



RP 12-2

**ELECTRICAL SYSTEMS AND
INSTALLATIONS -
ELECTRICAL EQUIPMENT IN
FLAMMABLE ATMOSPHERES AND
COMBUSTIBLE DUSTS**

March 1994

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BP GROUP RECOMMENDED PRACTICES AND SPECIFICATIONS FOR ENGINEERING											
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SCOPE AND PURPOSE This document provides advice which is supplementary to a number of national and international standards which themselves provide the guidance to the application and constructional specifications for electrical equipment to be used in potentially explosive atmospheres. The document places these national and international standards into a context relevant to BP operating approaches and provides engineering guidance where this has been found to be worthwhile in the past.											
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Issued by:- Engineering Practices Group, BP International Limited, Research & Engineering Centre Chertsey Road, Sunbury-on-Thames, Middlesex, TW16 7LN, UNITED KINGDOM Tel: +44 1932 76 4067 Fax: +44 1932 76 4077 Telex: 296041											

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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Recommended Practice

This document provides advice which is supplementary to a number of national and international standards which themselves provide the guidance to the application and constructional specifications for electrical equipment to be used in potentially explosive atmospheres. The document places these national and international standards into a context relevant to BP operating approaches and provides engineering guidance where this has been found to be worthwhile in the past.

The document has been prepared generally around IEC standards. This approach is in line with BP practice. However where IEC documents are unavailable at present or other factors override the exclusive reference to IEC standards, the appropriate BS document is referenced. It is noted that BS documents will be replaced by CENELEC documents covering the same material when these latter documents are published. The CENELEC documents are closely formatted to the IEC style and content.

Application

Text in italics is Commentary. Commentary provides background information which supports the requirements of the Recommended Practice, and may discuss alternative options.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Principal Changes from Previous Edition

This document replaces BP CP 17 Part 2 and has been updated to reflect emerging European and International Standards.



Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. SCOPE

BP Group RP 12-2 specifies the requirements for the selection of electrical equipment for use in locations where flammable and thus potentially explosive gas/air mixtures or atmospheres may be present. It also specifies the requirements for the selection of electrical equipment in the presence of combustible dusts.

This document may be used in conjunction with any detailed national code or statutory material appropriate to the country of application. This Recommended Practice sets out minimum requirements, but where national requirements are more stringent, clearly these must be met.

2. CERTIFICATION

2.1 Documents

This Recommended Practice is intended to satisfy the needs of safety in setting out an approach to placing electrical equipment in potentially hazardous atmospheres. In achieving this it also sets out to satisfy the requirements of a number of documents as follows:

European Directives for potentially hazardous atmospheres.

These documents are concerned with the Essential Safety Requirements. Compliance with the published CENELEC Standards is one way of satisfying the Essential Safety Requirements but is not the sole way of doing so.

IEC Standards for electrical equipment in potentially hazardous atmospheres.

The IEC 79 series of standards represents the International standards governing electrical equipment in potentially hazardous atmospheres. The content and form of the IEC documents and those produced by CENELEC on the same subject are closely similar and these latter will shortly replace the British Standards. It is for this reason that this document is based closely on the IEC documents rather than BS documents.

Statutory Instruments.

These provide the Requirements for Design and Construction on Offshore Platforms. Whilst not specific on hazardous areas, proper selection of equipment in accordance with International Standards would meet the safety requirements of the SIs.

UK Health and Safety Executive Safety Alerts.

Where appropriate for internal use, these have been accounted in the preparation of this document but new documents are subject to being issued for future or retrospective application at any time. Therefore the design engineer shall take into consideration any relevant safety alerts which may be appropriate at the time.



2.2

Requirements for Certificates

All electrical equipment installed in classified areas should be certified by a national or other appropriate certifying authority of the country of installation, or alternatively a body recognised in the country of installation of the equipment.

Certification is the procedure by which it is formally attested by a national or other certifying authority that a specified equipment complies with an appropriate standard. This attestation is confirmed by the issue of a certificate of assurance or a certificate of conformity and the equipment will bear the mark of the test house. Examples of the marking of recognised test houses are given in [IEC 79-0](#)

In UK offshore applications there is a requirement that a certification authority, recognised by the HSE is employed to approve the design and construction of a facility in order to support the Safety Case. Such approval covers the selection of electrical equipment in hazardous areas and extends also to the total design and construction. The certification authority issues a Certificate of Fitness for the prospective operator's (BP's) use in preparing the Safety Case to the HSE. The acceptance of the Safety Case by the HSE would result in the issue of an operating certificate. It is to be recommended that guidance be sought from the certifying body for those instances where non-certified electrical apparatus is to be used in order to be assured of the process which is intended will not be a later cause for concerned debate.

Inevitably there may arise the case of equipment being offered for use which is constructed and certified to a National Standard rather than an International Electrotechnical Standard. In principle the equipment may prove to be suitable for deployment but in order to accept the equipment, the application of the National Standard for construction must bear comparison with the requirements of the appropriate part of [IEC 79](#). For European National Standards, there should be published equivalence lists which should indicate deviations between the National Standard and IEC 79. This may aid the Project engineer but it must remain the responsibility of the Project's engineer to make specific acceptance of the equipment so certified. Where North American equipment is considered, it should be noted that the practice in the USA is to identify Divisions 1 and 2 locations only for area classification purposes. This practice would cover the European identification of Zone 0, Zone 1 and Zone 2 locations. North American Division 1 locations are equivalent to Zone 0 and Zone 2 locations in European Practice. The use of North American equipment certified for use in Division 1 areas is not suitable for Zone 0 classified areas however. Table 2 provides general North American to European hazardous area philosophy equivalences, however for any specific application the Project engineer should evaluate the particular equipment for the use envisaged and should record the basis for his acceptance of the equipment certification.

2.3

Use of Electrical Equipment Certified to Other National Standards

Where equipment is to be used in a country other than that in which it is certified and the equipment complies with a national standard which is not of the country of installation and is not harmonised with a CENELEC standard, the standard to which the equipment has been constructed and certified should be examined by the engineer responsible for the installation to verify that it satisfies the requirements



for the area of application and to approve its application for the specific case. For each such approval a formal record of the verification shall be issued to the operator of the equipment.

The verification of the certified equipment should be such as to be assured that the constructional standard against which the equipment has been certified is acceptable for the area classification in which it is to be installed.

2.4 Use of Non-Certified Equipment

Where necessary, equipment which does not conform to an appropriate constructional standard of [IEC 79](#) (or [BS 6467](#) or [BS 5501](#) in the case of combustible dusts) may be installed in a classified area provided:-

- (a) The equipment comprises socket outlets as detailed in 4.2.2, or
- (b) There has been a detailed examination made by an independent test authority of the construction of the equipment together with tests to demonstrate that the equipment has an acceptably low risk of ignition for the zone of application. The independent test authority should be one recognised by BP and the results of the examination and tests shall be issued to provide a formal record for the operator of the installation of which the equipment forms part of the suitability of use of the equipment.

The independent test authority should be one which is well respected and has a high degree of expertise and an impressive track record in undertaking such examinations. In the UK such organisations as ERA, SIRA and BASEEFA may be suitable and should not be excluded because they are not mentioned here. It is noted that the terms of reference for the independent test authority needs to be developed for the specific equipment item since this method of certification effectively parallels the normal certification process which can be both time consuming, lengthy and inappropriate to the application of this method to a project.

2.5 Dossiers

For each new installation or new extension to an existing installation, the following dossiers should be assembled:-

- (a) A schedule of electrical equipment which is certified for use in the classified areas. The schedule should identify classification of the area, location of the equipment, manufacturer, type of equipment, category of explosion protection and hazardous area test certificate cross reference.
- (b) A file of the certificates associated with the hazardous area equipment with suitable contents schedule which contains reference to the schedule of hazardous area electrical equipment



in order to identify all equipment conforming to a particular certificate.

The dossiers should be issued to the operator of the installation of which the electrical equipment forms part.

Manufacturers of hazardous area certified equipment need to have sufficient quality control to ensure that their design/manufacturing process for the equipment has not changed to compromise the original basis for the certificate. A QUASCO survey spanning 1991 through 1992 in the UK and in particular mainland Europe gave some cause for concern over this aspect. Selection of manufacturer for supply of equipment needs to address this possible area of concern.

3. AREA CLASSIFICATION FOR FLAMMABLE GASES, VAPOURS AND COMBUSTIBLE DUSTS

3.1 General

The classification of areas around equipment handling or storing flammable fluids or in areas where combustible dusts may be present is a prerequisite for the correct selection and location of fixed electrical equipment in those areas.

The results of hazardous area classification shall be recorded on drawings and, if necessary, schedules which should define parameters necessary for the selection and location of electrical equipment as follows:-

- Classification of the zone of risk
- Envelope of the zone of risk (both plan and elevation)
- Specification of the flammable material within the zone of risk
- Specification of the ignition temperature of the flammable material within the zone of risk.

The responsibility for the classification of hazardous areas lies with those having an intimate knowledge of the process and equipment handling the materials and who are able to identify the potential sources of hazard. The electrical engineer should not be responsible for hazardous area classification but should assist in the classification process in order to ensure that the need for hazardous area type electrical equipment is fully taken into account.

3.2 Area Classification for Flammable Gases and Vapours

Areas handling flammable gases and liquids should be classified in accordance with BP Group [RP 44-6](#), Area Classification to IP 15.

This requirement reflects the practice to be followed in those areas following the UK approach. As such, area classification is based upon The Institute of Petroleum Model Code of Safe Practice, Part 15. BP Group [RP 44-6](#) modifies and qualifies that basic document to account for particular circumstances. It is to be



noted that the IP Model Code of Safe Practice is based upon British Standards. (See clause 4.1.1). Where installations will follow other national standards, these may form the basis for area classification.

It is generally expected that zone 2 Area Classification will not consider the detailed point sources of release (unless of course these dominate a particular circumstance) but would generalise these to broad areas from which boundaries would be taken. Where necessary particular sources of potential release together with detailed calculations for ventilation conditions may be used in order to support a risk assessment for a particular circumstance.

3.3 Area Classification for Combustible Dusts

Where area classification is required, reference should be made to the appropriate Company international, or national standard.

BP Chemicals document [EC/ENG/530/10](#) is available for that industry. It was considered that a BP Group document would be unnecessary in view of the availability of this referenced document and because process considerations for the classification of the hazard were singularly associated with BP Chemicals. Notwithstanding this, the [IEC 1241](#)-series of documents would be expected to include advice on the classification of hazardous areas due to the presence of combustible dusts. When such a document is available, it will be included within the provisions of the Company documents.

4. SELECTION OF ELECTRICAL EQUIPMENT FOR USE IN HAZARDOUS AREAS GENERATED BY FLAMMABLE GASES AND VAPOURS

4.1 Standards, Codes and Recommendations

Electrical equipment and systems for installation in hazardous areas generated by flammable liquids and vapours should comply with the requirements specified in the documents referenced in the sub clauses below:-

The documents listed below are the primary documents relating to the use of electrical equipment and systems in hazardous areas. These documents reference other documents which may also be applicable. A comprehensive list of applicable documents is given in Appendix B.

The approach which is developed below is related to UK practices. Where the installation is subject to other national standards, these should be used.

4.1.1 Onshore Installations

[BS 5345](#) Selection, Installation and Maintenance of Electrical Apparatus in Potentially Explosive Atmospheres.

[BS 5345](#) represents the source material upon which IP Model Code of Practices are based. BP practice for the classification of hazardous areas is very closely aligned to Part 15 of the IP Model Code of Safe Practice and therefore, [BS 5345](#) remains



BP's recommended reference until replaced by the CENELEC documents and the IP Codes are correspondingly amended.

IEC 79-14 Electrical Apparatus for Explosive Gas Atmospheres
- Electrical Installations in Hazardous Atmospheres.

IEC 79-17 Electrical Apparatus for Explosive Gas Atmospheres
- Recommendations for Inspection and Maintenance of
Electrical Installations in Hazardous Atmospheres.

These IEC documents represent the international equivalents to [BS 5345](#). As CENELEC documents are published closely harmonised with these IEC documents, [BS 5345](#) will be withdrawn and these IEC documents will become the source material for BP practices. Until then they may be used as alternatives to [BS 5345](#).

IEC 79 Electrical Apparatus for Explosive Gas Atmospheres,
Parts 0, 1, 2, 5, 6, 7, 11, 13, 15 and 18.

These IEC documents represent the constructional standards for equipment for use in hazardous areas. [BS 5501](#) (EN 50 014 - EN 50 020) Electrical Apparatus for Potentially Explosive Atmospheres, Parts 1 to 9 and [BS 6941](#) Specification for Electrical Apparatus for Explosive Atmospheres with Type of Protection N may be used as alternatives to these.

[BS 683](#) and [BS 229](#) are older standards now superseded by the later issue of [BS 5501](#). However these standards may form the basis for equipment of the older designs. Equipment constructed and tested to these older standards are rarely offered for new equipment, however, where special circumstances exist, they may be acceptable for consideration if it is certain that safety is not compromised and if other project constraints permit.

4.1.2 Offshore Installations

As for 4.1.1 and including the following:-

The Institution of Electrical Engineers Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations.

4.2 Procedure for Selection of Electrical Equipment

4.2.1 General Principles

Electrical apparatus should be selected for use in hazardous areas in accordance with each of the following criteria:-

- The type of protection of the apparatus in relation to the zone of risk.
- The temperature classification of the apparatus in relation to the ignition temperatures of the gases and vapours involved.



- The Apparatus Gas Group in relation to the relevant properties of the gases and vapours involved .
- The apparatus construction and enclosure in relation to the environmental conditions.
- The fault containment rating of enclosures where appropriate.

Electrical systems in hazardous areas generated by flammable liquids or vapours should conform to the requirements of [IEC 79-14](#) .

The detailed procedures for selection of equipment are given within the documents detailed in 3.1.1 and 3.1.2 above. Clauses 4.2.2 through 4.2.5 give supplementary advice where experience has shown this to be worthwhile. Although primarily based upon UK practices, the procedure given above would also apply generally.

4.2.2 Selection of Apparatus According to Zone of Risk

Electrical apparatus should be selected in accordance with Table 1. Within each zone, types of equipment with lower order numbers should generally be used in preference to those with higher order numbers.

The merit order of selections shown in Table 1 represents a subjective assessment of a general approach considered to lead to an optimum lowest cost installation considering both Capital expenditure of the electrical/instrumentation equipment, associated Capital expenditure (e.g. support systems such as cabling and impact on structure), and maintenance costs over the life of an installation. The choices are not mandatory and there could be numerous examples of deviation from this merit order under particular circumstances. However where deviations are to be accepted it should be sufficient for the deviation to have been considered in the light of the merit order and the reasoning giving rise to it.

Apparatus for use in hazardous areas should be selected on a 'fit for zone' basis and where possible the most economic type of protection for each zone should be used. However for some bulk items of equipment such as junction boxes, light fittings, fire and gas detectors etc., there may be economic justification for selecting a single type of protection for use in all zones including non-hazardous areas in order to standardise on the type or to minimise the spares holding where it can be demonstrated that total life costs will be minimised.

Socket outlets which are required for the provision of power supplies to portable and transportable equipment used only for maintenance activities during plant shutdown and overhaul, need not be of the prerequisite explosion protection type, provided the power supply to any socket outlet is only energised when the specific location has been assessed to be free of flammable gas/vapour and is expected to remain free throughout the time the socket is energised. Permanently affixed labels on the socket outlets and their points of supply shall identify this requirement, controlled procedures shall be operated to ensure this requirement is adhered to, and the point of supply should be locked to prevent inadvertent energisation.



All cases involving electrical equipment installations in classified areas which are not constructed in accordance with the requirements of hazardous area electrical equipment should be specifically approved by the Project. In an offshore installation it is generally expected that all equipment will be certified for use in the hazardous area. In an offshore installation it is also expected that all portable apparatus which requires an electrical power supply would be fitted with a plug which would fit the certified sockets.

4.2.3 Selection of Apparatus According to Apparatus Sub-Grouping

Apparatus for use with flammable gases and vapours encountered within petrochemical installations shall fall within one of the three sub-groups of Apparatus Group II, namely IIA, IIB and IIC.

For installation of electrical equipment in battery rooms (see clause 5.7) IIB + H2 may be appropriate.

4.2.4 Selection of Apparatus According to Temperature Classification

The temperature classification (T Class) of equipment shall not exceed the ignition temperature of the gas or vapour in which the equipment is to be installed.

Gases and vapours encountered within petrochemical installations are frequently compounds of gases with varying ignition temperatures. It is essential that the electrical equipment has a temperature classification to suit either the compound ignition temperature or the minimum ignition temperature of the individual component gases within the compound. The ignition temperatures of compounds and gases should be provided with the hazardous area classification data.

As T Classifications are generally assigned on the assumption that the ambient temperature is 40°C, then where the equipment is to be installed in an ambient temperature greater than 40°C, the T Class temperature of the equipment shall be increased by the amount by which the ambient exceeds 40°C. This amended T Class shall not exceed the ignition temperature of the gas or vapour in which the equipment is installed.

4.2.5 Selection According to Environmental Conditions

The Ingress Protection (IP) for electrical apparatus should comply with the requirements of the appropriate constructional standard for the equipment. These are generally listed under 4.1.1 of this Recommended Practice.

Particular attention is drawn to maintaining the IP requirements when terminating cables into Ex 'e' and Ex 'n' enclosures.

4.3 Special Applications



4.3.1 General

In addition to the requirements specified in Clause 3 above, the requirements for the special applications detailed in Clauses 4.3.2 through 4.3.9 should also be met.

4.3.2 Escape Lighting Systems on Offshore Installations

All escape lighting equipment and systems shall be suitable for operation in a Zone 1 environment irrespective of location.

This includes escape lighting systems installed in all non-hazardous areas including accommodation areas.

4.3.3 Navigation Aids on Offshore Installations and Platform Identification Lights

All elements of the navigation aids system and the platform identification lights required to operate for the time period specified in the regulations appropriate to the location after the loss of the ac power supply shall be suitable for operation in a Zone 1 environment irrespective of the location.

In the North Sea 96 hours are required for Navigational aid duration. The requirements of this clause are also necessary for compliance with the Department of Energy Offshore Installations: Guide on Design and Construction, Part II Clause 8.8.1. Note that this will require battery packs to be suitable for use in a Zone 1 environment. (Ex 'e' battery enclosures are available.)

4.3.4 Helideck Lighting on Offshore Installations

Helideck demarcation lighting and systems shall be suitable for operation in a Zone 1 environment.

4.3.5 Public Address Systems and Emergency Telephone Systems on Offshore Installations

Speakers, flashing indicator lights and emergency telephones shall all be suitable for operation in a Zone 1 environment.

Control panels for such equipment, which are not suitable for operation in a Zone 1 environment should be monitored should that shutdown of all equipment will occur on detection of flammable materials within the rooms.

4.3.6 Batteries and Battery Rooms

Electrical equipment for Battery rooms shall be chosen in accordance with the requirements of the classification of the area. Where forced ventilation is necessary to keep Hydrogen concentrations below the Lower Explosive Limit (LEL), the electrical systems should be



arranged to anticipate that system being out of service by one of the following means:-

- (a) Where natural ventilation and float charging lead to Hydrogen concentrations below 0.8%, boost charging should be prevented by interlock when ventilation systems are shut down.
- (b) Where float charging would lead eventually to Hydrogen concentrations above the LEL then any equipment within the Battery Room shall be suitable for a Zone 1 area.

Where forced ventilation is necessary to keep concentrations of Hydrogen less than 0.8% by volume, the ventilation fan drive should either be assured to be in a clean air area safe from possible Hydrogen from the battery or shall be suitable for a zone 1 area.

Regardless of area classification, any electrical equipment installed within 0.5 m of the top of a continuously vented type battery shall be suitable for zone 1 area.

The approach in design situations is to ensure that there is sufficient natural ventilation to be assured of Hydrogen concentrations less than 0.8% where the LEL for Hydrogen is 4% by volume. Where this cannot be achieved the precautions for forced ventilation detailed above are considered necessary.

It is emphasised that 'sealed' battery designs yield small volumes of Hydrogen. This should be accounted when considering the battery room or cubicle.

The inside of battery cubicles should be considered in a like manner to battery rooms where electrical equipment is also included. (It is suggested that where sealed batteries are placed in the same cabinets as electrical equipment the area around the battery vent cap within which it is necessary to employ a zone 1 requirement should be reduced to 100 cm.) There should be no 'gas traps' in such cubicles where Hydrogen (lighter than air) can collect. Venting of the cubicle to the exterior of the cabinet should therefore be arranged at the highest point. The effect that the Hydrogen leaving the battery cubicle has on the room in which the battery cubicle is installed should be considered with the cubicle now substituting for the battery as far as other factors associated with room ventilation is concerned.

4.3.7 Gas Turbines

The principle for selection of electrical equipment to be installed within the enclosures surrounding Gas Turbines should be developed as part of the custom electrical control arrangement for electrical equipment which is part of the manufacturers supply. It is recognised that Gas Turbine enclosures could be subject to differing area classifications according to the amount of forced ventilation in operation. Where the Gas Turbine enclosure would be classified as hazardous, that electrical equipment which will remain energised under that condition of ventilation should be chosen in accordance with the requirements of [IEC 79-14](#) as suitable for the zone of classification. Upon ventilation



failure, any equipment not certified for use within the classification of area appropriate for that condition should be automatically disconnected following a time period which would allow safe shutdown of the Gas Turbine.

The classification within the Gas Turbine enclosure would normally be dependent upon the amount of ventilation which would itself be subject to ventilation fan integrity. IP Model Code of Practice Part 15, Area Classification Code for Petroleum Installations, Clause 8.8 is a good reference for classification of GT. hoods. It has been found that the ventilation arrangements within GT. hoods is often to the 'adequate' standard. (e.g. 12 air changes per hour.) This level would require Zone 2 equipment to be used throughout the interior of the Gas Turbine hood.

The concept of maintaining the Gas Turbine in operation following shut down of the ventilation system is based upon a subjective Risk Assessment and is dependent upon there being gas detectors installed within the Gas Turbine hood which, upon operation, would disconnect all electrical systems not suitable for a zone 1 area. The use of gas detectors within the Gas Turbine hood in this manner is meant as supplementary protection and should not be considered as sufficient for normal prolonged operation of the Gas Turbine regardless of other overtemperature considerations of the Gas Turbine.

The requirement that equipment should be chosen according to the requirements of IEC 79-14 reflects European practices. Where other national standards have been identified as the basis for equipment installation within hazardous areas, the equivalent national standard should be used.

4.3.8 Variable Speed Drives

Unless the Variable Speed Drive is applied to an Ex 'd' motor possessing embedded Thermistor protection which is part of the Ex 'd' documentation, the VSD and motor combination should have been tested and certified for the frequency and voltage range with the protective device included.

IEC 79-14 provides the approach to be employed. The primary concern is one of temperature rise under operating conditions but the capability of Ex 'e' terminal box insulation and the effect of overvoltages occurring in the waveform of the Variable Speed Device are also of concern and should be addressed.

4.3.9 Motors

Where a motor has been certified for Variable Speed duty, a VSD duty motor rating plate should be provided in addition to the normal motor rating plate detailing the Inverter characteristics for the speed range for which the motor is certified.

Where motors above 3 kV are to be installed in hazardous areas and are not of the Ex 'p' or Ex 'd' type, particular design consideration should be paid to the probability of spark generation under starting conditions in the following areas of concern:-



- (a) End Winding Discharge. To be assured that there can be no appreciable contamination of the end windings during operation.
- (b) Sparking of non active components. To be assured that motor covers and shields are suitably bonded or otherwise protected to be assured that no spark generation can occur due to magnetic induction.
- (c) Sparking within the air gap of the machine. To be assured that the phenomenon of air gap sparking cannot be a possible source of incendive sparking.

The phenomenon described in c) above should be considered for all direct- on-line started squirrel cage 2 pole induction machines with bar type rotors regardless of motor Voltage rating to be assured that the phenomenon cannot cause incendive sparks.

In general it is considered satisfactory for machine enclosures to have an protection (IP) rating of IP 65 or better and for there to be anti condensation heating for the question of contamination to be addressed. There may need to be additional precautions taken if water cooled machines are specified to ensure that the cooling system could not be a source of contamination.

The probability of sparking between non-active metal parts of a machine is generally reduced to an acceptable condition by the assurance by manufacturers that the earth bonding and, where necessary, insulation of covers and shields have been designed to be thus assured.

The matter of air gap sparking has been considered to be due to sparking between rotor bars and the iron of the rotor. Where assurance cannot be obtained that this phenomenon would not be present to incendive levels, there should be operational restrictions associated with the machine installation which should be detailed by the systems designer and accepted by the systems operator (e.g. There may need to be a purge carried out on the motor enclosure prior to the motor start at any time when there could have been gas or vapour drawn into the motor.)

5. ELECTRICAL EQUIPMENT IN THE PRESENCE OF COMBUSTIBLE DUSTS

5.1 Standards, Codes and Recommendations

Electrical equipment and systems for installation in hazardous areas generated by combustible dusts should comply with one or more of the following documents:-

BS 6467 Part 1 and Part 2 Electrical Apparatus With Protection by Enclosure for use in the Presence of Combustible Dusts



Part 2 of the document is a guide to the selection, installation and maintenance of electrical equipment and Part 1 provides the specification for such apparatus. Equipment complying with BS 6467 Part 1 should be certified by a national test authority to that standard.

There is in preparation IEC 1241 Parts 1-1 and 1-2 which are respectively Specification and Selection/Maintenance for equipment associated with Combustible Dusts. These will be issued during 1993/1994 and over that timeframe it is intended that there will be parallel voting on these documents for adoption as a CENELEC standard. When that document is finally published BS 6467 will be withdrawn.

BS 7535 Electrical Apparatus Complying with **BS 5501** or **BS 6941** in the Presence of Combustible Dusts.

This standard provides guidance on the use in combustible dust atmospheres of equipment which has been certified for use within potentially explosive gas or vapour atmospheres.

5.2

Procedures for Selection of Electrical Equipment

Electrical equipment for use in the presence of combustible dust should be selected in accordance with each of the following criteria:-

- The construction of the equipment in order to avoid accumulation of dusts, frictional problems with light alloy enclosures and environmental problems such as impact damage, thermal gain and corrosion
- The ingress protection of the equipment in respect of the area classification and the nature of the combustible dust.
- The maximum surface temperature of the equipment in respect of the minimum ignition temperature of the dusts involved.

Except where other specific certification is assured in accordance with Clauses 2.3 or 2.4, equipment selected for use in combustible dust atmospheres should be appropriately certified in accordance with **BS 6467** or should be certified in accordance with **BS 5501** and selected for use in accordance with **BS 7535**.

Electrical systems in combustible dust atmospheres should conform to the requirements of **BS 7535**.

Generally BS 6467 Part 2 or BS 7535 should be used as guidance in the selection of electrical equipment for use in combustible dust atmospheres. The following clauses 5.2.1 to 5.2.3 provide information supplementary to those standards. Where electrical equipment is to be installed within dust-handling equipment, BS 7535 and section 6 provide the only relevant guidance.



5.2.1 Selection of Apparatus According to Zone of Risk

Apparatus installed in Zone Z areas should be to ingress protection IP 6x (dust tight to [IEC 529](#))

Apparatus installed in Zone Y areas should be to a minimum of ingress protection IP 5x (dust-protected to [IEC 529](#))

Where the ignition of a small amount of dust within an enclosure can spread to the external atmosphere (train firing), the ingress protection IP 6x should be used whatever the area classification. Similar ingress protection should be used whatever the area classification where the combustible dust is electrically conductive.

The use of 'x' in IP protection signifies that there is no specific protection against the ingress of water. Notwithstanding this it is considered that a reasonable expectation for water ingress protection in association with the levels of dust protection specified would be levels IP 54(minimum) and IP 65(minimum) respectively.

BS/Euronorm equivalents of [IEC 529](#) are [BS EN 60529](#).

5.2.2 Selection of Apparatus According to Maximum Surface Temperature

For most BP applications, equipment whose maximum surface temperature does not exceed 200°C (Temperature class T3) should be suitable.

5.2.3 Selection of Apparatus According for Special Conditions

Generally [BS 7535](#) Clause 2.1.3 provides guidance on the selection of electrical equipment which may be used within dust-handling equipment. In special circumstances the equipment enclosure may be IP 6x, the maximum energy level that it can generate shall be less than 2/3 that of the maximum ignition energy of the appropriate dust/air mixture and the maximum surface temperature when submerged in the appropriate dust shall be at least 75°C below the minimum ignition temperature of a layer whose depth reflects the total submersion of the equipment. Individual testing and assessment of the equipment will be necessary to satisfy those requirements.

6. ELECTRICAL EQUIPMENT FOR HAZARDOUS ATMOSPHERES GENERATED BY BOTH FLAMMABLE GASES, VAPOURS AND BY COMBUSTIBLE DUSTS

On installations where there can be a simultaneous presence of flammable gas or vapour and combustible dust, the area classification should consider the probability of both hazards and the area classification drawings should reflect the results of both studies.

Electrical equipment should be selected in accordance with both section 4 and section 5 of this document.



Zone	Order of Protection	Type of		Protection
		Power Equipment		Control Equipment
<i>0</i>	<i>1</i>			<i>Ex 'ia'</i>
	<i>2</i>			<i>Ex 's'</i>
<i>1</i>	<i>1</i>	<i>Ex 'e')</i>		<i>Ex 'e'</i>
	<i>2</i>	<i>Ex 'd')</i>		<i>Ex 'd*'</i>
	<i>3</i>	<i>Ex 'd')Note 1</i>		<i>Ex 's'</i>
	<i>4</i>	<i>Ex 'p')</i>		<i>Ex 'd'</i>
	<i>5</i>	<i>Ex 's')</i>		<i>Ex 'ib'</i>
	<i>6</i>			<i>Ex 'p'</i>
		<i>Ex 'm')</i>		<i>Ex 'm')</i>
		<i>Ex 'o')Note 2</i>		<i>Ex 'o')Note 2</i>
		<i>Ex 'q')</i>		<i>Ex 'q')</i>
<i>2</i>	<i>1</i>	<i>Ex 'n'</i>		<i>Ex 'n'</i>
	<i>2</i>	<i>As Zone 1</i>		<i>As Zone 1</i>

Note 1 These preferences for electrical machines remain contentious (e.g. Ex(e) machines as preference to Ex(d) would also depend upon the relative availability and cost at the time of purchase). The objective in presenting the table is to enable general rules to exist for cost minimisation.

Note 2 These protection methods are inappropriate for a general preference allocation as they are not frequently encountered except when employed as components of other equipment.

** Equipment may employ a number of explosion protection methods. Typically Ex 'de' can be found when applied to motors but Ex 'eq' may be encountered for lighting fittings.*

TABLE 1
PROTECTION PREFERENCES



APPARATUS GAS GROUPINGS

Representative Gas	IEC Gas Group	NEC (USA) Group
<i>Methane (Fire Damp)</i>	<i>I</i>	<i>D</i>
<i>Propane</i>	<i>IIA</i>	<i>D</i>
<i>Ethylene</i>	<i>IIB</i>	<i>C</i>
<i>Hydrogen</i>	<i>IIIC</i>	<i>B</i>
<i>Carbon Disulphide</i>	<i>IIIC</i>	<i>Note 1</i>
<i>Acetylene</i>	<i>IIIC</i>	<i>A</i>

'T' CLASSIFICATION

Max. Surface Temperature °C	IEC Classification	NEC (USA) Identification No.
450	<i>T1</i>	<i>T1</i>
300	<i>T2</i>	<i>T2</i>
280	-	<i>T2A</i>
260	-	<i>T2B</i>
230	-	<i>T2C</i>
215	-	<i>T2D</i>
200	<i>T3</i>	<i>T3</i>
180	-	<i>T3A</i>
165	-	<i>T3B</i>
160	-	<i>T3C</i>
135	<i>T4</i>	<i>T4</i>
120	-	<i>T4A</i>
100	<i>T5</i>	<i>T5</i>
85	<i>T6</i>	<i>T6</i>

Note 1 North American practice would consider that because the auto-ignition temperature of Carbon Disulphide is low (90°C), then special safeguards would be required. e.g. Smaller joint clearances.

TABLE 2

NORTH AMERICAN TO IEC COMPARISONSHAZARDOUS AREA APPLICATIONS



DEFINITIONS AND ABBREVIATIONS**Definitions**

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

Abbreviations

BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmospheres
CENELEC	European Committee for Electrotechnical Standardisation. (Comité Européen de Normalisation Electrotechnique)
ERA	The Electrical Research Association
IEC	International Electrotechnical Commission
IP	Ingress Protection
QUASCO	Quality Appraisal Service Company
SIRA	Scientific Instrument Research Association



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

IEC Standards

IEC 79	Electrical Apparatus for Explosive Gas Atmospheres
	Part 0 - General Introduction
	Part 1 - Construction and Test of Flameproof Enclosures of Electrical Apparatus
	Part 2 - Electrical Apparatus Type of Protection 'p'
	Part 5 - Sand Filled Apparatus
	Part 6 - Oil-Immersed Apparatus
	Part 7 - Construction and Test of Apparatus of Protection 'e'
	Part 11 - Construction and Test of Intrinsically-Safe and Associated Apparatus
	Part 13 - Construction and Use of Rooms or Buildings Protected by Pressurisation
	Part 14 - Electrical Installations in Explosive gas Atmospheres (other than mines)
	Part 17 - Recommendations for Inspection & Maintenance of Electrical Installations in Hazardous Areas
	Part 18 - Encapsulation (m)
IEC 529	Specification for Degrees of Protection Provided for Enclosures (IP Code)

European Standards

EN 50000 Series	Electrical Installations in Potentially Explosive Gas Atmospheres (other than mines) - Electrical Installations in Hazardous Areas
EN 60529	Specification for Degrees of Protection Provided for Enclosures (IP Code)



British Standards

- [BS 5345](#) Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres (other than mining applications or explosives processing and manufacture)
- [BS 5501](#) Electrical Apparatus for Potentially Explosive Atmospheres
- [BS 6467](#) Electrical Apparatus with Protection by Enclosure for use in the Presence of Combustible Dusts:
Part 1 Specification for Apparatus
Part 2 Guide to Selection, Installation and Maintenance
- [BS 6941](#) Specification for Electrical Apparatus for Explosive Atmospheres with type of Protection N
- [BS7535](#) Guide to the use of Electrical Apparatus Complying With BS 5501 or BS 6941 in the Presence of Combustible Dusts.

Other Standards

IP Model Code of Safe Practice, Part 1. 'Electrical Safety Code'

IP Model Code of Safe Practice, Part 15 'Area Classification Code for Petroleum Installations'

IEE Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations.

Department of Energy Offshore Installations: 'Guide on Design and Construction' Part II.

BP Chemicals EC/ENG/530/10 Protection of Plants Handling Flammable Dusts

BP Group Documents

BP Group [RP 44-6](#) Area Classification to IP 15
(replaces BP CP 39)

