Acidity (see Note 1 above)	5 to 8 pH
Flow rate during normal operation	23.5 l min^{-1}
Maximum particulate size	100 µm
Total solid content	< 100 ppm
Acid waste water drain (see Note 2 above)	
Maximum extraction rate	25 l min^{-1}
Acid waste water pumping head capability	7.5 psi
Water inlet/waste water outlet differential temperature	13 °C
Backwash drain flowrate	28 l min^{-1}

Table A20 - Services Module scrubber water supply and waste water drain

1. Scrubber water supply inlet
2. Acid waste water outlet
3. Fuel gas inlet
4. Backwash outlet



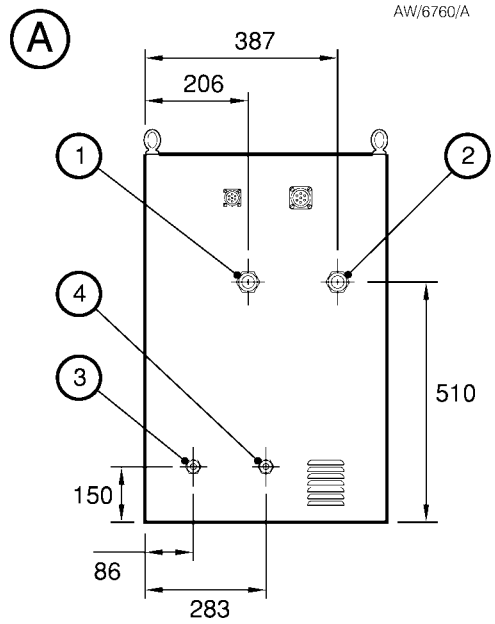
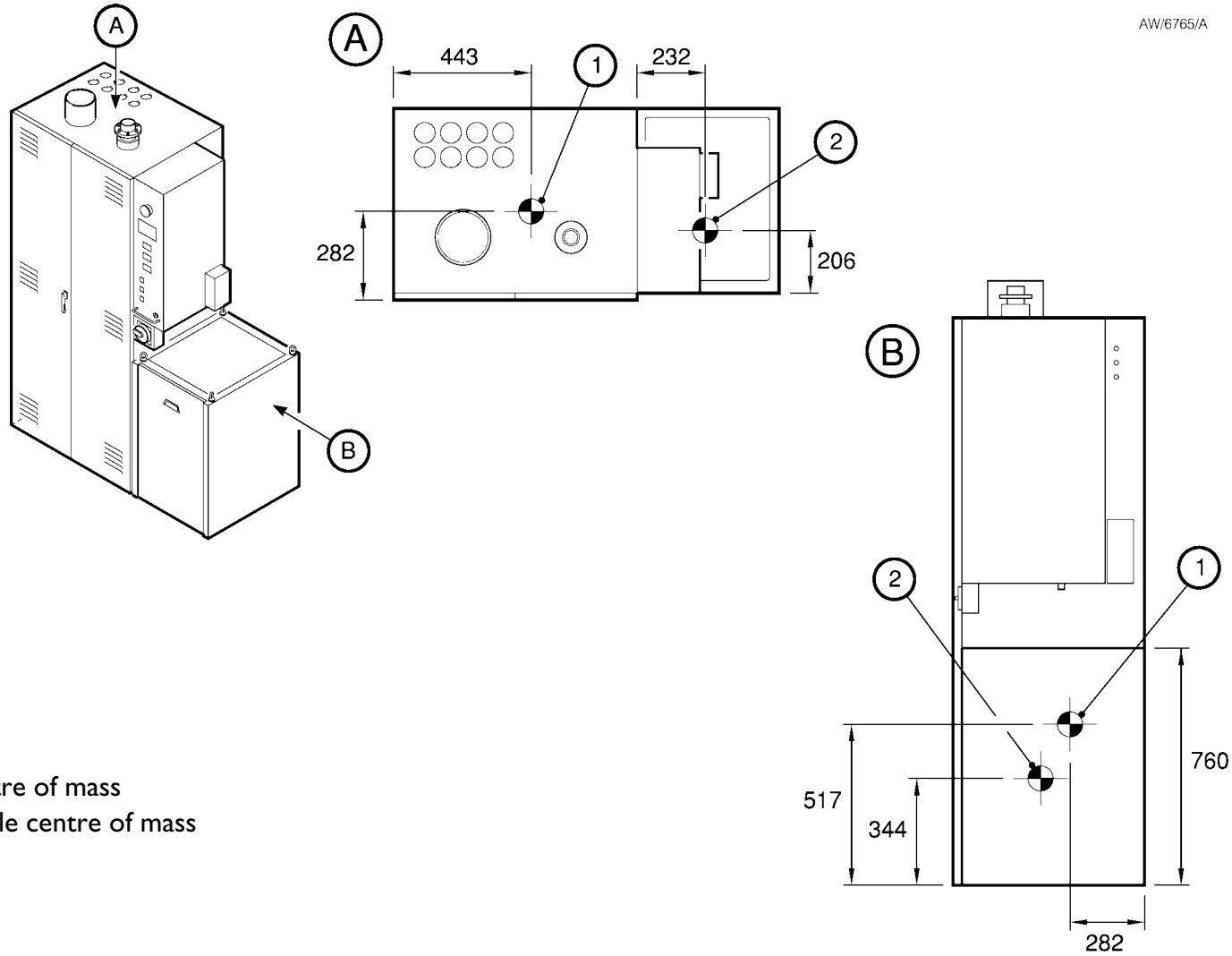


Figure A14 - Services Module connection dimensions (mm)



1. Enclosure centre of mass
2. Services Module centre of mass

Figure A15 - Services Module centre of mass

A8.3 Installation requirements

WARNING

When you refer to a section in the main part of this manual, you must obey the appropriate warnings and cautions given in the section.

A8.3.1 Order of installation

If the you have ordered the abatement system with the Services Module option, you must install the system and Services Module as described in Section 3 of this manual, however note the following:

- Instead of the procedure in Section 3.6, use the procedure in Section A8.3.2 to unpack and inspect the Services Module.
- Instead of the procedure in Section 3.8, use the procedure in Section A8.3.3 to locate the Services Module and fit the water leak detector.
- Instead of the procedure in Section 3.9, use the procedure in Section A8.3.4 to connect the Services Module to the abatement system enclosure.
- Instead of the procedure in Section 3.18, use the procedure in Section A8.3.5 to connect to your acid water drain system.
- Instead of the procedure in Section 3.21, use the procedure in Section A8.3.6 to connect the fuel gas supply to the Services Module.
- Instead of the procedure in Section 3.22, use the procedure in Section A8.3.7 to connect the scrubber water supply.
- The procedure in Section 3.23 (connect the cooling-water supply and return pipelines) is not applicable to a system with a Services Module.
- Before you make the electrical connections to the interface module (in Section 3.25), connect the Services Module backwash outlet as described in Section A8.3.9.
- When you make the electrical connections to the interface module (in Section 3.25), note that the PFC interface signals are not applicable to a TCS system with a Services Module.
- Instead of the procedure in Section 3.26, use the procedure in Section A8.3.8 to connect the electrical supply to the system.

A8.3.2 Unpack and inspect the Services Module

The procedure to unpack and inspect the Services Module is as described in Section 3.6, however you must refer to Table A21 instead of Table 23.

Quantity	Description	Refer to Section	Check (✓)
1	Services Module	A8.3.3	❑
2	NW25 trapped 'O' rings	A8.3.4	❑
2	NW25 clamping rings	A8.3.4	❑
1	Pumps electrical cable	A8.3.4	❑
1	'C' spanner (to remove the water filter housing)	A8.5.6	❑
1	Fittings kit	A8.3.3	❑

Table A21 - Checklist of Services Module items

A8.3.3 Locate the Services Module and fit the water leak detector

WARNING

Use suitable lifting equipment to move the Services Module. Refer to Section A8.2.2 for the mass of the Services Module.

WARNING

Ensure that you correctly bolt the Services Module to the system enclosure. If you do not, the gas and other connections may be stressed, and may leak.

1. Refer to Figure A16, detail A. Undo the four catches (8) which secure the transparent cover (7) to the Services Module, then use the handle (9) to lift off the transparent cover.
2. Attach suitable lifting equipment to the lifting-bolts (4) on the top of the Services Module and move the Services Module into its operating location, next to the abatement system enclosure.
3. From inside the abatement system enclosure, fit the three bolts (10, supplied in the fittings kit) to secure the Services Module to the enclosure.
4. Remove all packing materials from the Services Module water leak detector (supplied in the system enclosure).
5. Pass the water leak detector through the cabinet extract leadthrough hole (6) in the side of the abatement system enclosure and into the Services Module.
6. Refer to Figure A13. Pass the water leak detector (7) under the pipeline connected to the water drain pump isolation valve (9), towards its operating position on the transparent plastic mounting plate (8).
7. Peel off the backing paper from the double-sided adhesive tape on the base of the water leak detector (7), then use the tape to secure the base of the detector to the mounting plate (8).

A8.3.4 Connect the Services Module to the system enclosure

WARNING

The electrical supplies for the Services Module are supplied from the system enclosure. Do not connect external electrical supplies to the Services Module. If you do, you may damage the system enclosure or the Services Module, and the system will not operate correctly.

Use the following procedure to connect the Services Module to the abatement system enclosure. Refer to Figure A17 for the locations of the services connection leadthroughs on the system enclosure.

1. Refer to Figure A16. Pass the fuel gas connector (12) through the fuel gas pipe leadthrough hole (Figure A17, item 6) and connect it to the fuel gas inlet on the abatement system fuel gas multiblock, which is in-line with the fuel gas leadthrough hole.

(continued on page 212)

2. If fitted, remove the blanking cap and clamp from the water drain inlet connector (21) and from the waste water drain tank outlet (Figure A17, item 4) on the abatement system enclosure
3. Fit the water drain inlet connector (21) to the waste water drain tank outlet.
4. Remove the blanking cap and clamp (if fitted) from the scrubber water supply connector (14), then pass the connector through the water supply leadthrough hole (Figure A17, item 7)
5. Remove the blanking cap and clamp (if fitted) from the scrubber water supply inlet in the abatement system enclosure, then fit the water supply connector (14) to the scrubber water supply inlet.
6. Remove the blanking cap and clamp (if fitted) from the water recirculation connector (16), then pass the connector through the water recirculation leadthrough hole (Figure A17, item 13).
7. Remove the blanking cap and clamp (if fitted) from the water recirculation inlet in the abatement system enclosure, then fit the water recirculation connector (16) to the water recirculation inlet.
8. Refer to Figure A17. Fit the two connectors on the pumps cable to the water booster pump and water drain pump electrical connectors under the control unit (4 and 5); note that the connectors on the cable are keyed, so they cannot be fitted to the wrong connectors.
9. Fit the single connector (labelled CON1) on the pumps cable to connector CON1 (16) on the rear of the Services Module.
10. Refer to Figure A16. Fit the end of pneumatic pipe YV507 (13) to the nitrogen supply connector YV507 (Figure A17, item 8) on the side of the system enclosure.
11. Fit the end of pneumatic pipe YV622 (15) to the nitrogen supply connector YV622 (Figure A17, item 9) on the side of the system enclosure.
12. Ensure that the waste water drain valve (18) is in the closed position (that is, at a right-angle to the pipe).
13. Ensure that the water drain pump isolation valve (20) is open (that is, in-line with the pipe).
14. Ensure that the water recirculation valve (17) is open (that is, in-line with the pipe).
15. Ensure that the backwash valve (Figure A13, item 3) is closed (that is, at right-angles to the pipe).
16. Refit the transparent cover (7) to the Services Module and engage the catches (8) to secure the cover in place.

A8.3.5 Connect to your acid water drain system

Connect to your acid water drain system as described in Section 3.18, however note that:

- The acid waste water outlet (Figure A17, item 17) is on the rear of the Services Module.
- You will not need to incorporate elbows in the acid drain pipeline if the interface module is fitted to the rear of the control unit.

1. Abatement system enclosure door
2. Bolts (4 off)
3. Top cover
4. Lifting-bolts
5. Services Module
6. Cabinet extract leadthrough hole
7. Transparent cover
8. Catches (4 off)
9. Handle
10. Bolts (3 off)
11. Water drain isolation-valve
12. Fuel gas connector
13. Pneumatic pipe (YV507)
14. Scrubber water supply connector
15. Pneumatic pipe (YV622)
16. Water recirculation connector
17. Water recirculation valve
18. Waste water drain valve *
19. Water drain pump
20. Water drain pump isolation valve
21. Water drain pump inlet

* For servicing purposes only

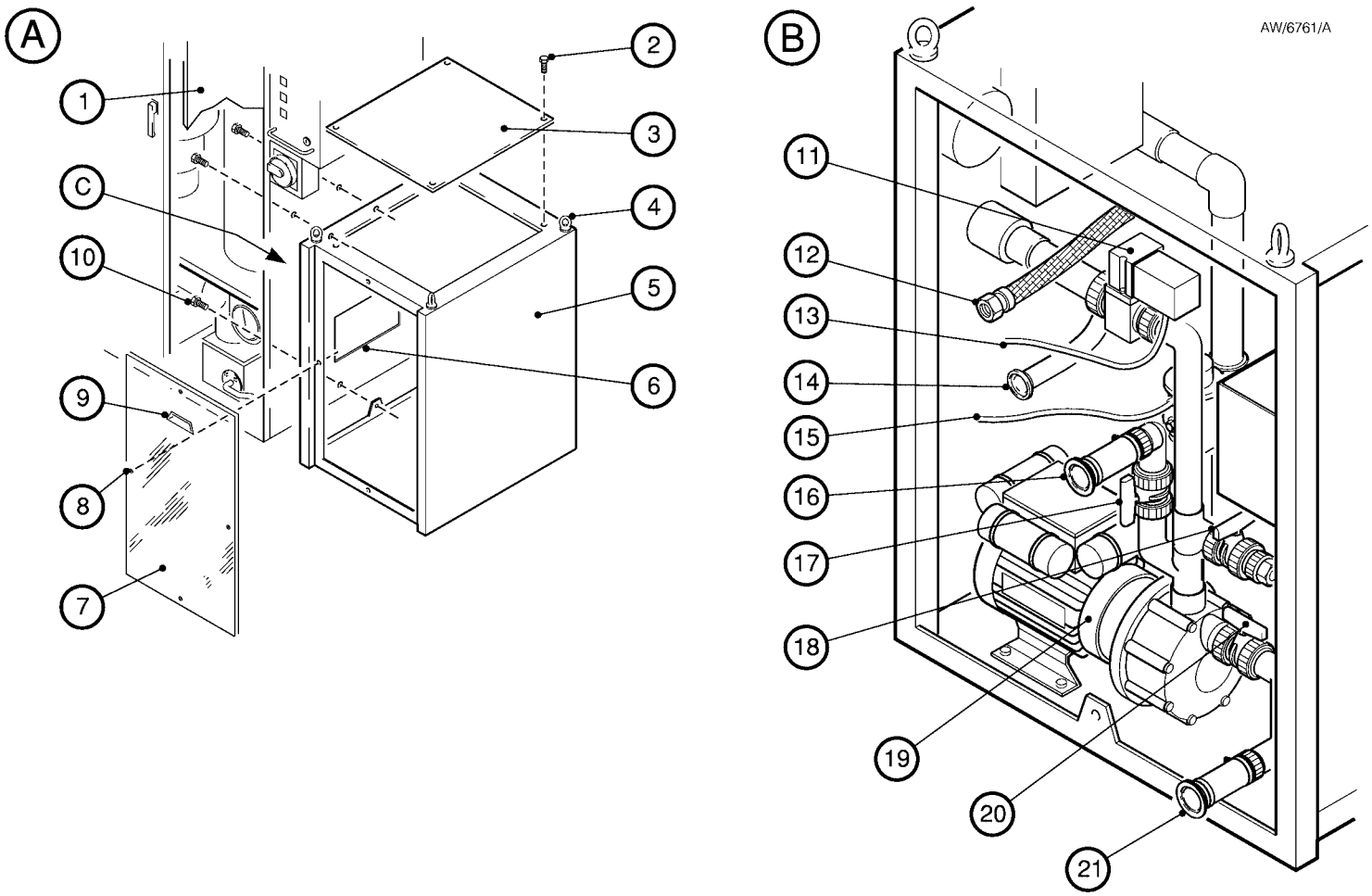


Figure A16 - Fit the Services Module to the abatement system enclosure

A8.3.6 Connect the fuel gas supply

Connect the fuel gas supply as described in Section 3.21, however note that the fuel gas inlet (Figure A17, item 18) is on the rear of the Services Module.

A8.3.7 Connect the scrubber water supply

CAUTION

Ensure that your scrubber water supply does not contain debris (with any dimension larger than 100 µm). Debris in the scrubber water can damage the system or cause the system to fail.

Connect your scrubber water supply to the inlet on the rear of the Services Module (Figure A17, item 20). Ensure that your scrubber water supply cannot be interrupted during system operation.

We recommend that:

- You incorporate an isolation valve in your scrubber water supply pipeline, so that you can switch off the supply.
- You incorporate a filter in your scrubber water supply pipeline, to prevent the entry of debris in the water supply into the system.

A8.3.8 Connect the electrical supply

Connect the electrical supply to the system as described in Section 3.26.3, or in Section 3.26.5 however note that if your system has a 'standard' electrical supply isolator, the cable-gland may be located either on the rear of the electrical supply isolator (as described in Section 3.26.3) or under the electrical supply isolator.

A8.3.9 Connect the backwash outlet

CAUTION

Only connect the backwash outlet to the acid waste water drain if the direction of backwash flow is the same as that of the acid waste water. Otherwise the backwash or acid waste water flow may be restricted.

Connect a suitable backwash waste pipe between the backwash outlet on the rear of the Services Module (Figure A17, item 19) and a suitable drain.

Only connect the backwash waste pipe to the acid waste water drain if the direction of flow of the backwash water is the same as the direction of flow of the acid waste water. If the directions of flow are opposed, one or both of the flows will be restricted, and the backwash or acid waste water will not flow correctly out of the system.

Incorporate a check-valve in the backwash waste pipe, to prevent the back-flow of waste water into the water filter in the Services Module.

A8.4 Operation

A8.4.1 Start-up

Note: You do not need to prime the Services Module.

To start up the system, switch on as described in Section 4.1. When you turn the start/stop switch to the start position, the PLC automatically starts up the abatement system.

(continued on page 216)

1. Pneumatics nitrogen inlet
2. Oxygen inlet†
3. Purge nitrogen inlet
4. Water drain pump electrical supply connector
5. Scrubber water supply booster pump electrical supply connector *
6. Fuel gas pipe leadthrough hole
7. Water supply leadthrough hole
8. Nitrogen supply connector (YV507)
9. Nitrogen supply connector (YV622)
10. Not used
11. Cabinet extract leadthrough hole
12. Drain tank outlet leadthrough hole
13. Water recirculation leadthrough
14. Not used
15. Not used
16. Pumps connector
17. Acid waste water outlet
18. Fuel gas inlet
19. Backwash outlet
20. Scrubber water supply inlet

† TPU or Kronis only
* Behind item 4

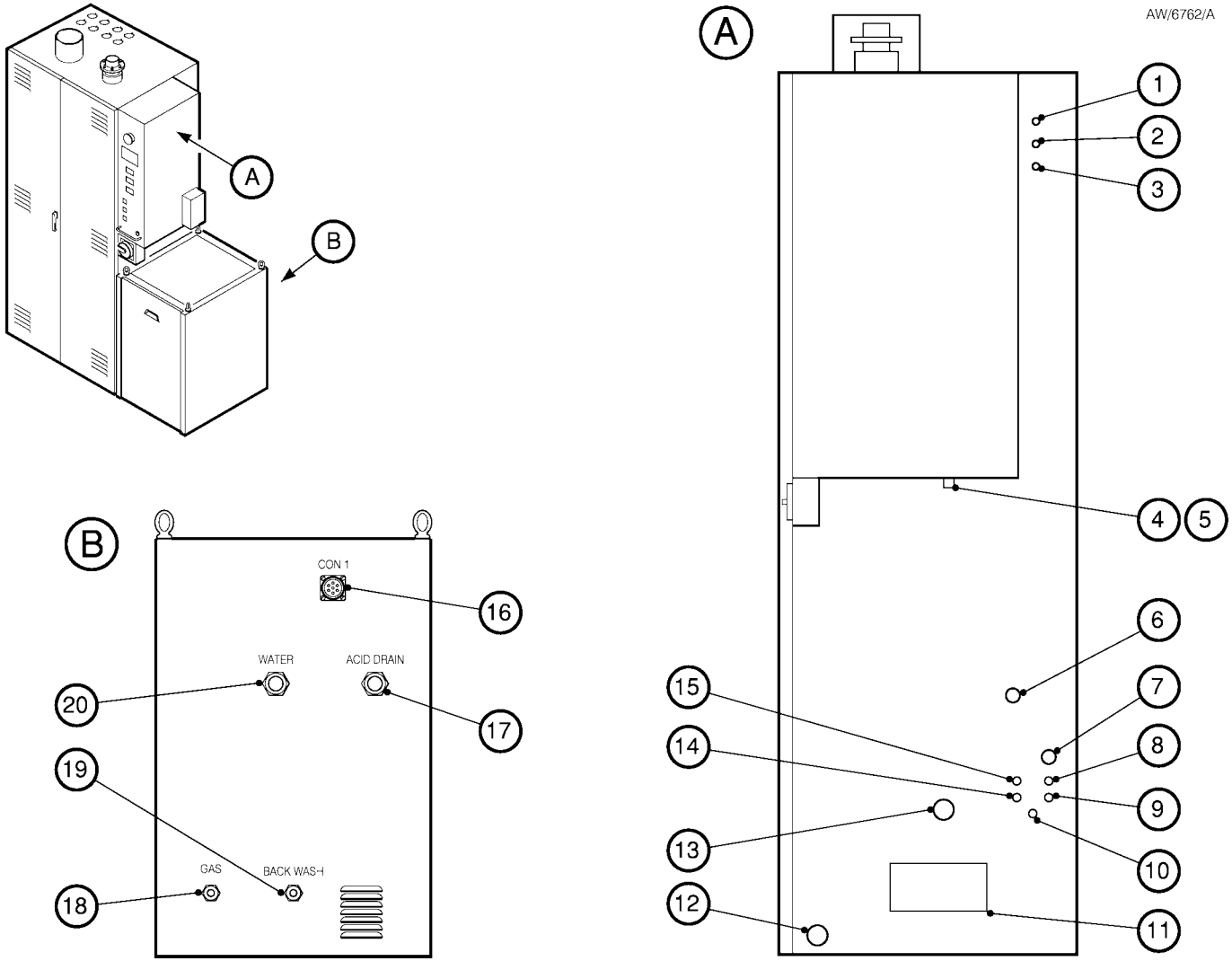


Figure A17 - Services Module service connections and leadthroughs on the abatement system enclosure

For a system with a Services Module, the sequence of automatic start-up operations is as described in Section 4.1.3, except that:

- You should ignore references to the operation of components in the WRU.
- The water drain pump in the Services Module is switched on after an elapsed time of 10 seconds.
- The water booster pump in the Services Module is switched on after an elapsed time of 16 seconds.

A8.4.2 Monitor the services pressures and flow rate

Monitor the services pressures and flow rates as described in Section 4.3, but use Steps 1 and 2 below instead of Steps 1 and 2 in Section 4.3.

1. Refer to Figure A13. During operation, regularly look at the water supply inlet and filter outlet pressure gauges (6, 11) to monitor the scrubber water supply pressure and flow rate:
   - If the pressure shown on the inlet pressure gauge (6) is as specified in Section 2, but the pressure shown on the outlet pressure gauge (11) is less than 4 bar, adjust the pressure regulator (1).
   - If there is a high pressure differential between the two gauges, you may need to backwash the filter: refer to Section A8.5.5.
2. During operation, regularly look at the fuel gas inlet and regulated pressure gauges (5, 2) and the flowmeter (4) to monitor the fuel gas pressure and flow rate. If the pressure and flow rate are too low or too high, contact your supplier or BOC Edwards for advice.

A8.4.3 Manual shut-down

Manually shut down the abatement system as described in Sections 4.4.1 and 4.4.2.

For a system with a Services Module, the sequence of manual shut-down operations is as described in Section 4.4.2, except that:

- You should ignore references to the operation of components in the WRU.
- The water drain pump and the water booster pump in the Services Module are switched off after an elapsed time of 16 seconds.

A8.4.4 Standby mode shut-down operations

If a system with a Services Module enters standby mode as described in Section 4.5, the sequence of standby mode shut-down operations is as described in Section 4.5, except that:

- You should ignore references to the operation of components in the WRU.
- The water drain pump and the water booster pump in the Services Module are switched off after an elapsed time of 216 seconds.

A8.4.5 Emergency shut-down

In an emergency, shut down the abatement system as described in Section 4.6.

Note that for a system with a Services Module, the emergency shutdown sequence is the same as the manual shut-down sequence: refer to Section A8.4.3.

A8.5 Maintenance requirements

A8.5.1Safety

WARNING

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

- A suitably trained and supervised technician must maintain the Services Module.
- Obey all of the safety instructions given in Section 5 of this manual when you maintain the Services Module.

A8.5.2Maintenance plan

When your system has a Services Module, maintain the system in accordance with the plan shown in Table A22.

Maintenance operation	Frequency	Refer to Section
Inspect the services pipelines and connections	Weekly	A8.5.3
Inspect the abatement system pipelines and connections	Weekly	5.4
Inspect the cyclone scrubber	Weekly	5.5
Inspect the Services Module pipelines and connections	Weekly	A8.5.4
Inspect the condition of the water filter and backwash if necessary	Weekly	A8.5.5
Inspect the abatement system inlet, bypass and exhaust pipelines and connections	Weekly	5.7
Replace a fuse	When necessary	5.8
Reset a circuit breaker	When necessary	5.9

Table A22 - Services Module maintenance plan

A8.5.3 Inspect the services pipelines and connections

WARNING

A suitably trained and registered technician must maintain the fuel gas pipelines.

WARNING

Ensure that you wear the correct personal protective equipment when you maintain the acid waste water pipelines: refer to Section 5.1.3.

Note: Where possible, we recommend that you investigate the cause of any damage or corrosion, and implement corrective measures to prevent any future damage of components.

1. Inspect all of your scrubber water supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
2. Refer to Figure A13. Look at the scrubber water supply pressure gauge (6) and check that the scrubber water supply pressure to the Services Module is correct; adjust the scrubber water supply if necessary.
3. Inspect all of your nitrogen supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
4. Check that the nitrogen supply pressure to the system is correct and adjust if necessary.
5. On TPU or Kronis systems: Inspect all of your oxygen supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
6. On TPU or Kronis systems: Check that the oxygen supply pressure to the abatement system is correct and adjust if necessary.
7. Inspect all of your fuel gas supply pipelines and connections and check that they are not damaged or corroded and that they do not leak. Ensure that any damaged or corroded component is repaired or replaced, and ensure that any leak found is sealed.
8. Look at the fuel gas supply pressure gauge (5) and check that the fuel gas supply pressure is correct; adjust the pressure if necessary.
9. Inspect your cabinet-extraction system and check that it provides the required extraction flow rate.
10. Inspect the acid waste water and backwash outlet pipelines and check that they are not damaged or corroded and that they do not leak. Repair or replace any damaged or corroded component and seal any leak found.
11. Inspect all of your electrical cables to the abatement system and check that they are not damaged and have not overheated. Repair or replace any damaged or overheated cable.

A8.5.4 Inspect the Services Module pipelines and connections

WARNING

A suitably trained and registered technician must maintain the fuel gas pipelines.

WARNING

Ensure that you wear the correct personal protective equipment when you maintain the acid waste water pipelines: refer to Section 5.1.3.

Use the following procedure to inspect the Services Module pipelines and connections. If any damaged or corroded component is found, or if a leak is found, contact your supplier or BOC Edwards to arrange an inspection and repair of the Services Module; do not use the system to treat process gases until the Services Module has been inspected and repaired.

1. Refer to Figure A16. Undo the four catches (8), then use the handle (9) to remove the transparent cover (7) from the Services Module.
2. Inspect the scrubber water supply pipelines and connections in the Services Module and check that they are not damaged or corroded and that they do not leak.
3. Inspect the acid water drain pipelines and connections in the Services Module and check that they are not damaged or corroded and that they do not leak.
4. Inspect the fuel gas supply pipelines and connections in the Services Module and check that they are not damaged or corroded and that they do not leak.
5. Inspect the electrical cables in the Services Module and check that they are not damaged and have not overheated.
6. Inspect the nitrogen pipe (from the system enclosure to the water inlet isolation-valve in the Services Module) and check that it is not damaged and that it does not leak.
7. Refit the transparent cover (7) to the Services Module and secure with the four catches (8).

A8.5.5 Inspect the condition of the water filter and backwash if necessary

WARNING

Ensure that you wear the correct personal protective equipment when you inspect the condition of the water filter: refer to Section 5.1.3.

Note: A 'PSL 501 LOW WATER PRESSURE FAULT' condition will occur when the backwash valve is open.

1. Use the following procedure to inspect the condition of the water filter, and to backwash it if necessary:
2. Refer to Figure A13. Look at the regulated scrubber water pressure gauge (11). If the pressure shown on the scrubber water supply pressure gauge (6) is as specified in Section 2, but the pressure shown on the regulated scrubber water pressure gauge (11) is less than 3.5 bar, continue at Step 3 to backwash the water filter.

3. Refer to Figure A16. Undo the four catches (8), then use the handle (9) to remove the transparent cover (7) from the Services Module.
4. Refer to Figure A13. Open the backwash valve (3) (that is, turn the valve so that the indicator bar on the valve is in-line with the pipe).
5. Wait 15 seconds or more, then close the backwash valve (3) (that is, turn it so that the indicator bar on the valve is at right-angles to the pipe).
6. Refer to Figure A16. Refit the transparent cover (7) to the Services Module, then engage the four catches (8) to secure the cover in place.

A8.5.6 Fault finding

Fault finding is generally as described in Section 5.14, however the applicability of some of the fault messages differs for a system with a Services Module: refer to Table A23.

Fault message	Applicability to an abatement system with a Services Module
BYPASS LOCKOUT	As in Table 33.
EMERGENCY STOP CHECK TPU BEFORE RESET OF EMS	As in Table 33.
FLAME CONTROLLER HAS TRIGGERED A FLAME FAILURE ALARM SIGNAL	As in Table 33, except that all references to "WRU" should be to "Services Module.
FMS CONTROLLER FAIL TO START UP	As in Table 33.
FSL 511 QUENCH WATER FLOW FAULT	As in Table 33, except that: • All references to "WRU" should be to "Services Module". • The "Has the make-up water supply failed ?" check and its associated actions should refer to "scrubber water supply" instead of "make-up water supply". • Actions for the "Is the water filter blocked ?" check, should read as follows: If the pressure of the external scrubber water supply is correct, but the internal scrubber water pressure is low, the water filter in the Services Module may need to be cleaned or replaced: contact your supplier or BOC Edwards. • The "Has the WRU water booster/drain pump failed ?" check and its associated actions only apply to the water booster pump in the Services Module, not to the water drain pump.

Table A23 - Status display fault message applicability for abatement systems with a Services Module (sheet 1 of 5)

Fault message	Applicability to an abatement system with a Services Module
FSL 604 PACKED TOWER WATER FLOW FAULT	As in Table 33, except that: • All references to "WRU" should be to "Services Module". • The "Has the make-up water supply failed ?" check and its associated actions should refer to "scrubber water supply" instead of "make-up water supply". • Actions for the "Is the water filter blocked ?" check, should read as follows: If the pressure of the external scrubber water supply is correct, but the internal scrubber water pressure is low, the water filter in the Services Module may need to be cleaned or replaced: contact your supplier or BOC Edwards. • The "Has the WRU water booster/drain pump failed ?" check and its associated actions only apply to the water booster pump in the Services Module, not to the water drain pump.
GAS SENSOR ALARM	As in Table 33.
LSH 601 DRAIN WATER LEVEL ALARM	As in Table 33, except that: • All references to "WRU" should be to "Services Module". • All references to "water booster/ drain pump" should be to "water drain pump".
LSH 609 SWITCH FAULT OR CONNECTION ERROR	Does not apply to an abatement system with a Services Module.
LSL 610 SWITCH FAULT OR CONNECTION ERROR	Does not apply to an abatement system with a Services Module.

Table A23 - Status display fault message applicability for abatement systems with a Services Module (sheet 2 of 5)

Fault message	Applicability to an abatement system with a Services Module
PISH 401 PLENUM GAS PRESSURE ALARM	As in Table 33.
PSH 703 OXYGEN PRESSURE WARNING	As in Table 33.
PSL 120 LOW NITROGEN PRESSURE FAULT	As in Table 33.
PSL 501 LOW WATER PRESSURE FAULT	As in Table 33, except that: • All references to "make-up water supply" should be to "scrubber water supply". • All references to "water booster/drain pump" should be to "water drain pump". • The actions for the "Is the water filter blocked ?" check should read as follows: If pressure gauge [PI-204] shows a pressure higher than 4 bar, and pressure gauge [PI-207] shows a pressure less than 3.5 bar, the water filter may be blocked. Manually actuate backwash (refer to Section A8.5.5) to remove any debris from the element in the filter.
REMOTE ALARM	As in Table 33.
TCH 405 PLENUM BURNER TEMPERATURE ALARM	As in Table 33.

Table A23 - Status display fault message applicability for abatement systems with a Services Module (sheet 3 of 5)

Fault message	Applicability to an abatement system with a Services Module	
TCH 406 COMBUSTOR OVER TEMPERATURE	As in Table 33.	
TCH 406 COMBUSTOR UNABLE TO REACH RUNNING TEMPERATURE	As in Table 33.	
TCH 509 QUENCH ZONE OVER TEMPERATURE	As in Table 33, except that, all references to "make-up water supply" should be to "scrubber water supply".	
TSH 505 TRANSITION TEMPERATURE ALARM	As in Table 33, except that, all references to "make-up water supply" should be to "scrubber water supply".	
TSH 602 CYCLONE TEMPERATURE ALARM	**Check**	**Actions**
	Has the scrubber water supply failed ?	Ensure that the scrubber water supply is switched on and that its pressure and temperature are as specified in Section A8.2.4.
	Has the weir/quench failed ?	Inspect the weir/quench and check that no water leaks from it. If there is a leak, contact your supplier or BOC Edwards.

Table A23 - Status display fault message applicability for abatement systems with a Services Module (sheet 4 of 5)

Fault message	Applicability to an abatement system with a Services Module	
TSH 602 CYCLONE TEMPERATURE ALARM (continued)	**Check**	**Actions**
	Is the temperature snap-switch disconnected or has it failed ?	If the above checks fail to identify the cause of the fault, the cyclone scrubber temperature snap-switch [TSH-602] may be disconnected, or it may have failed: contact your supplier or BOC Edwards.
TSH 603 INLET HEAD TEMPERATURE ALARM	As in Table 33.	
TSH 612 WATER TEMPERATURE ALARM	Not applicable to an abatement system with a Services Module.	
WARNING ACID DRAIN FAIL	Not applicable to an abatement system with a Services Module.	
WARNING WATER IN LOW	Not applicable to an abatement system with a Services Module.	
WATER LEAK DETECTOR ALARM	As in Table 33, except that all references to "WRU" should be to "Services Module".	

Table A23 - Status display fault message applicability for abatement systems with a Services Module (sheet 5 of 5)

A8.6 Storage and disposal

A8.6.1 Prepare the system

Prepare the system as in Section 6.1.1, but note that in Step 2, you will only switch off and disconnect the fuel gas, nitrogen, oxygen (if applicable), and scrubber water supplies.

A8.6.2 Disconnect the acid waste water pipeline and drain the abatement system (if necessary)

WARNING

Ensure that you wear the correct personal protective equipment when you disconnect the acid waste water pipeline (and drain the system): refer to Section 5.1.3.

CAUTION

Ensure that all scrubber water and acid waste water is drained from the system and the Services Module if you store the equipment in an area where the ambient temperature can fall close to 0 °C or below. If you do not, the system or Services Module can be damaged if the water freezes in the equipment.

1. Refer to Figure A17. Disconnect the acid waste water pipeline and the backwash outlet pipeline from the outlets (17, 19) on the rear of the Services Module.
2. If necessary (that is, if you want to store the equipment in an area where the ambient temperature can fall close to 0 °C or below), drain the scrubber water and acid waste water from the abatement system.

   To drain the waste water from the acid water drain tank:

   - Refer to Figure A11, detail A. Attach a suitable pump or other extraction mechanism to the outlet of the drain/sample valve (4) on the acid waste water drain tank (3).
   - Open the drain/sample valve (4) (so that the valve handle is in-line with the pipeline in which it is fitted) and drain the waste water from the tank.
   - Close the drain/sample valve (4) (so that the valve handle is at right-angles to the pipeline in which it is fitted), then disconnect your pump or other mechanism from the valve outlet.
3. Safely dispose of the acid waste water: refer to Section 6.2.

A8.6.3 Move the abatement system to the storage area (if required)

WARNING

Use suitable lifting equipment to move the abatement system enclosure and the Services Module: refer to Section A8.2.2 for the mass of the equipment.

CAUTION

Use suitable lifting equipment and a lifting frame to move the abatement system enclosure. If you do not, you can damage the system.

1. Refer to Figure A17. Disconnect the pumps cable from the two connectors (4, 5) under the control unit, and from the single connector (16) on the rear of the Services Module.
2. Refer to Figure A16. Undo the four catches (8), then use the handle (9) to remove the transparent cover (7) from the Services Module.
3. Disconnect the Services Module fuel gas connector (12) from the fuel gas inlet in the abatement system enclosure.
4. Disconnect the Services Module water drain connector (21) from the acid waste water tank outlet in the abatement system enclosure.
5. Disconnect the Services Module scrubber water supply connector (14) from the scrubber water supply inlet in the abatement system enclosure. Disconnect the Services Module water recirculation connector (16) from the recirculation connector in the enclosure.
6. Refit the transparent cover (7) to the Services Module and secure it with the four catches (8).
7. Remove the three bolts (10) which secure the Services Module to the abatement system enclosure.
8. Refer to Figure A13. Detach the Services Module leak detector (7) from the plastic mounting plate (8), then pass the leak detector and its cable through the cabinet extract leadthrough hole (Figure A16, item 11) and into the abatement system enclosure.
9. Refer to Figure A16. Attach suitable lifting equipment to the lifting bolts (4) on the top of the Services Module and move the Services Module to the storage area.
10. Refer to Figure 10. Attach suitable lifting equipment to a lifting frame (2) to distribute the load, and connect the lifting frame to the lifting bolts (1) on the top of the abatement system enclosure, as shown in detail B. Do not attach the lifting equipment directly to the lifting bolts (as shown in detail A), as you may damage the enclosure when you move it. Move the abatement system enclosure to the storage area.

A8.6.4 Store the abatement system

1. Fit blanking plates to all inlets and outlets.
2. Place protective covers over the services connection points.
3. Store the system in clean, dry conditions until required.
4. When required for use, prepare and install the system as described in Section 3.

A8.7 Spares

The additional spares for the Services Module are listed in Table A24; refer to Section 7.3 for the definition of essential and recommended spares types.

A8.8 Acid waste water drain tank filter (2.5 mm) accessory

Note: This accessory is fitted as standard to Kronis systems with a Services Module.

When fitted to the acid waste water drain tank, this filter prevents the egress of solids out of the tank and into the Services Module (and your waste water pipelines).

Accessory	Item Number
Acid waste water drain tank filter (2.5 mm)	A554-01-003

Spare	Item Number	Type
Services Module consumables kit: 'E' model	A554-C0-100	Consumable
Services Module consumables kit: 'S' and 'J' models	A554-C0-200	Consumable
Services Module essential spares kit: 'E' model	A554-E0-100	Essential
Services Module essential spares kit: 'S' and 'J' models	A554-E0-200	Essential
Acid waste water drain pump: 'E' model	A554-01-058	Recommended
Acid waste water drain pump: 'S' and 'J' models	Y042-10-170	Recommended
Acid waste water drain pump head repair kit	A554-20-014	Recommended
Acid waste water drain pump Viton seal rebuild kit	A554-20-016	Recommended
Scrubber water booster pump: 'J' model (50 Hz)	A554-03-003	Recommended
Scrubber water booster pump: 'J' model (60 Hz)	A554-20-013	Recommended
Scrubber water booster pump: 'S' model	A554-02-004	Recommended
Scrubber water booster pump: 'E' model	A554-01-059	Recommended
Gas regulator kit	Y042-10-088	Recommended
Water filter element: 100 micron	A554-20-011	Recommended
Acid waster water drain tank, without filter	A554-01-002	Recommended
Acid waster water drain tank, with filter	A554-01-001	Recommended
Acid waster water drain tank filter	A554-01-003	Recommended
Acid drain pump diffuser	A554-02-010	Recommended
Acid drain pump wet end	E260-01-026	Recommended
Acid drain pump Rulon ring	E260-01-027	Recommended

Table A24 - Services Module spares

APPENDIX

A9 BYPASS LOCK-OUT KIT ACCESSORY

Note: This Appendix describes the fitting and use of the Bypass Lock-Out Kit on a standard abatement system with the bypass valves inside the system enclosure. If your abatement system has the Remote Bypass Module ordering option, you must refer to Appendix A6 for the configuration of the bypass valves.

A9.1 Introduction

Fit the Bypass Lock-Out Kit to provide additional safety when you maintain or service the system.

Refer to Figure A18. During normal system operation, only the bracket is fitted as shown in detail A, allowing free movement of the bypass valves.

For maintenance or servicing, the lock-out bar can be fitted as shown in detail B, and:

- The cut-outs in the lock-out bar (5) fit over the valve stems (9) to lock the bypass valves in the off-line (bypass) position, and prevent movement of the valves to the on-line position.
- A clearly visible lock-out label (6, with the legend "CAUTION BYPASS LOCKED") identifies that the bypass valves are locked.

A9.2 Installation

A9.2.1 Unpack and inspect the accessory

1. Inspect the accessory. If the accessory is damaged, notify your supplier and the carrier in writing within three days; state the Item Number of the accessory, together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not continue to install and use the accessory if it is damaged.
2. Check that you have received the items listed in Table A25. If any of these items is missing, notify your supplier and the carrier in writing within three days.

Quantity	Description	Refer to Section	Check (✓)
1	Bracket	A9.2.2	❑
1	Lock-out bar (with label fitted)	A9.3.1/A9.3.2	❑
2	Padlocks	A9.3.1/A9.3.2	❑
4	Padlock keys (2 for each padlock)	A9.3.1/A9.3.2	❑

Table A25 - Checklist of Bypass Lock-Out Kit items

A9.2.2 Fit the bracket

1. Refer to Figure A18, detail A. Undo and remove the two bolts (3) which secure bypass valves for inlets 1 and 4 to the bypass valve mount (2); retain the bolts.
2. Use the two bolts (3) removed in Step 1 to fit the bracket (4) to the mount (2): ensure that the bracket is correctly orientated, as shown in Figure A18.
3. Securely retain the other components of the Kit (the lock-out bar, padlocks and keys) for future use (see Section A9.3).

A9.3 Use of the Lock-Out Kit

A9.3.1 Fit the lock-out bar before maintenance/servicing

When you want to lock the bypass valves in the bypass (off-line) position, and prevent movement of the bypass valves while you maintain or service the system:

1. Refer to Figure A18, detail B. With the bypass valves in the bypass (off-line) position, remove the position indicators (8) from the valve stems (9). Securely retain the position indicators for refitting at a later time (see Section A9.3.2).
2. Hold the lock-out bar (5) against the bracket, so that the cut-outs in the bar fit over the valve stems (9), and so that the lock-out label (6) is at the right, as shown in Figure A6-1.
3. Fit and lock the two padlocks (7) to secure the lock-out bar (5) to the bracket.

1. Bypass valves
2. Bypass valve mount
3. Bolts
4. Bracket
5. Lock-out bar
6. Lock-out label
7. Padlocks
8. Valve position indicators
9. Valve stems

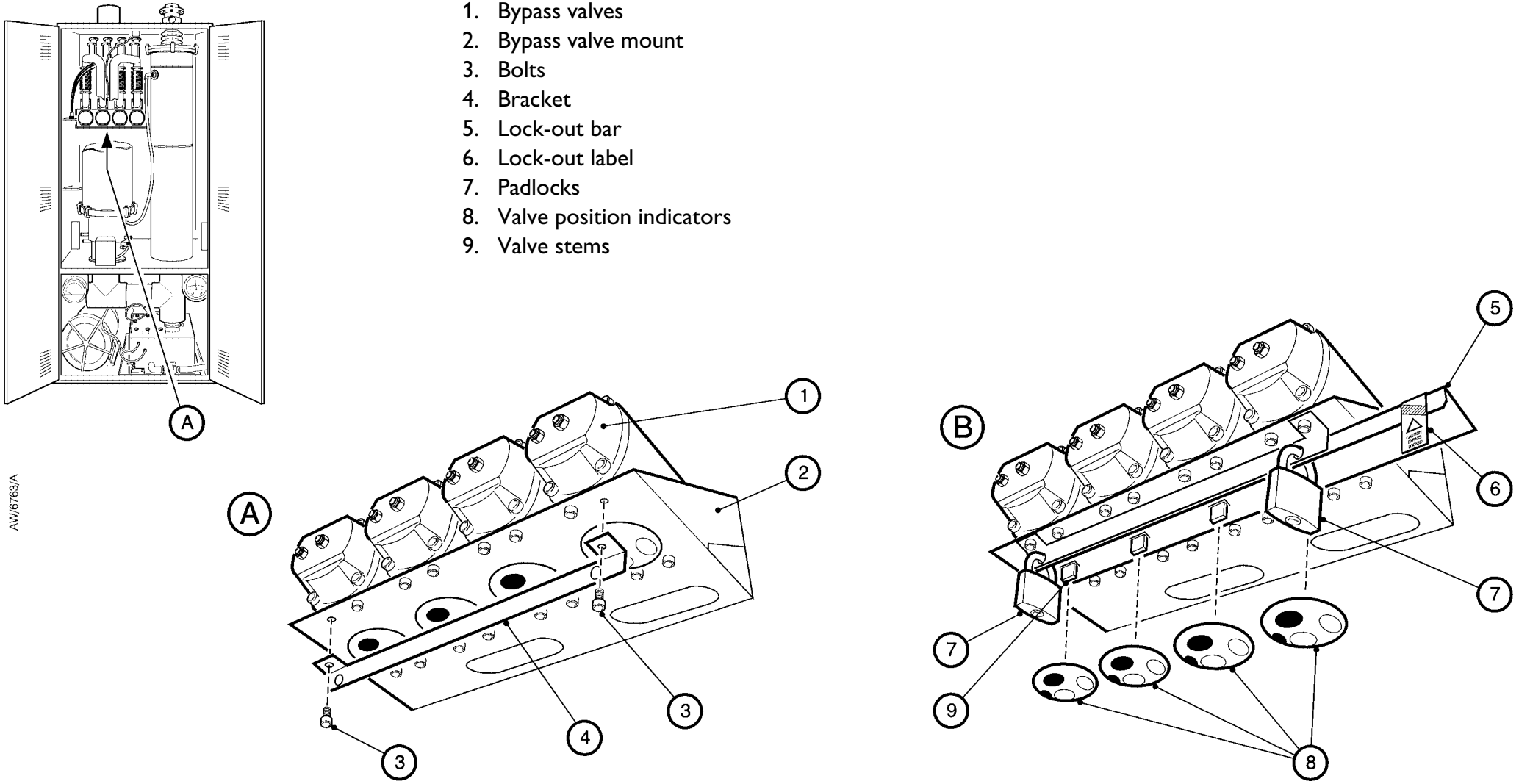


Figure A18 - Use of the Bypass Lock-Out Kit

A9.3.2 Remove the lock-out bar after maintenance/servicing

WARNING

You must remove the lock-out bar before you operate the system. If you do not, untreated process gases will be directed into your bypass pipelines and the abatement system will incorrectly indicate that the bypass valves are in the on-line position.

CAUTION

Ensure that you refit the valve position indicators in the correct orientation. If you do not, incorrect bypass valve positions will be indicated during subsequent system operation.

When you have finished maintenance/servicing of the system, and want to remove the lock-out bar before operating the system again.

Use the following procedure to remove the lock-out bar:

1. Refer to Figure A18, detail B. Unlock and remove one of the padlocks (7).
2. Support the lock-out bar (5) while you unlock and remove the second padlock (7), then remove the lock-out bar.
3. Refit the position indicators (8) to the valve stems (9): ensure that you fit them in the correct orientation (see Figure 21), otherwise bypass valve positions will be incorrectly indicated during subsequent system operation.
4. Securely retain the lock-out bar, padlocks and keys for future use.

APPENDIX

A10 SPRING RETURN BYPASS

A10.1 Introduction

This option provides additional safety in the event of an electrical supply or pneumatics nitrogen supply failure.

If you have ordered this option, the abatement system enclosure is supplied with return springs fitted in the bypass valves.

A10.2 Technical data

If your abatement system is supplied with this ordering option, technical data is as specified in Section 2.

A10.3 Operation

In the event of an electrical supply or pneumatics nitrogen supply failure, the return spring in each bypass valve will automatically actuate the bypass valve to the off-line position (so that any process gas passes directly through the bypass pipe to your back-up treatment system).

A10.4 Spares

The additional spares for the Spring Return Bypass option are listed in Table A26; refer to Section 7.3 for the definition of recommended spares types.

Spare	Item Number	Type
Spring return, CF_4 bypass	Y042-10-055	Recommended
Spring return, standard bypass	Y042-10-056	Recommended

Table A26 - Spring Return Bypass spares

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APPENDIX

A11 SECONDARY CONTAINMENT KIT

A11.1 Introduction

With this option, the abatement system is supplied with the following additional components:

- A secondary containment tray.
- An additional water leak detector (supplied in the abatement system enclosure).

You will install the abatement system enclosure and the WRU (or Services Module) on the secondary containment tray, which will contain any water leaks from the abatement system.

You will fit the water leak detector in the secondary containment tray, to provide an indication of abatement system, WRU or Services Module water leaks.

A11.2 Technical data

Secondary containment tray

Dimensions:	See Figure A19
Mass	25 kg

A11.3 Installation

A11.3.1Unpack and inspect

After you have unpacked and inspected the abatement system enclosure and the WRU (or Services Module), unpack and inspect the secondary containment tray and check that it is not damaged.

If the tray is damaged, notify your supplier and the carrier in writing within three days; state the Item Number and Serial Number of the equipment, together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the tray if it is damaged

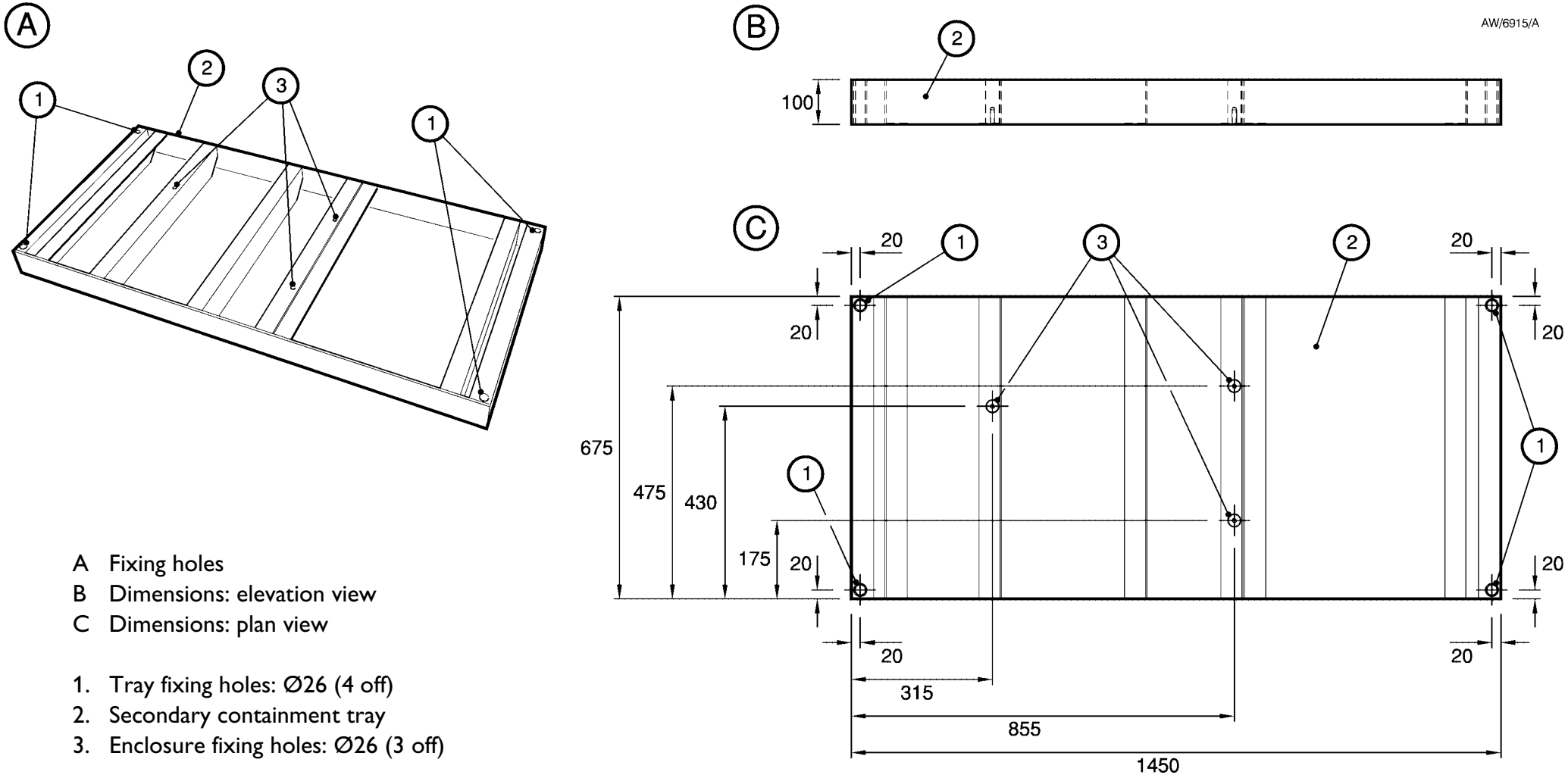
A11.3.2Install the secondary containment tray

Before you locate the abatement system enclosure and the WRU (or Services Module):

1. Refer to Figure A19. Locate the secondary containment tray (2) in its required operating position. Ensure that there is sufficient room for access around the tray, as described in Section 3.4.
2. Use four suitable bolts through the tray fixing holes (1) to secure the tray to its base.

A11.3.3Locate the abatement system enclosure

1. Refer to Figure A19. When you locate the enclosure as described in Section 3.7, locate the enclosure on the secondary containment tray (2), so that the fixing holes in the enclosure are aligned with the enclosure fixing holes (3) on the tray.
2. Use three suitable bolts through the fixing holes in the enclosure (Figure 8, items 7) and the fixing holes in the tray (Figure A19, items 3) to secure the enclosure to the tray.



A Fixing holes
B Dimensions: elevation view
C Dimensions: plan view

1. Tray fixing holes: Ø26 (4 off)
2. Secondary containment tray
3. Enclosure fixing holes: Ø26 (3 off)

Figure A19 - The secondary containment tray

A11.3.4Fit the additional water leak detector

After you have located the abatement system enclosure as in Section A11.3.3, and before you fit the WRU or Services Module, use the following procedure to fit the additional water leak detector in the secondary containment tray:

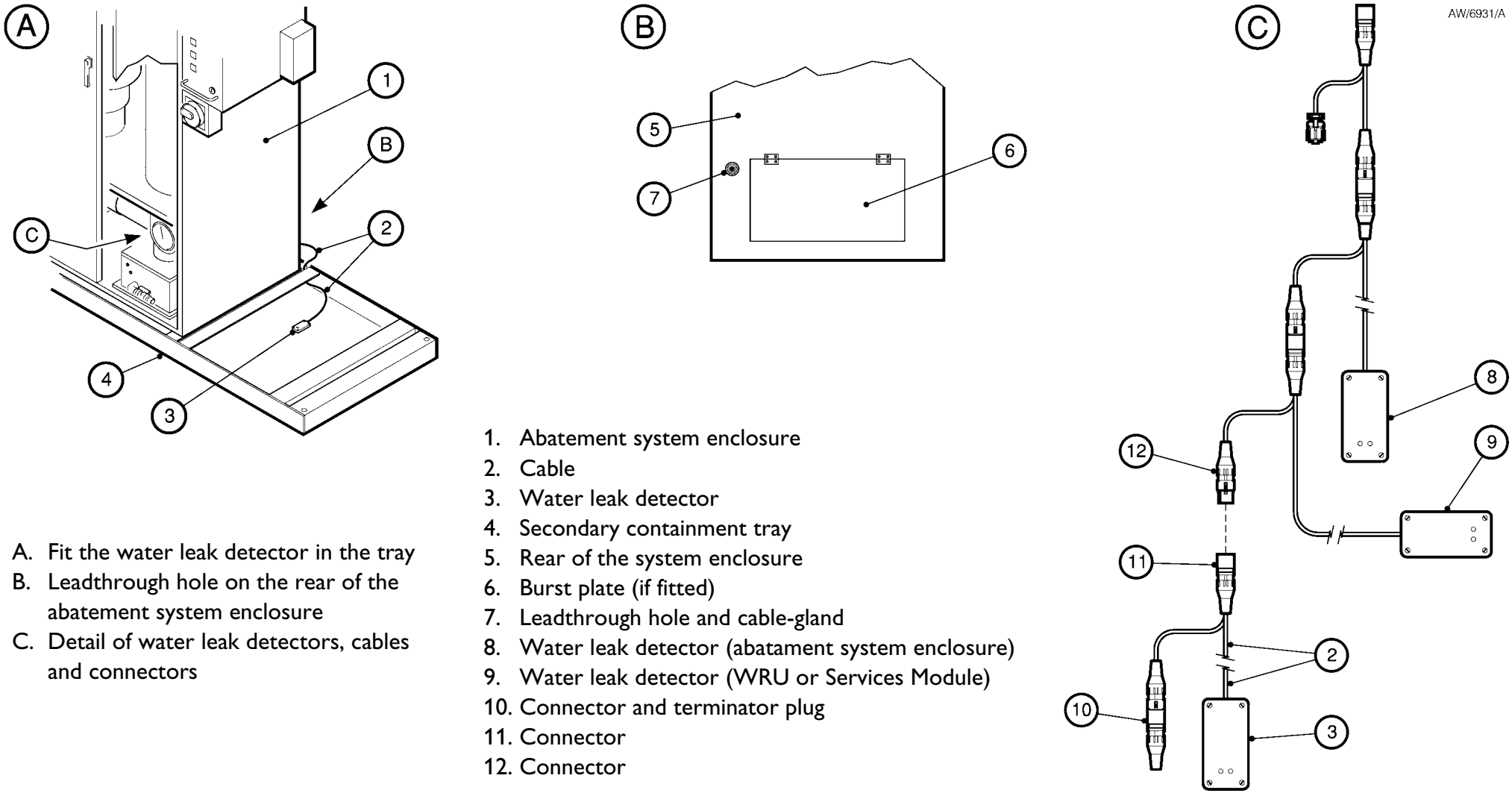
1. Refer to Figure A20 detail C. Remove the connector (11) on the containment tray water leak detector cable (2) from the connector (12) in the abatement system enclosure. (The connector (12) is an extension cable fitted to the cable on the WRU/Services Module water leak detector, 9).
2. Refer to detail A. Place the containment tray water leak detector (3) in position in the base of the secondary containment tray (4), so that it rests on the four metal pins, with the LEDs facing upwards.
3. Route the cable (2, with the connectors 10 and 11) through the triangular cut-out in the cross-member of the secondary containment tray (4) and up through the gap between the rear of the abatement system enclosure (1) and the frame of the secondary containment tray.
4. Refer to detail B. Pass the cable and connectors (detail C, items 2, 10 and 11) through the cable gland in the leadthrough hole (7) and into the abatement system enclosure.
5. Refer to detail C. Refit the connector (11) on the containment tray water leak detector cable (2) to the connector (12).

Note: Remove the terminator plug (10) if you want to connect additional water leak detectors.

A11.3.5Locate the WRU or Services Module

Refer to Figure A20. When you locate the WRU as described in Section 3.8, or locate the Services Module as described in Section A8.3.3, you must locate the WRU/Services Module on the secondary containment tray (4), next to the abatement system enclosure (1).

Take care not to trap or damage the water leak detector cable (2) when you fit the WRU or Services Module.



A. Fit the water leak detector in the tray
B. Leadthrough hole on the rear of the abatement system enclosure
C. Detail of water leak detectors, cables and connectors

1. Abatement system enclosure
2. Cable
3. Water leak detector
4. Secondary containment tray
5. Rear of the system enclosure
6. Burst plate (if fitted)
7. Leadthrough hole and cable-gland
8. Water leak detector (abatament system enclosure)
9. Water leak detector (WRU or Services Module)
10. Connector and terminator plug
11. Connector
12. Connector

Figure A20 - Fit the water leak detector in the secondary containment tray

APPENDIX

A12 CABINET-EXTRACTION INTERLOCK ACCESSORY

A12.1 Introduction

A12.1.1Description

Note: To comply with SEMI-S13 requirements, you must fit this accessory and connect the shut-down signal to the Process Tool.

When fitted, the Cabinet-Extraction Interlock accessory provides a signal which can be used to shut down the abatement system if your exhaust-extraction system fails.

You will fit the accessory to the cabinet-extraction port on the top of the abatement system enclosure, instead of the standard cabinet-extraction flange.

Refer to Figure A21. The accessory incorporates four sample ports (4), which allow you to connect gas detection or sampling equipment.

A12.1.2Output signals

The accessory provides two status output signals:

- A shut-down signal which indicates when the cabinet-extraction system has failed.
- A warning signal, which indicates that the cabinet-extraction system extraction rate is too high or too low.

You must connect the shut-down signal to your Process Tool or other control equipment, which must be configured to shut-down the abatement system when the signal indicates that the cabinet-extraction system has failed.

If required, you can connect the warning signal to your Process Tool or other control equipment, which can be configured to provide warning indications or carry out suitable actions when the signal indicates that the cabinet extraction rate is too high or too low.

Note: If you want to use the warning signal, the signal setpoints must be configured by a BOC Edwards Service Engineer.

A12.2 Technical data

Outlet	150 mm diameter
Sample ports	$^1/_4$ inch Swagelok, stainless steel
Output signals	
Shut-down	Refer to the instructions supplied with the accessory.
Warning	Refer to the instructions supplied with the accessory.

Table A27 - Cabinet-Extraction Interlock technical data

A12.3 Installation

A12.3.1Introduction

Use the procedure in Section A12.3.2 (instead of the procedure in Section 3.17) to fit the accessory to the abatement system enclosure and to connect to your cabinet-extraction system.

Use the procedure in Section A12.3.3 to connect the status output signals to your control system.

If required, fit suitable pipelines to the sample ports (Figure A21, items 4) to connect your gas detection or sampling equipment to the accessory.

A12.3.2Fit the accessory and connect to your cabinet-extraction system

> CAUTION
>
> Ensure that moisture or condensation cannot drain back from your cabinet-extraction system into the abatement system. If it does, there will be a risk of corrosion in the system.

Use the following procedure to fit the accessory to the abatement system enclosure.

Note that:

- Refer to Figure 13. To prevent the drainage of moisture or condensation back into the abatement system, you must route the cabinet-extraction conduit (1) into the top or side of your cabinet-extraction or exhaust-extraction system.
- Your cabinet-extraction system must provide the extraction flow specified in Section 2.10. This may require the installation of a flow-regulating damper downstream of the abatement system.

1. Refer to Figure A21. Use the bolts (3) supplied in the fittings kit to secure the accessory to the cabinet-extraction port on the top of the abatement system enclosure (Figure 9, item 3).

   Ensure that the digital display (2) is at the front and that the display bracket is fitted to the top of the accessory flange and secured with two of the bolts as shown in Figure A21.

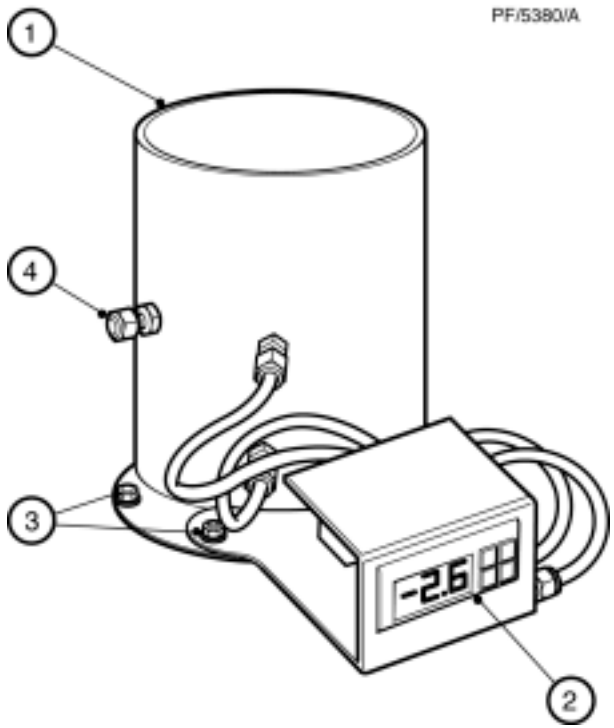
2. Use suitable conduit to connect the outlet (1) to your cabinet-extraction or exhaust-extraction system.

A12.3.3Connect to your control system

Connect the shut-down signal and (if required) the warning signal as specified in the instructions supplied with the accessory.

A12.4 Operation

Refer to Figure A21. During operation, the digital display (2) will show the differential cabinet-extraction pressure.



1. Outlet
2. Digital display
3. Securing bolts
4. Sample port

Figure A21 - The Cabinet-Extraction Interlock accessory

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APPENDIX

A13 PFC GAS CHROMATOGRAPH CONFORMANCE TESTING

A13.1 Introduction

Note: Gas chromatograph conformance testing cannot measure the presence of NF_3 gas.

If required, after the abatement system has been installed and commissioned, BOC Edwards engineers can perform gas chromatograph conformance testing to measure the system's gas destruction efficiency (DRE) for process gas streams which contain C_2F_6 and/or SF_6.

A13.2 Test method

The conformance testing system incorporates a computer with specially designed BOC Edwards software. The system takes a sample of gas from the abatement system exhaust outlet and interprets the quantity of the target gas (for example, C_2F_6) as an area on a graph relative to the concentration level.

Samples are taken with the abatement system switched off, to determine a baseline untreated measurement; samples are then taken with the abatement system operating normally, to provide fully treated measurements. The DRE figures are taken over a range of inlet conditions, and the results are presented in a formal report approximately two weeks after testing, so that the test equipment can be calibrated after on-site testing.

The testing method can measure C_2F_6 concentrations of < 10 ppm and > 10,000 ppm. The resolution of DRE is > 99.99%. Each sample sequence takes five minutes and requires stable gas flows from your Process Tool to give reliable results.

Sampling the gas stream with constant operating conditions is essential. The test does not resolve any other gas species and therefore cannot give a complete spectrum of by-products. Analysis of by-products is more suited to mass spectrometry; sample traces are available on request from BOC Edwards.

A13.3 Customer on-site preparation

In order to ensure that your site is prepared for testing, please take note of the following:

- You must be able to provide a period of time (between two to four hours) when all process gases to the abatement system can be controlled, at the request of the BOC Edwards test engineers.
- You must inform the BOC Edwards test engineer when process gas is flowing. We recommend that a telephone link (if necessary) will reduce confusion and minimise your Process Tool downtime.

(continued on page 244)

- You must provide a $^1/_4$ inch Swagelok type sample port, down stream from the abatement system. The sample port must be in a position that is not contaminated by any other process exhaust.
- You must be able to provide 1 litre of clean deionised water, and provide for disposal of 1 litre of dirty water.
- You must be able to provide four 110 V or 230 V electrical supply sockets for the test system.
- Ideally, you must be able to provide a small table or trolley within 2 metres of the sample port, to mount the test system.

A13.4 Test routine

A13.4.1Preparation

- Each abatement system inlet gas flow will be checked for conformance to the operating conditions specification (total flow per abatement system inlet, gas type, pressure, and so forth).
- The total flow to each inlet (nitrogen purge, process gas and post-pump purges) is checked to be less than 50 l min^{-1}.
- The operating conditions will be recorded:

  The fuel gas flows into the abatement system in all operating conditions.

  The air flow into the combustor.
- The abatement system will be checked for fault-free operation.

A13.4.2Procedure

- The BOC Edwards test engineer will disconnect the abatement system interface module and will replace it with a special test interface module for the duration of the test. Factory management systems that are connected to the interface module must be disconnected or disabled, so that false factory alarms do not interfere with the test.
- There are eight tests to complete (see Table A28); the first test is the baseline test that measures the presence of PFC gas in the exhaust stream. The other seven tests provide measurements over a wide range of different process conditions. The required flow rates for process gases are 0.5 l min^{-1} of C_2F_6 and 0.6 l min^{-1} of O_2. These flows will probably need to be set from the Process Tool for the duration of the test.

A13.4.3Results

The test results will be tabulated in a formal report which will be made available to you within two weeks of completion of the tests.

Abatement system conditions		**Test number**							
System inlet	**Gas flow l min^{-1}**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	C_2F_6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1	O_2	0.6	0.6	0	0.6	0.6	0.6	0.6	0
1	N2 purge	50	50	50	40	40	30	30	30
1	System inject	off	on	on	off	on	on	off	on
All other abatement system inlets must be purged with 50 l min^{-1} of nitrogen during testing									
Test results									
Run 1 count									
Run 2 count									
Run 3 count									

Table A28 - Gas chromatograph conformance test matrix

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APPENDIX

A14 CERTIFICATES

The certificates issued for the abatement systems are shown on the following sheets.

ITS Intertek Testing Services
ETL SEMKO

Certificate of Compliance

Item:	Zenith Integrated System
Model Reference Nos:	Y04 (TPU) / Y07 (TCS) and Y12 (Helios)
No. of Samples Tested:	One
Relevant Specification used as Basis of Tests:	EN61326-1:1997 + A1:1998 (Reference Table A1)

This is to certify that, on the basis of the tests undertaken, the sample of the above item is considered to comply with the essential requirements of the EMC Directive, number 89/336/EEC.

Signed:.....
J A Bearpark
Certifying Officer

Date of Issue:
10th July 2001

Address:
BOC Edwards
Kenn Business Park
Kenn Road
Clevedon
Somerset
BS21 6TH

Serial Number. 80011619

Reference No. EM01004606 (d)

ITS Intertek Testing Services
ETL SEMKO

Certificate of Compliance

Item:	Zenith Integrated System
Model Reference Nos:	Y28 (Kronis)
No. of Samples Tested:	One
Relevant Specification used as Basis of Tests:	Semi F47

This is to certify that, on the basis of the tests undertaken, the sample of the above item is considered to comply with the essential requirements of the above standard.

Signed:.....
D J Taylor
Certifying Officer

Date of Issue:
16th December 2002

Address:
BOC Edwards
Kenn Business Park
Kenn Road
Clevedon
Somerset
BS21 6TH

Serial Number. 80011903

Reference No. EM02008761

ITS Testing & Certification Ltd
ITS House, Cleeve Road, Leatherhead, Surrey KT22 7SB
Tel: +44 (0)1372 370900 Fax: +44 (0)1372 370999

Commissioning Request Form

(Form CRF-1)

Introduction

So that we can arrange for commissioning of your abatement system installation at a suitable time, please photocopy this form and complete Sections 1 and 2 (in block capital letters), then return the completed form to your supplier or to the address given at right.

Do not request commissioning until you have finished installation and have completed Form SIC-1.

BOC Edwards,
Exhaust Management Group,
Kenn Business Park,
Kenn Road, Kenn,
CLEVEDON
North Somerset
BS21 6TH
United Kingdom

Telephone : +44 (0) 1275 337100

Facsimile : +44 (0) 1275 337200

Email : support.clevedon@edwards.boc.com

SECTION 1 : APPLICATION DATA

Customer Name (Company) : _____

Customer Contact Name : _____

Customer Contact Telephone Number : _____

BOC Edwards Contact Name : _____

BOC Edwards Contact Telephone Number : _____

Abatement system Model & Serial Number : _____

WRU/Services Module :

Model & Serial Number : _____

Date on which commissioning is requested : _____

SECTION 2 : COMMISSIONING APPROVAL

We confirm that we have installed the equipment in accordance with the recommendations in the instruction manual, and have completed Form SIC-1 in readiness for commissioning.

We also confirm that we request commissioning of the installation, and that free access will be provided to the installation, on the date given above.

Print Your Name : _____

Job Title : _____

Signed : _____

Date : _____

System Installation Checklist

(Form SIC-1)

We recommend that you complete this checklist during or immediately after installation, to confirm that you have installed the abatement system correctly. Note that items inside square brackets denote where in this manual the corresponding requirements are specified. Do not request commissioning (using Form CRF-1) until this checklist has been completed.

INSTALLATION DETAILS

Installation site : _____

Process Recipe: _____

Your abatement system reference: _____

Abatement system serial number: _____

WRU/Services Module serial number: _____

ABATEMENT SYSTEM ENCLOSURE INSTALLATION

	Yes	No
Is the abatement system installation close to the pumping systems ? [Section 3.4]	❑	❑
Is the abatement system installed in a domestic building, or connected to an electrical supply which supplies domestic buildings ? [Section 2]	❑	❑
Does the location where the abatement system is installed comply with the required operating and storage conditions ? [Section 2.1]	❑	❑
Is there sufficient access around the abatement system ? [Figure 8]	❑	❑
Is the base on which the abatement system is installed firm and level ? [Section 3.4]	❑	❑
Were all of the components listed in the checklist received ? [Table 22]	❑	❑
Is the abatement system enclosure damaged ? [Section 3.5]	❑	❑
Is the abatement system enclosure level ? [Section 3.7]	❑	❑
Has the abatement system enclosure been secured to the base ? [Section 3.7]	❑	❑

WRU INSTALLATION AND CONNECTION

	Yes	No
Were all of the components listed in the checklist received ? [Table 23]	❑	❑
Is the WRU undamaged ? [Section 3.6]	❑	❑
Has the WRU been secured to the abatement system enclosure ? [Section 3.8]	❑	❑
Has the water leak detector been fitted to the WRU ? [Section 3.8]	❑	❑
Is the WRU fuel gas pipe connected to the inlet in the abatement system enclosure ? [Section 3.9]	❑	❑
Is the WRU scrubber water supply pipe connected to the scrubber water inlet in the abatement system enclosure ? [Section 3.9]	❑	❑
Is the WRU water return pipe connected to the acid waste water tank outlet in the abatement system enclosure ? [Section 3.9]	❑	❑
Are the WRU pneumatics and sample pipes fitted to the connectors on the enclosure ? [Section 3.9]	❑	❑

BYPASS OUTLET PIPELINES & CONNECTIONS

	Yes	No
Does your system design ensure that incompatible process gases cannot mix in the bypass pipelines ? [Section 3.11]	❑	❑
Do the bypass outlet pipelines incorporate flexible components ? [Sections 3.3.2 and 3.11]	❑	❑
Have suitable construction materials been used in the pipelines ? [Section 3.3.2]	❑	❑
Do the pipelines incorporate valves ? [Section 3.3.2]	❑	❑
Are all of the pipelines clearly labelled ? [Section 3.3.2]	❑	❑
Have all of the pipelines been helium leak tested ? [Section 3.3.2]	❑	❑

BYPASS OUTLET PIPELINES AND CONNECTIONS (CONTINUED)

	Yes	No
Is full supporting documentation (including a schematic diagram) for the pipelines installation available ? [Section 3.3.2]	❑	❑
Are the bypass pipelines connected to gas scrubbers ? [Section 3.3.4]	❑	❑
Are the pipelines configured so that moisture or condensation cannot drain back into the abatement system ? [Section 3.11]	❑	❑
Are your bypass pipelines correctly connected to the bypass outlets ? [Section 3.11]	❑	❑
Is a manifold fitted to the bypass outlets ? [Section 3.11]	❑	❑

PROCESS GAS INLET PIPELINES AND CONNECTIONS

	Yes	No
Do the inlet pipelines incorporate flexible components ? [Section 3.3.2]	❑	❑
Have suitable construction materials been used in the pipelines ? [Section 3.3.2]	❑	❑
Do the pipelines incorporate valves ? [Section 3.3.2]	❑	❑
Are all of the pipelines clearly labelled ? [Section 3.3.2]	❑	❑
Have all of the pipelines been helium leak tested ? [Section 3.3.2]	❑	❑
Is full supporting documentation (including a schematic diagram) for the pipelines installation available ? [Section 3.3.2]	❑	❑
Are the inlet pipelines of diameter 40 mm or less ? [Section 3.4]	❑	❑
Are your pumping systems fitted with check-valves ? [Section 2.3]	❑	❑
Is more than one pumping system connected to a single abatement system inlet ? [Section 3.12]	❑	❑
Does your system design ensure that the maximum process gas flow rates into the abatement system cannot be exceeded ? [Section 2.3, Section 3.12]	❑	❑

PROCESS GAS INLET PIPELINES AND CONNECTIONS (CONTINUED)

	Yes	No
Are your process gases compatible with the materials used in the abatement system ? [Section 2.13]	❑	❑
Are your process gas inlet pipelines correctly connected to the abatement system inlets ? [Section 3.12]	❑	❑
Are unused inlets configured so that they will be continuously purged during operation ? [Section 3.12]	❑	❑
Have the centring plates been refitted to the enclosure to secure the inlet pipelines (and the bypass outlet pipelines) in place ? [Section 3.13]	❑	❑

EXHAUST GAS OUTLET PIPELINE AND CONNECTIONS

	Yes	No
Is your exhaust-extraction system of non-metallic construction ? [Section 3.15]	❑	❑
Can your exhaust-extraction system provide the required flow rate ? [Section 2.9]	❑	❑
Has the outlet spool been correctly fitted to the enclosure ? [Section 3.14]	❑	❑
Is your exhaust gas outlet pipe of diameter 75 mm or more ? [Section 3.15]	❑	❑
Is the exhaust gas outlet pipe connected to the main header of your exhaust-extraction system, and configured so that moisture or condensation cannot drain from the main header back into the abatement system ? [Section 3.15]	❑	❑
Is the exhaust gas outlet pipe connected to a spur of your exhaust-extraction system, and configured so that moisture or condensation in the outlet gas stream can drain back into the abatement system ? [Section 3.15]	❑	❑
Has a flexible exhaust gas outlet pipe been correctly connected to the outlet spool ? [Section 3.15]	❑	❑
Is the damper adjusted correctly ? [Section 3.15]	❑	❑

EXHAUST GAS OUTLET PIPELINE AND CONNECTIONS (CONTINUED)

	Yes	No
Does your exhaust gas outlet pipe incorporate a sample port ? [Section 3.15]	❑	❑

LEAK TESTING

	Yes	No
Has the abatement system been helium leak tested, and have any leaks been sealed ? [Section 3.16]	❑	❑

CABINET-EXTRACTION SYSTEM AND CONNECTIONS

	Yes	No
Can your cabinet-extraction system provide the required flow rate ? [Section 2.10]	❑	❑
Have you installed gas detectors to monitor the cabinet-extraction pipeline for process gas and fuel gas leaks ? [Section 3.3.6]	❑	❑
Is the cabinet-extraction flange correctly fitted to the abatement system enclosure ? [Section 3.17]	❑	❑
Is your cabinet-extraction conduit correctly connected to the cabinet-extraction flange ? [Section 3.17]	❑	❑
Is your cabinet-extraction conduit configured so that moisture or condensation cannot drain back into the abatement system enclosure ? [Section 3.17]	❑	❑

ACID WASTE WATER DRAIN SYSTEM AND CONNECTIONS

	Yes	No
Is your acid waste water outlet connected to a non-pressurised drain ? [Section 2.8, Section 3.18]	❑	❑
Is your waste water outlet pipeline correctly connected to the waste water outlet on the WRU ? [Section 3.18]	❑	❑

ACID WASTE WATER DRAIN SYSTEM AND CONNECTIONS (CONTINUED)

	Yes	No
Does your waste water outlet pipeline incorporate a full-bore isolation valve ? [Section 3.18]	❑	❑
Does your waste water outlet pipeline incorporate non-return valves ? [Section 3.18]	❑	❑

NITROGEN SUPPLIES AND CONNECTIONS

	Yes	No
Are your nitrogen supplies suitable for use with the abatement system ? [Section 2.5]	❑	❑
Is your pneumatics nitrogen supply correctly connected to the inlet on the enclosure ? [Section 3.19]	❑	❑
Is your purge nitrogen supply correctly connected to the inlet on the enclosure ? [Section 3.19]	❑	❑
Do the nitrogen supply pipelines incorporate isolation valves ? [Section 3.19]	❑	❑

OXYGEN SUPPLY AND CONNECTIONS (ONLY APPLICABLE TO A TPU OR A KRONIS)

	Yes	No
Is your oxygen supply suitable for use with the abatement system ? [Section 2.6]	❑	❑
Is your oxygen supply correctly connected to the inlet on the enclosure ? [Section 3.20]	❑	❑
Does the oxygen supply pipeline incorporate an isolation valve ? [Section 3.20]	❑	❑

FUEL GAS SUPPLY AND CONNECTION

	Yes	No
Is your fuel gas supply suitable for use with the abatement system ? [Section 2.4]	❑	❑
Do the fuel gas supply pipelines incorporate flexible pipes/sleeving ? [Section 3.2]	❑	❑
Do the fuel gas supply pipelines incorporate lockable gas isolation valves ? [Section 3.2]	❑	❑
Are the fuel gas supply pipelines and valves labelled, and is there full supporting documentation for the installation ? [Section 3.2]	❑	❑
Is a fuel gas installation certificate available ? [Section 3.2]	❑	❑
Was the fuel gas supply pipeline over-pressurised during installation ? [Section 3.21]	❑	❑
Is your fuel gas supply pipeline correctly connected to the inlet on the WRU, and is the gas connection enclosure fitted and secured ? [Section 3.21]	❑	❑
Does your fuel gas supply pipeline incorporate an isolation valve ? [Section 3.21]	❑	❑

MAKE-UP WATER SUPPLY AND CONNECTIONS

	Yes	No
Is your make-up water supply suitable for use with the abatement system ? [Section 2.8]	❑	❑
Is your make-up water supply pipeline correctly connected to the inlet on the WRU ? [Section 3.22]	❑	❑
Does your make-up water supply pipeline incorporate a filter, to prevent the entry of debris into the abatement system ? [Section 3.22]	❑	❑
Does your make-up water supply pipeline incorporate an isolation valve ? [Section 3.22]	❑	❑

COOLING-WATER SUPPLY AND CONNECTIONS

	Yes	No
Is your cooling-water supply suitable for use with the abatement system ? [Section 2.7]	❑	❑
Is your cooling-water supply pipeline correctly connected to the inlet on the WRU ? [Section 3.23]	❑	❑
Does your cooling-water supply pipeline incorporate an isolation valve ? [Section 3.23]	❑	❑
Is your cooling-water return pipeline correctly connected to the outlet on the WRU ? [Section 3.23]	❑	❑
Does your cooling-water return pipeline incorporate an isolation valve ? [Section 3.23]	❑	❑

INTERFACE MODULE AND PROCESS TOOL CONNECTIONS

	Yes	No
Is the Process Tool correctly configured to provide the PUMP INTERFACE signals ? [Section 3.3.3]	❑	❑
Mandatory on TPU and Kronis systems, optional on TCS systems: Is the Process Tool correctly configured to provide the PFC INTERFACE signals ? [Section 3.3.3]	❑	❑
Is the Process Tool correctly configured to respond to the SYSTEM WARNING BYPASS ALARM and ALARM BEACON signals ? [Section 3.3.3]	❑	❑
Is the Process Tool correctly connected to the PUMP INTERFACE terminals in the Interface Module ? [Section 3.25]	❑	❑
Mandatory on TPU and Kronis systems, optional on TCS systems: Is the Process Tool correctly connected to the PFC INTERFACE terminals in the Interface Module ? [Section 3.25]	❑	❑
Is the Process Tool correctly connected to the bypass alarm relays in the Interface Module ? [Section 3.25]	❑	❑
Is the Process Tool correctly connected to the alarm beacon terminals in the Interface Module ? [Section 3.25]	❑	❑

INTERFACE MODULE AND PROCESS TOOL CONNECTIONS (CONTINUED)

	Yes	No
Is the Process Tool correctly connected to the system warning relay in the Interface Module ? [Section 3.25]	❑	❑
Is a remote level signal correctly connected to the REMOTE LEVEL terminals in the Interface Module ? [Section 3.25]	❑	❑
Is a remote on/off signal correctly connected to the REMOTE ON/OFF terminals in the Interface Module ? [Section 3.25]	❑	❑
Is a remote gas signal correctly connected to the REMOTE GAS terminals in the Interface Module ? [Section 3.25]	❑	❑
Are all of the signal connections to the volt-free terminals in the Interface Module voltage-free ? [Section 3.25]	❑	❑
Are all of the cables connected to the Interface Module correctly fitted through the cable glands ? [Section 3.25]	❑	❑
Are the covers fitted to the Interface Module ? [Section 3.25]	❑	❑

ELECTRICAL SUPPLY AND CONNECTIONS

	Yes	No
Is your electrical supply suitable for use with the abatement system ? [Section 2.11]	❑	❑
Is your electrical supply cable of the correct size/rating ? [Section 2.11]	❑	❑
Is the WRU model the same model as the abatement system enclosure ? [Section 3.6]	❑	❑
Has the WRU electrical cable been connected to the enclosure control unit ? [Section 3.9]	❑	❑
'S' and 'J' models only: Is the WRU electrical cable correctly connected to the electrical supply isolator or to the breaker disconnect ? [Section 3.26.2 or 3.26.4]	❑	❑

ELECTRICAL SUPPLY AND CONNECTIONS (CONTINUED)

	Yes	No
Is the electrical supply cable correctly connected to the electrical supply isolator or to the breaker disconnect ? [Section 3.26.3 or 3.26.5]	❑	❑
Have the strain-relief screws on the cable-glands been tightened ? [Section 3.26.3 or 3.26.5]	❑	❑

PUMPING SYSTEM TMS COMPONENTS (KRONIS ONLY)

	Yes	No
Have suitable TMS accessories been fitted to the pipelines from the pumping systems ? [Section 3.12, Section A5.3]	❑	❑

ORDERING OPTIONS

The following parts of this checklist are only applicable if you have the corresponding ordering option with your abatement system.

TMS (TEMPERATURE MANAGEMENT SYSTEM) ORDERING OPTION (TCS/TPU ONLY)

	Yes	No
Have suitable TMS accessories been fitted to the pipelines from the pumping systems ? [Section 3.12, Section A4.3]	❑	❑

REMOTE BYPASS MODULE ORDERING OPTION

	Yes	No
Were all of the components listed in the checklist ? [Table A14]	❑	❑
Is the Remote Bypass Module undamaged ? [Section A6.2.1]	❑	❑
Has the Remote Bypass Module been correctly fitted to the enclosure ? [Section A6.2.2]	❑	❑

BYPASS NITROGEN DILUTION ORDERING OPTION

	Yes	No
Is your nitrogen supply suitable for use with this option ? [Section A7.3]	❑	❑

SERVICES MODULE ORDERING OPTION

	Yes	No
Is your scrubber water supply suitable for use with the abatement system ? [Section A8.2.4]	❑	❑
Have you received all of the items listed in the checklist ? [Table A21]	❑	❑
Is the Services Module correctly bolted to the abatement system enclosure ? [Section A8.3.3]	❑	❑
Is the water leak detector correctly fitted in the Services Module ? [Section A8.3.3]	❑	❑
Is the fuel gas pipe connected to the inlet in the abatement system enclosure ? [Section A8.3.4]	❑	❑
Is the water drain inlet pipe connected to the acid waste water tank outlet in the enclosure ? [Section A8.3.4]	❑	❑
Is the scrubber water supply pipe connected to the scrubber water inlet in the abatement system enclosure ? [Section A8.3.4]	❑	❑
Is the water recirculation pipe connected to the water recirculation inlet in the abatement system enclosure ? [Section A8.3.4]	❑	❑
Is the Services Module electrical cable connected to the control unit ? [Section A8.3.4]	❑	❑

SERVICES MODULE ORDERING OPTION (CONTINUED)

	Yes	No
Are the two pneumatics pipes connected to the nitrogen supply connectors on the enclosure ? [Section A8.3.4]	❑	❑
Are the waste-water drain valve and the backwash valve closed ? [Section A8.3.4]	❑	❑
Are the water drain pump isolation valve and the water recirculation valve open ? [Section A8.3.4]	❑	❑
Is a backwash waste pipe connected to the backwash outlet ? [Section A8.3.9]	❑	❑
Is the backwash waste pipe connected to a suitable drain ? [Section A8.3.4]	❑	❑
If the waste pipe is connected to the acid waste water drain: is the direction of backwash flow the same as the flow of acid waste water ? [Section A8.3.9]	❑	❑
Does the backwash waste pipe incorporate a check-valve ? [Section A8.3.9]	❑	❑

SECONDARY CONTAINMENT KIT ORDERING OPTION

	Yes	No
Is the secondary containment tray damaged ? [Section A11.3.1]	❑	❑
Is the secondary containment tray secured to the base ? [Section A11.3.2]	❑	❑
Is the abatement system enclosure secured to the secondary containment tray ? [Section A11.3.3]	❑	❑
Has the water leak detector been fitted to the secondary containment tray ? [Section A11.3.4]	❑	❑
Is the WRU or Services Module correctly located on the secondary containment tray ? [Section A11.3.5]	❑	❑

CHECKLIST AUTHENTICATION

Completed by : _____

On (date) : _____

Notes :

Return of BOC Edwards Equipment - Procedure **(Form HS1)**

INTRODUCTION

Before returning your equipment, you must warn BOC Edwards if the substances used (and produced) in the equipment can be dangerous. 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 dangerous/hazardous. Your equipment is '**contaminated**' if it has been used with any dangerous/hazardous substances.
- If your equipment has been used with radioactive substances, 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 contaminated/ hazardous materials.

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

PROCEDURE

Use the following procedure:

1. Contact BOC Edwards and obtain a Return Authorisation Number for your equipment.
2. Complete the Return of BOC Edwards Equipment - Declaration (HS2).

(CONTINUED)

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 laws. **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 dangerous 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. Disconnect all accessories from the equipment.
6. Seal up all of the equipment's inlets and outlets (including those where accessories were attached) with blanking flanges or, for uncontaminated products, with heavy gauge tape.
7. Seal equipment in a thick polythene bag or sheet.
8. 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.
9. Fax or post a copy of the Declaration (HS2) to BOC Edwards. The Declaration must arrive before the equipment.
10. Give a copy of the Declaration to the transporter. You must tell your transporter if the equipment is contaminated.
11. 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.

Return of BOC Edwards Equipment - Declaration **(Form HS2)**

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 of the substances used or produced in the equipment

- Radioactive YES ❑ NO ❑
- Biologically active YES ❑ NO ❑
- Dangerous to human health and safety? YES ❑ NO ❑

(CONTINUED)

BOC Edwards will not accept delivery of any equipment that is contaminated with radioactive substances, 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
1			
2			
3			
4			
5			
6			

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

Name: _____ Job title: _____

Organisation Name and 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 have followed the Return of BOC Edwards Equipment Procedure (HS1).

Note: Please print form, **sign** and return hardcopy.

Signed: _____ Date _____