For safe and proper use,
follow these instructions.
Keep them for future reference.

P2000
Analyser Unit

Operating Manual

Protea
technology leadership
in measurement solutions

Manual Part No.	Revision status	Reason For amendment	Scope of amendment	Language
18-0004	11	Changes to appendix L Replacing the UV Source	CE/UKCA related changes	UK English

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Information regarding the installation and operational manual

The installation and operation manual, hereinafter referred to as the manual, must always be stored close to the product and be in a permanently legible condition. The manual must be handed over along with the product if it is sold or passed on.

NOTE	**Follow the instructions given in the manual**
	This manual contains all the basic instructions required for the safe operation of the product and must therefore be read before any actions are performed. Otherwise personal and material hazards as well as functional and operational malfunctions can occur.

Other applicable documents

This manual contains all the necessary steps for the installation and operation of the P2000 analyser. This manual should be used in conjunction with other manuals that describe the Control Unit. Two types of analyser controller are available for the P2000. Information for the use of these controllers can be found in the following manuals.

NOTE	**Other applicable documents**
	18-0003 Manual for Control Unit P-PC (the above Control Unit is used with 18-0006 Manual for P-PC (formerly ACWn) Software) 18-0008 Manual for Control Unit P-HMI

Explanation of the symbols and pictograms utilised

The symbols and pictograms utilised below indicate safety-relevant and important information which must be adhered to when performing an operation and to ensure safe and optimum operation.

In the documentation

Symbol/Pictogram	Description/Explanation
	GENERAL HAZARD SYMBOL (danger, warning, caution)
	ELECTRIC SHOCK HAZARD
	COMPRESSED GAS HAZARD
	EXPLOSIVE, FLAMABLE COMPRESSED GAS HAZARD
	TOXIC SUBSTANCE HAZARD (gas, solid or liquid)
	LIFTING HAZARD
	CONFINED SPACE HAZARD

	HOT SURFACE HAZARD
	BIOHAZARD
	ELECTRO STATIC DISCHARGE (ESD) SENSITIVE
	HIGH INTENSITY ULTRAVIOLET LIGHT
	DO NOT OIL
	READ AND OBSERVE INSTRUCTIONS IN MANUAL
	GENERAL INFORMATION
	WEAR PERSONAL PROTECTIVE EQUIPMENT SUITABLE TO THE WORK TASK

IMPORTANT - Please note that if the equipment described in this operating manual is used in a manner not specified by Protea Ltd, the protection provided by the equipment may be impaired.

Reasonably foreseeable inappropriate use

Reasonably foreseeable inappropriate use is deemed to have occurred if the P2000 or any accessories are used in any other way than that described in the “intended use”. Reasonably foreseeably inappropriate use includes the use of the product in a manner not intended by the manufacturer or distributor of the product but which may result from foreseeable human behaviour.

Reasonably foreseeable inappropriate use includes –

- Non application of existing or recommended safety devices
- Modifications to the product and/or control unit and other accessories
- Inappropriate connection and use of compressed gas with the product
- Not installing and supplying an instrument air supply to the standard set out in Appendix D
- Interruption of instrument air supply for an excessive duration
- Inappropriate or incorrectly connected electrical cables

This list is not exhaustive as not all possible inappropriate use can be foreseen in advance.

Legal warranty and liability for equipment defects

Protea “Terms and Conditions” can be found at

https://www.protea.ltd.uk/terms-and-conditions

Repair Policy

Protea recommends that repairs to the Protea Analyser System are only made by its own trained support staff, or by those of its distributors world-wide.

If you have the necessary technical qualifications, training and experience you may wish to make straightforward repairs in-house, and a spares list is given for this purpose. If a repair is incorrectly carried out, this may void or limit the warranty on the system. You should also note that this manual is *not* intended to describe fault-finding or repair down to component level.

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Skilled personnel

This manual addresses the specialist personnel listed below who are involved with work on the P2000 or its accessories.

Skilled personnel	Transport and storage
Transport and storage personnel are people who, due to their training, professional experience and qualification, have all the necessary skills to safely execute all actions in connection with the transport and storage of the P2000, to instruct, to recognise possible dangerous situations independently and to execute measures to avoid danger. Skills include experience with hoists, forklifts and lifting equipment and knowledge of local laws and regulations, standards and guidelines relating to transport and storage.	

Skilled personnel	Electrician
Electrician personnel are people who, due to their training, professional experience and qualification, have all the necessary skills to safely execute all actions and instruct all actions related to the electrical installation of systems, to independently foresee potential hazardous situations and implement any measures to avert any danger. Skills include the installation of industrial measurement and control technology, knowledge of AC voltage and DC low voltage power, electrical insulation and earthing, selection and termination of cables and wires to regional standards.	

Skilled personnel	Compressed gas technology
Compressed gas technology personnel are people who, due to their training, professional experience and qualification, possess all necessary capabilities to safely execute actions, and instruct all actions related to compressed gases and pressurised systems, to independently foresee potential hazardous situations and implement appropriate measures to avert any danger. The persons capabilities include, in particular, experience in handling measurement and control technology as well as knowledge of the regional applicable laws, standards and regulations for compressed gas technology.	

Safety Notes and Warning Messages

General Instructions

Safety notes indicate the potential hazard and, if appropriate the cause of the hazard, the probable consequence of ignoring the safety note and how the hazard can be avoided.

Warning messages in the instructional text precede the step-by-step procedure or may be placed just before a relevant step where the procedure described poses a hazard to personnel or the environment. Warning messages concisely indicate the potential hazard, their cause and consequences and how to avoid the hazard. Where the information about the consequences of the hazards or the measures needed to avoid the hazards are readily understood by the target audience then the warning message used in this manual may omit this information.

Safety notes and warning messages must be strictly observed in order to prevent accidents, personal injury or damage to property or impair the operation of the device.

The Safety Notes used in this manual are set out as in the example below

<table>
<tr><td>Signal Word</td><td>Type and source of danger</td></tr>
<tr><td rowspan="2"> 
Safety Symbol which may be followed by specific hazard</td><td>Possible consequences should the danger be ignored</td></tr>
<tr><td>Measure to prevent the danger</td></tr>
</table>

Signal words are set out in ISO3864-2

DANGER – There is imminent danger where non-compliance will probably result in death or serious injury.

WARNING – There is imminent danger where non-compliance could result in death or serious injury.

CAUTION – There is potential danger where non-compliance could result in minor or moderate injury.

NOTICE, ATTENTION, or TAKE CARE - These signal words are used to indicate potential risks of damage to the product or to other property.

Safety Notes used in this manual

DANGER	Electrical Shock from Live Electrical Equipment
	Death or serious injury can result through contact with live electrical equipment.
	Do not attempt to install this system unless you are qualified, competent and authorised to work on electrical equipment operating at your local mains electrical supply voltage. Read the following section in this manual in its entirety before commencing installation or maintenance of the device. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

DANGER	Compressed Gas
	Death or serious injury can result through contact with fast or suddenly escaping compressed gas or bursting system parts such as pipework. Gases used for verification of the P2000 may also present a Toxic, Flammable or explosive risk.
 	Consult local safety regulations and site safety procedures before handling compressed gas. Specific gas may present a toxic, flammable or explosive risk. Always consult local safety regulations and site safety procedures before handling toxic, flammable or explosive gases. Gas cylinders should be secured to a surface or mounted in a secured frame to protect the cylinder from damage or from impact that may result

	should the cylinder fall over. All work on the system must be carried out in the depressurised state and with the system secured against unintentional pressure build up. Gas regulators connected to gas cylinders must be turned off when performing installation, maintenance or repair actions. DO NOT make any structural changes or modifications to the P2000 to accommodate a pipe network. Set-up a safety zone around the system during all assembly, installation, maintenance and repair work. Before re-pressurising the system, check all the pipe connections and tighten if necessary. All piping should be assembled without mechanical stress. Vibration of the pipe network should be avoided using vibration dampeners. Slowly re-pressurise the system. Read the relevant section in this manual in its entirety before commencing installation or maintenance of the device and keep exactly to the step-by-step instructions given in this manual. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

DANGER	Contact with Optical Lens material presents a Toxic Hazard
	Death or serious injury could result from touching the Zinc Selenide lens material. Touching the lens material may result in residue material being digested.
	Customer specific P2000 analysers may contain long wavelength Zinc Selenide lenses. If your P2000 has such optics, this will be stated in the section of this manual entitled *Order-Specific Information*. DO NOT touch the optical component without using appropriate personal protective equipment (PPE). Refer to the Zinc Selenide material safety data sheet for safe handling and disposal information.

WARNING	Single person lift could cause injury
	Serious injury could result from lifting heavy load
	Seek assistance when moving or lifting a heavy load weighing more than 20 kg (44lbs). Lift the load correctly Bend your legs Keep your back as straight as possible Keep the load close to your body Grip the box or load at opposite corners where possible

WARNING	Inhalation of asbestos fibre presents a Biohazard
	Serious injury could result from the inhalation of asbestos fibres. Inhalation of asbestos can lead to a condition called asbestosis that leads to an increased susceptibility to cancer.
	If in doubt as to the type of insulating material in use then seek assistance or refer to plant specifications and drawings. Consider undertaking an asbestos survey if the insulation material is not specified. Strictly adhere to site health and safety regulations in regards to the safe handling and disposal of asbestos material. Ensure that you read and understand your risk assessments and method statements for working with asbestos material so that you are aware of the risks and know how the risk can be avoided. Review your asbestos survey report. Request asbestos aware training program if not previously trained. Check for asbestos warning symbols on or near the site of the insulation material. Always wear the correct PPE when handling asbestos material.

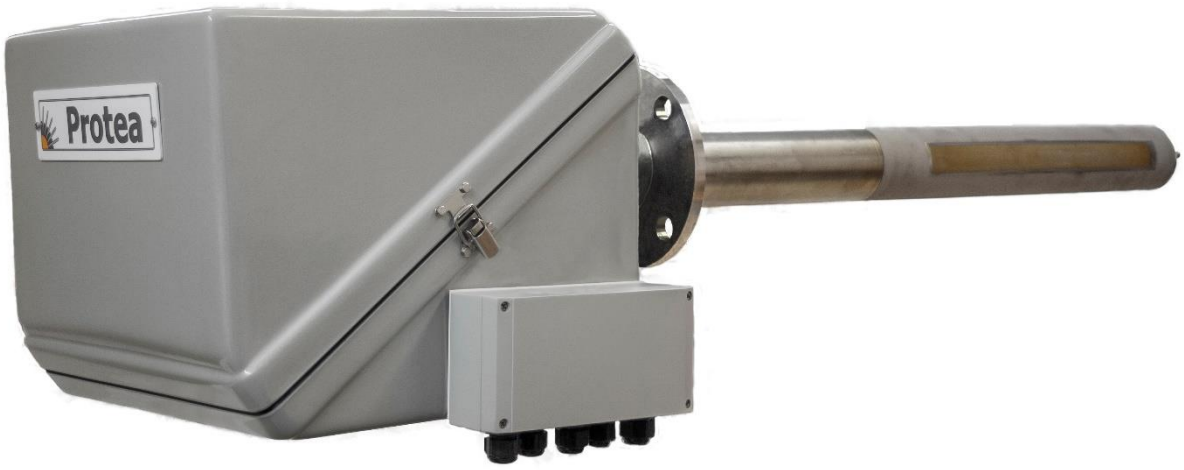
WARNING	Working in Confined Space could cause injury
	Serious injury could result from working in a confined space
	Ensure area is well ventilated Ensure area is well lit Use Personal Protective Equipment such as Knee pads if kneeling on floor Keep Entrance and Exit to the Confined space clear

WARNING	Touching Hot Surface could result in injury
	Serious injury could result from touching a hot surface
	Consult your site safety regulations or seek advice from supervisory personnel Be aware of the hot surfaces in the working area Use Personal Protective Equipment as directed by your site safety regulations such as Heat Resistant Gloves when handling hot objects Do Not Handle Hot Objects for Long periods

WARNING	Visual exposure or skin exposure to UV light could result in injury
	UV light is harmful to skin or eyes and may cause cancer.
	Avoid exposure to UV light when LED is operational. Precautions must be taken to avoid looking directly at the UV light without the use of UV light protective glasses. Use Personal Protective Equipment such as UV protective glasses as directed by your site safety regulations. DO NOT look directly at the front of the LED or at the LED's lens when the LED is operational.

ATTENTION	Damage to product may result if touched
	Device or component is sensitive to Electrostatic Discharge (ESD)
	Carefully follow the step-by-step instructions to prevent damage to the component or product. Care must be given to maintain the highest standards of compliance to the maximum electrical specifications when handling such devices. The device is particularly sensitive to any voltage that exceeds the absolute maximum ratings of the product. Any applied voltage greater than the maximum specification will cause damage and possible complete failure to the product. You must use handling procedures that prevent any electrostatic discharges or other voltage surges when handling or using the device.

Identifying the equipment



Protea P2000 Analyser with cover

Contents

1 Introduction

About this manual

This manual provides information for use of the P2000 series of analyser units. Information for use is provided so that the product can be used safely, effectively, and efficiently. This information has been prepared in accordance with BS EN 82079-1:2020 *Preparation of information for use (instructions for use) of products*.

The manual has been divided into the following sections

Introduction	This section presents an overview of the manual and the CEMS system with sources of further information and product support.
Installation	This section provides information on unpacking the system and the installation of the system.
Commissioning	This section describes the order that should be followed to connect services (air, power, and communication) to the P2000 and the appropriate Control Unit. The insertion of the P2000 into the stack is also described.
Operation	You should refer to additional documentation for the operation of the P2000 via the appropriate Control Unit. The P2000 as stand-alone product has no accessible controls or indicators.
Technical Specification	This section provides the specification for the P2000 and the integral Auto Verification Unit.
Inspection Schedules	This section provides information on quarterly and annual inspection schedules. Instructions are also provided for performing a field calibration check. A list of available spare parts is also provided.
Disposal Instructions	This section describes how the P2000 and its associated components should be safely disposed of without damage to the environment.
Transport and Storage	This section provides information that should be used to protect the P2000 and the safety of persons during transportation and storage.
Order-specific information	Gives additional information specific to the instrument you have purchased.

Appendix A	Gives details of the ATEX and IECEx approvals, which may be applicable.
Appendix B	Describes the P2000 with MCERTS approval
Appendix C	Describes issues surrounding US EPA compliance
Appendix D	Provides details of the Protea quality standard for Instrument air
Appendix E	Describes the Air Preparation Panel that Protea recommends for use with the P2000
Appendix F	Describes the local power supply unit that can be used to supply 24V to the P2000
Appendix G	Describes the In-situ Heater and how the in-situ heater should be installed
Appendix H	Describes the Hot Access Port used for moisture calibration
Appendix I	Describes the By-Pass for high temperature applications or applications where the stack or duct prevents the analyser from being fully inserted into the process.
Appendix J	Describes the In-Situ Steam heater for flue gas temperatures below 120º (248ºF)
Appendix K	Describes the Steam Heated By-Pass for use in Hazardous area applications where stack or duct prevents the analyser from being fully inserted into the process.
Appendix L	Describes the P2000D option where a UV source is used to measure low range gas concentrations in addition to an IR source.
Appendix M	Describes a special in-situ heater (Heater tape version) for Hazardous Areas
In-service history	Provides a template list for recording service inspections and repairs

About the P2000 series

The P2000 series is a range of high-performance infrared gas process/emission analyser systems. These systems are intended to be used for measuring gas concentrations, particularly in continuous industrial processes and flue stacks. The P2000 has the capability to measure up to six process gases.

A technical note describing the working principles behind the infrared system is available as a separate technical document. Every system including a P2000 Analyser Unit also incorporates an Analyser Controller. An In-Situ Heater (ISH) is available as an option, other options such as By-Pass, In-Situ Cooler (ISC), In-Situ Steam Heater (ISSH) and Steam heated By-Pass are described in the Appendices of this manual. Protea recommends the use of the Protea Air Preparation Panel and the Protea Power Supply unit with the P2000. The accessories and options described above are available upon request.

P2000 - an overview

Figure 1-1 shows a diagram of the P2000 system. The in-situ probe of the analyser is fitted into the process duct. The in-situ sample cell consists of sintered panels that allow the gas under study to permeate through the sample cell. Infrared radiation from the infrared source passes through the sample gas. The infrared radiation is reflected by a sample mirror located at the end of the in-situ probe. The reflected infrared radiation passes back through the sample gas to the detector assembly.

The P2000 has a built in Auto Verification Unit (AVU) which enables both automatic and manual purging of the In-Situ Sample Cell.

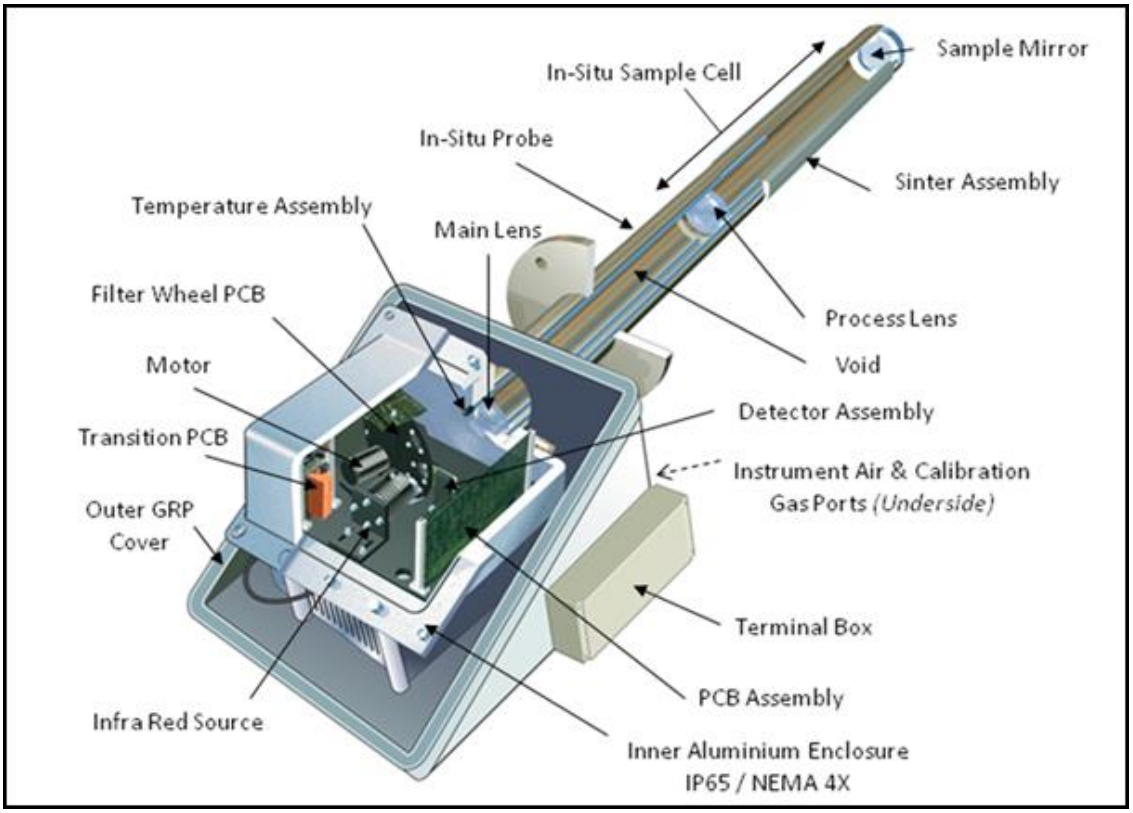


Figure 1-1 P2000 Overview Diagram

Figure 1-2 shows various interconnections between different parts of the P2000 system. Optional outputs from the P-PC control unit can be connected to external devices such as chart recorder, personal computer, alarm, web browser, printer, digital I/O, network, etc.

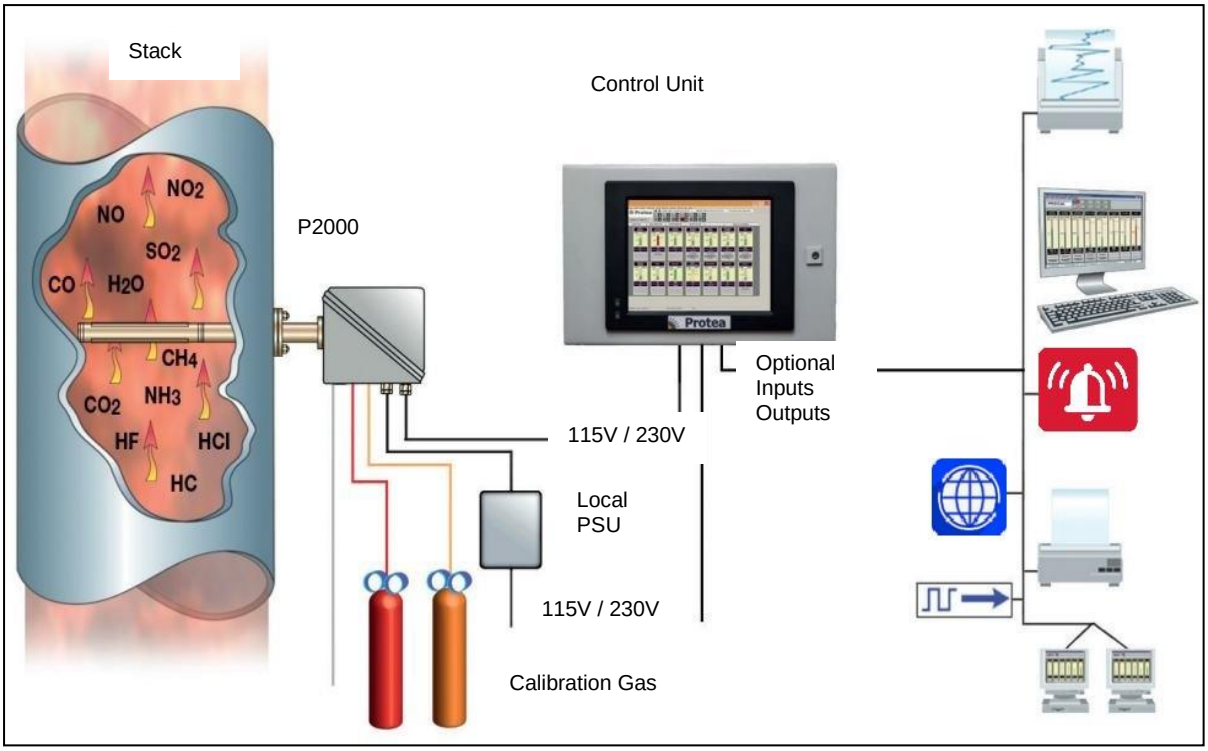


Figure 1-2 P2000 system schematic

Documentation conventions

Abbreviations

Within this manual, the following abbreviations are used:

Abbreviation	Meaning
IOU	Input Output Unit
IR	Infra-Red
ISH	In-Situ Heater
ISC	In-Situ Cooler
AU	Analyser Unit
AVU	Auto Verification Unit
GRP	Glass Reinforced Plastic

Lists

Often in this manual, instructions or information are presented in list form. Use of black squares ■■■ indicates that there is no special order to the instructions or information. However, when instructions are numbered, it is important that the individual instructions or points are followed sequentially.

Figures

Figures in the text are always numbered in the form *Figure X-Y*, where *X* is the section number, and *Y* is the sequential figure number within that section. For example, *Figure 3-2* is the second figure in section 3. When a figure reference is in brackets (Figure 9-4), this refers you to that figure, usually to confirm the location of a component, control or indicator.

Screen displays

Screen displays on the P2000 are presented in this manual as approximations. When values are shown on screens, it should be remembered that these appear by way of example only. It is highly unlikely that the values displayed on your screen will be the same as in this manual.

Some systems will have different screens because of custom modifications. If so, this will be highlighted in the section of this manual entitled *Order-specific information*.

Screen messages, prompts or options are repeated in text in a different typeface to the main text, for example: Auto-zero NOW.

Italics

Paragraphs in italics usually indicate background information which may be of benefit to the reader. Groups of words in italics are usually cross-referring the reader to a section or sub-section by name.

Dimensions

All dimensions in this *Operating Manual* are in mm (millimetres) unless otherwise indicated.

Analyser Identification

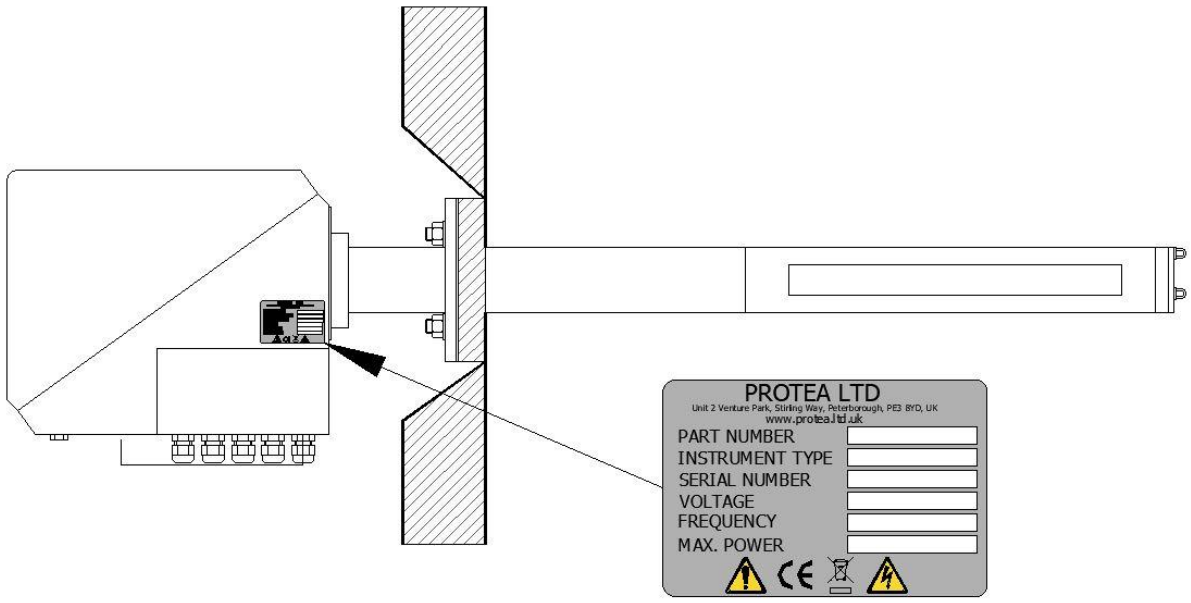


Figure 1-3 Location of P2000 Identification label

It is important to identify the analyser and ensure it is correctly located especially in multi analyser systems. The identification label is shown in figure 1-3.

If the identification label is missing or not legible then refer to the serial number label that is located on the base plate of the analyser (see figure 1-4)

In all correspondence associated with the analyser please use the serial number. – see below for the address for correspondence.

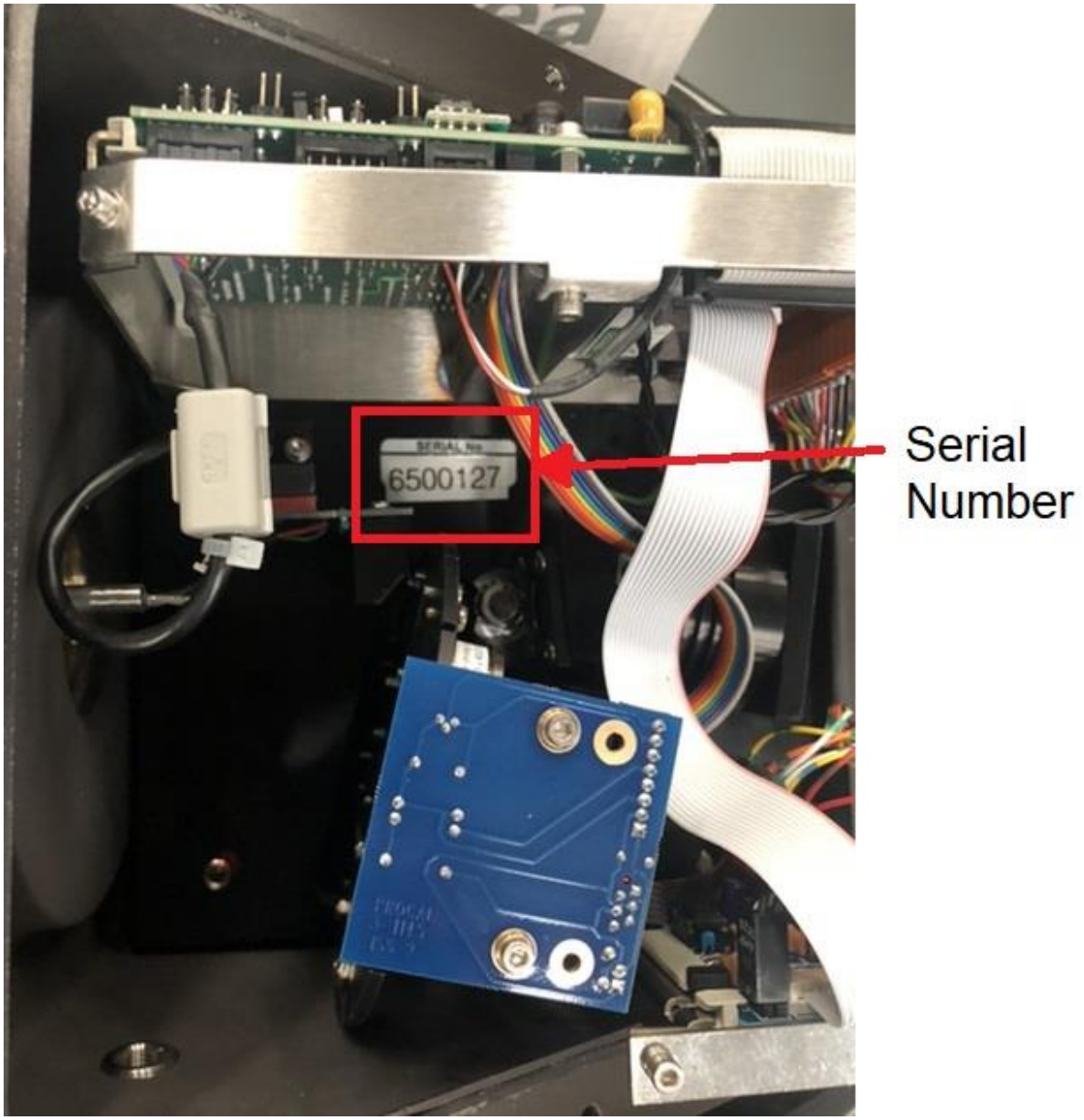


Figure 1-4 Location of Serial Number inside P2000

Further information

This Operating manual should give you all the information you require to install, commission, operate and dispose of your P2000 system. If you require any further information regarding the system or its use, you should contact Protea Ltd., or your Protea-authorised Protea distributor as shown in the panel below:

Sales & Manufacturing	Customer service and tools
Protea Ltd 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk	**Protea Ltd** 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk
For Protea Distributor information see www.protea.ltd.uk/global-network	

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2 Installation

IMPORTANT - Please read the Safety Warnings below before performing any functions set out in this section of the manual.

SAFETY WARNINGS

DANGER	Electrical Shock from Live Electrical Equipment
	Death or serious injury can result through contact with live electrical equipment.
	Do not attempt to install this system unless you are qualified, competent and authorised to work on electrical equipment operating at your local mains electrical supply voltage. Read the following section in this manual in its entirety before commencing installation or maintenance of the device. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

WARNING	Inhalation of asbestos fibre presents a Biohazard
	Serious injury could result from the inhalation of asbestos fibres. Inhalation of asbestos can lead to a condition called asbestosis that leads to an increased susceptibility to cancer.
	If in doubt as to the type of insulating material in use, then seek assistance or refer to plant specifications and drawings. Consider undertaking an asbestos survey if the insulation material is not specified. Strictly adhere to site health and safety regulations regarding the safe handling and disposal of asbestos material. Ensure that you read and understand your risk assessments and method statements for working with asbestos material so that you are aware of the risks and know how the risk can be avoided. Review your asbestos survey report. Request asbestos aware training program if not previously trained. Check for asbestos warning symbols on or near the site of the insulation material. Always wear the correct PPE when handling asbestos material.

WARNING	Single person lift could cause injury
	Serious injury could result from lifting heavy load
	Seek assistance when moving or lifting a heavy load weighing more than 20 kg (44lbs). Lift the load correctly Bend your legs Keep your back as straight as possible Keep the load close to your body Grip the box or load at opposite corners where possible

WARNING NOTICES

ATTENTION	DAMAGE TO EQUIPMENT
	Damage to the product may result if the P2000 analyser is inserted into the duct or stack without the instrument air purge being switched on. if electrical installation is not performed as per the installation instructions. if the factory-set optical components are adjusted or re-aligned. Adjustment of any optical components may invalidate the warranty and will almost certainly prevent the analyser from functioning properly.
	Carefully follow the step-by-step instructions to avoid damage to the analyser.

Introduction

This section describes how to install the standard P2000 Analyser.

Unpacking the system components

If this has not already been done, unpack the system components and check that they correspond to the units ordered and listed on the accompanying packing note. If there is any discrepancy, or any damage is apparent, do not attempt to install the system. Contact Protea, or your Protea-authorised Protea Distributor.

General description of packaging

The standard packaging consists of a rectangular cardboard container fastened to a wooden pallet by four galvanised nails. The P2000, In-Situ Heater and Control Unit are normally placed together in the same packaging container with the P2000 probe placed inside the In-Situ Heater. The products are protected from impact and vibration by polyurethane packing material that is formed and moulded around the products. The container is sealed with packing tape and nylon strapping which is secured with stainless steel tensioners. If special packaging requirements are needed, then please contact Protea for your Order Specific Packaging requirements.

Procedure for unpacking the system

Step	Method to remove packaging
1	Cut and remove the nylon strapping
2	Cut and remove the packing tape to open the package
3	Open the packaging and remove the documentation
4	Retain the documentation pack for future reference
5	Remove the polyurethane packing material
6	The P2000 has a weight of 25 kg (55 lbs) without the GRP cover (35 kg (77.2 lbs) with the GRP cover) and should therefore be lifted out of the container by two people.
7	Place the P2000 in a horizontal position on a flat surface
8	Check the list of items in the package against the delivery note

Location of items accompanying the P2000

Parts required for installation are packaged separately such as the key and wall mounting bracket for the P-HMI or P-PC Control unit. Gaskets for the analyser and in-situ heater flanges are packed between boards of card and placed inside the head cover as shown below (see Figure 2-1)

Figure 2-1 Cabinet key, wall Mounting bracket and flange gaskets

Safe disposal of packaging materials

The packaging material should be recycled where possible or disposed of in compliance with the requirements of environmental protection and waste disposal legislation and any local regional authority requirements.

NOTE - Protea recommends retaining the foam packaging section placed at the base of the P2000 analyser. This section of foam can be used to safely rest the analyser on a flat surface prior to installation.

Material	Recyclability	Recycling Information
Cardboard		The cardboard packaging can be recycled or retained for future use (e.g. for the returning of the product to Protea for future upgrade).
Wooden Pallet		The wooden pallet can re-used or recycled.
Nails & Tensioners		The galvanised nails and steel tensioners can generally be recycled.
Nylon Strapping		Nylon, like other types of plastic, strapping can be economically recovered and recycled into new plastic products. Recycling nylon strapping can form part of an effective waste management system, removing difficult waste from the work site and avoiding landfill costs.
Polyurethane Packaging		The Polyurethane packaging material is not generally recyclable but can be retained for future use. The polyurethane packaging material contains a mixture of urethane foam resin and polymeric isocyanate.

Pre-installation information

IMPORTANT - Before installing the system, you must confirm that:

A competent person will install the P2000 system (see Skilled Personnel in the pre-introduction section of this manual).

Suitable locations are available for all components of the system to be installed

With reference to the instrument serial number check the analyser is being installed in the correct location regarding your site system plan documents.

A suitably fused, switched, mains electrical power is available at 115 V / 230 V single-phase 50-60 Hz 1240W (240W if in-situ heater not included), adjacent to where the AU will be fitted. (1480W for P2000D UV/IR analyser (480W if in-situ heater not included).

Sufficient working space for two people to work is available around the point at which each AU is to be fitted. The working platform should be adequately fenced. You should refer to your site layout plan or to local codes and regulations regarding working space requirements for the analyser deployment.

Clean and dry instrument air, (Protea Standard *ISO 8573-1:2010 0 3 1* see Appendix D) for the analyser purge, auto-zero and sample cell protection is available adjacent to where the AU will be fitted. Pressure regulated to 6.0 Bar Gauge maximum (nominal inlet pressure of 2.5 to 3 Bar Gauge to the AU AVU). Flow rate of 1 l/min (constant) and 6 l/min (intermittent) during Auto-zero operation (typically 5 minutes every 12 hours).

NOTE – Flexible piping of sufficient length must be used between the air filtration system and the analyser to allow the removal of the analyser from the process stack or duct without having to disconnect the air supply (see *Order Specific Information*).

The cable route from the Control Unit to the P2000 is not more than 1,000 metres (greater distances may be possible: please consult Protea).

NOTE - The interconnection cables shall be of sufficient length to allow the removal of the analyser from the process stack or duct without having to disconnect the power or communication cables (see *Order Specific Information*).

All the interconnecting cables specified in this installation procedure are available from Protea.

In the section of this manual entitled *Order-specific information*, you will find drawings which may be useful during installation. The precise nature of these drawings will vary, the power source electrical voltage, the options supplied and the configuration.

Location

Suitable measurement sections and measurement sites are necessary to obtain reliable and comparable emission measurement results. Normally, suitable measurement sections and measurement sites are incorporated into the plant design.

For regulations and guidance on sampling location you should always consult your local or national environmental authority.

The European standard BS EN 15259:2007 specifies "Requirements for measurement sections and sites and for the measurement objective, plan and report".

For example, BS EN 15259:

- specifies requirements for stack emission monitoring measurement locations
- applies to both periodic measurements and to continuous emission measurement systems
- outlines the sampling strategy required to obtain a representative sample

Emission measurements require appropriate measurement ports and working platforms. Therefore, the installation of measurement ports and working platforms should be taken into account at the planning phase of a measurement section.

Safety must be considered at the earliest point in the monitoring strategy and must be given the highest priority. There are many hazards associated with stack monitoring and hazards will differ from site to site. It is recommended that, as a minimum, the potential hazards should be assessed using a risk assessment approach and appropriate mitigation be applied.

Preparing the process gas duct –

An optimum analyser installation into the process duct is shown below in figure 2-2.

A special flange as shown in figure 2-3 must be welded directly to the process duct to form a gas-tight entry. This flange may be manufactured from a 3” inch, 150 lb ANSI flange. This flange is available from Protea (Protea Part Number 3-0169).

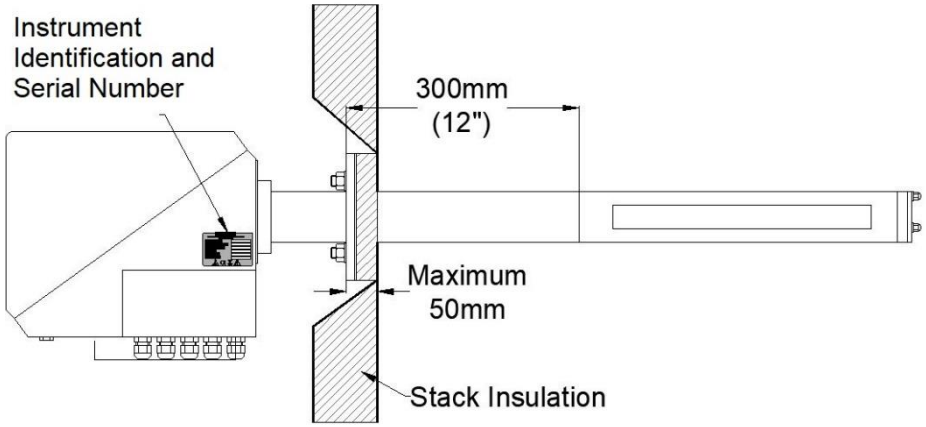


Figure 2-2 Drawing showing optimum flange installation

The mating surface of the process duct flange must be of a quality that will allow a gas-tight joint to be made when a gasket is used between the flange and the Analyser Unit (or In-Situ Heater if fitted).

NOTE – The installation of an In-Situ Cooler requires a larger 4” inch flange (Protea Part Number 3-0170).

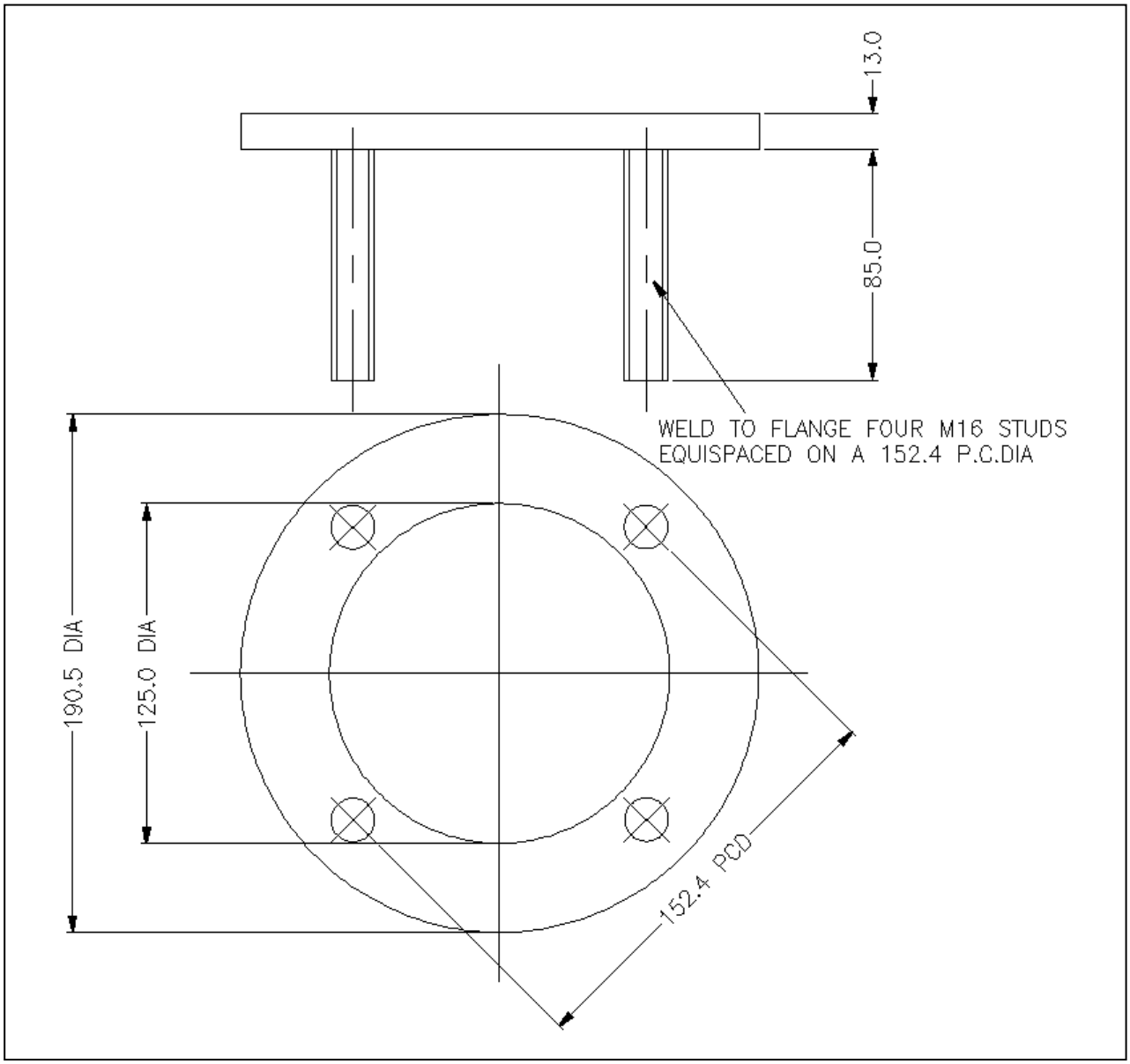


Figure 2-3 Flange Mounting (Protea Part 3-0169)

The use of a flange and stub arrangement should be avoided unless absolutely necessary, since this could lead to acidic condensation forming. Figure 2-4 shows the preferred mounting arrangement for the flange.

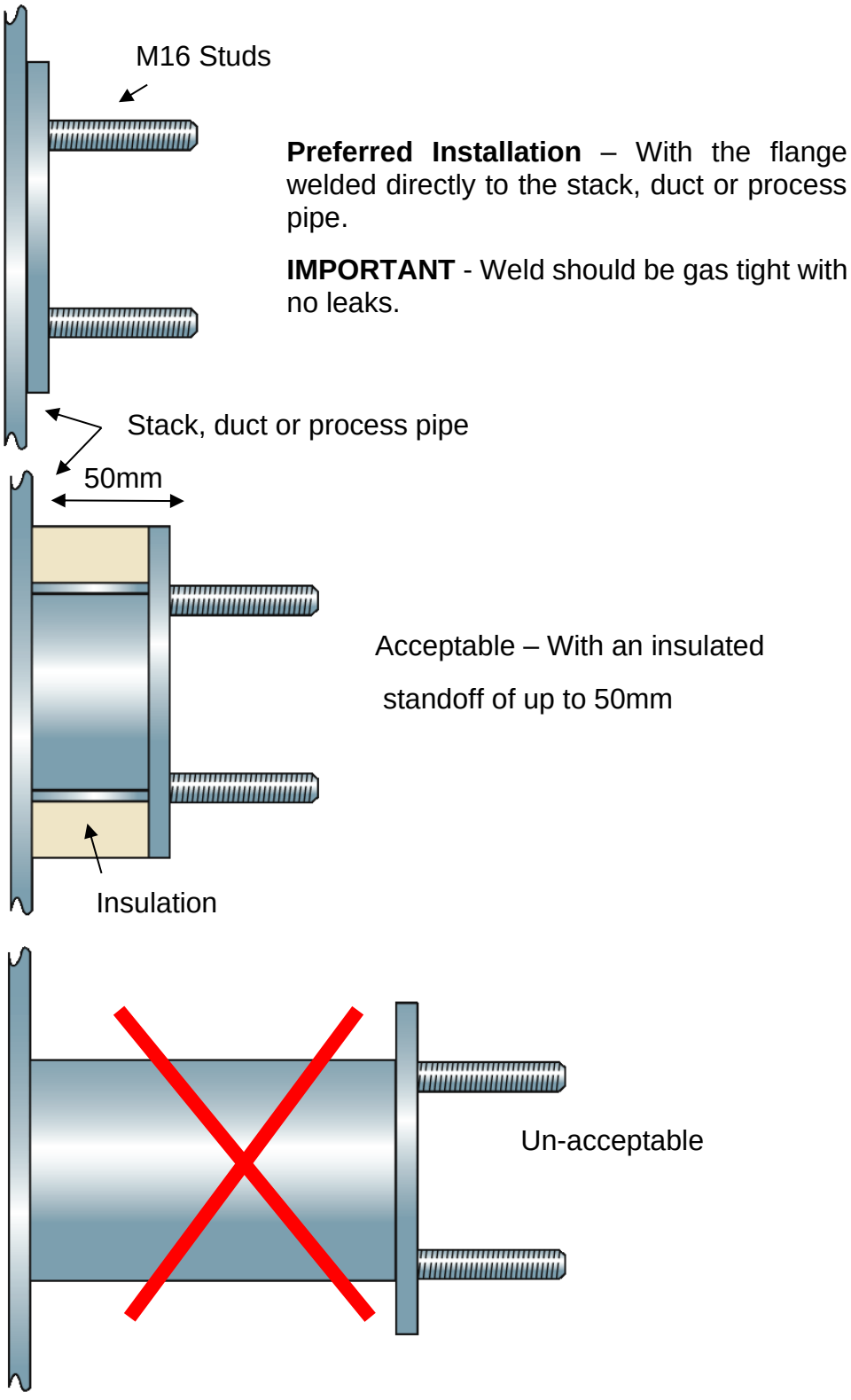


Figure 2-4 Preferred mounting arrangement for the flange

The studs should be aligned so that they are 45 degrees to the X-Y axis as shown in figure 2-5. This will ensure that the analyser will be at the correct orientation when the analyser is inserted into the stack or duct.

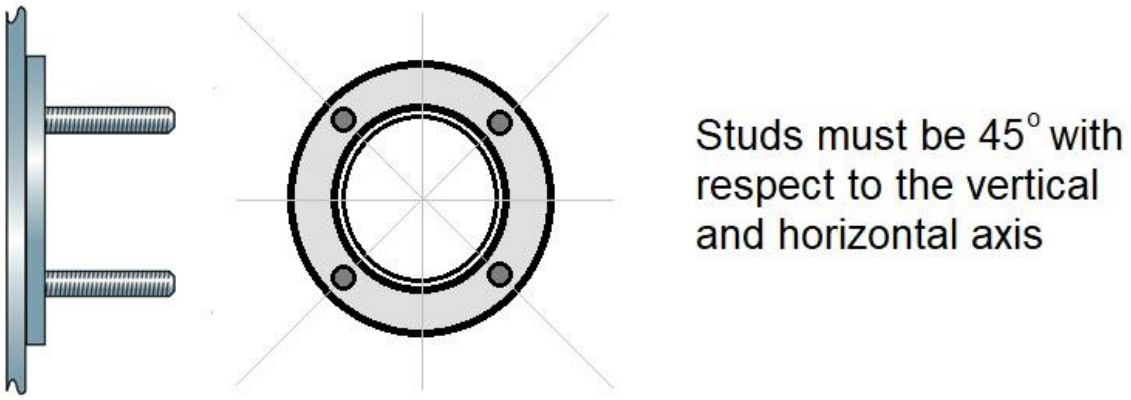


Figure 2-5 Orientation of the Protea standard flange

Re-fitting insulation

Normally, the flange installation process requires the removal of a large section of insulation from the stack wall. It is important to protect the analyser unit from radiated heat from the stack or duct. You should therefore refit the insulation around the flange so that radiated heat is minimised.

Attention should be drawn to the type of insulation material. Older plant constructions may have asbestos insulation material therefore extreme care should be taken.

Drilling the Control Unit Gland Plates

The P2000 is supplied with either a P-HMI or P-PC type Control unit. The Control Unit is designed to be wall mounted in a control room, shelter or other designated location. A wall mounting bracket is supplied with the P-HMI and the P-PC. The key for the door of the Control Unit is wrapped separately in bubble-wrap and supplied inside the Control unit packing container.

The P2000 and the appropriate Control unit are interconnected using cables and wires as specified in Table 2-1 below or as per relevant installation drawings in the *Order-specific Information* section of this manual.

Located on the base of the Control Unit is a cable gland plate (see figures 2-6 and figures 2-7). The interconnection cables are designed to pass through cable glands secured to the cable gland plate. The cable gland plate is supplied as a blank plate (*undrilled*).

NOTE - You should consider the installation drawings found in the *Order-specific Information* section to determine the number of cable gland holes that are required for the installation prior to drilling the gland plate.

IMPORTANT – You must remove the blank gland plate from the Control Unit before drilling holes for the cable glands (see figure 2-8).

After the drilling operation the gland plate should be thoroughly cleaned to remove any metal particles or swarf from the surface of the gland plate. Any residue metal left on the surface of the gland plate could result in a short circuit when the gland plate is re-fitted to the Control Unit and present a potential hazard of electric shock to an operator and/or damage the equipment.

ATTENTION

Wear appropriate PPE such as safety eye goggles when drilling or cutting the holes in the gland plate.

IMPORTANT – All unused gland holes must be sealed before commissioning the analyser.

Figure 2-6 P-HMI Control Unit

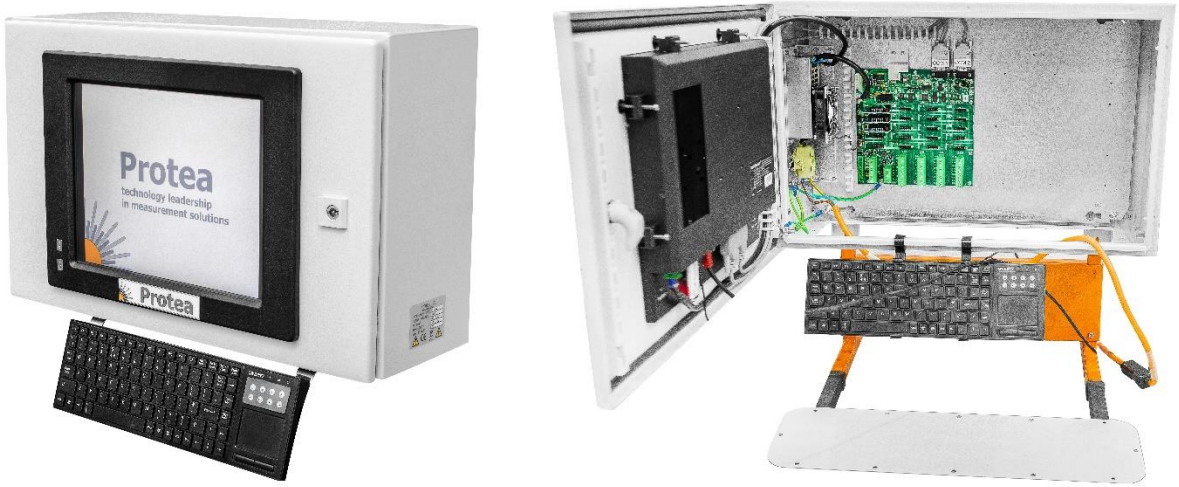


Figure 2-7 P-PC (formerly ACWn) Control Unit

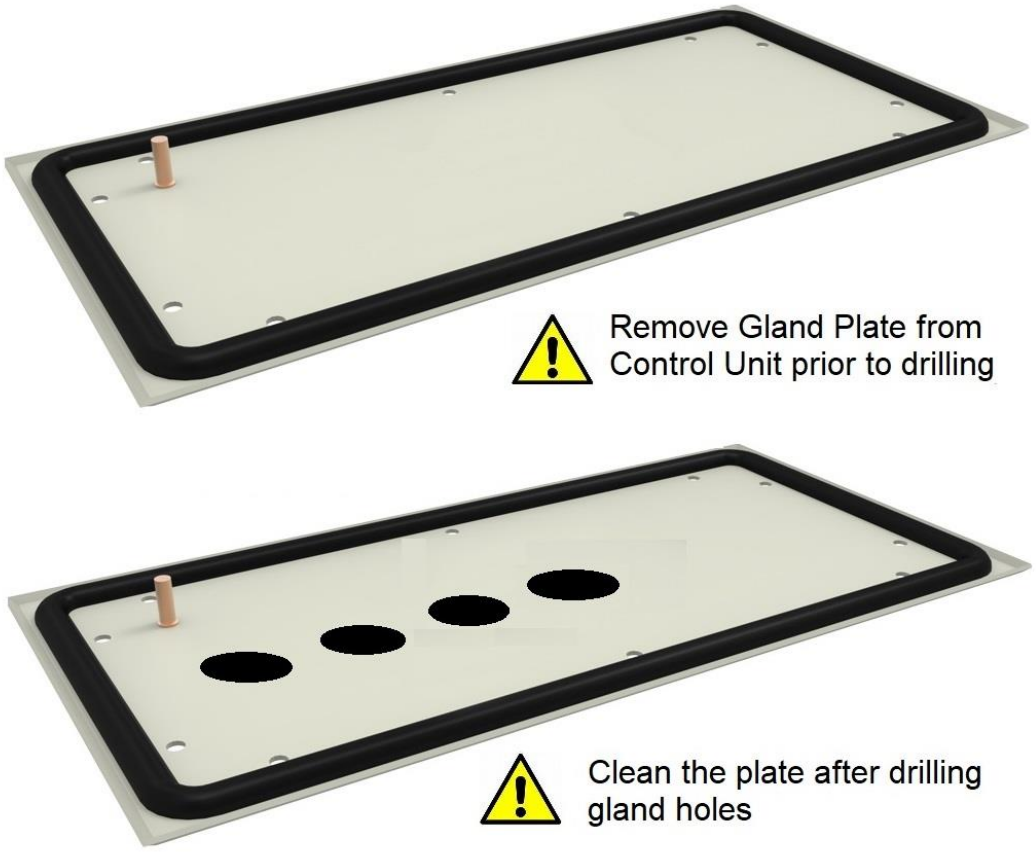


Figure 2-8 Remove the gland plate from Control Unit before drilling holes

Preparing the Analyser Unit for Wiring

During preparation of the Analyser Unit, you may need to refer to the relevant wiring table or *Order-specific information* installation drawing in the section of this manual, particularly if you will be making up your own interconnecting cables.

1. Place the Analyser Unit (AU) carefully on the ground or workbench, such that it is stable and horizontal. The retained foam base from the original packaging can be used when performing this operation to prevent damage to the analyser.
2. Remove and retain the four 5mm pozi-drive screws securing the cover of the Junction Box to access the Terminals on the side of the GRP cover (see Figure 2-9 below).

NOTE - If the junction box on your analyser is different to that shown below refer to your original manual or contact Protea for further information on previous instrument versions.

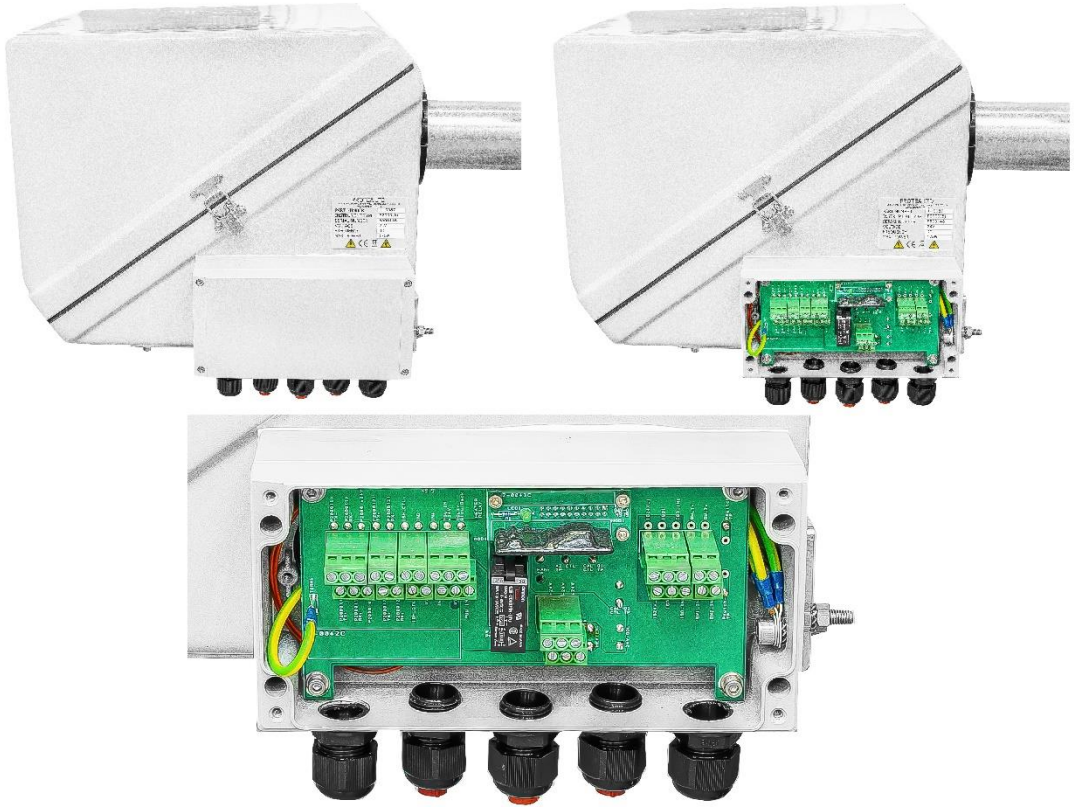


Figure 2-9 P2000 Junction Box

3. Identify the system wiring configuration to suit your installation – See Tables 2-1 for diagrams of the different options and the appropriate wiring information.

Options	Arrangement of Units
Option 1	Analyser (AU) → Protea P-HMI Control Unit with Local Power Supply Unit (PSU)
Option 2	Analyser (AU) → Protea P-PC Control Unit (formerly ACWn) Software with Local Power Supply Unit (PSU)
Option 3	Analyser (AU) → Protea Local Power Supply Unit (PSU) → Protea Control Unit
Option 4	Analyser (AU) → Protea Local Power Supply Unit (PSU) → Protea P-PC (formerly ACWn) Software

IMPORTANT – The power cable between the PSU and the analyser should be less than 5 metres. The communication interconnection cable from the Control Unit to the P2000 should be limited to no more than 1,000 metres. (Please consult with Protea if longer distances are required). The power cable and communication interconnection cable should be of sufficient length to allow the analyser to be removed from the stack or duct without disconnecting the cables.

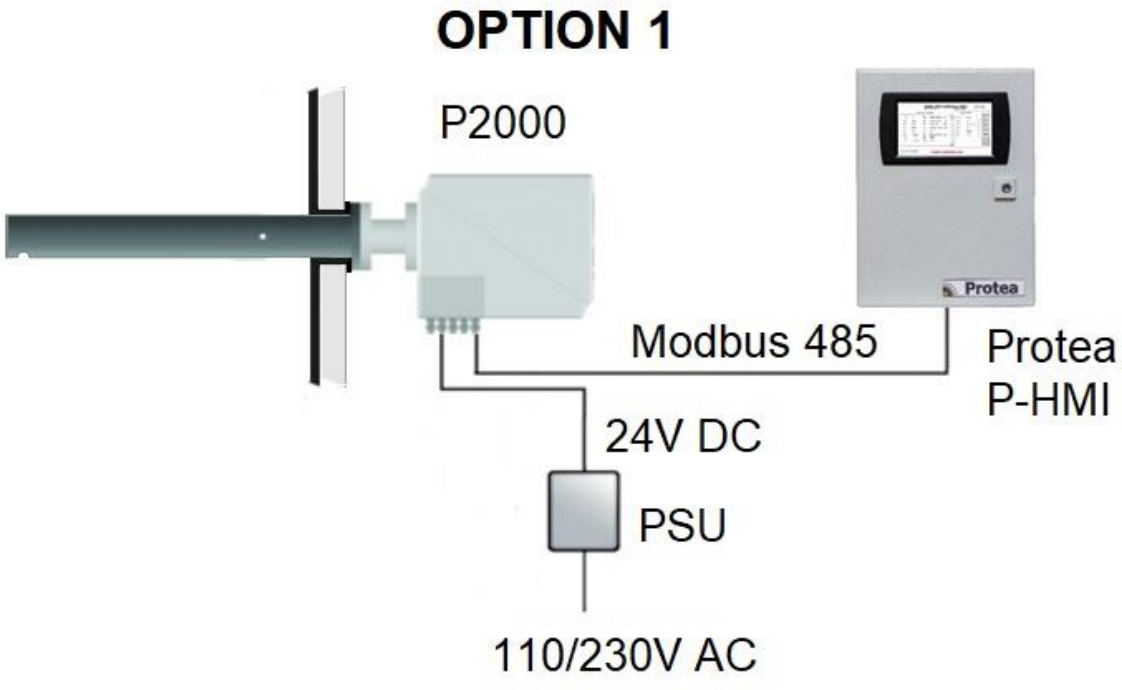
4. Locate the relevant cable as identified in the wiring tables (see Table 2-1).
5. Gently feed this end of the cable through the cable gland underneath the AU junction box. You should leave a 'loop' in the cable so that the AU can be withdrawn from the process duct without disconnecting the cable.
6. Repeat this procedure for all cables as indicated in the wiring table relevant to the installation.

Figure 2-10 View inside P2000 Junction Box

IMPORTANT – The P2000 Junction Box “Earth Terminal” connection is required. The Earth terminal must be bonded to local earth. The earth cable should be rated for 240W at either 230 or 115 Volts (or 480W for P2000D UV/IR analyser). When an in-situ heater is fitted the earth cable should be rated for the ISH isolator over current limits.

Wiring Tables

Option 1 - Analyser → Protea P-HMI Control Unit with Power Supply Unit (PSU)

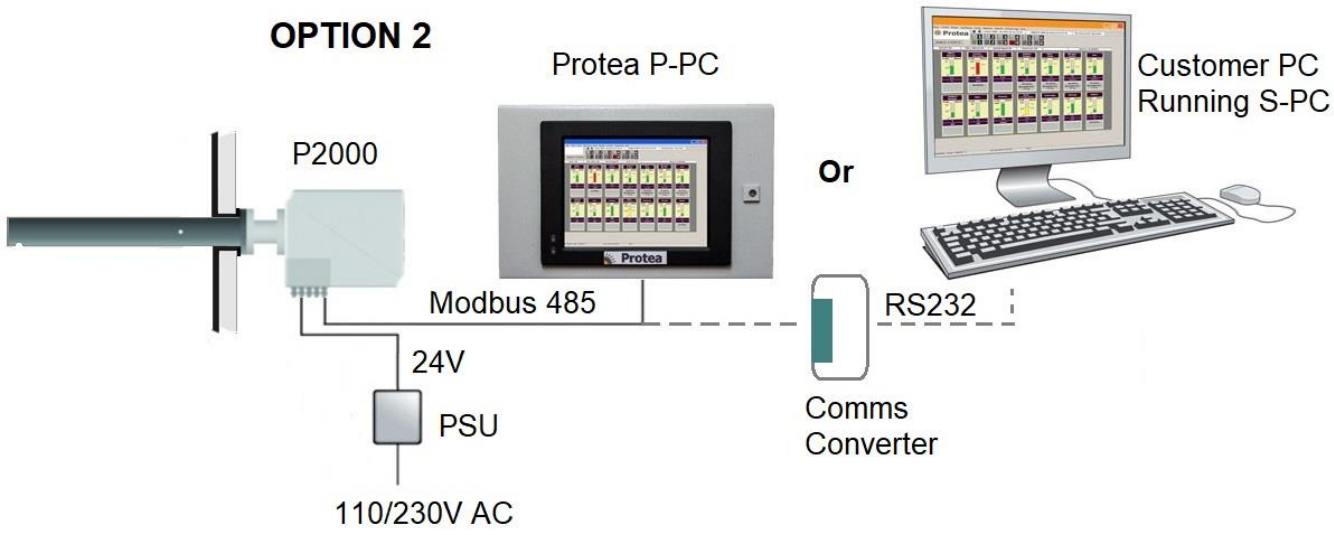


Function	AU Junction Box	Protea Control Unit	Cable Specification
Data Return R-	P2000(1) Tx-	TS6 – 1	Cable Type 13 2 Twisted pair cores with O/All screens. Nominal characteristics Znom 120ohms Belden 9842 or equivalent
Data Return R+	P2000(1) Tx+	TS6 – 2	
Data Out T-	P2000(1) Rx-	TS6 – 3	
Data Out T+	P2000(1) Rx+	TS6 – 4	
Screen	External Earth Terminal	Earth Terminal on internal pcb 2-1168	
+24 V	PSU IN +24V	From PSU 24V (terminal 4)	Cable Type 5 2 core 2.5mm^2 (screened)
0V	PSU IN -	From PSU 0V (terminal 5)	

NOTE – The PSU is supplied with a pre-wired 24V cable with the cable screen connected to an internal earthing point.

Function	From AC Supply	PSU	
LIVE (L)	Live	L	Cable Type 1 3 core 2.5mm^2
NEUTRAL (N)	Neutral	N	
EARTH (E)	Earth	⏚	

Option 2 - Analyser → Protea P-PC (formerly ACWn) with Power Supply Unit (PSU)

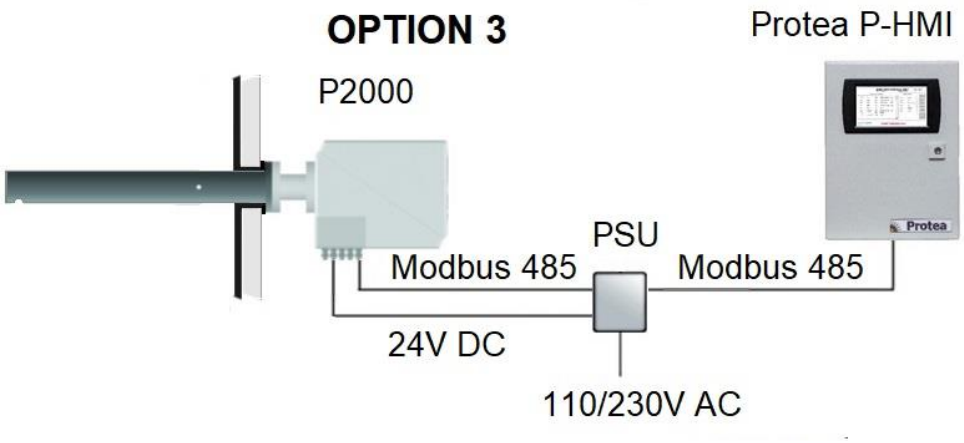


Function	AU Junction Box	Protea P-PC (formerly ACWn) Software	Customer PC with Comms Convertor	Cable Specification
Data Return R-	P2000(1) Tx-	TS6-1	Refer to your comms converter data sheet	Cable Type 13 2 Twisted pair cores with O/All screens. Nominal characteristics Znom 120ohms Belden 9842 or equivalent.
Data Return T+	P2000(1) Tx+	TS6-2	Refer to your comms converter data sheet	
Data Out T-	P2000(1) Rx-	TS6-3	Refer to your comms converter data sheet	
Data Out T+	P2000(1) Rx+	TS6-4	Refer to your comms converter data sheet	
Screen	External Earth terminal	Earth Terminal on internal pcb 2-1168	Refer to your comms converter data sheet	
+24 V	PSU IN +24V	From PSU 24V (terminal 4)	From PSU 24V (terminal 4)	Cable Type 5 2 core 2.5mm^2 (Screened)
0V	PSU IN -	From PSU 0V (terminal 5)	From PSU 0V (terminal 5)	

NOTE – The PSU is supplied with a pre-wired 24V cable with the cable screen connected to an internal earthing point.

Function	From AC Supply	PSU		Cable Specification
LIVE (L)	Live	L		Cable Type 1 3 core 2.5mm^2
Neutral (N)	Neutral	N		
EARTH (E)	Earth	⏚		

Option 3 Analyser → Power Supply with through Comms terminals → Protea P-HMI Control Unit

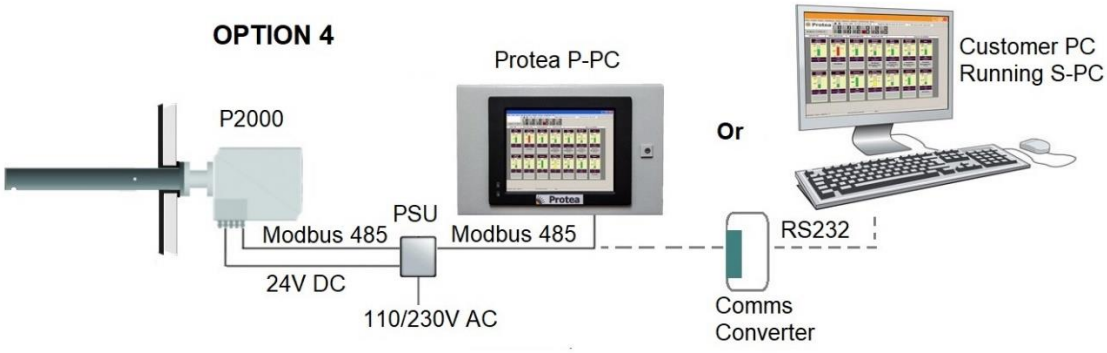


Function	AU Junction Box	Protea Power Supply Assembly with Comms		Protea Control Unit	Cable Specification
	Cable 1	Cable 1 (IN)	Cable 2 (OUT)	Cable 2 (IN)	Cable type 13 2 Twisted pair cores with O/All screens. Nominal characteristics Znom 120ohms Belden 9842 or equivalent.
Data Return R-	P2000(1) Tx-	Tx- (terminal 7)	Tx- (terminal 7)	TS6 - 1	
Data Return R+	P2000(1) Tx+	Tx+ (terminal 6)	Tx+ (terminal 6)	TS6 - 2	
Data Out T-	P2000(1) Rx-	Rx- (terminal 9)	Rx- (terminal 9)	TS6 - 3	
Data Out T+	P2000(1) Rx+	Rx+ (terminal 8)	Rx+ (terminal 8)	TS6 - 4	
Screen	External Earth terminal	Earth Terminal	Earth Terminal	Earth Terminal on internal pcb 2-1168	
+24 V	PSU IN +24V	24V (terminal 4)	N/A	N/A	Cable type 5 2 core 2.5mm² (screened)
0V	PSU IN -	0V (terminal 5)	N/A	N/A	

NOTE – The PSU is supplied with a pre-wired 24V cable with the screen connected to an internal earthing point.

Function	From AC Supply	PSU			Cable specification
LIVE (L)	Live	L			Cable Type 1 3 core 2.5mm²
NEUTRAL (N	Neutral	N			
EARTH (E)	Earth	⏚			

Option 4 Analyser → Protea Power Supply → Protea P-PC (formerly ACWn) Software

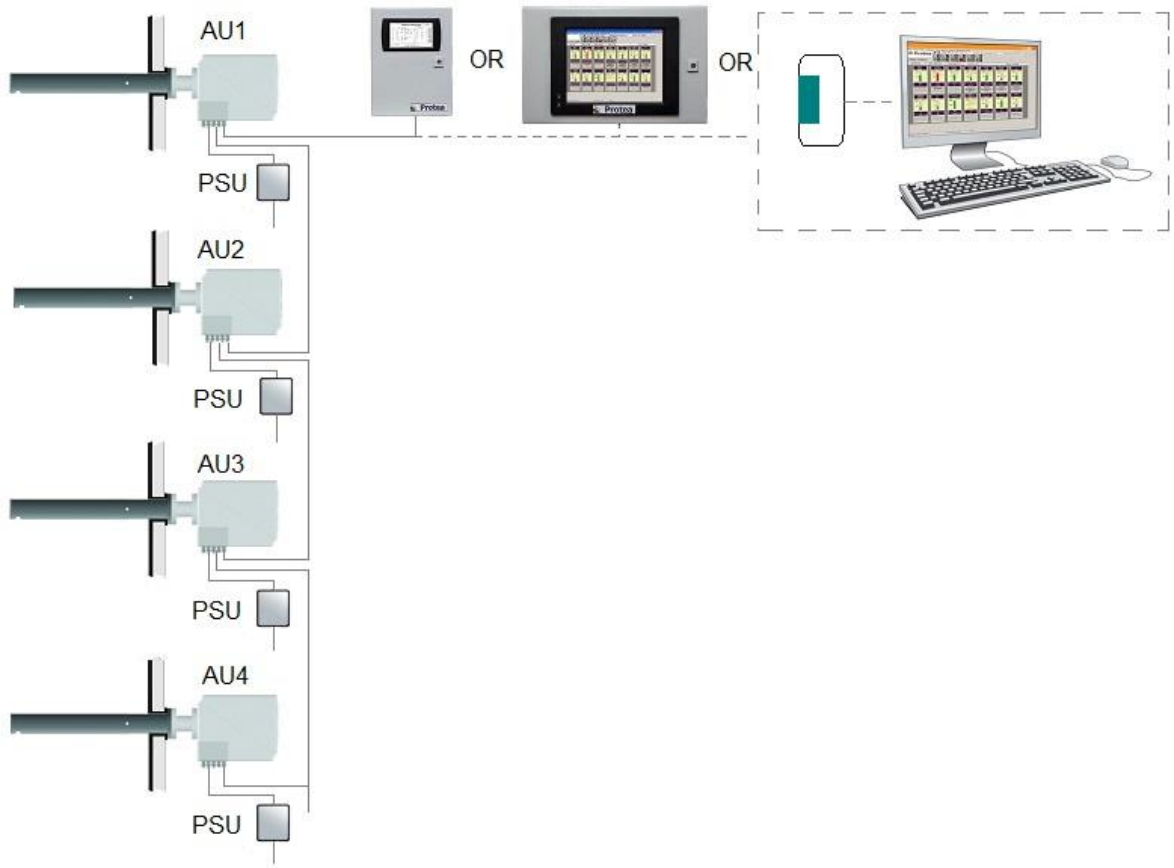


Function	AU Junction Box	Local Power Supply Assembly with Comms		Protea P-PC (formerly ACWn) Software	Customer PC with Comms Converter	Cable Specification
		IN	OUT			
Data Return R-	P2000(1) Tx-	Tx- (terminal 7)	Tx- (terminal 7)	TS6-1	Refer to your comms converter data sheet	Cable Type 13 2 Twisted pair cores with O/All screens. Nominal characteristics Znom 120ohms Belden 9842 or equivalent.
Data Return R+	P2000(1) Tx+	Tx+ (terminal 6)	Tx+ (terminal 6)	TS6-2	As above	
Data Out T-	P2000(1) Rx-	Rx- (terminal 9)	Rx- (terminal 9)	TS6-3	As above	
Data Out T+	P2000(1) Rx+	Rx+ (terminal 8)	Rx+ (terminal 8)	TS6-4	As above	
Screen	External Earth terminal	Earth Terminal	Earth Terminal	Earth Terminal on internal pcb 2-1168	As above	
+24 V	PSU IN +24V	24V (terminal 4)	N/A	N/A		Cable Type 5 2 core 2.5mm^2 (screened)
0V	PSU IN -	0V (terminal 5)	N/A	N/A		

NOTE – The PSU is supplied with a pre-wired 24V cable with the screen connected to an internal earthing point.

Function	From AC Supply	PSU				Cable specification
LIVE (L)	Live	L				Cable Type 1 3 core 2.5mm^2
NEUTRAL (N)	Neutral	N				
EARTH (E)	Earth	⏚				

Connecting additional Analysers Analyser 1 → Analyser 2 → Analyser 3 → Analyser 4



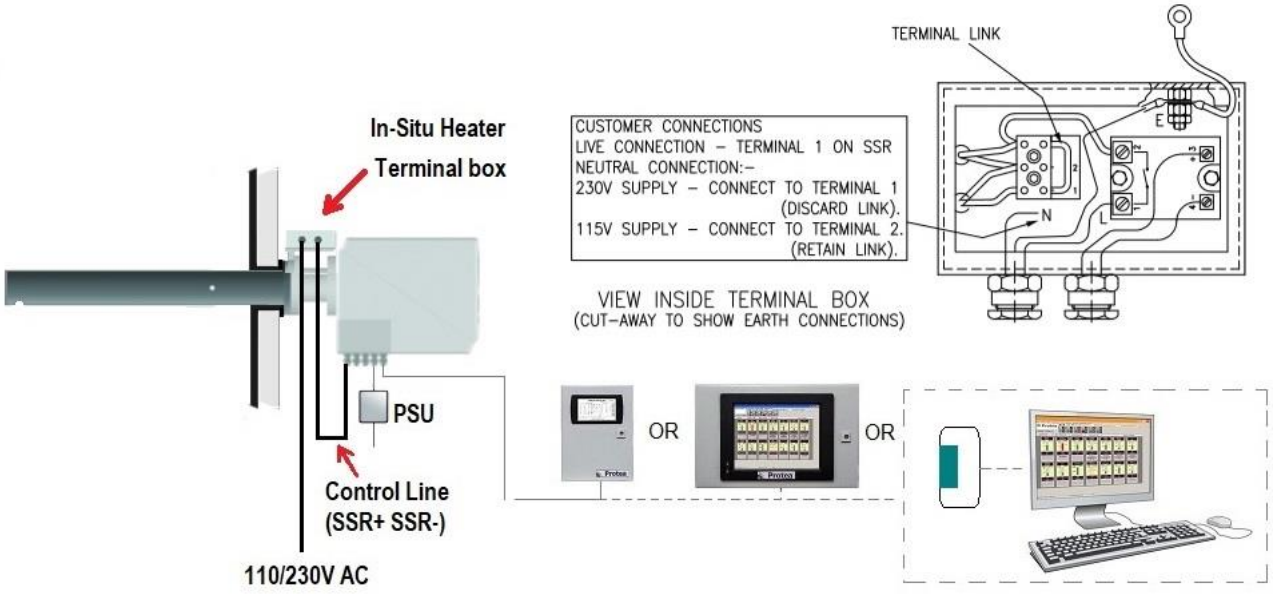
Function	**AU 1 Junction Box**	**AU 2 Junction Box**		**AU 3 Junction Box**		**AU 4 Junction Box**
	OUT	IN	OUT	IN	OUT	IN
Data Return R-	P2000(2) Tx-	P2000(1) Tx-	P2000(2) Tx-	P2000(1) Tx-	P2000(2) Tx-	P2000(1) Tx-
Data Return R+	P2000(2) Tx+	P2000(1) Tx+	P2000(2) Tx+	P2000(1) Tx+	P2000(2) Tx+	P2000(1) Tx+
Data Out T-	P2000(2) Rx-	P2000(1) Rx-	P2000(2) Rx-	P2000(1) Rx-	P2000(2) Rx-	P2000(1) Rx-
Data Out T+	P2000(2) Rx+	P2000(1) Rx+	P2000(2) Rx+	P2000(1) Rx+	P2000(2) Rx+	P2000(1) Rx+
Screen	External Earth terminal	External Earth terminal	External Earth terminal	External Earth terminal	External Earth terminal	External Earth terminal
+24 V	PSU IN +24V	PSU IN +24V		PSU IN +24V		PSU IN +24V
0V	PSU IN-	PSU IN-		PSU IN-		PSU IN-

NOTE – The PSU for each AU is supplied with a pre-wired 24V cable with the cable screen connected to an internal earthing point.

Analogue Inputs

Function	AU Junction Box	Analogue Input Type
0V	0V	
AUX I/P3 +	IN3	0-5V or 0-20mA or 4-20mA (Non-isolated)
AUX I/P4 +	IN4	0-5V or 0-20mA or 4-20mA (Non -isolated)

Connecting In-Situ Heater → Analyser



Function	AU Junction Box	In-Situ Heater (ISH)	Cable Specification
+ 24V DC	ISH_CTL+	SSR+	Cable Type 14 2 Core 0.22mm^2 (screened), External Insulation >1500V
Heater SSR	ISH_CTL-	SSR-	
Screen	External Earth terminal	Earthing point	

NOTE –The ISH is supplied with a pre-wired control cable with the cable screen connected to an internal earthing point inside the ISH.

		115 V	230 V	
Live (L)	NA	Terminal 1	Terminal 1	Cable type 1 3 core 2.5mm^2
Neutral (N)	NA	Terminal 1 (Discard Terminal Link)	Terminal 2 (Retain Terminal Link)	
Earth (E)	NA	Internal	Internal Earthing	

		Earthing Point	point	

Table 2-1

IMPORTANT - All unused glands must be sealed before commissioning the analyser

Analyser Covers

Protea analysers are fitted with two basic types of Cooler / Heater however there are the following exceptions:

- Analysers supplied with ATEX / IEC Certification
- Special Application Heater / Coolers

Refer to order specific drawings in these cases.

Option 1 – Fan Cooled Electrically Heated Cover fitted to Product Code:

P2000 AC/AVU-F-24V

This type can be identified by the presence of a 100mm spigot protruding from the base of the analyser cover (as shown in Figure 2-11).

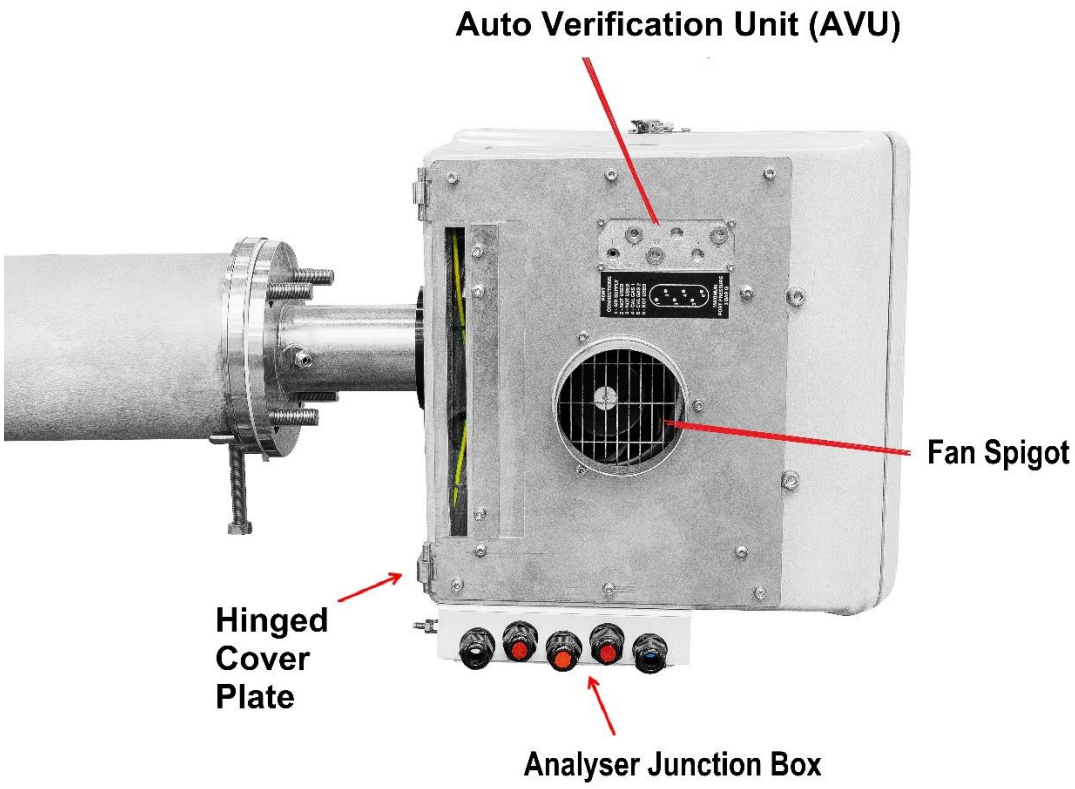


Figure 2-11 Underside Fan Cooled Electrically Heated P2000

AC/AVU-F-24V

The cover is fitted with an electrical heater and fan which enables the analyser to operate in ambient temperatures of -20 ºC to +50 ºC (-4ºF to 122ºF) (lower and higher ambient temperature operation available on application). The heater / cooler function is controlled by the AU, the set point is factory value.

Forced air from an integral low voltage electrical fan is channelled past the AU to draw heat away from the analyser. The Control of the fan is by the Analyser Unit and cooling capacity is dependent on the ambient air temperature.

Services required – None additional to an AU.

NOTE - The Fan/Heater combination require 240W, 24V. The Fan and Heater are not on at the same time.

As the Cover insulates the AU from the ambient air, then if the Fan is disabled the AU can self-heat to a higher-than-normal temperature.

The cover is fitted with a 100mm spigot to enable a flexible hose to be connected allowing cool air to be ducted to the analyser if installed in a high ambient temperature environment.

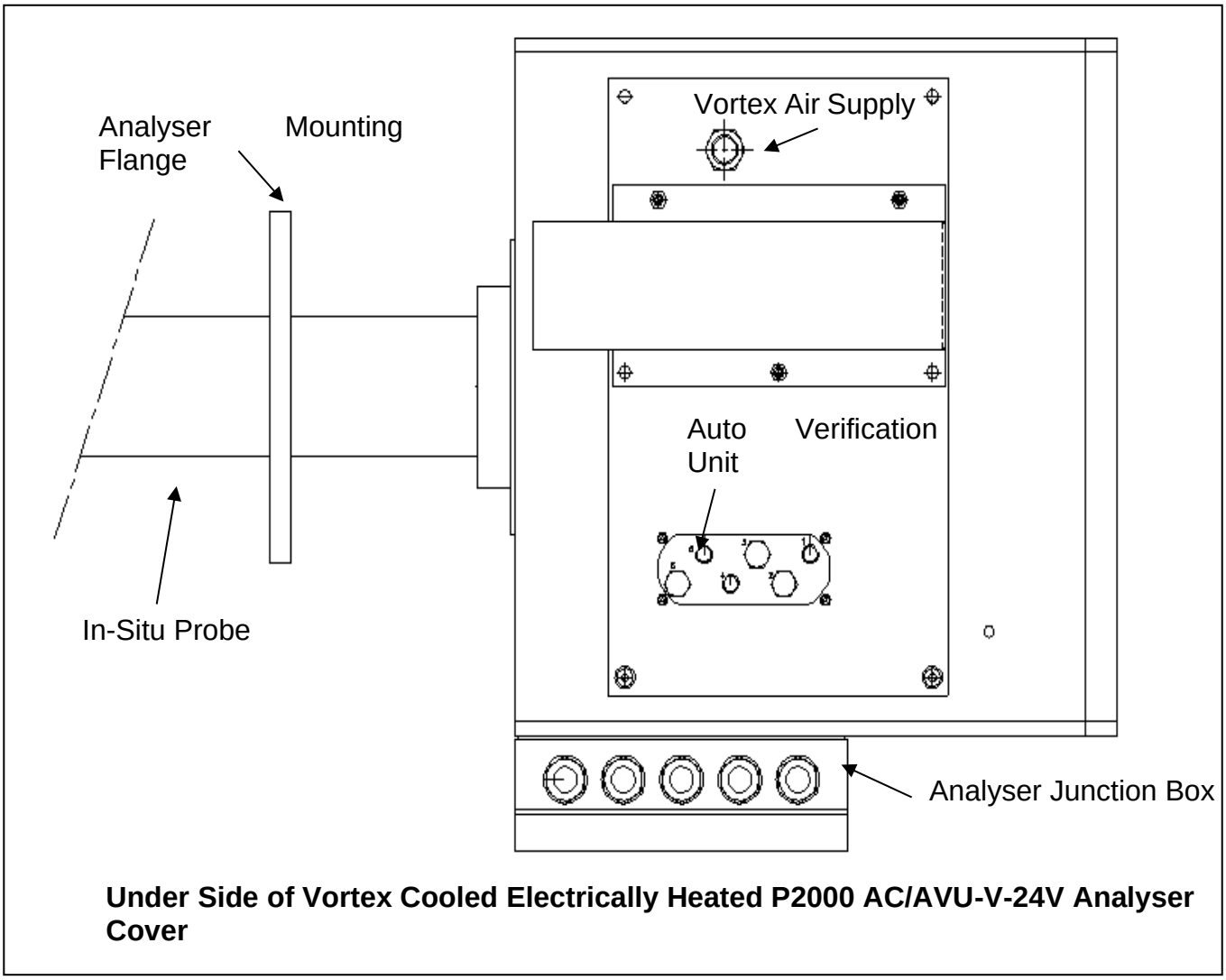
NOTE - the analyser is supplied with a 300mm length of hose. If an extended hose is not to be fitted, then the 300mm length of hose supplied by Protea should be fitted.

The cover also incorporates as standard an Auto Verification Unit internally piped and wired. The function of Auto Verification Unit is described later.

Option 2 – Vortex Cooled Electric Heated Cover fitted to Product Code:

P2000 AC/AVU-V-24V

This type can be identified by the Vortex Cooler Cover protruding from the base of the analyser cover as shown in Figure 2-12.



Under Side of Vortex Cooled Electrically Heated P2000 AC/AVU-V-24V Analyser Cover

Figure 2-12 Vortex Cooled Electrically Heated P2000 AC/AVU-V-24V

The cover is fitted with an electrical heater and vortex cooler which enables the analyser to operate in ambient temperatures of -20 ºC to +65 ºC (-4ºF to 149ºF). The heater / cooler function is controlled by the AU, the set point is factory set.

The Vortex cooler is a pressurised air powered cooler requiring an air supply; cooled air is generated by the vortex tube and is used in a special cover to cool the Analyser Unit. Control of the air supply is by the Analyser Unit. The Vortex Cooler system is designed to operate with ambient temperatures up to 65ºC (149ºF) and has a cooling capacity of 20ºC (-4ºF).

Services required - A supply of high-pressure plant air at 6.8-8 bar (100 -110 psi) and 311 l/min (11scfm). (see Protea Standard *ISO 8573-1:2010 2 4 2* in *appendix D*).

Integral Auto Verification Unit

All P2000 analysers are supplied with an Auto Verification Unit mounted on the reverse side of the lower cover as shown in figure 2-13 below.

The Auto Verification Unit hardware is a single panel of components. The software to operate the system is fully pre-programmed into the Control Unit and the P2000.

Figure 2-13 Location of Auto Verification Unit

The function of the Auto Verification Unit is described in the

following.

For information relating to the Specification of the Auto Verification Unit please see the Technical Specification chapter of this manual.

Function of the AVU

The integral Auto Verification Unit has two primary & three secondary functions.

Primary Functions

1. It provides totally automatic zeroing of the system, and secondly it acts as a safety purging system to prevent condensation forming in the sample cell of the Analyser Unit.

In its Auto-zero function, a zero check is instigated on a periodic basis by a command signal from the Control Unit. The control voltage switches a solenoid valve on the Auto Verification Unit which diverts a regulated flow of instrument air in to the Analyser Unit In-Situ Sample Cell.

After a predetermined stabilisation period, the Control Unit will read the zero-gas signal and, if necessary, adjust the zero offsets on every gas channel until a true zero is obtained. Once zeroed in this manner, a further signal from the Control Unit will shut off the supply of instrument air, and natural purging action will quickly refill the sample cell with process gas. The unit will go back to on-line process measurements.

NOTE - *During this Auto-zero procedure, all displays and outputs are frozen at the last 'on line' levels before commencement of the Auto-zero routine. This includes the time required for the sample cell to purge clear of instrument air at the end of the Auto-zero cycle. The frequency and duration of the flush times in the Auto-zero routine can be altered as described in the Operation section of the ACU Operating Manual.*

NOTE - *It is mandatory that the analyser is configured to instigate automatic zero's every 12 or 24 hours depending on application.*

2. In the event of a power failure to the system, the In-Situ Heater element (when fitted) and the sample cell will cool, possibly to below the dew point. Condensation could then occur on the process side of the sample lens. The de-energised solenoid valve on the Auto Verification Unit opens and floods the sample cell with dry instrument air, thus removing the possibility of condensation. (The solenoid valve is configured to open if the sample temperature

is less than 110ºC (230ºF)). The unit will continue to purge the cell until the fault condition is rectified

Secondary Functions

1 Optionally if the system is set up for Auto Calibration the Auto Verification Unit can switch on 1 of 2 Calibration Gas lines in the required sequence under control of the Control Unit to facilitate span calibration or verification.

2 To eliminate the ingress of moisture or absorbing gases into the VOID chamber of the reflector tube a continuous low purge is applied utilising a restrictor mounted on the Auto Verification Unit. The analyser is supplied with an external pipe that connects the VOID chamber to the AVU.

NOTE - *No action is required during installation*

3 To eliminate the ingress of moisture or absorbing gases into the ANALYSER OPTICAL HOUSING a continuous low purge is applied utilising a restrictor mounted on the Auto Verification Unit. The analyser is supplied with the purge piping already fitted.

NOTE - *No action is required during installation*

REQUIRED SERVICES

IMPORTANT

- Clean and dry instrument air (Protea Standard ISO *8573-1:2010 0 3 1* see Appendix D) for the analyser purge, auto-zero and sample cell protection should be available adjacent to where the AU will be fitted. Pressure should be regulated to a maximum of 6.0 Bar gauge (and should provide a nominal inlet pressure of 2.5 to 3 Bar Gauge to the AU AVU). The AVU provides a flow rate of 1 l/min (constant) for the AU head compartment and void space in the reflector tube and 6 l/min (intermittent) during the auto-zero operation (typically 5 minutes every 12 hours) is required.
- Protea strongly recommends using the Air Preparation Panel (see Appendix E) to meet the Protea Instrument Air Standard *ISO 8573-1:2010 0 3 1 (see Appendix D).*

NOTE – *In the case of a wall mounted regulator that is not supplied by Protea the regulator should have a 3µm filter and a capacity of 10 litres per minute with input pressure range of 6-10 bar and output pressure of 2 bar or less.*

NOTE - *the air supply fitted with an appropriate regulator, filter and isolation valve should be located within 1 meter of the AU. The connection from the filtered air to the AU should be made with flexible PTFE tubing so that the analyser can be withdrawn from*

the stack or duct without the need to disconnect the air supply.

- Source of electrical power 115/230V 50-60Hz suitably rated for the power requirements of all the components of the CEMs system (see the *Technical* section of this manual). Isolated single throw, two pole isolation, fused or with mini circuit breaker (MCB) is recommended.
- Pressurised gas cylinders (up to a maximum of two) containing a known mixture of the gases under analysis.

NOTE - If only one pressurised gas cylinder is connected to the AVU then Port 5 (designated for Calibration Gas Cylinder 2) on the AVU should be fitted with a blanking plug.

The Auto Zero / Verification function is achieved by activating a series of solenoid valves mounted on a manifold. The manifold is mounted on an access plate which is secured to the cover by four M4 socket head screws (as shown in Figure 2-14 below).

NOTE - *It is not necessary to remove the access plate during installation.*

Auto Verification Unit Port Connections

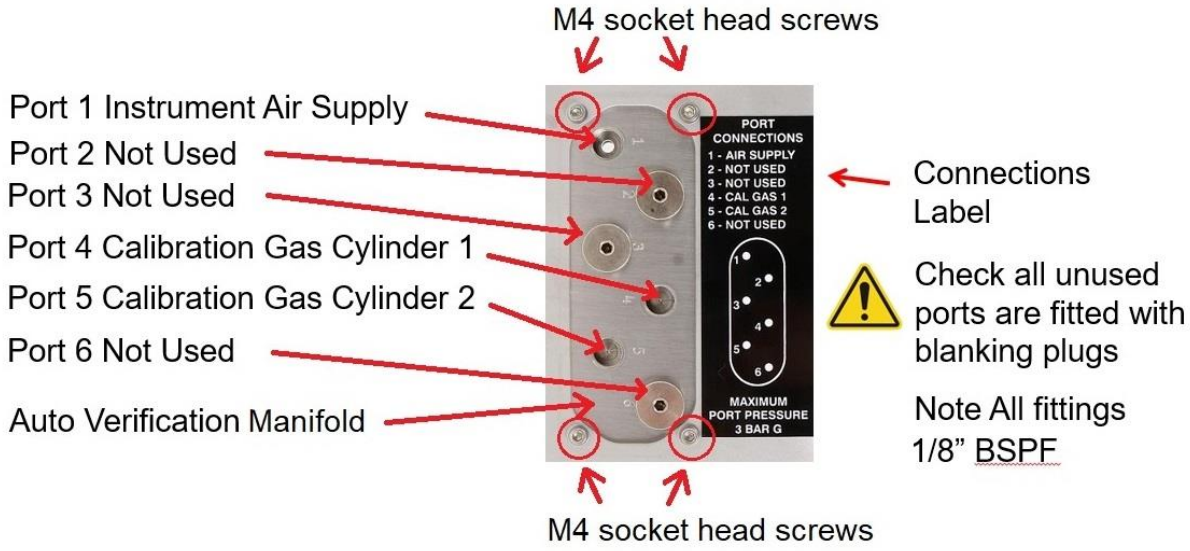


Figure 2-14 AVU Port Connections

Connection of Zero and Test Gas to the Auto Verification Unit		
Function	From	To
Zero / Purge Supply	Wall Mounted Regulator (Part No. 1-0094) Set to provide output of 2 Bar Gauge (Range 0-6 Bar Gauge)	Analyser AVU Port 1
Calibration Gas	Gas Cylinder 1 Regulator Set to 2 Bar Gauge	Analyser AVU Port 4
Calibration Gas	Gas Cylinder 2 Regulator Set to 2 Bar Gauge	Analyser AVU Port 5
Notes:		
All pipe fittings 1/8” BSPF (NPT kit 12-0036)		
The unit is supplied with all internal wiring and piping necessary for the operation of the analyser		
If only one gas cylinder is connected to the AVU then Port 5 should be fitted with a suitable blanking plug		

AVU needle valve to adjust air and gas flow rates

The zero (Instrument Air) and test gas flow rates are controlled by a needle valve mounted on the manifold. The needle valve has a slotted screw for adjustment as shown in figure 2-15 below. The needle valve is set in the factory to provide the correct flow rate.

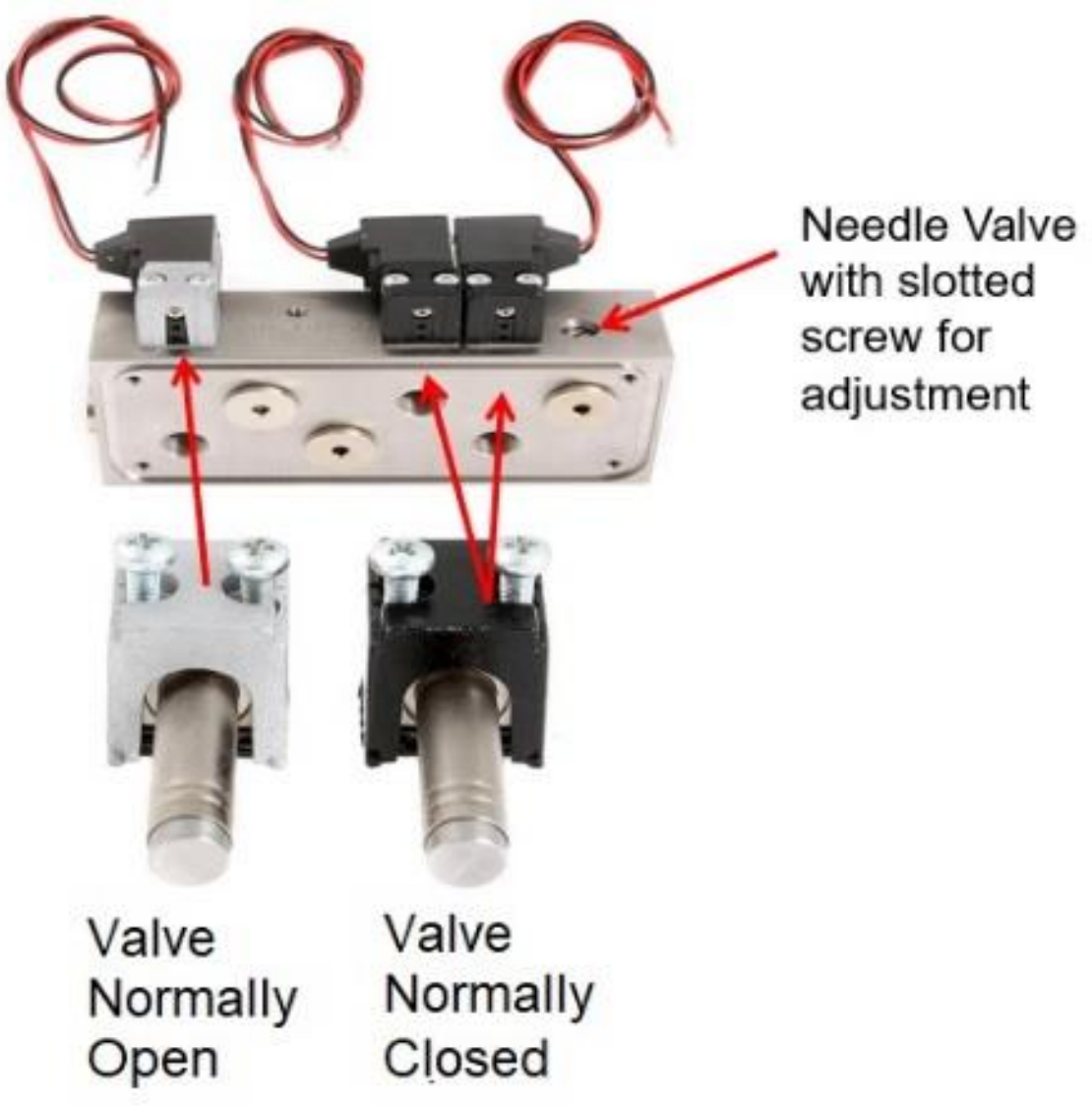


Figure 2-15 Location of Needle Valve on AVU

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3 Commissioning

IMPORTANT - Please read the Safety Warnings below before performing any maintenance function set out in this section of the manual.

DANGER	Electrical Shock from Live Electrical Equipment
	Death or serious injury can result through contact with live electrical equipment.
	Do not attempt to install this system unless you are qualified, competent and authorised to work on electrical equipment operating at your local mains electrical supply voltage. Read the following section in this manual in its entirety before commencing installation or maintenance of the device. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

ATTENTION	DAMAGE TO EQUIPMENT
	Damage to the product may result if the P2000 analyser is inserted into the duct or stack without the instrument air purge being switched on. if electrical installation is not performed as per the installation instructions. if the factory-set optical components are adjusted or re-aligned. Adjustment of any optical components may invalidate the warranty and will almost certainly prevent the analyser from functioning properly.
	Carefully follow the step-by-step instructions to avoid damage to the analyser.

Introduction

This section describes the order that should be followed to prepare the analyser for operation.

Mounting of CEM system components

ATTENTION

When drilling fixing holes for mounting the cabinets or enclosures described below you must wear appropriate personal protective equipment.

1. You should first install the Control Unit using the mounting bracket provided. The wall mounting system is comprised of two brackets – one pre-fitted to the Control Unit and another bracket secured to the wall (as shown in figure 3-1 below)

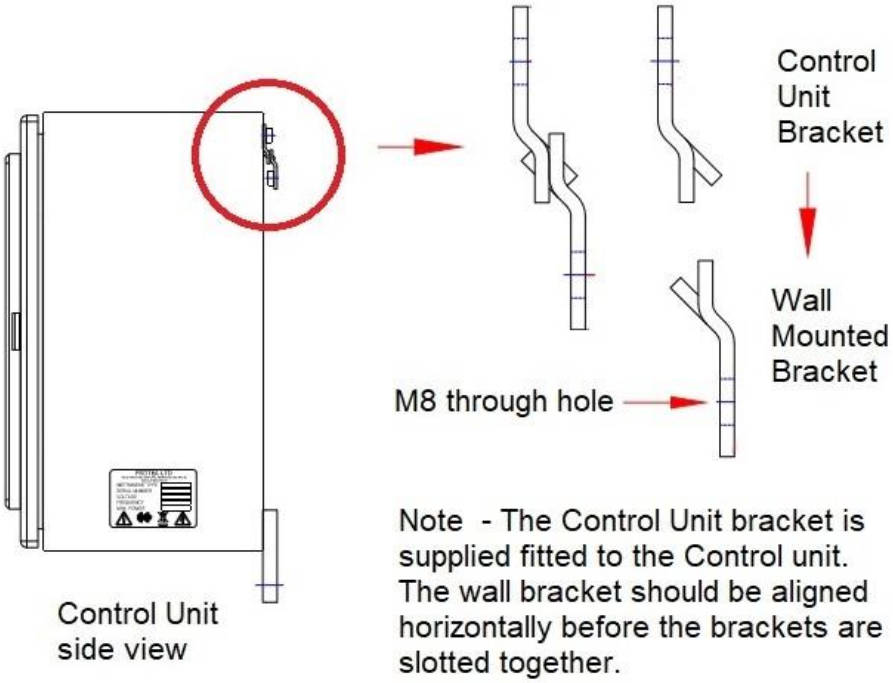

Figure 3-1 Mounting of Control Unit (bracket mounting)

2. You must also fasten the Control Unit to the wall using the additional eyelets located at the base of the Control Unit (as shown in figure 3-2)

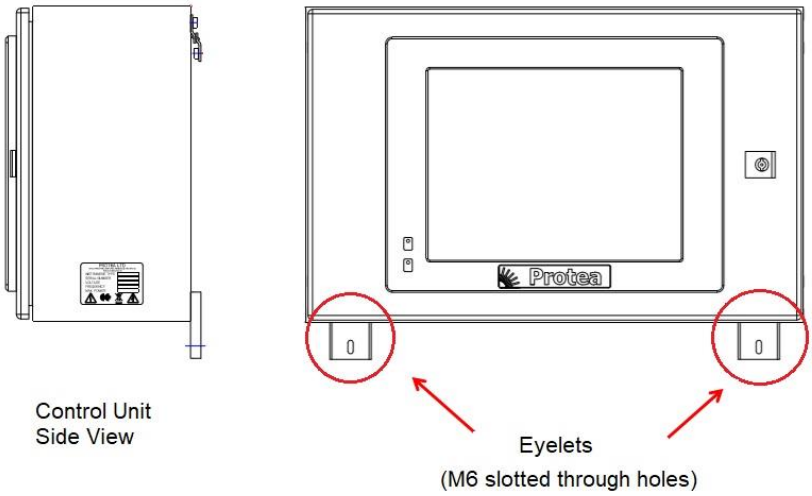

Figure 3-2 Mounting of Control Unit (Eyelet Fixings)

3. You must then remove the gland plate from the Control Unit. The gland plate is not pre-drilled. You must therefore determine the number of cable entries required and then drill appropriate holes for the cable glands. After drilling you must clean the gland plate, making sure that any metal residue left by the drilling process is removed. You should then fit your cable glands and re-attach the gland plate on to the Control Unit.

4. You should then mount the Power Supply Unit to a wall or other suitable structure (as shown in figure 3-3). The PSU should be located close to the analyser unit. The maximum length of the power cable from the PSU to the analyser must not exceed 5 metres (~16 feet).

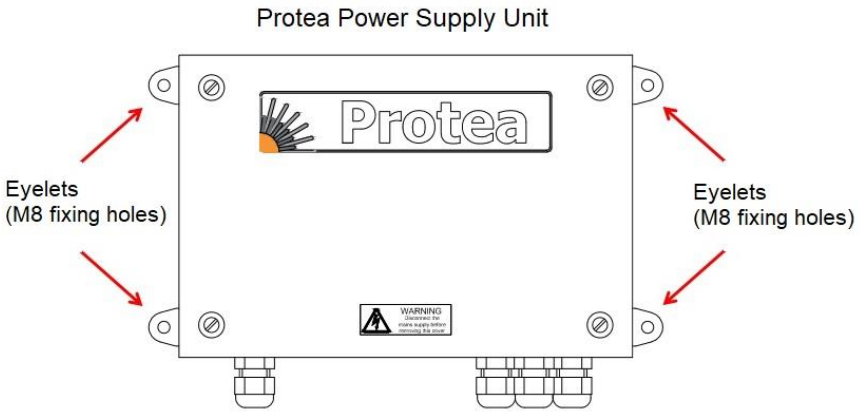

Figure 3-3 Mounting of the Power Supply Unit

5. You should then secure the instrument air preparation panel to a wall or suitable structure using the four M5 fixing holes (as shown in figure 3-4).

Figure 3-4 Mounting of the Air Preparation Panel

Connection of Instrument Air Supply

6. You should next connect the inlet of the Air Preparation Panel to the air supply. The input air must be supplied from an oil free compressor (see Protea Instrument Air standard ISO *8573-1:2010 0 3 1* see Appendix D).

7. You must then connect the outlet of the Air Preparation Panel to the inlet of the Auto Verification Unit located on the analyser (Port 1 Instrument Air Supply).

   NOTE - The tubing from the Air Preparation Panel to the AVU must be made flexible and be of sufficient length so that the analyser unit can be withdrawn from the stack or duct without the need to disconnect the air supply. (Protea recommends PTFE tubing with outside diameter of 6mm with internal diameter of 4mm (equivalent to ¼" PTFE)

8. You should now switch the air supply to the analyser on. You should use the pressure regulator on the Air Preparation Panel to adjust the air pressure displayed on the pressure gauge to 3 Bar Gauge (43.5 psig).

   NOTE - The AVU valve that provides air to the analyser sample cell will automatically be ON as the valve is a normally open type valve (ON when no power is connected). The analyser sample cell must receive a continuous purge when the analyser is inserted into the process otherwise damage to the analyser may occur.

Connection of communication

9. You should next connect the communication cable from the Control Unit to the Analyser junction box. Refer to Table 2-1 for wiring instructions once you have selected your CEMs configuration option. (If applicable check the *Order Specific Information* section of this manual for specific wiring instructions).

   NOTE - All cable glands should be properly fastened to secure the through cable. Blanking plugs must be fitted to any unused cable glands. You must ensure that the cable is of sufficient length to allow the removal of the analyser from

the stack or duct without the need to disconnect the communication cable.

Connections to the AC Power Source

10. You should next connect the Control Unit to the isolated AC power source (50-60Hz 115/230V AC 200W). Isolate the AC power source before making your connections.

NOTE - The Control Unit will switch on when the power is connected and the installed software will automatically load.

11. You should then connect the PSU to the isolated AC power supply (50-60Hz 115/230V AC 240W (480W for P2000 UV/LED analyser). Isolate the AC power source to the PSU before making your connections.

12. You should then connect the PSU 24V and 0V outputs to the analyser junction box as described in Table 2-1. Isolate the AC power source to the PSU before making your connections.

13. You should then view the display on the Control Unit to check that the analyser is communicating with the Control Unit. For Control Unit with S-PC (formerly ACWn) software a “Connected” message should appear and for a Control Unit with P-HMI software a “Status OK” message should appear).

NOTE – If the status message on the Control Unit remains in a Disconnected state then you should do the following (otherwise go to instruction 14)

A. using a multi-meter check that the analyser voltage at the Junction box (voltage between terminals PSU IN – and PSU IN +24V is 24V see Table 2-1). If not, then you must check the output from the PSU (see Table 2-1). Isolate the AC power source when removing the lid of the PSU

B. check that the interconnection cable between the analyser junction box and the Control Unit are properly connected (see Table 2-1).

C. If the above does not resolve the “connection” status, then you should remove the lid of the head cover and

visually observe that the filter wheel is rotating (see figure 3-5).

D. If filter wheel is not rotating and the above checks have been completed, then please contact Protea or your Protea-authorised Protea Distributor for further assistance.

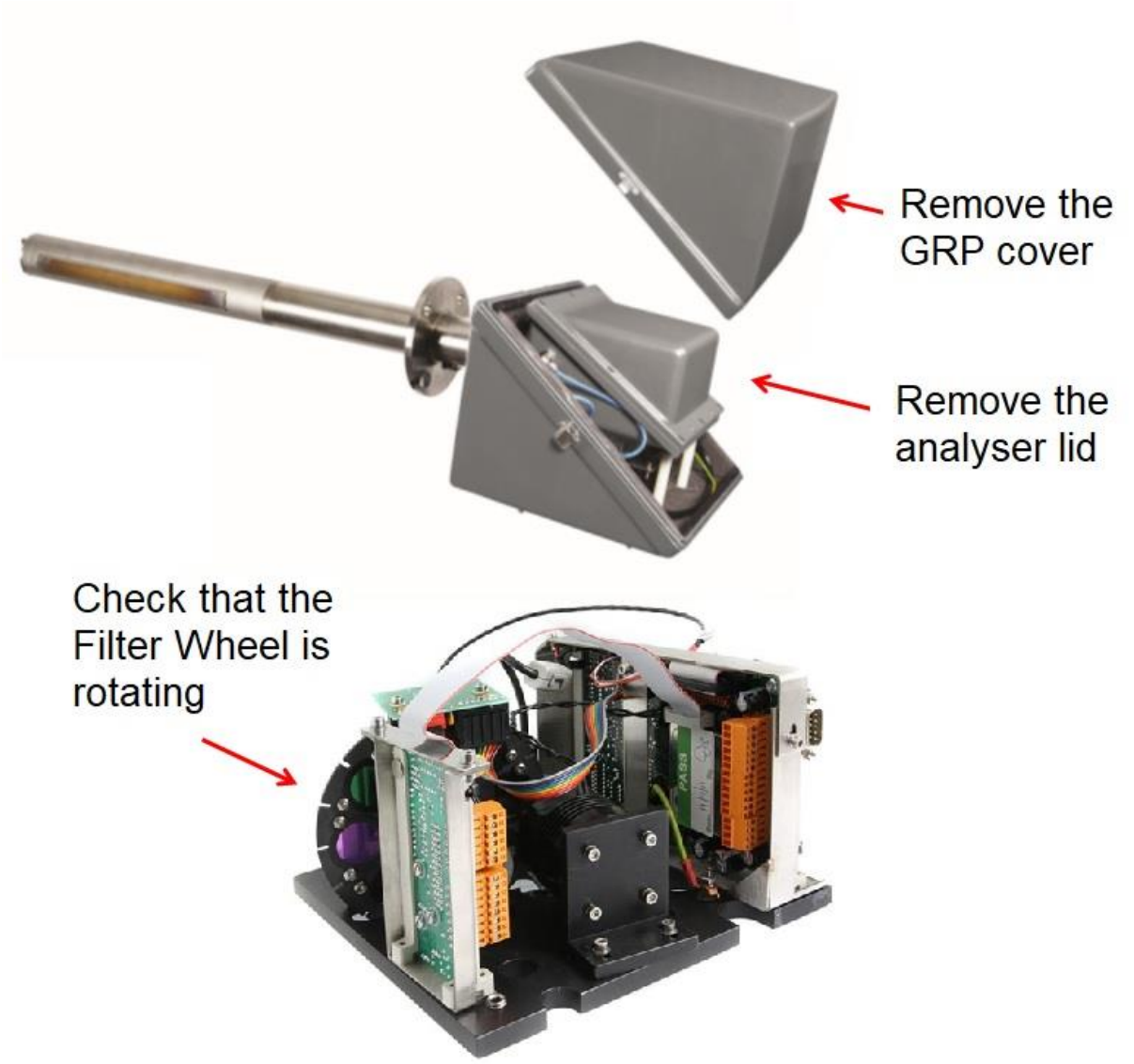

Figure 3-5 Checking the status of the filter wheel

Insertion and wiring of In-Situ Heater

14. If an In-Situ Heater is supplied, then you must first fit the In-Situ Heater gasket on to the stack or duct flange.
15. You must then insert the In-Situ heater into the process stack or duct.
16. You must then connect the control cable from the in-situ heater to the analyser junction box.

NOTE - You must ensure that the control cable is sufficiently long enough to allow the removal of the analyser without needing to disconnect the control cable.

17. You must then connect the isolated power source to the In-Situ Heater (50-60Hz 115 V / 230 V 1000W). Isolate the AC power source before making your connections.

Insertion of the Analyser

18. You must next fit the graphite gasket supplied for the analyser
19. You must then slowly insert the analyser probe end into the stack or duct.

NOTE - The purge to the sample cell must be on when the analyser is inserted. The analyser sample cell must receive a continuous purge when the analyser is inserted into the process otherwise damage to the analyser may occur.

20. You must then secure the analyser onto the flange using M16 flat washer, spring washer and M16 Nut.

Stack Process Conditions & Operational Readings

NOTE - The analyser will take a period of time (typically 1 hour) to reach the process temperature, or the sample temperature set point in the case of an analyser fitted with an in-situ heater.

21. The sample temperature should be viewed by accessing the Control unit TREND SCREEN. The analyser should reach the process temperature or the pre-configured set point (for In-Situ Heater) after approximately 1 hour. The TREND screen should be viewed to check that the sample temperature is increasing.

22. The TEST SCREEN displays both the Sample Temperature and the Sample Heating as a percentage figure (with ISH fitted) or as “Not Fitted” (when ISH is not fitted) as shown in Figure 3-6 below. The Sample Heating will normally show 100% when the in-situ heater is in full heating mode and the temperature is rising towards the pre-configured temperature set point.

NOTE – the AIR PURGE will be shown as ON until the sample temperature reaches a value greater than 110ºC (230ºF).

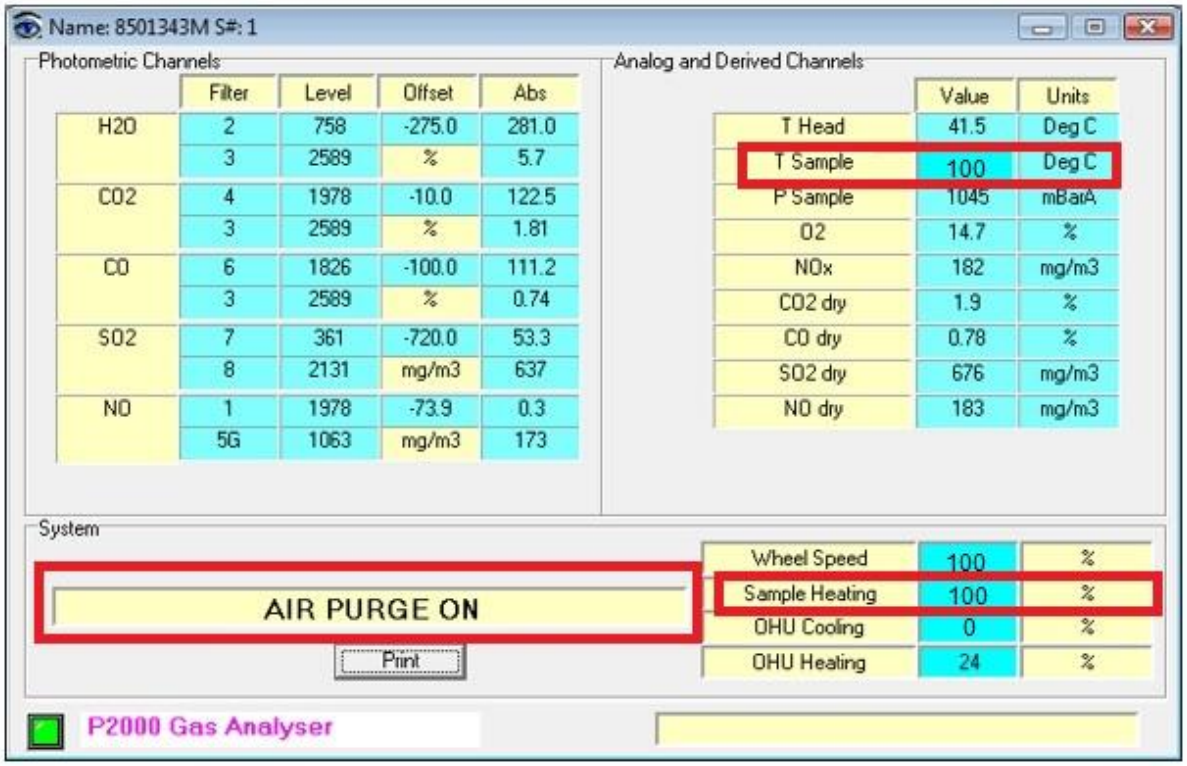

Figure 3-6 P2000 Analyser Test Screen (S-PC (formerly ACWn)) software

23. If after 1 hour the sample temperature has not reached the set point then the analyser should be left for a further hour.
24. As the Sample Temperature levels off the reading should be within ±5ºC of the process temperature (if no ISH is used) or within ±5ºC of the pre-configured set point (if an ISH is fitted).
25. When this condition is satisfied the operator should do the following

    - Record the process pressure as displayed on the Trend screen
    - Switch on the Manual Air Purge
    - With the Manual Air Purge switched on the Zero pressure reading should increase to 20 to 40mbar relative to the process pressure reading. If the pressure increase (relative to the process pressure) is not within this range, then the needle valve on the AVU must be adjusted – See Installation section of this operating manual).

- Log the Filter - Level readings and compare these with the Filter – Level readings on the configuration sheet that was supplied with the original analyser documentation pack). The Filter – Level readings should be within 20% of the Filter- Level readings recorded on the original documentation.
- On the TEST SCREEN select the AUTOZERO menu and from the pull-down list select the AUTO-ZERO NOW option.

26. After the P2000 has completed the AUTOZERO the analyser should then be in the monitoring mode measuring the gas concentrations in the process.
27. Finally, check that all the components and interconnections of the CEM system are secured. Check that all pipe joints and compression fittings in air supply network are adequately tightened and that no leaks are present.

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4 Operation

Introduction

The P2000 Analyser Unit must be operated as part of a system incorporating a Protea Control Unit. There are no user accessible controls or indicators on the P2000 as the whole system operates under the control of the Control Unit. Full operating instructions for the Control Unit and the complete Protea system are given in the *Operator's Manual* supplied with the Control Unit

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5 Technical Specification

Introduction

The method by which the P2000 utilises the theory of infra-red spectroscopy for gas measurement is provided in a technical note that is available from Protea upon request.

P2000 Technical Specification

The Technical Specification of the P2000 analyser and the Auto Verification Unit is described below

P2000 analyser specification	
Principle of Operation	Infra-red absorption with multiple wavelength selection using Gas Filter Correlation (GFC). Interference filters and gas cells mounted on a rotating filter wheel. Sample cell uses the enveloped folded beam principle.
Spectra Range	Specific application-dependent wavelengths (up to 8) are selected between 2 µm and 12 µm.
IR Source	Enclosed Nichrome filament
IR Detector	Solid state pyro-electric element
Sample Path length	1 metre (enveloped folded beam)
No. of Gases Measured	Up to 6 hetero atomic gases as determined by the application
Typical Gas Ranges (For other gases see Instrument range data sheet (19-6AD0808)	Carbon Monoxide (CO) 0-150ppm (0-187 mg/m^3) Sulphur Dioxide (SO_2) 0-150ppm (0-430 mg/m^3) Nitric Oxide (NO) 0-240ppm (0-320 mg/m^3) Nitrogen Dioxide (NO_2) 0-200ppm (0-410 mg/m^3) Nitrous Oxide (N_2O) 0-300ppm (0-590 mg/m^3) Carbon Dioxide (CO_2) 0-15% Water (H_2O) 0-30%

Accuracy	Dependent on application Typically, ±2% of full-scale concentration
Response time	Dependent on application Typically, less than 120 seconds to 90% of full scale (T90).
Sample Temperature	Up to 350°C (660°F) – (Higher temperatures on application).
Cross-sensitivity	Minimal due to wavelength selection and advanced algorithms in the processor software.
Calibration requirements	Supplied pre-calibrated. Short term drift of less than the quoted accuracy is removed by automatic zero calibration, performed automatically at pre-set intervals, typically 4 - 24 hours.
Enclosure Rating Class	Aluminium alloy casting with high protection finish, protected to IP65 (NEMA 4X)
Operating Temperature Range	Typically -20°C to 60°C (4°F to 140°F) The ambient temperature range for applications requiring ATEX/IECEx or MCERTS approvals are specified below ATEX/IECEx – The P2000 has a surface temperature classification of **T6**, which indicates a maximum surface temperature of 85ºC (185ºF) and is approved for the ambient temperature range -20ºC to 40ºC (4ºF to 104ºF). ATEX/IECEx - The P2000 also has a surface temperature classification of **T4**, which indicates a maximum surface temperature of 135ºC (275ºF) and is approved for the ambient temperature range -20ºC to +60ºC (4ºF to 140ºF). ATEX/IECEx - The P2000 when fitted with the P2000 ATEC/IEC Cooler Option (Vortex Cover) has a Protea Declaration of Conformity to a surface temperature classification of **T4**, which indicates a maximum surface temperature of 135ºC (275ºF) and is approved for the ambient temperature range -20ºC to +60ºC (4ºF to 140ºF). MCERTS – Ambient temperature range -20ºC to +50ºC (-4ºF to 122ºF)

Materials in contact with process gas	Calcium fluoride (optical components), 316 stainless steel (probe) & graphite (gaskets). Customer specific applications may include other materials such as Inconel, Hastelloy and Zinc Selenide optical components
Weight	25 kg (55 lbs) without GRP cover 35 kg (77.2 lbs) with GRP cover
Dimensions	1360mm (53.5”) x 380mm (15”) x 315mm (12.4”)
Centre of Gravity	330 mm measured from left to right from end of GRP cover – see the Transport and Storage section of this manual.

P2000 Electrical and Air Service Requirements	
P2000 DC Voltage Requirements	24V 240W (provided by Power Supply Unit)
P2000D UV/IR DC Voltage Requirements	24V 480W (provided by Power Supply Unit)
Power Supply Unit Voltage Power requirements	50-60Hz, 115/230V AC 240W (provided by AC Power source)
Power Supply Unit (P2000D UV/LED) Voltage Power Requirements	50-60Hz, 115/230V AC 480W (provided by AC Power source)
In-situ Heater	50-60Hz, 115/230V 1000W (provided by AC Power source)
Instrument Air Supply (Analyser AVU)	Clean and dry instrument air (Protea Standard *ISO 8573-1:2010 0 3 1* see Appendix D) Pressure regulated to 6.0 bar(g) Maximum Inlet pressure to AVU should be between 2.5 to 3 bar(g). The AVU provides a flow rate of 1 l/min (constant) for the AU head compartment and void space in the reflector tube and 6 l/min (intermittent) during auto-zero operation (typically 5 minutes every 12 hours) is required.
Instrument Air Supply (for Vortex Cooled Option)	A supply of high-pressure plant air (Protea Standard *ISO 8573-1:2010 2 4 2* see appendix D). Pressure regulated at between 6.8-8 bar (100 -110 psi) and flow of 311 l/min (11scfm).
Auxiliary Inputs	Two analogue non-isolated inputs (0– 20 mA or 4-20mA or 0 - 5 V (link selectable)

Electrical Outputs	Control Outputs (24V Switching) for Output 1 - Zero Gas (air purge) Output 2 - Cal Cas 1 Output 3 - Cal Gas 2, Output 4 - Special Purge, Eductor or Blowback Output 5 - In-Situ Heater/In Situ Cooler Output 6 - (Pre-set) for Heater/Fan or Heater/Vortex Output 7 - Pressure Switch (all units with AZ manifold)

Auto Verification Unit specification

Auto Verification Unit Specification	
Material	Stainless steel, nitrile rubber (seals), techno-polymer aluminium (valve body)
Dimensions	Length 115mm x Width 50mm x Depth 30mm
Weight	1.4 Kg (3lbs)
Number of Inlet Flow Ports	3 configured (one for Instrument Air and two for Calibration gas cylinder connections)
Number of Outlet Flow Ports	3 configured (one for Auto-zero/Calibration, one for Analyser Purge and one for Void Purge. (Analyser & void purge ports are fitted with external restrictor)
Number of solenoid valves	3 (15 mm Microvalves)
Solenoid for Instrument Air	1 (Normally Open 3/2 Type)
Solenoids for Calibration Gas Cylinders	2 (Normally Closed 3/2 Type)
Ambient Temperature	-5 to +50ºC (located inside a temperature-controlled enclosure)
Fluid temp (max)	+50ºC
Pressure	9 bar Max
Flow rate (per valve)	26 N l/min Max
Adjustable Flow needle valve	1 (located on the side of the manifold)
Protection rating	IP65
Voltage	24V DC (2W per coil) (Note - minimum voltage to operate valves is 22V)
Flying leads on Coils	Twisted pair 300 mm long with two-way EDAC 572 female connectors

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6 Inspection Schedules

IMPORTANT - Please read the Safety Warnings below before performing any inspection function set out in this section of the manual.

DANGER	Electrical Shock from Live Electrical Equipment
	Death or serious injury can result through contact with live electrical equipment.
	Do not attempt to install this system unless you are qualified, competent and authorised to work on electrical equipment operating at your local mains electrical supply voltage. Read the following section in this manual in its entirety before commencing installation or maintenance of the device. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

DANGER	Compressed Gas
 	Death or serious injury can result through contact with fast or suddenly escaping compressed gas or bursting system parts such as pipework. Gases used for verification of the P2000 may also present a Toxic, Flammable or explosive risk.
	Consult local safety regulations and site safety procedures before handling compressed gas. Specific gas may present a toxic, flammable or explosive risk. Always consult local safety

	regulations and site safety procedures before handling toxic, flammable, or explosive gases. Gas cylinders should be secured to a surface or mounted in a secured frame to protect the cylinder from damage or from impact that may result should the cylinder fall over. All work on the system must be carried out in the depressurised state and with the system secured against unintentional pressure build up. Gas regulators connected to gas cylinders must be turned off when performing installation, maintenance or repair actions. DO NOT make any structural changes or modifications to the P2000 to accommodate a pipe network. Set-up a safety zone around the system during all assembly, installation, maintenance and repair work. Before re-pressurising the system, check all the pipe connections and tighten if necessary. All piping should be assembled without mechanical stress. Vibration of the pipe network should be avoided using vibration dampeners. Slowly re-pressurise the system. Read the relevant section in this manual in its entirety before commencing installation or maintenance of the device and keep exactly to the step-by-step instructions given in this manual. If there is anything you do not understand or you do not feel confident of your ability to follow the step-by-step instructions, DO NOT PROCEED. Contact Protea or your Protea authorised distributor for assistance. Always ensure that you have a valid permit to work on the pipework or ducting to which the P2000 analyser unit is to be fitted. Always ensure that you comply with local safety regulations and procedures.

ATTENTION	DAMAGE TO EQUIPMENT
	Damage to the product may result if the P2000 analyser is inserted into the duct or stack without the instrument air purge being switched on. if electrical installation is not performed as per the installation instructions. if the factory-set optical components are adjusted or re-aligned. Adjustment of any optical components may invalidate the warranty and will almost certainly prevent the analyser from functioning properly.
	Carefully follow the step-by-step instructions to avoid damage to the analyser.

ATTENTION	DAMAGE TO EQUIPMENT
	Damage to the product may result if OIL is applied to the P2000 analyser probe or any of the analyser components. Applying oil to any of the components may invalidate the warranty and will almost certainly prevent the analyser from functioning properly.
	Carefully follow the step-by-step instructions to avoid damage to the analyser.

Introduction

The P2000 is a high-technology analytical tool. Like other specialised industrial equipment, it needs regular inspection and maintenance if it is to operate at peak performance.

It is strongly recommended that if a P2000 system is purchased, a service contract is taken out. This will cover regular cleaning, calibration and routine preventative maintenance. A service contract will assure priority response to emergency callouts. Please contact Protea or your Protea-authorised Protea Distributor for further information about service contracts.

Your first point of contact for maintenance and service should always be your local Protea-authorised Protea Distributor.

UK Sales & Manufacturing	Customer service and tools
Protea Ltd 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk	Protea Ltd 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk
For Protea Distributor information see www.protea.ltd.uk/global-network	

Nature and frequency of inspections

If you do not have a service contract and decide to undertake routine preventative maintenance in-house, the following schedules should be strictly followed.

Please note that if the system is not properly maintained, the manufacturer's guarantee may be voided or limited.

Calibration may be required more frequently by the local pollution inspectorate or other regulatory authority.

Quarterly (Three Monthly) Schedule

The quarterly scheduled inspection of the analyser DOES NOT require removal of the analyser from the stack or duct.

1. You should undertake a visual inspection of the exterior of the analyser for physical signs of damage. Protea recommends that you check cables for damage to the insulation and that you also check gas pipe connections to ensure that they are correctly sealed. Be aware of the safety hazards that could be caused by damaged electrical insulation or improper gas pipe connections that are not to an acceptable standard.
2. You should inspect the Air Preparation Panel for visible signs of moisture/particulate or oil contamination in the filter housings. The frequency of filter element replacement will depend on the quality of the air supply. As a minimum the filters should be replaced during the annual inspection schedule – see Annual schedule below.
3. You should access the Control Unit TEST screen, and check all operational data is displayed and that analyser to control unit communication is stable and not intermittent.
4. You should note the status of several key parameters on the Control Unit Test Screen as described in the tables below. If any of the key parameter values are outside the optimum operational values stated in the tables below then see the section *Obtaining Further Data.*

Key Parameters are

Signal levels

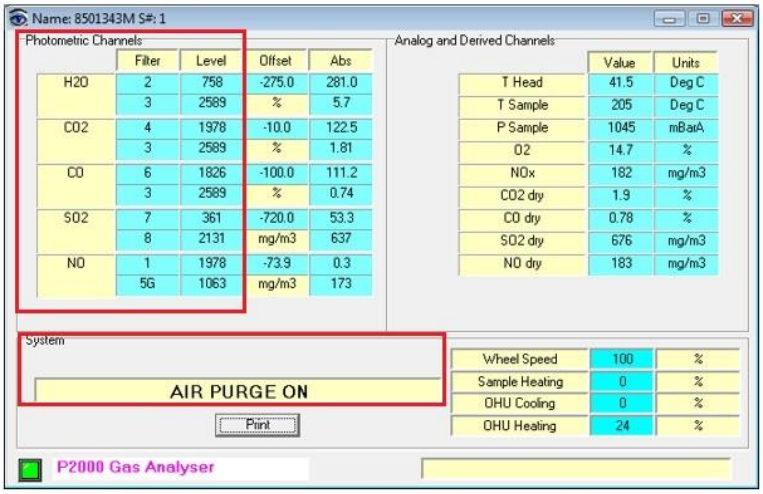
Sample Pressure - Process Gas and Zero Gas (Air On)

Sample Temperature

AU Temperature (T Head)

Signal Level Check

Parameter	Instructions for checking parameter
Signal Levels (Air Purge On)	
Step 1	Turn the Manual Air Purge On (see Control Unit Manual
Step 2	Wait for a few minutes until sample cell has purged
Step 3	Record the Signal level for each of the Filters
Step 4	Check Signal levels against the values recorded on the configuration sheet (supplied with your Original Documentation)
Step 5	Signal levels should be within +/- 20% of the original values
Step 6	If signals are outside this range then you should contact Protea or your Protea-authorised Protea Distributor to seek further advice and assistance



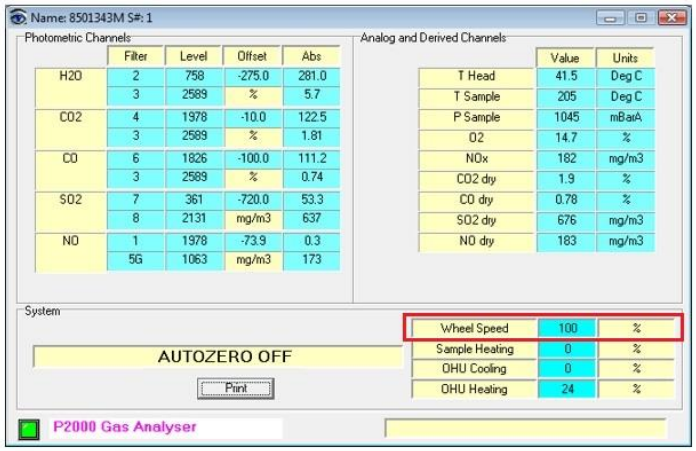
Sample Pressure Check

Parameter	Instructions for checking parameter
Sample Pressure	
Step 1	Record the sample pressure with process gas in the probe
Step 2	Cross check the P2000 Pressure reading with the value from an independent pressure sensor monitoring the process.
Step 3	Is the pressure value correct?
Step 4	Turn the Manual Purge (see the Control Unit manual).
Step 5	Purge the process gas from the sample cell (Process gas to Zero gas).
Step 6	Check the pressure by observing the TREND screen for a few minutes until the pressure has stabilised
Step 7	Record the increase in pressure due to the Manual Air Purge
Step 8	A pressure rise between 20mbars (0.3psi) and 50 mbars (0.72psi) should be observed when going from process gas to zero gas.
Step 9	If Pressure difference is < 20 mbars (0.3psi) then there may be a problem with the air supply to the sample cell of the probe or the needle valve in the AVU may need to be adjusted.
Step 10	If the Pressure difference is >50 mbars (0.72psi) then the sintered panel is partially blocked. You should contact Protea or your Protea-authorised Protea Distributor to seek further advice and assistance.

Temperature Checks

Parameter	Instructions for checking parameter
Sample Temperature	
Step 1	Record the analyser Sample Temperature with process gas present in the measuring probe.
Step 2	Record the process temperature with an independent temperature sensor.
Step 3	Does the P2000 temperature reading equal the reading from an independent temperature sensor?
Step 4	If an in-situ heater is fitted, then check the Control Unit software configuration for the in-situ heater temperature set point.
Step 5	Is the sample temperature stable?
Step 6	Sample temperature should be within ±5ºC (±9ºF) of the process temperature.
Step 7	If an in-situ heater is fitted, then sample temperature should be stable within ±5ºC (±9ºF) of the in-situ heater temperature set point.
Step 8	If you have any concerns relating to the sample temperature, then you should contact Protea or your Protea-authorised Protea Distributor to seek further advice and assistance.
Parameter	Instructions for checking parameter
AU Temperature (T Head)	
Step 1	Record the AU temperature value.
Step 2	For an analyser unit with a temperature-controlled cover check the Control Unit software configuration for the AU temperature set point.
Step 3	Is the AU temperature stable?
Step 4	Is the AU temperature equal to the set point? (within ±5ºC (±9ºF) of the set value)

Wheel Speed Check

Parameter	Instructions for checking parameter
Filter Wheel Speed	
Step 1	Record the wheel speed.
Step 2	If the “Wheel Speed” value is 100% then the filter wheel is functioning correctly.
Step 3	If the speed is not constant, then the value will be less than 100% - see below
	
Wheel Speed = 100%	Filter wheel is functioning correctly and no interaction is required
Wheel Speed = 60 to 90%	The wheel speed is not constant. Readings in this range indicate an impending problem with the filter wheel motor. You should consider replacing the motor.
Wheel Speed ≤50%	A value ≤ 50% will affect the accuracy of the gas readings. A “System Fault” alarm will also be triggered. The wheel speed value on the Test screen will be coloured RED. If a “System Fault” occurs, you should contact Protea or your Protea-authorised Protea Distributor to order a replacement motor.

5. Regular calibration checks of the P2000 may be required by regulatory authorities. For Calibration (see *Field calibration checks* within this section)

Annual Schedule

The annual scheduled inspection of the analyser DOES NOT require removal of the analyser from the stack or duct.

1. You should make an internal visual inspection of the analyser for signs of ingress of dust, moisture or process fluids and/or gases. DO NOT attempt to clean the optical components.
2. You should undertake a visual inspection of the exterior of the analyser for physical signs of damage. Protea recommends that you check cables for damage to their insulation and that you also check gas pipe connections to ensure that they are correctly sealed. Be aware of the safety hazards that could be caused by damaged electrical insulation or improper gas pipe connections that are not to an acceptable standard.
3. You should inspect the Air Preparation Panel for visible signs of moisture/particulate or oil contamination in the filter housings. The filter elements should be replaced during each annual maintenance schedule. (See Appendix E for the procedure for replacing filter elements)
4. You should access the Control Unit TEST screen, and check all operational data is displayed and that analyser to control unit communication is stable and not intermittent.
5. You should note the status of several key parameters on the Control Unit Test Screen as described in the quarterly schedule. If any of the key parameter values are outside the optimum operational values stated in the tables below then see the section *Obtaining Further Data.*

Key Parameters are

Signal levels

Sample Pressure - Process Gas and Zero Gas (Air On)

Sample Temperature

AU Temperature (T Head)

6. Regular calibration checks of the P2000 may be required by regulatory authorities. For Calibration (see *Field calibration checks* within this section)

Obtaining further data in the case of a fault

Should a non-conformance be noted during the quarterly or annual inspection then Protea recommends that prior to contacting Protea or your Protea-authorised Protea Distributor that you should obtain further data to aid the diagnosis and quicken the pathway to remedial action.

For a P2000 Control Unit P-PC with S-PC (formerly ACWn) software please obtain the Automatic Field Data Collection (AFDC) file. Instructions for running the Automatic Field Data Collection program and for obtaining the AFDC file are provided in the Manual for the S-PC (formerly ACWn) software (18-0006). When contacting Protea or your Protea-authorised Protea distributor then please send the AFDC file (P2000_AFDC_LOG.LOG.txt).

For P2000 with P-HMI Control Unit you should provide the key parameter values described above (Signals Levels, Pressure and Temperature values and Wheel Speed. Version 1.0.0 of the P-HMI Control Unit has function keys that also allow the Database, Error Log and Auto Verification log files to be dumped to a USB memory device. See 18-0008 Manual for Control Unit P-HMI) (From Main screen select SETUP, select SYSTEM MENU, select UTILITIES and select log type to be dumped.

NOTE	**Other applicable documents**
	18-0003 Manual for Control Unit P-PC (the above Control Unit is used with 18-0006 Manual for S-PC (formerly ACWn) Software) 18-0008 Manual for Control Unit P-HMI

Cleaning

Please do not attempt to clean any of the optical surfaces within the instrument. Contact Protea, or your Protea-authorised Protea Distributor, for a cleaning service. If you attempt to clean optical surfaces and cause damage, the warranty on the P2000 system may be voided or limited.

Under no circumstances must any oil be applied to the sinter panels. Oil will block the pores of the sinter panels rendering them impermeable to gas. Contact Protea, or your Protea-authorised Protea Distributor, for advice on cleaning the probe or other analyser components.

Field gas calibration check

Introduction

The gases used in the original factory calibration have a supplier certificate of calibration and the calibration achieved using them should not be discarded lightly.

Note that the *Routine Inspection* schedules described within this section DO NOT call for a mandatory calibration check.

However, periodical calibration checks may be required by your local environmental authority.

The calibration gases must be in cylinders that can be located close to the AU. Each cylinder must be fitted with a regulator. It is very important that each cylinder has a supplier certificate of calibration, since experience has shown that large variations in actual concentration can be encountered.

It is important that the competent person performing the calibration should be aware that the gases used may be toxic and that all safety procedures associated with the handling of high-pressure – toxic gas cylinders are followed. The appropriate personal protective equipment must be worn the gas calibration check.

Equipment required for the calibration gas check:

- Gas Cylinder with concentration equal to 75% of the gas channel range.
- A gas regulator with appropriate stem for connection to outlet of gas cylinder.
- PTFE tubing to connect gas cylinder to AVU calibration gas port.
- A Protea Field Calibrator is required if undertaking a water vapour concentration check.

Gas Calibration

(For US EPA instruments see Appendix C)

In order to carry out the Gas calibration check of the analyser the testing engineer must be at ENGINEER access level –. Details of switching between Access Levels can be found in the analyser Control Unit manual. It should be noted that NO CHANGES should be carried out for calibration without the approval of the customer based on QAL 3 results.

1. On the Test Screen of P-PC (formerly ACWn) select START AUTOZERO NOW from the AUTOZERO drop down menu and allow the analyser to go through the whole cycle, noting pressure, absorbance and concentration readings.

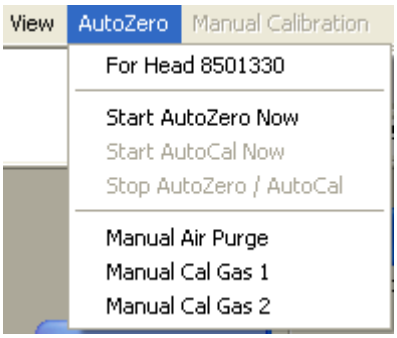


Figure 6-1: Selection of Auto Zero and Manual Air

2. Upon completion of Auto-zero, select MANUAL AIR PURGE from the same drop-down menu, wait for the readings to stabilise and then record the results. Readings should be as close to zero as possible, to provide a baseline for calibration.

3. Connect the outlet of the gas cylinder via the necessary fittings and regulator to the AVU CAL port. The CAL ports are located on the underside of the AU outer cover (Use Port 4 for CAL gas 1 or Port 5 for CAL gas 2)).
4. From the AUTOZERO menu (see *figure 6-1*) select MAN CAL GAS 1, open gas regulator and set pressure to approx. 1.9 bar(g) (27psig).
5. To ensure that all water vapour and auto-zeroing gas has been driven out of the sample cell wait for at least three minutes before taking any readings.
6. Observe the TEST screen and note the reading for water vapour, which should have reduced to a level of less than 2% of the absorbance reading during normal operation (e.g. if abs during normal operation is 100, reading should be <= 2). If it is higher, slightly increase the gas flow.
7. After allowing enough time for the calibration gas in question to stabilise (around 3 minutes) record the readings. If the displayed concentration reading is within ±2% of actual cylinder concentration value no calibration is necessary and the user can go to Step 15 or select another gas channel to calibrate.
8. If the display shows a calibration reading that is >±2% of the gas bottle, recalibration is required using steps 12-13.
9. Turn off the gas regulator and gas cylinder and allow the regulator pressure to decrease to zero.
10. Select MANUAL AIR PURGE from the AUTOZERO menu (see *Figure 6-1*).
11. AFTER readings on TEST screen have stabilised around 0 repeat steps 2-7.
12. On the TEST screen go to MANUAL CALIBRATION on the main menu and select CALIBRATE COMPONENTS from the drop-down menu (see Figure 6-*2*). If the manual calibration choice is greyed out it is because *operator* access level is selected. Change to *Engineer* level and continue.

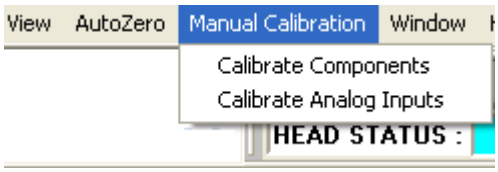


Figure 6-2 Manual Calibration Drop Down list

13. After selecting CALIBRATE COMPONENTS the Manual Calibration settings window will open (see figure 6-3). To calibrate the gas in question, select the gas from the drop-down text box, enter the ACTUAL Gas cylinder concentration in the EXPECTED VALUE box, and then click the ADJUST BUTTON.

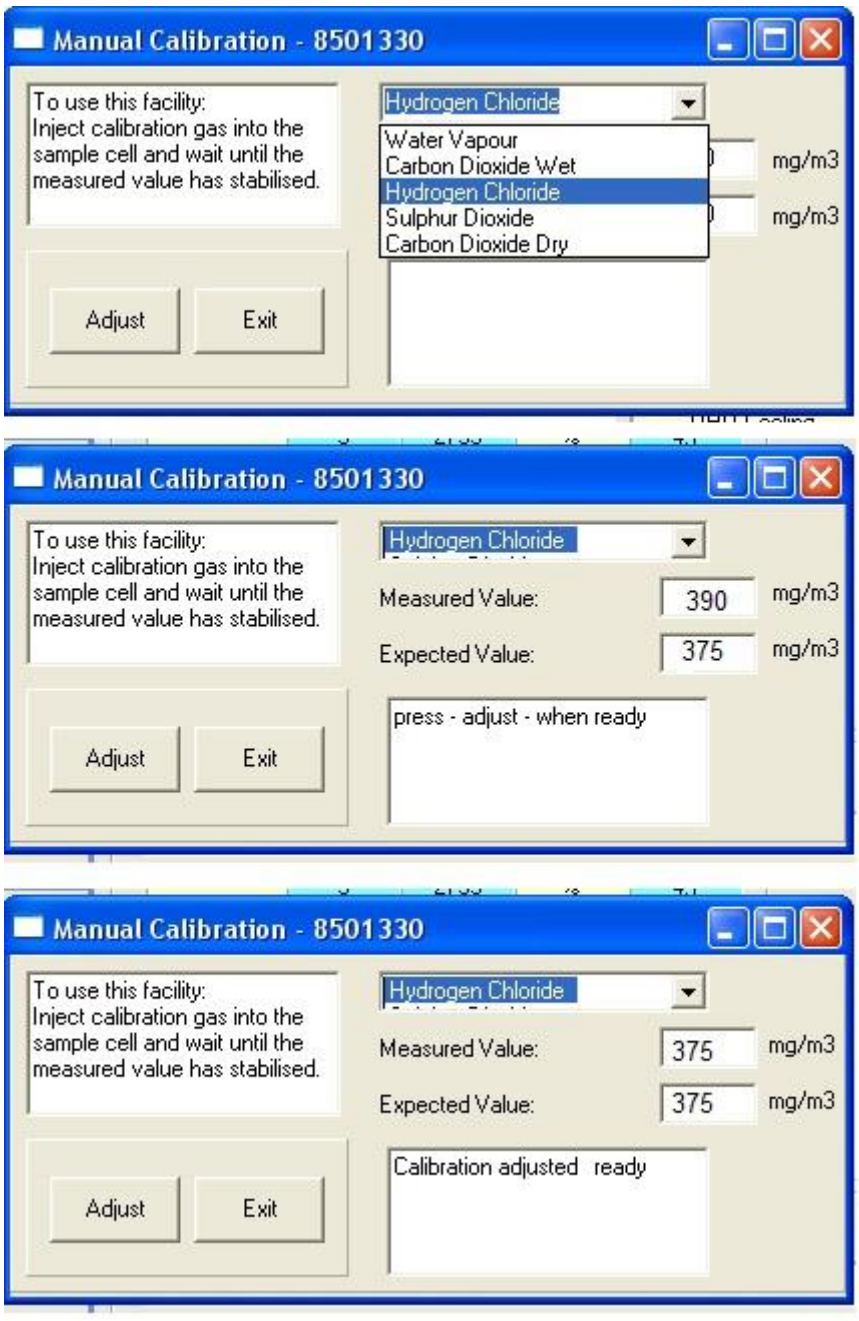


Figure 6-3 Manual Calibration Step-by-step screens

14. The software automatically recalculates the coefficients for the given gas so that returning to the TEST screen should give the correct reading. An indication in the information window will display a successful calibration. To return to the TEST screen simply select the EXIT button (shown in Figure 6-3). Figure 6-3 shows the selection of *Hydrogen Chloride* from the drop-down menu, and a successful calibration.
15. When all necessary channels have been calibrated disconnect the cylinder from the CAL Gas port.
16. Select MANUAL AIR PURGE from the AUTOZERO menu (see Figure 6-1).
17. After taking zero readings de-select MANUAL AIR PURGE again from AUTOZERO menu to turn off air (NOTE - MANUAL AIR PURGE should NOT have a check tick mark next to it in the menu). This returns the analyser to the normal process operation.

Water Vapour Calibration Check

A water vapour calibration should only be performed in the field if there is good reason to doubt the readings obtained. This is because laboratory conditions CANNOT be repeated in the field. A calibration carried out in the field IS NOT as accurate as one done in the factory.

If you have any concern with respect to the water vapour readings determined by the analyser then you should contact Protea, or your Protea-authorised Protea Distributor, for information on recalibrating the water vapour channel.

Fault-finding and Repair policy

Please contact Protea, or your Protea-authorised Protea Distributor in the case of a fault. Protea does not recommend performing any fault-finding process until you have discussed the nature of the fault with your Protea-authorised Protea Distributor. Protea will then provide targeted assistance to remedy the fault reported. Fault-finding processes and repairs to the P2000 system should only be undertaken by Protea's own trained support staff, or by those of its Protea Distributors world-wide.

Please note that if any unauthorised repair is incorrectly carried out, this may void or limit the warranty on the system.

Spares list

Part No	Description	Quantity
1-0007E	Source Element	1
1-0008	Brushless Motor assembly	1
1-0001	Sintered Tube assembly	1
3-0040	Mirror	1
1-0004	PRT Assembly P200/P5000	1
2-0002C	Filter wheel PCB MK3	1
2-2003E	AU PCB	1
3-0039	Process lens	1
3-0005	Main lens	1
1-0057	P2000/P5000 Seals kit	1
3-0241	Domed Nut (SS)	3
8-0380	Fuse 20mm Slow Blow 5A 250VAC (Local PSU 1-0093)	4
1-0260	Air Preparation Panel Spares kit	1

Table 6-1 Spares List

The figure in the right-hand column is the quantity of that part fitted to the analyser or the accessory described.

All spare parts must be supplied by Protea or your Protea-authorised Protea Distributor.

If you wish to order a spare part, please contact Protea, or your Protea-authorised Protea Distributor.

IMPORTANT -When ordering spare parts for the P2000, please state whether the P2000 analyser is used in an area with an explosive gas atmosphere (e.g. if Analyser is ATEX approved).

If you require a spare part that is not listed here, please contact Protea, or your Protea-authorised Protea Distributor.

When ordering spare parts, please quote both the Part Number *and* the serial number of the component part of your CEM system concerned (e.g. AU, Control Unit or ISH serial number). This information will help Protea provide you with a quick and efficient service.

Protea Ltd. reserves the right to change the prices, specifications, or manufacture of any component parts without notice.

UK Sales & Manufacturing	Customer service and tools
Protea Ltd 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk	**Protea Ltd** 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk
For Protea Distributor information see www.protea.ltd.uk/global-network	

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7 Disposal Instructions

Introduction

It is important that, at the end of the products life cycle, all parts of the P2000 are safely disposed of in accordance with all local environmental statutes and regulations which are lawfully in force.

If you are ever in any doubt about how to dispose of the P2000, you may return it to Protea in the United Kingdom, carriage paid. Protea will dispose of the system for you. There will be no charge for this service, but neither will you receive any payment or allowance for any components or materials recovered.

Disposal of Stored Data

Your attention should be drawn to data that maybe stored on the P2000 and/or the associated accessories such as the Control Unit.

You, as the owner of the P2000 and the associated accessories, are responsible for the data stored within the equipment and therefore subsequently for the disposal of the stored data when disposing of or recycling the hardware. Protea recommends that you consult with your colleagues in your IT department as to how the data can be erased and the removal of the data can be confirmed.

Disk wipe type software packages are available that overwrite the existing data with new, random and meaningless data many times to ensure that data is fully erased.

Alternatively, the hard drive of the devices in which data is stored can be physically destroyed.

NOTE - This manual is an integral part of the P2000 analyser system. If you pass the CEM system on other than for final disposal, you should always pass this manual on with it.

Zinc Selenide optics

DANGER	Contact with Optical Lens material presents a Toxic Hazard
	Death or serious injury could result from touching the Zinc Selenide lens material. Touching the lens material may result in residue material being digested.
	Customer specific P2000 analysers may contain long wavelength Zinc Selenide lenses. If your P2000 has such optics, this will be stated in the section of this manual entitled *Order-Specific Information*. DO NOT touch the optical component without using appropriate personal protective equipment (PPE). Refer to the Zinc Selenide material safety data sheet for safe handling and disposal information.

YOU MAY ONLY DISPOSE OF ZINC SELENIDE OPTICAL COMPONENTS BY DELIVERING THEM TO AN ENVIRONMENTAL WASTE DISPOSAL AGENCY THAT ACCEPTS SUCH MATERIAL OR BY RETURNING THE OPTICS TO PROTEA IN STRONG PROTECTIVE PACKAGING.

DISPOSAL BY ANY OTHER MEANS MAY LEAD TO DAMAGE TO HUMAN HEALTH AND THE ENVIRONMENT.

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8 Transport & Storage Instructions

IMPORTANT - Please read the Safety Warnings below before performing any function set out in this section of the manual.

DANGER	Single person lift could cause injury
	Serious injury could result from lifting heavy load
	Seek assistance when moving or lifting a heavy load weighing more than 20 kg (44lbs). Lift the load correctly Bend your legs Keep your back as straight as possible Keep the load close to your body Grip the box or load at opposite corners where possible

DANGER	Working in Confined Space could cause injury
	Serious injury could result from working in a confined space
	Ensure area is well ventilated Ensure area is well lit Use Personal Protective Equipment such as Knee pads if kneeling on floor Keep Entrance and Exit to the Confined space clear

DANGER	Touching Hot Surface could result in injury
	Serious injury could result from touching a hot surface
	Consult your site safety regulations or seek advice from supervisory personnel Be aware of the hot surfaces in the working area Use Personal Protective Equipment as directed by your site safety regulations such as Heat Resistant Gloves when handling hot objects Do Not Handle Hot Objects for Long periods

Packaging for Transportation

The P2000 analyser is packed inside a cardboard container. The analyser is protected by moulded polyurethane packing material that protects the analyser from impacts and vibration. Accessories such as the Control Unit and in-situ heater are normally packed in the same container as the analyser and similarly protected by moulded polyurethane packaging material.

The base of the cardboard container is fastened to a wooden pallet using galvanised nails. The cardboard container is sealed with parcel tape and the package secured with tensioned nylon strapping.

General Information

Parameter	Units of measurement
Dimensions	1360 mm (53.5”) x 380 mm (15”) x 315 mm (12.4”)
Weight	25 kg (55 lbs) without GRP cover 35 kg (77.2 lbs) with GRP cover
Centre of Gravity	The CoG resides inside the head cover close to the probe interface. The centre of gravity is located 330 mm measured from left to right of head cover as in the figure below

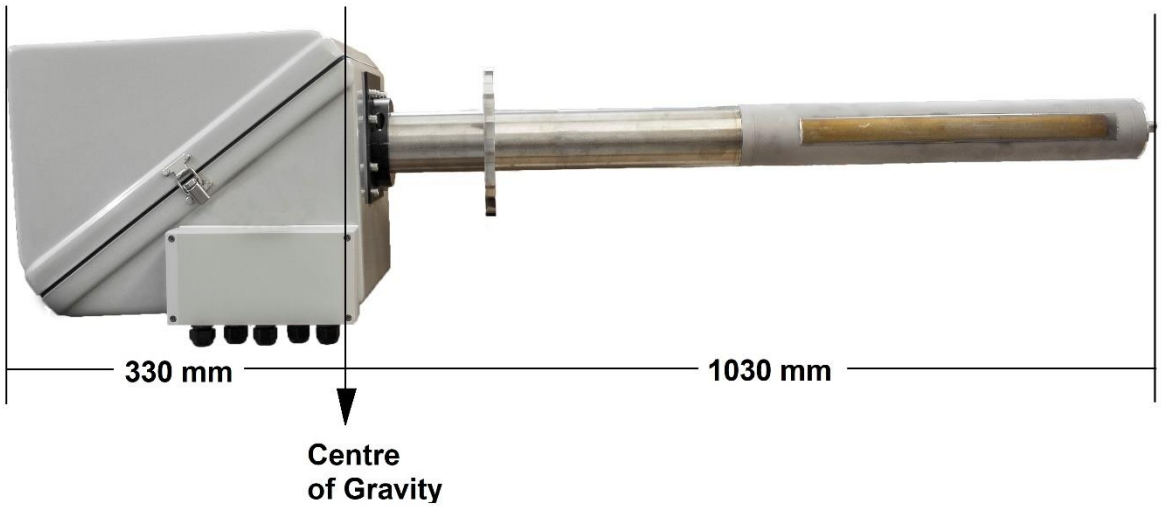

Figure 8-1 P2000 Centre of Gravity

Procedure for lifting and handling analyser

ATTENTION

Two persons are required to lift and carry the analyser. The persons tasked with lifting and carrying the analyser should lift by applying upward force at the opposite ends of the analyser. The analyser is supplied with a foam inlay as part of the packaging material. The foam insert can be used to seat the analyser when it is set down on a flat surface.

Procedure for removing analyser from a hot process

ATTENTION

Mitigate the risk to injury that could result from handling a hot object in a confined space.

Avoid touching the probe end when removing the analyser from the stack.

Wear suitable PPE – for example heat resistant gauntlets, eye protection, hard hat and steel toe capped boots.

NOTE – when working on a live stack a personal gas detector should be carried – consult your site working regulations or site supervisor before commencing work.

Remove the analyser probe slowly.

Set down on flat surface and allow to cool before lifting.

Fix an appropriate blanking plate to the stack or duct flange.

Storage Conditions

Parameter	Storage Conditions
Storage Temperature	-20ºC to +50ºC (-4ºF to 122ºF) ideally Store in a dry, clean, well-ventilated area at room temperature between 15ºC and 25ºC (59ºF-77ºF)
Humidity	< 60% Relative Humidity
Storage position	Store Flat (preferably on foam inlay that is supplied with the analyser)
Effect of Direct Sunlight	NOTE - Labels are manufactured from polyester and back printed to withstand oil, solvents and chemicals. A UV inhibitor added to the polyester material provides protection against direct sunlight. The GRP cover is stable to UV light

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9 Order-specific information

Introduction

This section contains summary installation diagrams and information specific to the P2000 series system with which you have been supplied. The following standard drawings of the version current at date of publication are included as a guide only.

Title

- Installation overview – Analyser/Protea Control Unit P-HMI
- Installation overview – Analyser/Protea Control Unit P-PC (formerly ACWn) Software

For full installation details and for installation drawing versions applying to your specific delivery refer to the Drawing Package referenced below as delivered with the equipment.

- Installation Drawing Package – P2000
- Included for reference - Air Specification Quality Standard for Instrument Air Supplied to Protea Analysers – see *Appendix D*.

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Appendix A - The P2000 with ATEX/IECEx approvals

Introduction

Versions of the P2000 have been granted ATEX II Ex 2 G Ex db IIB T6 Gb approval (Type Examination Certificate Number Baseefa 18ATEX0060X) and IECEx Ex db IIB T6 Gb approval (Certificate of Conformity Number IECEx BAS 18.0040x) both for use in flammable atmospheres, Zones 1 and 2 with an ambient temperature range from -20°C to 40°C (4°F to 104°F).

Versions of the P2000 have been granted ATEX II Ex 2 G Ex db IIB T4 Gb approval (Type Examination Certificate Number Baseefa 18ATEX0060X) and IECEx Ex db IIB T4 Gb approval (Certificate of Conformity Number IECEx BAS 18.0040x) both for use in flammable atmospheres, Zones 1 and 2 with an ambient temperature range from -20°C to +60°C (4°F to 140°F).

To achieve this, the equipment has undergone rigorous tests at the Baseefa authority against the British and European Standards BS EN 60079-0:20 + A11 2013 and BS EN 60079-1:2014 and 60079-0:2018.

Tests and QA in production to Standard BS EN ISO/IEC 80079-34:2018 ensure that the equipment cannot cause an explosion when operated correctly in the stated hazardous areas.

Quality assurance during production

To comply with the requirements of the approval, several steps must occur during production under the terms of the licence 7765 held by Protea.

- The materials used in safety critical parts are supplied with Certificates of Conformity
- Certain mechanical parts are inspected to drawing to ensure that critical dimensions are correct and records are kept.
- The optical head casting is subject to a pressure of 10.65 bar (g) (154.5 psig) for a minimum of 10 minutes without damage, permanent deformation, or leakage other than through the flame paths.

- The potted lens assembly is subject to a pressure of 10.65 bar (g) (154.5 psig) for a minimum of 1 minute and no leakage through the cemented joint is permitted.
- The thermo-pocket of the reflector tube is subject to a pressure test of 47.5 Bar (689 psi) for 10 seconds in line with the certified product requirements. No leaks, distortion or deformation are accepted.
- The completed analyser is subject to final inspection against the overall approval drawing.
- Details are available on request to Protea.
- The Protea Quality System is certified to ISO 9001:2015 and EN 80079-34:2018 (Explosive atmospheres – part 34: Application of QMS for Ex product manufacture) ensuring that the Quality System is suitable to provide the control required by the ATEX/IECEx approval.

Allowed environments

The standards above detail the gases, and environments, in with which approved equipment is allowed to be used. Reference may be made to them.

- The P2000 is approved for use in potentially explosive gas atmospheres classified as IIB
- The P2000 should be mounted horizontally and the sample temperature should not exceed 200°C (392°F)
- The P2000 has a surface temperature classification of T6, which indicates a maximum surface temperature of 85°C (185ºF) and is approved for the ambient temperature range –20°C to +40°C (4°F to 104°F).
- The P2000 also has a surface temperature classification of T4, which indicates a maximum surface temperature of 135ºC (275ºF) and is approved for the ambient temperature range -20ºC to +60ºC (4°F to 140°F). See the Installation section for other restrictions on ambient temperature.
- The P2000 when fitted with the P2000 ATEX/IEC Cooler Option (Vortex Cover) has a Protea Declaration of Conformity to a surface temperature classification of T4, which indicates a maximum surface temperature of 135ºC (275ºF) and is certified for the ambient temperature range –

20°C to +60°C (4°F to 140°F). See the Installation section for other restrictions on ambient temperature.

IT IS THE USER'S RESPONSIBILITY TO ENSURE THAT THE ANALYSER IS BEING USED IN AN APPLICATION FOR WHICH IT IS APPROVED.

THE PURCHASER MUST MAKE THE MANUFACTURER AWARE OF ANY EXTERNAL EFFECTS OR AGGRESSIVE SUBSTANCES, THAT THE EQUPIMENT MAY BE EXPOSED TO.

Maintenance additional requirements

Quarterly and Annual inspection schedules are described in the Inspection Schedules chapter of the P2000 operating manual. For maintenance instructions, such as the replacement of the process lens and end mirror, please contact Protea or your Protea-authorised Protea Distributor.

NOTE - Special precautions are essential in hazardous areas because if certain parts of the P2000 are changed, this may affect the analyser's certification status.

When ordering spare parts for the P2000 from either Protea or your Protea-authorised Protea Distributor please provide the serial number of the analyser and additional information as to whether the spare part required is for use in an area with an explosive gas atmosphere.

To obviate any risk from energy storage devices, the enclosure must not be opened when the unit is energised, or an explosive atmosphere is present.

The cable entry devices, thread adapters and stopping plugs used shall be suitable for the equipment, the cable and the conditions of use and shall be suitably certified. All unused entries are to be fitted with suitably certified flameproof stopping plugs.

Any replacement glands and hole blanking plugs must have the same thread form (M16, M20, M25) as the original items, and be suitably certified

No unauthorised modifications shall be carried out on any part of the enclosure or to the cabling there to. The main bonded lens can only be repaired by Protea and must not be replaced or repaired by the user.

The external earth stud on the underside of the enclosure shall be connected to a convenient earth or ground point. This equipment must be earthed.

The maximum penetration of any fastening bolts used into the four M8 threaded holes provided must be no more than 6.75 mm thereby leaving one free thread.

The main lens is potted and can only be replaced by Protea. Do not attempt to disturb or maintain.

The joint surfaces of the enclosure and its cover shall be clean before re-assembly. If there is any damage to these surfaces consult Protea or their Protea-authorised Protea Distributor.

All bolts fixing the enclosure lid to the base (8 stainless steel fixing bolts size M6 X 16) are tightened and torqued to 13.5 Nm (+0/-1 Nm) or 10 ftlb (+0/-1ftlb). All bolts must be stainless steel and graded A2-70. Missing or damaged ones must only be replaced by bolts ordered from Protea.

The maximum cover / base flame-path gap permitted is 0.08mm. A calibrated set of feeler gauges must be used to check that the gap between parts forming part of the flame paths, between the casting lid and base do not exceed the maximum gap of 0.08mm that is permitted.

Laws and regulations about flammable atmospheres that apply to the customer should be observed in addition to these ATEX requirements.

To avoid a possible electrostatic charge, only clean with a damp cloth.

See also Vortex Cover and ATEX PSU AVU for accessory details (below).

The Special Conditions for Safe Use shall be observed – see below

Special Conditions for Safe Use

RATING CLASSES:


II 2 G Ex db IIB T6 Gb

(-20°C ≤ Tamb ≤+40°C)


II 2 G Ex db IIB T4 Gb

(-20°C ≤ Tamb ≤+60°C)

ELECTRICAL RATING:

24V 1.0A Max

ATEX CERTIFICATE:
Baseefa18ATEX0060X

IECEx CERTIFICATE:
IECEx BAS 18.0040x

Summary of Special Conditions for Safe Use P2000:

- It is the responsibility of the user to ensure that the gas passed through the enclosure (purge) is instrument air or inert gas, and that the inlet pressure does not exceed 0.1bar (10 kPa or 1.45 psi).
- It is the responsibility of the user to ensure that the gas passed through the void assembly (purge) is instrument air or an inert gas, and that the inlet pressure does not exceed 0.48 bar (7 psi).

Summary of Special Conditions for Safe Use P300:

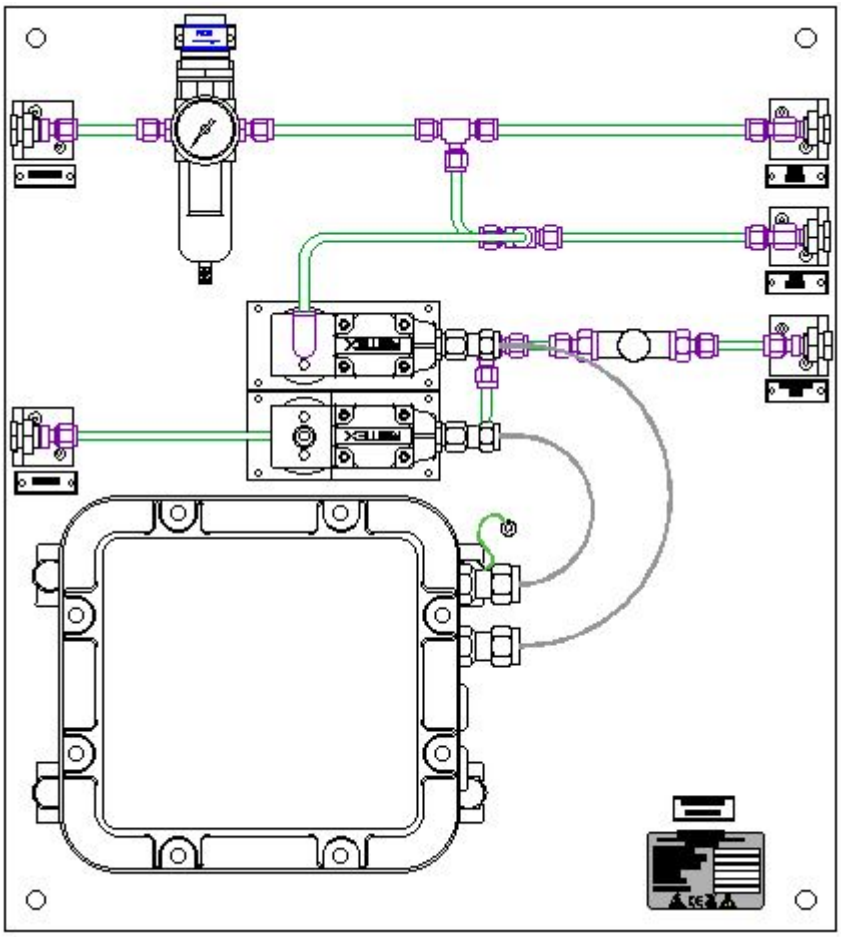
In addition to the P2000 conditions:

It is the responsibility of the user to ensure that the pressure of the sample passed through the sample cell does not exceed 12 bar (174 psi).

ATEX PSU AVU

The ATEX Auto Zero / Verification Unit facilitates automatic zero and verification / calibration routines. It is mandatory that the analyser is configured to instigate automatic zero's every 12 or 24 hours depending on application.

- Clean and dry instrument air (Protea Standard ISO *8573-1:2010 0 3 1* see Appendix D) for the analyser purge, auto-zero and sample cell protection should be available adjacent to where the AU will be fitted. Pressure should be regulated to a maximum of 6.0 Bar gauge (and should provide a nominal inlet pressure of 2.5 to 3 Bar Gauge to the AU AVU). The AVU provides a flow rate of 1 l/min (constant) for the AU head compartment and void space in the reflector tube and 6 l/min (intermittent) during auto-zero operation (typically 5 minutes every 12 hours) is required.
- Pressurised gas cylinders (Up to two) containing a known mixture of the gases under analysis.



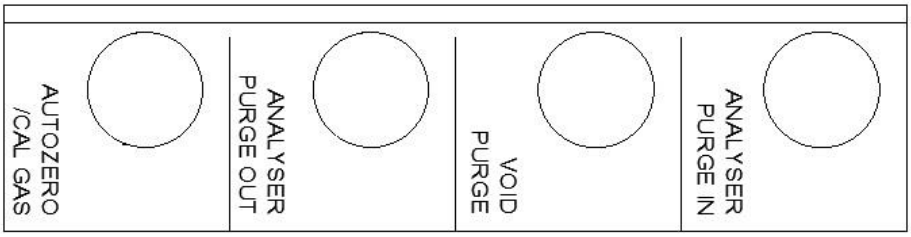
The Auto Zero / Verification function is achieved by activating a series of solenoid valves mounted on a manifold block. The manifold block is mounted on an access plate which is secured to the cover by four M4 socket headed screws.

Note: It is not necessary to remove the access plate during installation.

- The ATEx PSU AVU has a surface temperature classification of T6, which indicates a maximum surface temperature of 85°C (185ºF) and is approved for the ambient temperature range –20°C to +60°C (4°F to 140°F).

The solenoid and enclosure lids should not be removed, or any changes or maintenance carried out (contact Protea for support).

A bulkhead plate that aligns with the autozero/cal gas and purge ports is attached to the cover. The Bulkhead plate is shown in the figure below



Connection of Zero and Test Gas to the Analyser		
Function	From	To
Zero / Purge Supply	Wall Mounted Regulator Set to 2 Bar Gauge	Analyser Cover Port 1
Calibration Gas	Gas Cylinder 1 Regulator Set to 2 Bar Gauge	Analyser Cover Port 4
Calibration Gas	Gas Cylinder 2 Regulator Set to 2 Bar Gauge	Analyser Cover Port 5
Notes:		
All pipe fittings 1/8” BSP		
The unit is supplied with all internal wiring and piping necessary for the operation of the analyser		

RATING CLASSES:

II 2 G Ex db IIB T6 Gb

(-40°C ≤ Tamb ≤+35°C)

II 2 G Ex db IIB T4 Gb

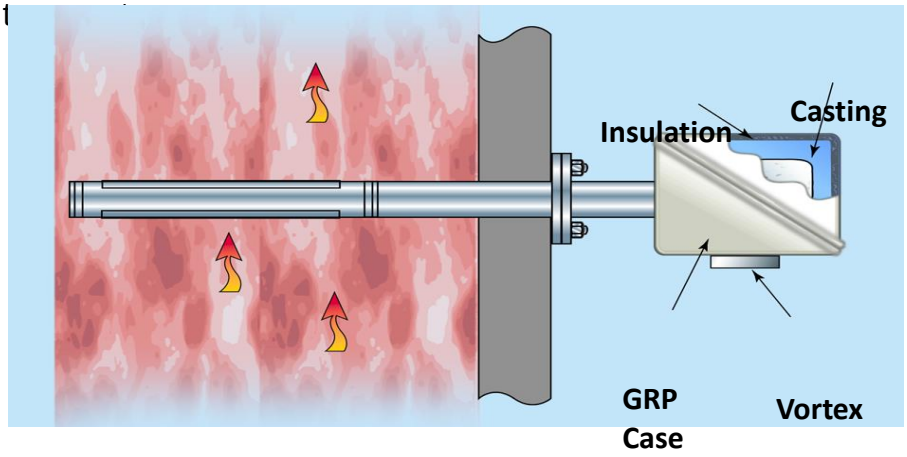
(-40°C ≤ Tamb ≤+60°C)

ELECTRICAL RATING:

90-264VAC 1.5A Max

ATEX Analyser Cooler

The analyser cooler is a standard accessory which is fitted over the casting assemby of the P2000 anayser. It is used to reduce the ambient temperature of the analyser and reduce the fluctuations in t



The vortex tube is a mechanical cooling device, with no moving parts, no electricity and no freon, that separates a compressed gas (air) into hot and cold streams.

Pressurised air is injected into a swirl chamber and accelerated at a high rate of rotoation. Due to a conical nozzel at the end of the tube, only the outer shell of the compressed gas is allowed to escape at that end.

The cold air is directed onto the casting to provide cooling. The operation of the cooler is controlled by monitoring the temperature inside the casting assembly and switching the air supply to the vortex tube via an Ex type solenoid valve.

The hot end of the vortex tube is considered to present an ignition hazard and therefore an ignition hazard risk assessment has been conducted and a technical file constructed.

The materials of construction could present an ignition hazard and therefore an ignition hazard risk assessment has been conducted and a technical file constructed.

The cover is of GRP material and surface resistance could present a hazard.

There is a solenoid valve to switch the air that is Ex d mb IIC T4, T5 and T6 Gb (IP67)

To meet the maximum surface temperature rating of T4 (135ºC (275ºF) the maximum air supply pressure must not exceed 100 psi (7 bar) for the ambient temperature range ≥ -20ºC to ≤ 60ºC (-4ºF to 140ºF). (See Drawing 19-0037)

The cover is to be inspected for conformity to

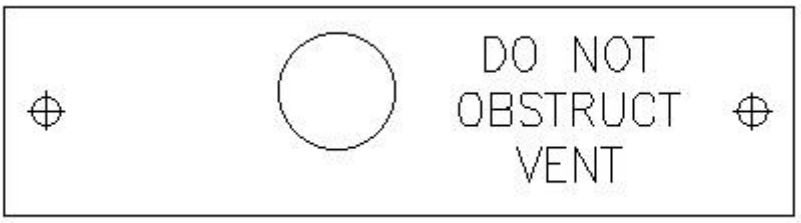
Drawing 1-0174A

The gap between the casting and the cover is at a minimum between the inner edge of the insulation and the edge of the casting at the top two corners. The minimum distance between the flameproof “d” flange openings and obstructions must not be less than 30mm (as per drawing 1-0174A).

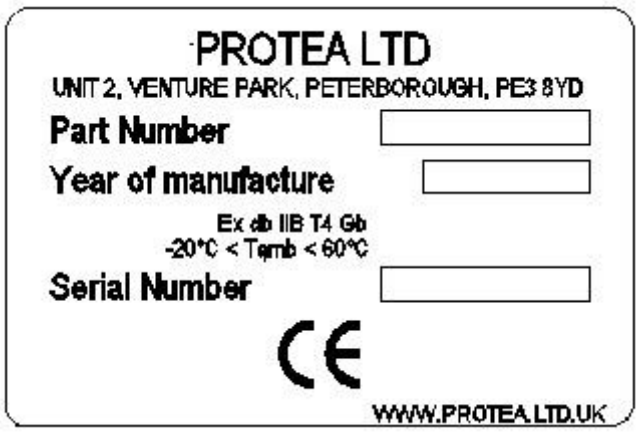
The cover should not be removed, or any changes or maintenance undertaken – please contact Protea for support regarding the ATEX cover.

The Vent hole in the cover is aligned with the flame arrestor to prevent an obstruction to the head purge air vent (as per drawing 1-0174A).

The plate below is placed on cover to align with the vent, the plate warns against obstructing the vent as in the figure below.



The plate below, that indicates the ATEX approval, is also fastened to the cover.



Appendix B - P2000 with MCERTS approval

Introduction

The P2000 with the Control Unit have been granted MCERTS Certification No Sira 050060.

The full certificate detailing the performance criteria test results, precautions, application, environment and maintenance requirement can be viewed at

https://www.csagroupuk.org/wp-content/uploads/2018/12/MC05006014.pdf

.

This certification shows compliance with

MCERTS Performance Standards for Continuous Emission Monitoring Systems, Version 4 dated July 2018

EN15267-3:2007, & QAL 1 as defined in EN 14181: 2014

The Certification Ranges are:

NO2	0 to 200 ppm, 0 to 5000 ppm
N2O	0 to 300 ppm, 0 to 5000 ppm
NO	0 to 240 ppm, 0 to 1500 ppm
SO2	0 to 150 ppm, 0 to 1500 ppm
CO	0 to 150 ppm, 0 to 3500 ppm
CO2	0 to 15 Vol.%, 0 to 25 Vol.%
H2O	0 to 30 Vol.%

The certificate identifies the following points:-

The user should ensure, in consultation with the manufacturer, that the monitoring system is suitable for the intended application.

This CEM has been proven suitable for its measuring task (parameter and composition of the flue gas) by use of the QAL 1 procedure specified in EN14181, for Industrial Emissions IED Chapter III and IED Chapter 1V applications for the ranges specified. The lowest certified range for each determinant shall not be more than 1.5X the daily average emission limit value (ELV) for IED Chapter IV applications, and not more than 2.5X the ELV for IED Chapter III and other types of application.

This certificate applies to all instruments fitted with software version 2.7.2 (serial number 8501226M) onwards.

The instrument was evaluated for use under the following conditions:

Ambient Temperature Range: -20°C to +50°C (-4ºF to 122ºF)

Instrument IP rating: IP 65

Quality assurance during production

To comply with the requirements of the approval several steps have to occur during production and design under the terms of the certification held by Protea.

- All changes to the system design or build have to be evaluated and recorded by the Protea Quality System to determine if the change could impact the conformance to the MCERTS requirements.
- Where the evaluation has demonstrated no measurable impact on performance, the change can be implemented and records of test evidence are maintained for review.
- Where a change evaluation shows a measurable impact on performance would occur, then a re-testing schedule has to be approved by SIRA, and the test results approved by SIRA prior to implementation.
- The record of changes to design where there has been no measurable impact on performance is audited by Sira each year and an MCERTS Design Schedule is re-issued each year to Protea for this Certificate by Sira to show confirmation of authorisation for all changes to design or manufacture. Note this also applies to all changes (up issues) to the Control Unit Control Unit software.
- The Protea Quality System is ISO 9001 approved for Design, manufacture, installation and servicing of analytical instruments and audited yearly, ensuring the Quality System is suitable to provide the control required by the MCERTS certification.

Maintenance additional requirements

General Maintenance operations are described in the chapters of the P2000 operating manual. However, a specific procedure is stated in the MCERTS certificate as follows:-

“The P2000 MCERTS analyser has a maintenance interval of 1 month. The work details below must be carried out at regular intervals, depending on local conditions:

1. Check that the analyser(s) and associated units are functioning correctly by logging and comparing the “test screen” readings with those previously logged.
2. Select zero gas purge and verify the P2000 indicates zero within 2% of span, then select span gas and verify it is within 2% FSD of the cylinders' certified concentrations.
3. If the system outputs are connected to a plant DCS verify that the current readings are displayed correctly on the DCS display.
4. Before leaving site ensure that the system is left in its normal operational mode. “

Appendix C - Protea analysers for US EPA compliance

Introduction

To satisfy the environmental regulations in the USA and some other countries, it is necessary to both check and demonstrate that the analyser is within its quoted calibration accuracy. This requires that the Autozero facility should be augmented by an automatic check of the span calibration of the analyser.

Once a day the analyser zero and span accuracy is to be checked and recorded. This record is maintained on a rolling 7-day basis, and the record for the previous seven days should be available for viewing and printing at any time on demand. This appendix describes the implementation of US EPA 40 CFR Part 75 in the P2000. It must be read in conjunction with the main technical manual.

Services

The following services are required for this option:

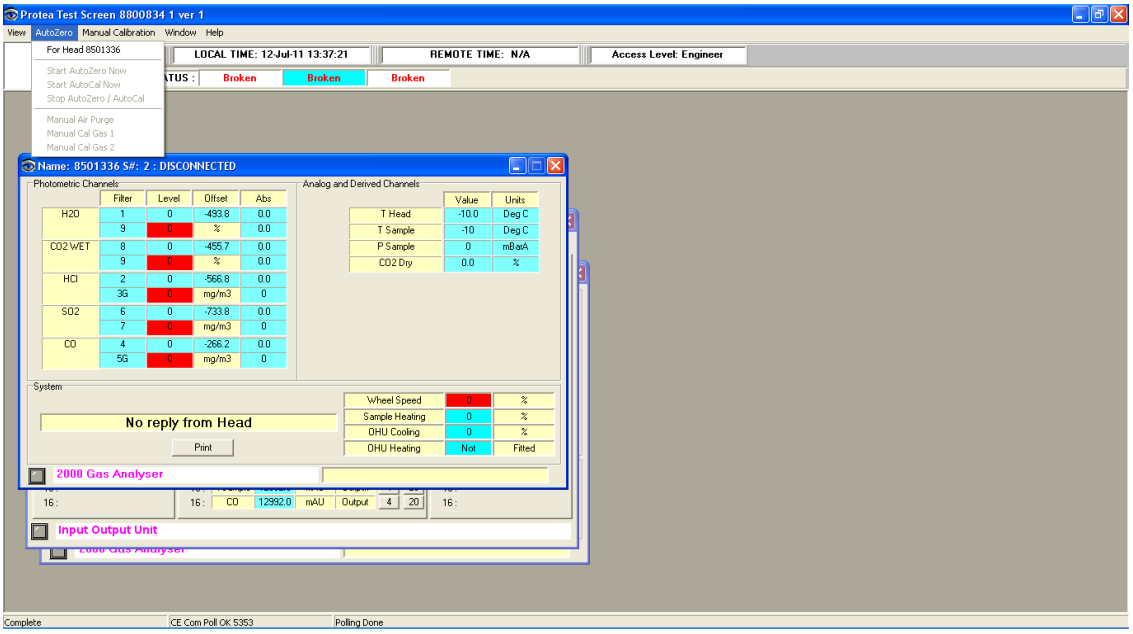
ZERO GAS Clean, dry instrument air at a continuous 0.5 litre/min for the analyser void purge and 5 litres/min for 4 minutes. The zero-gas solenoid is energised-closed so that in the event of a power failure the analyser sample cell is filled with zero gas, thus preventing damage due to acidic condensation of the sample gas in the sample cell.

SPAN GAS This should be a gas mixture containing all the gases for which verification is required. The concentration of each gas should be between 80% and 100% of the full-scale sensitivity of its measured channel. Consumption is 5 litres/min for 4 minutes every 24 hours. NO, CO, SO_2 etc. should be mixed with N_2. NO_2 should be mixed with pure air. The span gas concentration (from the certificate) must be entered at the menu item ‘Calibration verification’ on the Control Unit each time a new gas bottle is installed. For US EPA compliance purposes it should be EPA Protocol 1, calibration gas, vendor certificated.

Operation

Manual operation of Auto-Zero is carried out using the following steps;

1. If not already on the TEST screen, select the EYE symbol to navigate there.
2. Select AUTOZERO from the menu, this will give a drop-down menu giving the serial number of the Analyser head S-PC (formerly ACWn) is looking at. Ensure the serial number is for the head requiring the Auto-Zero.



3. Select START AUTOZERO NOW from the drop-down menu.

The above steps assume that MANUAL AIR PURGE is NOT on. An Auto-Zero cannot be carried out with manual air on, so this should be turned off beforehand. This is done by following the above steps but selecting MANUAL AIR PURGE instead of *Start AutoZero Now*.

An *automatic* Auto-Zero is done on a settable time interval – usually every 12hours, the set up for which is done on the MAIN SCREEN. This is also the place where the Auto-Zero function can be turned ON or OFF, the procedure for this is detailed in the S-PC (formerly ACWn) Control Manual.

During the first Auto-Zero cycle after midnight a calibration routine is included in the operation, this data will be recorded once per day over a 7-day period. This data can be inspected and printed as described in *Viewing the results.*

During calibration phase the introduction of the gases causes the pressure in the cell to increase slightly. To allow for both variations in the process pressure and in the pressure during auto calibration, a transducer in the analyser is used to provide continuous pressure compensation. In addition, to ensure that calibration gas is present, the calibration gas cylinder pressure is sensed by a pressure switch (set to operate at 100psi) integral with its regulator. An alarm is set up within S-PC (formerly ACWn) that can be set to trigger if the gas pressure is low.

A further function is for the remote start of an Autozero cycle, which overrides the internal automatic timer. This facility is activated by shorting 2 inputs on the Analyser Unit with the volt-free contact.

Figure C-1 shows a table giving the phases of the calibration cycle including Auto-Zero, their default timings and the states of the gas solenoids during the automatic calibration.

NOTE - the Zero gas solenoid valve is energized-closed so that in the event of a power failure the valve opens, flooding the sample cell with dry air and excluding low temperature sample gas that could cause acidic condensation and hence corrosion.

Phase	Name	Function	Default Duration	Zero Gas Solenoid State (AIR)	Span Gas Solenoid State (Cal Gas)
1	ANALYSE	Normal Analyser Operation on Process	12 hours	Energised (CLOSED)	De-energised (CLOSED)
2	ZERO FLUSH	Introduce zero gas (air), thereby purging the sample gas	4 mins	De-energised (OPEN)	De-energised (CLOSED)
3	ZERO CALCULATE	Average readings on zero	2 mins	De-energised (OPEN)	De-energised (CLOSED)
4	ZERO UPDATE	Log the concentration reading and reset the zero level	1 sec	Energised (CLOSED)	De-energised (CLOSED)
5	SPAN FLUSH	Introduce span gas, thereby purging the zero gas	4 mins	Energised (CLOSED)	Energised (OPEN)
6	SPAN CALCULATE	Average the readings	2 mins	Energised (CLOSED)	Energised (OPEN)
7	SPAN UPDATE	Log the concentration reading and act upon the error accordingly	1 sec	Energised (CLOSED)	Energised (OPEN)
8	PROCESS FLUSH	Switch off the span gas allowing sample gas to re-enter	4 mins	Energised (CLOSED)	De-energised (CLOSED)

Figure C-0-1: Table showing solenoid states for AUTOZERO/AUTO CAL

Action on calibration error

If a calibration error occurs, the action required depends on the scale of the error:

- If the error is less than 2.5% of full scale, no action is required as the calibration is within specification
- for a change in calibration of between 2.5% and 5% of full scale, the analyser calibration is automatically adjusted to give the correct reading and the calibration is OK
- if an error is greater than 5% error or if the gas cylinder pressure falls below 100 psi, the analyser is considered to be out of calibration; no re-calibration action is taken and the readings on the MAIN screen are shown thus:

(235) PPM Total NOx

Viewing the results

The results of this are accessed via the MENU item “Calibration verification”. The following items are shown on the screen with some example values:

Channel		NOx
Print this day		
Print last 7 days		
Date		1st Jan
Time		00:00
(status)		OK
Cal Gas conc	(PPM)	300
Zero conc	(PPM)	0
Zero error	(%)	0.0
Span conc	(PPM)	300
Span error	(%)	0.0

If ‘Print this day’ is selected, then the report for that day is printed. Similarly, if ‘Print last 7 days’ is selected then the reports for that period are printed.

Electrical connections

The electrical connections to enable the Calibration Gas controls are detailed on the Installation Drawing

Appendix D – Quality Standard for Instrument Air Supplied to Protea Analysers

Introduction

It is essential that the air used for optical purge, void purge and auto zero is of the required standard. This section describes the quality of air supplied. If in doubt it essential that the Quality of Air is tested to confirm that it meets the required standard as stated below.

If the air is shown to be inadequate, please install an Air Preparation Panel (see appendix E).

Quality Standard for Instrument Air Supplied to Protea Analysers

The quality of air is defined in ISO8573-1:2010 Compressed Air - Contaminants and Purity Classes.

The quality of the instrument air supplied to the analyser for purging the head optical compartment, void chamber and sample cell is defined with reference to the following table.

The quality of the instrument air should be ISO 8573-1:2010 0 3 1

Where the 0 3 1 represents the parameters A B C in the table below

ISO8573-1:2020 Class	Maximum Number of Particulates/m^3 (A)			Vapour Pressure Dewpoint (B)	Total Oil (aerosol, liquid and vapour) (C)
	0.1-0.5µm	0.5-1.0µm	>1.0-5 µm		
0 as defined by supplier	100	1	0		
1	≤20,000	≤400	≤10	≤-70 ºC (≤-94ºF)	≤0.01 mg/m^3
2	≤400,000	≤6,000	≤100	≤-40 ºC (≤-40ºF)	≤0.1 mg/m^3
3	-	≤90,000	≤1,000	≤-20ºC(≤-4ºF)	≤1 mg/m^3
4	-	-	≤10,000	≤+3 ºC (≤+37ºF)	≤5 mg/m^3

For example, A is the figure for Solid Particulates

The Protea standard for Instrument Air defines A as being equal to the Particulate parameters in Class 0 (A=0).

Defined as: - The Maximum number of particulates per m^3 allowed whose size is between 0.1µm and 0.5µm diameter is 100, and the Maximum number of particulates per m^3 allowed whose size is between 0.5 and 1.0µm diameter is 1. None are allowed above 1.0µm. Particles allowed below 0.1µm diameter is not specified.

B is the figure for Humidity or liquid water classes

(B is equal to the Class 3 value for humidity (B=3))

e.g. The Pressure Dew point =< -20°C (-4ºF)

(very dry with water condensing out at –20°C (-4ºF))

C is the figure for Total Oil classes

(C is equal to Class 1 value for Total Oil (C=3))

The conc. of Total Oil (aerosol, liquid and vapour) should be less than =<0.01 mg/m^3.

Particulates

Limit of 40µm Particulate Size - ISO Class 7.

Humidity

Pressure Dew Pont of 18°F below minimum temperature encountered. Or not exceeding 39°F at line pressure – Approximately ISO Class 4 (< +3 °C)

Total Oil

Lubricant content should in no circumstances exceed 1 part per million by weight or volume. – Very approximately ISO Class 4. (< $5mg/m^3$ or < 0.006 ppm) being the maximum class size quoted

Hence to achieve the ISO standard additional air conditioning equipment is required.

The Protea standard for Compressed Air supplied to the Vortex should be ISO 8573-1:2010 2 4 2

Where Particulates A=2

The Maximum number of particulates per m^3 allowed whose size is between 0.1µm and 0.5µm diameter should be less than or equal to 400,000, and the Maximum number of particulates per m^3 allowed whose size is between 0.5 and 1.0µm diameter is less than or equal to 6,000. Less than 100 particulates are allowed whose size is between 1.0 to 5 µm.

Where Humidity B=4

e.g. The Pressure Dew point =< +3°C (+37ºF)

(water condensing out at +3°C (37ºF))

Total Oil C =2

The concentration of Total Oil (aerosol, liquid and vapour) should be less than or equal 5 mg/m^3.

Appendix E – Air Preparation Panel

Introduction

As stated, the instrument air supplied to the analyser must conform to the specification as laid out in the document:

Quality Standard for Instrument Air Supplied to Protea Analysers

On installations where the quality of instrument air does not meet the required specification it is strongly recommended that the optional Air Preparation Panel is installed.

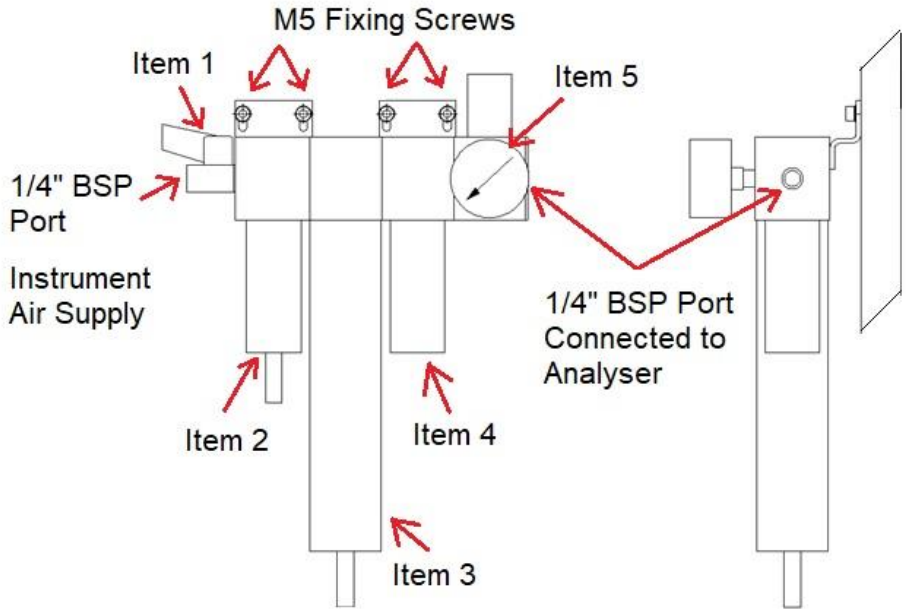


Figure E1 Shows the Air Preparation Panel

Component Identification

Item	Description	Note
1	Isolation Ball Valve	Isolate assembly before maintenance or inspection
2	Particulate Filter	Under normal operation a continuous purge exhausts and must be kept clear
3	Membrane Dryer	
4	Active Carbon Filter	
5	Pressure Regulator	Set at 1 Bar Gauge above the process pressure

Maintenance

The Air Preparation Panel should be inspected at regular intervals for visible signs of moisture / particulate or oil contamination in the filter housings. The frequency of filter element will depend on the quality of the air supply however as a minimum the filters should be changed at least annually.

Housing	Comment
Particulate Filter	Remove Filter Bowl to access element
Membrane Dryer	Remove Lower section of housing to access element
Active Carbon Filter	Remove Filter Bowl to access element

Please refer to section 7 Inspection Schedules – Spares List for spare parts for the Air preparation panel

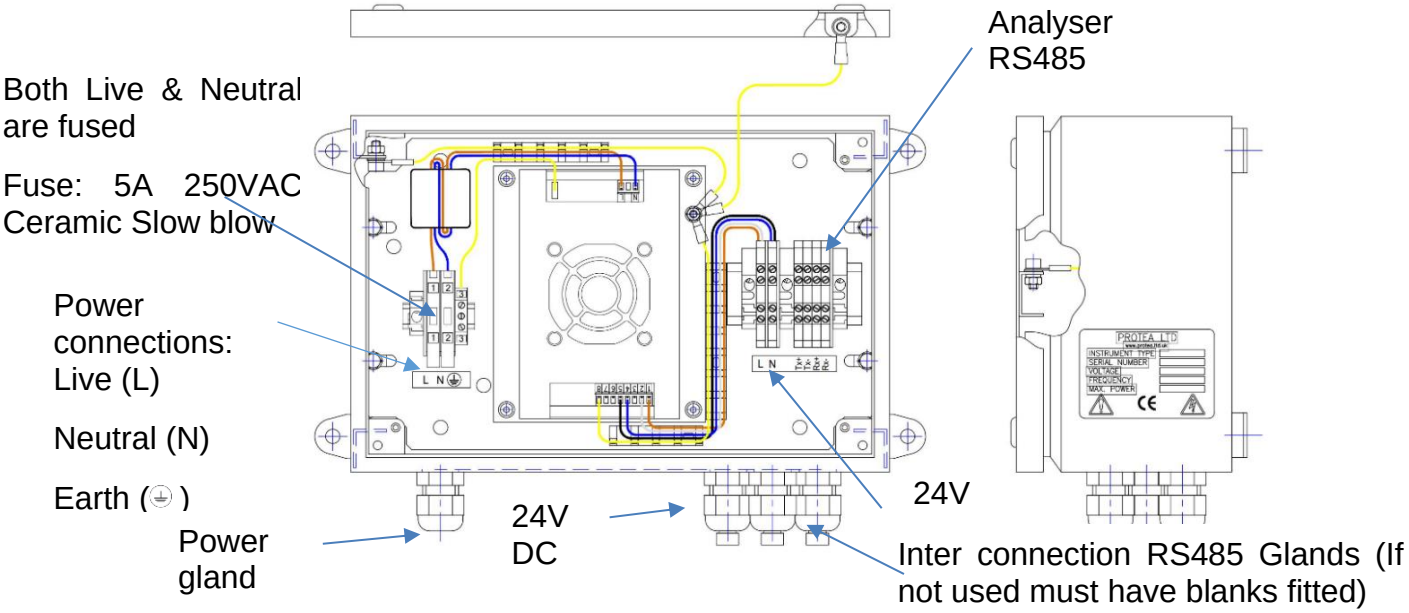
Appendix F – Power Supply Unit

Introduction

The system wiring details are shown in the “Wiring Table” in section 2 of this manual which also includes connection to remote Power Supply Unit (PSU).

Please note:-

- Wiring must conform to local electrical codes.
- An electrical earth must be connected
- The lid is earth bonded this must not be removed
- Supply Voltage 115V/230V 50Hz/60Hz
- Output Voltage 24V DC ±1%
- The PSU must be securely fixed to a wall or panel using the enclosure external fixing brackets
- All glands should be watertight
- All unused glands to have the supplied “gland blanks” fitted
- Isolate power before opening the PSU lid
- A local two pole, single isolation switch should be installed adjacent to the PSU. (Recommended Isolator should be fused or with a Mini Contact Breaker).
- The power to the PSU should have an appropriate rated Mini Contact Breaker (MCB)



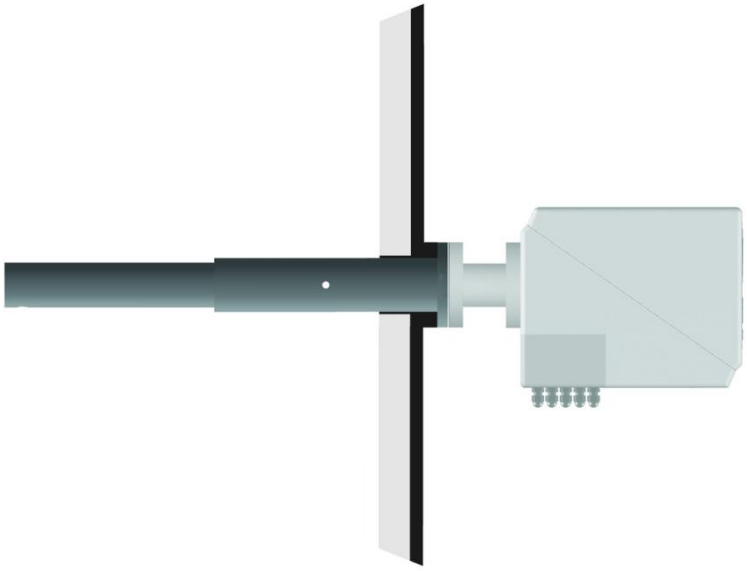
Power Supply Unit Part Number 1-0093

It is strongly recommended that the Protea PSU is installed. However, if a third-party PSU or a 24V DC plant supply is used then please note the DC supply should be 24V ±1% with a load capability of at least 240W per analyser.

Appendix G - In-Situ Heater

Introduction

Some P2000 systems are supplied with an optional In-Situ Heater (ISH). This *Appendix* describes this option and describes how the In-Situ heater should be installed.



In-Situ Heater description

An optional In-Situ Heater (ISH) may be fitted around the sample cell and is recommended for applications involving flue gases at temperatures below 120°C, or on applications with high acid dew point or where monitoring is required when process is off. The ISH contains an electrical heater, which has the effect of keeping the temperature of the sample cell well above the dew point, thus preventing condensation onto any optics in contact with the process gas.

Regulation of the ISH is from the P2000 and is automatic.

The additional power requirement for the In-Situ Heater is 1 kW.

Technical Specification

Parameter	Range
EXTERNAL OPERATING TEMPERATURE	-10°C to 55°C (14ºF to 131ºF)
STACK AMBIENT TEMPERATURE	50°C to 350°C (122ºF to 662ºF)
SAMPLE TEMPERATURE ACHIEVED	120°C to 350°C (248ºF to 662ºF)
SIZE INSERT / LENGTHS	To fit 121mm dia. aperture, 986, 1200, 1800, 3000mm
FLANGE	ANSI 3” 150lb
LENGTH/WEIGHT	986mm = 12.5kg 3000mm = 20.0kg
VOLTAGE	115V or 230V ±10%
POWER	1000 W
CLASS	I
IP Rating (Junction Box)	IP65

NOTE – The ANSI 3” 150lb stack flange is non-standard – please refer to Installation section

Minimum Mains Cable Specification

Parameter	Range
NUNMBER OF CONDUCTORS	3 cores
EXTERNAL INSULATION	>1500V
CURRENT RATING	4.5A (230V), 9A (115V)
TEMPERATURE RATING	>85°C (>185ºF)
RECOMMENDED WIRE SIZE	Cable Type 1

	2.5 mm^2

NOTE - THE INSTALLER IS ADVISED TO USE RING CRIMPS FOR THE LIVE CONNECTION (M4-5) AND THE EARTH CONNECTION (M6) AND A CRIMP BLADE OR FERRULE FOR THE NEUTRAL CONNECTION – THESE SHOULD BE SPECIFIED FOR >85°C (>185ºF)

Control Cable Specification

Parameter	Range
NUMBER OF CONDUCTORS	2 cores with overall screen
EXTERNAL INSULATION	>1500V
CURRENT RATING	4.5A (230V), 9A (115V)
TEMPERATURE RATING	>85°C (>185ºF)
RECOMMENDED WIRE SIZE	0.22 mm^2

Fitting the In-Situ Heater

DANGER

THIS SYMBOL (HAZARD WARNING LABEL OPPOSITE), WHEN NOTED ON A PRODUCT ENCLOSURE OR BARRIER, INDICATES THAT A RISK OF ELECTRICAL SHOCK AND/OR ELECTROCUTION EXISTS. DO NOT CONNECT ANY MAINS CABLE (LINE CORD) TO THE ELECTRICAL SUPPLY UNTIL ALL CONNECTIONS WITHIN THE ISH HAVE BEEN MADE AND THE UNITS ARE SECURELY CLOSED ONCE MORE. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

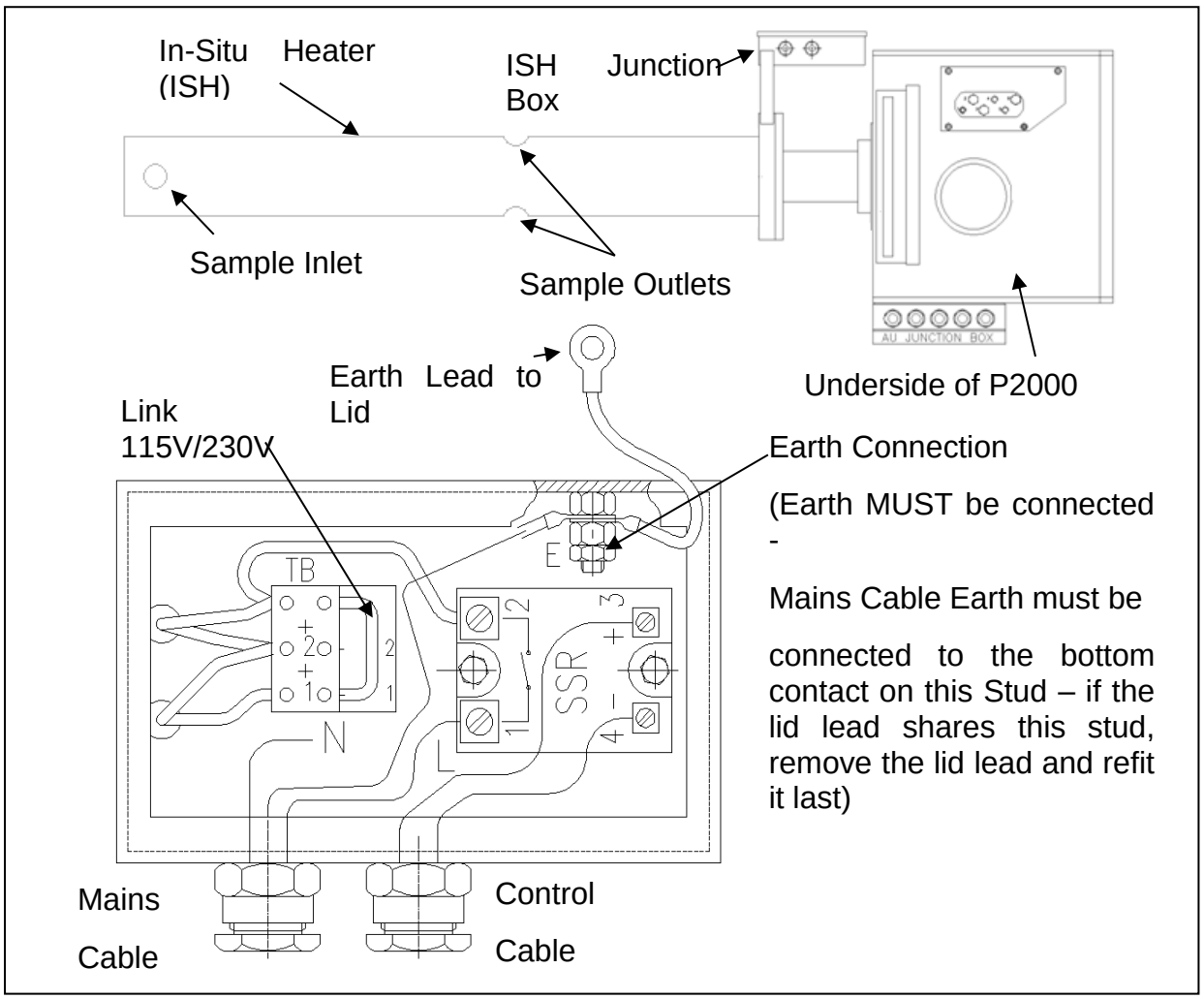
DANGER

RISK OF ELECTRIC SHOCK – DO NOT REMOVE THE COVER WHEN EQUIPMENT IS POWERED – DISCONNECT THE MAINS SUPPLY BEFORE REMOVING COVER

ATTENTION

Do not attempt to connect any mains cable (line cord) to the ISH if the voltage configuration of the ISH differs from your local electrical supply voltage. Contact Protea, or your Protea-authorised Protea Distributor. Using an incorrect supply voltage will result in the In-Situ Heater failing to function properly.

Connecting the optional In-Situ Heater to the Mains Supply.



NOTE – Sample Inlet should be perpendicular to the stack flow and the outlet holes should be in the flow.

(See *Appendix F* for isolator information)

IT IS ESSENTIAL FOR CONFORMANCE WITH EN61010 THAT A FIXED MAINS INSTALLATION HAS AN ISOLATOR FITTED IN THE SUPPLY CLOSE TO THE ISH, THIS ISOLATOR MUST BE LABELLED WITH “ISH SUPPLY” AND MUST DICONNECT BOTH LIVE AND NEUTRAL LINES, AND THIS SHOULD BE PROVIDED BY THE SITE SUPPLY DISTRIBUTION POINT.

THE ISOLATOR MUST PROVIDE OVERCURRENT PROTECTION FOR THIS PERMANENTLY CONNECTED EQUIPMENT.

NOTE: THE ISH IS SHIPPED WIRED FOR 230V WITH A LINK WIRE RETAINED IN THE LID FOR 115V OPERATION – WIRE AS PER THE INSTRUCTION ON THE LID USING THE LINK PROVIDED IF REQUIRED. FOR SAFETY REASONS IDENTIFY THE LINK SUPPLIED AND REMOVE IT FROM THE JUNCTION BOX, IT IS NO LONGER REQUIRED

If an In-Situ Heater (ISH) is to be fitted, a cable rated at 4.5A (230 V supply) or 9A (115 V supply) must supplied to the ISH.

1. Determine voltage of supply 115V or 230V (Others consult Protea Ltd or Protea-authorised Protea Distributor)
2. Remove and retain the four screws securing the lid of the ISH junction box.
3. Feed through one end of the ISH power cable through the Left-Hand cable gland in the ISH junction box.
4. Connect the power cable: 115V (Note colours may change depending on local code)

Brown (live) Terminal 1 on SSR

Blue (neutral) TB 2

5. Fit supplied link TB1 to TB3 (as per lid diagram)
6. Green/yellow (earth) to the earth stud (Note – the earth lead should be no longer than the Live and Neutral, such that if the cable is pulled out of the gland the earth lead will be the last one connected).
7. Connect the power cable: 230V (Note colours may change depending on local code)

Brown (live) Terminal 1 on SSR

Blue (neutral) TB 1 (Discard link)

Green/yellow (earth) to the earth stud (Note – the earth lead should be no longer than the Live and Neutral, such that if the cable is pulled out of the gland the earth cable will be the last one connected).

8. Finger-tighten the cable glands in the ISH junction box.
9. Connect the AU control to the ISH SSR wiring the control cable through the other gland (Note – for control cable specification and connections refer to Table 2-1).

SSR+ to AU Terminal Box ISH CTRL+

SSR- to AU Terminal Box ISH CTRL-

Ensure the control cable is securely connected and with adequate clearance from the mains supply terminations.

NOTE – for control cable specification and connections refer to Table 2-1.

Tighten all glands with a tool and replace the lid securely, ensuring the lid earth wire is fitted, ensure the cables cannot pull or twist in their glands.

Connecting the mains voltage to the ISH

BEFORE CONNECTING THE MAINS ENSURE AN EARTH BOND LEAD IS FITTED FROM THE P2000 TO THE LOCAL STACK EARTH – THIS IS ONLY REQUIRED WHEN INSTALLING AN ISH

When you are satisfied that the voltage configuration of the ISH and the local electrical supply voltage are the same, you can connect the mains supply voltage to the ISH - noting the previous WARNING.

Fitting the In-Situ Heater

WARNING

PHYSICALLY DISCONNECT THE MAINS VOLTAGE SUPPLY BEFORE FITTING THE IN-SITU HEATER. FAILURE TO FOLLOW THIS WARNING COULD RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

AFTER THE ISH HAS BEEN FITTED IF IT IS THEN REQUIRED TO REMOVE IT TAKE PPE PRECAUTIONS. THE ISH MAY BE HOT FROM STACK GASES AND IF IT HAS BEEN POWERED IT

WILL RETAIN THE HEAT FROM ITS OWN HETAER FOR MANY HOURS. HEAT RESISTANT GLOVES MUST BE WORN.

DISCONNECT THE MAINS SUPPLY BEFORE ACCESSING THE WIRING.

During installation of the In-Situ Heater, you may need to refer to the relevant installation drawing in the *Order-specific information* section of this manual, particularly if you will be making up your own interconnecting cables.

1 Fit the supplied circular gasket to the four M16 bolts on the vertical flange already fitted to the process gas duct.

2 Offer up the ISH to the vertical flange. Introduce the heater gently into the duct and fit the ISH flange onto the four M16 bolts.

3 If the AU is not to be fitted immediately, fit nuts to the four bolts, and finger-tighten to retain the ISH safely.

4 Once the In-Situ Heater has been fitted, you may go on to fit the Analyser Unit.

Fault on the ISH

When an ISH is fitted, the TEST screen will display the heater power level. This should start at 100% when the analyser is cold, and then reduce to a lower percentage as the analyser warms up and reaches its set point.

If the set point shown on the Control Unit TEST screen is consistently below 110^{o}C, then it is likely that the ISH is not working properly. Take the following actions:

1. Check set point of ISH in S/W is correct
2. Measure the voltage between ISH CTRL+ and ISH CTRL- on the AU junction box. This should show a steady or pulsing 24 V dc.
3. Check that all the connections between the AU and the Control Unit are properly made.
4. Confirm that a steady or slowly switching mains voltage appears between the L and N terminals in the ISH mains connection box.

Appendix H - Hot Access Port

Introduction

The Hot Access Port has been added to the reflector tube on the P2000 analyser (See Figure H2 for location) to enable water vapour injection while minimising condensation in the analyser probe. This will hence enable water vapour-based re-calibration on site from a suitably accurate water vapour generator. The Field Calibrator, including Water Vapour control is available.

Additionally, this port can be used as a sample extraction port without disconnection of any other gas lines on the instrument.

Warning

AS THIS PORT IS CONNECTED TO THE INSTRUMENT MEASURING CELL IT MUST BE CLOSED GAS TIGHT TO AVOID LEAKAGE OUT OR IN, WHEN NOT IN USE. A LEAK WILL INVALIDATE BOTH THE AUTO ZERO / AUTOCAL RESULT AND CONTINUOUS MEASUREMENT RESULTS.

This port is on the main stack flange; an optional insulation jacket is available, to raise the port's temperature whilst allowing access. See *Figure H1 – Insulation Jacket* for details.

Operation

For most installations the use of the hot access port for water vapour injection will require the fitting of an insulated jacket around the port to reduce the risk of condensation. See Fig H1 for fitting details. When the jacket is fitted the system temperature should be allowed to stabilise before continuing with any measurements. This may take up to 30 minutes. The jacket allows for connection or disconnection without removal of the insulation as shown on Fig.H1.

Before using the Hot Access Port for calibration first carry out an Auto-Zero with the Hot Access Port closed off.

Carefully remove the plug with a 5mm Allen Key and place in a secure location for re-installing later. See *Figure H1 – Insulation Jacket* and *Figure H2 – Reflector Tube* for details. Note that gases from the process may escape from this port when it is open. Suitable precautions must be taken, i.e. avoid breathing the hot escaping gas.

When applying water vapour, a heated line or a purpose designed close coupled evaporator should be used, and any exposed pipe or fittings containing hot vapour should be insulated. See *Figure H3 –*

Water Vapour Line Fitting P2000. On completion of tests remove the connecting line and replace it with the hot access port plug, a 1/8 BSP taper plug using PTFE tape to seal the thread. Ensure this is tightened to form a gas tight seal.

Drawings

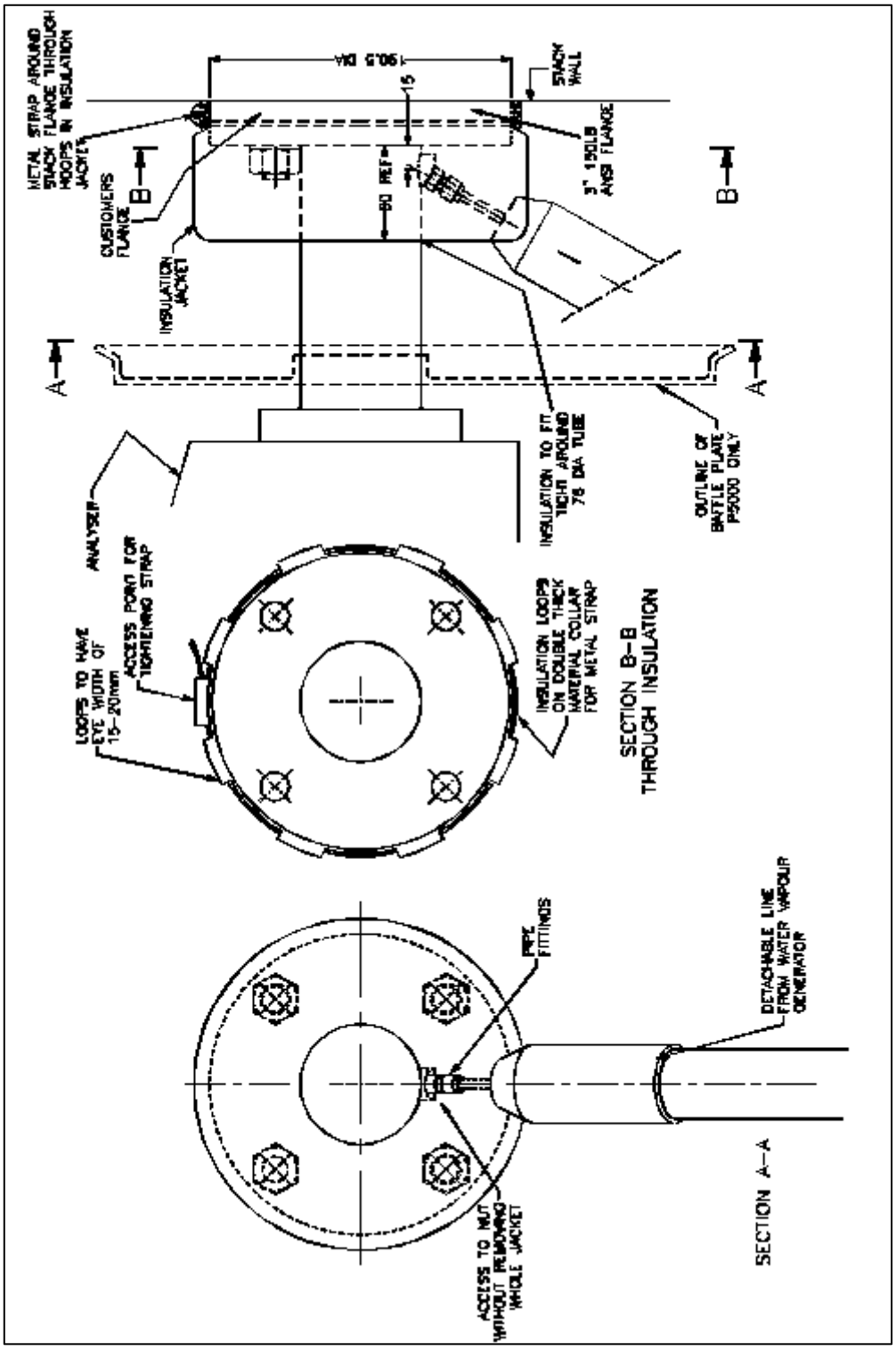


Figure H1 – Insulation Jacket.

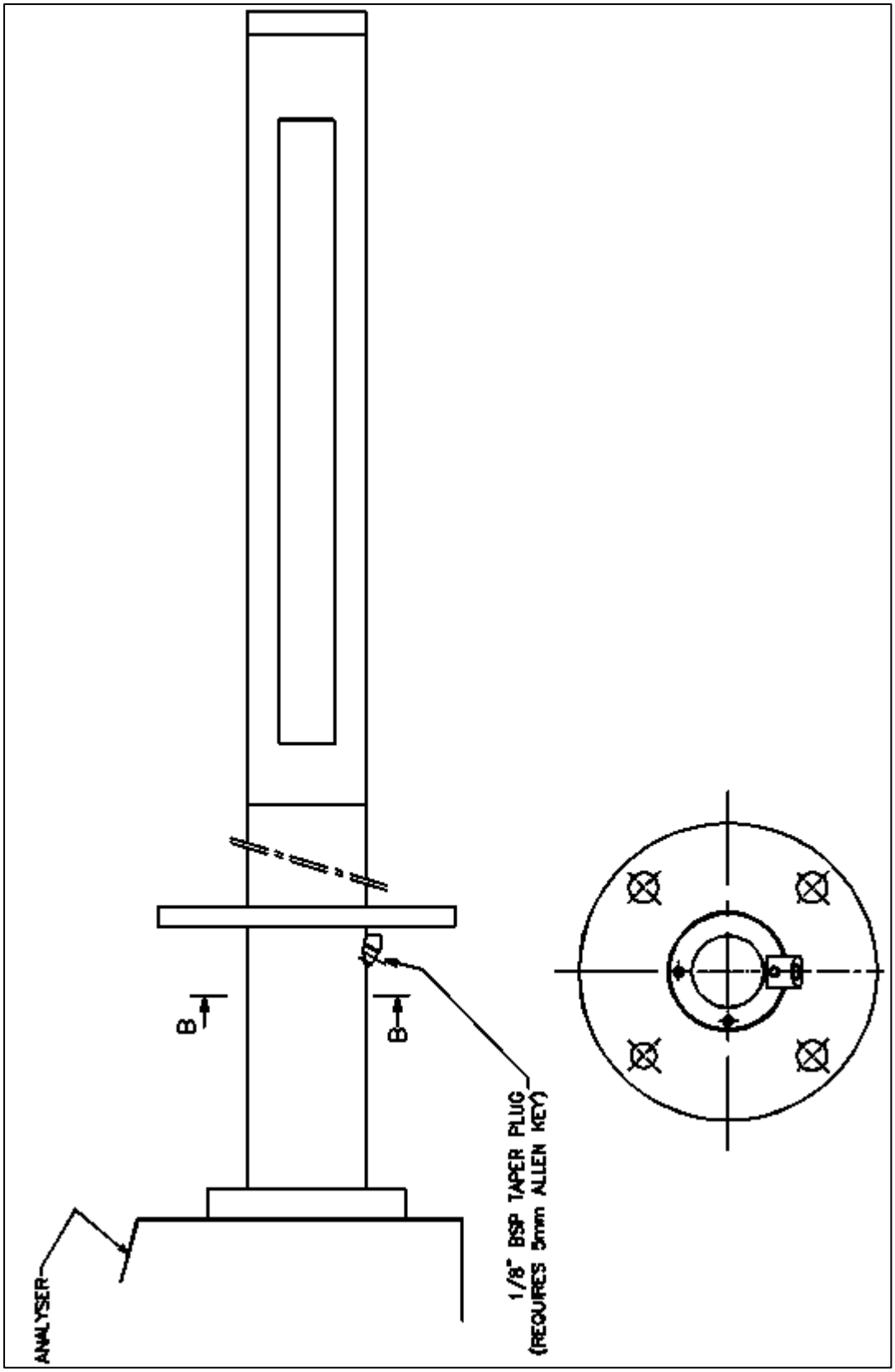


Figure H2 – Reflector Tube

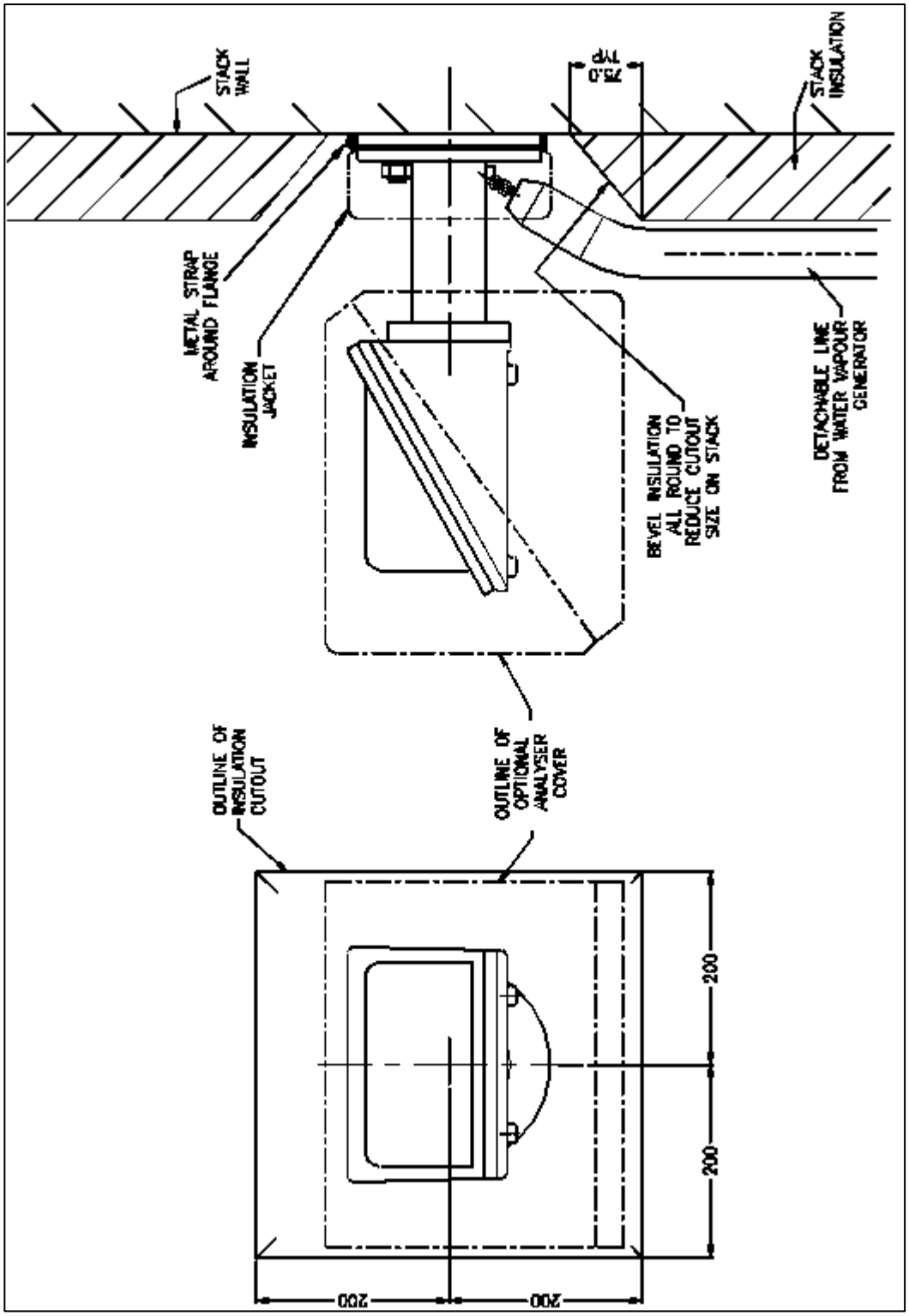


Figure H3 – Water Vapour Line Fitting P2000

Appendix I – By-Pass

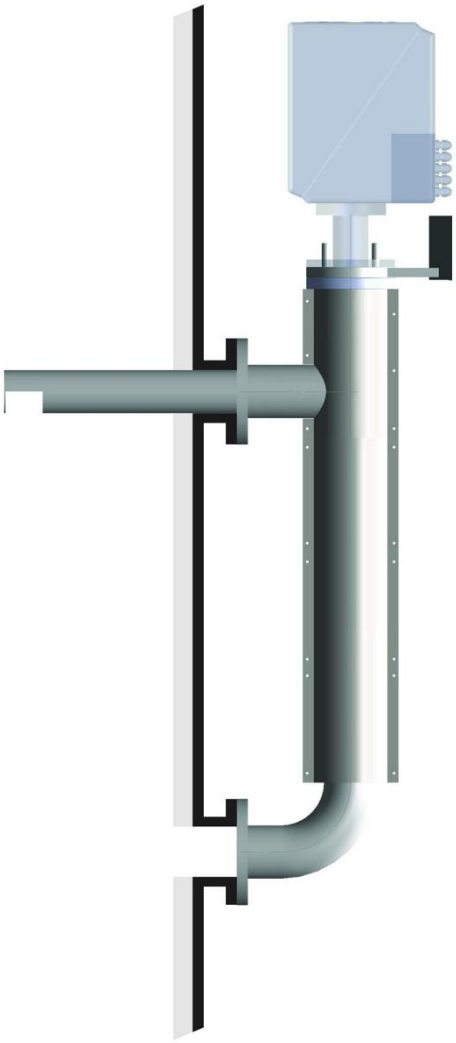
Introduction

Some P2000 systems are supplied with an optional By-Pass Assembly

For the following applications

- Where the process temperature is > 350°C and < 800°C (> 660°F and < 1112°F)
- For small diameter Stacks / Ducts < 900mm (< 3 ft)

This *Appendix* describes this option and describes how the By-Pass should be installed.



By-Pass description

The optional By-Pass assembly is used in high temperature applications or where the stack or duct size does not allow the analyser to be fully inserted. The assembly requires two flanges to be welded to the stack or duct. The spacing, specification and orientation of the flanges is critical, refer to the appropriate By-Pass drawing. In some applications with a high flow rate an orifice plate may have to be fitted between one of the stacks mounting flanges and the By-Pass assembly.

The By-Pass assembly also includes a heater assembly to maintain the Analyser In-Situ sample cell at the control temperature. The electrical heater, which has the effect of keeping the temperature of the sample cell well above the dew point, thus preventing condensation onto any optics in contact with the process gas.

Control of the Heater is from the P2000 and is automatic.

The additional power requirement for the By-Pass In-Situ Heater is 1 kW.

The assembly also includes a sample scoop which can be fitted to either branch of the By-Pass. A proportion of the stack / process gas is diverted through the By-Pass and passed into the P2000 In-Situ Cell enabling the gas concentrations to be monitored. The stack gas is driven through the By-Pass by both the action of the scoop and a “Chimney” effect caused by the dissimilar gas temperature in the stack and By-Pass. It is therefore recommended that when the stack temperature is higher than the By-Pass Heater set point the scoop is mounted on the upper By-Pass branch and when the stack temperature is lower than the By-Pass temperature the scoop is mounted on the lower branch.

Technical Specification

Parameter	Range
EXTERNAL OPERATING TEMPERATURE	-10°C to 55°C (14ºF to 131ºF)
STACK AMBIENT TEMPERATURE	50°C to 350°C (122ºF to 662ºF)
SAMPLE TEMPERATURE ACHIEVED	120°C to 350°C (248ºF to 662ºF)
SIZE APERTURE	To fit 121mm dia.
SIZE INSERT LENGTHS	986, 1200, 1800, 3000mm
SIZE 3” FLANGE	190.5mm dia.
WEIGHT	986mm = 12.5kg 3000mm = 20.0kg
VOLTAGE	115V or 230V ±10%
POWER	1000 W
CLASS	I
IP Rating (Junction Box)	IP65

Mains Cable Specification

Parameter	Range
EXTERNAL INSULATION	>1500V
CURRENT RATING	4.5A (230V), 9A (115V)
TEMPERATURE RATING	>85°C (>185ºF)
OUTSIDE DIAMETER	5mm to 9mm
RECOMMENDED WIRE SIZE	1.0 mm^2

NOTE - THE INSTALLER IS ADVISED TO USE RING CRIMPS FOR THE LIVE CONNECTION (M4-5) AND THE EARTH CONNECTION (M6) AND A CRIMP BLADE OR FERRULEFOR THE NEUTRAL CONNECTION – THESE SHOULD BE SPECIFIED FOR >85°C (>185ºF)

Control Cable Specification

Parameter	Range
EXTERNAL INSULATION	>1500V
CURRENT RATING	4.5A (230V), 9A (115V)
TEMPERATURE RATING	>85°C (>185ºF)
OUTSIDE DIAMETER	5mm to 9mm
RECOMMENDED WIRE SIZE	1.0 mm^2

Fitting the Optional By-Pass

NOTE - Before commencing installation of the By-Pass it is imperative that you have access to the correct installation drawing. The By-Pass part number as stated on the packing note should appear as the drawing number in the bottom right-hand corner of the installation drawing.

DANGER - RISK OF ELECTRIC SHOCK – DO NOT REMOVE THE COVER WHEN EQUIPMENT IS POWERED – DISCONNECT THE MAINS SUPPLY BEFORE REMOVING COVER

There are two basic By-Pass designs.

- Heated By-Pass - main wetted parts Stainless Steel

- Heated By-Pass - main wetted parts Hastelloy C276 / Heater Assy Inconel 825

Other order specific By-Pass assemblies may be supplied, contact Protea Ltd or your Protea-authorised Protea Distributor to obtain the appropriate installation drawing.

The By-Pass consists of three main components

- By-Pass Assembly
- Heater Assembly
- Scoop – Note the length of the scoop is application specific and therefore must be defined at the order stage. The scoop can be attached to either of the By-Pass branches and is secured by four counter sunk screws.The appropriate branch to fit the scoop is included in the By-Pass description section.

Mounting Flanges

The By-Pass is mounted on two 4” 150lb flat face ANSI Flanges (Not normally supplied by Protea Ltd). The flanges are welded to the stack and it is important the weld is gas tight. Note that the correct orientation of the flange is observed.

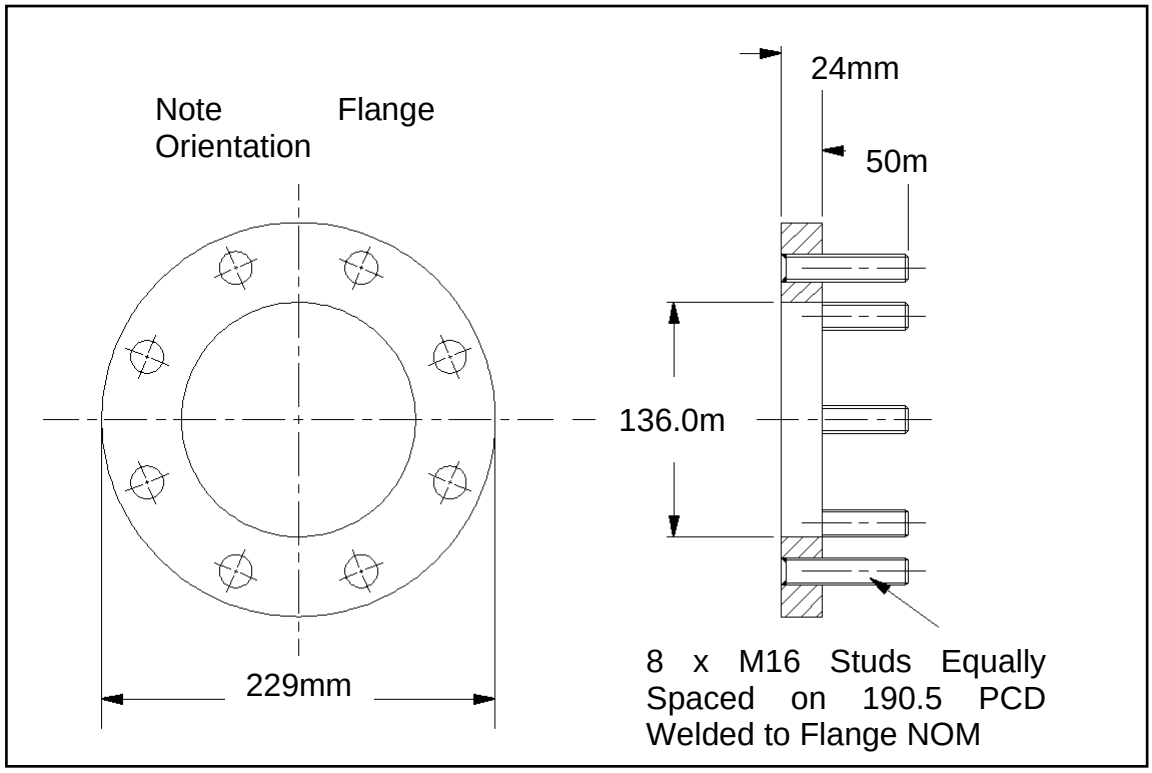


Figure showing Stack Mounting Flange

Mounting By-Pass to the stack.

The scoop should be attached to the appropriate branch before installation of the By-Pass. The By-Pass is supplied with graphite gaskets, these should be inspected before installation. It is important the supplied gaskets are used in the installation

Part : 4” 150lb Graphite Gasket

Secure the By-Pass to the stack mounted flanges using 8 x M16 nuts & washes per flange.

Heater Assembly

The By-Pass is supplied with the Heater Assembly fitted, it can be removed for inspection and cleaning. If removed a new gasket should be used on re installation.

Working on the Heater Assembly

WARNING

PHYSICALLY DISCONNECT THE MAINS VOLTAGE SUPPLY BEFORE FITTING THE IN-SITU HEATER. FAILURE TO FOLLOW THIS WARNING COULD RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

AFTER THE ISH HAS BEEN FITTED IF IT IS THEN REQUIRED TO REMOVE IT TAKE PPE PRECAUTIONS. THE ISH MAY BE HOT FROM STACK GASES AND IF IT HAS BEEN POWERED IT WILL RETAIN THE HEAT FROM ITS OWN HETAER FOR MANY HOURS. HEAT RESISTANT GLOVES MUST BE WORN.

DISCONNECT THE MAINS SUPPLY BEFORE ACCESSING THE WIRING.

To remove the Heater Assembly

1. Remove the AU ensuring it is stored in a safely in a clean and dry environment taking precautions not to damage any of the cables, glands or pie fitting protruding from the base of the AU cover.
2. With the Heater disconnected remove the four M16 nuts which are recessed in the horizontal By-Pass Flange.
3. The Heater Assembly can then be removed for inspection.
4. Before reinstalling ensure all particulates have been removed from the Heater Assembly and By-Pass.
5. It is important that both gasket between the Heater Assembly and AU are replaced during reassembly.

Connecting the Heater

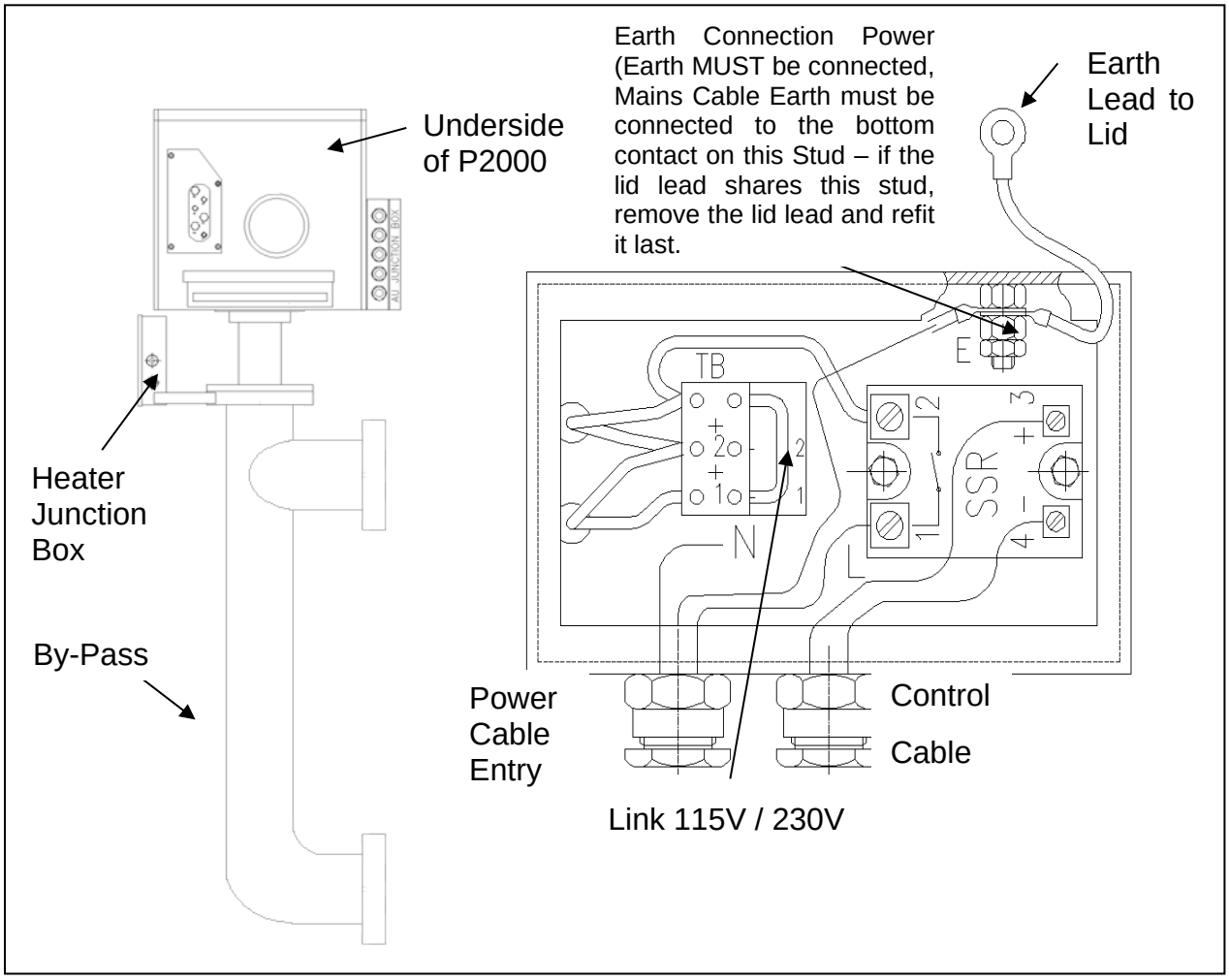
WARNING

DO NOT CONNECT ANY MAINS CABLE (LINE CORD) TO THE ELECTRICAL SUPPLY UNTIL ALL CONNECTIONS WITHIN THE HEATER HAVE BEEN MADE AND THE UNITS ARE SECURELY CLOSED ONCE MORE. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

ATTENTION

Do not attempt to connect any mains cable (line cord) to the Heater if the voltage configuration of the Heater differs from your local electrical supply voltage. Contact Protea, or your Protea-authorised Protea Distributor. Using an incorrect supply voltage will result in the In-Situ Heater failing to function properly.

Connecting the By-Pass Heater to the Mains Supply.



IT IS ESSENTIAL FOR CONFORMANCE WITH EN61010 THAT A

FIXED MAINS INSTALLATION HAS AN ISOLATOR FITTED IN THE SUPPLY CLOSE TO THE ISH, THIS ISOLATOR MUST BE LABELLED WITH “ISH SUPPLY” AND MUST DICONNECT BOTH LIVE AND NEUTRAL LINES, AND THIS SHOULD BE PROVIDED BY THE SITE SUPPLY DISTRIBUTION POINT.

THE ISOLATOR MUST PROVIDE OVERCURRENT PROTECTION FOR THIS PERMANENTLY CONNECTED EQUIPMENT.

NOTE: THE ISH IS SHIPPED WIRED FOR 230V WITH A LINK WIRE RETAINED IN THE LID FOR 115V OPERATION – WIRE AS PER THE INSTRUCTION ON THE LID USING THE LINK PROVIDED IF REQUIRED. FOR SAFETY REASONS IDENTIFY THE LINK SUPPLIED AND REMOVE IT FROM THE JUNCTION BOX, IT IS NO LONGER REQUIRED

If an In-Situ Heater (ISH) is to be fitted, a cable rated at 4.5A (230 V) or 9A (115 V) must supplied to the ISH.

1. Determine voltage of supply 115V or 230V (Otherwise consult Protea Ltd or your Protea-authorised Protea Distributor)
2. Remove and retain the four screws securing the lid of the Heater junction box.
3. Feed through one end of the Heater power cable through the Left Hand cable gland in the Heater junction box.

4. Connect the power cable: 115V (Note - colours may change depending on local code)

   Brown (live) Terminal 1 on SSR

   Blue (neutral) TB 2

5. Fit supplied link TB1 to TB3 (as per lid diagram)

   Green/yellow (earth) to the earth stud (Note – the earth stud should be no longer than the Live and Neutral, such that is the cable pulled out of the gland the earth cable will be the last one connected).

6. Connect the power cable: 230V (Note colours may change depending on local code)

   Brown (live) Terminal 1 on SSR

   Blue (neutral) TB 1 (Discard link)

   Green/yellow (earth) to the earth stud (Note – the earth stud should be no longer than the Live and Neutral, such that is the cable pulled

out of the gland the earth cable will be the last one connected).

7. Finger-tighten the cable glands in the Heater junction box.

8. Connect the AU control to the Heater SSR wiring the control cable through the other gland (Note – for control cable specification and connections refer to Table 2-1.

SSR + to AU Terminal Box ISH CTRL+

SSR - to AU Terminal Box ISH CTRL-

1. Ensure the control cable is securely connected and with adequate clearance from the mains supply terminations **NOTE** – for control cable specification and connections refer to Table 2-1.

2. Tighten all glands with a tool and replace the lid securely, ensuring the lid earth wire is fitted, ensure the cables cannot pull or twist in their glands.

Connecting the mains voltage to the Heater

BEFORE CONNECTING THE MAINS ENSURE AN EARTH BOND LEAD IS FITTED FROM THE P2000 TO THE LOCAL STACK EARTH – THIS IS ONLY REQUIRED WHEN INSTALLING AN ISH

When you are satisfied that the voltage configuration of the Heater and the local electrical supply voltage are the same, you can connect the mains supply voltage to the Heater - noting the previous WARNING.

Fault on the HEATER

When a HEATER is fitted, the TEST screen will display the heater power level. This should start at 100% when the analyser is cold, and then reduce to a lower percentage as the analyser warms up and reaches its set point.

If the sample temperature shown on the Control Unit TEST screen is consistently below 110^{o}C (230^{o}F), then it is likely that the HEATER is not working properly. Take the following actions:

1 Measure the voltage between ISH CTRL+ and ISH CTRL+ on the AU junction box. This should show a steady or pulsing 24 V dc.

2 Check that all the connections between the AU and the Control Unit are properly made.

3 Confirm that a steady or slowly switching mains voltage appears between the L and N terminals in the Heater mains connection box.

Over Heating

If the sample temperature is higher than the Heater set point it is necessary to reduce the flow through the By-Pass this can be achieved by introducing an orifice plate in the branch which does not have the scoop attached.

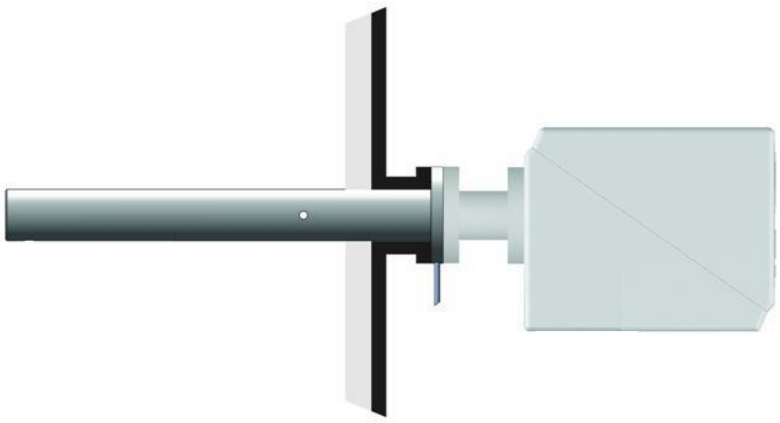
Appendix J - In-Situ Steam Heater

Introduction

Some P2000 systems are supplied with an optional In-Situ Steam Heater (ISSH). This *Appendix* describes this option and describes how the ISSH should be installed.

For the following applications

Hazardous Areas (It is the responsibility of the customer to determine that the equipment is suitable for the hazardous are it is to be installed in, taking into account the maximum permitted surface temperature).



In-Situ Steam Heater description

An optional In-Situ Steam Heater (ISSH) may be fitted around the sample cell and is recommended for applications involving flue gases at temperatures below 110^{O}C (230ºF). The ISSH uses steam as a heater, which has the effect of keeping the temperature of the sample cell well above the dew point, thus preventing condensation onto any optics in contact with the process gas.

Regulation of the ISSH is controlled by a Steam Regulator and steam trap not supplied with the ISSH

Typical Steam Pressure required to maintain the Probe at 150°C (302ºF) is 6 bar(g) (87psig). Consult the supplier of the steam regulator for detailed advice and recommendations.

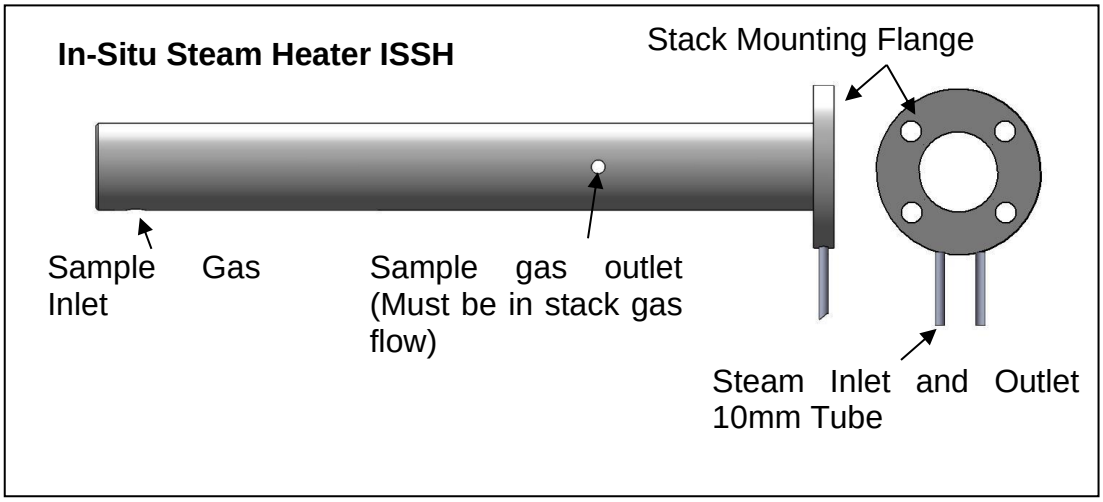
Fitting the In-Situ Steam Heater

Fitting the In-Situ Steam Heater

During installation of the In-Situ Steam Heater, you may need to refer to the relevant installation drawing in the *Order-specific information* section of this manual.

There are two basic In-Situ Steam Heater designs.

- In-Situ Steam Heater - main wetted parts Inconel 825
- In-Situ Steam Heater - main wetted parts Hastelloy C276



Fitting the In-Situ Heater

WARNING

PHYSICALLY ISOLATE THE STEAM SUPPLY BEFORE FITTING OR WORKING ON THE IN-SITU STEAM HEATER. FAILURE TO FOLLOW THIS WARNING COULD RESULT IN SERIOUS OR FATAL INJURY

1. Fit the supplied circular gasket to the four M16 bolts on the vertical flange already fitted to the process gas duct.
2. Offer up the ISSH to the vertical flange. Introduce the heater gently into the duct and fit the ISSH flange onto the four M16 bolts.
3. If the AU is not to be fitted immediately, fit nuts to the four bolts, and finger-tighten to retain the ISSH safely.
4. Once the In-Situ Heater has been fitted, you may go on to fit the Analyser Unit.
5. Connect the steam supply to the Inlet and Outlet 10mm OD Tubes using appropriate pipefittings.

6. Observe the temperature of the sample (T Sample) on the TEST screen of the Control Unit, adjust the Steam Regulator until T Sample is maintained at the calibration temperature (T Cal), as stated in the Analyser Configuration Sheet supplied with the Analyser documentation pack.

Fault on the ISSH

When an ISSH is fitted, the TEST screen will display the temperature of the sample (T Sample) this should be within ± 10°C (±50°F) of the calibration temperature (T Cal), as stated in the analyser dispatch data Analyser Configuration Sheet.

If the sample temperature shown on the Control Unit TEST screen is consistently below T Cal, then it is likely that the ISSH is not working properly. Take the following actions:

1 Check setting on the Steam Regulator

Appendix K – Steam Heated By Pass

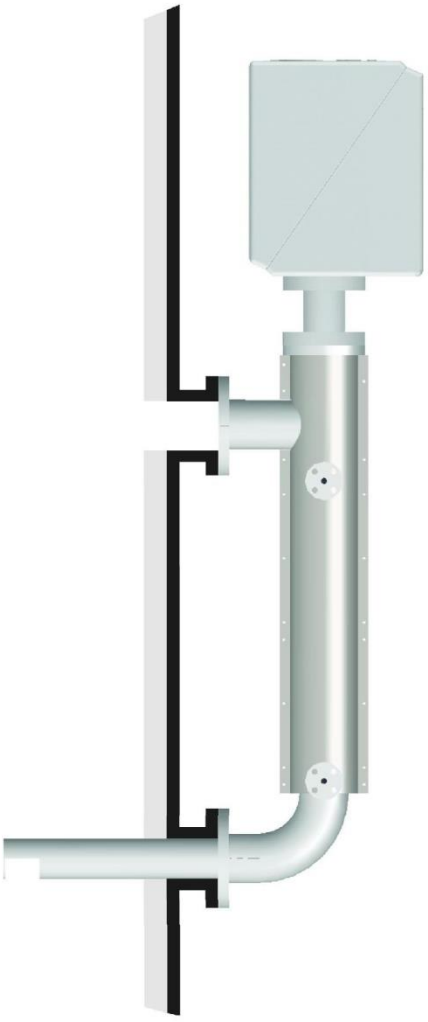
Introduction

Some P2000 systems are supplied with an optional Steam Heated By-Pass Assembly

For the following applications

- For small diameter Stacks / Ducts < 900mm (< 3 ft) in Hazardous Areas (It is the responsibility of the customer to determine that the equipment is suitable for the hazardous area it is to be installed in, considering the maximum permitted surface temperature).

This *Appendix* describes this option and describes how the Steam heated bypass should be installed.



By-Pass description

The optional By-Pass assembly is used in hazardous area applications where the stack or duct size does not allow the analyser to be fully inserted. The assembly requires two flanges to be wielded to the stack or duct. The spacing, specification and orientation of the flanges is critical, refer to the appropriate Steam Heated By-Pass drawing. In some applications with a high flow rate an orifice plate may have to be fitted between one of the stacks mounting flanges and the Steam Heated By-Pass assembly.

The Steam Heated By-Pass assembly maintains the Analyser In-Situ sample cell at the control calibration temperature. The steam heater, which has the effect of keeping the temperature of the sample cell well above the dew point, thus preventing condensation onto any optics in contact with the process gas.

Regulation of the Steam Heated By-Pass is controlled by a Steam Regulator not supplied with the Steam Heated By-Pass

Typical Steam Pressure required to maintain the Probe at 150°C (302ºF) is 6 bar(g) (87psig). Consult the supplier of the steam regulator for detailed advice and recommendations.

The assembly also includes a sample scoop which can be fitted to either branch of the By-Pass. A proportion of the stack / process gas is diverted through the By-Pass and passed the P2000 In-Situ Cell enabling the gas concentrations to be monitored. The stack gas is driven through the By-Pass by both the action of the scoop and a “Chimney” effect caused by the dissimilar gas temperature in the stack and By-Pass. It is therefore recommended that the scoop is mounted on the lower branch.

Fitting the Optional Steam Heated By-Pass

Note - Before commencing installation of the By-Pass it is imperative that you have access to the correct installation drawing.

There is one basic By-Pass design.

- Steam Heated By-Pass - main wetted parts Stainless Steel

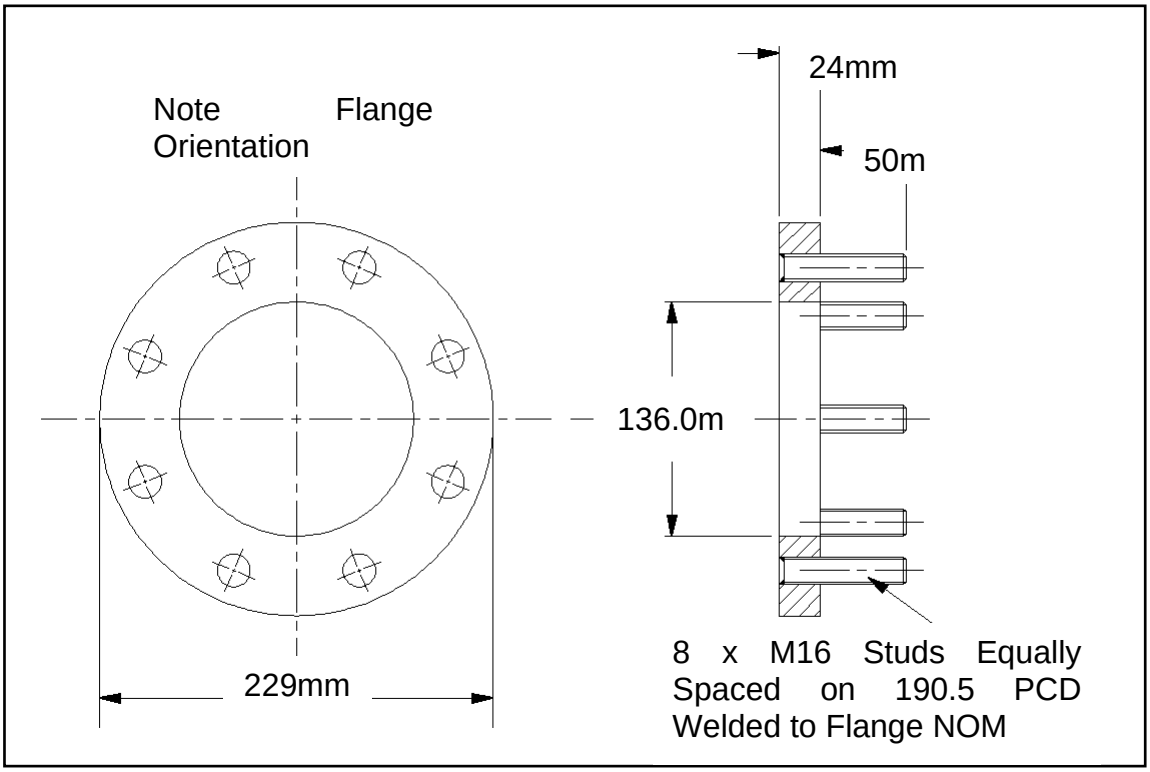
Other order specific By-Pass assemblies may be supplied, contact Protea Ltd or your Protea-authorised Protea Distributor to obtain the appropriate installation drawing.

The By-Pass consists of two main components

- Steam Heated By-Pass Assembly
- Scoop – Note the length of the scoop is application specific and therefore must be defined at the order stage. The scoop can be attached to the By-Pass branch and is secured by four counter sunk screws.

Mounting Flanges

The By-Pass is mounted on two 4” 150lb flat face ANSI Flanges with (Not normally supplied by Protea Ltd). The flanges are welded to the stack and it is important that the weld is gas tight. Note the correct orientation of the flange is observed.



Stack Mounting Flanges

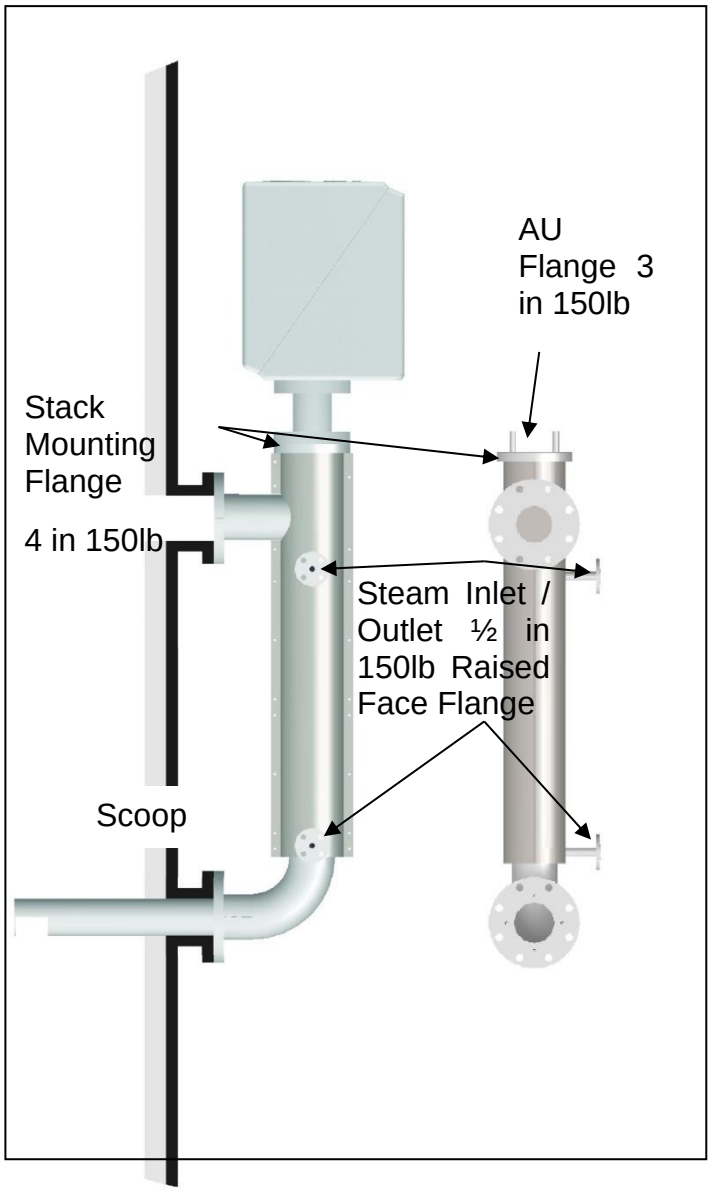
Steam Heater

The By-Pass has an integral steam heater

Working on the Steam Heated By-Pass Heater

DANGER

PHYSICALLY ISOLATE THE STEAM SUPPLY BEFORE FITTING OR WORKING ON THE IN-SITU STEAM HEATER. FAILURE TO FOLLOW THIS WARNING COULD RESULT IN SERIOUS OR FATAL INJURY



Mounting By-Pass to the stack.

The scoop should be attached to the appropriate branch before installation of the By-Pass. The By-Pass is supplied with graphite gaskets, these should be inspected before installation. It is important the supplied gaskets are used in the installation

Part: 4" 150lb Graphite Gasket

Secure the By-Pass to the stack mounted flanges using 8 x M16 nuts & washes per flange.

Connecting Steam

1. Connect the steam supply to the Inlet and Outlet 1 Steam Inlet / Outlet ½ in 150lb Raised Face Flange

2. Observe the temperature of the sample (T Sample) on the TEST screen of the Control Unit, adjust the Steam Regulator until T Sample is maintained at the calibration temperature (T Cal), as stated in the analyser dispatch data Analyser Configuration Sheet.

Over Heating

If the sample temperature is higher than the Heater set point it is necessary to reduce the flow through the By-Pass this can be achieved by introducing an Orifice plate in the branch which does not have the scoop attached.

Appendix L – P2000D (UV Diode)

IMPORTANT - Please read the Safety Warnings below before performing any maintenance function set out in this section of the manual.

WARNING	Visual exposure or skin exposure to UV light could result in injury
	UV light is harmful to skin or eyes and may cause cancer.
	Avoid exposure to UV light when LED is operational. Precautions must be taken to avoid looking directly at the UV light without the use of UV light protective glasses. Use Personal Protective Equipment such as UV protective glasses as directed by your site safety regulations. DO NOT look directly at the front of the LED or at the LED's lens when the LED is operational.

ATTENTION	Damage to product may result if touched
	Device or component is sensitive to Electrostatic Discharge (ESD)
	Carefully follow the step-by-step instructions to prevent damage to the component or product. Care must be given to maintain the highest standards of compliance to the maximum electrical specifications when handling such devices. The device is particularly sensitive to any voltage that exceeds the absolute maximum ratings of the product. Any applied voltage in excess of the maximum specification will cause damage and possible complete failure to the product. You must use handling procedures that prevent any electrostatic discharges or other voltage surges when handling or using the device.

Introduction

P2000D is a combined infra-red (IR) and Ultraviolet (UV), duct or stack-mounted Analyser, designed to provide In-Situ analysis of up to eight gas-phase emission components. A typical system comprises of a stack mounted Analyser, an integral Calibration Module and a Control Unit with options which include a powerful In-Situ Heater and a stand-alone analysis software package.

P2000D uses the reflective beam principal to directly measure process gas as it enters the in-situ sample cell. Unlike higher maintenance extractive systems, Protea's patented, sintered metal technology removes the need for gas filtering or sample conditioning. The P2000D analyser requires very little maintenance and achieves a gas as it enters the in-situ sample cell.

The P2000 analyser requires very little maintenance and achieves class-beating availability of over 98% in demanding applications. The Control Unit can support multiple analysers from the Protea range.

Many pollutant gases can be monitored in the Infra-Red (IR). However, in some cases it is beneficial to monitor in the Ultraviolet (UV), low concentrations of SO2 & NO2 in the presence of high levels of water vapour.

P2000 Infra-Red (IR)

The Infra-Red (IR) measurement operates on the dual wavelength single beam principle. IR pulses, at two specific wavelengths per monitored component, are transmitted through the sample cell. The 'measure' pulse is partially absorbed by the gases being measured while the 'reference' pulse remains unaffected. Up to eight wavelengths are available, sometimes sharing reference wavelengths, allowing up to six gas-phase concentrations to me monitored.

P2000 Ultra Violet (UV)

The Ultraviolet (UV) measurement operates on the single-wavelength dual beam UV principle. UV pulses, at a specific wavelengths per monitored component are sequentially transmitted through the sample cell (measure pulse) then directly to the detector (reference pulse). The 'measure' pulse is partially absorbed by the gases being measured while the 'reference' pulse remains unaffected. By comparing the UV pulses the gas concentration can be calculated. Two wavelengths are available allowing two gases to be monitored.

Features	Benefits
Multi-component gas analysis	Each P2000 can measure up to eight component six IR & two UV
Direct in-situ measurements	No requirement for high cost, high maintenance sample handling system or sample conditioning
Wet or dry readings	Can inherently report on Wet or Dry gas basis
Automatic signal verification and recalibration	No operator intervention during routine use
Oxygen (O_2) or (CO_2) measurement normalisation (option)	Report monitored concentrations normalised to O_2 or CO_2 reference conditions
Combined Infra-Red & Ultraviolet	Single analyser using most appropriate technique for the application

Gases	Infra-Red Ranges		Ultra-Violet Ranges	
Carbon Monoxide (CO)	0-150 ppm	0-187 mg/m^3		
Nitic Oxide (NO)	0-240 ppm	0-320 mg/m^3		
Nitrogen Dioxide (NO_2)	0-200 ppm	0-410 mg/m^3	0-30 ppm	0-62 mg/m^3
Nitrous Oxide (N_2O)	0-300 ppm	0-590 mg/m^3		
Sulphur Dioxide (SO_2)	0-150ppm	0-430 mg/m^3	0-30ppm	0-86 mg/m^3
Water in Gases ($H_2O(g)$)	0-30%			
Carbon Dioxide (CO_2)	0-15%			

Maintenance of the P2000D

The UV source of P2000D should be replaced annually as part of the annual maintenance schedule. The part number of the UV light emitting diode (LED) is given in the Spare Parts table below.

IMPORTANT

The UV LED is ESD (electrostatic discharge) sensitive and as a result are not covered under warranty.

The UV LED is ESD (electrostatic discharge) sensitive. To ensure the proper functioning of an LED care must be given to maintain the highest standards of compliance to the maximum electrical specifications when handling such devices. The LEDs are particularly sensitive to any voltage that exceeds the absolute maximum ratings of the product. Any applied voltage greater thanthe maximum specification will cause damage and possible complete failure to the product. The user must use handling procedures that prevent any electrostatic discharges or other voltage surges when handling or using these devices.

During operation, the LED emits high intensity ultraviolet (UV) light, which is harmful to skin and eyes. UV light is hazardous to skin and may cause cancer. Avoid exposure to UV light when LED is operational. Precautions must be taken to avoid looking directly at the UV light without the use of UV light protective glasses (BS EN 170:2002). Do not look directly at the front of the LED or at the LED's lens when LED is operational.

SPARE PARTS

Part No	Description	Quantity
6-0417	UV LED	1
6-0419	Peltier Cooler	1
1-0217	PSU 480W	1
2-0050E	Analyser PCB (P2000D)	1

If you wish to order a spare part, please contact Protea, or your Protea-authorised Protea Distributor.

If you require a spare part that is not listed here, please contact Protea, or your Protea-authorised Protea Distributor.

When ordering spare parts, please quote both the Part Number *and* the serial number of the component part of your CEM system concerned (e.g. AU, Control Unit or ISH serial number). This information will help Protea provide you with a quick and efficient service.

Protea Ltd. reserves the right to change the prices, specifications, or manufacture of any component parts without notice.

UK Sales & Manufacturing	Customer service and tools
Protea Ltd 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk	**Protea Ltd** 2 Venture Park Stirling Way Peterborough Cambridgeshire PE3 8YD United Kingdom Tel:+ 44 (0)1733 215300 sales@protea.ltd.uk www.protea.ltd.uk
For Protea Distributor information see www.protea.ltd.uk/global-network	

Replacing the UV source – 1-0271 Peltier UV Diode Assembly iss01

There are currently 2 different types of uv diode mount, please use the relevant instructions below.

NOTE:

Protea recommends that after a diode replacement a calibration check is carried out and a manual adjustment made if required.

1. Remove the lid of the GRP cover if the P2000D is fitted with a head cover.

Figure L-1 Removing the GRP cover

2. Before removing the analyser lid make sure that the power to the analyser is switched off or wear protective UV glasses when accessing the analyser enclosure when the analyser is in an energised state.

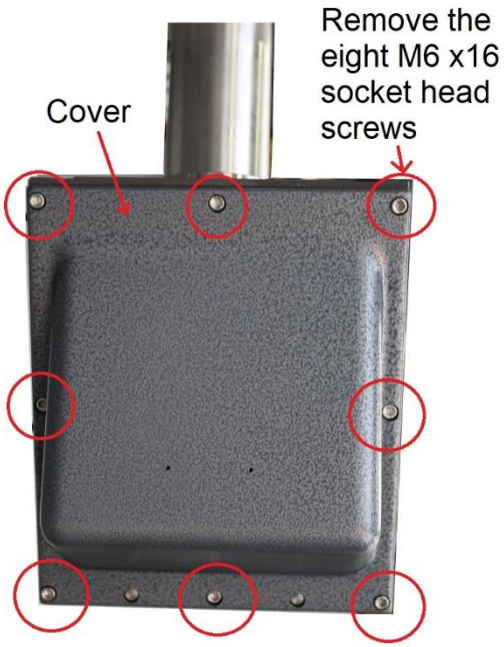


Figure L-2 Removing the analyser lid

3. Locate the UV source assembly and disconnect the power connector from the Peltier pcb as shown in figure L-3 below.

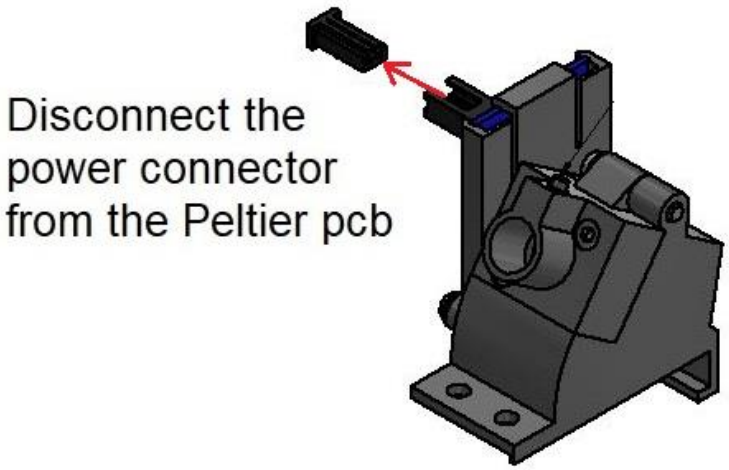


Figure L-3 Disconnecting the power connector from the Peltier pcb

4. Disconnect the UV LED connector (PL5) from the analyser pcb as shown in figure L-4 below

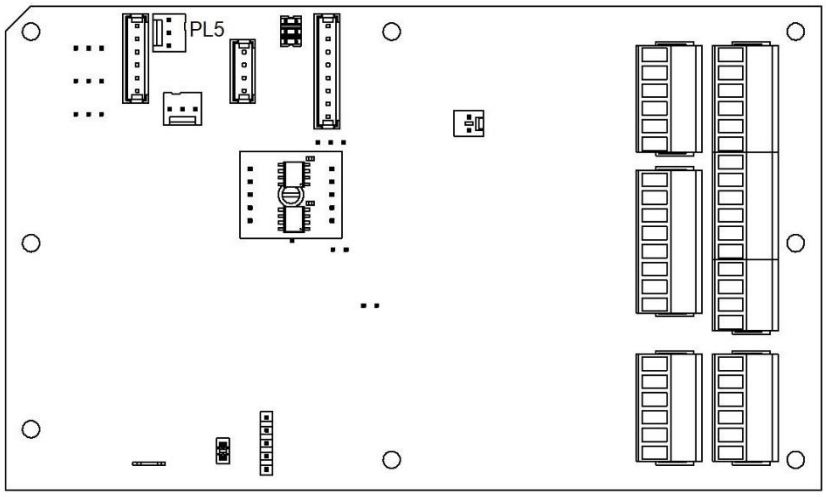


Figure L-4 Disconnection of the UV LED from the analyser pcb1

5. Unfasten the m3 grub screw and release the fibre bundle from the mount. Then unfasten and remove the two M3 x20 socket head screws as shown in figure L-5.

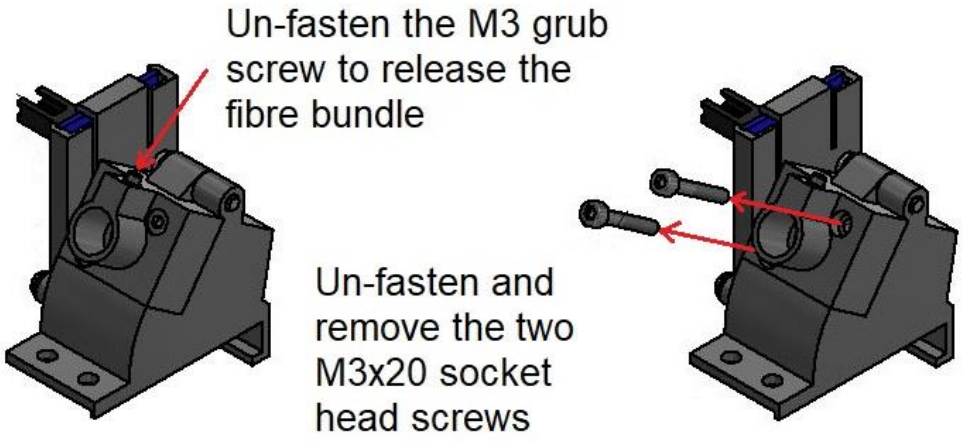


Figure L-5 Removing the fibre bundle

6. Lift the fibre mount up and unfasten the two M3 x10 socket head screws as shown in figure L-6. Then withdraw the Peltier front heat sink from the assembly.

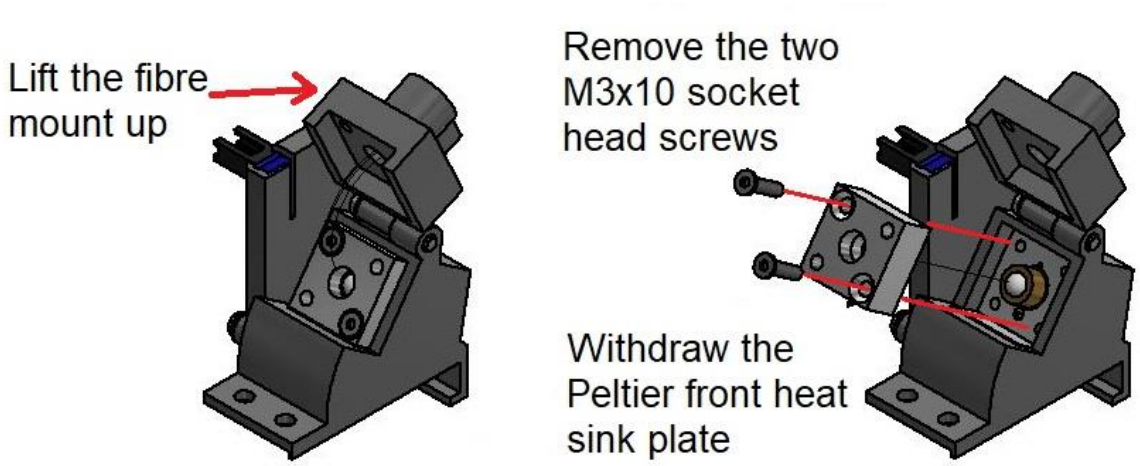


Figure L-6 Remove the Peltier front heat sink to access the diode

7. Carefully, remove the diode from the socket as shown in figure L-7. The diode is sensitive to electrostatic discharge (ESD). Precautions must be taken to prevent ESD such as wearing an earthing strap and using a grounded mat.

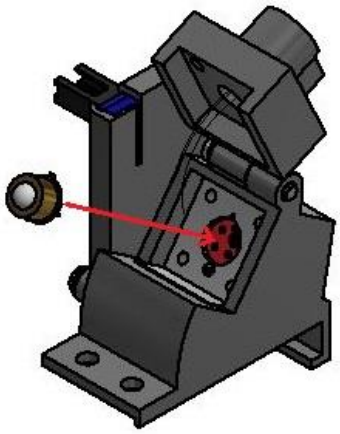
Figure L-7 Removing the diode from the UV source assembly

8. Carefully, remove the new diode from the anti-static packing.

Figure L-8 Packaging of New UV Diode

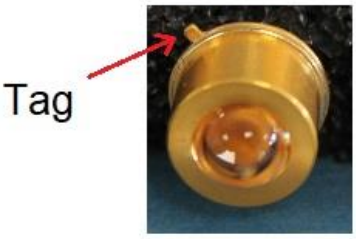
9. Carefully, fit the new diode into the connector. Use the diode tag to align the diode with the connector. Do not bend the pins. The diode must be flush with the connector as shown in figure L-9.

The diode is ESD sensitive. to prevent ESD damage wear an ESD wrist strap and use a grounding mat when fitting the diode.



Fit the diode into the connector.

Use the diode tag to align the diode with the connector



The diode base must be flush with the connector surface.

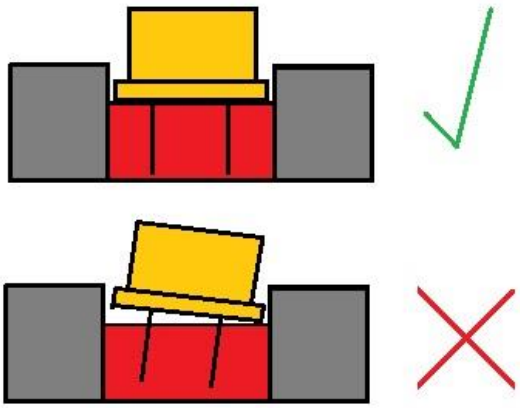


Figure L-9 Fitting a replacement diode

10. To re-assembly repeat the disassembly steps in reverse e.g. 6, 5, 4, 3, 2, 1. You must wear UV protective glasses when the UV diode is energised.

Replacing the UV source – 1-0271 Peltier UV Diode Assembly iss02

1. Remove the lid of the GRP cover if the P2000D is fitted with a head cover.

Figure L-1 Removing the GRP cover

2. Before removing the analyser lid make sure that the power to the analyser is switched off or wear protective UV glasses when accessing the analyser enclosure when the analyser is in an energised state.

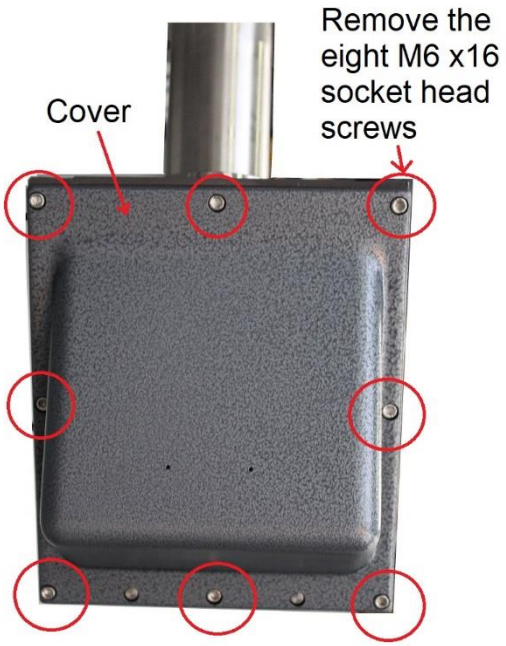


Figure L-2 Removing the analyser lid

3. Locate the UV source assembly and disconnect the power connector from the Peltier pcb as shown in figure L-3 below.

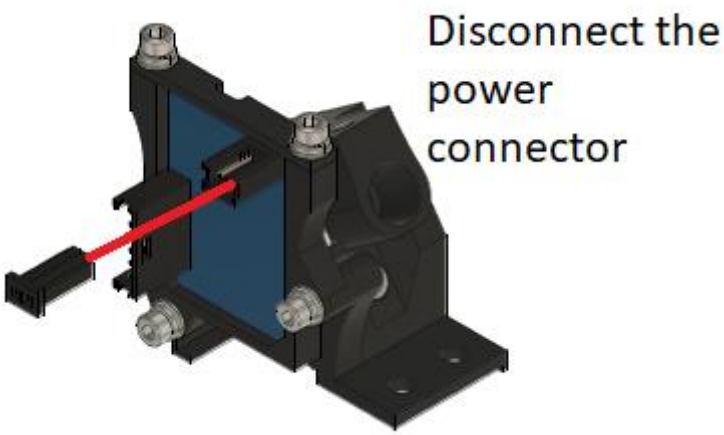


Figure L-3 Disconnecting the power connector from the Peltier pcb

4. Disconnect the UV LED connector (PL5) from the analyser pcb as shown in figure L-4 below

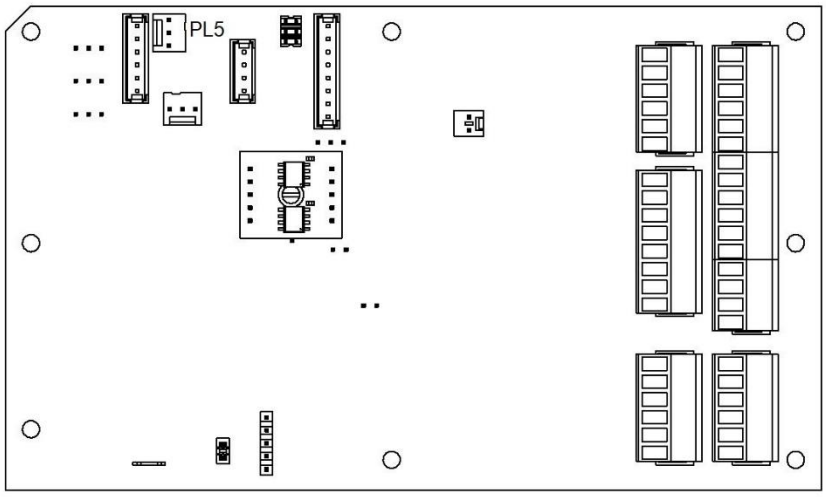


Figure L-4 Disconnection of the UV LED from the analyser pcb2

5. Unfasten the m3 grub screw and release the fibre bundle from the mount. Then unfasten and remove the two M3 x20 socket head screws as shown in figure L-5.

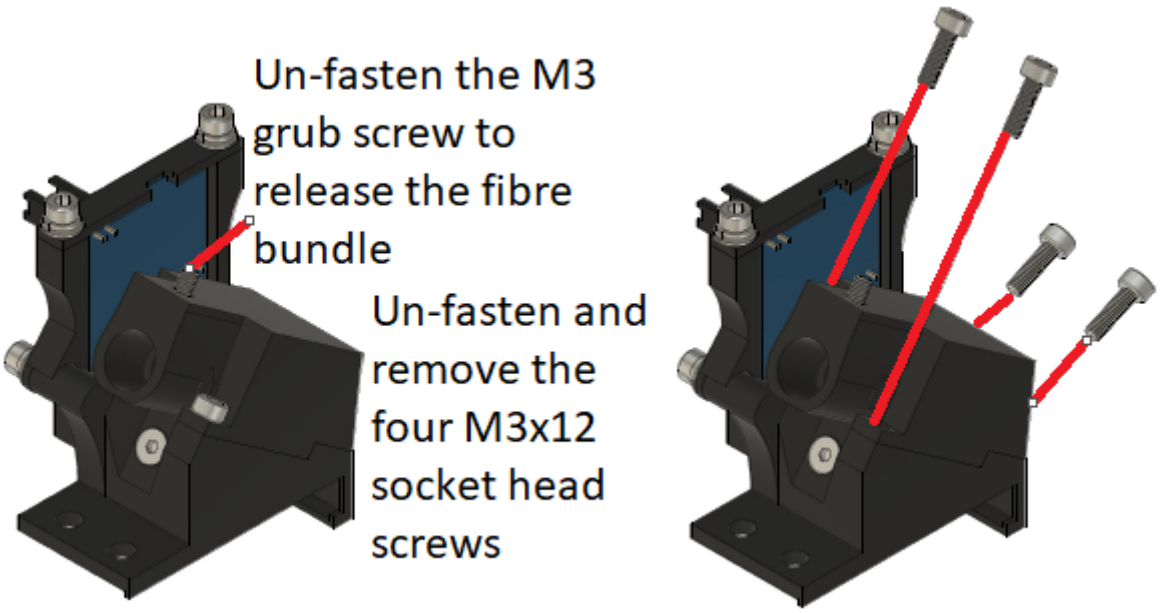


Figure L-5 Removing the fibre bundle

6. Lift the fibre mount up and unfasten the two M3 x10 socket head screws as shown in figure L-6. Then withdraw the Peltier front heat sink from the assembly.

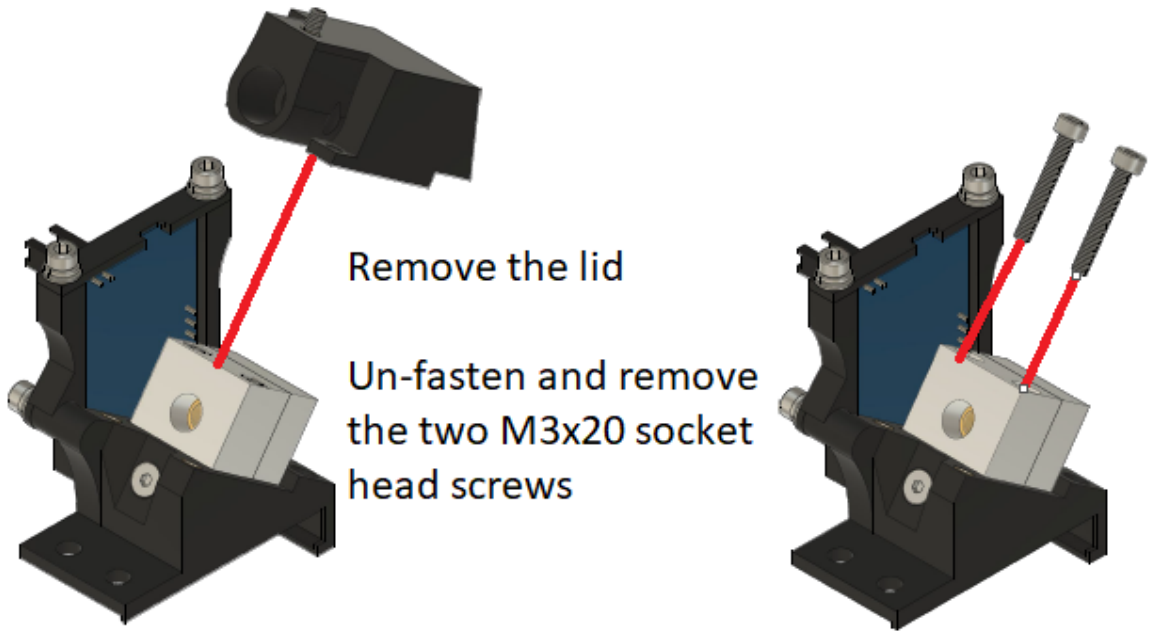
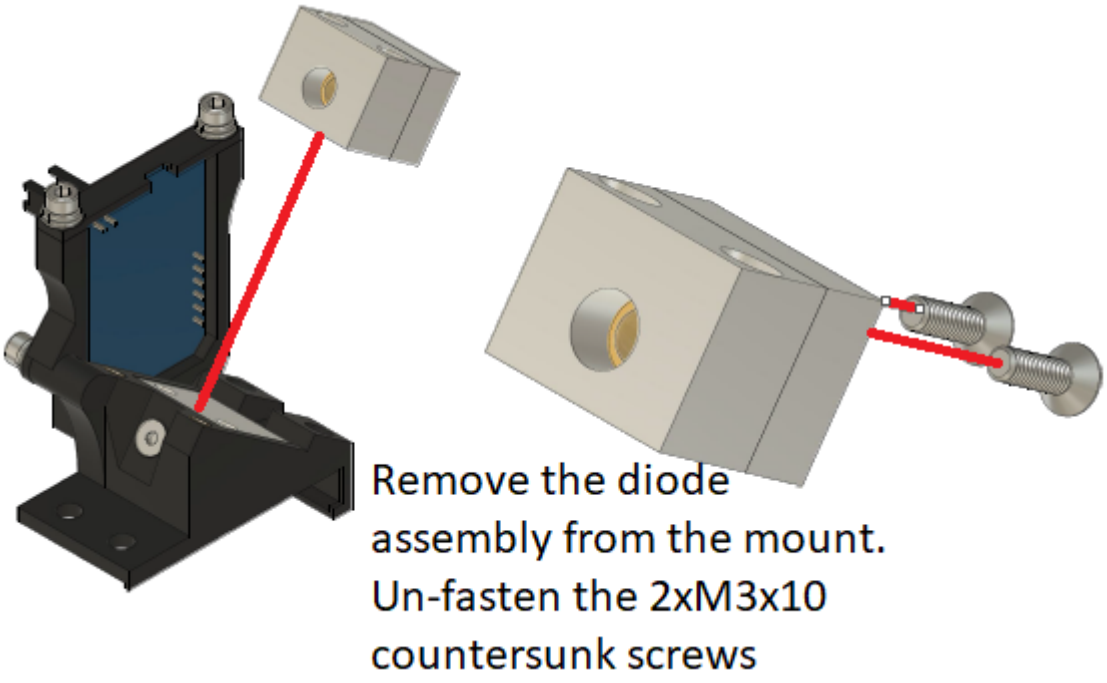


Figure L-6 Remove the Peltier front heat sink to access the diode



7. Carefully, remove the diode from the socket as shown in figure L-7. The diode is sensitive to electrostatic discharge (ESD). Precautions must be taken to prevent ESD such as wearing an earthing strap and using a grounded mat.

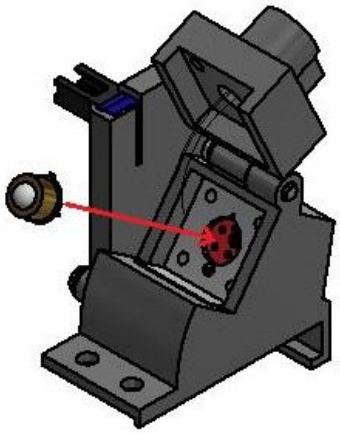
Figure L-7 Removing the diode from the UV source assembly

8. Carefully, remove the new diode from the anti-static packing.

Figure L-8 Packaging of New UV Diode

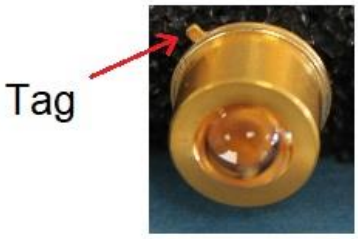
9. Carefully, fit the new diode into the connector. Use the diode tag to align the diode with the connector. Do not bend the pins. The diode must be flush with the connector as shown in figure L-9.

The diode is ESD sensitive. to prevent ESD damage wear an ESD wrist strap and use a grounding mat when fitting the diode.



Fit the diode into the connector.

Use the diode tag to align the diode with the connector



The diode base must be flush with the connector surface.

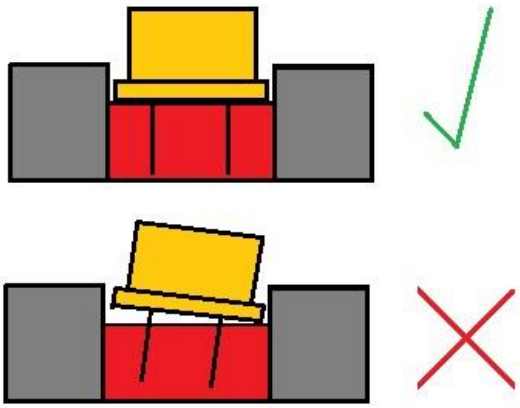


Figure L-9 Fitting a replacement diode

10. To re-assembly repeat the disassembly steps in reverse e.g. 6, 5, 4, 3, 2, 1. You must wear UV protective glasses when the UV diode is energised.

Appendix M - In-Situ Heater – Heater Tape Version, Length 1m with 6” Flange

Introduction

This *Appendix* describes a special in-situ heater that uses a self-limiting electrical heater tape (Protea part Number 1-0257). This appendix describes how the In-Situ heater (Heater Tape Version) should be installed.

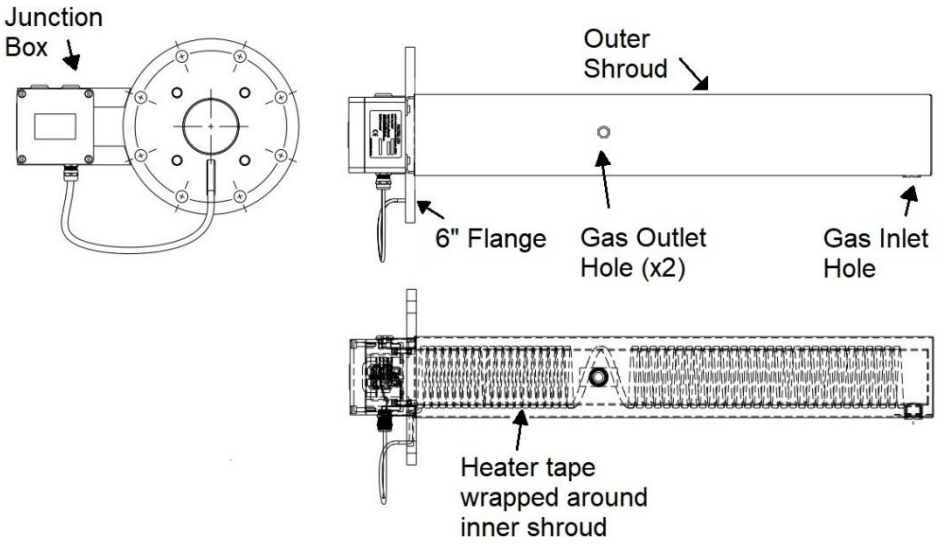


Figure M-1 In-situ heater (Heater tape version) schematic

In-Situ Heater description

An optional In-Situ Heater (ISH) may be fitted around the sample cell and is recommended for applications involving flue gases at temperatures below 120°C, or on applications with high acid dew point or where monitoring is required when process is off. The ISH contains an electrical heater, which has the effect of keeping the temperature of the sample cell well above the dew point, thus preventing condensation onto any optics in contact with the process gas.

Regulation of the ISH is achieved via the self-limiting heater tape.

A temperature-dependent resistive element between two copper conductors regulates and limits the power output of the heating tape according to the ambient temperature. If the ambient temperature rises, the power output of the heating tape is reduced. This self-regulating property prevents overheating even when the tape is overlapped.

As the heater tape is self-limiting the maximum surface temperature is 120°C (248°F). This surface temperature is within the limits of a T4 environment.

The additional power requirement for the In-Situ Heater (Heater Tape version) is 210 W.

Technical Specification

Parameter	Range
EXTERNAL AMBIENT OPERATING TEMPERATURE	-20ºC to +60ºC (4°F to 140°F)
STACK AMBIENT TEMPERATURE	Or 50°C to 130°C (122ºF to 266ºF) (T4)
MAXIMUM SAMPLE TEMPERATURE ACHIEVED	120°C (248ºF)
SURFACE TEMPERATURE	120°C (248ºF)
SIZE INSERT LENGTH	1000mm
FLANGE	ANSI 6” (316 stainless steel)
WEIGHT	25kg
VOLTAGE	230V ±10%
POWER	210 W
IP RATING (JUNCTION BOX)	IP66

NOTE – The ANSI 6” stack flange is non-standard – please refer to the *Installation section* in this manual.

Minimum Mains Cable Specification

Parameter	Range
NUNMBER OF CONDUCTORS	3 cores
INSULATION	>1500V
CURRENT RATING	4.5A (230V),
TEMPERATURE RATING	>85°C (>185ºF)
RECOMMENDED WIRE SIZE	Cable Type 1 2.5 mm^2

Special Conditions for Safe Use

RATING CLASSES:

II 2 G Ex e IIC 130°C T4 Gb

II 2 G Ex tb IIIC T130°C Db

ELECTRICAL RATING:

230V 210W Max

ATEX CERTIFICATE: **KEMA 02 ATEX 2327 U \ Baseefafa07ATEX0140X**

CSA CERTIFICATE: **CSA 1862457**

IECEx CERTIFICATE: **IECEx KEM 07.0048**

Summary of Special Conditions for Safe Use Heater Tape:

[1] The heater cannot be installed in the hazardous area unless it is fitted with a valid external certification label.

[2] It is the responsibility of the user of the equipment to ensure that:-

[a] Connections made to and from this product must be made in accordance with BS EN 60079-14:2008. The specific requirements of the following sections shall be met at all times:

Section 8	Emergency switch-off and electrical isolation
Section 9	Wiring systems
Section 10	Cable entry systems

[b] Only glands certified EEx d may be used and should be in accordance with the gas group of the enclosure as a minimum.

[c] Before opening the enclosure, the system must be turned off and the waiting time marked on the certification label must be adhered to (typically 30 minutes).

[3] The cable entry devices, thread adapters and stopping plugs used shall be suitable for the equipment, the cable and the conditions of use and shall be certified as Equipment (not a Component) under an EC Type Examination Certificate to Directive 94/9/EC. All unused entries are to be fitted with certified flameproof stopping plugs.

[4] No unauthorised modifications shall be carried out on any part of the product Unit or to the cabling there to.

[5] The external earth stud on the side of the product enclosure shall be connected to a convenient earth or ground point.

Fitting the In-Situ Heater

DANGER

DO NOT CONNECT ANY MAINS CABLE (LINE CORD) TO THE ELECTRICAL SUPPLY UNTIL ALL THE INTERNAL CONNECTIONS WITHIN THE ISH JUNCTION BOX HAVE BEEN MADE AND THE UNITS ARE SECURELY CLOSED ONCE MORE. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

DANGER

RISK OF ELECTRIC SHOCK – DO NOT REMOVE THE COVER WHEN EQUIPMENT IS POWERED – DISCONNECT THE MAINS SUPPLY BEFORE REMOVING COVER.

ATTENTION

Do not attempt to connect any mains cable (line cord) to the ISH if the voltage configuration of the ISH differs from your local electrical supply voltage. Contact Protea, or your Protea-authorised Protea Distributor. Using an incorrect supply voltage will result in the In-Situ Heater failing to function properly.

See the following Installation Drawings to install the In-situ heater (Heater tape version), copies of which can be found in the *Order Specific Information* section of this manual

- 19-0080 Installation of AVU Ex Panel & P2000 in (T4)
- 19-0091 Installation of In-situ heater 1-0257

IMPORTANT

You should refer to the Installation drawings in the *Order Specific Information* section for drawings relating to your specific installation.

Connecting the In-Situ Heater (Heater Tape Version) to the Mains Supply.

IMPORTANT

IT IS ESSENTIAL FOR CONFORMANCE WITH EN61010 THAT A FIXED MAINS INSTALLATION HAS AN ISOLATOR FITTED IN THE SUPPLY CLOSE TO THE ISH, THIS ISOLATOR MUST BE LABELLED WITH “ISH SUPPLY” AND MUST DICONNECT BOTH LIVE AND NEUTRAL LINES, AND THIS SHOULD BE PROVIDED BY THE SITE SUPPLY DISTRIBUTION POINT.

THE ISOLATOR MUST PROVIDE OVERCURRENT PROTECTION FOR THIS PERMANENTLY CONNECTED EQUIPMENT.

You should refer to Appendix F for information on the type of isolator recommended by Protea.

NOTE: The In-situ Heater (Heater Tape version), Protea Part Number 1-0257, is rated for 230V only.

IMPORTANT

BEFORE CONNECTING THE MAINS ENSURE AN EARTH BOND LEAD IS FITTED FROM THE P2000 TO THE LOCAL STACK EARTH – THIS IS ONLY REQUIRED WHEN INSTALLING AN ISH

When you are satisfied that the voltage configuration of the ISH and the local electrical supply voltage are the same, you can connect the mains supply voltage to the ISH - noting the previous WARNING.

IMPORTANT

THE INSTALLER IS RESPONSIBLE FOR INSTALLING THE IN-SITU HEATER (HEATER TAPE VERSION) AND FOR THE TERMINATION AND CONNECTION OF ANY POWER CABLES AND/OR EARTH CONTINUITY CONNECTION. IN ADDITION, THE INSTALLER IS RESPONSIBLE FOR SELECTING CABLE ENTRY DEVICES AND FOR ENSURING THAT A MINIMUM INGRESS PROTECTION OF IP66 AT EACH CABLE ENTRY POINT IS ACHIEVED. THE INSTALLER IS ALSO RESPONSIBLE FOR BLANKING OFF UNUSED ENTRY HOLES WITH APPROPRIATE STOPPING PLUGS. INFORMATION THE SPECIAL CONDITIONS FOR SAFE USE PROVIDED IN THIS

APPENDIX ABOVE MUST BE ADHERED TO WHEN INSTALLING THIS DEVICE IN A HAZARDOUS AREA:

The installer should consult the IEC 60079:14 2014 standard when connecting mains power to the In-situ heater.

The following information is for guidance only

Figure M-2 The Junction Box of the In-situ Heater (Heater Tape Version)

1. Remove and retain the four screws securing the cover of the ISH junction box as shown in figure M-3.

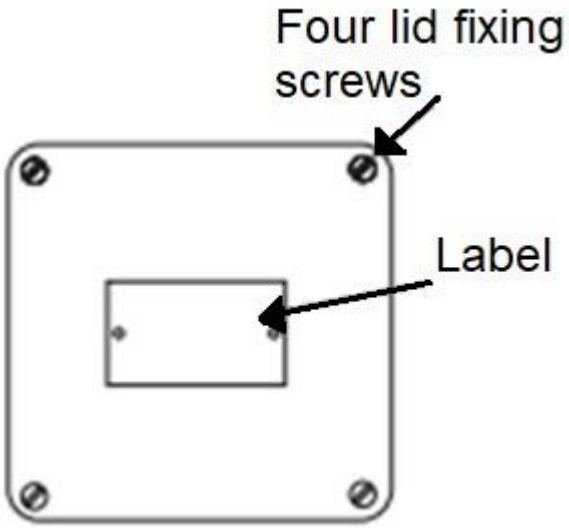


Figure M-3 – Junction Box lid

2. Connection of the Mains Power is shown in figure M-4

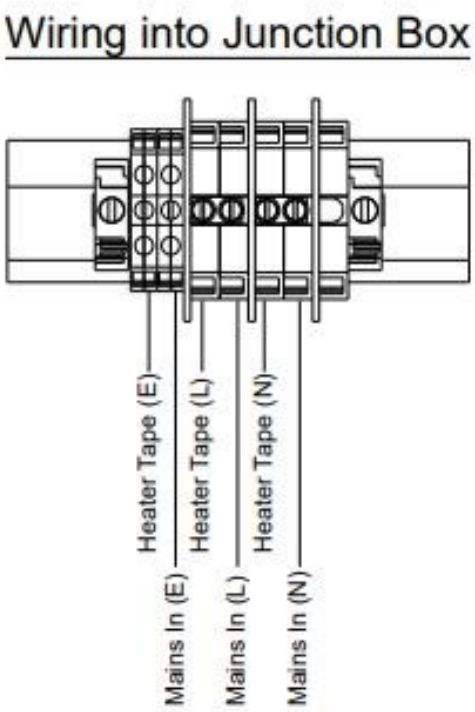


Figure M-4 – Wiring into the Junction Box

3. Only one conductor shall be connected to each terminal way.
4. Conductor insulation shall extend to within 1mm of the metal in the terminal throat (as shown in figure M-5)

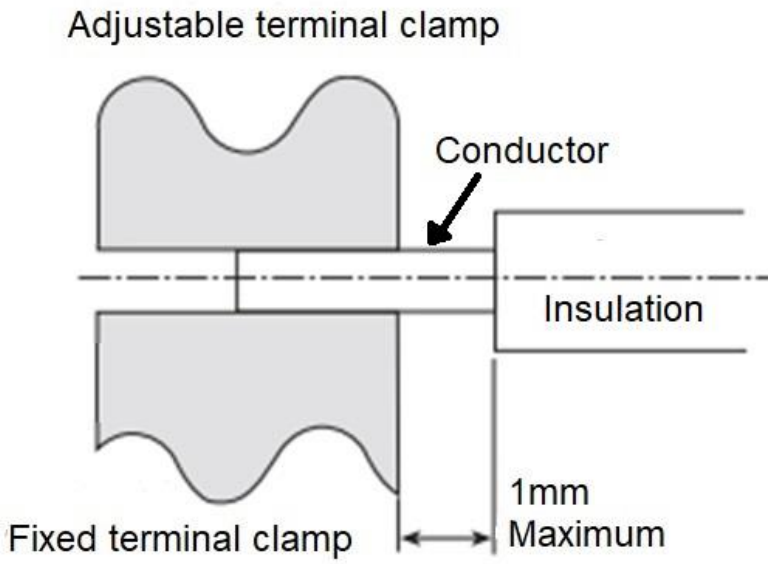


Figure M-5 – Clamping a conductor in the terminal block

5. The installer shall use an appropriate method to ensure a minimum ingress protection of IP66 at each cable entry. Select cable entry devices in accordance with BS EN 60079:14 2014 – section 10.

6. Where earth continuity is required, via cable entry devices, either
    a. The entry device shall be screwed into a tapped hole in the wall of the enclosure and the locknut shall be securely tightened against the “dimples” provided around the clearance hole in the earth continuity plate, or
    b. If the hole in the enclosure wall is a clearance hole and/or the clearance hole in the earth continuity plate is not provided with the “dimples” then the installer shall provide a resilient washer for installation between the earth continuity plate and the locknut.
    c. The installer is responsible for ensuring that the resilient washer is suitable for the conditions of use,

noting particularly that any earth fault current must pass via the washer.

7. Replace the cover securely, ensuring the cover earth wire is fitted, ensure the cables are potted correctly in their cable glands.

Installing the In-Situ Heater in the stack

WARNING

PHYSICALLY DISCONNECT THE MAINS VOLTAGE SUPPLY BEFORE FITTING THE IN-SITU HEATER. FAILURE TO FOLLOW THIS WARNING COULD RESULT IN SERIOUS OR FATAL INJURY FROM ELECTRIC SHOCK.

AFTER THE ISH HAS BEEN FITTED IF IT IS THEN REQUIRED TO REMOVE IT TAKE PPE PRECAUTIONS. THE ISH MAY BE HOT FROM STACK GASES AND IF IT HAS BEEN POWERED IT WILL RETAIN THE HEAT FROM ITS OWN HETAER FOR MANY HOURS. HEAT RESISTANT GLOVES MUST BE WORN.

DISCONNECT THE MAINS SUPPLY BEFORE ACCESSING THE WIRING.

During installation of the In-Situ Heater, you may need to refer to the relevant installation drawing in the *Order-specific information* section of this manual.

1 Fit the supplied circular gasket (Protea Part Number 3-3015) to the four M16 bolts on the vertical flange already fitted to the process gas duct (see figure M-6).

2 Offer up the ISH to the vertical flange. Introduce the heater gently into the duct and fit the ISH flange onto the four M16 bolts.

3 If the AU is not to be fitted immediately, fit nuts to the four bolts, and finger-tighten to retain the ISH safely.

4 Once the In-Situ Heater has been fitted, you may go on to fit the Analyser Unit.

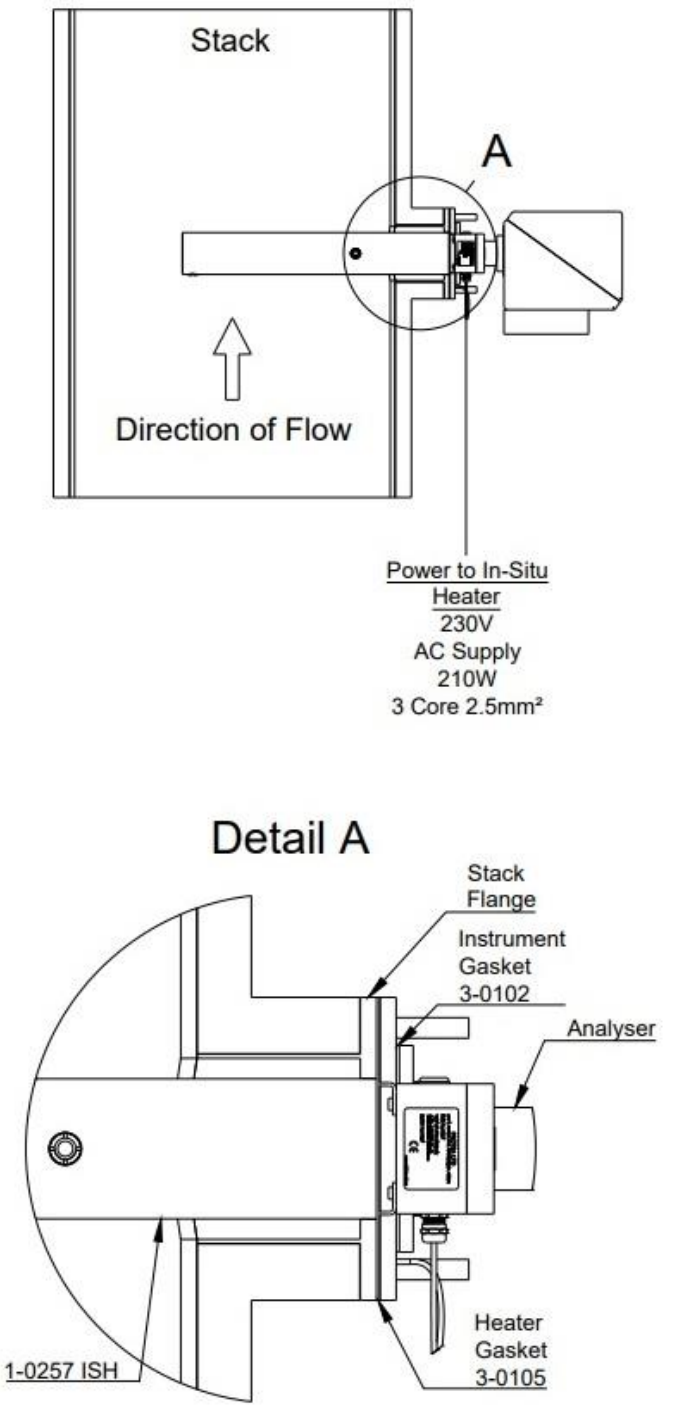


Figure M-6 Overview of the installation of the In-situ heater (heater tape version). (You should refer to the Installation drawings in the *Order Specific Information* section for drawings relating to your specific installation.

NOTE – The sample Inlet hole should be perpendicular to the stack flow and the outlet holes should be in the flow.

In-service history

Date	Action	Signature
