Electrical Equipment in Hazardous Areas: Field Inspections

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Abstract

Electrical equipment and installations that fall within explosive gas atmospheres are required to comply with the applicable regulations of the Australian State or Territory. The general requirements for the selection, installation and maintenance of electrical equipment for explosive gas atmospheres are detailed in AS/NZS 2381.1:2005. The requirements of this standard are mandatory and are called up in the applicable Acts or Regulations of each State or Territory.

An important requirement of AS 2381.1:2005 Section 4 is to ensure that installations are maintained in a satisfactory condition and shall be subject to **Electrical Equipment in Hazardous Areas (EEHA)** inspections**.**

1. Background: Why perform electrical equipment in hazardous areas inspections?

Perhaps you have heard the expression 'if it's not broken don't fix it'. The same can be said for Electrical Equipment in Hazardous Areas (EEHA) inspections and there is often a great deal of resistance from engineering and production managers to perform electrical inspections which may involve the isolation certain equipment or partial plant shutdown. It is a fact that if the electrical inspector lacks the necessary experience, the EEHA inspection could indeed do more harm than good, resulting in damage to electrical apparatus, tripping of electrical circuits or extended isolations. For this reason only competent personnel should be employed for the purpose of performing EEHA inspections. Using a competent electrical inspector will provide the owners or users of the plant with a condition assessment of the electrical installation in hazardous areas to ensure that it is maintained in a satisfactory condition. It is also a requirement of AS/NZS 2381.1:2005 Section 4 that EEHA inspections be performed on a regular periodic basis or under continuous supervision by competent personnel. The requirements of this standard are mandatory in Western Australia, where reference is made to Australian Standard 2381 in the *Electricity (Licensing) Regulations 1991 (WA).* Other Australian States and Territories have similar legislation referring to AS 2381.

Before embarking upon an inspection of electrical equipment within a hazardous area, the hazards associated with the flammable gas or vapour must be understood and the extent of the hazardous zone must be clearly defined. It is a fruitless exercise to begin an EEHA inspection without a clear definition of the hazardous zones. Internationally, the classification of hazardous areas has traditionally been carried out by individuals

representing the legal owners/users of the plant. Often these persons lack expertise in hazardous areas classifications as well as the specific knowledge of the properties of the flammable materials. As a result, inconsistencies may exist in the limits of the hazardous zones. However, in more recent times hazardous areas classification has tended to be carried out by professional multidisciplinary engineering consultancies specialising in hazardous locations classifications. The electrical inspector performing the EEHA inspection should verify that the existing area classification remains correct and that there have been no changes to plant or processes that may affect the hazardous zones.

2. The classification of hazardous locations and the selection of apparatus for such locations

Understanding the zone classification

Hazardous locations are classified into zones so as to facilitate the selection of the correct electrical apparatus and to ensure that the electrical design and installation meets the specified requirements to be used in different areas. The zone classification is based on the likelihood and the duration of an explosive atmosphere.

The zone classification for gases is divided into three zones, namely Zone 0, Zone 1 and Zone 2 and for dusts Zone 20, Zone 21 and Zone 22.

Definition of hazardous area zones (AS/NZS 60079.10):

Zone 0

"Place in which an explosive atmosphere consisting of a mixture with air of flammable substance in the form of gas, vapour or mist is present continuously for long periods or frequently"

It is the author's experience that a Zone 0 condition is rarely encountered and is limited mainly to confined spaces (such as the vapour space of closed process vessels, closed storage tanks and closed containers), although it can occur in larger rooms, such as chemical plants. From the Institute of Petroleum (IP 15) an exposure exceeding 1000 hours per year is often used.

Zone 1

"Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally"

A Zone 1 classification usually includes locations where volatile flammable liquids or liquefied flammable gasses are transferred; gas generator rooms; inadequately ventilated pump rooms for flammable gases or for volatile flammable liquids; and most other locations where hazardous concentrations of flammable vapours or gases can occur in the course of normal operations. IP 15 stipulates between 10 hours and 1000.

Zone 2

"Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only"

Generally, for an area to be classified as a Zone 2 location the following conditions shall normally be regarded as the minimum requirements for the area:

a) the area is so well ventilated that if an abnormal conditions arises, ignitable concentrations of the gas or vapour are rapidly dispersed; and
b) complete segregation from Zone 1 locations is ensured.

In this case an expose to flammable vapours or gases of less than 10 hours per annum is prescribed in IP 15.

Review: Has the appropriate apparatus for the zone classification been installed?

The table below lists the suitable electrical apparatus for Zone 0, Zone 1 and Zone 2 locations. From this table is can clearly be seen that electrical explosion protected flameproof (Ex d) equipment may not be installed in a Zone 0 location, although equipment certified for use a Zone 0 location may be installed in a Zone 1 or Zone 2 area. When performing an EEHA inspection, the suitability of the method of protection for the given zone will need to be verified.

Selection of Electrical Equipment for Zone 0, 1 and 2 Hazardous Areas

Description of Explosion Protection Technique	Designated Symbol	Comments
Zone 0 – Limited to the Following explosion protection techniques		
Intrinsically Safe	Ex ia	
Encapsulated	Ex ma	
Special Protection	Ex s	To Zone 0 requirements
Zone 1 – In addition to Zone 0 techniques the following methods are acceptable		
Intrinsically Safe	Ex ib	
Encapsulated	Ex mb or Ex m	
Special Protection	Ex s	To Zone 1 requirements
Increased Safety	Ex e	
Ventilation	Ex v	To Zone 1 requirements
Powder or Sand Quartz Filling	Ex q	
Flameproof	Ex d	
Oil Immersion	Ex o	
Pressurised rooms and enclosures	Ex p	To Zone 1 requirements
Zone 2 – In addition to Zone 0 and Zone 1 techniques the following methods are acceptable		
Special Protection	Ex s	To Zone 2 requirements
Ventilation	Ex v	To Zone 2 requirements
Pressurised rooms and enclosures	Ex p	To Zone 2 requirements
Non-sparking	Ex n	

Review: Class of hazard

Hazardous areas have traditionally been divided into two classes namely Class 1 and Class 2. Class 1 was for gases and vapours and Class 2 was for dusts. When performing electrical inspections, the class of the equipment would be noted on the Explosion Protection Certificate and on the Ex I.D. plate and should be recorded for inspection purposes. However, in 1999 Australia adopted the IEC system which does not refer to classes, and as such the class classification system is now obsolete in Australia.

Review: Gas group

When performing an electrical inspection, it is important to recognise that the criterion for determining if electrical apparatus is certified for use in a given location is not only based on the zone classification, but on the selection of the gas group and the temperature for the flammable atmosphere.

It is a common misconception that explosion protected apparatus suitable for a Zone 1 area such as Flameproof (Ex d) apparatus is automatically suitable for all Zone 1 locations. The gas group of the environment also needs to be considered.

Electrical equipment for hazardous gas areas is grouped as follows:

a) Group I – electrical equipment for mines susceptible to methane, and
b) Group II – electrical equipment for all places with an explosive gas atmosphere, other than mines susceptible to methane.

Group II is then further divided into subgroups IIA, IIB or IIC.

Note: if the equipment is certified for gas group IIA is may not be used in a group IIB or IIC environment. Equipment identified as suitable for gas group IIB can also be used for gas group IIA. If the equipment is certified for gas group IIC this encompasses use in gas group IIA, IIB, or IIC environments.

For example equipment certified for Zone 1 Ex d, IIB, T6 may not be used in explosive hydrogen environments as the gas group is IIC.

Ignition characteristics – gas groups

Gas / Vapour Group	Representative Test Gas
I	Methane
IIA	Propane
IIB	Ethylene
IIC	Hydrogen

Review: Surface temperature applicable to the flammable material

When determining the suitability of installed electrical apparatus for a hazardous area, the temperature class also needs to be reviewed. The temperature rating of the apparatus will be found on the Explosion Protection Certificate issued by the testing authority and on the Explosion Protected identification plate on the apparatus identified T1 to T6. The ignition temperatures of some flammable liquids, gases and volatile solids are given in AS/NZS 60079.20. Once the ignition temperature is determined, the electrical apparatus must be selected so that the maximum surface temperature that could cause in ignition of the flammable product is not exceeded.

For example if an explosion protected light fitting is rated T2 it may not be used in an explosive environment where the ignition temperature of the flammable gas is 290 ºC.

When performing an electrical inspection the temperature classes of the flammable substance(s) need to be reviewed and the suitability of the electrical apparatus verified.
Classification of maximum surface temperatures for group II electrical equipment

Temperature Class	Maximum Surface Temperature ºC
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

3. Determine the ignition characteristics of the flammable substance

In order to ensure that the electrical equipment has been suitably selected for a given flammable substance, the ignition characteristics should be clearly stated on the EEHA inspection document. It should be borne in mind that the final flammable product may consist of a mix of a number of flammable gases. The ignition information should be sourced from the Material Safety Data Sheet provided. However, experience has shown that this not always a reliable source of information for hazardous areas classification purposes and it is recommended that standard AS/NZS 60079.20:2000 (Electrical apparatus for explosive gas atmospheres Part 20: Data for flammable gas and vapours, relating to the use of electrical apparatus) be referred to when determining the temperature class and gas group. It should be noted that this standard does not cover mixtures that may be found in real life and special mixing rules are needed or worst case properties are often applied.

An example would be for product X used for protective coating for vehicle rims comprising more than one flammable substance:

Gas group and temperature class for product X.

Reference	Gas or Vapour	Ignition Temp	Temp Class	Group
112	Diisobutylamine	256 °C	T3	IIA
136	Ethane	515 °C	T1	IIA
184	Methane	537 °C	T1	IIA
272	Tetrahydrofuran	224 °C	T3	IIB

Suitable apparatus temperature rating T3, or T4, or T5, or T6
Suitable apparatus gas group II B, or II C

4. Determine the type of inspection

It is a requirement of AS/NZS 2381.1, *Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance, Part 1: General requirements,* Section 4, to ensure that the installations are maintained in a satisfactory condition for continued use within a hazardous area. In terms of this standard, the area shall be subject to either:

a) Regular periodic inspections; or
b) Continuous supervision by competent personnel and, where necessary, maintenance.

NOTE: Continuous supervision is intended to apply to plants where regular maintenance activities are undertaken by competent personnel (see IEC 60079-17).

The periodic inspection interval shall be based upon the expected rate of deterioration.

AS/NZS 2381.1, *Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance, Part 1: General requirements,* provides information on the types of inspection.

Initial inspection - An initial inspection shall be performed for all new installations before the plant is brought into service.

Periodic inspection – Periodic inspections are inspections of all equipment carried out on a routine basis. The inspections may be visual or close which may in turn lead to the need for a further detailed inspection.

Sample inspection – Sample inspections are inspections of a proportion of the installed electrical equipment. Sample inspections may be used to determine the intervals and grade of periodic inspection and never to reveal faults of a random nature.

5. Establish the grade of inspection

AS/NZS 2381.1, *Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance, Part 1: General requirements* also provides information on the grade of inspection.

The grade of inspection can be visual (V), close (C) or detailed (D); Table A1 details the specific checks required for these three grades of inspection. Visual and close inspections can be performed with the equipment energized. Detailed inspections will generally require the equipment to be isolated.

There are three grades of inspection identified:

- **Visual inspection** - A visual inspection is an inspection which identifies, without the use of access equipment or tools, those defects, e.g. missing bolts, which are apparent to the eye.

- **Close inspection** - A close inspection is an inspection which encompasses those aspects covered by a visual inspection and, in addition, identifies those defects, e.g. loose bolts, which will become apparent only when access equipment, e.g. steps (where necessary) and tools are used. Close inspections do not normally require the enclosure to be opened or the equipment to be de-energized.

- **Detailed Inspection** - A detailed inspection is an inspection which encompasses those aspects covered by a close inspection and, in addition, identifies those defects, e.g. loose terminations, which only become apparent when the enclosure is opened up, or by the use of tools and test equipment.

6. Determine the frequency of periodic inspections

The frequency of periodic inspections varies depending on the type of explosion protected equipment. When performing an EEHA inspection it is generally practical to inspect all types of explosion protected equipment during the same inspection.

Listed below are the Australian Standards inspection requirements for the various methods of protection.

NOTE: Not all explosion protection methods have been quoted.

AS/NZS 2381.2: **Flameproof Equipment** (Ex d), Appendix A, states that: "The interval between inspection periods shall not exceed **four years**, without seeking expert advice".

AS 2381.6: **Increased Safety** (Ex e), Appendix B, states that: "The interval between inspection periods shall not exceed **three years**, without seeking expert advice."

AS 2381.7: **Intrinsic Safety** (Ex i), Appendix C, states that: "In extremely adverse conditions, the interval between Periodic Inspections may be as low as three months but should not **normally exceed two years**. However, in extremely good, stable environmental conditions, the interval between inspections may be extended to four years, if it can be shown that this is justified, e.g. by a continuing zero fault rate over several successive inspection periods.

In addition to sample inspections, it is the author's recommended that the minimum requirement of a visual inspection of all equipment be carried out at least every two years. Depending on the rate of equipment deterioration (based on the results of the visual inspection) the interval between inspections periods may need to be reduced.

However, in consultation with an expert, the EEHA inspection interval of three or fours years may be appropriate in certain cases.

7. EEHA Inspectors: qualifications of personnel

The competency requirements of persons carrying out electrical work in hazardous areas have been an issue of debate for some time. At this stage, there is **no** mandatory assessment or formal qualification for persons carrying out electrical work and performing EEHA inspections in Western Australia. In certain countries a formal electrical qualification, achieved by a national examination, is required for taking responsibility for hazardous areas electrical installations and issuing a Certificate of Compliance. In Australia, competency **may** be demonstrated in accordance with AS/NZS 4761, *Competencies for working with electrical equipment for hazardous areas (EEHA),* or equivalent training and assessment framework. EEHA training and competency assessments are provided by a number of training institutions including certain TAFE colleges and registered training organizations. It is a requirement of AS/NZS 2381.1, *Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance*, Part 1: General requirements that the design, construction, maintenance, testing and inspection of installations covering electrical equipment in hazardous areas is carried out only by competent persons.

8. Inspecting intrinsically safe circuits

Inspecting intrinsically safe circuits can often be a source of confusion. Intrinsic safety is a design technique used in hazardous locations based on limiting energy (electrical and thermal) to a level below required to ignite a specific hazardous atmospheric mixture and is used extensively for Zone 0 and Zone 1 areas. Intrinsically safe circuits have an energy limiting device such as an Intrinsically Safe Barrier or Isolator and the intrinsically safe circuit should be clearly identified by the use of the light blue colour to identify the circuit. One of the main advantages is that non-certified "simple devices" can be used in hazardous locations. Therefore, do not make the mistake of automatically assuming that these passive (non energy storing) components are not suitable for use in a hazardous area.
Remember – simple devices may only be used in a hazardous area in conjunction with Intrinsically Safe energy limiting circuits.

Simple devices include:

- Limit switches;
- Pressure switches;
- Push button stations;
- RTDs; and
- Micro switches

9. Proposed EEHA inspection template

Every organisation or individual that performs EEHA inspections will have a different approach to carry site inspections.

The inspection requirements for flameproof equipment (Ex d) are provided in AS/NZS 2381.2:2006 Table A1 (Appendix A). There are similar inspection requirements for increased safety (Ex e) equipment which are provided in AS/NZS 2381.6:1993 Table B1 (Appendix B) and the inspection checks for intrinsic safety (Ex i) are listed in AS/NZS 2381.7:1989 Table C1 (Appendix C).

Each method of explosion protection requires specific checks. To facilitate efficient site inspections and verification, the checks have been combined on a single inspection template.

This inspection template should be suitable for most visual inspections of flameproof, increased safety and intrinsically safe equipment

EEHA Visual Inspection (sample)
ABC Manufacturing

Competent Person:	Bill Rankin
Signature:	
Date of Inspection:	25 July 2007
Contact Number:	0438 978 230
Area Inspected:	ABC Spray Booth No. 1
Flammable Substance:	Product X
Ignition Characteristics:	Gas Group IIB Temperature Class T4

					Equipment Checks								Installation			Environment			Ex d	Ex e	Ex i	Ex i	EX i	Ex i
					All Equipment								All			All								
Description	**Certification**	**Protection**	**Zone**	**Punch List 07-000 Reference No.**	1 Equipment is appropriate to area classification	2 Equipment gas group is correct	3 Equipment temperature class is correct	4 Equipment carries the correct circuit identification	5 Equipment is clearly marked	6 Enclosure, glasses, glass-to-metal sealing sat.	7 There are no unauthorized modifications	8 Bolts, glands, drain/entry plugs are complete	9 Earthing / equipotential bonding are satisfactory	10 No visible damage to equipment or cables	11 Special conditions (note 'X') are complied with	12 Equipment protected against environmental cond.	13 No undue accumulation of dust or dirt	14 Electrical installation is clean and dry	15 Sealing of trunking, ducts, pipes & conduits sat.	16 Glands certified Ex e or Ex d with IP washer	17 Segregation maintained – I.S. & non-I.S. circuits	18 I.S. circuits earthing accordance documentation	19 Earth connection maintains integrity protection	20 Barrier units, relays, and other energy limiting devices are of the correct type, and installed in accordance with the certification requirements and securely earth (if earthing required)
Extraction Fan Motor F101	Aus Ex 3402X	Ex d IIB T4	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
Extraction Fan Motor F201	Aus Ex 3402X	Ex d IIB T4	1	1	✓	✓	✓	✓	✓	✓	✓	✓	**X**	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Emergency Stop Push Button Q1	Aus Ex 610X	Ex d IIB T6	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-
Emergency Stop Push Button Q1	Aus Ex 610X	Ex d IIB T6	2		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-
I.S. Proximity Switch Z101	IEC Ex 02.304	Ex ia IIC T4	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓
Temp. Element (RTD) ZT201	None	Ex i (Simple)	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓
Incandescent Lamp L101	IEC Ex 02.3405	Ex e IIA T2	1	2	✓	**X**	**X**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-
Position Switch Z201	Aus Ex 528	Ex d IIC T6	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
Drum Motor	IEC Ex 04.704	Ex n IIC T4	1	3	**X**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
Ex Stop/Start Push Button Q2	PTB 85.C.2205	EEx e IIB T6	1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-

Proposed visual inspection template for explosion protected equipment (Ex d, Ex e, Ex i)

10. Performing site inspections: field recording template

When carrying out EEHA field surveys, it is convenient to record the information is a standardized format. Naturally the format will depend on what works effectively for each inspector.

A sample format is provided below that should be suitable for the majority of field surveys.

Area				**Zone**	
Identification				**I.S.**	
Description				**No.**	
Manufacturer				**Photo**	
Model No.		**Serial No.**			
Certification		**Protection**			
Comments					

With equipment information recorded…

Area	**Spray Booth No. 1**			**Zone**	**1**
Identification	**Tag No. UY101**			**I.S.**	**No**
Description	**Emergency Stop Push Button Station**			**No.**	**A1**
Manufacturer	**Govan**			**Photo**	**C22**
Model No.	**FC4 1-6**	**Serial No.**	**D16444**		
Certification	**Aus Ex 610X**	**Protection**	**Ex d IIB T6**		
Comments	**Equipment in satisfactory condition and suitable for continued use.**				

11. Site inspections: typical faults

There is great value in making use of an independent inspector to perform EEHA inspections as it may happen that the electrician(s) performing the day to day maintenance activities may not be aware that the installation is non compliant. The list below includes a list of typical equipment and installation faults that might be noted during the EEHA audit:

- The zone classifications have not been carried out or are no longer correct due to a process change;
- The use of non explosion protected equipment installed in hazardous areas;
- The equipment is certified for use in a hazardous area but the glands/adaptors are not explosion protected or missing stoppers or blanking plates;
- Unauthorised modifications to equipment – particularly additional cable entries drilled into flameproof (Ex d) junction boxes or extra holes drilled in increased safety (Ex e) fluorescent lights to facilitate mounting;
- The equipment does not hold Aus Ex, ANZ Ex or IEC Ex certification and a conformity assessment has not been completed;
- The IP washer has perished and no longer provides protection for Ex e equipment
- Damage to equipment and cables;
- Missing gaskets (where required) on flameproof (Ex d) equipment;
- Non sparking (Ex n) motors and luminaries used in a Zone 1 location;
- Equipment has been taken out of service for maintenance and the live conductors have not been correctly terminated and made safe;
- Missing / loose bolts on flameproof (Ex d) equipment;
- The Ex certification Identity Plate has faded and is no longer legible;
- The equipment holds Explosion Protection certification for dust (DIP) but is not suitable for gases;
- The use of non explosion protected equipment mounted inside increased safety (Ex e) enclosures;
- The ventilation (Ex v) or pressurization (Ex p) system has been switched off as it is 'too noisy';
- The use of increased safety (Ex e) polycarbonate push button stations in a chemical environment reacts with and severely damages the polycarbonate housing;
- A compound sealant has been applied to the mating flanges of flameproof (Ex d) apparatus to 'improve' the manufacturers design;
- Cracked glass or missing seals on explosion protected light fittings;
- Severe deterioration of cables and equipment caused by UV penetration and weathering;
- Intrinsically safe and non intrinsically safe circuits using cores of the same conductor;
- The use of non intrinsically safe proximity switches on intrinsically safe loops;
- The intrinsically safe barriers or isolators have been 'bridged' to facilitate production requirements; and
- Intrinsically safe circuits have not been earthed according to documentation.

12. Conclusion

It is anticipated that each inspection model will need to be tailored to the specific requirements of a given site and that all the methods explosion protection methods employed will need to be considered. I am hopeful that this broad and coherent model can be as a suitable template by EEHA inspectors for effective field surveys.

Appendix A

AS/NZS 2381.2:2006 Table A1

Inspection Schedule for Equipment with Type of Protection: 'd'

Check that:		Grade of Inspection			
A	**Equipment**	**D**	**C**	**V**	**Notes**
1	Equipment is appropriate to area classification	X	X	X	Refer Paragraph A3.1
2	Equipment gas group is correct	X	X		Refer Paragraph A3.2
3	Equipment temperature class is correct	X	X		Refer Paragraph A3.3
4	Equipment carries the correct circuit identification	X			Refer Paragraph A3.4
5	Equipment is clearly marked	X	X	X	Refer Paragraph A3.5
6	Enclosure, glasses, glass-to-metal sealing gaskets or compounds are satisfactory	X	X	X	Refer Paragraphs A3.6 and A3.7
7	There are no unauthorized modifications	X	X	X	Refer Paragraph A3.8
8	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight	X	X		Refer Paragraph A3.6
9	Flange faces are clean and undamaged and gaskets, if any, are satisfactory	X			Refer Paragraph A3.9
10	Flange gap dimensions are within permitted specifications	X	X		Refer Paragraph A3.9
11	Lamp ratings, type and position are correct	X			A detailed inspection is necessary after relamping
12	Motor fans have sufficient clearance to enclosures and covers	X			

Check that:		Grade			
B	**Installation**	**D**	**C**	**V**	**Notes**
13	Type of cable is appropriate	X			Refer Paragraph A3.10
14	There is no obvious damage to cables	X	X	X	
15	Sealing of trunking, ducts, pipes and conduits is satisfactory	X	X	X	
16	Stopper boxes and cable boxes are correctly filled	X			
17	Integrity of conduit system and interface with mixed system is maintained	X			
18	Earthing and equipotential bonding is satisfactory	X	X	X	Refer Paragraph A3.11
19	Insulation resistance is satisfactory	X			
20	Automatic electrical protection devices operate within permitted limits	X			
21	Automatic electrical protection devices are set correctly				
22	Special conditions of use (if applicable) are complied with	X	X		Refer Paragraph A3.12

Check that:		Grade			
C	**Environment**	**D**	**C**	**V**	**Notes**
23	Equipment is adequately protected against corrosion, weather, vibration and other adverse effects	X	X	X	Refer Paragraph 3.13
24	No undue accumulation of dust or dirt	X	X	X	Accumulation of dust or dirt can interfere with heat dissipation and result in surface temperature higher than permitted

Appendix B

AS 2381.6:1993 Table B1

Inspection Schedule for Equipment with Type of Protection: 'e'

Check that:		Grade of Inspection			
A	**Equipment**	**D**	**C**	**V**	**Notes**
1	Equipment is appropriate to area classification	X	X	X	Refer Paragraph B4.1
2	Are there any modifications	X	X	X	Refer Paragraph B4.2
3	Equipment temperature class is correct	X	X		Refer Paragraph B4.3
4	Equipment is clearly marked	X	X		Refer Paragraph B4.4
5	Equipment carries the correct circuit identification	X	X		Refer Paragraph B4.5
6	There are no unauthorised modifications	X	X	X	Refer Paragraph B4.11
7	There is no undue accumulation of dust or dirt	X	X	X	Accumulation of dust or dirt can result in surface temperatures higher than those permitted
8	Bolts, glands, drain plugs and entry plugs are complete and tight	X	X	X	
9	Condition of enclosure gaskets is satisfactory	X			
10	Motor fans and couplings are not rubbing on cowls/guards	X			
11	Guards are correctly fitted	X			
Check that:		**Grade**			
B	**Installation**	**D**	**C**	**V**	**Notes**
12	Earthing and equipotential bonding are satisfactory	X	X	X	Refer Paragraph B4.7
13	Electrical connections are tight	X			Refer Paragraph B4.8
14	There is no visible damage to equipment or cables	X	X	X	Refer Paragraph B4.9
Check that:		**Grade**			
C	**Environment**	**D**	**C**	**V**	**Notes**
15	Equipment is adequately protected against corrosion, moisture, vibration, excess temperature, and other adverse factors	X	X	X	Refer Paragraph B4.9
16	Electrical protection is satisfactory	X			Refer Paragraph B4.10
17	Lamp rating and type are correct	X			A detailed inspection is necessary after replacing a lamp
18	Installation is in compliance with documentation	X	X		Refer Paragraph B4.11

Appendix C

AS 2381.7:1989 Table C1

Inspection and Test Schedule for Intrinsically Safe (Ex i) Installations

Check that:		Type of Inspection			
		Detailed	Periodic	Visual	Notes
1	System or equipment is appropriate to area classification	All	All	All	Refer Paragraph C2.1
2	Are there any modifications	All	Sample	All	Refer Paragraph C2.2
3	System group is correct	All	Sample	-	Refer Paragraph C2.3
4	Electrical temperature class is correct	All	Sample	-	Refer Paragraph C2.4
5	Equipment or system is clearly marked	All	Sample	-	Refer Paragraph C2.5
6	Equipment or system carried correct circuit identification	All	Sample	-	Refer Paragraph C2.6
7	There are no unauthorised modifications to type and rating of readily accessible lamps and fuses	All	Sample	All	Refer Paragraph C2.7
8	Barrier units, relays, and other energy limiting devices are of the correct type, and installed in accordance with the certification requirements and securely earth (if earthing required)	All	All	All	Refer Paragraph C2.8
9	Segregation is maintained between intrinsically safe and non-intrinsically safe circuits in marshalling boxes or relay cubicles	All	All	All	Refer Paragraph C2.9
10	Cabling installed in accordance with the documentation	All			Refer Paragraph C2.10
11	Cable screens are earthed in accordance with the documentation	All	Sample	-	Refer Paragraph C2.11
12	Intrinsically safe circuits is earthing in accordance with documentation	All	All	All	Refer Paragraph C2.12
13	Earth connections maintain integrity of type of protection	All	All	All	Refer Paragraph C2.13
14	Earth continuity is satisfactory	All	-	-	Refer Paragraph C2.12/Clause 4.4.3
15	Electrical connections are tight	All	Sample	-	Refer Paragraph C2.13
16	Point to point connections are all correct	All	-	-	
17	There is no visible damage to equipment or cables and there is no undue accumulation of dust or dirt	All	All	All	Refer Paragraph C2.14
18	Equipment is adequately protected against corrosion, moisture, vibration, excessive temperature, and other adverse factors	All	All	All	Refer Paragraph C2.14
19	Installation is in compliance with documentation	All	Sample	-	Refer Paragraph C2.15

NOTE: ‘Detailed’, ‘Periodic’ and ‘Visual’ inspections, and ‘Sample’ are detailed in AS 2381.7 Paragraph C1.