

Subject:

Inspection and maintenance of
electrical equipment installed
in hazardous areas

NKTECHNICAL INFORMATION

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To: Shipowners and Shipbuilders concerned

IACS has published a Recommendation "Inspection and Maintenance of Electrical Equipment Installed in Hazardous Areas" (Recommendation No.35). Application of this recommendation is not mandatory, but it covers details concerning inspection and maintenance of electrical equipment installed in hazardous areas and a copy of the text is given in the attached hereto for your reference.

Attachment: IACS Recommendation No.35

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No. 35 Inspection and Maintenance of Electrical Equipment Installed in Hazardous Areas

(1992)

Introduction

Electrical installations in hazardous areas possess features specially designed to render them suitable for operation in such atmospheres. It is essential for reasons of safety in those areas that, throughout the life of such installations, the integrity of those special features is preserved: they therefore require INITIAL inspection and either:

1. regular PERIODIC INSPECTIONS thereafter or
2. continuous supervision by skilled personnel (See 3.2.)

and when necessary, maintenance.

Note:

Correct functional operation of hazardous areas installations does not mean, and should not be interpreted as meaning that the integrity of the special features referred to above is preserved.

1. Scope

This document is to be regarded as a guide for owners (or their representatives), builders and Surveyors. It covers factors directly related to the inspection and maintenance of the electrical equipment comprising certified safe type electrical apparatuses, installed within hazardous areas. Application of this guide, either totally or in part, is the responsibility of builders regarding new installation and of owners (or their representatives) for equipment maintenance.

The document does not include conventional requirements for electrical installations nor for testing or certification purposes.

Note:

This guide is supported by the IEC Report 79-17 (1990): "Recommendations for Inspection and Maintenance of Electric Installations in Hazardous Areas (other than mines):".

2. Definitions

2.1. Maintenance

A combination of any actions carried out to retain an item in, or restore it to, conditions in which it is able to meet the requirements of the relevant specifications and perform its required functions.

2.2. Inspection

An action comprising careful scrutiny of an item carried out either without dismantling, or with the addition of partial dismantling as required, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of this item.

3. General

3.1. Documentation

Up-to-date information should be available about:

- 3.1.1. the classification of hazardous areas,
- 3.1.2. apparatus group and temperature class,
- 3.1.3. list and location of apparatus, spares,
- 3.1.4. technical data apparatus.

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3.2. Qualifications of personnel

The inspection and maintenance of installations should be carried out by personnel whose training has included instruction on the various types of protection and installation practices, relevant rules and regulations and on the general principles of area classification. Appropriate refresher training should be given to such personnel on a regular basis.

Qualified personnel responsible for inspection or maintenance works should be appointed by owners and builders, in accordance with the applicable rules and regulations.

3.3 Inspections

3.3.1 General

Before plant or apparatus is brought into service it should be given an INITIAL INSPECTION and then subsequently, periodically, re-inspected to ensure that the installation is being maintained in a satisfactory condition for continued use within a hazardous area.

To predict accurately an appropriate PERIODIC INSPECTION interval may not be easy but it should be fixed. The major factors governing the deterioration of apparatus and therefore the appropriate periodic inspection interval are:

- . susceptibility to corrosion,
- . exposure to chemicals or solvents,
- . likelihood of accumulation of dust, dirt or sand,
- . likelihood of water ingress,
- . exposure to excessive ambient temperatures,
- . exposure to U.V. radiation,
- . risk of mechanical damage,
- . exposure to undue vibrations,
- . training and experience of personnel,
- . likelihood of unauthorised modifications or adjustments,
- . likelihood of inappropriate maintenance.

Following any replacement, repair, modification or adjustment, the items concerned should be inspected in accordance with the relevant items of Tables 1, 2 and 3.

If there is a change in the area classification or if any apparatus is moved from one location to another, a check should be made to ensure that the type of protection, apparatus group and temperature class are suitable for the revised conditions.

When large numbers of similar items such as luminaries, junction boxes, are installed in similar environment, it may be feasible to carry out PERIODIC INSPECTIONS on a sample basis, provided that all items are subjected, at least, to VISUAL INSPECTION.

If plant or apparatus is dismantled during the course of an inspection, precautions should be taken during reassembly to ensure that the integrity of the type of protection is not impaired.

3.3.2 Types of inspection

a) INITIAL INSPECTIONS

INITIAL INSPECTIONS are inspections of all the electrical apparatus, systems and installations before they are brought into service.

They are to be DETAILED as referred to in Tables 1, 2 and 3, as appropriate. The results of INITIAL INSPECTIONS should be recorded.

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b) PERIODIC INSPECTIONS

PERIODIC INSPECTIONS are inspections of all apparatus carried out on a routine basis. They may be **VISUAL** or **CLOSE** as referred to in Tables 1, 2 and 3, as appropriate.

A **VISUAL** or **CLOSE PERIODIC INSPECTION** may lead to the need to a further **DETAILED INSPECTION**.

The grade of inspection and the interval between **PERIODIC INSPECTIONS** should be determined taking into account the type of equipment, manufacturers' guidance, if any, the major factors governing its deterioration (see 3.3.1.), the zone of use and the results of previous inspections.

The interval between **PERIODIC INSPECTIONS** or cycle of the continuous survey should not exceed five years. Nevertheless, where equipment is continuously under the supervision of skilled personnel, the inspection intervals may be further extended or the inspection eliminated, where it is permitted by the applicable rules and regulations.

The results of all **PERIODIC INSPECTIONS** should be recorded.

c) SAMPLE INSPECTIONS

SAMPLE INSPECTIONS are inspections of a portion of the installed apparatus. They may be **VISUAL**, **CLOSE** or **DETAILED**. The size and composition of all Samples should be determined having regard to the purpose of the inspection.

The results of all **SAMPLE INSPECTIONS** should be recorded.

3.3.3 Degree of inspection

The degree of inspection can be **VISUAL**, **CLOSE** or **DETAILED**. Tables 1, 2 and 3 detail the specific checks required for these three degrees of inspection.

– 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 will be apparent to the naked eye.

– Close inspection

A **CLOSE INSPECTION** is an inspection which encompasses the aspects covered by a **VISUAL INSPECTION** and, in addition, identifies those defects, e.g. loose bolts, which will be apparent only by the use of access equipment, e.g. scales, (where necessary), or tools, e.g. wrench or screw driver. **CLOSE INSPECTIONS** do not normally require the enclosure to be opened or the equipment to be deenergized.

– Detailed inspection

A **DETAILED INSPECTION** is an inspection which encompasses the aspects covered by a **CLOSE INSPECTION** and, in addition, identifies those defects, e.g. loose terminations, which will only be apparent by opening-up the enclosure and/or using, where necessary, tools and test equipment.

3.4. Maintenance recommendations**3.4.1. Alterations to apparatus**

The general condition of all apparatus should be noted periodically and appropriate remedial measures should be taken where necessary.

Care should be taken to maintain the integrity of the type of protection provided for the apparatus; this may require consultation with the manufacturer. Replacement parts should be in accordance with the safety documentation. Alterations to apparatus should not be carried without authority, where they may adversely affect the safety of the apparatus; in such case, the modified apparatus should be re-certified by an independent competent institution.

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Alterations should be reported to the Society with every necessary documentation.

- Notes:
- Care should be taken to preserve the means of employed by the manufacturer to reduce the effects of static electricity.
 - When replacing lamps in luminaries, the correct rating and type should be used or excessive temperature may result.
 - The etching, painting or screening of light transmitting parts or the incorrect positioning of the luminaire may lead to excessive temperatures.

3.4.2. Maintenance of flexible cables

Flexible cables, flexible conduits and their terminations are particularly prone to damage. They should be inspected at regular intervals and should be replaced or reconditioned if found to be damaged or defective.

3.4.3. Withdrawal from service

Should it be necessary for maintenance purposes to withdraw apparatus, etc, from service, the exposed conductors should be terminated in an appropriate certified enclosure; alternatively, the cable may be protected adequately by insulating the ends of the conductors and isolating the cable from all sources of power supply. Should the apparatus be permanently withdrawn from service, associated wiring should be removed, or, alternatively, otherwise correctly terminated by an appropriate certified enclosure.

3.4.4. Fastenings and tools

Where special bolts and other fastenings or special tools are required, these items should be available and should be used.

3.5. Environmental conditions

Electrical apparatus in a hazardous area can be adversely affected by the environmental conditions in which it is used. Some of the key elements to consider are corrosion, ambient temperature, ultraviolet radiation, ingress of water, accumulation of dust or sand, mechanical effects and chemical attack.

The corrosion of metal, or the influences of chemicals (particularly solvents) on plastic or elastomeric components may affect the type and degree of protection of the apparatus. If the enclosure of component is severely corroded, the part should be replaced. Plastic enclosures may exhibit surface cracking which can affect the integrity of the enclosure. Metallic enclosures of apparatus should, where necessary, be treated with an appropriate protective coating as a precaution against corrosion, the frequency and nature of such a treatment being determined by the environmental conditions.

All parts of installations should be kept clean and free from accumulations of dust and deteriorious substances of such a nature as could cause excessive rise in temperature.

Care should be taken to ensure that the weather protection of the apparatus is maintained. Damaged gaskets should be replaced.

Anticondensation devices, such as breathing, draining or heating elements should be checked to ensure correct operation.

If the apparatus is subject to vibration, special care should be taken to ensure that bolts and cable entries remain tight.

Care should be taken to avoid the generation of static electricity during the cleaning of non-conductive electrical apparatus. In particular, the cleaning of plastic transparent pieces of the luminaries should be done with wet cloth.



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3.6. Isolation of apparatus

3.6.1. Installations other than intrinsically safe circuits

- a) Electrical apparatus containing live parts which are not intrinsically safe and which is located in a hazardous area should not be opened (except as described in (b) or (c)) without isolating all incoming and, where necessary, outgoing connections. Isolation in this context means withdrawal of fuses and links or the locking off of an isolator or switch. The enclosure should not be opened until sufficient time has been allowed to permit any surface temperature or stored electrical energy to decay to a level below which it is incapable of causing ignition.
- b) If, for the period of time needed for the proposed work, absence of a flammable atmosphere can be guaranteed, e.g. by means of appropriate measurements, essential work, for which the exposure of live parts is necessary may be carried out subject to the precautions which would be applied in a non-hazardous area.
- c) A relaxation is possible in Zone 2 area only, where relevant rules and regulations permit it, and where a safety assessment shows that the following conditions are satisfied:
 - the proposed work on energized apparatus would not product sparks capable of ignition;
 - the circuits would not be of such a design as to preclude the production of sparks;
 - the apparatus and any associated circuits within the hazardous area would not include any hot surfaces capable of producing ignition.

If these conditions can be met, then work may be carried out subject only to the precautions which would be applied in a non-hazardous area.

3.6.2. Intrinsically safe installations

Maintenance work may be carried out, energized, subject to the conditions detailed below:

a) Maintenance work in hazardous areas

Maintenance works should be limited to:

- i) disconnection, removal or replacement of items of electrical apparatus and cabling.
- ii) adjustment, as necessary, for the calibration of the electrical apparatus or system,
- iii) removal and replacement of any plug-in components or assemblies,
- iv) testing by means of instruments which do not affect the intrinsic safety features,
- v) any other maintenance activity specifically permitted by the relevant documentation.

b) Maintenance work in non-hazardous areas

Maintenance of associated electrical apparatus and parts of intrinsically safe circuits located in non-hazardous areas should be restricted to that described in (a) whilst such electrical apparatus or parts of circuits remain inter-connected with parts of intrinsically safe systems located in hazardous areas.

Safety barrier earth connections should not be removed without disconnecting first the hazardous area circuits.

The other maintenance works should be carried out only when the electrical apparatus or part of circuit is disconnected from the part of the circuit located in a hazardous area.

3.7. Earthing and equipotential bonding

Care should be taken to ensure that the earthing and bonding provisions in hazardous areas are maintained in good condition (see Table 1 B6, Table 2 B6 and B7 and Table 3 B3).

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3.8. Some explanations for the inspection schedules (to be read together with Tables 1 to 3)

3.8.1. Apparatus is appropriate to area classification (See IACS Recommendation No. 22)

3.8.2. Apparatus group is correct (See relevant Classification Society Rules)

3.8.3. Apparatus temperature class is correct (See relevant Classification Society Rules)

3.8.4. Apparatus circuit identification

It should be ensured that apparatus can be correctly isolated whenever work is to be done. This can be achieved in a variety of ways, e.g.:

- a) apparatus fitted with a permanent label which specifies the source of supply,
- b) apparatus fitted with a tag number, or cable fitted with a cable number adjacent to the apparatus; the source of supply can be determined from a drawing or schedule by reference to the tag number or cable number,
- c) item shown on a drawing from which the source of supply can be identified.

It is necessary to confirm for all apparatus, at the INITIAL INSPECTION, that the information is correct. The availability of the necessary information should be checked at the opportunity of the DETAILED INSPECTIONS, when the circuit is isolated before the DETAILED checks.

3.8.5. Cable entry devices

The check-tightening of cable entry devices at a CLOSE INSPECTION can be done by hand without the need to remove weather-proofing tape or shrouds. DETAILED INSPECTIONS may necessitate that the cable entry devices should be dismantled.

3.8.6 Type of cable is appropriate (See IEC Publication 70-14, Clause 9.2)

3.8.7. Sealing of trunking, ducts, pipes and/or conduits are satisfactory. See IEC Publication 79-14 Clause 9.1.6.

3.8.8. Overloads (See IEC Publication 79-14 Clause 15.1 concerning rotating electrical machines).

It is necessary to check that:

- the protective device is set to the rated current I (at INITIAL and DETAILED INSPECTIONS),
- the protective device is designed to operate in 2 hours or less at 1.20 times the set (rated) current and not to operate within 2 hours at 1.05 times the set (rated) current (at INITIAL INSPECTION).

4. Additional Recommendations

4.1. Type of protection "d" - flameproof enclosure - See Table 1

4.1.1. Flameproof joints

When re-assembling flameproof enclosures, all joints should be thoroughly cleaned and lightly smeared with a suitable grease to prevent corrosion and to assist weather-proofing. Blind bolt-holes should be kept clear of grease. Only non-metallic scrapers and non-corrosive cleaning fluids should be used to clean flanges.

It is normally not considered necessary to check the diametral clearance of spigot, shaft, spindle and threaded joints, unless there is evidence of wear, distortion, corrosion or other damage in which case reference should be made to the manufacturers' documents.

Joints which are not normally capable of being dismantled need not be subjected to the inspection checks A10 and A11 of Table 1.

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Note:

Bolts, screws and similar parts, upon which the type of protection depends, should only be replaced by similar parts in accordance with the manufacturers' design.

4.2. Type of protection "e" – increased safety – See Table 1

4.2.1. Overloads

The windings of Exe motors are protected by suitable devices to ensure that the limiting temperature cannot be exceeded in service (including stalling).

It is therefore necessary to check that the protective device is so selected that the tripping time from cold taken from the delay characteristic of the protective device, for the current ratio I_M/I_N of the motor to be protected, is not longer than the stated time t_E on the marking plate of the motor (at INITIAL INSPECTION).

Depending on experience it may or may not be necessary to measure the tripping times by current injection at the INITIAL INSPECTION and/or PERIODIC INSPECTION. The tripping time in real operation should be the same as the time taken from the delay characteristic with a tolerance of maximum + 20%.

4.3. Type of protection "i" – intrinsic safety – See Table 2

4.3.1. Documentation

The documentation referred to in Table 2 should, as a minimum, include details of:

- circuit safety documents, where appropriate,
- manufacturer, apparatus type and certificate numbers, category, apparatus group and temperature class,
- where appropriate, electrical parameters such as capacitance and inductance, length, type and route of cables,
- special requirements of apparatus certificate and detailed methods by which such requirements are met in the particular installation,
- physical location of each item in the plant.

4.3.2. Labelling

Labels should be inspected to ensure that they are legible and comply with the requirements laid down in the appropriate documentation to ensure that the apparatus actually fitted is that specified.

4.3.3. Unauthorized modification

The requirement to check that there are "no unauthorized modifications" can present some problems, in that it is difficult to detect alteration to, for example, a printed circuit board. It may be possible to utilize the fact that the soldering associated with most repairs/alterations is not of the same type or quality as the original. Photographs of the original boards supported by listings of the key components upon which the safety of the circuit depends may be useful.

4.3.4. Interface devices between intrinsically safe and non-intrinsically safe circuits

Diode safety barrier installations should be inspected to ensure that the correct types of barriers have been used and that all such devices are firmly fixed to the barrier earth bar in a way which gives good earth continuity.

Installations should be inspected to ensure that relays which act as safety barriers between circuits have not become damaged by repeated operation or vibration in a way which reduces the segregation afforded.

4.3.5. Cables

Installations should be inspected to ensure that the cables used comply with the documentation. Particular attention should be paid to the possibility of unauthorized circuits in multicore cables containing more than one intrinsically safe systems and to the protection afforded where cables containing intrinsically safe systems and other cables are run in the same pipe, duct or cable tray.

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Note:

Before initial inspection it is assumed that for intrinsically safe systems the electrical parameters of cables and/or apparatus have been approved and verified for the application.

4.3.6. Cable screens

Installations should be inspected to ensure that cable screens are earthed in accordance with the appropriate documentation. Particular attention should be paid to installations utilizing multicore cables which contain more than one intrinsically safe system.

4.3.7. Point to point connections

This check is only required at the INITIAL INSPECTION.

4.3.8. Earth continuity

The continuity of the earth connection between intrinsically safe circuits and the earth point should be measured on INITIAL INSPECTION.

The measurement should be made using a tester specifically designed for use on intrinsically safe circuits.

A representative sample of connections, selected by the responsible person, should be measured periodically to confirm the continuing integrity of the connections.

4.3.9. Intrinsically safe circuit earthing and/or insulation

The insulation testing of intrinsically safe circuits is necessary to confirm that they are either earthed or insulated from earth, according to the original design.

Insulation testing of intrinsically safe systems or circuits should only be carried out using a test device specifically designed for connection to such circuits.

For these tests, the normal earth connection should be disconnected. This can only be done if either the plant is free from hazard or if power is removed completely from the system. These conditions, on modern integrated systems, can only be met at major shutdowns of the ship. This test is only required on a sample basis.

4.3.10 Separation between intrinsically safe and non-intrinsically safe circuits

Junction boxes and boxes containing safety barriers should be inspected to ensure that they contain no wiring not specified in the documentation.

4.4. Type of protection "p" – pressurized enclosure – See Table 3

(See IEC Publication 79-14 Clause 13).

4.5. Apparatus used in Zone 2

Explosion protected apparatus should be inspected in accordance with the appropriate columns of Table 1, 2 or 3.

4.5.1 Restricted breathing enclosures

With the exception of luminaries, restricted breathing enclosures should be subjected to periodic pressure test measurement (see IEC 79-15) with a period of [6 months] or more as experience dictates.

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Table 1
Inspection schedule for Ex "d", Ex "e" and Ex "n" installations
(D = Detailed, C = Close, and V = Visual)

	CHECK THAT:	Ex "d"			Ex "e"			Ex "n"		
		GRADE OF INSPECTION								
		D	C	V	D	C	V	D	C	V
A	APPARATUS									
1	Apparatus is appropriate to area classification	*	*	*	*	*	*	*	*	*
2	Apparatus group is correct	*	*		*	*		*	*	
3	Apparatus temperature class is correct	*	*		*	*		*	*	
4	Apparatus circuit identification is correct	*			*			*		
5	Apparatus circuit identification is available	*	*	*	*	*	*	*	*	*
6	Enclosure, glasses and glass to metal sealing gaskets and/or compounds are satisfactory	*	*	*	*	*	*	*	*	*
7	There are no unauthorized modifications	*			*			*		
8	There are no visible unauthorized modifications		*	*		*	*		*	*
9	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight									
	Physical check	*	*		*	*		*	*	
	Visual check			*			*			*
10	Flange faces are clean and undamaged and gaskets, if any, are satisfactory	*								
11	Flange gap dimensions are within permitted maxima	*	*							
12	Lamp rating, type and position are correct	*			*			*		
13	Electrical connections are tight				*			*		
14	Conditions of enclosure gaskets are satisfactory				*			*		
15	Enclosed – break and hermetically sealed devices are undamaged							*		
16	Restricted breathing enclosure is satisfactory							*		
17	Motor fans have sufficient clearance to enclosures and/or covers	*			*			*		

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B	INSTALLATION									
1	Type of cable is appropriate	*			*			*		
2	There is no obvious damage to cables	*	*	*	*	*	*	*	*	*
3	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	*	*	*	*	*	*	*	*	*
4	Stopper boxes and cable boxes are correctly filled	*								
5	Integrity of conduit system and interface with mixed system is maintained	*			*			*		
6	Earthing connections, including any supplementary earthing bonding connections are satisfactory. (e.g. connections are tight and conductors are of sufficient cross-section).	*			*			*		
	Physical check	*			*			*		
	Visual check		*	*		*	*		*	*
7	Fault loop impedance, (TN system), or earthing resistance (TT systems) is satisfactory	*			*			*		
8	Insulation resistance is satisfactory	*			*			*		
9	Automatic electrical protective devices operate within permitted limits	*			*			*		
10	Automatic electrical protective devices are set correctly (autoreset not possible in Zone 1)	*			*			*		
11	Special conditions of use (if applicable) are complied with	*			*			*		
C	ENVIRONMENT									
1	Apparatus is adequately protected against corrosion, weather, vibration and other adverse factors	*	*	*	*	*	*	*	*	*
2	No undue accumulation of dust and dirt	*	*	*	*	*	*	*	*	*
3	Electrical insulation is clean and dry				*			*		

Note:

General: The checks used for apparatus using both types of protection "e" and "d" should be a combination of both columns.

Items B7 & B8: Account should be taken of the possibility of an explosive atmosphere in the vicinity of the apparatus when using electrical test equipment



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Table 2
Inspection schedule for Ex "i" installations

	CHECK THAT:	GRADE OF INSPECTION		
		Detailed	Close	Visual
A	APPARATUS			
1	Circuit and/or apparatus documentation is appropriate to area classification	*	*	*
2	Apparatus installed is that specified in the documentation – fixed apparatus only	*	*	
3	Circuit and/or apparatus category and group is correct	*	*	
4	Apparatus temperature class is correct	*	*	
5	Installed is clearly labelled	*	*	
6	There are no unauthorized modifications	*		
7	There are no visible unauthorized modifications		*	*
8	BARRIER UNITS, relays and other energy limiting devices are of the approved type, installed in accordance with the certification requirements and securely earthed where required	*	*	*
9	Electrical connections are tight	*		
10	Printed circuit board are clean and undamaged	*		
B	INSTALLATION			
1	Cables are installed in accordance with the documentation	*		
2	Cable screens are earthed in accordance with the documentation	*		
3	There is no obvious damage to cables	*	*	*
4	Sealing of trunking, ducts and/or conduits are satisfactory	*	*	*
5	Point to point connections are all correct			
6	Earth continuity is satisfactory (e.g. connections are tight and conductors are of sufficient cross-section)	*		
7	Earth connections maintain the integrity of the type of protection	*	*	*
8	The intrinsically safe circuit is isolated from earth or earthed at one point only (refer to documentation)	*		

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9	Separation is maintained between intrinsically safe and non-intrinsically safe circuits in common distribution boxes or relay cubicles	*		
10	As applicable, short circuit protection of the power supply is in accordance with the documentation	*		
11	Special conditions of use (if applicable) are complied with	*		
C	ENVIRONMENT			
1	Apparatus is adequately protected against corrosion, weather, vibration and other adverse factors	*	*	*
2	There is no undue external accumulation of dust and dirt	*	*	*

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Table 3
Inspection schedule for Ex "p" installations (Pressurized or Continuous Dilution)

	CHECK THAT:	GRADE OF INSPECTION		
		Detailed	Close	Visual
A	APPARATUS			
1	Apparatus is appropriate to area classification	*	*	*
2	Apparatus group is correct	*	*	
3	Apparatus temperature class is correct	*	*	
4	Apparatus circuit identification is correct	*		
5	Apparatus circuit identification is available	*	*	*
6	Enclosure, glasses and glass to metal sealing gaskets and/or compounds are satisfactory	*	*	*
7	There are no unauthorized modifications	*		
8	There are no visible unauthorized modifications		*	*
9	Lamp rating, type and position are correct	*		
B	INSTALLATION			
1	Type of cable is appropriate	*		
2	There is no obvious damage to cables	*	*	*
3	Earthing connections, including any supplementary earthing bonding connections are satisfactory. (e.g. connections are tight and conductors are of sufficient cross-section)			
	Physical check	*		
	Visual check		*	*
4	Fault loop impedance, (TN systems), or earthing resistance (IT systems) is satisfactory	*		
5	Automatic electrical protective devices operate within permitted limits	*		
6	Automatic electrical protective devices are set correctly	*		

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7	Protective gas inlet temperature is below maximum specified	*		
8	Ducts, pipes and enclosures are in good condition	*	*	*
9	Protective gas is substantially free from contaminants	*	*	*
10	Protective gas pressure and/or flow is adequate	*	*	*
11	Pressure and/or flow indicators, alarms and interlocks function correctly	*		
12	Pre-energizing purge period is adequate	*		
13	Special conditions of use (if applicable) are complied with	*		
C	ENVIRONMENT			
1	Apparatus is adequately protected against corrosion, weather, vibration and other adverse factors	*	*	*
2	No undue accumulation of dust and dirt	*	*	*