

# ABB ANALYTICAL

## The Company

ABB Analytical specializes in the engineering, manufacture, sale and support of high quality, highly functional, analytical instrumentation for on-line analysis of process streams.

ABB Analytical is committed to quality leadership in the on-line analyser industry. The Company-wide, world-wide commitment is well expressed in the **quality statement** for ABB Analytical:

**'We will conform to requirements and deliver defect-free products on time, to satisfy the needs of our internal and external customers.'**

## Use of Instructions



### **Warning.**

An instruction that draws attention to the risk of injury or death.



### **Note.**

Clarification of an instruction or additional information.



### **Caution.**

An instruction that draws attention to the risk of damage to the product, process or surroundings.



### **Information.**

Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of Technical Communications Department, ABB Analytical.

### **Health and Safety**

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

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# 1 INTRODUCTION

## 1.1 Documentation – Fig. 1.1

Documentation for the EXGP Oxygen Analyzer System is shown in Fig. 1.1.

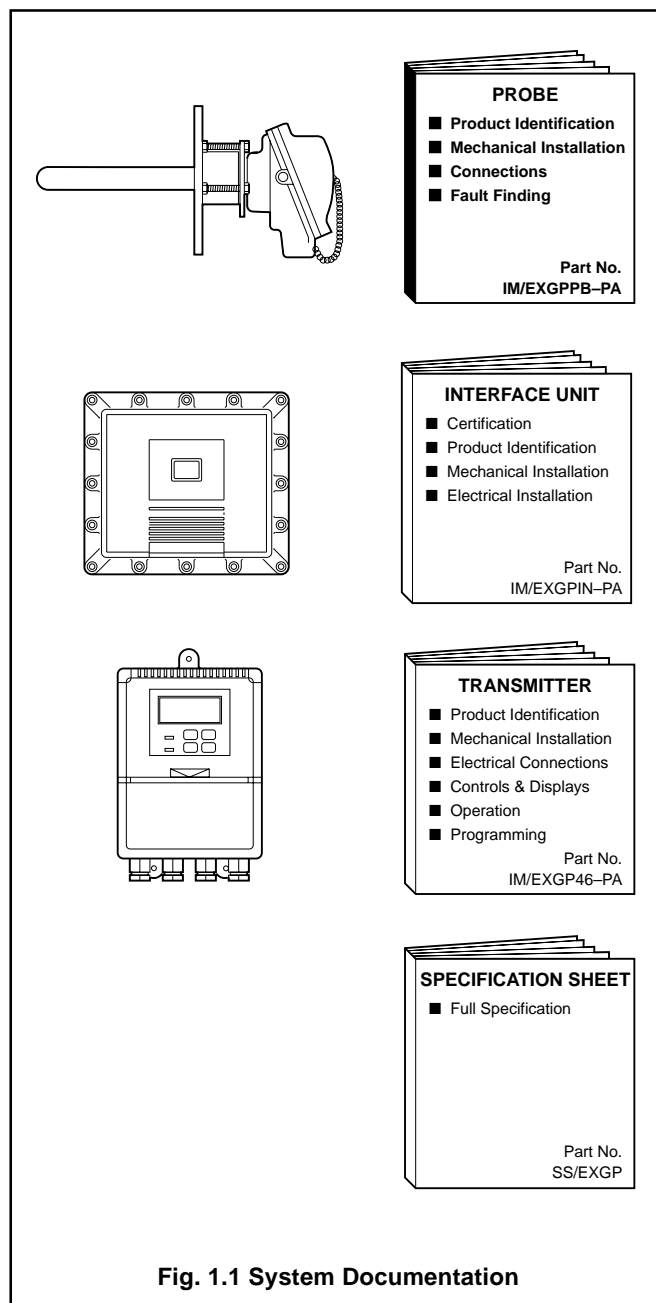
## 1.2 Certification

The EXGP Probe is classed as a 'Simple Apparatus' and may therefore be installed in Zone 1 Hazardous Areas as an intrinsically safe product.



**Note.** A 'Simple Apparatus' is a device that does not generate more than 1.2V, 0.1A, 20mJ and 25mW.

Documented evidence confirming the compliance of EXGP Probes is available and is endorsed by BASEEFA.



**Fig. 1.1 System Documentation**

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## ...1 INTRODUCTION

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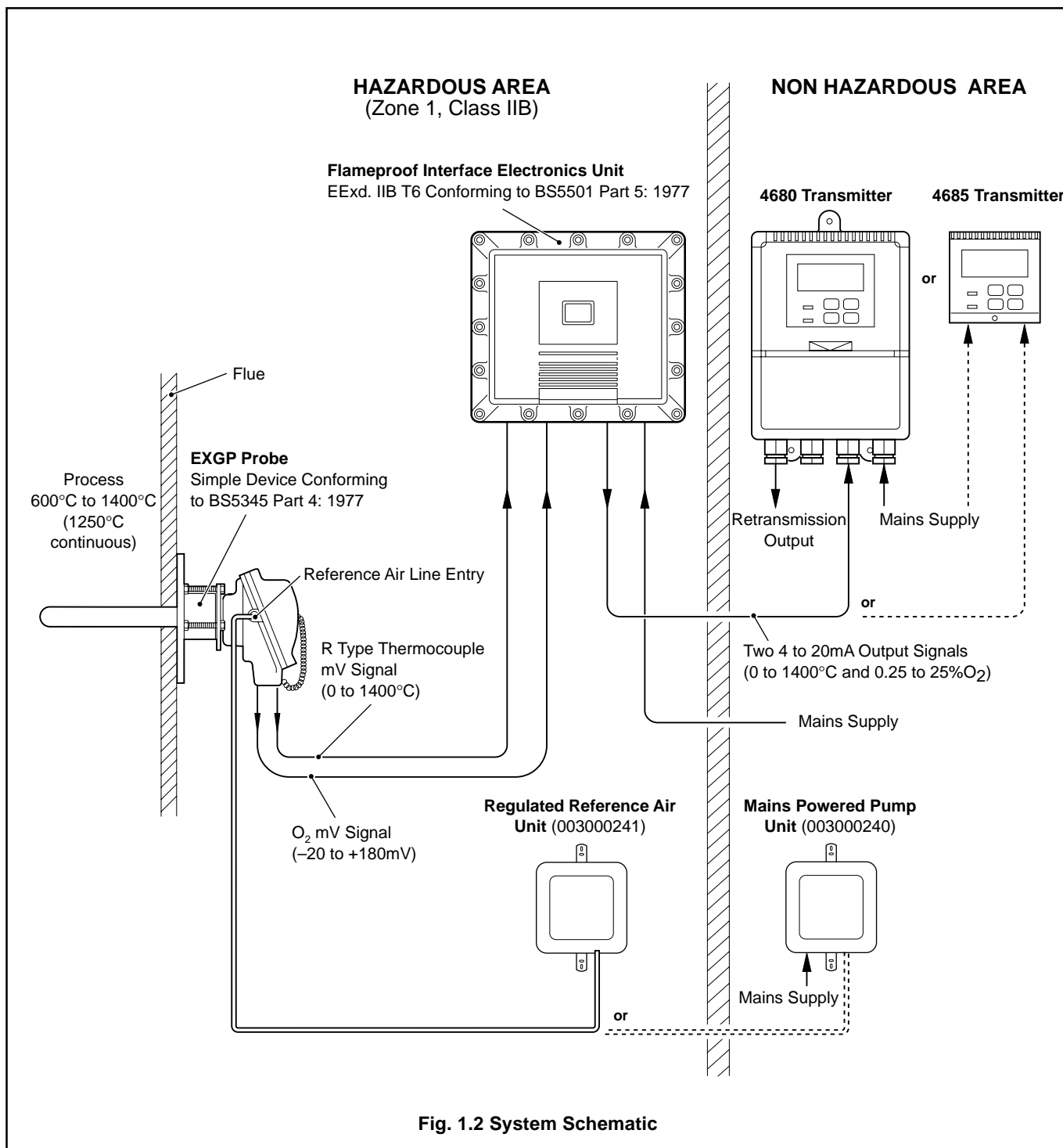
### 1.3 System Hardware – Fig. 1.2

The EXGP Oxygen Probe is an 'in situ' method of measuring oxygen concentration designed for use in hazardous areas (Zone 1). When used in conjunction with the EXGP Interface Electronics Unit (also Zone 1 Certified), it enables signals to be retransmitted up to 1km into a safe area.

The oxygen probe provides a mV signal that relates directly to oxygen concentration in the range 0.25 to 25% O<sub>2</sub>, over a process temperature range of 600°C to 1250°C. An integral 'R' type thermocouple provides accurate continuous measurement of the process temperature.

A calibration gas inlet port is provided to enable the probe to be checked using test gas mixtures without removing it from the process.

Reference air supplied at a rate of 100 to 1000cm<sup>3</sup>/hr (0.2 to 2ft<sup>3</sup>/hr) is required for accurate operation and can be provided by a pump or regulator unit – see Fig. 1.2.



2 PREPARATION

2.1 Unpacking

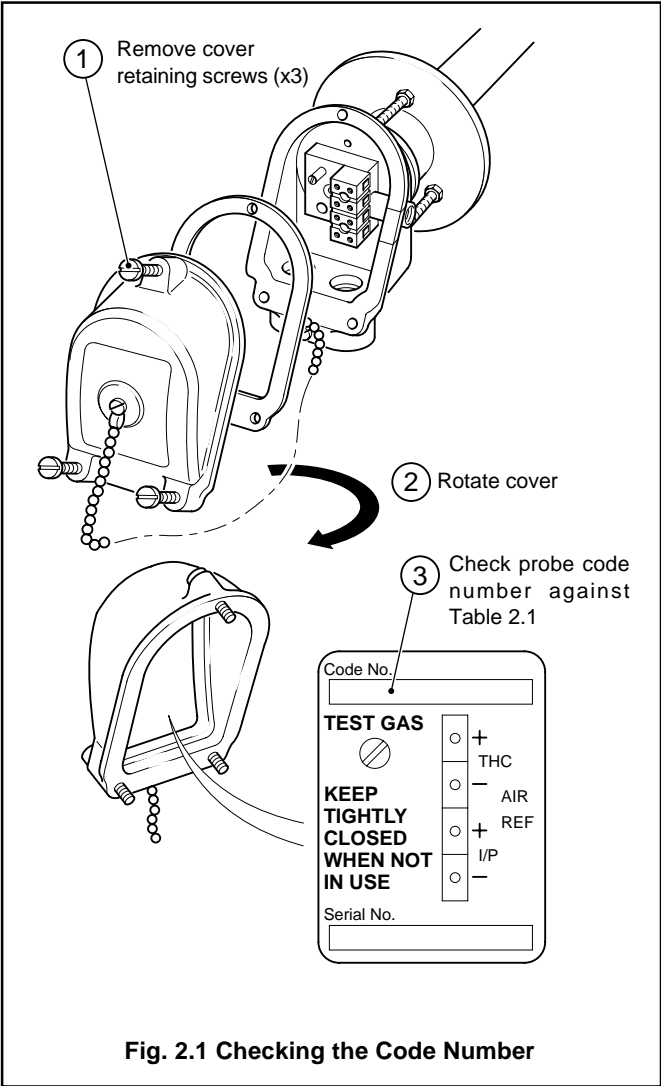
**Caution.** The probe is very fragile. Unpack and handle with care.

Each probe is despatched with its components individually placed within a common pack. Remove the probe from its packing as follows:

- a) Place the polystyrene pack, top uppermost, on a flat surface and cut the tapes holding the two halves together.
- b) Carefully lift the top half of the pack to gain access to the probe components which are individually located within the bottom half.
- c) When removing the components from the pack take great care to support the probe head and not to twist or bend the electrode assembly attached to it.
- d) Reassemble the packing and retain for future use.

2.2 Checking the Code Number – Fig. 2.1

Before installing the equipment, check the code number on the probe – see Fig. 2.1.



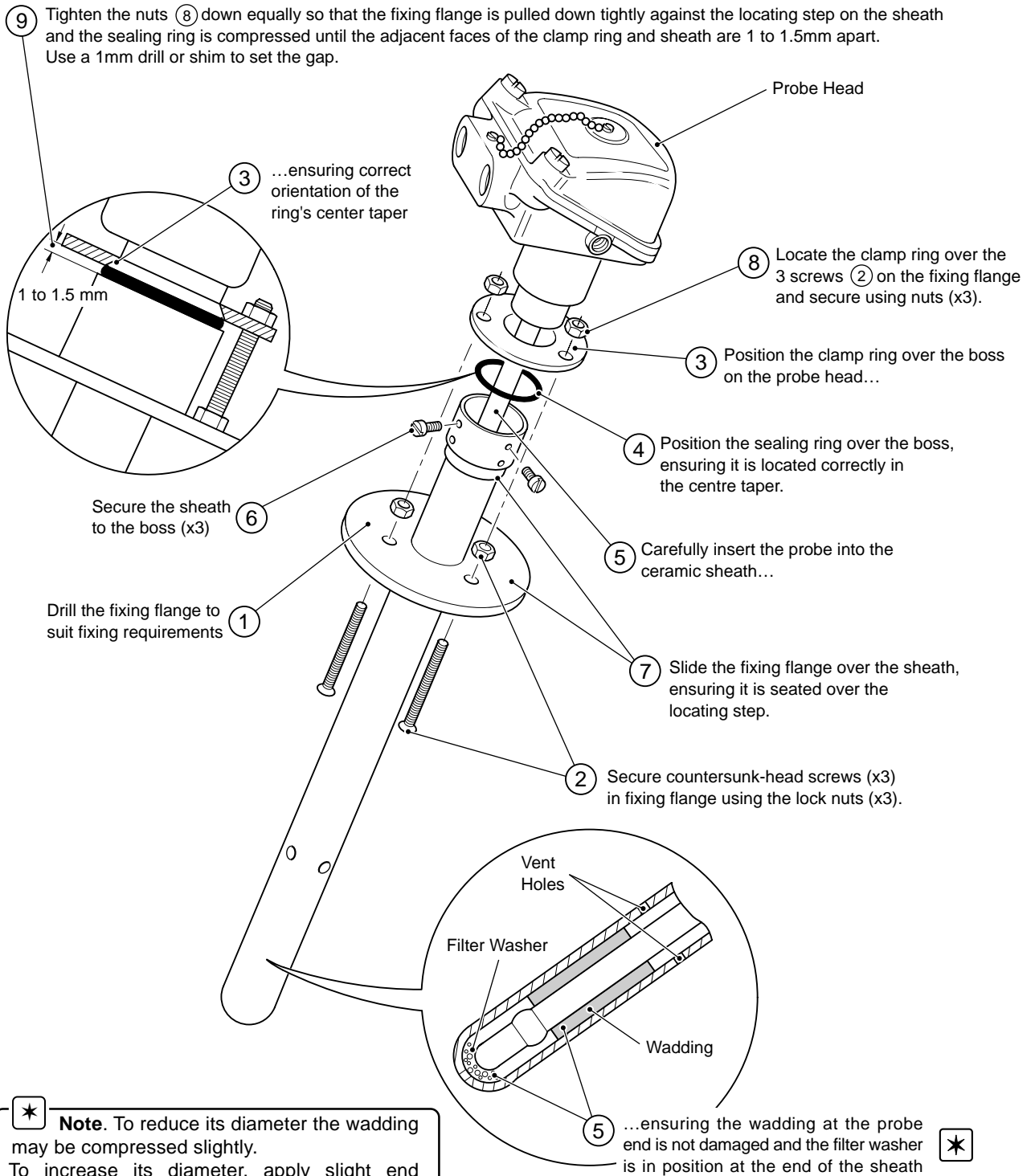
EXGP Probe		EXGP /	X	X	X	0	0	0
Length	None		0					
	600mm		1					
	1000mm		2					
	Special		9					
Sheath	None			0				
	Incoloy 800			1				
	Aluminous Porcelain			2				
	Special			9				
Standard Items	None				0			
	Twin gland Type C95 (Flange mounted, 'R' type thermocouple Pt/Pt 13% Rh BS4937)				1			

Table 2.1 Code Number Interpretation

### 2.3 Assembling the Probe – Fig. 2.2



**Caution.** Take care to avoid damage to the probe when fitting the sheath assembly.



**Note.** To reduce its diameter the wadding may be compressed slightly. To increase its diameter, apply slight end pressure on the wire bonding at both ends of the wadding. Mould the wadding by hand to ensure a light push fit into the sheath.

**Fig. 2.2 Assembling the Probe**

### 3 INSTALLATION



**Warning.** The probe operates at high temperatures – take all necessary precautions to avoid injury through burns.



**Caution.** Thermal shock may damage the zirconia cell if the flue is cleaned using a high pressure water hose. If this method of cleaning is used, remove the probe from the flue prior to cleaning. Never use the probe without the sheath.

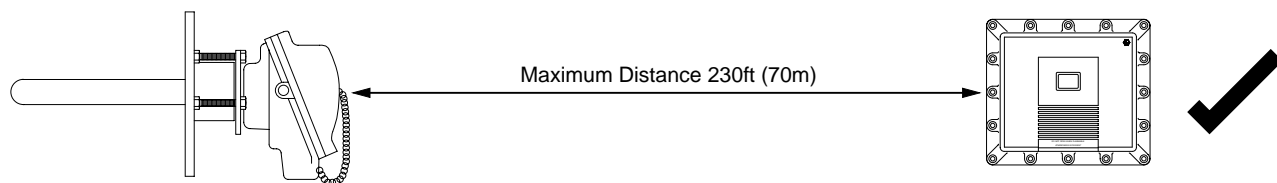
#### 3.1 Siting – Fig. 3.1

Select the position for the probe avoiding obstructions which may inhibit insertion or subsequent removal. Dimensions for the probe are shown in Fig. 3.2. A clearance of at least 1in (25mm) in excess of the overall probe length is necessary for installation or removal procedures.

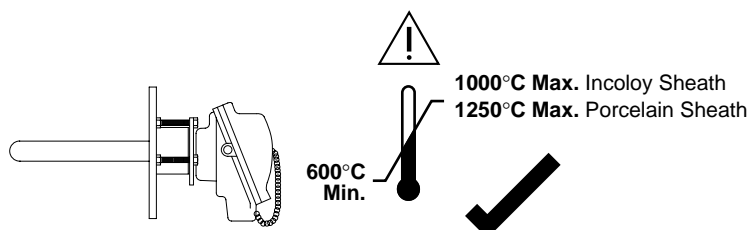


**Caution.** The probe **must not** be sited:

- Where it would be subjected to mechanical or thermal shock.
- In the presence of aggressive compounds, e.g. molten slags, molten silicates, metals and vapors of lead, zinc, silicon and vanadium.



**A – Maximum Distance Between EXGP Probe and Interface Electronics Unit**



**B – Within Process Temperature Limits**

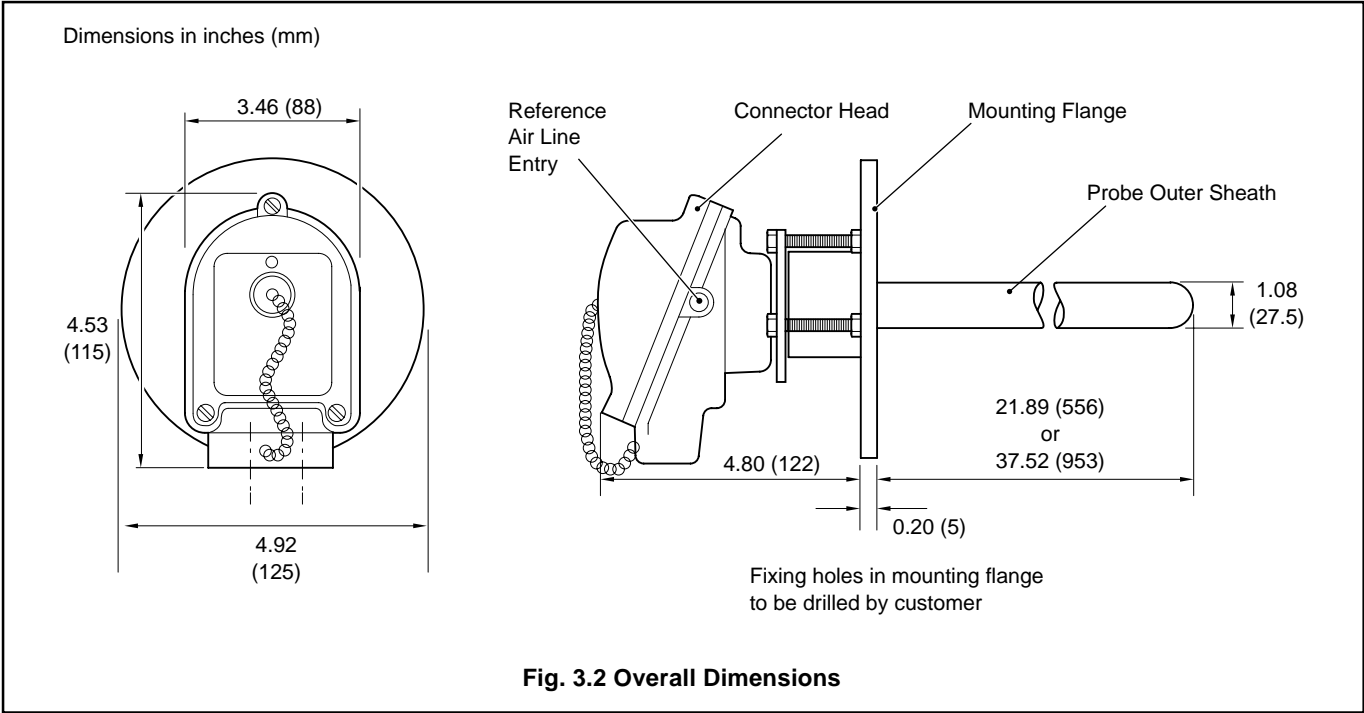


**Caution.** Reduced probe life may result if probe is operated above 1250°C.

**Fig. 3.1 Siting**



3.2 Mounting – Figs. 3.2 and 3.3



### ...3 INSTALLATION

#### 3.2.1 Mounting Configurations – Fig. 3.3

The probe may be fitted horizontally or, preferably, vertically for prolonged high temperature operation.

Mount the probe through the furnace wall using the preferred method shown in Fig. 3.3A. Ensure that a sufficiently large hole is provided through the mounting – min. bore 1.65ins (42mm) diameter – to avoid damage to the probe during insertion or use.

Drill the fixing flange to suit the local fixing requirements before assembling the probe – see Section 2.3.



**Caution.** To prevent furnace gas from contaminating the reference air, always ensure that the clamp ring, fixing flange and sealing ring are fitted to the probe as described in Section 2.3.

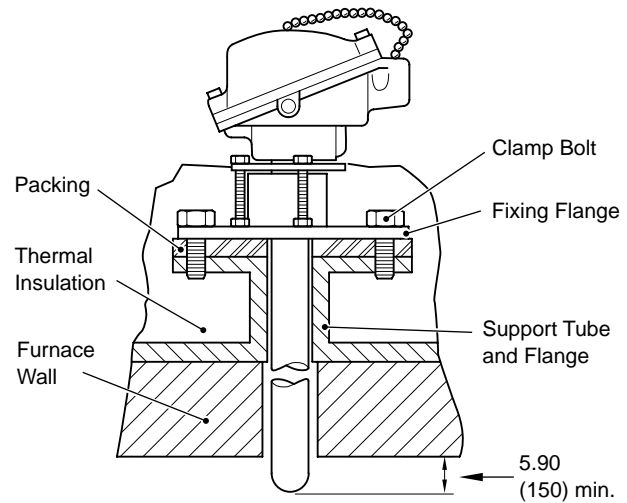
With applications such as high temperature incinerators, fluid bed boilers and ore roasters, where the level of water vapor in the waste gases to be measured can be extremely high, it is important that the mounting flange of the probe, including any standoff which may be used, is thermally insulated to minimize condensation within the probe – see Fig. 3.3A.

Condensation within the probe sheath, particularly in outdoor installations, can be sufficient to allow water to come into contact with the hot ceramic (zirconia) tube leading to thermal shock and failure of the sensor. This problem is most likely to occur on such installations where the plant is shut down regularly over the weekend. Additionally, take care to protect the head of the probe from the elements in outdoor installations.

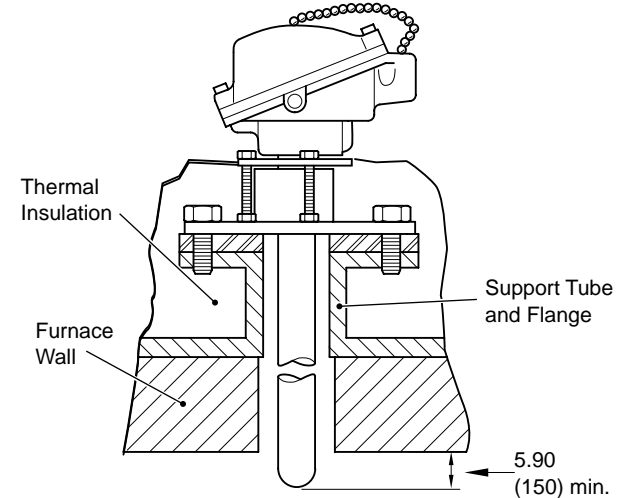
Raising the temperature of the probe as rapidly as possible assists in reducing the level of condensation. This is not possible on some processes where the plant temperature is gradually raised to the normal operating level. The temperature rise at the head of the probe can be assisted by having a large clearance hole in the refractory allowing hot gases to get up to the mounting flange/standoff – see Fig. 3.3B.

Horizontal installations are more likely to exhibit the problems described. Where it is not possible to mount the probe in the vertical position, install the probe with a slope of at least 10 to 15° downwards from the head of the probe – see Fig. 3.3C.

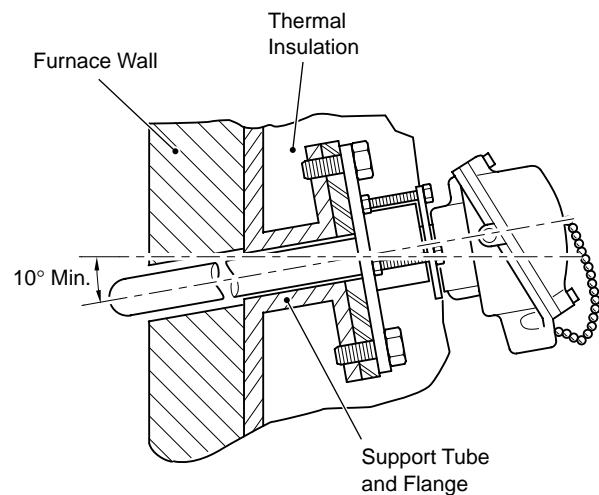
Dimensions in inches (mm)



**A – Standard Configuration**



**B – Improved Probe Heating**



**C – Inclined Configuration**

**Fig. 3.3 Probe Mounting**

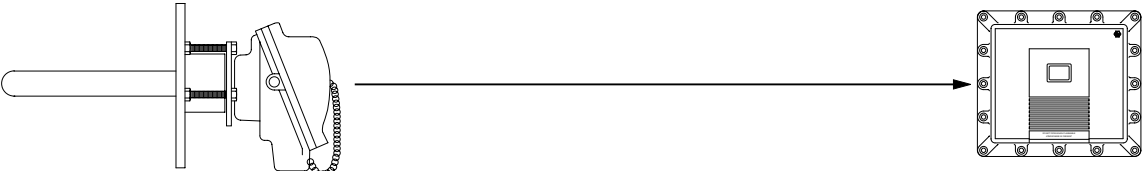
## 4 CONNECTIONS

### 4.1 Cable and Gland Specifications – Table 4.1



**Caution.** Cables and glands are not supplied with the probe and must conform to the following requirements:

- The Capacitance and Inductance or Inductance to Resistance (L/R) ratio of the cables connected to the output (hazardous area terminals) of the zener barriers mounted in the EXGP Interface Electronics Unit must not exceed the values shown.
- All cables must conform to BS5345 for flameproof 'd' type enclosures for mechanical construction.
- EEx d glands used on the Interface Electronics Unit must be of the EEx d 'Barrier Gland' type with BASEEFA certification because the enclosure is over 2 litres volume, has a source of ignition within and is designed for use in Zone 1 areas (reference BS5345 part 3).



Gland Specification – Probe	Cable Specification (Intrinsically Safe Signals)	Gland Specification – Interface
M16 Non-certified	R Type Thermocouple (mV) Input: 16/0.2, 2-core, overall screen, R-type thermocouple compensating cable to BS4937 ⚠ Capacitance 3μf, Inductance 0.27mH, L/R Ratio 28μH/Ω	M20 BASEEFA Certified barrier gland 'd' (flameproof)
M16 Non-certified	Oxygen (mV) Input: 16/0.2, 2-core copper, overall screened ⚠ Capacitance 3μf, Inductance 0.27mH, L/R Ratio 28μH/Ω	M20 BASEEFA Certified barrier gland 'd' (flameproof)

**Table 4.1 Cable and Gland Specifications (electrical requirements only)**

### 4.2 Access to Electrical Connections – Fig. 4.1

For access to the terminal block – see Fig.4.1.

### 4.3 Electrical Connections – Fig. 4.2

Make connections as shown in Fig. 4.2 and on the label inside the probe head cover. The connecting cable must enter the probe head via the two M16 cable glands.

### 4.4 Reference Air Connection – Fig. 4.2

The reference air connector is 1/8in. BSP fitted with an adaptor to accept 1/4in i.d. x 3/8in o.d. nylon or PVC tubing (100°C ambient maximum).

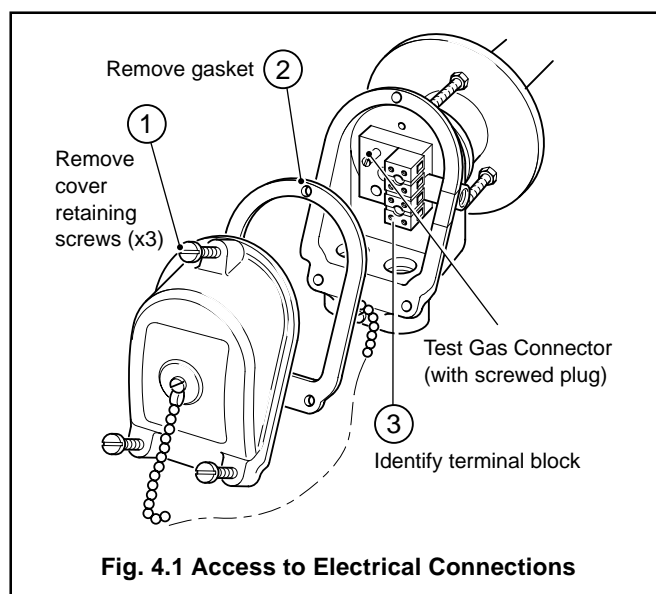
The probe requires clean, dry air supplied at 100 to 1000cm<sup>3</sup>/hr (0.2 to 2ft<sup>3</sup>/hr). The air may be regulated instrument air or preferably atmospheric air from a small pump unit. Suitable air supply units are available from the Company:

- Model 003000240 – mains powered pump unit with flow gauge for use in safe areas only.
- Model 003000241 – regulated air supply unit for use in both safe and hazardous areas.

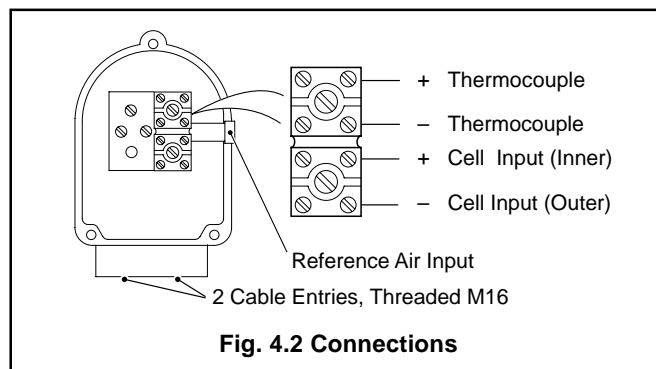
### 4.5 Routine Maintenance

No maintenance is necessary, or possible, on the probe and any attempt to dismantle it could cause irreparable damage. The probe can be tested for accuracy whilst connected to its measuring system but without removal from its operating position.

It is recommended that at least one spare probe is held for replacement or comparison purposes.



**Fig. 4.1 Access to Electrical Connections**



**Fig. 4.2 Connections**

## 5 FAULT FINDING



**Warning.** The probe operates at high temperatures. Take all necessary precautions to avoid injury through burns.

During its working life, under normal recommended conditions, the probe output remains accurate and without drift. However, probe malfunctions can result from a fault in the probe or from incorrect operating conditions.

The testing of a suspect probe can only be carried out satisfactorily in its working position or in a furnace controlled within the normal probe operating temperature range.

If a probe failure is suspected, first perform a test gas check as described in the following sections.

### 5.1 In Situ Checking Using a Test Gas

This procedure introduces a test gas of known O<sub>2</sub> concentration around the outer electrode of the probe in the space between the filter washer, at the bottom of the sheath, and the wadding around the lower end of the probe. Four vent holes (see Fig. 2.2) prevent the gas from being trapped in the upper part of the sheath.

- Gain access to the interior of the probe head by unscrewing the lid fixing screws – see Fig. 4.1.
- Remove the screwed plug from the test gas connector – see Fig. 4.1.
- Fit 1/4in i.d. x 3/8in o.d. plastic or similar tubing and supply a test gas of known oxygen between 0.25 and 25% O<sub>2</sub> concentration to the probe at a steady flow rate of 800 to 1000ml/min. Allow at least 5 minutes for the system to stabilize before making a measurement.
- Check that the oxygen concentration measured by the 4680 or 4685 transmitter (mounted in a safe area), compares with the specification for the test gas used.



**Note.** The O<sub>2</sub> concentration measured by the probe can be checked locally by taking readings from the probe thermocouple (for temperature) and the cell O<sub>2</sub> mV input and entering the results in to the Nernst Equation.

- Disconnect the test gas and ensure that the screwed plug is replaced in the test gas connector. Failure to do this may result in serious measurement errors due to the entry of air into the probe.
- Proceed to Table 5.1.

Result of Test Gas Check	Possible Cause of Operation Malfunction	Action
Correct	—	None
Incorrect	Reference air supply failure (high O <sub>2</sub> reading)	Check probe reference air supply
	Faulty electronics unit or indicator	Check operation of units concerned
	Leak in zirconia tube within probe or broken zirconia tube (high O <sub>2</sub> reading)	Compare operation with another O <sub>2</sub> tube – replace if necessary
Zero or drifting readings with no response to test gas	Open circuit probe cell connections	Carry out a continuity check – see Section 5.4
	Faulty electronics unit indicator or connections	Check operation of units concerned

Table 5.1 Fault Finding

### 5.2 Comparison with Another O<sub>2</sub> Probe

The probe may be checked by comparison with another of known reliability, either by replacing the suspect probe with the known probe or by mounting the known probe in close proximity and monitoring both probes continuously for a short period.

### 5.3 Returning the Probe to the Manufacturer for Checking

If it is not possible to carry out the above tests on site and failure or malfunction is suspected, the probe may be returned to the Company for checking.

If returning the probe, carefully dismantle the probe components by reversing the procedure detailed in Fig. 2.2. Repack in the original packing to ensure safe carriage.

### 5.4 Continuity Check

Connect a 100kΩ resistor across the probe output. If the output drops to near zero millivolts and then drifts when the resistance is removed, this indicates that the probe may be open circuit or have a high impedance.

## APPENDIX

### A1 Principles of Operation

The EXGP probe comprises a ceramic detector cell housed in a protective sheath. A thermocouple is fitted within the probe to enable the process temperature to be monitored or for automatic temperature compensation to be provided.

The sheath material may be either aluminous porcelain (recommended for oxidizing atmospheres) or Incoloy 800 (recommended for reducing atmospheres) for use at maximum temperatures of 1250°C and 1000°C respectively. Special sheaths are available for use up to 1400°C. Connections for the cell output, thermocouple and reference air are all made at the probe connector head.

The probe contains a high temperature oxygen concentration cell using zirconium oxide as a solid electrolyte. Inner and outer electrodes are attached to the cell which is specific to oxygen.

Air is supplied to the inner reference electrode to provide a constant partial pressure of oxygen while the process gas to be measured is in contact with the outer electrode.

A voltage is generated across the electrodes which is a function of the ratio of the oxygen partial pressures at the two electrodes. This voltage output represents 'oxygen potential' and can be used to control the atmosphere of annealing processes etc.

For the measurement of 'oxygen concentration' it is necessary to correct for absolute temperature of the probe. The temperature term in the Nernst equation, on which the voltage output depends, illustrates this point:

### Nernst Equation

$$E = 0.0496 T (\log_{10} P_0/P_1) + C \text{ mV}$$

Where:

T	=	Absolute Temperature (°K)
P <sub>0</sub>	=	Partial Pressure Reference Gas
P <sub>1</sub>	=	Partial Pressure Sample Gas
C	=	Cell Constant

### A2 Range of Operation – Fig. A1

The internal resistance of the cell, i.e. the resistance of the electrolyte between the electrodes, decreases approximately exponentially with increasing temperature and for this reason it is recommended that the probe is used at temperatures greater than 600°C.

The maximum operating temperature is limited by two factors:

- The onset of electronic conduction through the electrolyte which reduces the measured output below its theoretical value.
- Evaporation of the outer electrode.

Electronic conduction is a function of both temperature, oxygen partial pressure and, for stabilized zirconia, it occurs at low levels of oxygen and high temperature. For the above reasons it is recommended that the probe is used at temperatures between 600°C and 1250°C – see Fig. A1.

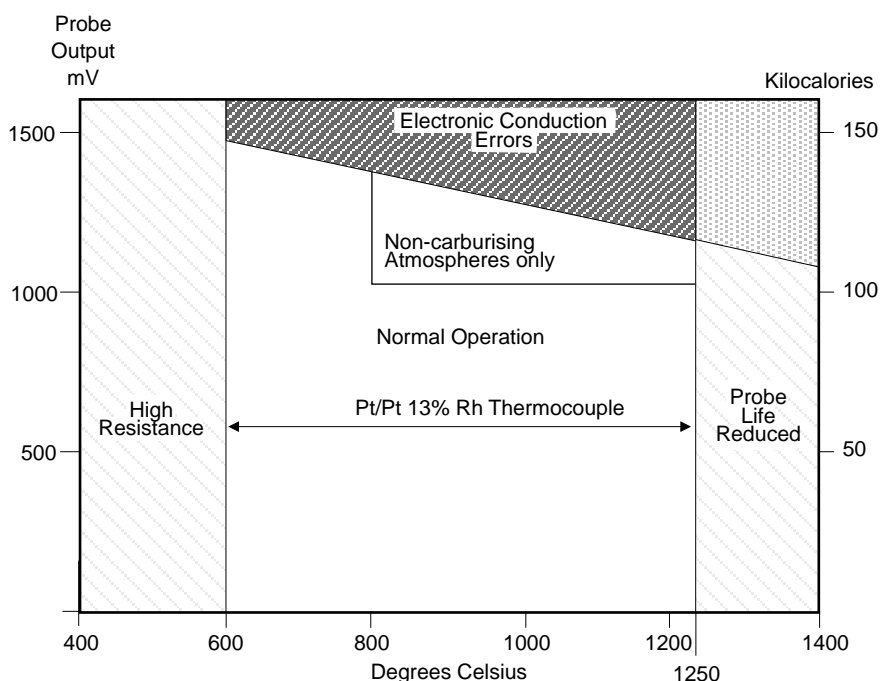


Fig. A1 Range of Operation

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**NOTES**

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# CUSTOMER SUPPORT

## Service, Support and Maintenance

ABB Analytical's commitment to quality doesn't end when we deliver our equipment.

We also provide, at the client's request: start-up services, maintenance services, training services, reconditioning, repair and replacement parts services.

Training services are available for virtually every aspect of operating and maintaining ABB Analytical analyzers and systems. Training may be arranged on-site or at any of our training centres.

Maintenance services are available on an unscheduled, as needed basis, or by way of long-term, scheduled maintenance agreements.

## Facilities

ABB Analytical's primary manufacturing and administrative facility is located in Lewisburg, West Virginia. We also operate sales and service centres in Houston, Texas; Baton Rouge, Louisiana; Sarnia, Ontario; UK; France; Italy; The Netherlands and Singapore. Training centres are located in Lewisburg, Houston and Europe.

For complete information and assistance with ABB Analytical analyzers, systems and services, contact any of our facilities for details of your nearest Service and Repair Centre.

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