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FINAL REPORT

DISPLACEMENT OF METHANE FROM THE GOAF INTO THE WORKING PLACE AS A RESULT OF WIND BLASTS IN UNDERGROUND COAL MINES

C7031

August 2001

ACARP

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Any results given in this report are provisional and may be superseded as further wind blast and methane expulsion data become available. Inquiries regarding up-to-date information may be made of the Author at the above address or by the following means.

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ABSTRACT

The potential expulsion of methane from the goaf during wind blasts and its possible incursion into the working place has been of concern to the Australian underground coal mining industry for many years. For example, the explosions at Moura No. 4 Mine in Queensland in 1986 and at Endeavour (formerly Newvale No. 2) Colliery in NSW in 1995 are believed to have involved such an occurrence.

The principal objective of the project described in this report, the development, construction and testing of a new 'tool' with which to study and quantify the phenomenon—the Wind Blast and Methane Expulsion Monitoring System (WBMEMS)—has been achieved.

Development of the WBMEMS was funded by Australian Coal Research Limited (ACR) under the Australian Coal Association Research Program (ACARP) with additional financial support provided by Coal Operations Australia Limited and Oceanic Coal Australia Limited. ACR's contribution formed part of its broader funding for the project described in this report and for Project No. C8017 'Reducing the hazard of wind blast in underground coal mines'. The WBMEMS is capable of detecting and recording transient methane levels, air velocities and overpressures during wind blasts.

Field monitoring of wind blasts in 'non-gassy' longwall mines has demonstrated that air which is expelled from the goaf may penetrate up to 200 metres into the working place. Consequently, it is recommended that in 'gassy' wind blast prone mines, the assessment of risk associated with the potential for wind blast should consider the hazards which may arise from the expulsion of methane from the goaf. A potential control to manage this hazard would be the extension of the 'hazardous zone' to 200 metres on the intake side of the longwall face and the exclusion of non explosion protected electrical apparatus from this extended 'hazardous zone'.

It remains to be proven by direct measurement whether or not methane in explosive concentrations is expelled from the goaf during wind blasts in 'gassy' coal mines. Unfortunately, no suitable site was available during the current project after substantial completion of the WBMEMS. It is anticipated, however, that such a site may become available in 2002. Consequently, the resolution of this issue has been 'carried forward' as one of the objectives of ACARP project No. C10024 'Wind blast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 and C8017'. It is anticipated that such measurements will facilitate the drawing up of further guidance for the industry regarding safe working practices in mines subject to the potential expulsion of methane from the goaf during wind blasts and its possible incursion into the working place.

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1.0 BACKGROUND

In some underground coal mines where the roof comprises strong and massive rock, the roof strata do not cave regularly as extraction progresses but 'hang up', leading to extensive areas of unsupported roof. These areas can collapse, suddenly and often without warning, compressing the air beneath and forcing it out of the goaf through surrounding openings giving rise to a phenomenon known as *wind blast*. The force of the wind can, and sometimes does, cause injury to mine personnel, disruption to the ventilation system and damage to plant and equipment. It may also increase the hazard of explosion if methane in explosive concentrations is expelled from the goaf and mixed with raised coal dust.

The impetus for the School of Mining Engineering at The University of New South Wales (UNSW) to undertake research into the phenomenon of wind blast arising from roof falls was provided by two incidents which occurred in 1989/90 at underground coal mines in the Lake Macquarie district of the Newcastle Coalfield of New South Wales. Wind blasts in underground coal mines resulting in injury or death had previously been reported from both New South Wales and Queensland, as well as from the United States of America, South Africa, China and India. Several of these incidents are described in detail in Fowler (1997).

It is of particular concern that methane in explosive concentrations may be expelled from the goaf into the working place as a consequence of wind blast. At Moura No. 4 Mine in Queensland, twelve miners were killed in 1986 in an explosion that was considered to have been preceded by a wind blast. The 1995 explosion at Endeavour (formerly Newvale No. 2) Colliery in NSW, described in detail in Coal Mining Inspectorate and Engineering Branch (1996) and in outline in Fowler and Torabi (1997), is also believed to have involved just such an occurrence.

The incidence of wind blasts is likely to increase as a result of the trend away from pillar extraction to longwall mining. Moreover, the risk of personal injury & of damage to mine infrastructure may become greater as a result of increased wind blast intensity caused by the restricted number of openings through which the wind blast can be dissipated and, perhaps, by increased extraction height. Mining under strong, massive roof, such as some sandstones and conglomerates, increases the risk, particularly where longwall face length is restricted for reasons which may include strata control, structural geology or subsidence issues. Panels that are of less than 'critical width' often do not cave regularly and are notoriously prone to 'hang up'.

For example, wind blast has already been a serious issue for some collieries mining the West Borehole seam under massive channel conglomerates to the north west of Lake Macquarie in the Newcastle Coalfield of NSW. It also poses a significant potential problem for those collieries in the south of Lake Macquarie which already mine, or are proposing to mine, the Great Northern Seam under the Teralba Conglomerate by the longwall method.

1.1 OBJECTIVES OF THE RESEARCH

The aim of the programme of wind blast research currently being undertaken by the School of Mining Engineering at The University of New South Wales is to develop a fundamental understanding of the wind blast and methane expulsion phenomena resulting from massive roof failure in underground coal mines and thus provide a basis on which to develop strategies to mitigate the hazards.

The principal objective of the work described in this report, Australian Coal Association Research Program (ACARP) project No. C7031 'The displacement of methane from the goaf into the working place as a result of wind blasts in underground coal mines', is to develop and deploy a high-speed monitoring system capable of accurately responding to rapid changes in methane concentration over a short time period.

Other objectives are to develop an understanding of the phenomenon of methane incursion associated with wind blast and to minimise the explosion risk by developing and defining guidelines for safe working practices.

1.2 PREVIOUS REPORTS

Three interim research reports dealing with the subject of wind blast are available from the Author at the UNSW School of Mining Engineering. Contact details are included on p. iii of this report.

The first interim report (Project Report No. 1) was initially issued in April 1994 and reissued in May 1997 (Fowler 1997). Its contents include the following.

1. A worldwide wind blast literature review.
2. Details of three Australian case histories (Cooranbong, 26 October 1983; Wallarah, 27 November 1989; and Myuna, 15 February 1990).
3. A full description of the Wind Blast Monitoring System.
4. Details of field monitoring at Wallarah and Cooranbong Collieries during 1992.

The second interim report (Project Report No. 3) was first issued in July 1994 and reissued in May 1997 (Fowler & Torabi 1997). Its contents include the following.

1. Details of a further Australian case history (Endeavour [formerly Newvale No. 2] Colliery, 28 June 1995).
2. A full description of the Laboratory Wind Blast Model.
3. Preliminary results of laboratory modelling.

4. Details of field monitoring at Newstan Colliery during 1995/97.
5. Preliminary results from Wallarah, Cooranbong and Newstan Collieries.

The third interim report (Project Report No. 4) was issued in January 2000 (Fowler & Sharma 2000). Its contents include the following.

1. Results obtained from field monitoring at Newstan Colliery during 1995-97.
2. Results obtained from field monitoring at Moonee Colliery during 1998-99.
3. Provisional findings regarding the fluid mechanics involved in the compression and distribution of air during wind blasts.
4. Provisional conclusions regarding wind blast hazard management.

1.3 OUTCOMES AND RECOMMENDATIONS

The principal objective of the project described in this report, the development, construction and testing of a new 'tool' with which to study and quantify the phenomenon—the Wind Blast and Methane Expulsion Monitoring System (WBMEMS)—has been achieved.

Development of the WBMEMS was funded by Australian Coal Research Limited (ACR) under the Australian Coal Association Research Program (ACARP) with additional financial support provided by Coal Operations Australia Limited and Oceanic Coal Australia Limited. ACR's contribution formed part of its broader funding for the project described in this report and for Project No. C8017 'Reducing the hazard of wind blast in underground coal mines'. The WBMEMS is capable of detecting and recording transient methane levels, air velocities and overpressures during wind blasts.

The system has been completed and all necessary Certifications obtained for installation in Queensland underground coal mines. All necessary Approvals for installation in New South Wales underground coal mines have been obtained with the exception of that for an Intrinsically Safe Battery Assembly which has only one function, to energise the clock chip and associated circuitry in the data logger so that date and time functionality is not lost when reticulated power to the WBMEMS is interrupted. It is expected that the issue will be resolved in the near future (see sec. 2, pp 21-23). In the meantime, the system is able to be installed in New South Wales underground coal mines without the IS Battery Assembly. Should the power supply be interrupted, date and time will have to be reset manually from a personal computer located at the surface via the modem.

Building upon the work undertaken as part of project No. C6030 'The dynamics of wind blasts in underground coal mines', where a 'world first'—the successful instrumental

'capture' of wind blasts and the elucidation of their characteristics—had been achieved (Fowler & Sharma 2000), an extensive programme of field monitoring, undertaken at Moonee Colliery during the mining of longwall panels nos 3, 4A and 4B has enabled the fluid mechanics involved in the compression and distribution of air during wind blasts to be better defined.

The results from Moonee Colliery, a 'non-gassy' longwall mine, have demonstrated that air that is expelled from the goaf may penetrate up to 200 metres into the working place. Consequently, it is recommended that in 'gassy' wind blast prone mines, the assessment of risk associated with the potential for wind blast should consider the hazards which may arise from the expulsion of methane from the goaf. A potential control to manage this hazard would be the extension of the 'hazardous zone' to 200 metres on the intake side of the longwall face and the exclusion of non explosion protected electrical apparatus from this extended 'hazardous zone'.

It remains to be proven by direct measurement whether or not methane in explosive concentrations is expelled from the goaf during wind blasts in 'gassy' coal mines. Unfortunately, no suitable site was available during the current project after substantial completion of the WBMEMS. It is anticipated, however, that such a site may become available in 2002. Consequently, the resolution of this issue has been 'carried forward' as one of the objectives of ACARP project No. C10024 'Wind blast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 and C8017'.

It is anticipated that the results of field monitoring work carried out as part of the extension project will facilitate the drawing up of further guidance for the industry regarding safe working practices in mines subject to the potential expulsion of methane from the goaf during wind blasts and its possible incursion into the working place.

2.0 UNSW WIND BLAST MONITORING SYSTEMS

Two Wind Blast Monitoring Systems have been developed in order to detect and record air transients during wind blasts generated by large area roof falls in underground coal mines.

The prototype University of New South Wales Wind Blast Monitoring System (WBMS) was completed in 1992. Its development was supported financially by a grant under the National Energy Research, Development and Demonstration (NERD&D) Programme, administered by the Department of Primary Industries and Energy, together with financial contributions from three coal producers, namely Newcom Collieries Pty Limited, Elcom Collieries Pty Ltd and Coal & Allied Operations Pty Limited.

It is described in detail in Fowler 1997 but a brief outline is given below (sec. 2.1). It has been deployed at six underground coal mines in Queensland & NSW and is currently still in use. Using the WBMS a 'world first' was achieved, the successful instrumental 'capture' of wind blast velocities and overpressures and the elucidation of their characteristics

Development and construction of the new Wind Blast and Methane Expulsion Monitoring System (WBMEMS) has been funded by Australian Coal Research Limited (ACR) under the Australian Coal Association Research Program (ACARP) with additional financial support provided by Coal Operations Australia Limited and Oceanic Coal Australia Limited. ACR's contribution formed part of their broader funding for two projects: C7031 'The displacement of methane from the goaf into the working place as a result of wind blasts in underground coal mines' and C8017 'Reducing the hazard of wind blast in underground coal mines'.

The WBMEMS is described in detail below (sec. 2.2). Although the general concept is the same as that of the highly successful WBMS, advantage has been taken of advances in electronics and computing over the intervening decade to achieve substantial improvements in performance and functionality, the most significant being support for high speed methane monitoring.

2.1 THE WIND BLAST MONITORING SYSTEM (WBMS)

The Wind Blast Monitoring System (WBMS) comprises system hardware, downloading & analysis software and interpretation 'know-how'.

In outline, the WBMS hardware consists of four intrinsically safe (Ex ia) wind blast sensor pods, each providing two current loop outputs. One output is a function of the dynamic pressure of the air at the pod and the other a function of the local absolute atmospheric pressure. Each sensor pod is connected by cable to associated electrical equipment that

includes a power supply, batteries, barriers & data logger and is mounted in a flameproof enclosure. Analogue input signals are continuously digitised and processed but are only written into memory when a preset trigger is exceeded. Triggers are independently set for each sensor pod and comprise an absolute pressure level & duration and an air velocity level & duration. All eight inputs are recorded when any one of these eight triggers is exceeded.

An intrinsically safe (Ex ia) hand-held interface unit is employed to both program the WBMS and transfer data to a personal computer for further processing.

The WBMS is Certified and Approved for use in hazardous locations in underground coal mines in both Queensland and NSW. Its principal operational parameters are as follows.

a. Support for four sensor pods

b. An absolute pressure range of 0-206.8 kPa (0-30.0 psi)

c. A dynamic pressure range of ±13.79 kPa (±2.0 psi) which corresponds to an air velocity range of ±150.0 m/s (at STP)

   (The original dynamic pressure range of ±996 Pa (±4.0 inches water gauge) which corresponds to an air velocity range of ±40.3 m/s (at STP) had proven to be inadequate.)

d. A sampling frequency of 1000 scans per second

e. A fixed recording time for each event of eight seconds with two seconds pre-trigger

f. Storage for up to 16 events in non-volatile memory

g. Eight bit resolution

h. Battery back up which powers the WBMS for 16 hours or more in the event of interruption to the reticulated power supply

2.2 WIND BLAST & METHANE EXPULSION MONITORING SYSTEM

Like the WBMS, the Wind Blast and Methane Expulsion Monitoring System (WBMEMS) comprises system hardware, downloading & analysis software and interpretation 'know-how'. The WBMEMS is capable of supporting six intrinsically safe (Ex ia) sensor pods (sec. 2.2.1) and four intrinsically safe (Ex ia) methane detectors (sec. 2.2.2).

The associated electrical equipment includes a power supply, barriers, data logger, intrinsically safe battery assembly and modem mounted together in an enclosure which must be located in a non-hazardous zone. The modem is designed to be connected via an Austdac Intrinsically Safe Telephone System Type ST/1 to a personal computer (PC) located at the surface. The PC is employed to program the WBMEMS, receive downloaded wind blast data and process the information.

The principal operational parameters of the WBMEMS are as follows.

a. Support for up to six sensor pods and up to four methane detectors
b. An absolute pressure range of 0-206.8 kPa (0-30.0 psi)
c. A dynamic pressure range of ±13.79 kPa (±2.0 psi) which corresponds to an air velocity range of ±150.0 m/s (at STP)
d. Methane measurement ranges of 0-100% LEL (lower explosive limit) or 0-100% by volume
e. A sampling frequency of 1000 scans per second
f. A variable length recording time for each event with variable length pre-trigger
g. Storage in non-volatile memory for more events than in the case of the WBMS
h. Sixteen bit resolution
i. Remote control and data downloading via an in-built modem

2.2.1 SENSOR PODS

Fig. 2.1 Wind blast sensor pod

A wind blast sensor pod is illustrated in figure 2.1 above. Although the WBMEMS has the capability to support for up to six sensor pods, only four have been initially constructed owing to budget constraints.

The sensor pods are essentially pitot tubes. When the pod is aligned parallel to the flow of air, the nose port responds to changes in the total or stagnation pressure of the air while the cross port responds to changes in the static pressure. The difference between these is the dynamic pressure from which the air velocity may be calculated.

Located in the front compartment of the sensor pod and mounted off the rear of the nose cone is the stagnation pressure transducer (fig. 2.2), a piezoresistive differential pressure transducer. Within the same compartment, but mounted off the centre block, is the static pressure transducer, a second identical unit.

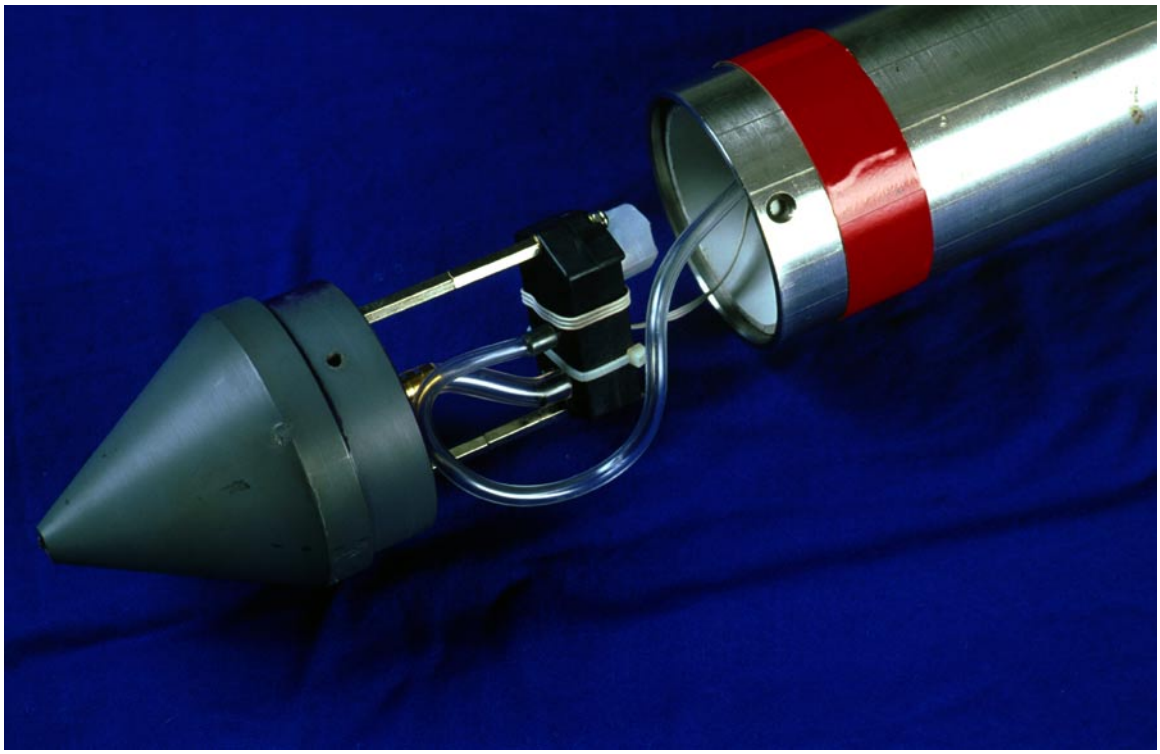

Fig. 2.2 Stagnation pressure transducer and nose cone

An exploded view of the differential pressure transducer (Honeywell MicroSwitch Type 143PC03D, SenSym Type 143SC03D or equivalent) is given in figure 2.3. The sensor chip comprises four nearly identical piezoresistors buried in the obverse surface of a thin silicon slice. The diaphragm is formed by chemically etching a circular cavity into the reverse surface. The unetched section of the silicon slice provides a rigid boundary constraint for the diaphragm and a means of mounting the chip.

A change in pressure causes the diaphragm to flex, inducing a strain in the diaphragm and hence in the buried piezoresistors and, consequently, a change in their electrical resistance.

The resistors are connected in a full Wheatstone bridge arrangement such that the change in output voltage is proportional to the change in pressure. Temperature compensation circuitry and signal conditioning are built in.

The transducer design ensures a flat frequency response, up to at least 500 Hz, when pressure changes are applied to the 'P2' port (Letchford, C 1992, pers. comm., 27 October).

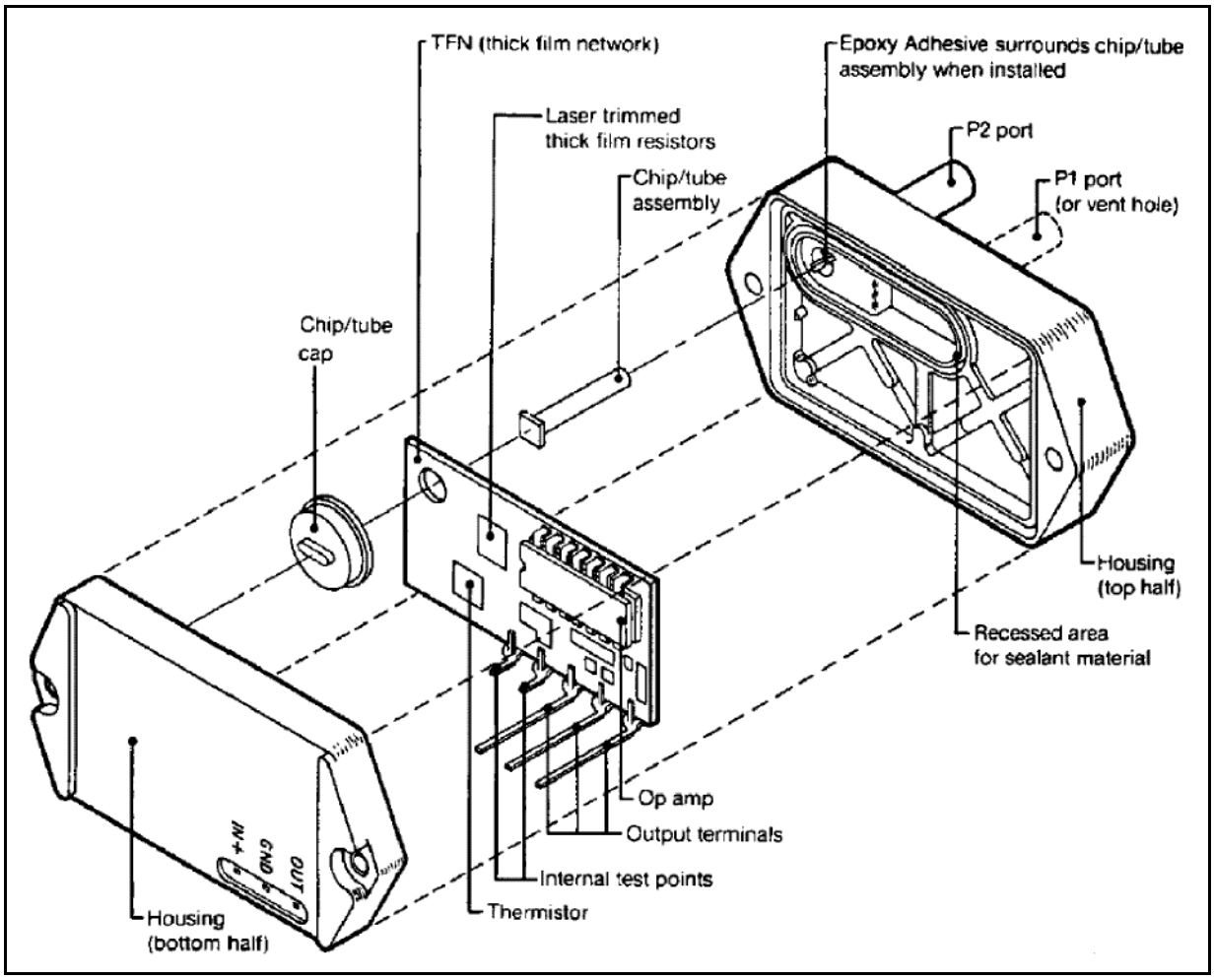

Fig. 2.3 Differential pressure transducer incorporating piezoresistive sensor chip

The 'P2' port on the stagnation pressure transducer is joined to a connector located behind the stagnation pressure port in the nose of the sensor pod by 5 mm nominal bore uPVC tubing. The 'P2' port on the static pressure transducer and a connection to the cross port (static pressure port) in the centre block are joined by 3 mm nominal bore uPVC tubing. The 'P1' ports on both transducers are joined together and to a second cross port connector by similar tubing (fig. 2.4).

Immediately off the static pressure transducer is mounted a bracket which supports the differential pressure printed circuit board (PCB). The PCB is joined to each of the differential pressure transducers by three wire connections and supplies power at a nominal 8 volts. Each pressure transducer returns a voltage signal that is a function of the differential pressure between the 'P1' and 'P2' ports.

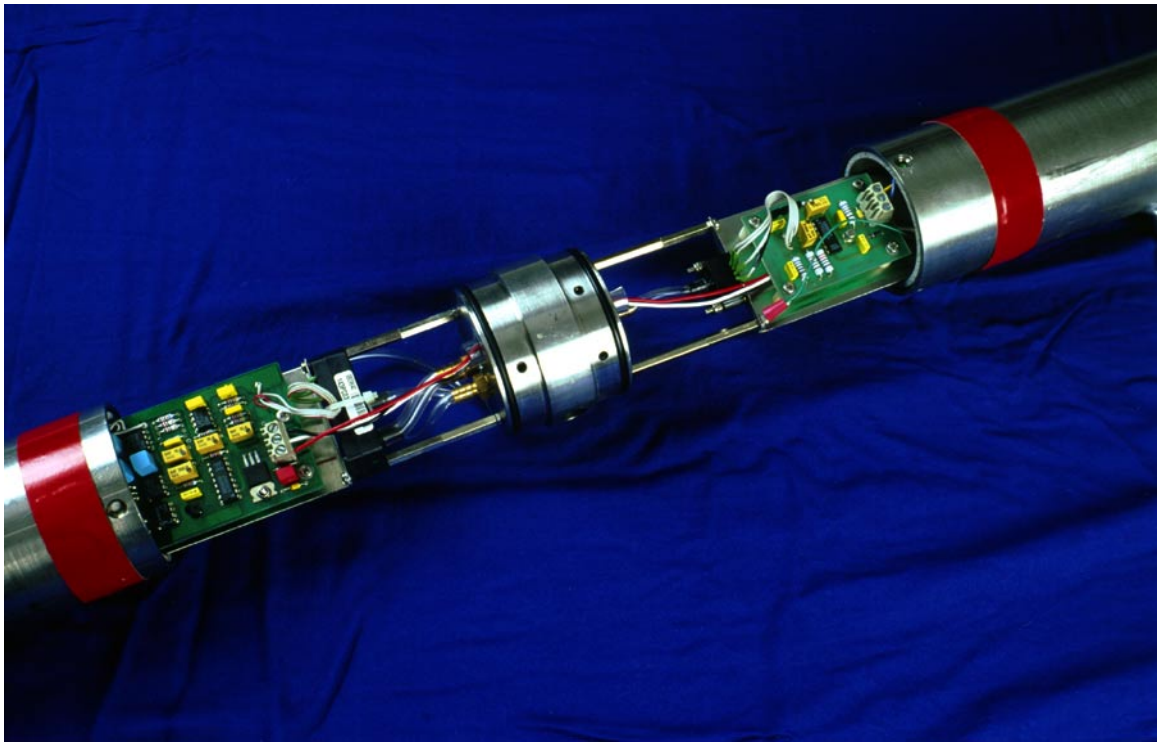

Fig. 2.4 Interior of wind blast sensor pod

The PCB is joined to a six way connector mounted on the rear of the pod by a three wire connection. Power is supplied at a nominal 24 volts and the PCB returns a current loop output signal. The output is generally set up as follows.

Table 2.1 Differential pressure output current standard set-up

Air velocity at STP (m/s)	Differential pressure (kPa)	Output current (mA)
-150.0	-13.79	1.0
0.0	0.0	6.0
+150.0	+13.79	11.0

Located in the rear compartment of the sensor pod and mounted off the rear of the centre block is a bracket which supports the absolute pressure transducer, a SenSym type SCX30AN. Like the differential pressure transducer, this incorporates a piezoresistive sensor chip. The 'A' port on the absolute pressure transducer and a connection to the cross port (static pressure port) in the centre block are joined by 3 mm nominal bore uPVC tubing (fig. 2.4 above).

The bracket upon which the absolute pressure transducer is mounted also supports the absolute pressure printed circuit board (PCB). The PCB is joined to the absolute pressure transducer by a two wire connection and supplies power at a nominal 5 volts. The pressure transducer returns a voltage signal that is a function of the absolute atmospheric pressure (barometric pressure).

The PCB is joined to a six way connector mounted on the rear of the pod by a two wire connection. Power is supplied at a nominal 24 volts and the PCB returns a current loop output signal. The output is generally set up as follows.

Table 2.2 Absolute pressure output current - standard set-up

Absolute pressure (kPa)	Output current (mA)	Comments
206.84	20.0	30.0 psi
101.325	11.838	International Standard Atmosphere
0.0	4.0	

The design of the Type 2A sensor pod is generally similar to that of the earlier version described in Fowler 1997 but several improvements have been made, mainly as a result of experience gained during the deployment of the latter. The principal design changes include the following.

a. An alternative nose cone shape intended to reduce the possibility of blockage of the total pressure port by air entrained debris during wind blasts.

b. Increased centre block 'spigot' lengths in order to increase the overall stiffness of the body.

c. Increased distance between the nose and the cross (static pressure) port in order to reduce the possibility of turbulence at the latter.

d. A thicker fixing bracket fabricated from stainless steel rather than mild steel to obviate the possibility of the bracket being bent or corroded in service.

e. The substitution of a connector at the rear of the pod for the cable 'tail' in order to obviate the tendency for conductors in the latter to break as a result of repeated flexing.

f. The substitution for the Honeywell MicroSwitch differential pressure transducers of functionally equivalent SenSym transducers.

   (This was necessary because detailed drawings of the pressure transducers were necessary for the purposes of Certification of the sensor pod and it had proven impossible to obtain such drawings of the MicroSwitch units.)

Static calibration of the wind blast sensor pod outputs was carried out at the UNSW School of Mining Engineering (App. A1). Wind tunnel calibration to verify the sensor pod aerodynamic characteristics (including both the original and alternative nose cone shapes) was undertaken at the Defence Science and Technology Organisation's Aeronautical and Maritime Research Laboratory in Melbourne at air speeds up to 95 metres per second (App. A2)

The Type 2A sensor pod has been Tested & Certified Ex ia and Assessed & Approved for use in a Zone 0 hazardous area for gas Group 1 in New South Wales underground coal mines (App. C).

2.2.2 INFRA-RED METHANE DETECTORS

Dräger Polytron IR Ex and IR Ex IL methane detectors, which utilise an infra-red measurement technique, are utilised in the Wind Blast and Methane Expulsion Monitoring System. They are described in detail in Dräger (1998) and Dräger (1996), respectively, but a brief outline is given below.

The infra-red measuring principle, which is employed in these detectors, is based upon the fact that gas molecules may be excited by infra-red radiation of a certain wavelength and absorb some energy from the radiation. Compared with the original infra-red radiation intensity, the attenuated intensity within the optical path is a function of the gas concentration. A wavelength of 3.4 □m is used by Dräger in this particular application.

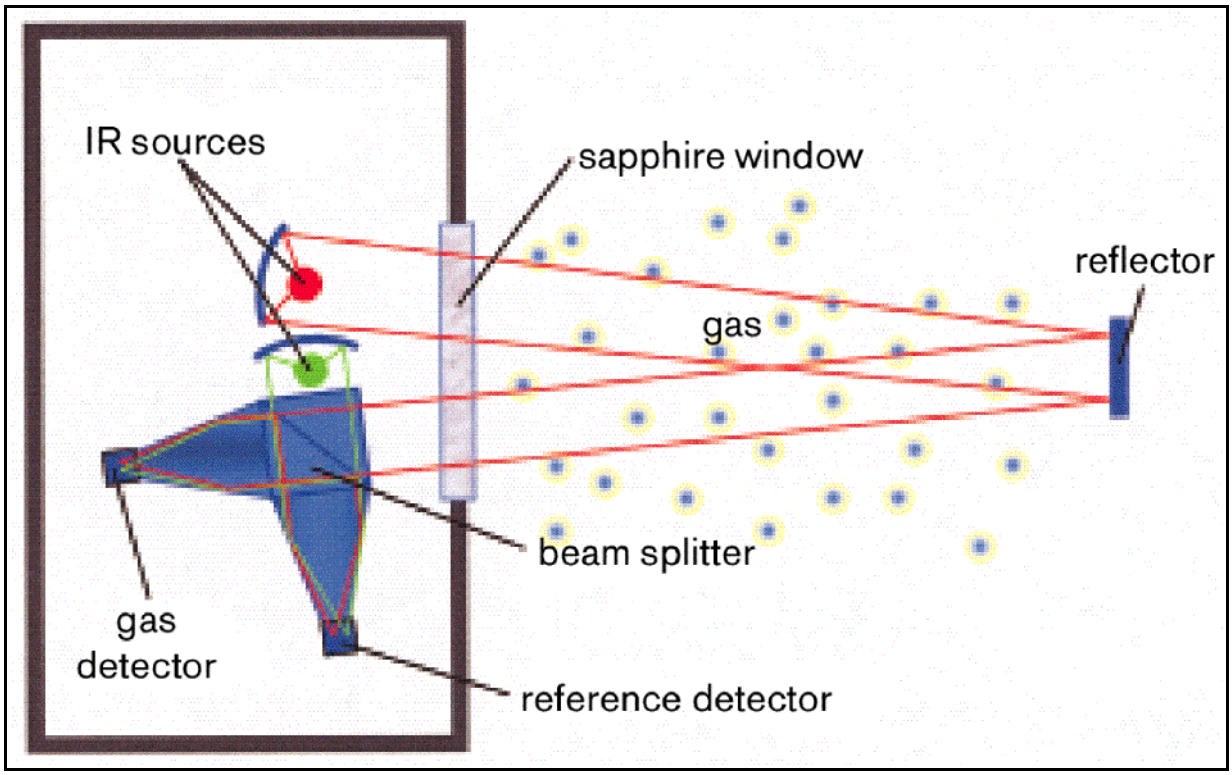

Fig. 2.5 Double compensated infra-red measuring principle

In order to make the infra-red system tolerant to changes in environmental conditions such as dust, dirt on optical surfaces or humidity and to alterations in the intensity of the radiation source itself, a second, reference beam with a wavelength not absorbed by the target gas may be employed (fig. 2.5 above). (A wavelength of 2.1 □m? is used.) In order to reduce the effects of temperature and time related changes, a second infra-red source is also incorporated in such a way that its optical path does not pass through the target gas. Consequently, four parallel

readings are taken and are combined to give the gas absorption, the technique being known as 'double compensated infra-red measurement'.

The advantages of infra-red methane detection and measurement include high sensitivity, measuring ranges up to 100% methane by volume, time stability of readings, resistance to typical catalytic sensor 'poisons', measurement in inert atmospheres (independence from oxygen) and speed of response. However, the latter may be illusory if the rate at which air from the general body passes through a sinter or filter into the measuring cuvette is slow.

Fig. 2.6 Dräger Polytron IR Ex methane detector

The designers of the Dräger Polytron IR Ex methane detector (fig. 2.6 above) have sought to maximise the filter area by employing a cylindrical measuring cuvette enclosed by a cylindrical dust filter. Although a step change in methane concentration within the cuvette would be detected within one second, the response time for a change in methane concentration in the general body of air surrounding the cuvette is longer. Details of a programme of laboratory

testing undertaken at the UNSW School of Mining Engineering in order to determine response time are presented in Appendix B2.

Fig. 2.7 Dräger Polytron IR Ex methane detector fitted with splash guard

The use of a splash guard (fig. 2.7 above) is mandated in the Australian Certification and NSW Approval (App. D). However, the presence of the splash guard lengthens considerably the response time (App. B2). Consequently, a new configuration was devised at the UNSW School of Mining Engineering which made maximum use of the dynamic pressure during a wind blast in order to force the air through the cuvette. This configuration employed a Dräger Polytron IR Ex IL methane detector fitted with air 'directors' on either side of the cuvette (fig. 2.8). The axis of the directors is arranged to be parallel to the air flow during a wind blast.

The Dräger Polytron IR Ex IL detector is designed for in-line monitoring of methane concentration in closed systems. In essence, the cylindrical dust filter that surrounds the cuvette in the Polytron IR Ex is replaced by a cylindrical stainless steel enclosure. Three

openings, respectively 1/2 in NPT, 1/2 in NPT and 3/4 in NPT, are provided the front, bottom and rear of the enclosure. In the conventional mode of operation, these openings are used for pipe connections and for inspection & cleaning of the interior of the cuvette.

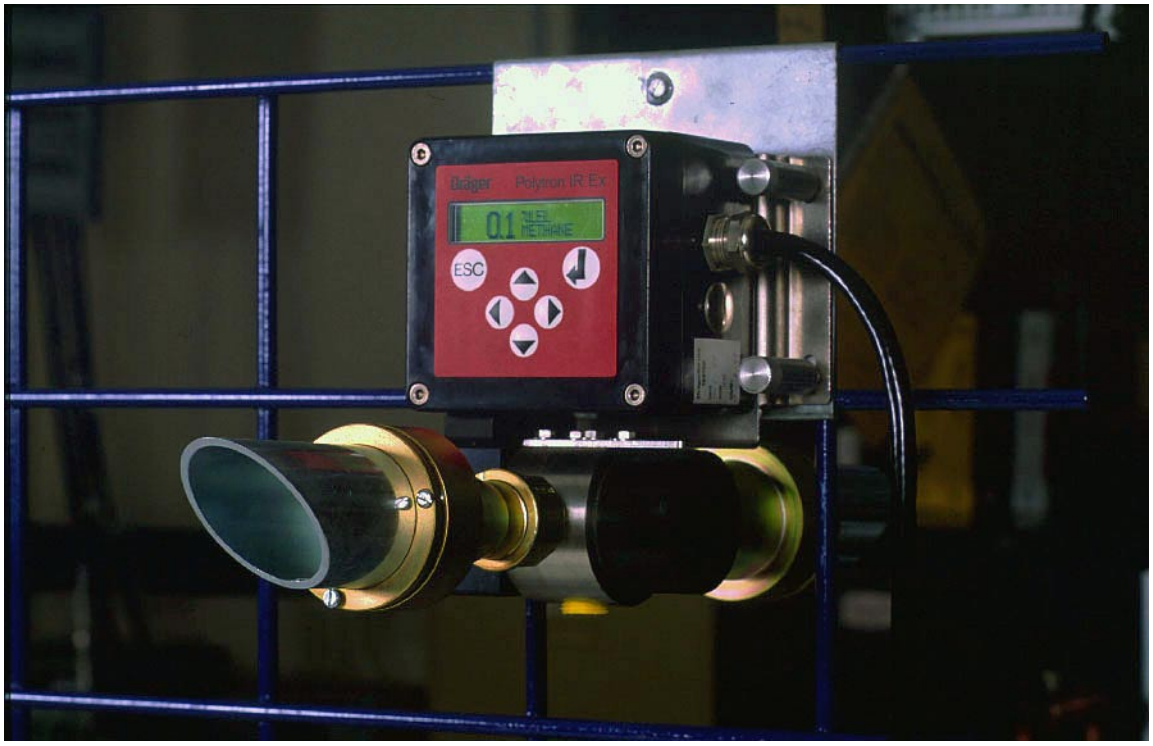

Fig. 2.8 Dräger Polytron IR Ex IL methane detector fitted with air directors

Details of the air directors employed in the modified configuration are given in figures 2.9 and 2.10. The main body comprises a hollow brass cone that supports a filter at its larger opening. Perforated stainless steel cover plates protect the filter from perforation by air entrained debris during wind blasts. A splash guard is fitted to the front of the cone. Because of the possibility of debris building up on the outer cover plate and primary filter during successive wind blasts, provision is made for changing this filter while the methane detector is underground. In order for this to be undertaken without dust settling on the optical surfaces within the cuvette, a secondary filter that is not removed while underground is located near to the cuvette.

The Polytron IR Ex IL detector fitted with air directors has been shown to have a response time in simulated wind blast conditions which is much superior to that of the Polytron IR Ex detector fitted with a splash guard (table B1).

The Dräger Polytron IR Ex methane detector has been Tested & Certified Ex ia and Assessed & Approved for use in New South Wales underground coal mines (App. D).

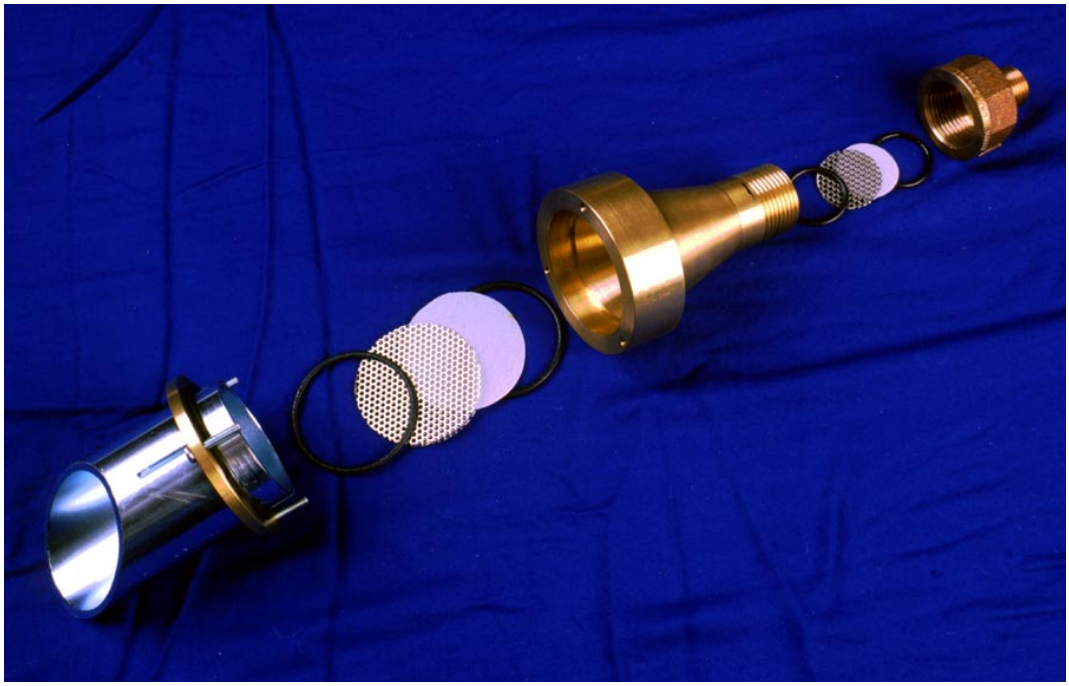

Fig. 2.9 'Exploded' view of air director

Fig. 2.10 Air director fully assembled

2.2.3 ASSOCIATED ELECTRICAL EQUIPMENT

Each wind blast sensor pod and methane detector is connected by cable to associated electrical equipment includes a power supply, barriers, data logger, intrinsically safe battery assembly and modem mounted together in an enclosure (fig. 2.11) which must be located in a non-hazardous zone.

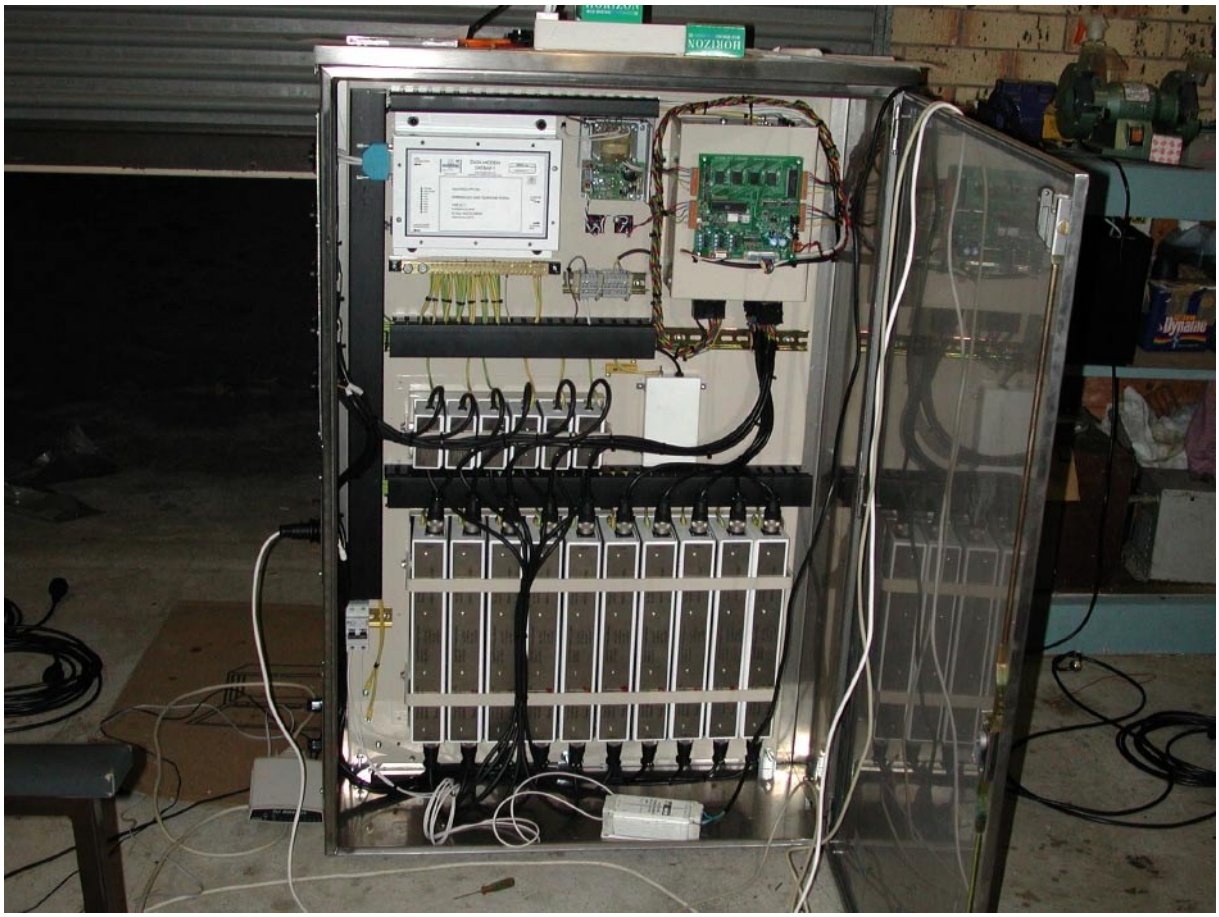

Fig. 2.11 Enclosure containing associated electrical equipment

Reticulated mine power, at a nominal potential of ±60 volts relative to earth, is connected to the power supply via a socket on the side of the enclosure (fig. 2.12). The power supply Type P104 Option 1 provides a separate 33 volt (nominal) output to each power barrier (fig. 2.13) of which there are a total of ten: six Type P001 Option 5 barriers which support sensor pods and four Type P001 Option 4 barriers which support methane detectors. Power supply connector wiring details are given in figure 2.14.

The power supply and barriers (fig. 2.15) were purpose designed and built by Furzy Electronics Pty Ltd of Sydney.

Fig. 2.12 Connections to enclosure containing associated electrical equipment

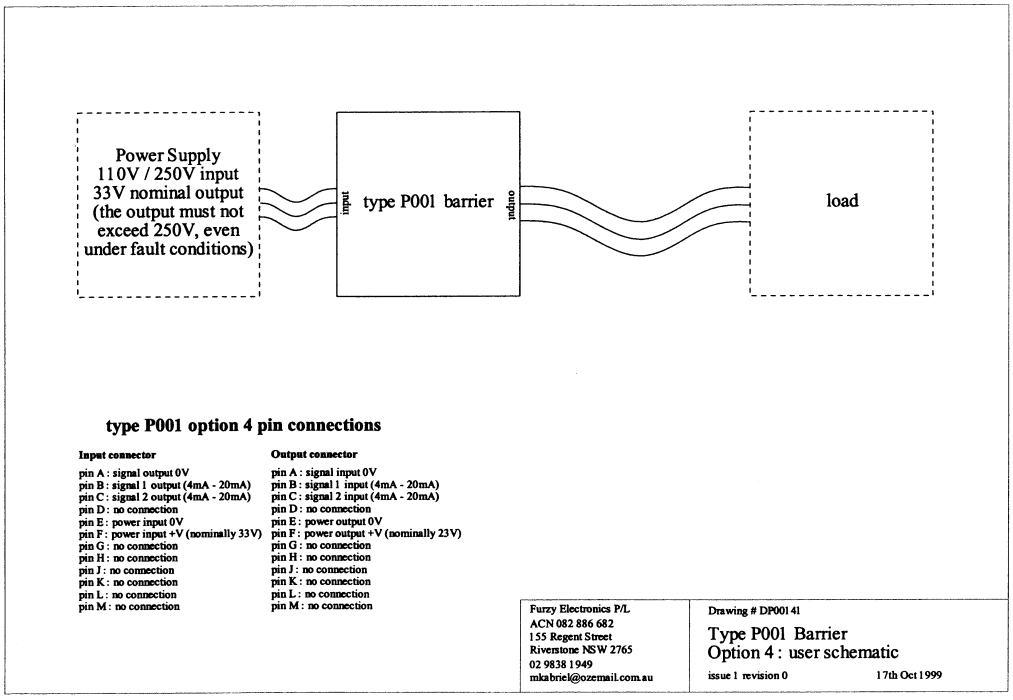

Fig. 2.13 Power supply and barrier schematic

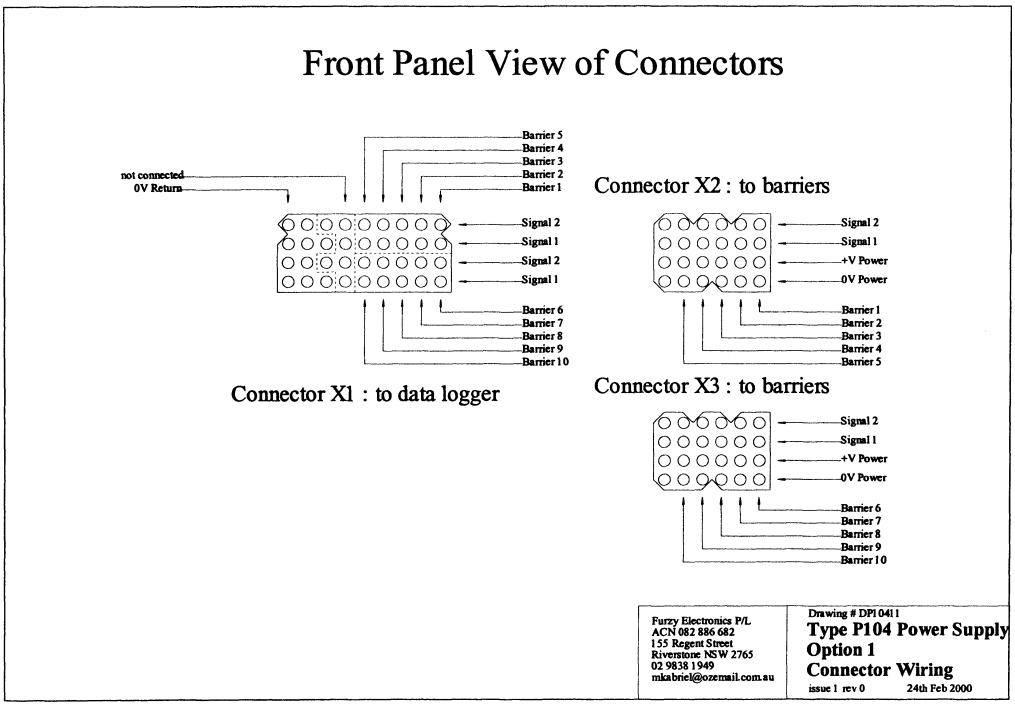

Fig. 2.14 Power supply connector wiring details

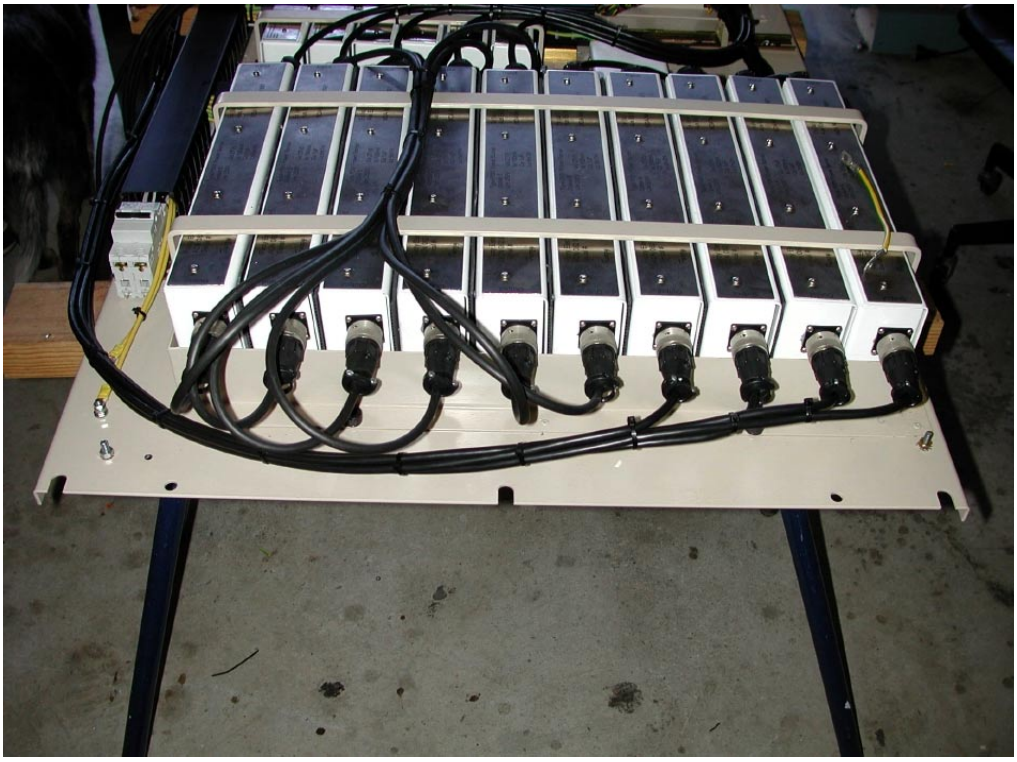

Fig. 2.15 Power barriers Type P001

Each Type P001 Option 4 power barrier supplies a nominal 23 volt intrinsically safe output to power a Dräger Polytron IR Ex or IR Ex IL methane detector (sec. 2.2.2) via a socket on the side of the enclosure (fig. 2.12). The methane detector returns a current loop signals to the barrier via the same socket. This input signal is a function of the methane concentration. The barrier output signal is a 'clone' of the input signal. Power barrier Type P001 Option 4 connector wiring details are given in figure 2.16.

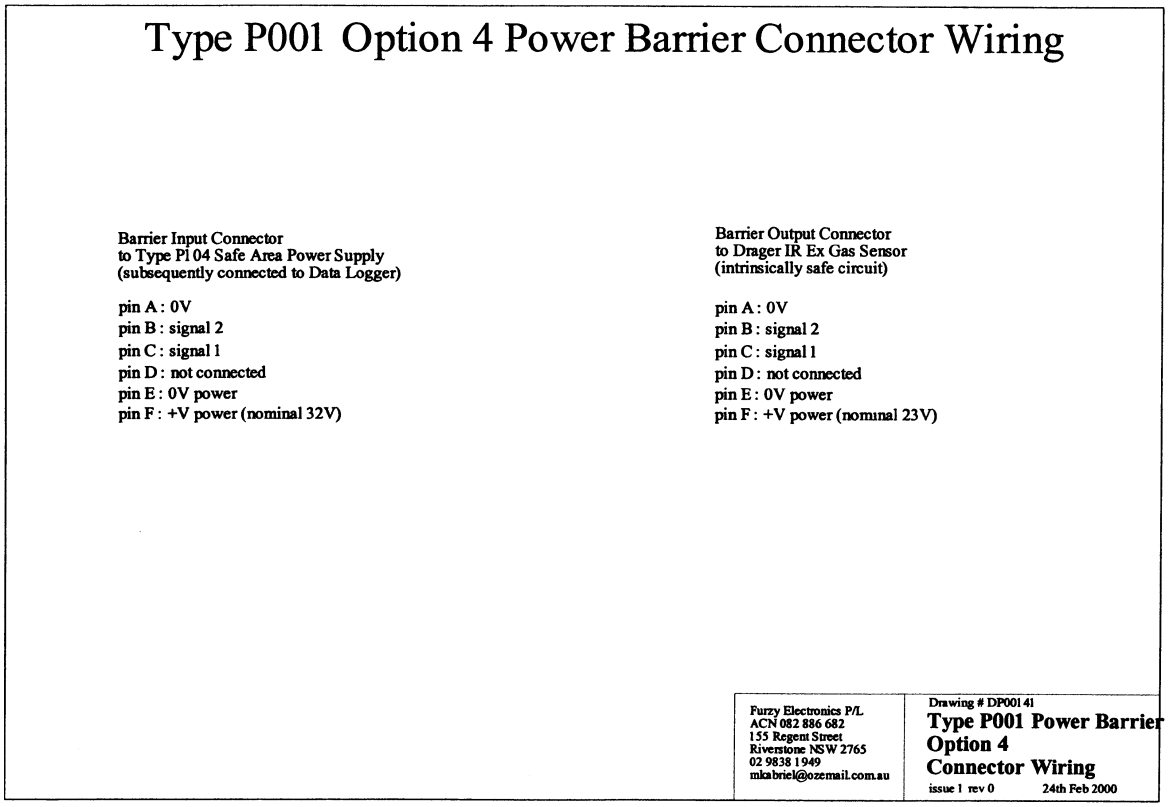

Fig. 2.16 Power barrier Type P001 Option 4 connector wiring details

Each Type P001 Option 5 power barrier supplies two nominal 23 volt intrinsically safe outputs to a wind blast sensor pod via a Type P003 Option 1 Gizmo switch and a socket on the side of the enclosure (fig. 2.12). One output powers the senor pod differential pressure circuitry and the other powers the absolute pressure circuitry (sec. 2.2.1). The sensor pod returns two current loop signals to the barrier via the same socket: an input signal which is a function of the differential pressure between the stagnation & static pressure ports and one which is a function of the absolute atmospheric pressure (barometric pressure). The barrier output signals are 'clones' of the input signals. Power barrier Type P001 Option 5 connector wiring details are given in figure 2.17.

The Gizmo switch is necessary to achieve electrical compatibility between the sensor pod and the Type P001 Option 5 power barrier. Gizmo switch Type P003 Option 1 connector wiring details are given in figure 2.18. For convenience, each Gizmo switch is located adjacent to the barrier which it supports (fig. 2.19).

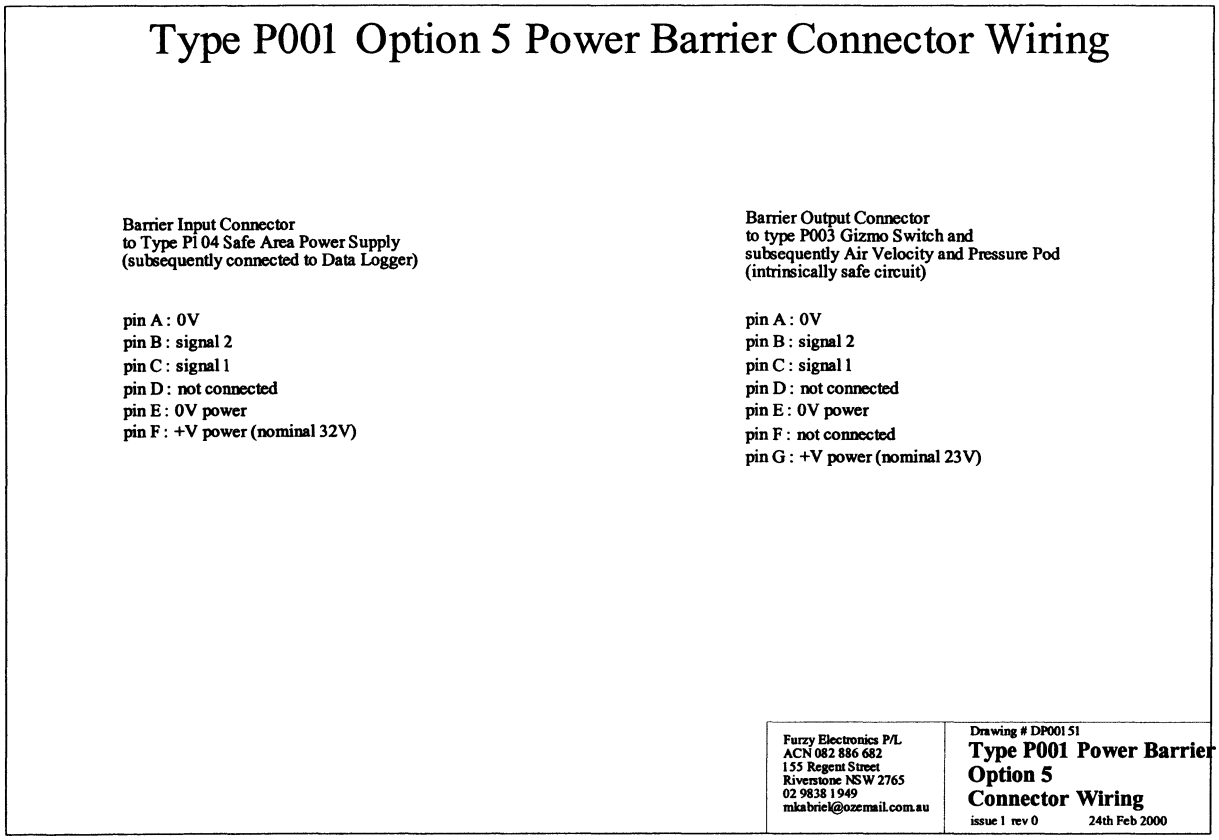

Fig. 2.17 Power barrier Type P001 Option 5 connector wiring details

The Intrinsically Safe Power Barrier Type P001 has been Tested & Certified Ex (ia) and Assessed & Approved for installation in a non-hazardous area in New South Wales underground coal mines to provide intrinsically safe power and signal connections to equipment located in a hazardous area (App. E).

The Intrinsically Safe Gizmo Switch Type P003 has been Tested in accordance with the relevant Australian Standards and Assessed & Approved for installation in New South Wales underground coal mines to delay the application of electrical power to a connected load (App. F). The specific approval category is 'Explosion Protected – Intrinsically Safe'.

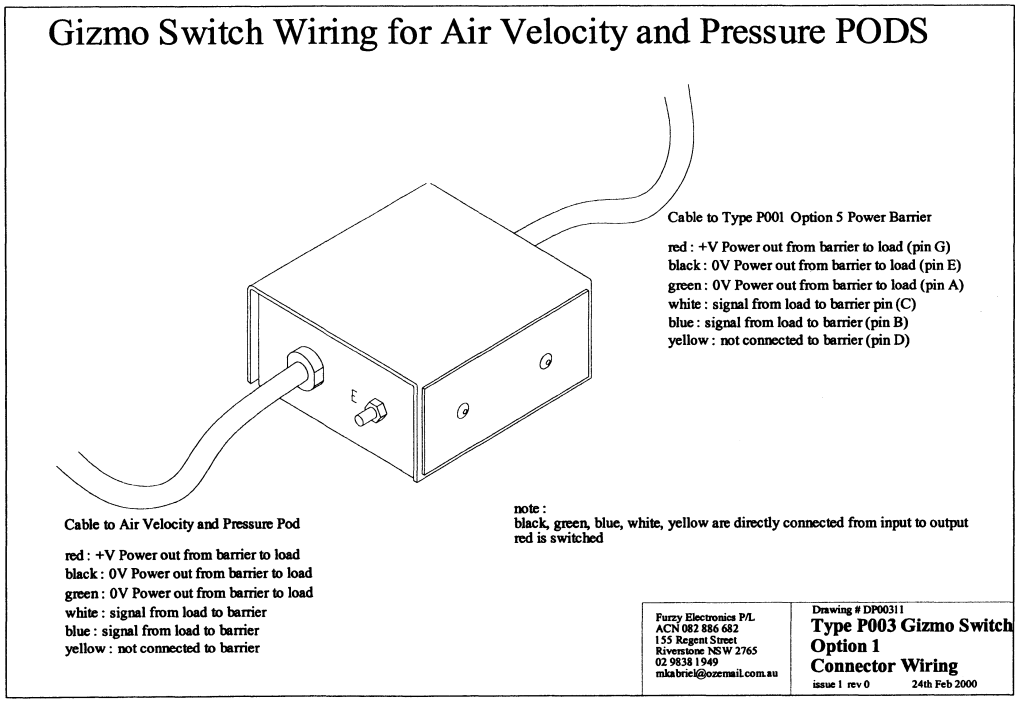

Fig. 2.18 Gizmo switch connector wiring details

Fig. 2.19 Gizmo switches mounted adjacent to power barriers

The data logger (fig. 2.20) is mounted on the power supply within the enclosure. The sixteen analogue signals from the barriers are passed to the data logger where they are continuously digitised and processed but are only written into memory when a preset trigger is exceeded. Triggers are independently set for each channel and comprise a signal level and duration. All sixteen input signals are recorded when any trigger is exceeded.

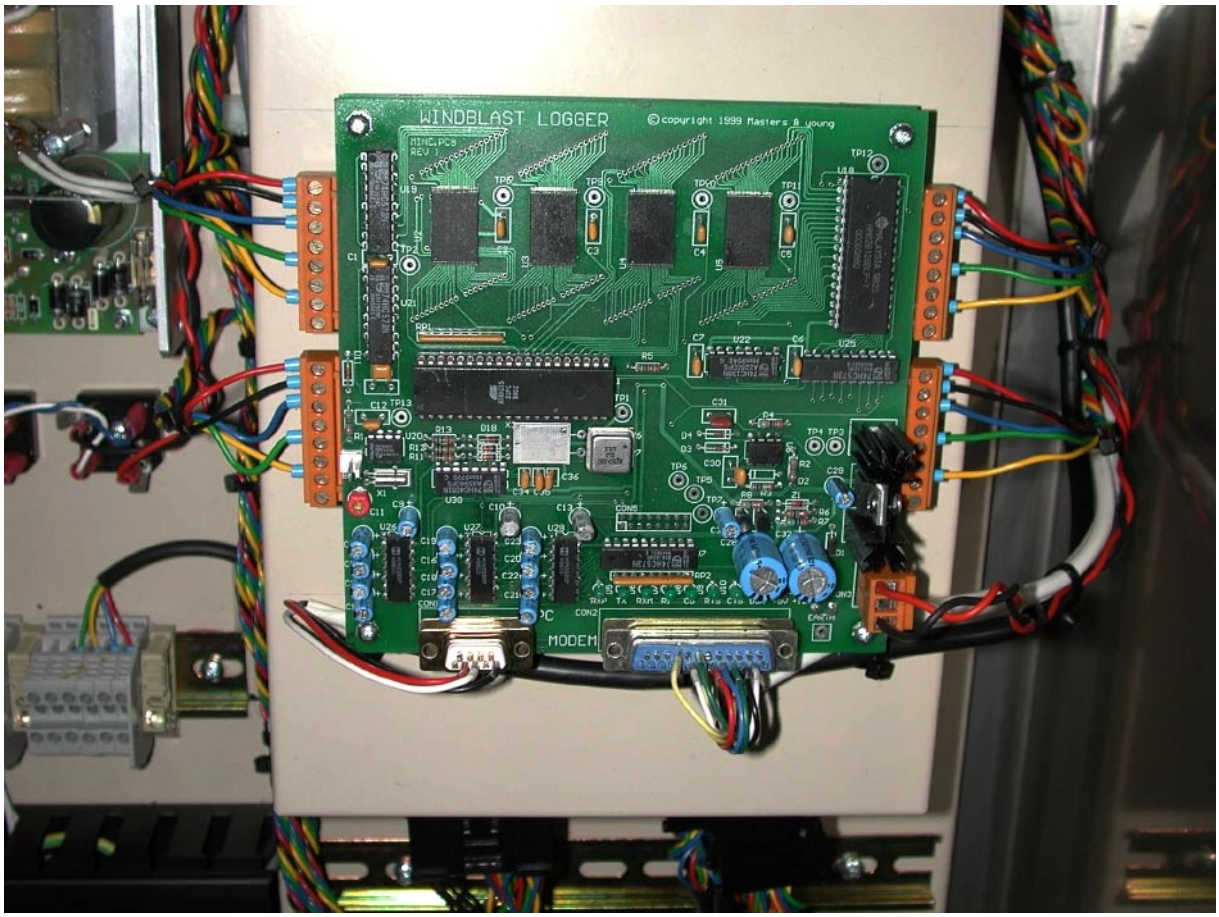

Fig. 2.20 Data logger mounted on power supply

The Barrier Unit (Data Modem) DAT-BAR1 (fig. 2.21) is designed to be connected, via a socket on the side of the enclosure (fig. 2.12), to an Austdac Intrinsically Safe Telephone System Type ST/1 and hence to a personal computer (PC) located anywhere on the surface. The PC is employed to program and control the WBMEMS, download wind blast data and process the information. Alternatively, a notebook PC may be connected to the data logger via the socket on the side of the enclosure, thus bypassing the modem.

The Data Modem forms part of the Intrinsically Safe Telephone System Type ST/1. The latter has been Tested & Certified Ex (ia) and Assessed & Approved for installation in New South Wales underground coal mines (App. G).

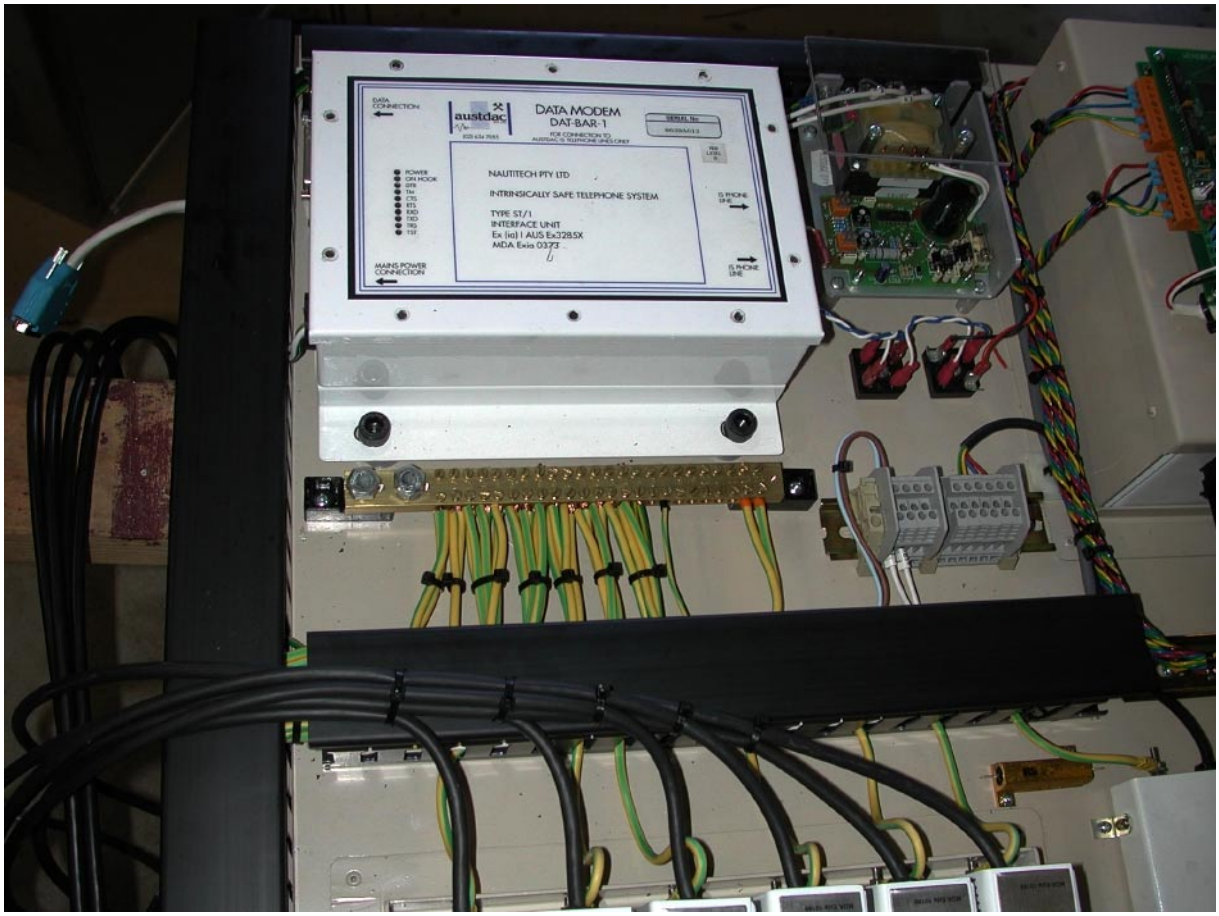

Fig. 2.21 Barrier Unit (Data Modem) DAT-BAR1

The Intrinsically Safe Battery Assembly Type P002 Option 3 (figs 2.22 & 2.23) has only one function, to energise the clock chip and associated circuitry in the data logger so that date and time functionality is not lost when reticulated power to the WBMEMS is interrupted. Consequently, the battery assembly was designed to be electrically compatible with the circuitry in the WBMEMS that it was to energise.

Although mounted within the associated electrical equipment enclosure (fig. 2.11) which must be located in a non-hazardous zone, the battery assembly is required to be explosion protected so that it does not constitute a potential ignition source should failure of the main mine ventilation fan or other circumstance result in an explosive atmosphere in its vicinity.

Consequently, the battery assembly was designed and constructed to be 'intrinsically safe' in accordance with the then current, relevant Australian Standards for electrical apparatus for explosive gas atmospheres including AS 2380.1–1989 and AS 2380.7–1987. It was considered that the structure and electrical parameters of the battery assembly were sufficiently well defined to allow the ignition curves and method cited in Clause 5.1 and Appendix A of AS 2380.7–1987 to be applied.

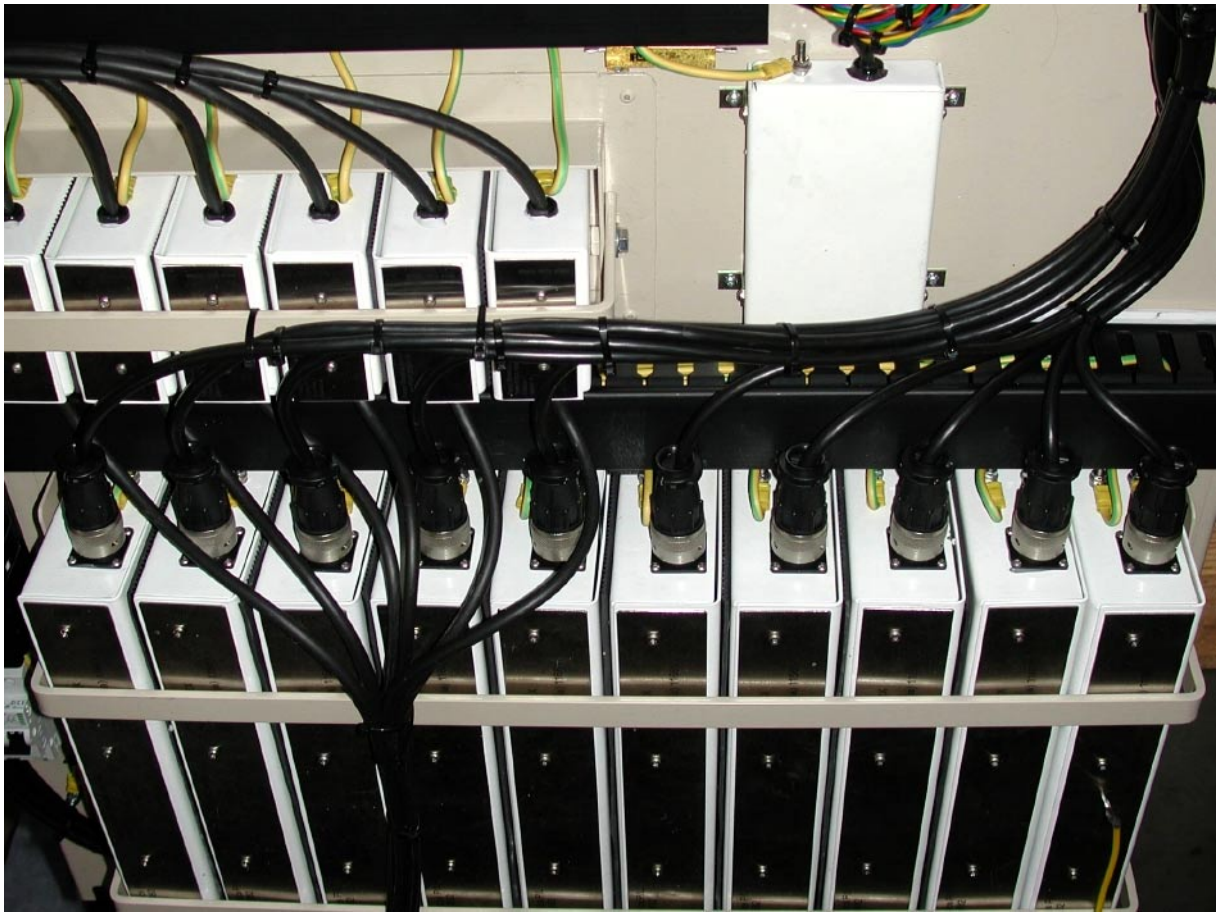

Fig. 2.22 Intrinsically Safe Battery Assembly Type P002

The battery assembly was tested and assessed by SIMTARS and Test Report NI00/0004 (App. H) issued on 17 April 2000. The Test Report confirms that the battery assembly complies with the relevant requirements of AS 2380.1–1989 and AS 2380.7–1987 for intrinsically safe electrical equipment (Ex ia) and is suitable for installation in Class 1 Zone 0 hazardous areas and underground coal mines. It also assigns electrical 'entity concept parameters'. The characteristics of the circuitry within the WBMEMS are compatible with these parameters.

On the understanding that the necessary requirement for the issuing of an Approval by the NSW Department of Mineral Resources was compliance with AS 2380.1–1989 and AS 2380.7–1987, approval was sought from the Department for the use of the battery assembly in underground coal mines in NSW. However, approval on the basis of the Test Report, that confirmed such compliance, was refused as the Department insisted on spark gap testing despite the exemption given in Clause 5.1 of AS 2380.7–1987. In the absence of spark gap testing, Approval No. MDA Exia 10186 was issued on 4 August 2000 for the use of the battery assembly in New South Wales underground coal mines as a backup power supply for data logging equipment (App. H). However, the Approval assigns 'entity concept parameters' which are more onerous than those given in the Test Report.

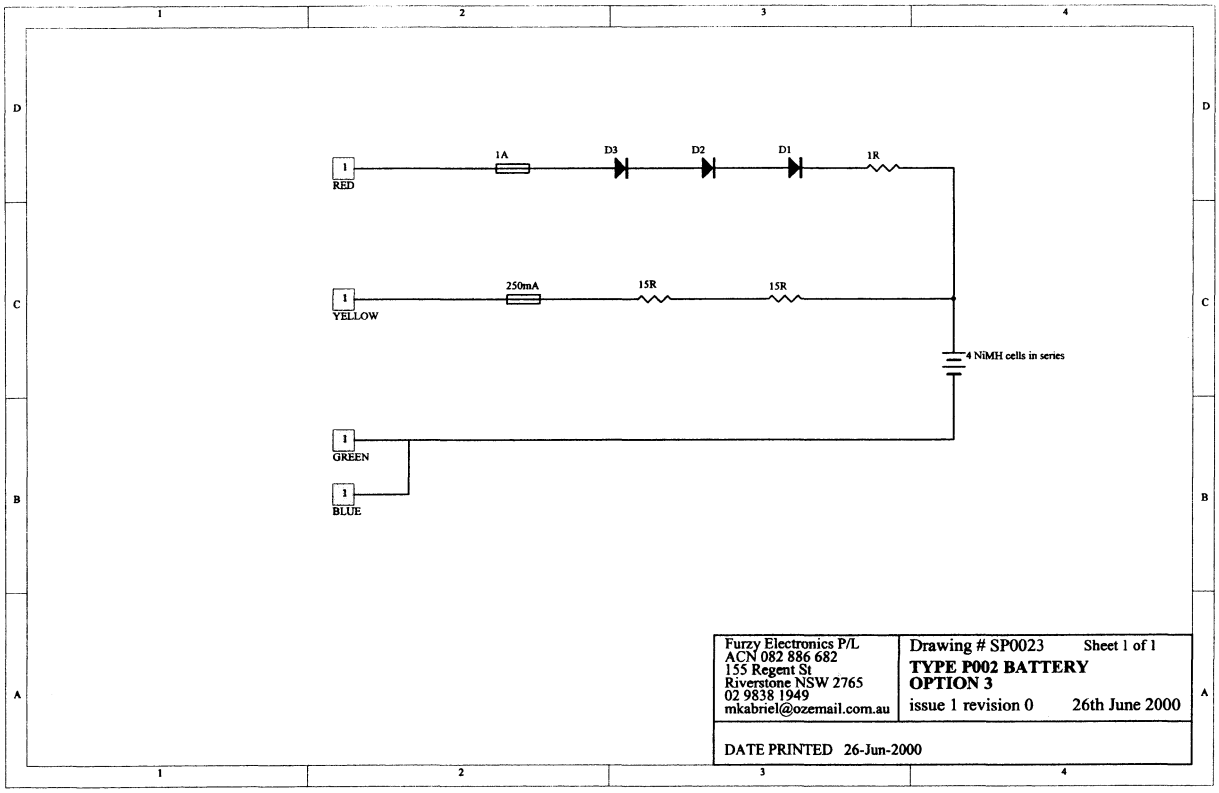

Fig. 2.23 Intrinsically safe battery assembly schematic

A subsequent letter from the NSW Department of Mineral Resources to the 'industry' dated 18 August 2000 (App. H, p. 7) states their position on the assessment of intrinsically safe apparatus. Consequently, the circuitry in the WBMEMS is being modified and spark gap testing may need to be undertaken. It is also possible that a further Approval may need to be obtained.

2.2.4 TYPICAL FIELD DEPLOYMENT OF THE WBMEMS

It is envisaged that, at each measuring station, a wind blast sensor pod will be mounted, either alone or together with a methane detector (fig. 2.24). As the output of the methane detector is influenced by the pressure in the cuvette, it will be necessary to monitor absolute atmospheric pressure in its immediate vicinity and use the values to correct the apparent methane concentration.

Fig. 2.24 WBMEMS measuring station

A mounting bracket with three degrees of freedom permits the sensor pod and parallel methane detector to be aligned with the anticipated direction of air flow during a wind blast irrespective of the orientation of the support member on which the bracket is mounted. The support arrangements are site specific but in the case of a longwall panel the following alternatives are envisaged.

a. A vertical leg secured to a roof bolt and stabilised with an inverted tripod

b. A horizontal arm secured to a rib bolt and stabilised with a tripod

c. A horizontal arm or vertical leg secured to an item of equipment on the 'pantec'

d. A horizontal arm secured to one of the 'mules' which runs along the monorail

Arrangements such as (a) and (b) would afford fixed locations. In general, such measuring stations would have to be relocated outbye as mining proceeded. In the case of arrangements such as (c) and (d) the measuring stations would move outbye as the face and associated equipment retreated.

2.2.5 OPERATION OF THE WBMEMS

The program WinBlast has been specifically developed to program the WBMEMS and to control the downloading of wind blast data. It runs on a PC under Microsoft Windows 97. The WinBlast graphical user interface is shown in figure 2.25.

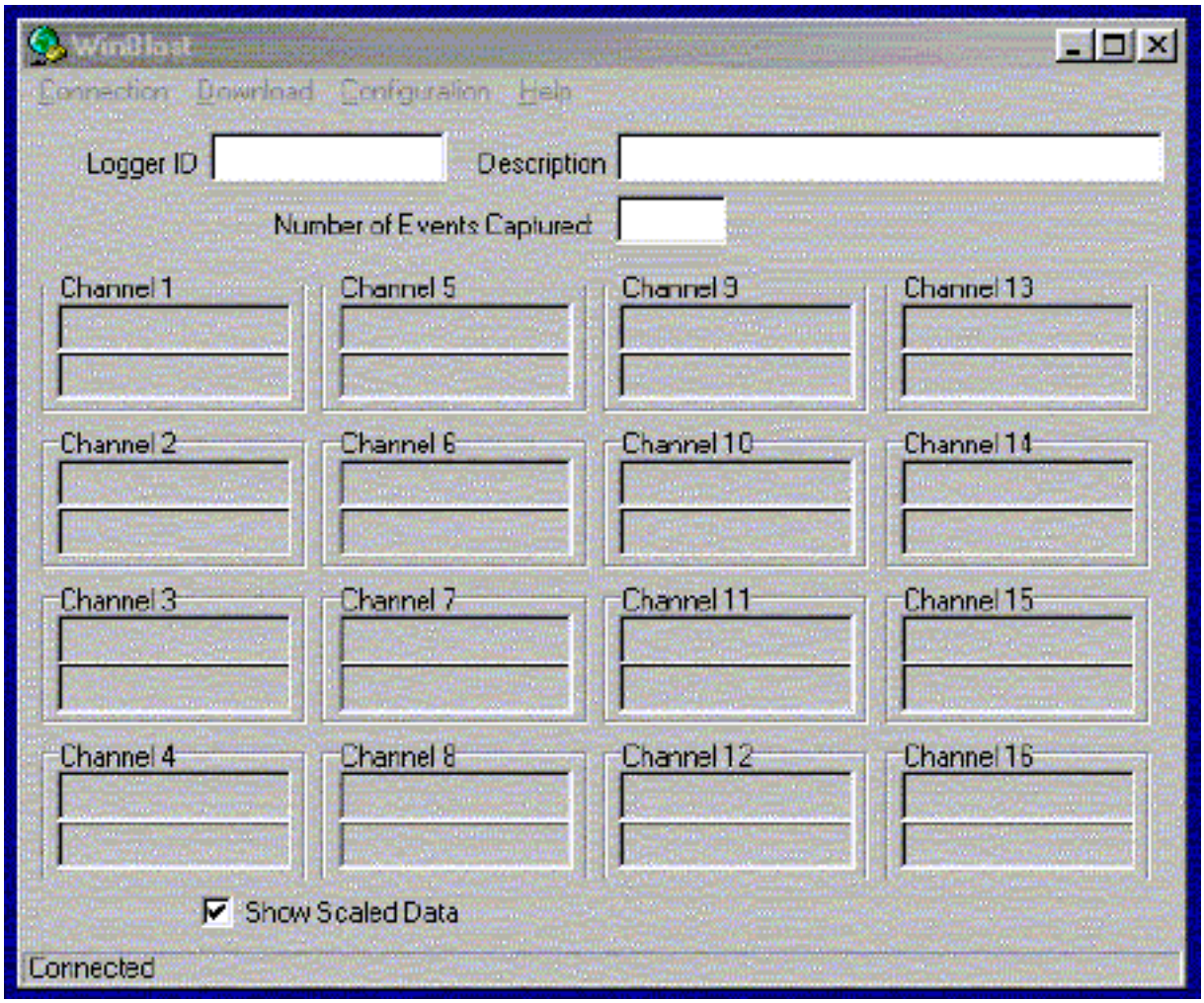

Fig. 2.25 WinBlast graphical user interface

WinBlast may be programmed to return unscaled or scaled data. In the case of the former, the output is a function of the current in mA which is returned by the wind blast sensor pod or

methane detector. In the case of the latter, WinBlast must be programmed with appropriate constants of proportionality and offset values in order for it to convert the output to engineering units. For example absolute and differential pressure may be directly output in kPa and apparent methane concentration in % LEL or % by volume. Only linear conversions are possible and so conversion to air velocity in m/s, which involves taking a square root, is not possible within WinBlast.

Triggers, which are independently set for each channel, may also be in unscaled or scaled units. In the case of the former, the trigger would comprise a current level in mA and a duration in ms. In the case of the latter, the level could be in appropriate engineering units.

Data that has been downloaded to a PC is displayed by WinBlast in the form of a simple time history for each channel.

2.2.6 DATA ANALYSIS

Files which are obviously not the result of spurious triggering are then further processed and graphical output produced using macros written in WaveMetrics Igor Pro version 3.13.

Standard graphical output includes, for each measuring location, the methane concentration time history and the overpressure time history together with the integral and differential of the latter from which the impulse and rates of rise (and fall) of overpressure are obtained. The methane concentration time history, after absolute atmospheric pressure correction, and the excursion time history are of particular importance in quantifying the expulsion of methane from the goaf and its incursion into the working place.

Also included in the output is the wind velocity time history together with its integral and differential from which the excursion and rates of rise (and fall) of velocity are obtained. The time histories may be smoothed as necessary. Other graphical output, such as the differential pressure time history and its derivatives, are generated as required and, when appropriate, a Fast Fourier Transform (FFT) algorithm is employed to transform time histories into the frequency domain for further study.

Further data analysis utilises Microsoft Excel version 7.0 and SPSS DeltaGraph version 4.5.

3.0 FIELD MEASUREMENTS AND DATA ANALYSIS

Unfortunately, it had not yet been possible, at the time of publication of this report, to deploy the Wind Blast and Methane Expulsion Monitoring System (WBMEMS) in a 'gassy' mine subject to wind blast as no suitable site had become available since the equipment was substantially completed. However, considerable insight into the expulsion of goaf gas into the working place has been afforded by the very extensive programme of wind blast monitoring undertaken at Moonee Colliery as part of ACARP Projects Nos C7031 and C8017.

It is anticipated that in 2002 a site will become available in a 'gassy' mine subject to wind blast in the Lake Macquarie area of the Newcastle Coalfield. As Projects Nos C7031 and C8017 have both been completed, an ACARP-funded extension project, C10024 'Wind blast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 AND C8017', has been approved. It is anticipated that this project will be formally commenced in mid-2001 and will include field monitoring at the site mentioned above using the WBMEMS. In addition, the extension project will encompass the continuing programme of wind blast monitoring at Moonee Colliery.

3.1 FIELD MONITORING AT MOONEE COLLIERY

An extensive programme of wind blast monitoring was undertaken at Moonee Colliery during the mining of five longwall panels (Nos 1, 2, 3, 4A & 4B) in the period February 1998 to November 2000 and a definitive data set obtained. Some of the results are given in the Final Reports for Projects Nos C6030 'The dynamics of wind blasts in underground coal mines' (Fowler & Sharma 2000) and C8017 'Reducing the hazard of wind blast in underground coal mines' (Fowler & Sharma 2001). More than 100 significant wind blasts events were recorded & analysed in detail and the maximum values of the various key wind blast parameters are shown in table 3.1 (for terminology, see Fowler & Sharma 2000).

Table 3.1 Maximum recorded values of wind blast parameters, Moonee Colliery

Parameter	Maximum value recorded during the mining of LW1 to LW4B
Peak wind blast velocity	123 m/s
Maximum rate of rise of wind blast velocity	182 m/s/s
Maximum excursion (air flow distance)	197 metres
Peak dynamic pressure	12 kPa
Peak overpressure	35 kPa
Maximum rate of rise of overpressure	34 kPa/s
Impulse	89 kPa.s

3.2 RESULTS RELEVANT TO GOAF GAS EXPULSION

An example of a wind velocity time history is given in figure 3.1. Such time histories were acquired at each sensor pod location for each event.

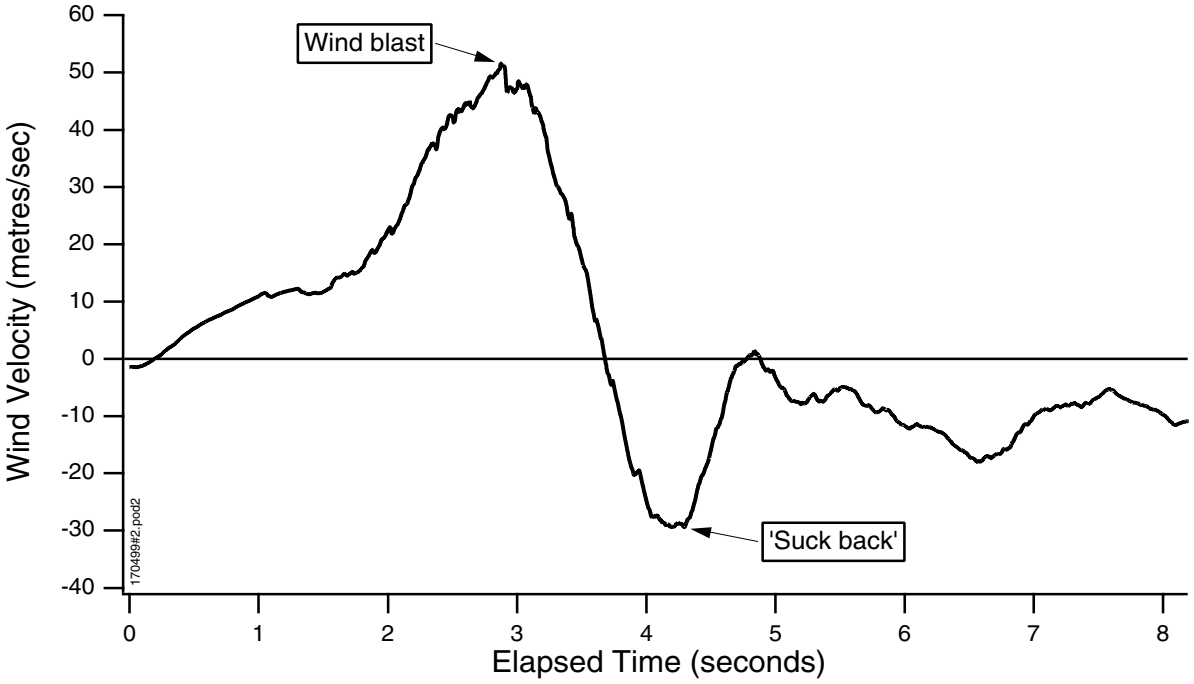

Fig. 3.1 Wind velocity time history

It will be seen that the initial air velocity is positive, i.e away from the goaf fall. The wind velocity rises rapidly to a maximum and then exhibits a sudden reversal, the flow of air travelling back towards the fall in what coal miners refer to as 'suck back'.

By integrating the wind velocity time history, the excursion time history as given in figure 3.2. is obtained. The excursion is the distance travelled by the flow of air past the sensor pod. It will be seen from figure 3.2 that the excursion reaches a peak, the maximum excursion, and then declines. The maximum excursion is the greatest distance that the air is displaced as a result of a wind blast event.

Throughout the period of wind blast monitoring at Moonee Colliery, one of the sensor pods (pod #2) was mounted on an item of equipment in the maingate (belt road) at a fixed distance of 11 metres from the faceline. Values of maximum excursion at this location could not be calculated for every significant wind blast. However, of those that could, 13 were more than 100 metres and the greatest was 197 metres (table 3.1).

These values are of considerable significance in that the value of maximum excursion has been shown to increase with decreasing distance from the fall (Fowler & Sharma 2000). Consequently, the greatest maximum excursion at a point adjacent to the longwall support shields could well exceed the value of 197 metres measured slightly further outbye.

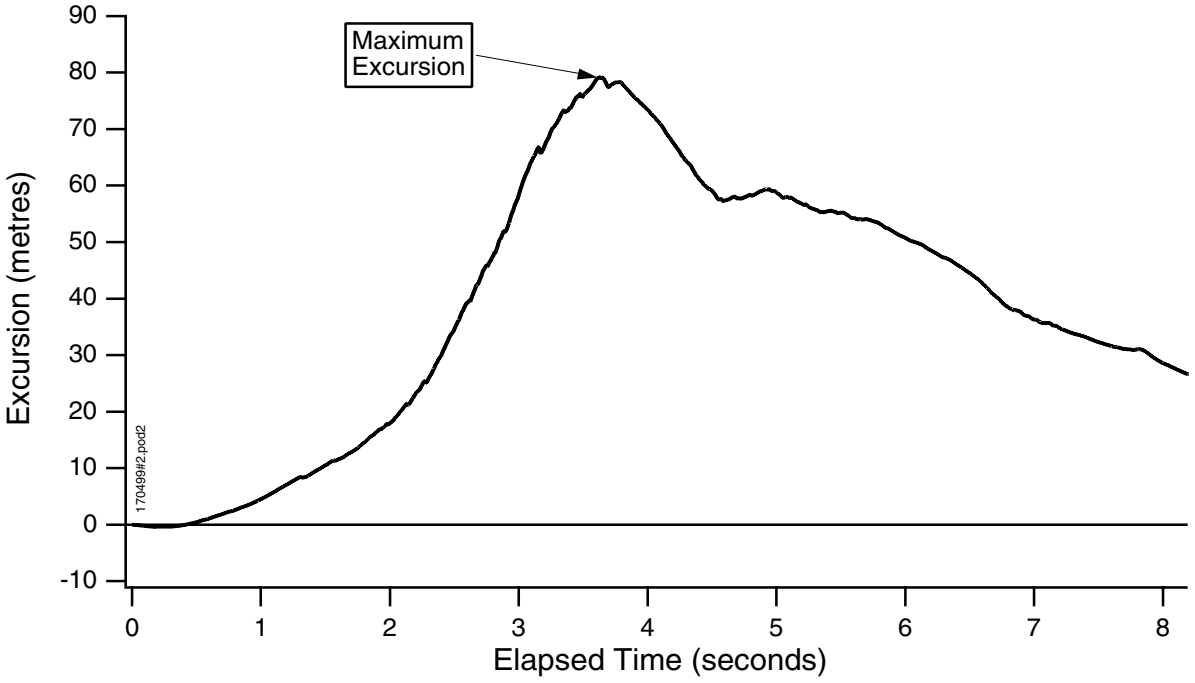

Fig. 3.2 Excursion time history

The implication is that in a 'gassy' mine which has similar panel geometry, geology and goaf caving characteristics to those of Longwall Panels Nos 1 to 4B at Moonee Colliery, a potentially explosive methane/air mixture could be expelled from the goaf and penetrate of the order of 200 metres into the working place. However, such an occurrence is yet to be demonstrated in a 'gassy' mine by direct measurement of transient methane concentrations during wind blasts.

It is anticipated that measurements of the concentration of methane in gases expelled from the goaf will be undertaken as a component of extension project C10024.

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4.0 CONCLUSIONS AND FUTURE WORK

An extensive programme of monitoring at Moonee Colliery has revealed, amongst many other findings, that during intense wind blasts goaf gases are displaced of the order of 200 metres into the working place.

In order to quantify the presence of expelled methane in the working place during wind blasts, it is planned to deploy the WBMEMS in 2002 at a site in a 'gassy' mine which it is anticipated will be subject to wind blast. This work will be supported financially by an ACARP-funded extension project, C10024 'Wind blast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 and C8017', which has been approved and is anticipated to be formally commenced in mid-2001. In addition, the project will include the continuing programme of wind blast monitoring at Moonee Colliery as longwall mining is undertaken in a changing geological environment.

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5.0 TECHNOLOGY TRANSFER

Because of the lack of guidance on the wind blast and methane expulsion phenomena currently available to the underground coal mining industry, the results of the research have been progressively transferred to the industry as they have become available rather than waiting until the end of the project.

Results have been promulgated in the following ways.

1. Frequent contact has been maintained with key personnel at those underground coal mines where wind blast monitoring has been undertaken.
2. Informal discussions/workshops have been held at those collieries where wind blast monitoring has been undertaken or where the probability of wind blast and/or methane expulsion was considered to be high.
3. R & D Technology Transfer Workshops, which encompassed many of the ACARP-sponsored projects in the current UNSW School of Mining Engineering Research Programme, were held in both Queensland and NSW. Extensive presentation on wind blast were included.
4. Papers on wind blast was presented at the 1st International Underground Coal Conference and at other international conferences.
5. A wind blast and methane expulsion module has been incorporated into the Ventilation Officer Training Course offered by the School of Mining Engineering.
6. Research results have been incorporated into the School of Mining Engineering undergraduate and postgraduate teaching programmes.
7. The final report will be widely disseminated.

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6.0 ACKNOWLEDGMENTS

The Author wishes to extend his sincere thanks to the following persons and organisations for directly or indirectly contributing to the success of the project:

The Industry Monitor, Mr N Hamilton, Principal, Hamilton Management Initiatives Pty Ltd, and former General Manager – Operations, Oceanic Coal Australia Limited, and the Project Administrator, Mr SD Wilkinson, Australian Research Administration Pty Ltd, for their advice, guidance and assistance;

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The Author also wishes to acknowledge the following persons and organisations for permission to reproduce the illustrations cited:

Honeywell Inc. for figure 2.3 and Dräger Sicherheitstechnik GmbH for figure 2.5.

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APPENDIX A – CALIBRATION OF WIND BLAST SENSOR PODS

A1 PRESSURE OUTPUT CALIBRATION

Static calibration of the wind blast sensor pod pressure outputs was carried out at the UNSW School of Mining Engineering.

A1.1 DIFFERENTIAL PRESSURE OUTPUT

The SenSym differential pressure transducer type 143SC03D has a nominal range of range of ±17.24 kPa (±2.5 psi). Only part of this range (±13.79 kPa or ±2.0 psi) is employed in this application.

Fig. A1 Calibration of differential pressure output

An Askania WS-Minimeter mercury filled manometer with a range of 0-20 kPa (0-150 mm mercury) was employed to apply a differential pressure between the ports of the transducer. 'Back to back' calibration utilised a Druck Digital Pressure Indicator Model DPI 705. This has a range of 20 kPa, a resolution of 1 Pa, a stated accuracy of better than 20 Pa and a calibration traceable to relevant International Standards. The calibration set-up is indicated in figure A1 above.

The differential pressure output current of the sensor pod was adjusted to the following values.

Table A1 Differential pressure output current

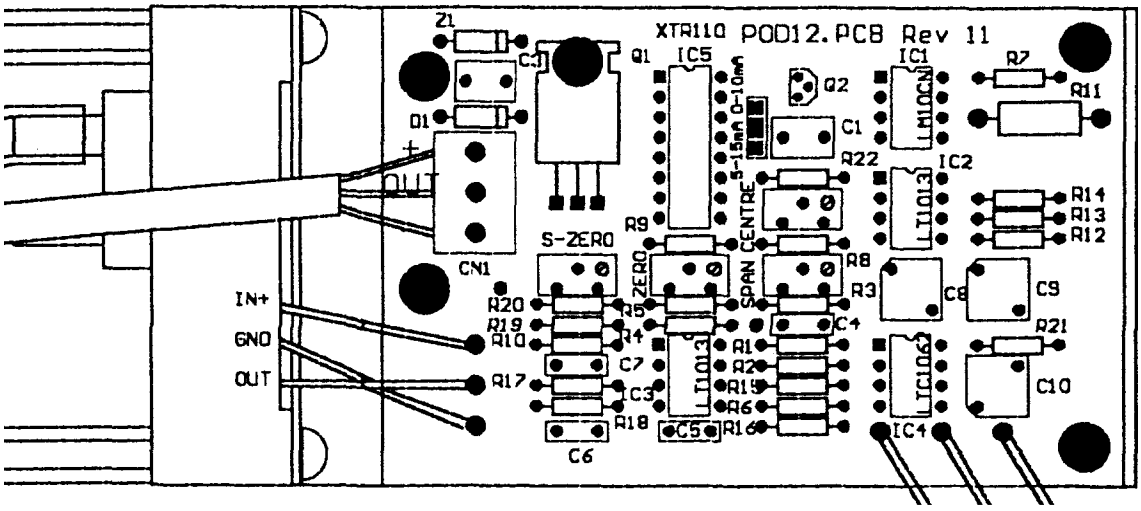
Differential pressure (kPa)	Output current (mA)
-13.79	1.0
-6.895	3.5
0.0	6.0
+6.895	8.5
+13.79	11.0

Calibration was carried out on each occasion that a pod was removed from the mine and at a maximum interval of six months. The calibration procedure is set out on the following four pages.

Brief guide to calibrating a Wind Blast Sensor Pod
Differential pressure calibration
SenSym 143SC03D transducers

1. Remove the three retaining screws and slide out the nose cone of the Wind Blast Sensor Pod in order to expose the SenSym 143SC03D stagnation pressure transducer.
2. Remove the three retaining screws and slide open the front section of the Wind Blast Sensor Pod in order to expose the differential pressure PC board and the SenSym 143SC03D static pressure transducer.
3. Confirm that the uPVC ‘Y’ tubing is connected to the Askania WS-Minimeter.
4. Connect one 3 mm nominal bore arm of the uPVC ‘Y’ tubing to the ‘+’ (high pressure) port of the Druck Digital Pressure Indicator Model DPI 705 (Ser. No. 378/98-06).
5. Turn on the power supply, set the voltage to +24 Volts and then turn off the power supply.
6. Confirm that junction box terminals 1 to 6 on the sensor pod side are all wired.
7. Confirm that junction box terminals 3 and 4 on the power supply side are connected to the black (neutral) and red (+24 Volt) input wires respectively.
8. Confirm that junction box terminals 2 and 4 are connected together (red to blue, both +24 Volts).
9. Connect the Sensor Pod to the junction box.
10. Connect the black and red input wires to the power supply and turn on.
11. Set the range on the Fluke Model 27 Multimeter (Ser. No. 3690067) to ‘mA/A⎓’ and plug the black test lead into the ‘COM’ socket and the red test lead into the ‘mA/µA’ socket.
12. Connect the black Multimeter test lead to terminal 3 (black wire) on the junction box and the red test lead to terminal 6 (white wire).

13. The Multimeter displays the Sensor Pod differential pressure current loop output in mA.
14. Turn on the Druck Digital Pressure Indicator and set ‘units’ to ‘psi’.
15. The Digital Pressure Indicator displays the differential pressure in psi.
16. Slide the short uPVC tube that is joined to the Sensor Pod stagnation pressure port off the ‘P2’ port of the stagnation pressure transducer.
17. Slide the long uPVC tube that is joined to the Sensor Pod static pressure port off the ‘P1’ port of the stagnation pressure transducer.



Schematic of Wind Blast Sensor Pod differential pressure PC board

18. Adjust variable resistor CENTRE on the Sensor Pod differential pressure PC board until the Multimeter display is equal to the theoretical current loop output value (6.0 mA).
19. Confirm that the reservoir of the Askania WS-Minimeter is set to its lowest level, i.e. knurled top turned fully anti-clockwise.
20. Slide the 4.5 mm nominal bore arm of the uPVC ‘Y’ tubing over the ‘P2’ port of the stagnation pressure transducer.

21. Turn the knurled top of the Askania WS-Minimeter clockwise to raise the reservoir until the Digital Pressure Indicator displays exactly 1.000 psi.
22. Adjust variable resistor SPAN on the Sensor Pod differential pressure PC board until the current loop output equals 8.50 mA (the theoretical value corresponding to an differential pressure +1.000 psi).
23. Turn the knurled top of the Askania WS-Minimeter clockwise to raise the reservoir until the Digital Pressure Indicator displays exactly 2.000 psi.
24. Adjust variable resistor SPAN on the Sensor Pod differential pressure PC board until the current loop output equals 11.00 mA (the theoretical value corresponding to an differential pressure +2.000 psi).
25. Disconnect the 4.5 mm nominal bore arm of the uPVC ‘Y’ tubing from the stagnation pressure transducer.
26. Repeat steps 18 to 25 but with the 4.5 mm nominal bore arm of the uPVC ‘Y’ tubing connected to the ‘P1’ port of the stagnation pressure transducer. The theoretical current loop outputs corresponding to differential pressures of -1.000 and –2.000 psi are 3.5 mA and 1.0 mA respectively.)
27. Replace the two uPVC tubes on the ‘P1’ and ‘P2’ ports of the stagnation pressure transducer.
28. Replace the nose cone of the Wind Blast Sensor Pod and fit the three retaining screws.
29. Repeat steps 16 to 27 but with the 4.5 mm nominal bore arm of the uPVC ‘Y’ tubing connected to the static pressure transducer rather than the stagnation pressure transducer. Port pressurization must be reversed (‘P1’ replaces ‘P2’ and vice versa) and the variable resistor S-ZERO (span zero), rather than SPAN, adjusted to give the theoretical current loop outputs.
30. Slide the front section of the Wind Blast Sensor Pod closed and fit the three retaining screws.
31. Turn off the power supply and disconnect the Sensor Pod from the junction box.

Determination of air velocity
SenSym 143SC03D pressure transducer

Current I (mA)	Differential Pressure ΔP (Pa)	Air Velocity v (m/s)
	(I-6.0)*(13790/5)	1.278*√ΔP
11.10	14065.8	151.57
11.09	14038.2	151.42
11.08	14010.6	151.27
11.07	13983.1	151.12
11.06	13955.5	150.97
11.05	13927.9	150.83
11.04	13900.3	150.68
11.03	13872.7	150.53
11.02	13845.2	150.38
11.01	13817.6	150.23
11.00	13790.0	150.08
10.99	13762.4	149.93
10.98	13734.8	149.78
10.97	13707.3	149.63
10.96	13679.7	149.48
10.95	13652.1	149.32
10.94	13624.5	149.17
10.93	13596.9	149.02
10.92	13569.4	148.87
10.91	13541.8	148.72
10.90	13514.2	148.57
6.20	551.6	30.02
6.19	524.0	29.26
6.18	496.4	28.48
6.17	468.9	27.67
6.16	441.3	26.85
6.15	413.7	25.99
6.14	386.1	25.11
6.13	358.5	24.20
6.12	331.0	23.25
6.11	303.4	22.26
6.10	275.8	21.22
6.09	248.2	20.13
6.08	220.6	18.98
6.07	193.1	17.76
6.06	165.5	16.44
6.05	137.9	15.01
6.04	110.3	13.42
6.03	82.7	11.62
6.02	55.2	9.49
6.01	27.6	6.71
6.00	0.0	0.00

A1.2 ABSOLUTE PRESSURE OUTPUT

The SenSym absolute pressure transducer type SCX30AN has a nominal range of range of 0-206.8 kPa (0-30.0 psi) and the whole of this range is employed in the Type 2A Wind Blast Sensor Pod.

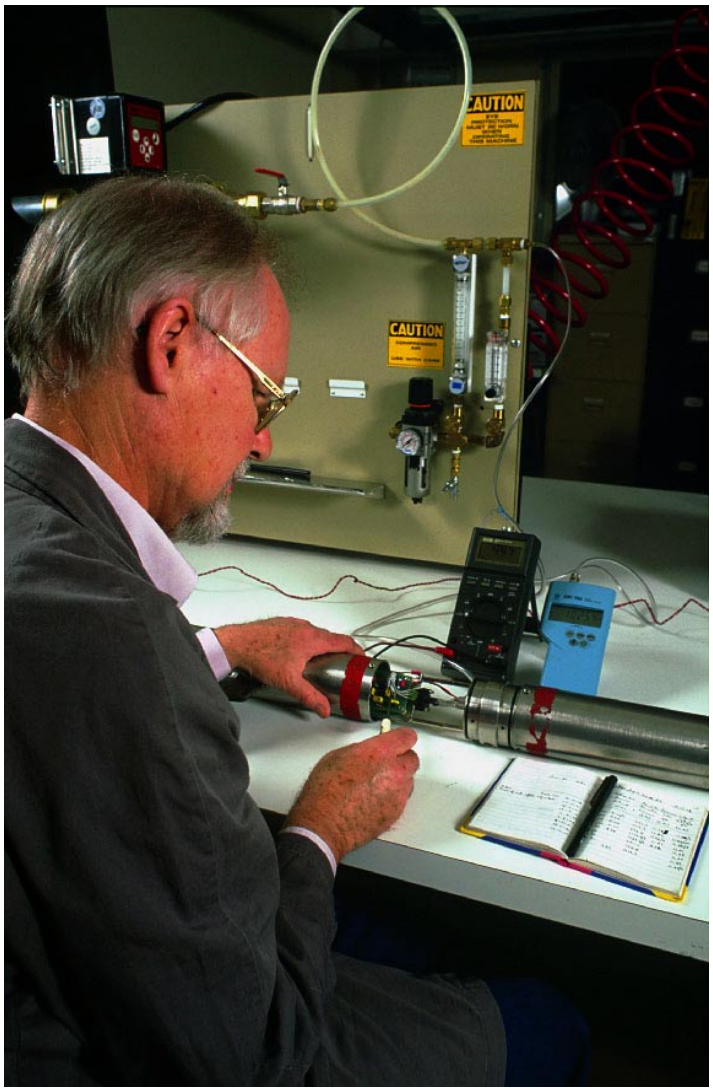


Fig. A2 Calibration of absolute pressure output

The laboratory reticulated air supply and a pressure regulator were employed to apply a absolute pressure to the transducer port. 'Back to back' calibration utilised a Druck Digital Pressure Indicator Model DPI 705. This has a range of 200 kPa, a resolution of 10 Pa, a stated accuracy of better than 200 Pa and a calibration traceable to relevant International Standards. The calibration set-up is indicated above in figure A2.

The absolute pressure output current of the sensor pod was adjusted to the following values.

Table A2 Absolute pressure output current

Absolute pressure (kPa)	Output current (mA)	Comments
206.84	20.0	30.0 psi
101.325	11.838	International Standard Atmosphere
0.0	4.0	

Calibration was carried out on each occasion that a pod was removed from the mine and at a maximum interval of six months. The calibration procedure is set out on the following five pages.

Brief guide to calibrating a Wind Blast Sensor Pod
Absolute pressure calibration
SenSym SCX30AN transducer

1. Confirm that the main compressed air control valve above the Pneumatic Calibration Rig is set to ‘off’, i.e. handle perpendicular to axis of flow.
2. Turn on the compressor at the control in room 39 and set the timer to ‘two hours’.
3. Visually check all compressed air lines, connections, controls and indicators.
4. Confirm that the pressure regulator on the Pneumatic Calibration Rig is closed, i.e. turned fully anti-clockwise.
5. Confirm that the silver needle valve on the immediate right of the pressure regulator is open, i.e. turned fully anti-clockwise.
6. Confirm that both brass flowmeter control valves are closed, i.e. turned fully clockwise.
7. Confirm that the ball valve (red handle) near the top of the Pneumatic Calibration Rig is set to ‘off’, i.e. handle perpendicular to axis of flow.
8. Turn the main compressed air control valve above the Pneumatic Calibration Rig to ‘on’, i.e. handle parallel to axis of flow.
9. Remove the three retaining screws and slide open the rear section of the Wind Blast Sensor Pod in order to expose the absolute pressure PC board.
10. Confirm that the uPVC ‘Y’ tubing is disconnected from the Pneumatic Calibration Rig.
11. Slide the short uPVC tube that is joined to the Sensor Pod static pressure port off the ‘A’ (pressure) port of the SenSym SCX30AN transducer.
12. Slide the 4.5 mm nominal bore arm of the uPVC ‘Y’ tubing over the ‘A’ (pressure) port of the SenSym SCX30AN transducer.

13. Connect one 3 mm nominal bore arm of the uPVC ‘Y’ tubing to the Druck Digital Pressure Indicator Model DPI 705 (Ser. No. 185/98-04).

14. Turn on the power supply, set the voltage to +24 Volts and then turn off the power supply.

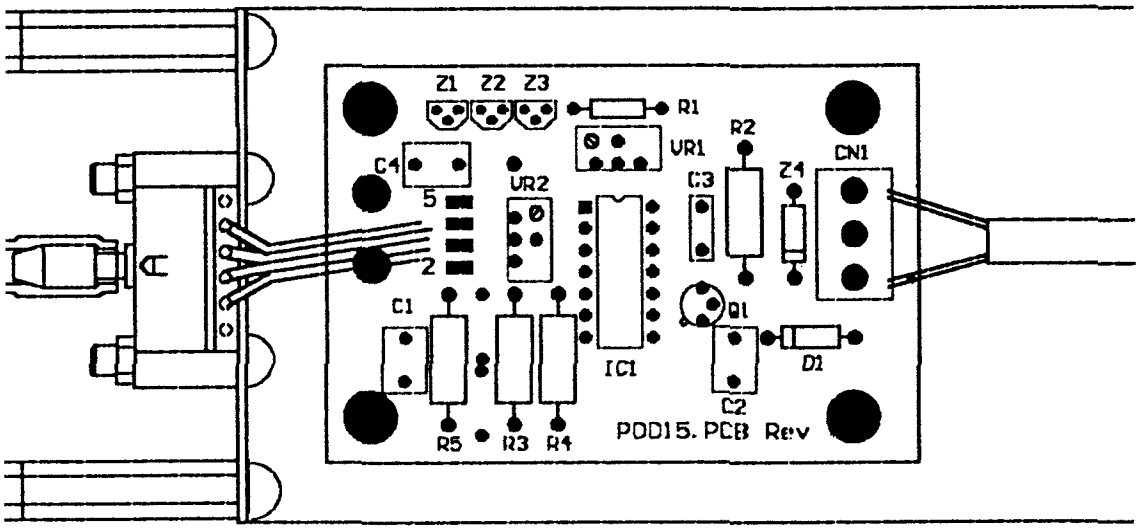
15. Confirm that junction box terminals 1 to 6 on the sensor pod side are all wired and connect the Sensor Pod to the junction box.

16. Confirm that junction box terminals 3 and 4 on the power supply side are connected to the black (neutral) and red (+24 Volt) input wires respectively.

17. Confirm that junction box terminals 2 and 4 are connected together (red to blue, both +24 Volts).

18. Connect the black and red input wires to the power supply and turn on.

19. Set the range on the Fluke Model 27 Multimeter (Ser. No. 3690067) to ‘mA/A⎓’ and plug the black test lead into the ‘COM’ socket and the red test lead into the ‘mA/µA’ socket.



Schematic of Wind Blast Sensor Pod absolute pressure PC board

20. Connect the black Multimeter test lead to terminal 3 (black wire) on the junction box and the red test lead to terminal 5 (yellow wire).

21. The Multimeter displays the Sensor Pod absolute pressure current loop output in mA.
22. Turn on the Druck Digital Pressure Indicator and set ‘units’ to ‘psi’.
23. The Digital Pressure Indicator displays the ambient absolute atmospheric pressure in psi.
24. Look up in the attached table the theoretical Sensor Pod current loop output that corresponds to the indicated ambient absolute atmospheric pressure.
25. Adjust variable resistor VR1 on the Sensor Pod absolute pressure PC board until the Multimeter display is equal to the theoretical current loop output value.
26. Connect the remaining 3 mm nominal bore arm of the uPVC ‘Y’ tubing to the Pneumatic Calibration Rig at the outlet above the Dwyer flowmeter.
27. Turn the brass control valves below the InFlux flowmeter anticlockwise to fully open.
28. SLOWLY turn clockwise to open the pressure regulator on the Pneumatic Calibration Rig until the Digital Pressure Indicator displays approximately 29.5 psi.
29. SLOWLY turn clockwise to close the needle valve on the immediate right of the pressure regulator until the Digital Pressure Indicator displays exactly 30.000 psi. The needle valve MUST remain partially open as evidenced by the sound of escaping air.
30. Adjust variable resistor VR2 on the Sensor Pod absolute pressure PC board until the current loop output equals 20.00 mA (the theoretical value corresponding to an ambient absolute atmospheric pressure 30.000 psi).
31. Turn the brass control valves below the INFLUX flowmeter clockwise to fully close.
32. Disconnect the 3 mm nominal bore arm of the uPVC ‘Y’ tubing from the Pneumatic Calibration Rig.
33. Adjusting variable resistor VR2 will also have caused a small shift in the output at ambient pressure. Consequently,

it is necessary to repeat steps 23 to 32 iteratively until the required current loop outputs are achieved.

34. Turn the pressure regulator on the Pneumatic Calibration Rig fully anti-clockwise to close.
35. Turn the silver needle valve on the immediate right of the pressure regulator fully anti-clockwise to open.
36. Turn off the main compressed air control valve above the pneumatic calibration rig.
37. Slide the arm of the uPVC ‘Y’ tubing off the ‘A’ (pressure) port of the SenSym SCX30AN transducer.
38. Slide the short uPVC tube that is joined to the Sensor Pod static pressure port onto the ‘A’ (pressure) port of the SenSym SCX30AN transducer.
39. Slide the rear section of the Wind Blast Sensor Pod closed and fit the three retaining screws.
40. Turn off the power supply and disconnect the Sensor Pod from the junction box.

CurrentToPresConv.sch220699

School of Mining Engineering 22-Jun-99

Determination of atmospheric pressure
SenSym SCX30AN pressure transducer

Current I (mA)	Atmospheric Pressure P (psi)	Atmospheric Pressure P (hPa)
	(I-4.0)*(30/16)	psi*68.9476
20.00	30.00	2068.4
12.00	15.00	1034.2
11.99	14.98	1032.9
11.98	14.96	1031.6
11.97	14.94	1030.3
11.96	14.93	1029.0
11.95	14.91	1027.8
11.94	14.89	1026.5
11.93	14.87	1025.2
11.92	14.85	1023.9
11.91	14.83	1022.6
11.90	14.81	1021.3
11.89	14.79	1020.0
11.88	14.78	1018.7
11.87	14.76	1017.4
11.86	14.74	1016.1
11.85	14.72	1014.8
11.84	14.70	1013.5
11.83	14.68	1012.2
11.82	14.66	1010.9
11.81	14.64	1009.7
11.80	14.63	1008.4
11.79	14.61	1007.1
11.78	14.59	1005.8
11.77	14.57	1004.5
11.76	14.55	1003.2
11.75	14.53	1001.9
11.74	14.51	1000.6
11.73	14.49	999.3
11.72	14.48	998.0
11.71	14.46	996.7
11.70	14.44	995.4
4.00	0.00	0.0

APPENDIX A

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A2 WIND TUNNEL CALIBRATION

The design of the sensor pods is based upon the principle of the Pitot tube and, consequently, the pods require calibration in a wind tunnel in order to verify their aerodynamic characteristics. A sensor pod was calibrated (fig. A3) in the wind tunnel at the Defence Science and Technology Organisation's Aeronautical and Maritime Research Laboratory in Melbourne which affords the highest velocity of any suitable facility in Australia.

Fig. A3 Wind tunnel testing of the wind blast sensor pod

The deviation from theoretical was less than 2% at air speeds up to of 95 metres per second, the upper limit for the wind tunnel. This range is compatible with the range of air velocities anticipated during wind blasts.

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APPENDIX B – CALIBRATION OF METHANE DETECTORS

B1 STATIC CALIBRATION

Static calibration of the Dräger Polytron IR Ex and IR Ex IL methane detectors, a standard procedure (Dräger 1996, 1998), was carried out by Coal Mines Technical Services, a NATA accredited laboratory and NSW Department of Minerals and Energy Approved Testing Authority. The calibration was performed by filling the cuvette with standard concentrations of methane-in-air in static or quasi-static conditions and adjusting both the display & the 4-20 mA current loop output.

B2 RESPONSE TIME

The 'inherent' response time of a Polytron IR Ex or IR Ex IL methane detector depends only upon the reaction time of the system hardware and software. Each second the system takes two readings and updates the display & the 4-20 mA current loop output. Consequently, the 'inherent' response time is less than one second.

Fig. B1 Determination of methane detector response time using air blower

Although a step change in methane concentration within the cuvette would be detected in less than one second, the response time for a change in methane concentration in the general body

of air surrounding the cuvette would be longer and would depend on the rate at which air in the general body passed into the cuvette.

Redman (2000) undertook two extensive series of tests in order to determine how the response times of the Polytron IR Ex and IR Ex IL methane detectors were affected by air velocity. He employed two techniques, both of which entailed filling the cuvette with a 2% methane-in-air mixture and measuring the time t_{95} for the displayed reading and / or 4-20 mA current loop output to fall to 5% of its initial value.

In the first series of tests (fig. B1 above), a blower was used to generate flows of air of known velocity in the vicinity of the methane detector. Five methane detector configurations were employed: Polytron IR Ex IL with the longitudinal axis of the cuvette perpendicular to the air flow, Polytron IR Ex without splash guard and with cuvette parallel & perpendicular to air flow, and Polytron IR Ex with splash guard and cuvette parallel & perpendicular to air flow.

Fig. B2 Determination of methane detector response time using quasi-dynamic pressure

The second series of tests (fig. B2 above) employed only the Polytron IR Ex IL. Pressure differentials were applied across the cuvette and directors in order to simulate the dynamic pressures that would result from air flows of differing velocities. This arrangement facilitated

testing at dynamic pressures that were higher than those achievable with the air blower. Over the range of overlapping velocities, the results of both series of tests showed good agreement, thus validating the techniques.

The results of the tests are summarised in table B1. It will be noted that all the response times are very long at low air velocities where the dominant mechanism for the exchange of air between the general body and the interior of the cuvette is diffusion. As velocities increase, the dynamic pressure forces the air through the cuvette, decreasing the response time.

Table B1 Effect of air velocity on methane detector response time

Config-uration number	Dräger Polytron methane detector model	Orientation of air flow with respect to longitudinal axis of cuvette	Air velocity (m/s)				
			1	2	5	10	20
			Response time t_{95} (seconds)				
1	IR Ex without splash guard	Parallel	60	31	13	6	3
2	IR Ex without splash guard	Perpendicular	14	7	3	2	1
3	IR Ex with splash guard	Parallel	68	52	36	27	20
4	IR Ex with splash guard	Perpendicular	57	36	19	12	8
5	IR Ex IL with air directors	Perpendicular	724	206	39	11	3

In practice, configurations nos 1 and 2 (table B1) would not be employed in an Australian underground coal mine as the use of a splash guard is mandated in the Australian Certification and NSW Approval (App. D). Configuration no. 4 would generally be preferred to no. 3 as it exposes the maximum frontal area of the cuvette filter to the air stream and, consequently, ensures a faster response. However, extrapolating the data suggests that not even configuration no. 4 would achieve a one second response time, even at velocities as high as 100 metres per second which is of the order of the upper limit for wind blasts (table 3.1).

The only configuration capable of achieving a fast response time is no. 5, a configuration that was specifically designed to employ the dynamic pressure during a wind blast to force the air through the cuvette. Testing of this configuration suggested that a velocity of the order of 40 metres per second would be sufficient to achieve a one second response time.

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APPENDIX C – WIND BLAST SENSOR POD TESTING AND CERTIFICATION ASSESSMENT AND APPROVAL

The Air Blast (Wind Blast) Sensor Pod Type 2A has been Tested and Certified by SIMTARS (Certificate No. Ex 2452X) to be in conformity with the following Australian Standards.

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

The Type of Protection is Ex ia I IP55 and electrical parameters have been assigned under the 'entity concept'.

The Air Blast (Wind Blast) Sensor Pod Type 2A has been Assessed and Approved for use in a Zone 0 hazardous area for gas Group 1 in New South Wales underground coal mines (Approval No. Exia.11668. Issue O-A2507). The specific approval category is 'Intrinsically Safe'.

APPENDIX C

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SYSTEMS APPROVALS PTY. LTD.

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Fax: (02) 4958 6827.
Mobile: 0418 685252.

The Manager,
University Of N.S.W.
School of Mining Engineering
SYDNEY. N.S.W. 2052.

OUR REF: A1413.

FILE REF No.: **C99/0929.**

ATTENTION: **CHRIS FOWLER.**

ITEM APPROVAL

Dear Sir,

ITEM: **AIR BLAST SENSOR POD.**

IDENTIFICATION: **2A.**

APPROVAL NUMBER: **MDA. Exia.11668. ISSUE O-A2507.**

DESCRIPTION OF APPROVAL ITEM

The Air Blast Sensor Pod Type 2A is suitable for mounting in a Zone O hazardous area for gas Group I in underground coal mines to measure windblasts, air velocities and absolute pressures during roof falls.

Please find enclosed herewith the attached schedule, Approval Document, Approval Drawings, and relevant Supplementary Documentation.

Yours Faithfully,

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
For the Chief Inspector of Coal Mines

New South Wales

Department of Mineral Resources

Accredited Assessing Authority MDA-2507

NOTICE OF PRIMARY APPROVAL

APPROVAL No: **Exia.11668. ISSUE O.**

FILE REF No: **C99/0929.**

DATE: **01/11/1999.**

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby **APPROVED** in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 70 and 73 of the Coal Mines (General)Regulation, 1999.

This APPROVAL is issued to: **UNIVERSITY OF N.S.W. SCHOOL OF ENGINEERING.**

Address of Approval Holder: **SYDNEY. N.S.W. 2052.**

Approved Item: **AIR BLAST SENSOR PODS.**

Item Identification: **2A.**

C.M.R.A. Regulation: Electrical U/G. Clause 140(1). **EXPLOSION PROTECTED.**

Specific Approval Category: **INTRINSICALLY SAFE. Exia.**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to the MANUFACTURERS and/or SUPPLIERS of Approved Items.

The Authority issuing this Approval may, for the purposes of the Occupational Health and Safety Act, 1983, append a Schedul (includung drawings, documents, etc) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from details included in the Schedule, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the Approved Item.

The Approval Number shall appear in a conspicuous place in a legible manner on each approved item, unless specifically excluded.

A copy of this Approval Document together with a copy of the Schedule from the Authority issuing the Approval shall be supplied to each user of the Approved Item.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1982.

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES

Minerals & Energy House, PO Box 536, St Leonards, NSW 1590, Australia

Telephone: (02) 9901 8888 Facsimile: (02) 9901 8777

SYSTEMS APPROVALS PTY. LTD.

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APPROVAL No.: **Exia.11668. Issue O.**

FILE REF No.: **C99/0929.**

DATE: **01/11/1999.**

DESCRIPTION OF APPROVED ITEM

The Air Blast Sensor Pod Type 2A is suitable for mounting in a Zone O hazardous area for gas Group I in underground coal mines to measure windblasts, air velocities and absolute pressures during roof falls.
The equipment is connected to associated apparatus in a safe area via a (6) pin plug and cable.
The enclosure is constructed from stainless steel.

OTHER INFORMATION

Gas-Group I
Hazardous Area - Zone O
Degree of Protection - IP55
Ambient Temperature - -20°C to +40°C
Temperature Class - 150°C External Surface/450°C Internal Surfaces
SIMTARS Test Report No. N199/0016, Dated 08/10/1999.

SCHEDULE 1 - ELECTRICAL PARAMETERS

Under the 'Entity' concept the following parameters must be taken into consideration during installation -

PIN CONFIGURATION 1-2-3-4-5-6

U_i (max) - 40V
I_i (max) - 150mA
C_i (int) - 0.26uF
L_i (int) - 0mH

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

SYSTEMS APPROVALS PTY. LTD.

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APPROVAL No.: **Exia.11668. Issue O.**
FILE REF No.: **C99/0929.**
DATE: **01/11/1999.**

SCHEDULE 2 - DRAWINGS

Drawing Number	Drawing title	Rev	Dated
2000/P1	Pod body parts	15	24/6/99
2000/P2	Pressure PCB mounting	13	13/3/99
2000/P3	Static pressure PCB mounting	14	9/4/99
2000/P4	Nose and centre blocks	14	20/3/99
2000/P5	Pod internal wiring	15	28/6/99
2000/P6	Pod external connections	13	1/9/99
2000/P9	Identification plate	12	1/9/99
2000/P10	Diff pressure sensor circuit	14	15/9/99
2000/P11	Absolute pressure sensor circuit	13	2/5/99
2000/P13	Mechanical detail of 2000/P12	13	28/4/99
2000/P16	Mechanical detail of 2000/P15	12	27/4/99
2000/P18 (2) shts.	Component parts list	14	15/9/99

SCHEDULE 3 - RECOMMENDATIONS FOR SUPPLY AND USE

1. Any repair to this apparatus that may affect its explosion protected properties shall be carried out only at a workshop registered for the purpose.

2. The manufacturer shall on his own responsibility carry out such tests and examinations as are necessary to ensure that this apparatus provides satisfactory operation in service.

3. All parts of this system that are not intrinsically safe shall be installed in an explosion protected enclosure, or be located in a safe area.

4. Adequate precautions shall be taken to guard against danger arising from interconnection of intrinsically safe sources of current, and the charging of intrinsically safe circuits by leakage or induction from other circuits.

5. No apparatus connected to the safe area terminals of any zener diode safety barrier shall be supplied from or contain under normal or abnormal conditions a source of potential in excess of 250 volts rms.

MARKING ON APPARATUS

1. The manufacturers' name or mark, and the approval number **MDA No.Exia.11668.** shall be inscribed in a durable manner in a prominent position on the apparatus.

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

SIMTARS
Committed to Safety

SIMTARS
Engineering, Testing and Certification Centre

2 Smith Street, REDBANK, QLD 4301, Australia
Postal Address: PO Box 467, GOODNA, QLD, 4300 Australia

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Test Report

Electrical Equipment for Explosive Atmospheres

Explosion-Protection Techniques

- ***AS 2380.1 - 1989, General Requirements***
- ***AS 2380.7 - 1987, Intrinsic Safety i***

Report No:	**NI99/0016**
Date of Issue:	8 October 1999
Job No.:	99/0060
Applicant/Customer Name:	University of New South Wales School of Mining Engineering SYDNEY NSW 2052
Equipment Details:	Air Blast Sensor Pod Type 2A
Type of Protection:	Ex ia
Apparatus Group:	I
Temperature Class:	150°C (External surfaces) 450°C (Internal surfaces)
Ambient Temperature	-20°C to +40°C
Degree of Protection:	IP55
Hazardous Area:	Class I Zone 0 (Underground Coal Mines)

C.M.R.A. APPROVAL DOCUMEN
MDA No Exia 11668 FILE No C99/0929
DATE 27-10-99 MDA-A2507
ACCEPTED ASSESSING AUTHORI

CHECKED: APPROVED SIGNATORY:

Test Report NI99/0016

TEST SUMMARY

1.0 DESCRIPTION OF APPARATUS

1.1 General

The Air Blast Sensor Pod Type 2A is designed to be mounted in the hazardous area to measure wind blast air velocities and absolute pressures during roof falls in underground coal mines. The equipment is connected to associated apparatus in the safe area via the 6 pin plug. The enclosure is constructed from stainless steel.

2.0 DRAWINGS

The drawings listed in Schedule 1 form part of this test report.

3.0 TEST SPECIFICATION

The equipment was tested to AS 2380.1-1989 and AS 2380.7-1987.

3.1 The following clauses of AS 2380.1 were applied:

1.1, 1.2, 1.7, 1.8, 2.1, 2.3, 2.4, 2.9, 2.10, 4.1, 4.2, 4.4, 4.7, 5.1, 5.3, 5.5

The following tests of AS 2380.1 were not conducted:

- Clause 5.2.2: Drop Test

  The equipment is not a portable item and is permanently mounted.

- Clause 5.6: Thermal Shock Test

  The equipment contains no glass parts or windows requiring testing.

- Clause 5.7: Insulation Resistance of Plastic Parts

  The equipment contains no external fans or rotating plastic parts requiring testing.

CHECKED: APPROVED SIGNATORY:

3.2 The following clauses of AS 2380.7 were applied:

1.1, 1.4, 1.5, 1.6, 1.8, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.8, 3.1, 3.2, 5.1, 5.6, 6.1, 6.3

The following tests of AS 2380.7 were not conducted:

- Clause 5.5: Tests with the Spark Test Apparatus

  The structure and electrical parameters of the equipment are sufficiently well defined to allow the ignition curves and method given in Appendix A of AS 2380.7 to be applied.

- Clause 5.7: Impact Test

  There are no non intrinsically safe components/circuits which would invalidate the explosion protection of the equipment when subject to impact in accordance with the standard.

3.3 To satisfy the requirements of AS 2380.1 Clause 5.3 and AS 2380.7 Clause 2.4, the Air Blast Sensor Pod Type 2A was also tested to AS 1939-1990 for Degree of Protection IP55.

4.0 SUMMARY OF TEST RESULTS

The equipment complies with the relevant requirements of the standards as listed in Section 3 of this report for intrinsically safe electrical equipment with the following grouping and classification:

Ex ia I IP55
(-20 to +40°C ambient temperature range)

The equipment is suitable for installation in Class I Zone 0 (Underground Coal Mines) hazardous areas.

5.0 CONDITIONS

It is recommended that the following conditions of safe use be included in the certificate for the apparatus:

5.1 The entity parameters, as listed below, shall be observed:

ENTITY PARAMETERS					
APPARATUS	CONFIG.	C_i (µF)	L_i (mH)	GROUP I	
				U_i (V)	I_i (mA)
Air Blast Sensor Pod Type 2A	pins 1, 2, 3, 5 & 6	0.26	0	40	150

6.0 ADDITIONAL INFORMATION

Nil.

CHECKED: APPROVED SIGNATORY:

SCHEDULE 1

DRAWINGS

DRAWING NO	DRAWING TITLE	REV	DATE
2000/P1	Pod Body Parts	15	24/6/99
2000/P2	Pressure PCB Mounting	13	13/3/99
2000/P3	Static Pressure PCB Mounting	14	9/4/99
2000/P4	Nose and Centre Blocks	14	20/3/99
2000/P5	Pod Internal Wiring	15	28/6/99
2000/P6	Pod External Connections	13	1/9/99
2000/P9	Identification Plate	12	1/9/99
2000/P10	DIFF PRESSURE SENSOR CIRCUIT	14	15-SEP 1999
2000/P11	ABSOLUTE PRESSURE SENSOR CIRCUIT	13	2-MAY 1999
2000/P13	Mechanical detail of 2000/P12	13	28/4/99
2000/P16	Mechanical detail of 2000/P15	12	27/4/99
2000/P18 (2 Sheets)	Component Parts List	14	15/9/99

CHECKED: APPROVED SIGNATORY:

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Certificate of Conformity

Certificate No.: **Ex 2452X** **Issue 0:** **12 October 1999** **Original Issue**

Date of expiry: **12 October 2009**

Certificate Holder: **University of New South Wales**
School of Mining Engineering
SYDNEY NSW 2052

Electrical Equipment: **Air Blast Sensor Pod Type 2A**

Type of Protection and Marking Code: **Ex ia I IP55**
AUS Ex 2452X

Manufactured by: **Masters and Young Pty Ltd**
11 Tralee Road
EAGLEBY QLD 4207

Issued by:

Engineering, Testing and Certification Centre
2 Smith Street, REDBANK, QLD 4301, Australia
Postal Address: PO Box 467, GOODNA, QLD 4300, Australia
Phone: (07) 3810 6381 *Fax: +61 7 3810 6366*

STANDARDS AUSTRALIA
Standards Australia Quality Assurance Services Pty Limited A.C.N. 050 611 642

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

This certificate is granted subject to the conditions as set out in Standards Australia Miscellaneous Publication MP 69 and the Procedures (Doc Q7134) of the scheme.

The electrical equipment and any acceptable variation to it specified in the schedule to this certificate and the identified documents, was found to comply with the following standards:

AS 2380.1 - 1989	**Electrical equipment for explosive atmospheres - Explosion-protection techniques - Part 1 : General requirements**
AS 2380.7 - 1987	**Electrical equipment for explosive atmospheres - Explosion-protection techniques - Part 7 : Intrinsic safety i**

This certificate does not ensure compliance with electrical safety and performance requirements other than those included in the standards listed above.

The equipment listed has successfully met the examination and test requirements as recorded in

Test Report No: **NI99/0016**

File Reference: **99/0060** **P80810**

Signed for and on behalf of issuing authority

Senior Engineer - Certification
Engineering, Testing and Certification Centre
Position

12 October 1999
Date of issue

This certificate and schedule may not be reproduced except in full.

This certificate is not transferable and remains the property of Standards Australia Quality Assurance Services and must be returned in the event of its being revoked or not renewed.

Certificate No.: Ex 2452X **Issue: 0**

Issued by:

Engineering, Testing and Certification Centre
2 Smith Street, REDBANK, QLD 4301, Australia
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SIMTARS
Quality System Certified to AS/NZS ISO 9001 Certification No 6039

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Schedule

Equipment:

The Air Blast Sensor Pod Type 2A is designed to be mounted in the hazardous area to measure wind blast air velocities and absolute pressures during roof falls in underground coal mines. The equipment is connected to associated apparatus in the safe area via the 6 pin plug. The enclosure is constructed from stainless steel.

Drawings:

DRAWING NO.	DRAWING TITLE	REVISION NO.	DRAWN/ REVISION DATE
2000/P1	Pod Body Parts	15	24/6/99
2000/P2	Pressure PCB Mounting	13	13/3/99
2000/P3	Static Pressure PCB Mounting	14	9/4/99
2000/P4	Nose and Centre Blocks	14	20/3/99
2000/P5	Pod Internal Wiring	15	28/6/99
2000/P6	Pod External Connections	13	1/9/99
2000/P9	Identification Plate	12	1/9/99
2000/P10	DIFF PRESSURE SENSOR CIRCUIT	14	15-SEP 1999
2000/P11	ABSOLUTE PRESSURE SENSOR CIRCUIT	13	2-MAY 1999
2000/P13	Mechanical detail of 2000/P12	13	28/4/99
2000/P16	Mechanical detail of 2000/P15	12	27/4/99
2000/P18 (2 Sheets)	Component Parts List	14	15/9/99

Certificate No.: Ex 2452X Issue: 0 Date of Issue: 12 October 1999

Issued by:

Engineering, Testing and Certification Centre

2 Smith Street, REDBANK, QLD 4301, Australia
Postal Address: PO Box 467, GOODNA, QLD 4300, Australia
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Quality System Certified to AS/NZS ISO 9001 Certification No 6039

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Addendum to Certificate No.....: **Ex 2452X**

Issue: **0**

Date of Issue: **12 October 1999**

Conditions of Certification:

The entity parameters, as listed below, shall be observed:

ENTITY PARAMETERS					
APPARATUS	CONFIG.	*Ci* (μF)	*Li* (mH)	GROUP I	
				Ui (V)	*Ii* (mA)
Air Blast Sensor Pod Type 2A	pins 1, 2, 3, 5 & 6	0.26	0	40	150

Issued by:

Engineering, Testing and Certification Centre

2 Smith Street, REDBANK, QLD 4301, Australia
Postal Address: PO Box 467, GOODNA, QLD 4300, Australia
Phone: (07) 3810 6381 Fax: +617 3810 6366

SIMTARS
Quality System Certified to AS/NZS ISO 9001 Certification No 6039

STANDARDS AUSTRALIA

Standards Australia Quality Assurance Services Pty Limited A.C.N. 050 611 642

APPENDIX D – METHANE DETECTOR TESTING AND CERTIFICATION ASSESSMENT AND APPROVAL

The Dräger Polytron Gas (Methane) Detector Model IR Ex has been Tested and Certified by the Londonderry Occupational and Safety Centre (Certificate No. AUS Ex 3216X Issue 0) to be in conformity with the following Australian Standards.

AS 2275.1–1979 Combustible gas detection instruments for use explosive atmospheres – General requirements for explosion protection of electrical apparatus and systems

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

AS 1939–1990 Degrees of protection provided by enclosures of electrical equipment (IP code)

The Type of Protection is Ex ia s I/IIB+H_2 T6 IP54 and electrical parameters have been assigned under the 'entity concept'.

The Dräger Polytron Gas (Methane) Detector Model IR Ex has been Assessed and Approved for use in New South Wales underground coal mines (Approval No. MDA Exia 14190. Issue: A2508-0). The specific approval category is 'Explosion Protected – Intrinsically Safe'.

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New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2508

COAL MINES REGULATION ACT, 1982
NOTICE OF PRIMARY APPROVAL

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby APPROVED in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 6 and 7A of the Coal Mines Regulation (Approval of Items) Regulation, 1984.

This APPROVAL is issued to:	**Drager Australia Pty Ltd**
Address of Approval Holder:	**3 Ferntree Place NOTTING HILL Victoria 3168**
Approved Item:	**Polytron Gas Monitor**
Item Identification:	**IR Ex and IR CO_2**
CMRA Regulation:	**Coal Mines Regulation (Electrical - Underground Mines) Regulation, 1984**
CMRA Approval Clause:	**27 (b)**
Specific Approval Category:	**Explosion Protected - Intrinsically Safe**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act, 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to MANUFACTURERS and/or SUPPLIERS of Approved Items.

The Authority issuing the Approval has, for the purposes of the Occupational Health and Safety Act, 1983, appended a Schedule, (including drawings, documents, etc.) that are applicable to the approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the details included in the Schedule, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the approved item.

The Approval Number shall appear in a conspicuous place and in a legible manner on each approved item, unless specifically excluded.

A copy of this Approval Document together with a copy of the Schedule from the Authority issuing the Approval shall be supplied to each user of the approved item.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1982.

K. Fisher

K J Fisher
Accredited Assessing Authority (MDA-A2508)
for The Chief Inspector of Coal Mines

Minerals & Energy House, PO Box 536, St Leonards, NSW 2065, Australia
Telephone:(02)901 8888 Facsimile:(02)901 8777

LONGDERRY OCCUPATIONAL SAFETY CENTRE 919 Longdenry Road, Longdenry NSW 2763
Phone: (047) 244 900 Toll Free 1800 02 4205 Fax (047) 244 999

Reference

WORKCOVER NEW SOUTH WALES

QUALITY SYSTEM NATA CERTIFIED

Approval Schedule

This Schedule is issued in accordance with the Coal Mines Regulation Act, 1982, and forms an integral part of the Approval in respect of the apparatus described herein. A copy of this Schedule is required to supplied with the nominated Approval.

Apparatus Description

The Polytron Gas Monitors Models IR Ex and IR CO_2 are used for stationary, continuous monitoring of gas mixtures containing either hydrocarbons or Carbon-Dioxide by the process of Infra-Red (IR) absorption. The equipment consists of a display and keypad enclosure coupled to an IR cell contained within a splash guard to maintain degree of protection IP54. The monitor display is selectable to indicate gas concentrations as a percentage of volume or LEL and provides for the following gases:

Methane	-	0-100%
CO_2	-	0-25%

Applicable Drawings

Drawing No	Drawing Title	Issue	Date (d/m/yy)
8312042-D Shts 1 to 4	LP Messkopf Measure Head PCB (Polytron IR EX)	5	23/2/93
8312378-D/e	Folientastatur Membrane Switch (Polytron IR EX)	-	13/4/94
8312411-D/e	LP Temp. Sicherung. UGR. Mounted Temperature Fuse PCB (Polytron IR EX)	-	13/4/94
8312412-D/e Shts 1 to 3	LP Temperatursicherung Temperature Fuse PCB (Polytron) IR EX)	0	13/4/94
8312031-D/e Shts 1 & 2	Bestbild.Graphik - Display Mounted Graphik - Display	1	20/4/94
8312204-D/e	Splan LP Versorgung CD Power-Supply PCB (Polytron IR EX)	2	13/4/94
8312497-D Shts 1 & 2	Polytron IR	2	13/4/94
8312527-D/e	Kabel Cable	1	13/4/94
8312529-D/e Shts 1 & 2	Blockschaltbild Block Diagram (Polytron IR EX)	6	13/4/94
8312531-D/e	Isolierpappe Isolation Card Board	-	13/4/94
8312588-D/e Shts 1 to5	HB Strahlebruecke HB Source Bridge Unit (Polytron IR)	01	13/4/94
8312032-D/e Shts 1 & 2	LP Graphik-Display - Graphic-Display PCB (Polytron IR EX)	2	20/4/94
8312044-D	Splan LP Messkopf	6	15/3/93
8312497-D/e	Polytron IR	7	13/4/94
8355011-D Shts 1 & 2	Best.LP Sensor Mounted Sensor PCB (Polytron IR)	0	6/10/93
8355012-D Shts 1 & 2	LP Sensor PCB (Polytron IR)	0	6/10/93
8355014-D	Splan LP Sensor CD Sensor (Polytron IR)	0	6/10/93
8312044-D/e	Splan LP Messkopf CD Measure Head PCB (Polytron IR-EX)	5	13/4/94

LONDONDERRY OCCUPATIONAL SAFETY CENTRE, 91B Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free 1800 02 4205 Fax: (047) 244 999

Reference

WORKCOVER NEW SOUTH WALES

QUALITY SYSTEM NATA CERTIFIED.

Approval Schedule

This Schedule is issued in accordance with the Coal Mines Regulation Act, 1982, and forms an integral part of the Approval in respect of the apparatus described herein. A copy of this Schedule is required to supplied with the nominated Approval.

Applicable Drawings (continued)

Drawing No	Drawing Title	Issue	Date (d/m/yy)
8312362-D/e	EX-Schutz Blockschaltbild IR-Messkopf Polytron Ex-Block Diagram IR-Measure Head	-	13/4/94
8312202-D/e Shts 1 to 3	LP Versorgung Power-Supply PCB (Polytron IR-EX)	1	13/4/94
8312201-D/e Shts 1 & 2	Bestueckungsbild LP Versorgung Mounted Power-Supply (Polytron IR-EX)	3	13/1/94
8312041-D/e Shts 1 & 2	Best LP Messkopf Mounted Measure Head PCB (Polytron IR-EX)	6	13/4/94
6808278	OPT. Infrarot-Sensor (Approval AUS)	1	27/5/94
6808279	Heizung (Approval AUS)	00	24/5/94
6808292	OPT.Infrarot-Sensor (Approval AUS)	0	24/5/94
6808293	OPT. Infrarot-Sensor (Polytron) (Approval AUS)	00	24/5/94

Compliance Documents

a. Certificate of Conformity AUS Ex 3216X covering compliance with:

- AS 2380.1-1989 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - General Requirements
- AS 2380.7-1987 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - Intrinsic Safety 'i'
- AS 2275.1-1979 Electrical Equipment for explosive atmospheres - Combustible Gas Detection Instruments
- AS 1939-1990 Degrees of Protection Provided by Enclosures of Electrical Equipment (IP Code)

b. Department of Mineral Resources Mine Safety Unit Test Reports 97/236 and 97/235.

Conditions Of Manufacture And Safe Use

1. The apparatus has been assessed to the 'Entity' Concept and accordingly the following electrical parameters must be taken into account during installation:

Maximum Input voltage (U_i)	=	30 Volts
Maximum Input current (I_i)	=	300 milliamperes
Maximum Internal Capacitance (C_i)	=	0 F
Maximum Internal Inductance (L_i)	=	0 H

LONDONDERRY OCCUPATIONAL SAFETY CENTRE, 918 Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free 1800 02 4205 Fax (047) 244 999

Reference

COPY

WORKCOVER NEW SOUTH WALES

QUALITY SYSTEM NATA CERTIFIED

Approval Schedule

This Schedule is issued in accordance with the Coal Mines Regulation Act, 1982, and forms an integral part of the Approval in respect of the apparatus described herein. A copy of this Schedule is required to supplied with the nominated Approval.

Conditions Of Manufacture And Safe Use (continued)

2. It is a condition of safe use that the apparatus be fitted with splash guard Part No. 68 08 671 whilst in use.

3. At each mine where the apparatus is used the Manager shall ensure the apparatus is maintained in accordance with the current issue of Australian Standard 2290.3 'Electrical equipment for coal mines - Maintenance and overhaul - Part 3 Maintenance of gas detecting and monitoring equipment'.

K. J. Fisher

K J Fisher
Accredited Assessing Authority (MDA-A2508)
Londonderry Occupational Safety Centre

Certification of

COPY

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Certificate of Conformity

Certificate No: AUS Ex 3216X

Issue 0: Original Issue 17/2/1997
Issue 1:

Date of Expiry: 17/2/2007

Certificate Holder: Drager Australia Pty Ltd
3 Ferntree Place
NOTTING HILL Victoria 3168

Electrical Equipment: Polytron Gas Monitors Models IR Ex and IR CO_2

Type of Protection and Marking Code: Ex ia s I/IIB+H_2 T6 IP54
AUS Ex 3216X

Manufactured By: Dragerwerk AG
Moislinger Allee 53/55
23542 Luebeck Germany

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

STANDARDS AUSTRALIA

Standards Australia Quality Assurance Services Pty Limited A.C.N. 050 611 642

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Ex 3216X

This certificate is granted subject to the conditions as set out in Standards Australia Miscellaneous Publication MP 69 and the Procedures (Doc Q7134) of the scheme.

The electrical equipment and any acceptable variation to it specified in the schedule to this certificate and the identified documents, was found to comply with the following standards:

AS 2275.1-1979	Combustible gas detection instruments for use in explosive atmospheres - General requirements for explosion protection of electrical apparatus and systems
AS 2380.1-1989	Electrical equipment for explosive atmospheres - Explosion-protection techniques - General requirements
AS 2380.7-1987	Electrical Equipment for explosive atmospheres - Explosion-protection techniques - Intrinsic safety 'i'
AS 1939-1990	Degrees of protection provided by enclosures of electrical equipment (IP Code)

The equipment listed has successfully met the examination and test requirements as recorded in

Test Report No: LOSC 13651A

File Reference: LOSC 95/6925

K J Finale
Signed for and on behalf of issuing authority

Coordinator Approvals-Certification
Position

17/2/1997
Date of issue

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This certificate is not transferable and remains the property of Standards Australia Quality Assurance Services and must be returned in the event of its being revoked or not renewed.

Issued by:

WorkCover NEW SOUTH WALES

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STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Schedule

Certificate No: AUS Ex 3216X **Issue:** 0 **Date of Issue:** 17/2/1997

Certified Equipment: The Polytron Gas Monitors Models IR Ex and IR CO_2 are used for stationary, continuous monitoring of gas mixtures containing either hydrocarbons or Carbon-Dioxide by the process of Infra-Red (IR) absorption. The equipment consists of a display and keypad enclosure coupled to an IR cell contained within a splash guard to maintain degree of protection IP54. The monitor display is selectable to indicate gas concentrations as a percentage of volume or LEL and with some hydrocarbons PPM.

Conditions of Certification:

1. The equipment has been assessed to the 'Entity' Concept and accordingly the following electrical parameters must be taken into account during installation:

Maximum Input voltage (U_i)	=	30 Volts
Maximum Input current (I_i)	=	300 milliamperes
Maximum Internal Capacitance (C_i)	=	0 F
Maximum Internal Inductance (L_i)	=	0 H

2. It is a condition of safe use for Group I applications that the equipment be fitted with splash guard Part No. 68 08 671.

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

STANDARDS AUSTRALIA

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Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Addendum to Certificate No. Ex 3216X

Drawing Schedule

Drawing No	Drawing Title	Issue	Date (d/m/yy)
8312042-D Shts 1 to 4	LP Messkopf Measure Head PCB (Polytron IR Ex)	5	23/2/93
8312378-D/e	Folientastatur Membrane Switch (Polytron IR Ex)	-	13/4/94
8312411-D/e	LP Temp. Sicherung. UGR. Mounted Temperature Fuse PCB (Polytron IR Ex)	-	13/4/94
8312412-D/e Shts 1 to 3	LP Temperatursicherung Temperature Fuse PCB (Polytron) IR Ex)	0	13/4/94
8312031-D/e Shts 1 & 2	Besthild.Graphik - Display Mounted Graphik - Display	1	20/4/94
8312204-D/e	Splan LP Versorgung CD Power-Supply PCB (Polytron IR Ex)	2	13/4/94
8312497-D Shts 1 & 2	Polytron IR	2	13/4/94
8312527-D/e	Kabel Cable	1	13/4/94
2529-D/e Shts 1 & 2	Blockschaltbild Block Diagram (Polytron IR Ex)	6	13/4/94
2531-D/e	Isolierpappe Isolation Card Board	-	13/4/94
2588-D/e Shts 1 to5	HB Strahlebruecke HB Source Bridge Unit (Polytron IR)	01	13/4/94
8312032-D/e Shts 1 & 2	LP Graphik-Display - Graphic-Display PCB (Polytron IR Ex)	2	20/4/94
8312044-D	Splan LP Messkopf	6	15/3/93
8312497-D/e	Polytron IR	7	13/4/94
8355011-D Shts 1 & 2	Best.LP Sensor Mounted Sensor PCB (Polytron IR)	0	6/10/93
8355012-D Shts 1 & 2	LP Sensor PCB (Polytron IR)	0	6/10/93
8355014-D	Splan LP Sensor CD Sensor (Polytron IR)	0	6/10/93
8312044-D/e	Splan LP Messkopf CD Measure Head PCB (Polytron IR-Ex)	5	13/4/94
8312362-D/e	EX-Schutz Blockschaltbild IR-Messkopf Polytron Ex- Block Diagram IR-Measure Head	-	13/4/94
8312202-D/e Shts 1 to 3	LP Versorgung Power-Supply PCB (Polytron IR-EX)	1	13/4/94
8312201-D/e Shts 1 & 2	Bestueckungsbild LP Versorgung Mounted Power-Supply (Polytron IR-Ex)	3	13/1/94
8312041-D/e Shts 1 & 2	Best LP Messkopf Mounted Measure Head PCB (Polytron IR-Ex)	6	13/4/94
8312034-D/e	Splan LP Graphik - Display CD Graphic -Display (Polytron IR Ex)	3	20/4/94
90 23 253-GA4675.128d/e	Instructions for use	4	3/94
35 39593-06	Label Polytron IR	B	29/9/95
6808278	OPT. Inframt-Sensor (Approval AUS)	1	27/5/94
08279	Heizung (Approval AUS)	00	24/5/94
8292	OPT.Infrarot-Sensor (Approval AUS)	0	24/5/94
8293	OPT. Infrarot-Sensor (Polytron) (Approval AUS)	00	24/5/94

Issued by:

WorkCover New South Wales

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

STANDARDS AUSTRALIA

Standards Australia Quality Assurance Services Pty Limited A.C.N. 050 611 642

APPENDIX E – INTRINSICALLY SAFE POWER BARRIER TESTING AND CERTIFICATION ASSESSMENT AND APPROVAL

The Intrinsically Safe Power Barrier Type P001 has been Tested and Certified by TestSafe Australia (Certificate No. AUS Ex 3232X Issue 0) to be in conformity with the following Australian Standards.

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements (incorporating amendment 1)

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

AS 1939–1990 Degrees of protection provided by enclosures of electrical equipment (IP code)

The Type of Protection is Ex (ia) I and electrical parameters have been assigned under the 'entity concept'.

The Intrinsically Safe Power Barrier Type P001 has been Assessed and Approved for installation in a non-hazardous area in New South Wales underground coal mines to provide intrinsically safe power and signal connections to equipment located in a hazardous area (Approval No. Ex(ia)11661. Issue: 0-A2507). The specific approval category is 'Intrinsically Safe'.

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SYSTEMS APPROVALS PTY. LTD.

Postal Address: P.O.Box 45,
BOOLAROO, N.S.W. 2284.

A.C.N. 054191347.

Private Address: 14 Raymond St,
SPEERS POINT, N.S.W. 2284.
Phone: (02) 4958 6811.
Fax: (02) 4958 6827.
Mobile: 0418 685252.

The Manager,
Furzy Electronics Pty. Ltd.
155 (Lot 5) Regent St,
RIVERSTONE. N.S.W. 2765.

OUR REF: A1391.

FILE REF No.: C99/0736.

ATTENTION: **MICHAEL KABRIEL.**

ITEM APPROVAL

Dear Sir,

ITEM: **INTRINSICALLY SAFE POWER BARRIER.**

IDENTIFICATION: **P001.**

APPROVAL NUMBER: **Ex(ia)11661. ISSUE O - A2507.**

DESCRIPTION OF APPROVAL ITEM

The Type P001 barrier is designed for installation in a non-hazardous area to provide intrinsically safe power and signal connections to equipment located in a hazardous area.

Please find enclosed herewith the attached schedule, Approval Document, Approval Drawings, and relevant Supplementary Documentation.

Yours Faithfully,

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
For the Chief Inspector of Coal Mines

New South Wales

Department of Mineral Resources

Accredited Assessing Authority MDA-2507

NOTICE OF PRIMARY APPROVAL

APPROVAL No: **Ex(ia)11661. ISSUE O.**

FILE REF No: **C99/0736.**

DATE: **09/09/1999.**

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby **APPROVED** in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 6 and 7A of the Coal Mines Regulation (Approval of Items) Regulation, 1984.

This APPROVAL is issued to: **FURZY ELECTRONICS PTY. LTD.**

Address of Approval Holder: **155 (LOT 5) REGENT ST, RIVERSTONE. N.S.W. 2765.**

Description of Item: **INTRINSICALLY SAFE POWER BARRIER.**

Identification: **P001.**

C.M.R.A. Regulation: Electrical U/G. Clause 140 (1). **EXPLOSION PROTECTED.**

Specific Approval Category: **INTRINSICALLY SAFE. Ex(ia).**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to the MANUFACTURERS and/or SUPPLIERS of Approved Items.

The Authority issuing this Approval may, for the purposes of the Occupational Health and Safety Act, 1983, append a list of recommendations, (including drawings, documents, etc.) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the list of recommendations, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the Approved Item.

The Approval Number shall appear in a conspicuous place in a legible manner on each approved item, unless specifically excluded.

A copy of this Approval Document together with a copy of the recommendations from the Issuing Authority shall be supplied to each user of the Approved Item.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1983.

Albert Weeks

Albert Weeks

Accredited Assessing Authority - MDA - A-2507.

FOR CHIEF INSPECTOR OF COAL MINES

Minerals & Energy House, PO Box 536, St Leonards, NSW 1590, Australia

Telephone: (02) 9901 8888 Facsimile: (02) 9901 8777

SYSTEMS APPROVALS PTY. LTD.

Postal Address: P.O. Box 45,
BOOLAROO. N.S.W. 2284.

Private Address: 14 Raymond St,
SPEERS POINT .N.S.W. 2284.

APPROVAL No.: **Ex(ia)11661. Issue O.**

FILE REF No.: **C99/0736.**

DATE: **09/09/1999.**

DESCRIPTION OF APPROVED ITEM

The Type P001 power barrier is designed for installation in a non-hazardous area to provide intrinsically safe power and signal connections to equipment located in a hazardous area.

It consists of a number of printed circuit boards and a heat sink totally encapsulated in a metal enclosure with two connectors mounted opposite ends of the enclosure. The zener diodes, which provide voltage limitation, are mounted on the heat sink and the triplicated current limiting circuits are situated on printed circuit board 1. Current limiting resistors for the signal circuits are located on printed circuit board 4. There is one power connection, and two signal connections, into the hazardous area.

There are (4) types of barrier; Option 1 to Option 4 have a maximum power output current of 300mA, and Option 2 and Option 5 have a maximum power output current of 100mA.
All Options have a maximum power output voltage of 27.5V.

The (2) signal connections have a maximum output voltage of 5.355V and a maximum output current of 2.56mA for all Options.

INSTALLATION

Any barrier must be installed and earthed in accordance with AS2380.7.

OTHER INFORMATION

Gas - Group I (Methane)
Temperature Classification - Tamb. 40°C
Type of Protection - Ex(ia)
Degree of Protection - IP54
Hazardous Area - Zone 0-1-2
Australian Standards - AS2380.1-1989, AS2380.7-1987and AS1939-1990
Work Safe Test Report- 18964, Dated 29/07/1999
Certificate of Conformity - AusEx3632X Issue O Dated 02/08/1999

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

SYSTEMS APPROVALS PTY. LTD.

Postal Address: P.O. Box 45,
BOOLAROO. N.S.W. 2284.

Private Address: 14 Raymond St,
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APPROVAL No: Ex(ia)11661. Issue O.
FILE REF No: C99/0736.
DATE: 09/09/1999.

SCHEDULE 1 - ELECTRICAL PARAMETERS

Under the 'entity' concept the following parameters must not be exceeded -

Input Parameter	Input Connector
Max. Input Voltage Um	250V

Output Parameter	Output Connector Terminals A,B,C	Output Connector Terminals E,F,G,H	Output Connector Terminals J,K,L,M
OPTIONS 1 & 4			
Max. Uo	5.355V	27.5	27.5V
Max. Io	2.56mA	294mA	300mA
Max. Po	3.5mW	8.1W	8.1W
Max. Co	3000uF	1uF	1uF
Max. Lo	500mH	2.2mH	2.2mH
	Output Connector	Output Connector	Output Connector
OPTIONS 2 & 5	Terminals A,B,C	Terminals E,F,G,H	Terminals J,K,L,M
Max. Uo	5.355V	27.5	27.5V
Max. Io	2.56mA	94mA	100mA
Max. Po	3.5mW	2.7W	2.7W
Max. Co	3000uF	1uF	1uF
Max. Lo	500mH	6.73mH	6.73mH

SCHEDULE 2 - DRAWINGS

Drawing Number	Drawing Title	Issue	Date
DP0011	Type P001 barrier ex. system	1 Rev 2	20/7/99
	with P001 barriers		
OPTION 1			
SP0011 Shts. 1 to 7	Type P001 barrier option1	1 Rev H	19/7/99
	Uo<30V Io<300mA		
BP0011 Shts 1 to 5	Type P001 barrier option 1	1 Rev H	15/7/99
MP0011	Type P001 barrier option 1: bottom blank	1 Rev C	14/7/99
MP0013	Type P001 barrier option 1: top blank	1 Rev B	29/5/99
MP0015	Type P001 barrier option 1: label	1 Rev E	14/7/99
MP0016	Type P001 barrier option 1: GA	1 Rev E	19/7/99
MP0017	Type P001 barrier option 1: GA	1 Rev E	19/7/99
MP0018	Type P001 barrier option 1: GA	1 Rev E	14/7/99

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES

SYSTEMS APPROVALS PTY. LTD.

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APPROVAL No: Ex(ia)11661. Issue O.
FILE REF No: C99/0736.
DATE: 09/09/1999.

SCHEDULE 2 DRAWINGS - CONTINUED

Drawing Number	Drawing Title	Issue	Date
OPTION 2			
SP0012 Shts 1 to 7	Type P001 barrier option 2	1 Rev J	20/7/99
	Uo<30V Io<100mA		
BP0012 Shts 1 to 5	Type P001 barrier option 2	1 Rev H	15/7/99
MP0019	Type P001 barrier option 2: bottom blank	1 Rev B	14/7/99
MP001 A	Type P001 barrier option 2: top blank	1 Rev A	6/7/99
MP001 B	Type P001 barrier option 2: label	1 Rev B	14/7/99
MP001 C	Type P001 barrier option 2: GA	1 Rev D	19/7/99
MP001 D	Type P001 barrier option 2: GA	1 Rev D	19/7/99
MP001 E	Type P001 barrier option 2: GA	1 Rev B	14/7/99
OPTION 4			
SP0014 Shts 1 to 7	Type P001 barrier option 4	1 Rev A	19/7/99
	Uo<30V Io<100mA		
BP0014 Shts 1 to 5	Type P001 barrier option 4	1 Rev E	19/7/99
MP00141	Type P001 barrier option 4: bottom blank	1 Rev A	19/7/99
MP00143	Type P001 barrier option 4: top blank	1 Rev A	19/7/99
MP00145	Type P001 barrier option 4: label	1 Rev A	19/7/99
MP00146	Type P001 barrier option 4: GA	1 Rev A	19/7/99
MP00147	Type P001 barrier option 4: GA	1 Rev A	19/7/99
MP00148	Type P001 barrier option 4: GA	1 Rev A	19/7/99
MP00149	Type P001 barrier option 4: GA	1 Rev A	19/7/99
OPTION 5			
SP0015 Shts 1 to 7	Type P001 barrier option 5	1 Rev A	20/7/99
	Uo<30V Io<100mA		
BP0015 Shts 1 to 5	Type P001 barrier option 5	1 Rev E	20/7/99
MP00151	Type P001 barrier option 5: bottom blank	1 Rev A	20/7/99
MP00153	Type P001 barrier option 5: top blank	1 Rev A	20/7/99
MP00155	Type P001 barrier option 5: label	1 Rev A	20/7/99
MP00156	Type P001 barrier option 5: GA	1 Rev A	20/7/99
MP00157	Type P001 barrier option 5: GA	1 Rev A	20/7/99
MP00158	Type P001 barrier option 5: GA	1 Rev A	20/7/99
MP00159	Type P001 barrier option 5: GA	1 Rev A	20/7/99

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APPROVAL No.: Ex(ia)11661. Issue O.

FILE REF No.: C99/0736.

DATE: 09/09/1999.

SCHEDULE 3 - RECOMMENDATIONS FOR SUPPLY AND USE

1. Any repair to this apparatus that may affect its explosion protected properties shall be carried out only at a workshop registered for the purpose.

2. The manufacturer shall on his own responsibility carry out such tests and examinations as are necessary to ensure that this apparatus provides satisfactory operation in service.

3. All parts of this system that are not intrinsically safe shall be installed in an explosion protected enclosure, or be located in a safe area.

4. Adequate precautions shall be taken to guard against danger arising from interconnection of intrinsically safe sources of current, and the charging of intrinsically safe circuits by leakage or induction from other circuits.

5. No apparatus connected to the safe area terminals of any zener diode safety barrier shall be supplied from or contain underr normal or abnormal conditions a source of potential in excess of 250 volts rms.

6. Any power safety barrier used shall be installed and maintained strictly in accordance with AS2381.7

7. Earthing of power safety barrier shall be in accordance with clause 3.4 of AS2381.7

MARKING ON APPARATUS

It is a condition of this approval that each barrier be fitted with a label as per drawing number MP0015 with the following information displayed:

* **Identification Number**
* **U_m Max. Input Voltage**
* **U_o Max. Output Voltage**
* **I_o Max. Output Current**
* **C_o Max. External Capacitance**
* **L_o Max. External Inductance**
* **Approval No. MDA No. Ex(ia)11661**

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Certificate of Conformity

Certificate No: AUS Ex 3632X **Issue 0:** Original Issue 2/8/1999

Date of Expiry: 2/3/2009

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ISSUE NO. 001
SIGN [signature] DATE 16th Aug 1999

Certificate Holder: Furzy Electronics Pty Ltd
155 (Lot 5) Regent Street
RIVERSTONE, NSW 2765

Electrical Equipment: Type P001 Power Barrier

Type of Protection: Ex (ia)

Marking Code: Ex (ia) I
AUS Ex 3632X

Manufactured By: Furzy Electronics Pty Ltd
155 (Lot 5) Regent Street
RIVERSTONE, NSW 2765

Issued by:

Test Safe AUSTRALIA

919 Londonderry Road Londonderry NSW 2753
Phone: (02) 4724 4900 *Fax: (02) 4724 4999*

INTERNATIONAL QUALITY MANAGEMENT SYSTEM ISO 9002 NATA CERTIFIED

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Ex 3632X

This certificate is granted subject to the conditions as set out in Standards Australia Miscellaneous Publication MP 69 and the Procedures (Doc Q7134) of the scheme.

The electrical equipment and any acceptable variation to it specified in the schedule to this certificate and the identified documents, was found to comply with the following standards:

AS 2380.1-1989	Electrical equipment for explosive atmospheres - Explosion-protection techniques - General requirements (incorporating Amendment 1)
AS 2380.7-1987	Electrical Equipment for explosive atmospheres - Explosion-protection techniques - Intrinsic safety 'i'
AS 1939-1990	Degrees of protection provided by enclosures of electrical equipment (IP Code)

This certificate does not ensure compliance with electrical safety requirements and performance other than those included in the Standard(s) listed above

The equipment listed has successfully met the examination and test requirements as recorded in

Test Report No: TestSafe 18964

File Reference: TestSafe 99/9046

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ISSUE NO. 001

SIGN [signature] DATE 16th Aug 1999

Signed for and on behalf of issuing authority
Technical Services Manager
TestSafe Australia

Position

2/8/1999

Date of issue

This certificate and schedule may not be reproduced except in full.

This certificate is not transferable and remains the property of Standards Australia Quality Assurance Services and must be returned in the event of its being revoked or not renewed.

Issued by:

Test Safe AUSTRALIA

919 Londonderry Road Londonderry NSW 2753
Phone: (02) 4724 4900 *Fax: (02) 4724 4999*

INTERNATIONAL QUALITY MANAGEMENT SYSTEM ISO 9002 NATA CERTIFIED

STANDARDS AUSTRALIA

Schedule

Certificate No: AUS Ex 3632X **Issue:** 0 **Date of Issue:** 2/8/1999

Certified Equipment: The Type P001 Power Barrier is designed for installation in a non-hazardous area to provide intrinsically safe power and signal connections to equipment located in a hazardous area.

It consists of a number of printed circuit boards and a heat sink totally encapsulated in a metal enclosure with two connectors mounted at opposite ends of the enclosure. The zener diodes, which provide voltage limitation, are mounted on the heat sink and the triplicated current limiting circuits are situated on printed circuit board 1. Current limiting resistors for the signal circuits are located on printed circuit board 4. There is one power connection, and two signal connections, into the hazardous area.

There are four types of barrier; Option 1 and Option 4 have a maximum power output current of 300mA, and Option 2 and Option 5 have a maximum power output current of 100mA.All Options have a maximum power output voltage of 27.5V.

The two signal connections have a maximum output voltage of 5.355V and a maximum output current of 2.56mA for all Options.

Conditions of Certification:

1. It is a condition of safe use that that the following parameters shall not be exceeded:

Input Parameters	Input Socket
Maximum Input Voltage Um	250V

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SIGN J Kabriel DATE 16th Aug 1999

Issued by:

Test Safe AUSTRALIA

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INTERNATIONAL QUALITY MANAGEMENT SYSTEM ISO9002 NATA CERTIFIED

STANDARDS AUSTRALIA

Conditions of Certification: - continued

Output Parameters	Output Connector Terminals A, B and C	Output Connector, Terminals E and F	Output Connector, Terminals A to F
OPTIONS 1 and 4			
Maximum Output Voltage *Uo*	5.355 V	27.5 V	27.5 V
Maximum Output Current I_O	2.56 mA	294 mA	300 mA
Maximum Output Power P_O	3.5 mW	8.1 W	8.1 W
Maximum External Capacitance C_O	3000 µF	1 µF	1µF
Maximum External Inductance L_O	500 mH	2.2 mH	2.2mH
OPTIONS 2 and 5	Output Connector Terminals A, B and C	Output Connector, Terminals E and G	Output Connector, Terminals A and G
Maximum Output Voltage *Uo*	5.355 V	27.5 V	27.5V
Maximum Output Current I_O	2.56 mA	94 mA	100 mA
Maximum Output Power P_O	3.5 mW	2.7 W	2.7W
Maximum External Capacitance C_O	3000 µF	1 µF	1µF
Maximum External Inductance L_O	500 mH	6.73 mH	6.73mH

2. The apparatus is intended to supply either a Gas Sensor to AUS Ex 3216X or other suitably certified hazardous area apparatus.

Drawing Schedule

Drawing No	Drawing Title	Issue	Date
DP0011	Type P001 Barrier Example System with P001 barriers	1 revision 2	20 July 1999
OPTION 1			
SP0011, Shts 1-7	Type P001 Barrier Option 1 :Uo <30V Io <300mA	1 revision H	19 July 1999
BP0011, Shts 1-5	Type P001 Barrier Option 1	1 revision H	15 July 1999
MP0011	Type P001 Barrier Option 1 : bottom blank	1 revision C	14 July 1999
MP0013	Type P001 Barrier Option 1 : top blank	1 revision B	29 May 1999
MP0015	Type P001 Barrier Option 1 : Label	1 revision E	14 July 1999

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Test Safe AUSTRALIA

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INTERNATIONAL QUALITY MANAGEMENT SYSTEM ISO 9002 NATA CERTIFIED

STANDARDS AUSTRALIA

Ex 3632X

Addendum to Certificate No.....

Drawing Schedule - continued

Drawing No	Drawing Title	Issue	Date
MP0016	Type P001 Barrier Option 1 : general assembly	1 revision E	19 July 1999
MP0017	Type P001 Barrier Option 1 : general assembly	1 revision E	19 July 1999
MP0018	Type P001 Barrier Option 1 : general assembly	1 revision B	14 July 1999
OPTION 2			
SP0012, Shts 1-7	Type P001 Barrier Option 2 :Uo <30V Io <100mA	1 revision J	20 July 1999
BP0012, Shts 1-5	Type P001 Barrier Option 2	1 revision H	15 July 1999
MP0019	Type P001 Barrier Option 2 : bottom blank	1 revision B	14 July 1999
MP001 A	Type P001 Barrier Option 2 : top blank	1 revision A	6 July 1999
MP001 B	Type P001 Barrier Option 2 : label	1 revision B	14 July 1999
MP001 C	Type P001 Barrier Option 2 : general assembly	1 revision D	19 July 1999
MP001 D	Type P001 Barrier Option 2 : general assembly	1 revision D	19 July 1999
MP001 E	Type P001 Barrier Option 2 : general assembly	1 revision B	14 July 1999
OPTION 4			
SP0014, Shts 1-7	Type P001 Barrier Option 4 : Uo <30V Io<300mA	1 revision A	19 July 1999
BP0014, Shts 1-5	Type P001 Barrier Option 4	1 revision E	19 July 1999
MP00141	Type P001 Barrier Option 4 : bottom blank	1 revision A	19 July 1999
MP00143	Type P001 Barrier Option 4 : top blank	1 revision A	19 July 1999
MP00145	Type P001 Barrier Option 4 : label	1 revision A	19 July 1999
MP00146	Type P001 Barrier Option 4 : general assembly	1 revision A	19 July 1999
MP00147	Type P001 Barrier Option 4 : general assembly	1 revision A	19 July 1999
MP00148	Type P001 Barrier Option 4 : general assembly	1 revision A	19 July 1999
MP00149	Type P001 Barrier Option 4 : general assembly	1 revision A	19 July 1999
OPTION 5			
SP0015, Shts 1-7	Type P001 Barrier Option 5 : Uo<30V Io<100mA	1 revision A	20 July 1999
BP0015, Shts 1-5	Type P001 Barrier Option 5	1 revision E	20 July 1999
MP00151	Type P001 Barrier Option 5 : bottom blank	1 revision A	20 July 1999
MP00153	Type P001 Barrier Option 5 : top blank	1 revision A	20 July 1999
MP00155	Type P001 Barrier Option 5 : label	1 revision A	20 July 1999
MP00156	Type P001 Barrier Option 5 : general assembly	1 revision A	20 July 1999
MP00157	Type P001 Barrier Option 5 : general assembly	1 revision A	20 July 1999
MP00158	Type P001 Barrier Option 5 : general assembly	1 revision A	20 July 1999
MP00159	Type P001 Barrier Option 5 : general assembly	1 revision A	20 July 1999

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INTERNATIONAL QUALITY MANAGEMENT SYSTEM ISO9002 NATA CERTIFIED

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APPENDIX F – INTRINSICALLY SAFE GIZMO SWITCH TESTING, ASSESSMENT AND APPROVAL

The Intrinsically Safe Gizmo Switch Type P003 has been Tested by TestSafe Australia (Test Report No. 19758 dated 25 January 2000) in accordance with the following Australian Standards.

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements (incorporating amendment 1)

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

The Intrinsically Safe Gizmo Switch Type P003 has been Assessed and Approved for installation in New South Wales underground coal mines to delay the application of electrical power to a connected load (Approval No. MDA Exia 10169. Issue: A2586-00).

The specific approval category is 'Explosion Protected – Intrinsically Safe' and the degree of protection has been assessed as IP66/67. Electrical parameters have been assigned under the 'entity concept'.

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New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2586

COAL MINES REGULATION ACT, 1982

APPROVAL No : **MDA Exia 10169**
ISSUE : **A2586-00**
DATE : **21st February 2000**

NOTICE OF PRIMARY APPROVAL

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby APPROVED in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 74 and 77 of the Coal Mines Regulation (General) Regulation 1999.

This APPROVAL is issued to	:	**Furzy Electronics Pty Ltd**
Address of Approval Holder	:	**155A Regent Street RIVERSTONE NSW 2765**
Description of Item/s	:	**Intrinsically Safe Gizmo Switch**
Manufacturer	:	**Furzy Electronics Pty Ltd**
Model/Type	:	**P003**
C.M.R.A Regulation	:	**Coal Mines (Underground) Regulation 1999** Clause : **140 (1)**
Specific Approval Category	:	**Explosion Protected - Intrinsically Safe**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to the MANUFACTURERS and /or SUPPLIERS of Approved Items.

The Authority issuing this Approval has, for the purpose of the Occupational Health and Safety Act, 1983, appended a list of conditions / recommendations (including drawings, documents, etc.) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the list of conditions / recommendations, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the approved item.

The Approval Number shall appear in a conspicuous place and in a legible manner on each approved item, unless specifically excluded.

A copy of the Approval Documentation shall be supplied to each user of the approved item and shall comprise the number of pages listed in the footer block together with supplementary documentation as listed in the Schedule and in respect to drawings, <u>all</u> drawings as listed in the schedule or those drawings specifically nominated for the purposes of repair and maintenance.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1982.

L.R. Jego
Accredited Assessing Authority (MDA-A2586)
FOR CHIEF INSPECTOR OF COAL MINES

Minerals & Energy House. PO Box 536, St Leonards, NSW 2065, Australia
Telephone:(02)901 8888 Facsimile:(02)901 8777

New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2586

COAL MINES REGULATION ACT,
1982

APPROVAL No : **MDA Exia 10169**
ISSUE : **A2586-00**
DATE : **21st February 2000**

PRIMARY APPROVAL SCHEDULE

Apparatus Description :

The P003 Gizmo Switch is an electronic switch whose function is to delay the application of power to a connected load. The load is connected through the device without altering the output parameters of the power supply.

The equipment consists of a steel enclosure which houses a single printed circuit board encapsulated in Silicone RTV. The power supply and connected load are cable connected and glanded into the steel enclosure. The Degree of Protection has been assessed as IP66/67.

Compliance Documents :

Test Safe Australia (Londonderry) Test Report No. 19758 dated 25 January 2000
File No. 99/9389 TSA-001

Establishing compliance with :

* *AS2380.1 - 1989, General Requirements*
(Including Amendment No.1 - September 1998)

* *AS2380.7 - 1987, Intrinsic Safety i*

Approval Drawings :

Number	*Revision*	*Revision Date*
MP00311	*Issue 1 Rev 1*	*18/1/00*
MP00312	*Issue 1 Rev 1*	*18/1/00*
MP00313	*Issue 1 Rev 1*	*18/1/00*
MP00314	*Issue 1 Rev 1*	*18/1/00*
MP00315	*Issue 1 Rev 0*	*18/1/00*
SP0031	*Issue 1 Rev 0*	*14/12/99*
BP0031	*Issue 1 Rev 0*	*14/12/99*

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New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2586

COAL MINES REGULATION ACT, 1982

APPROVAL No : **MDA Exia 10169**
ISSUE : **A2586-00**
DATE : **21st February 2000**

PRIMARY APPROVAL SCHEDULE

Conditions for Supply and Use :

1. *It is the responsibility of the user of the Approved Item to conduct a site specific Operational Risk Assessment and to implement all Barriers identified in the Risk Assessment prior to the introduction of the Item into a Coal Mine in New South Wales.*

2. *A routine high voltage test on each unit manufactured shall be undertaken at 500V a.c. r.m.s applied between the incoming and outgoing wires and the enclosure earth for at least 1 minute, without any disruptive discharge.*

3. *The following Entity Concept Parameters shall be taken into account to ensure the Intrinsic Safety of the installed system :*

INPUT PARAMETERS

Maximum Input Voltage	U_i	*30V*
Maximum Input Current	I_i	*300mA*
Maximum Input Power	P_i	*9W*
Maximum Internal Capacitance	C_i	*0*
Maximum Internal Inductance	L_i	*0*

EQUIVALENT OUTPUT CABLE PARAMETERS

Maximum Equivalent Capacitance	C_{eq}	*0*
Maximum Equivalent Inductance	L_{eq}	*0*

NOTE :

* *The apparatus does not contain any energy creating or storing components and acts like a switch.*

* *The parameters of the incoming and outgoing cables to this device must be taken into account when assessing the suitability of a Power Supply to be used in conjunction with this switching device.*

L.R. Jego
Accredited Assessing Authority (MDA-A2586)
FOR CHIEF INSPECTOR OF COAL MINES

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APPENDIX G – DATA MODEM TESTING AND CERTIFICATION ASSESSMENT AND APPROVAL

The Barrier Unit (Data Modem) DAT-BAR1 forms part of the Intrinsically Safe Telephone System Type ST/1. The latter has been Tested and Certified by the Londonderry Occupational and Safety Centre (Certificate No. AUS Ex 3285X Issue 0) to be in conformity with the following Australian Standards.

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

AS 1939–1990 Degrees of protection provided by enclosures of electrical equipment (IP code)

The Data Modem's Type of Protection is Ex (ia) I and electrical parameters have been assigned under the 'entity concept'.

The Data Modem is intended to be installed in a safe area to allow interfacing of non-intrinsically safe data acquisition systems to the Intrinsically Safe Telephone System Type ST/1. The latter has been Assessed and Approved for installation in New South Wales underground coal mines (Supplementary Approvals Nos MDA Exi 0373. Issue: A2508-2 and MDA Exia 0373. Issue: A2507-1).

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SYSTEMS APPROVALS PTY. LTD.

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BOOLAROO. N.S.W. 2284.

A.C.N. 054191347.

Private Address: 14 Raymond St,
SPEERS POINT. N.S.W. 2284.
Phone: (02) 4958 6811.
Fax: (02) 4958 6827.
Mobile: 0418 685252.

The Manager,
Austdac Pty. Ltd.
2/4 Packard Ave,
CASTLE HILL. N.S.W. 2154.

OUR REF: SA1397.

FILE REF No.: **M76/2065.**

ATTENTION: **PHIL BROWN.**

ITEM SUPPLEMENTARY APPROVAL

Dear Sir,

ITEM: **INTRINSICALLY SAFE TELEPHONE SYSTEM.**

IDENTIFICATION: **ST/1.**

ORIGINAL APPROVAL No: ~~**MDA Exi.0373.**~~

PREVIOUS APPROVAL No.: **MDA Exi.0373. ISSUE A2508-2.**

ORIGINAL APPROVAL HOLDER: **AUSTDAC PTY. LTD.**

SUPPLEMENTARY APPROVAL No: **MDA Exia.0373. ISSUE A2507-1.**

DESCRIPTION OF APPROVAL ITEM

* Approval keywords changed from (Exi) to (Exia).

Please find enclosed herewith the attached schedule, Approval Document, Approval Drawings, and relevant Supplementary Documentation.

Yours Faithfully,

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES

New South Wales

Department of Mineral Resources

Accredited Assessing Authority MDA-2507

NOTICE OF SUPPLEMENTARY APPROVAL

SUPPLEMENTARY APPROVAL No: **Exia.0373. ISSUE 1.**

FILE REF No: **M76/2605.**

DATE: **24/09/1999.**

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby **APPROVED** in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 6 and 7A of the Coal Mines Regulation (Approval of Items) Regulation, 1984.

This APPROVAL is issued to: **AUSTDAC PTY. LTD.**

Address of Approval Holder: **2/4 PACKARD AVE, CASTLE HILL. N.S.W. 2154.**

Description of Item: **INTRINSICALLY SAFE TELEPHONE SYSTEM.**

Identification: **ST/1.**

C.M.R.A. Regulation: Electrical U/G. Clause 140(1). **EXPLOSION PROTECTED.**

Specific Approval Category: **INTRINSICALLY SAFE. Exia.**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to the MANUFACTURERS and/or SUPPLIERS of Approved Items.

The Authority issuing this Approval may, for the purposes of the Occupational Health and Safety Act, 1983, append a list of recommendations, (including drawings, documents, etc.) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the list of recommendations, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the Approved Item.

The Approval Number shall appear in a conspicuous place in a legible manner on each approved item, unless specifically excluded.

A copy of this Approval Document together with a copy of the recommendations from the Issuing Authority shall be supplied to each user of the Approved Item.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1983.

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES

Minerals & Energy House, PO Box 536, St Leonards, NSW 1590, Australia
Telephone: (02) 9901 8888 Facsimile: (02) 9901 8777

SYSTEMS APPROVALS PTY. LTD.

Postal Address: P.O. Box 45, BOOLAROO. N.S.W. 2284.

Private Address: 14 Raymond St, SPEERS POINT. N.S.W. 2284.

SUPPLEMENTARY APPROVAL No.: **Exia.0373. Issue 1.**
FILE REF No.: **M76/2605.**
DATE: **24/09/1999.**

DESCRIPTION OF APPROVED ITEM

Keyword 'Exi' is issued to cover a complete system either 'Exia' or 'Exib'. This can lead to confusion as to whether the hazardous are components of the system are 'Exib' or Exia'.
Clause (139.3.d) of the CMR (UG) 1999 require telephonic communication systems to be approved as 'Exia'.

ST/1 SYSTEM CLASSIFICATION - FROM TEST REPORT 14234, DATED JUNE 1996.

IS Telephones AD100 and AD101	**Exia I-IP65**
IS Telephones AD102	**Exia I-IP65**
Interface Unit ST/1/IU	**Ex(ia) I**
Barrier Unit DAT-BAR1	**Ex(ia) I**

The Intrinsically Safe Telephone System Type ST/I is designed to provide voice communication in underground coal mines as an extension of the surface telephone system.

ALLOWABLE VARIATIONS

* Optional use of IS telephones Types D101 and AD102 located in a hazardous area. Each telephone contains an audio amplifier, tone generator and other electronics powered from a rechargeable nickel cadmium battery pack, which is re-charged via telephone cable.
* Optional use of an encapsulated barrier unit Type DAT-BAR1 to allow interfacing of non-intrinsically safe data acquisition systems located in a safe are to an unused pair located in the intrinsically safe telephone cable.

SCHEDULE 1 - ELECTRICAL PARAMETERS

It is a condition of safe use that the electrical parameters of any cable used with the equipment not exceed the following values:

Connection Source

	3uF	3000uF
	28mH	3.8mH
	455uH/ohm	714uH/ohm

It is a condition of safe use that only intrinsically safe circuits having a source of potential not exceeding 30V dc be connected to the becon terminals of any telephone unit.

It is a condition of safe use that no apparatus connected to the safe area terminals of any interface or barrier unit be supplied at nor contain, under normal or abnormal conditions, a source of potential with respect to earth in excess of 250V rms or 250Vdc.

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

SYSTEMS APPROVALS PTY. LTD.

Postal Address: P.O. Box 45,
BOOLAROO. N.S.W. 2284.

Private Address: 14 Raymond St,
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SUPPLEMENTARY APPROVAL No.: **Exia.0373. Issue 1.**
FILE REF No.: **M76/2605.**
DATE: **24/09/1999.**

SCHEDULE 2 - DRAWING

AS PER ORIGINAL APPROVAL AND TEST REPORT No.14234

SCHEDULE 3 - RECOMMENDATIONS FOR SUPPLY AND USE

1. Any repair to this apparatus that may affect its explosion protected properties shall be carried out only at a workshop registered for the purpose.

2. The manufacturer shall on his own responsibility carry out such tests and examinations as are necessary to ensure that this apparatus provides satisfactory operation in service.

3. All parts of this system that are not intrinsically safe shall be installed in an explosion protected enclosure, or be located in a safe area.

4. Adequate precautions shall be taken to guard against danger arising from interconnection of intrinsically safe sources of current, and the charging of intrinsically safe circuits by leakage or induction from other circuits.

5. No apparatus connected to the safe area terminals of any interface or barrier unit shall be supplied from or contain under normal or abnormal conditions a source of potential in excess of 250V rms.

MARKING ON APPARATUS

1. The manufacturers' name or mark, and the approval number **MDA No. Exia.0373.** shall be inscribed in a durable manner in a prominent position on each part of the apparatus covered by this approval.

Albert Weeks
Accredited Assessing Authority - MDA - A-2507.
FOR CHIEF INSPECTOR OF COAL MINES.

New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2508

COAL MINES REGULATION ACT, 1982
NOTICE OF SUPPLEMENTARY APPROVAL

Approval No: MDA	Exi 0373
Issue:	A2508-2
CMRA File Number:	M76/2605
Date of Issue:	24/6/1996

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby APPROVED in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 6 and 7A of the Coal Mines Regulation (Approval of Items) Regulation, 1984.

This APPROVAL is issued to:	Austdac Pty Limited
Address of Approval Holder:	2/4 Packard Avenue CASTLE HILL NSW 2154
Description of Item/s:	Intrinsically Safe Telephone System
Item Identification:	ST/1
CMRA Regulation:	Coal Mines Regulation (Electrical - Underground Mines) Regulation, 1984
CMRA Approval Clause:	27 (b)
Specific Approval Category:	Explosion Protected - Intrinsically Safe

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act, 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to MANUFACTURERS and/or SUPPLIERS of Approved Items.

The Authority issuing the Approval has, for the purposes of the Occupational Health and Safety Act, 1983, appended a list of recommendations, (including drawings, documents, etc.) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the list of recommendations, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the approved item.

The Approval Number shall appear in a conspicuous place and in a legible manner on each approved item, unless specifically excluded.

A copy of this Approval Document together with a copy of the recommendations from the Authority issuing the Approval shall be supplied to each user of the approved item.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1982.

K. J. Fisher

K.J. Fisher
Accredited Assessing Authority (MDA-A2508)
for The Chief Inspector of Coal Mines

LONDONDERRY OCCUPATIONAL SAFETY CENTRE 132 Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free (008) 02 4205 Fax (047) 244 999

Reference

WORKCOVER NEW SOUTH WALES

QUALITY SYSTE NATA CERTIFIE ISO9002

List of Approval Recommendations

These recommendations are issued in accordance with the Coal Mines Regulation Act, 1982, in respect of the apparatus covered by the nominated Approval. A copy of these recommendations shall be supplied with the nominated Approval.

Approval No: MDA	**Exi 0373**
Issue:	**A2508-2**
File Number:	**M76/2605**
Date of Issue:	**24/6/1996**

APPARATUS DESCRIPTION

The Intrinsically Safe Telephone System Type ST/1 is designed to provide voice communication in underground coal mines as an extension of the surface telephone system.

ALLOWABLE VARIATIONS

1. Optional use of IS telephones Types AD101 and AD102 located in a hazardous area. Each telephone contains an audio amplifier, tone generator and other electronics powered from a rechargeable nickel cadmium battery pack, which is re-charged via telephone cable.

2. Optional use of an encapsulated Barrier Unit Type DAT-BAR1 to allow interfacing of non-intrinsically safe data acquisition systems located in a safe area to an unused pair located in the intrinsically safe telephone cable.

DRAWINGS RELATING TO ALLOWABLE VARIATIONS

Telephone Type AD101

022-01-0013 Sht 1	Issue 2	dated 29/9/92
022-01-0013 Sht 2	Issue 2	dated 6/11/92
022-01-0013 Sht 3	Issue 1	dated 28/4/92
022-01-0013 Sht 4	Issue 1	dated 28/4/92
022-01-0013 Sht 5	Issue 2	dated 29/9/92
022-01-0013 Sht 6	Issue 1	dated 28/4/92
052-01-0025	Issue 2	dated 29/9/92
990-01-1625 Sht 1	Issue 2	dated 28/4/92
990-01-1625 Sht 2	Issue 2	dated 28/4/92
26-07-13	Issue 1	dated 22/5/96
00-11-0097	Issue 2	dated 11/11/93

LONDONDERRY OCCUPATIONAL SAFETY CENTRE, 132 Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free (008) 02 4205 Fax (047) 244 999

Reference

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QUALITY SYSTE
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ISO9002

List of Approval Recommendations

These recommendations are issued in accordance with the Coal Mines Regulation Act, 1982, in respect of the apparatus covered by the nominated Approval. A copy of these recommendations shall be supplied with the nominated Approval.

Approval No: MDA	**Exi 0373**
Issue:	**A2508-2**
File Number:	**M76/2605**
Date of Issue:	**24/6/1996**

DRAWINGS RELATING TO ALLOWABLE VARIATIONS (continued)

Telephone Type AD 102

022-01-0015 Sht 1	Issue 4	dated 22/5/96
022-01-0015 Sht 2	Issue 4	dated 22/5/96
022-01-0015 Sht 3	Issue 3	dated 18/1/96
022-01-0015 Sht 4	Issue 4	dated 27/3/96
052-01-0029	Issue 4	dated 22/5/96
991-01-0178	Issue 1	dated 11/8/95
022-01-0014	Issue 5	dated 15/5/96
999-01-0625 Shts 1 & 2	Issue 2	dated 1/5/96
999-01-0627 Shts 1 & 2	Issue 2	dated 1/5/96
502-02-0398-001	Issue 2	dated 22/5/96
502-02-0399-001	Issue 2	dated 22/5/96

Barrier Unit Type DAT-BAR1

ISM-TYP-1	Issue B	dated 15/2/96
ISM-BAR-1	Issue D	dated 7/6/96
ISM-CRS-1	Issue C	dated 21/3/96
ISM-LAB-1	Issue B	dated 28/5/96
ISM-CON-1	Issue D	dated 11/6/96
DAT-PCB-1	Issue C	dated 15/2/96
DAT-PCB-2	Issue B	dated 15/2/96
DAT-PCB-3	Issue B	dated 15/2/96
DAT-PCB-4	Issue B	dated 15/2/96
ISM-LAB-2	Issue B	dated 28/5/96

LONDONDERRY OCCUPATIONAL SAFETY CENTRE, 132 Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free (008) 02 4205 Fax (047) 244 999

Reference

WORKCOVER NEW SOUTH WALES

QUALITY SYSTEM NATA CERTIFIED ISO9002

List of Approval Recommendations

These recommendations are issued in accordance with the Coal Mines Regulation Act, 1982, in respect of the apparatus covered by the nominated Approval. A copy of these recommendations shall be supplied with the nominated Approval.

Approval No: MDA	**Exi 0373**
Issue:	**A2508-2**
File Number:	**M76/2605**
Date of Issue:	**24/6/1996**

COMPLIANCE DOCUMENTS

Certificate of Conformity AUS Ex 3285X covering compliance with:

- AS 2380.1-1989 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - General Requirements
- AS 2380.7-1987 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - Intrinsic Safety 'i'
- AS 1939-1990 Degrees of Protection Provided by Enclosures of Electrical Equipment (IP Code)

CONDITIONS OF MANUFACTURE AND SAFE USE

1. It is a condition of safe use that the electrical parameters of any cable used with the equipment not exceed the following values:

Cable Parameter	Connection Source	
	Interface Unit ST1IU	Barrier Unit DAT-BAR1
Maximum Capacitance	3 µF	3000 µF
Maximum Inductance	28 mH	3.8 mH
Maximum L/R Ratio	455 µH/Ω	714 µH/Ω

2. It is a condition of safe use that only intrinsically safe circuits having a source potential not exceeding 30 V dc be connected to the beacon terminals of any telephone unit.

LONDONDERRY OCCUPATIONAL SAFETY CENTRE. 132 Londonderry Road, Londonderry NSW 2753
Phone: (047) 244 900 Toll Free (008) 02 4205 Fax (047) 244 999

Reference

WorkCover NEW SOUTH WALES

QUALITY SYSTEM NATA CERTIFIED ISO9002

List of Approval Recommendations

These recommendations are issued in accordance with the Coal Mines Regulation Act, 1982, in respect of the apparatus covered by the nominated Approval. A copy of these recommendations shall be supplied with the nominated Approval.

Approval No: MDA	Exi 0373
Issue:	A2508-2
File Number:	M76/2605
Date of Issue:	24/6/1996

CONDITIONS OF MANUFACTURE AND SAFE USE (continued)

3. It is a condition of safe use that the no apparatus connected to the safe area terminals of any interface or barrier unit be supplied at nor contain, under normal or abnormal conditions, a source of potential with respect to earth in excess of 250 V rms or 250 Vdc.

K. J. Fisher

K.J. Fisher
Accredited Assessing Authority (MDA-A2508)
Londonderry Occupational Safety Centre

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Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Certificate of Conformity

Certificate No: AUS Ex 3285X

Issue 0: Original Issue 24/6/1996
Issue 1:

Date of Expiry: 24/6/2006

Certificate Holder:
Austdac Pty Limited
2/4 Packard Avenue
CASTLE HILL NSW 2154

Electrical Equipment: Intrinsically Safe Telephone System Type ST/1

Type of Protection and Marking Code:

IS Telephones AD100 and AD101:	Ex ia I IP65
IS Telephone AD102:	Ex ia I IP55
Interface Unit ST/1/IU:	Ex (ia) I
Barrier Unit DAT-BAR1:	Ex (ia) I

AUS Ex 3285X

Manufactured By:

Telephone System:
NEI Mining Equipment Ltd
Burton-upon-Trent
DE14 2UH UK

Barrier Unit:
Nautitech Pty Ltd
Unit 45, 5 Anella Avenue
CASTLE HILL NSW 2154

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

QUALITY SYSTEM NATA CERTIFIED AS3902.ISO9002

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Ex 3285X

This certificate is granted subject to the conditions as set out in Standards Australia Miscellaneous Publication MP 69 and the Procedures (Doc Q7134) of the scheme.

The electrical equipment and any acceptable variation to it specified in the schedule to this certificate and the identified documents, was found to comply with the following standards:

AS 2380.1-1989 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - General Requirements
AS 2380.7-1987 Electrical Equipment for Explosive Atmospheres - Explosion-protection Techniques - Intrinsic Safety 'i'
AS 1939-1990 Degrees of Protection Provided by Enclosures of Electrical Equipment (IP Code)

The equipment listed has successfully met the examination and test requirements as recorded in

Test Report No: LOSC 14234

File Reference: LOSC 95/7318

K.J. Hale
Signed for and on behalf of issuing authority

Coordinator, Approvals & Certifica
Position

24/6/1996
Date of issue

This certificate and schedule may not be reproduced except in full.

This certificate is not transferable and remains the property of Standards Australia Quality Assurance Services and must be returned in the event of its being revoked or not renewed.

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

QUALITY SYSTEM NAQS CERTIFIED AS3902.ISO9002

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Schedule

Certificate No: AUS Ex 3285X Issue: 0 Date of Issue: 24/6/1996

Certified Equipment: The Intrinsically Safe Telephone System Type ST/1 is designed to provide voice communication in underground coal mines as an extension of the surface telephone system and consists of:

a. Interface Unit Type ST/1/IU, located on the surface, provides an electrical interface between essentially unspecified equipment located in the safe area and intrinsically safe telephones located in the hazardous area. The safe area equipment may optionally include surface batteries enable the system to function in the event of mains power failure.

b. IS telephones Types AD100, AD101 and AD102 located in a hazardous area. Each telephone contains an audio amplifier, tone generator and other electronics powered from a rechargeable nickel cadmium battery pack, which is re-charged via telephone cable.

c. Internonnecting cable.

Optionally the telephone system may be used in conjunction with an encapsulated Barrier Unit Type DAT-BAR1 to allow interfacing of non-intrinsically safe data acquisition systems located in a safe area to an unused pair located in the intrinsically safe telephone cable.

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

QUALITY SYSTEM NAQA CERTIFIED AS3902.ISO9002

STANDARDS AUSTRALIA

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Addendum to Certificate No. Ex 3285X

Conditions of Certification:

1. It is a condition of safe use that the electrical parameters of any cable used with the equipment not exceed the following values:

Cable Parameter	Connection Source	
	Interface Unit ST1IU	Barrier Unit DAT-BAR1
Maximum Capacitance	3 μF	3000 μF
Maximum Inductance	28 mH	3.8 mH
Maximum L/R Ratio	455 μH/Ω	714 μH/Ω

2. It is a condition of safe use that only intrinsically safe circuits having a source potential not exceeding 30 V dc be connected to the beacon terminals of any telephone unit.

3. It is a condition of safe use that the no apparatus connected to the safe area terminals of any interface or barrier unit be supplied at nor contain, under normal or abnormal conditions, a source of potential with respect to earth in excess of 250 V rms or 250 Vdc.

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

QUALITY SYSTEM NACA CERTIFIED AS3902.ISO9002

Certification of

EXPLOSION PROTECTED ELECTRICAL EQUIPMENT

Administered by: Standards Australia Quality Assurance Services

Addendum to Certificate No. Ex 3285X

Drawing Schedule

Drawing No	Drawing Title	Issue	Date
Telephone Type AD100			
022-01-0012 Sht 1	Auteldac 100 I.S. Mine Telephone circuit and mechanical details	2	5/7/89
022-01-0012 Sht 2	Auteldac 100 I.S. Mine Telephone typical assembly details	2	5/7/89
022-01-0012 Sht 3	Auteldac 100 I.S. Telephone service chamber and wiring details	2	5/7/89
022-01-0012 Sht 4	Auteldac 100 I.S. Mine Telephone circuit board detail	2	5/7/89
052-01-0023	Assembly: Battery Unit Type 052-02-0023-etc	1	20/6/89
40146D	Details of Mylar Cone Loudspeaker	1	30/4/87
15991D	Transformer Type ST1	1	28/11/74
26-06-13	AD100 Telephone Label Details	1	22/5/96
Telephone Type AD101			
022-01-0013 Sht 1	AutelDac 101 IS Mine Telephone circuit and mechanical details	2	29/9/92
022-01-0013 Sht 2	AutelDac 101 IS Mine Telephone Typical Assembly details	2	6/11/92
022-01-0013 Sht 3	AutelDac 101 IS Mine Telephone Service Chamber & wiring details	1	28/4/92
022-01-0013 Sht 4	Details of Mylar Cone Loudspeaker	1	28/4/92
022-01-0013 Sht 5	Transformer Type ST1	2	29/9/92
022-01-0013 Sht 6	P.C. Board ISMT002 Component layout and tracking	1	28/4/92
052-01-0025	Assembly: Battery Unit BP002 Type 052-02-0025, etc	2	29/9/92
990-01-1625 Sht 1	IMO Relay type G4D	2	28/4/92
990-01-1625 Sht 2	Assembly Details: G4D Relay/diode encapsulation	2	28/4/92
26-07-13	AD101 Telephone label details	1	22/5/96
00-11-0097	Typical Scheme showing Plessey 731 system IS1735 U/O Telephones and DAC ISMT002 Telephones to DAC surface units ST/1/IU	2	11/11/93

Issued by:

WORKCOVER NEW SOUTH WALES

Londonderry Occupational Safety Centre

132 Londonderry Road LONDONDERRY NSW 2753
Phone: (047) 244 900 Fax: (047) 244 999

QUALITY SYSTEM NAS CERTIFIED AS3902.ISO9002

STANDARDS AUSTRALIA

Drawing Schedule (continued)

Drawing No	Drawing Title	Issue	Date
Telephone Type AD 102			
022-01-0015 Sht 1	IS Mine Telephone Type ISMT003	4	22/5/96
022-01-0015 Sht 2	IS Mine Telephone Type ISMT003	4	22/5/96
022-01-0015 Sht 3	IS Mine Telephone Type ISMT003	3	18/1/96
022-01-0015 Sht 4	IS Mine Telephone Type ISMT003 Ea Notes	4	27/3/96
052-01-0029	Battery Unit Type BP003	4	22/5/96
991-01-0178	Transformer Type ST1	1	11/8/95
022-01-0014	Typical System ISMT002	5	15/5/96
999-01-0625 Shts 1 & 2	Main PCB Layout	2	1/5/96
999-01-0627 Shts 1 & 2	Keypad PCB Layout	2	1/5/96
502-02-0398-001	Label: Cert AD102 ISMT003 - Austdac	2	22/5/96
502-02-0399-001	Label: Battery Bracket - Austdac	2	22/5/96
Interface Unit Type ST/1/IU			
26-08-13	ST/1/IU Interface Label Details	1	22/5/96
001 999.03.0139 002	Interface Unit Assembly Details	12	10/4/85
047-01-0017 Sht 1	Interface Unit Type 047-02-0017	2	24/6/80
047-01-0017 Sht 2	Typical Arrangement of I.S. Telephone interface unit type 047-02-0017	2	24/680
991-03-0044	Transformer Assembly	5	23/4/85
015-97-0020 Sht 1	Typical arrangements mechanical details interface unit type ST/1/IU power supply and control unit type ST/1/PS	2	16/8/78
015-97-0020 Sht 2	Circuit diagram of safe telephone power supply and control unit type ST/1/PS	2	5/2/81
015-97-0040 Sht 1	Circuit diagram battery charger type ST/1/BC safe telephone system	1	5/2/81
015-97-0040 Sht 2	Circuit Diagram supply distribution and control unit type ST/1/DCU	1	5/2/81
015-97-0040 Sht 3	Typical arrangement of safe telephone battery charging unit type ST/1/BC	1	5/2/81
015-97-0040 Sht 4	Typical arrangement supply distribution and control unit, Type ST/1/ICU	1	5/2/81
017-99-0014 Sht 1	Safe telephone emergency desk	2	15/9/76

Drawing Schedule (continued)

Drawing No	Drawing Title	Issue	Date
Interface Unit Type ST/1/IU			
017-99-0014 Sht 2	Safe telephone emergency desk	2	21/10/76
017-99-0014 Shts 3 & 4	Safe telephone emergency desk	1	4/3/76
017-99-0014 Sht 5	Snatch Exchange Line Facility	1	14/10/76
995-03-4009-002	Zener Diode-Selected BZY93C27	2	25/1/94
Barrier Unit Type DAT-BAR1			
ISM-TYP-1	Typical arrangement Barrier Assembly	B	15/2/96
ISM-BAR-1	Data I.S. Barrier	D	7/6/96
ISM-CRS-1	Barrier Cross Section	C	21/3/96
ISM-LAB-1	Label - Barrier	B	28/5/96
ISM-CON-1	IS Modem - Interconnection	D	11/6/96
DAT-PCB-1	Data Barrier - PCB - Top layer	C	15/2/96
DAT-PCB-2	Data Barrier PCB-Bottom Layer	B	15/2/96
DAT-PCB-3	Data Barrier PCB - Top component Overlay	B	15/2/96
DAT-PCB-4	Data Barrier PCB - Bottom component Overlay	B	15/2/96
ISM-LAB-2	Label - Interface	B	28/5/96

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APPENDIX H – INTRINSICALLY SAFE BATTERY ASSEMBLY TESTING, ASSESSMENT AND APPROVAL

The Intrinsically Safe Battery Assembly Type P002 Option 3 has been Tested by SIMTARS (Test Report No. NI00/0004 dated 14 April 2000) in accordance with the following Australian Standards.

AS 2380.1–1989 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 1: General requirements (incorporating amendment 1)

AS 2380.7–1987 Electrical equipment for explosive atmospheres – Explosion-protection techniques – Part 7: Intrinsic safety i

The Type of Protection is Ex ia and electrical parameters have been assigned under the 'entity concept'.

The Intrinsically Safe Battery Assembly Type P002 Battery – Option 3 has been Assessed and Approved for installation in New South Wales underground coal mines as a backup power supply for data logging equipment (Approval No. MDA Exia 10186. Issue: A2586-00).

The specific approval category is 'Explosion Protected – Intrinsically Safe'. The electrical parameters assigned under the 'entity concept' differ from those of the Test Report.

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New South Wales

Department of Mineral Resources

Accredited Assessing Authority MDA-A2586

COAL MINES REGULATION ACT, 1982

APPROVAL No : **MDA Exia 10186**
ISSUE : **A2586-00**
DATE : **4 August 2000**

NOTICE OF PRIMARY APPROVAL

It is hereby notified that the Approved Item listed herein has been assessed for compliance with the Coal Mines Regulation Act and appropriate standards or requirements, and is hereby APPROVED in accordance with the requirements of the COAL MINES REGULATION ACT 1982. This approval is issued pursuant to the provisions of Clause 70 and 71 of the Coal Mines Regulation (General) Regulation 1999.

This APPROVAL is issued to	:	**Furzy Electronics Pty Ltd**
Address of Approval Holder	:	**155 Regent Street RIVERSTONE NSW 2765**
Description of Item/s	:	**Intrinsically Safe Battery Assembly**
Manufacturer	:	**Furzy Electronics Pty Ltd**
Model/Type	:	**P002 Battery - Option 3**
C.M.R.A Regulation	:	**Coal Mines (Underground) Regulation 1999** Clause : **140 (1)**
Specific Approval Category	:	**Explosion Protected - Intrinsically Safe**

This Approval is issued subject to compliance with the requirements of the Occupational Health and Safety Act 1983, with particular reference to Sections 15 to 17 of the said Act as it applies to USERS of Approved Items, and to Section 18 of the said Act as it applies to the MANUFACTURERS and /or SUPPLIERS of Approved Items.

The Authority issuing this Approval has, for the purpose of the Occupational Health and Safety Act, 1983, appended a list of conditions / recommendations (including drawings, documents, etc.) that are applicable to this approved item, as identified during test and/or assessment, to assist the Approval Holder and User to comply with the obligations of the Occupational Health and Safety Act, 1983. The onus is on the Supplier and/or User to ensure the Approved Item, and any deviation from the list of conditions / recommendations, in reference to that item is not inferior in any way to the item tested and/or assessed, this includes the supply, installation and continuing use of the approved item.

The Approval Number shall appear in a conspicuous place and in a legible manner on each approved item, unless specifically excluded.

A copy of the Approval Documentation shall be supplied to each user of the approved item and shall comprise the number of pages listed in the footer block together with supplementary documentation as listed in the Schedule and in respect to drawings, all drawings as listed in the schedule or those drawings specifically nominated for the purposes of repair and maintenance.

Any Maintenance, Repair or Overhaul of Approved Items shall be carried out in accordance with the requirements of the Coal Mines Regulation Act, 1982.

L.R. Jego
Accredited Assessing Authority (MDA-A2586)
FOR CHIEF INSPECTOR OF COAL MINES

Minerals & Energy House. PO Box 536, St Leonards, NSW 2065, Australia
Telephone:(02)901 8888 Facsimile:(02)901 8777

New South Wales
Department of Mineral Resources
Accredited Assessing Authority MDA-A2586

COAL MINES REGULATION ACT, 1982

APPROVAL No : **MDA Exia 10186**
ISSUE : **A2586-00**
DATE : **4 August 2000**

PRIMARY APPROVAL SCHEDULE

Apparatus Description :

An Intrinsically Safe Battery Assembly intended to be used as a backup power supply for data logging equipment.

The apparatus consists of four series connected 1.5V NiMH, infallible current limiting resistors and fuses with a triple diode protected and fused recharging facility. All components are encapsulated within a steel enclosure.

Compliance Documents :

SIMTARS Engineering, Testing & Certification Centre Test Report No. NI00 / 0004 dated 17 April 2000

Confirming compliance with :

AS 2380.1 - 1989, General Requirements
(Including Amendment No.1 - September 1998)

AS 2380.7 - 1987, Intrinsic Safety i

Approval Drawings :

Number	*Revision*	*Revision Date*
BP0023	*0*	*5th Oct 1999*
MP00231	*1*	*3rd March 2000*
MP00232	*0*	*10 Oct 1999*
MP00233	*0*	*10 Oct 199*
MP00234	*3*	*13th April 2000*
SP0023	*0*	*3rd Nov 1999*
MP00315	*0*	*10th March 2000*

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COAL MINES REGULATION ACT,
1982

APPROVAL No : **MDA Exia 10186**
ISSUE : **A2586-00**
DATE : **4 August 2000**

PRIMARY APPROVAL SCHEDULE

Conditions for Supply and Use :

1. *It is the responsibility of the user of the Approved Item to conduct a site specific Operational Risk Assessment and to implement all Barriers identified in the Risk Assessment prior to the introduction of the Item into a Coal Mine in New South Wales.*

2. *The following Entity Concept Parameters apply to the apparatus to ensure safety of the installed system :*

a. *The Maximum External Capacitance which may be connected to the output Terminals of the Battery* C_o = 5800μF ***only when the externally connected Inductance is zero.***

b. *The Maximum External Inductance which may be connected to the output Terminals of the Battery* L_o = 8.6mH , *or* L/R = 1228$\mu H/\Omega$ ***only when the externally connected Capacitance is zero.***

c. *Use of the apparatus with any simultaneous combination of Capacitance and Inductance will require a separate Approval.*

L.R. Jego
Accredited Assessing Authority (MDA-A2586)
FOR CHIEF INSPECTOR OF COAL MINES

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MINERAL RESOURCES NEW SOUTH WALES

NSW DEPARTMENT OF MINERAL RESOURCES
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18 August 2000

NSW Underground Coal Mines
Accredited Assessing Authorities
Inspectors of Coal Mines
Mine Safety Officers
TestSafe, Londonderry
SIMTARS, Qld
Department of Mines & Energy, Qld

Our ref: C99/0007
Contact: J F Waudby (02) 4942 2300

Dear Sir,

re: Assessment of Intrinsically Safe apparatus.

An intrinsically safe power supply was assessed against standard AS2380.7 "Electrical equipment for explosive atmospheres - Explosion-protection techniques, Part 7 - Intrinsic safety i". The ignition curves were used in this assessment and the assessment concluded conformance. Maximum external inductance and maximum external capacitance were determined using the relevant curves in the standard. However the effect of the combination of the power supply, maximum inductance and maximum capacitance was not assessed.

Serious concerns were raised that the power supply, maximum inductance and maximum capacitance connected together could cause the ignition of the test gas in the spark test apparatus. These concerns were increased when testing on a similar power supply with maximum inductance and capacitance ignited a test gas with a safety factor of 1.5. This matter has been raised with Standards Australia. Until this matter is resolved the Chief Inspector of Coal Mines will approve intrinsically safe apparatus assessed by using the ignition curves, only, if the combined power supply, external inductance and external capacitance pass the spark test. This position is consistent with standard AS/NZS 60079.11:2000 "Electrical apparatus for explosive gas atmospheres, Part 11: Intrinsic safety i".

Yours faithfully,

R Regan,
ASSISTANT DIRECTOR, SAFETY OPERATIONS

FILE NO.	DOCUMENT NAME	PAGE NO.	DATE	AUTHOR
C99/0007	C:\SAFETYOPERATIONS\ADSO-CICM\REGULATION\APPROVALS\ASSMNT OF IS APP AS2380.7& AS-NZS600079.11.DOC	PAGE 1 of 1	18/08/00	J F WAUDBY

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SIMTARS
Committed to Safety

SIMTARS
Engineering, Testing and Certification Centre

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Postal Address: PO Box 467, GOODNA, QLD, 4300 Australia

Phone +61 7 3810 6381
Fax +61 7 3810 6366

Test Report

Electrical Equipment for Explosive Atmospheres

Explosion-Protection Techniques

- ***AS 2380.1 - 1989,*** ***General Requirements***
  (Amendment 1, 5 September 1998)
- ***AS 2380.7 - 1987,*** ***Intrinsic Safety i***

Report No:	**NI00/0004**
Date of Issue:	17 April 2000
Job No.:	99/0124
Applicant/Customer Name:	Furzy Electronics Pty Ltd 155 Regent Street RIVERSTONE NSW 2765
Equipment Details:	Type P002 Battery - Option 3
Type of Protection:	Ex ia
Apparatus Group:	I
Temperature Class:	150°C (External surfaces) 450°C (Internal surfaces)
Ambient Temperature	-20°C to +40°C
Degree of Protection:	IP55
Hazardous Area:	Class I Zone 0; Underground Coal Mines

CHECKED: APPROVED SIGNATORY:

Test Report NI00/0004

TEST SUMMARY

1.0 DESCRIPTION OF APPARATUS

1.1 General

The battery assembly is used to backup power for data logging equipment i.e. RAM and Clock.

The equipment is installed in a safe area, and is only considered as Intrinsically Safe when mains power is de-energised i.e. for maintenance.

The batteries use infallible current limiting resistors protected against mains power when installed.

2.0 DRAWINGS

The drawings listed in Schedule 1 form part of this test report.

3.0 TEST SPECIFICATION

The equipment was tested to AS 2380.1-1989 and AS 2380.7-1987.

3.1 The following clauses of AS 2380.1 were applied:

1.1, 1.2, 1.7, 1.8, 2.1, 2.3, 2.9, 2.10, 4.1, 4.2, 4.4, 4.7, 5.1, 5.3, 5.5

The following tests of AS 2380.1 were not conducted:

- Clause 5.2.2: Drop Test

  The equipment is not a portable item and is permanently mounted.

- Clause 5.3: Degree of Protection Test

  Not required as the equipment is fully encapsulated and satisfies the requirements of AS 1939 for degree of protection IP55.

- Clause 5.6: Thermal Shock Test

  The equipment contains no glass parts or windows requiring testing.

- Clause 5.7: Insulation Resistance of Plastic Parts

  The equipment contains no external fans or rotating plastic parts requiring testing.

CHECKED: APPROVED SIGNATORY:

3.2 The following clauses of AS 2380.7 were applied:

1.1, 1.4, 1.5, 1.6, 1.8, 2.1, 2.2, 2.3, 2.4, 2.6, 2.8, 3.1, 3.2, 5.1, 5.6, 5.7, 6.1

The following tests of AS 2380.7 were not conducted:

- Clause 5.5: Tests with the Spark Test Apparatus

  The structure and electrical parameters of the equipment are sufficiently well defined to allow the ignition curves and method given in Appendix A of AS 2380.7 to be applied.

4.0 SUMMARY OF TEST RESULTS

The equipment complies with the relevant requirements of the standards as listed in Section 3 of this report for intrinsically safe electrical equipment with the following grouping and classification:

Ex ia I IP55
(-20 to +40°C ambient temperature range)

The equipment is suitable for installation in Class I Zone 0 hazardous areas and underground coal mines.

5.0 CONDITIONS

It is recommended that the following conditions of safe use be included in the certificate for the apparatus:

5.1 The entity parameters, as listed below (and as marked on the equipment), shall be observed:

Um = 250V

ENTITY PARAMETERS						
APPARATUS	*Uo* (V)	*Io* (mA)	*Po* (W)	GROUP I		
				Co (µF)	*Lo* (mH)	*L/R* (µH/Ω)
Type P002	6.4	225	0.24	5800	8.6	1228

6.0 ADDITIONAL INFORMATION

6.1 The cable must be terminated in a separately certified IP55 plug or terminal compartment to ensure that the enclosure maintains a minimum Degree of Protection of IP55.

CHECKED: APPROVED SIGNATORY:

Test Report NI00/0004

SCHEDULE 1

DRAWINGS

DRAWING NO	DRAWING TITLE	REV	DATE
BP0023	TYPE P002 BATTERY OPTION 3	0	5th Oct 1999
MP00231	Type P002 Battery General Assembly 1	1	3rd March 2000
MP00232	Type P002 Battery Bottom Blank	0	10 Oct 1999
MP00233	Type P002 Battery Top Blank	0	10 Oct 1999
MP00234	Type P002 Battery Label	3	13th April 2000
SP0023	TYPE P002 BATTERY OPTION 2	0	3rd Nov 1999
MP00315	Type P002 Battery General Assembly 2	0	10th March 2000

CHECKED: APPROVED SIGNATORY: