

RP 59-1

TELECOMMUNICATIONS - EMERGENCY SHUTDOWN SYSTEMS

December 1992

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BP GROUP RECOMMENDED PRACTICES AND SPECIFICATIONS FOR ENGINEERING											
Doc. No. RP 59-1		Issue Date December 1992	Latest Amendment Date								
Document Title TELECOMMUNICATIONS - EMERGENCY SHUTDOWN SYSTEMS											
APPLICABILITY Regional Applicability: International											
SCOPE AND PURPOSE This Recommended Practice provides a guide for design and installation of Telecommunications Emergency Shutdown Systems for the protection of process plant, storage facilities, pipelines and other areas including offshore installations where flammable atmospheres may be present. Its purpose is to provide design engineers and plant management with:- (a) guidance on the need for telecommunications emergency shutdown systems; (b) a basis for designing, evaluating and selecting telecommunications emergency shutdown systems in various applications; (c) guidance on health and safety aspects associated with the operation of telecommunications emergency shutdown systems.											
AMENDMENTS <table border="0"> <thead> <tr> <th>Amd</th> <th>Date</th> <th>Page(s)</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td colspan="4"> </td> </tr> </tbody> </table>				Amd	Date	Page(s)	Description				
Amd	Date	Page(s)	Description								
CUSTODIAN (See Quarterly Status List for Contact) Telecommunications											
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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

The reason for producing a BP Recommended Practice on Emergency Shutdown Systems for Telecommunications is because there is currently no formal document in existence covering such systems. Future applications will benefit from the ability to specify and procure such best-practice systems in a quicker and more cost-effective manner. It is anticipated that this Recommended Practice will stimulate standard products to emerge and these will produce cost benefits compared with current bespoke systems.

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.

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 Engineering or the Custodian. See Quarterly Status List for contacts.



1. SCOPE

This Recommended Practice provides a guide for design and installation of Telecommunications Emergency Shutdown Systems used to protect process plant, storage facilities, pipelines and other areas including offshore installations where flammable atmospheres may be present. The Recommended Practice is concerned solely with the protection of such installations from specific potential hazards that may, in certain circumstances, arise from the operation of Telecommunications equipment and systems within or in the vicinity of the installation. It takes into account health and safety practices, good design practice and technical and economic considerations for the selection of Telecommunications emergency shutdown systems, and is applicable to onshore and offshore installations.

The following are not covered by this Recommended Practice:-

- (a) The emergency shutdown of plant, machinery or any other non-Telecommunications device.
- (b) The protection against hazards arising from electromagnetic fields or electrical discharges generated by means other than Telecommunications devices, such as electric storms, electricity generating installations or other electrical equipment.
- (c) Hazards associated with the use of electro-explosive devices (EED).
- (d) The biological hazards of exposure to radio-frequency fields.
- (e) Electromagnetic Compatibility
- (f) The generation of sparks where the basic source of energy for the spark is not derived from the electrical supply connected to the Telecommunications equipment.
- (g) The ignition of media other than flammable atmospheres.
- (h) Considerations relating to the conceptual and detailed design of Telecommunication systems which contribute to the promotion of safe practices, except those specifically concerning Emergency Shutdown systems.

The purpose of this Recommended Practice is the prevention of ignition of flammable atmospheres by the operation of Telecommunications equipment and systems. In the context of this Recommended Practice, ignition of a flammable atmosphere will be initiated if a spark having the ability to extract sufficient power or energy occurs at a suitable inadvertent electrical discontinuity. The power or energy to produce the spark can be transferred to the discontinuity, either by a direct electrical connection, as could occur in the event of a cable being accidentally severed, or by the electrical conducting structure, in which the spark gap is formed, being subject to incident electromagnetic



(radio-frequency) radiation. Other possible causes of ignition are also included within the scope of this Recommended Practice.

For the purposes of this Recommended Practice a flammable atmosphere is an ignitable mixture of flammable gas, vapour or mist with air.

This Recommended Practice is not restricted in applicability to formally designated Hazardous areas. Non-Hazardous areas surrounding Hazardous areas are also considered because these could, in extreme or catastrophic conditions (particularly on offshore installations), be subject to the presence of flammable atmospheres. The majority of Telecommunications equipment is usually located in Non-Hazardous areas and because certain items are required for emergency communications, it is desirable to maintain these in operation for as long as possible. Such provisions are an essential component of this Recommended Practice.

2. DEFINITIONS

2.1 Telecommunications

In terms which are generally accepted, Telecommunications is defined as the transportation of voice, image, text or data between physically separated points. To achieve this function, electronic devices predominate, with either cable or radio connections being employed to implement the physical interconnections. Optical technology is however is being used in an increasing number of applications, particularly in the field of optical fibre cables.

2.2 Telecommunications Systems

Within the definition of this Recommended Practice, a Telecommunications System is defined as a collection of individual items of equipment interconnected by means of transmission media to form a communications network. Such a network is used to provide the transmission path for any combination of voice, image, text or data communications.

2.3 Telecommunications Emergency Shutdown Systems

Within the definition of this Recommended Practice, an ESD System for Telecommunications is a set of measures to protect process plant, storage facilities, pipelines and other areas such as offshore installations where flammable areas may be present, against the operation of Telecommunications equipment in circumstances where such operation would constitute a threat.

The Telecommunications ESD System requires inputs from other systems to initiate shutdown actions. Typically these inputs would be derived from interfaces with the Plant/Installation Emergency Shutdown System, Distributed Control System and Fire and Gas System. Such inputs would relate to the Shutdown status of the plant or installation and to the detection of gas.



3. POTENTIAL HAZARDS AND CONCEPTS FOR PREVENTION

3.1 General

The sole purpose of this Recommended Practice is to ensure that Telecommunications systems, either in normal operation or under fault conditions, are prevented from igniting a flammable atmosphere, either directly or indirectly. The main cause of ignition considered is the electrical spark, but hazards due to direct combustion are also examined.

A typical characteristic of Telecommunications systems is that they comprise some form of central or nodal equipment connected by either an electrical cable network or by electromagnetic radiation to other nodal points or some form of subsidiary items some distance away. This arrangement implies that electrical or electromagnetic (radio wave or optical) energy is fed, directly or indirectly, from one point to another. Normally a system which has been correctly designed and installed and which is properly maintained and operated should not pose any sparking or ignition threat. However there are certain fault and damage situations or conditions caused by electromagnetic radiation which could lead to either the production of an electrical spark or to other sources of ignition. Therefore when such systems are installed within, or in the vicinity of, offshore installations, process plant, storage facilities, pipelines or other areas where flammable atmospheres may be present, it is essential that certain protecting measures are incorporated.

In considering spark-making mechanisms, the nature of the gap and the characteristics of the electrical supply to the gap are of prime importance. Discharges occur most easily if two parts initially in contact are drawn apart, i.e. if a break-spark occurs. The breakdown of gaps that are not in intermittent contact requires considerably higher voltages than those necessary to produce ignitions from break-sparks. Therefore discharges across a fixed gap are not considered to be a significant problem, especially as voltages produced by Telecommunications equipment are relatively low. Also of importance in considering the probability of a spark being produced, is the ability of the structure or electrical connection forming the gap to produce or extract the necessary energy or power levels.

A flammable atmosphere is an ignitable mixture of a flammable gas, vapour or mist with air. For radio-frequency spark ignition to occur, the power or energy in the spark has to exceed a certain threshold value, which depends on the nature and concentration of the gas or vapour. Different flammable gases and vapours have been grouped according to their ease of ignition and the threshold power or energy of a radio-frequency spark for a representative gas for each group has been established. In each case the most easily ignitable concentration of the flammable gas or vapour is considered. The parameters affecting the threshold ignition powers or energy levels are the form of modulation applied, the frequency, the connecting lead length and the source impedance of the structure or electric connection. The frequency range over which these power or energy thresholds apply is generally 15 kHz to 35 GHz, although corroborated physical testing has only been carried out over the range 1 kHz to 10 MHz. Thresholds increase linearly with frequency from 1 kHz to 1 MHz with some levelling-off between 1 MHz and 10 MHz. There is some indication that thresholds decrease above 10 MHz, but it is recognised that more research should be carried out to establish the trend definitively and to quantify the variation of threshold of ignition power or energy

with frequency. Similarly there is no awareness of measurements being made below 1kHz or with a direct current source and as a consequence the need for investigations here has also been identified.

3.2 Radio-frequency Induced Ignition Hazards

3.2.1 Hazard Mechanism and Assessment

Published Standards exist (in particular [BS 6656](#): 1991 'Guide to Prevention of inadvertent ignition of flammable atmospheres by radio-frequency radiation'), which provide guidance in assessing the potential ignition hazard from the inadvertent extraction of energy from electromagnetic fields, propagated from communication, radar, or other transmitting antennas to plant where potentially flammable atmospheres may be present. Detailed consideration is necessary of the conditions that have to be satisfied simultaneously for hazard to exist; these are as follows:-

- (a) electromagnetic radiation of sufficient intensity;

An electromagnetic field of sufficient intensity may be generated by a fixed or mobile transmitter. The magnitude of the field obtained will depend on the transmitter power, the antenna gain and the proximity of the site under consideration. In this context, mobile transmitters in ships, vehicles, aircraft and those personally carried need to be considered.

- (b) structure capable of behaving as a receiving antenna;

All conducting structures act as receiving antennas, but the magnitude of the induced current and voltage will depend on the frequency, the method of construction and the configuration of the structure.

- (c) establishment of a mechanism whereby the received energy or power can be delivered as a spark;

In this context, the generation of a spark is dependant on the appearance of a small discontinuity in a receiving structure. This could occur when parts of a structure normally in contact are caused to separate, either during maintenance or at any time by flexing, mechanical vibration or similar actions.

- (d) presence of a flammable atmosphere.

In normal operation all flammable gases will be either contained or flared in carefully controlled circumstances. However in the event of a leak or escape, the gas will become mixed with air. In order for an inflammable mixture to exist, the air and the flammable gas must be mixed in certain proportions governed by the flammable limits of the combustible gas. The limits are bounded by an 'upper explosive limit' (UEL) and a 'lower explosive limit' (LEL) and these will vary depending on the concentration of oxygen present and the temperature and pressure of the mixture. In

making a assessment of a radio-frequency induced ignition hazard, it is assumed that the composition is at its optimum for ignition to take place.

The applicable assessment procedure should be followed for every installation to which this Recommended Practice applies. It is recommended that specialist assistance be sought to advise on this task.

The theoretical assessment procedure for radio-frequency induced ignition hazards consists of determining the field strength resulting from single or multiple transmissions at the location of the structure being investigated. Using this value and parameters relating to the structure under investigation, a value of maximum extractable power or energy is determined. This is compared with the radio-frequency power or energy threshold likely to produce ignition for the gas group and plant characteristics concerned. Should it be greater than the applicable threshold, then a possible hazard exists and appropriate preventative measures should be adopted.

The formal assessment procedure specifies radio-frequency power and energy thresholds values for different gas groupings and structures. A safety factor is incorporated within each of these values to allow for the effects of antenna gain and the enhancement of incident field strengths by reflection or other field reinforcement mechanisms. The fact that there must be four simultaneously occurring requirements for the ignition of a flammable atmosphere indicates that there is a relatively low probability of hazard. However in making the assessment, it is assumed that the composition is at its optimum for ignition to take place. This in itself provides a further margin of safety under most circumstances, since the energy required for ignition of a particular atmosphere generally increases rapidly as its composition moves away from the optimum. Likewise the assessment assumes that the structure forms a particularly efficient receiving antenna, which in most instances will not be so. The ability of the structure to extract energy from an incident field reduces significantly if it is not configured to act as a well tuned antenna.

However in applying the assessment procedure in certain instances, a practice has been established to add a further safety factor to protect against the following:-

- (i) Errors in the output power settings of transmitters due to inaccuracies of measuring equipment, to drift in time due to component aging and temperature effects and to human error.*
- (ii) The normal variations of transmitter output power due to characterisation spread and power supply tolerances.*
- (iii) General uncertainties concerning the lack of knowledge of threshold ignition powers below 1 kHz and above 10 MHz.*

As a consequence it has been the BP policy to recommend that the ignition threshold for the gas group corresponding to hydrocarbons normally associated with oil and gas exploitation should be 2 Watts in all circumstances. There are instances where some relaxation up to the assessment procedure thresholds may be possible. This may be for reasons of increased confidence concerning one or more of the factors which caused the safety margins to be introduced. Alternatively the radio transmission concerned may be highly directional as is the case with satellite, tropospheric scatter or line-of-sight communications antennas which normally

would be pointed away from any structure likely to act as an inadvertent receiving antenna.

3.2.2 Hazard Prevention

Should the formal assessment procedures indicate that a potential hazard exists, then the following measures are available to make the plant safe:-

- (a) When flammable gas is detected, to switch off the transmitter or transmitters contributing to the creation of the hazard or to reduce their output power to safe levels.
- (b) Reduce the antenna/s gain, in the direction of the plant, of the transmission/s contributing to the creation of the hazard by altering the radiation pattern/s, assuming that this does not unduly affect the service effectiveness. The gain reduction should be sufficient to reduce the levels of extractable power to below the appropriate threshold
- (c) An alternative to (b) above, is to physically move the antennas away from the plant to a point where safe levels of extractable power are obtained.
- (d) To take measures to reduce the power extractable from the structures concerned. These measures, which also require specialist advice, are bonding, insulating, altering the physical size of the structure, electromagnetic screening and de-tuning.

3.3 Electrical Hazards by Direct Connection

3.3.1 Hazard Mechanism

The potential hazard arises from electrical or optical energy being connected directly from one zone or area to remote equipment or cables in another zone or area which have been subject to either mechanical or fire damage. Should this damage have created a mechanism capable of creating an electrical spark in a location containing a flammable atmosphere, then a potentially hazardous situation will exist.

3.3.2 Hazard Prevention

Such hazards are prevented by the disconnection of the source of energy to a zone or area where the presence of gas has been established or where any over-riding shutdown action has been activated. Such a disconnection should be made in a zone or area which is deemed to be free of flammable atmospheres, assuming that it is not already subject to a shutdown action in which case the disconnection would have been implemented at that time.



Where the equipment or systems in the zone or area subject to either gas detection or shutdown are certified as being totally suitable for use in hazardous areas and where the service provided is considered essential for an emergency situation, then such connections can be maintained, assuming that the zone or area where the electrical source is located remains gas free or not subject to any other over-riding emergency shutdown actions. The connection can also be maintained if the entire system is suitable for hazardous area operation.

The protection will be enhanced by ensuring that all such connections are, in addition to the shutdown actions described above, provided with an appropriate form of protection which operates automatically in cases of electrical overload or high reflected power.

3.4 Hazards from Direct Combustion

3.4.1 Hazard Mechanism

In extremely rare circumstances, a fault may develop in Telecommunications equipment which will lead to a fire, a spark, a very high surface temperature of a component or other forms of combustion. If such a fault occurs in the presence of a flammable atmosphere, then a potentially hazardous situation will occur.

3.4.2 Hazard Prevention

All equipment and their associated power supplies should incorporate adequate power supply, output connection overload and high reflected power protection measures which would be expected to operate in such fault conditions. In equipments where significant amounts of heat energy are dissipated or where components exist with a high surface temperature, then heat operated fusible links should be incorporated in addition to the normal current overload devices. These measures will ensure that the appropriate electrical supplies were disconnected to prevent any further energy being dissipated in the fault, thereby reducing the likelihood of the potential source of ignition being sustained. However further levels of protection are desirable in the event of the combustion continuing subsequent to the power disconnection and in such circumstances total reliance shall be placed on an electrical shutdown by either the Fire and Gas System or by the action of the prescribed Fire Protection Measures.

Telecommunications equipment or systems which are certified as suitable for installation in hazardous areas are deemed to exhibit a negligible probability of such a fault occurring.

3.5 Hazards from Stored Energy

3.5.1 Hazard Mechanism

The shutdown of Telecommunications equipment, caused by the detection of a flammable atmosphere, is usually effected by



disconnection from the electrical supply. However some items of equipment or systems may incorporate mechanisms or devices which enable energy to be stored either on a temporary or a semi-permanent basis. In some circumstances a mechanism may exist whereby this energy may be discharged in the form of a spark. Should this occur in the presence of a flammable atmosphere then a hazardous situation will result.

This potential hazard is of particular relevance to instances where non-certified equipment is located in non-hazardous areas, but the area is equipped with fire and gas detection. The purpose of this protection is to enable the operational function of that area or certain equipment contained in it to continue functioning for as long as possible in emergency situations. Only when gas is detected in such areas is a complete electrical shutdown initiated of the maintained equipment.

3.5.2 Hazard Prevention

By means of a formal audit procedure, all equipment should be examined for components, assemblies and sub-systems where significant amounts of energy could be stored after the disconnection of the power supply. Typical items include large capacitors and inductors, delay and transmission lines and electrical storage batteries.

Cells or batteries which are not an integral part of equipment certified as suitable for hazardous area operation and which have parameters which violate any of the following values shall be isolated at Red Shutdown unless the area in which they are housed is protected by a Post-Red Shutdown system, in which case they shall be isolated on first confirmed detection of gas in that area:-

- a terminal voltage in excess of 5.5 Volts,
- a short-circuit current in excess of 100 mA d.c.,
- a maximum aggregate capacitance associated with the circuit directly energised by the cell or battery in excess of 3000 μ F,
- a maximum aggregate inductance of all discrete inductive components in the circuit directly energised by the cell or battery in excess 10 mH,
- a capacity in excess of 4 Ah.

No specific guide-lines can be offered at this time for devices capable of energy storage other than cells or batteries, apart from one general requirement that if they meet the requirements for intrinsic safety, then generally they will not pose a risk of ignition to flammable atmospheres.

Typical hazard prevention methods include:-



- (a) Electrical disconnection or isolation in the event of gas detection.
- (b) The incorporation of bleed resistors to dissipate energy within a reasonable time.
- (c) The use of alternative products or solutions which do not incorporate such potential hazards.

Attention is drawn to the requirements not to short-circuit cells or batteries. Equipment designs and training programmes should incorporate measures to prevent this being carried out accidentally or inadvertently. The charging of primary cells should be prevented by similar means.

3.6 Hazards from Optical Devices

3.6.1 Hazard Mechanism

Optical devices using visible and near-visible wavelengths are being applied to Telecommunications in increasing volume. Generally their application in petro-chemical plant, where flammable atmospheres may be present, poses a significantly lower risk of ignition than the directly equivalent electrical, electronic or radiowave system.

Optical Fibre cables are available in a wide variety of configurations, but all operate in essentially the same manner. A low energy light source is coupled to the fibre core and the light propagates in the manner of a guided wave to a detector at the remote end. The electronic devices which are incorporated into the optical transmitter and receiver should be treated in exactly the same manner in the emergency shutdown context as normal Telecommunications equipment. Systems are also available which, in common with optical fibres use electronically driven optical transmitters and receivers, but propagate through free space. Such devices usually operate at infra-red and are inevitably used for short range applications.

A potential hazard has been identified with all such devices. Such a hazard would exist if the following conditions are met:-

- (a) by the system incorporating a means by which the light energy from an optical source is capable of being focussed into a very small area;

Such lenses may be an integral component of such a device, but a mechanism which has been the subject of study is where a fortuitously produced lens may be formed at the point of fracture of an optical fibre.

- (b) by a particle of matter being located at the point of focus of the lens;



- (c) by the energy incident on the particle being sufficient to raise the temperature of the particle to incandescence levels;
- (d) the presence of a flammable atmosphere.

The early (1985) limited work on this mechanism suggested that a particle of 50 μm diameter absorbing approximately 6 mW may be capable of causing the ignition of a flammable atmosphere consisting of the most easily ignited concentration of diethyl ether in air. It is understood that a launched power of 40 mW is currently available from laser diodes coupled to optical fibres and that much higher powers are available from conventional power sources including other forms of laser. However the instances where launch powers of these magnitudes are employed in Telecommunications are believed to be very few and specific to such applications such as long range (trans-ocean) submarine cables where optical amplifiers having output powers up to 1 watt are beginning to become available. Telecommunications is a rapidly evolving technology and new devices, systems and application are appearing constantly and therefore all such innovations and developments should be examined as a matter of routine to determine if such a potential hazard exists.

A 3 year programme of further research into this potential hazard commenced in December 1990. This is being funded by the UK Optical Sensors Collaborative Association (OSCA) and the European Community. The partners in the study are Sira, CERCHAR, Imperial College, Leeds University and PTB. The study objective is to establish the operating conditions under which the use of optical instruments in hazardous industrial environments can be judged not to give rise to a hazard.

3.6.2 Hazard Prevention

Because of the limited amount of research carried out to evaluate this potential hazard, it is not possible to set or quote any definitive hazard thresholds or limits. However the probability of such a potential hazard occurring can only be evaluated as being low. This conclusion must be reached by considering the individual probabilities of occurrence of each of the four factors contributing to the potential hazard.

However it is considered essential that this Recommended Practice should provide some guidance in this matter. It is understood that studies into this potential hazard are continuing, but this may not lead to a formal limit being published until approximately 1995. However it is now accepted that negligible risk exists at optical launch powers of 1 mW or below. It is therefore recommended that where the optical launch power associated with such a system exceeds 1 mW and this level of power is transmitted through an area where flammable atmospheres may be present, then the following protection measures should be considered:

- (a) Shutdown on occasions of gas detection

Normally this will be the preferred option as the number of applications, where optical launch powers in excess of 1mW are transmitted, will be extremely few. The one application in a petro-chemical environment which may be affected would be when optical fibre submarine cables are

used for communications between offshore platforms and either the shore or adjacent platforms. Typically such systems use optical launch powers higher than 1 mW, but each such case should be assessed individually and the degree of risk from the potential hazard set against any possible hazard or loss of functionality introduced by the loss of a significant communication capacity.

- (b) By individual assessment.

Where the optical launch power exceeds 1 mW, or where it is considered that special circumstances apply, and when emergency shutdown it is not considered desirable or justifiable action, then this Recommended Practice proposes an individual assessment. It is recommended that a specialist organisation or individual, having up-to-date knowledge of work and research in this field, should undertake such a task.

3.7 Assumed Background Practices

The emergency shutdown measures set out in this Recommended Practice assume that the following general protective features or practices have been incorporated or followed in the overall design:

- (a) Equipment or systems within formally declared Hazardous areas to conform to the design, construction, installation and maintenance requirements appropriate to the classification of the area.
- (b) However, exceptions to (a) should be considered because certain Telecommunications systems assume increased importance in emergency or catastrophic situations when their operational effectiveness needs to be maintained. In such cases the equipment and systems installed in a non-hazardous area will require to be suitable for installation and operation in a hazardous area
- (c) Without exception all uncertified, commercially available Telecommunications equipment shall be only installed in areas which have been formally declared Non Hazardous.
- (d) Within hazardous areas all cables to conform to standards which require Fire Resistance characteristics and Steel Armouring mechanical protection. Cables conforming to this requirement should also be installed in Non-hazardous areas if the service they support is required in emergency and catastrophic situations.
- (e) All other cables should conform to Flame Retardant standards which also require the low emission of smoke and toxic fumes. Such cables shall also incorporate steel wire armouring where

they pass through external locations and where considered appropriate.

There may be circumstances, such as where short lengths of special proprietary cable connect cabinets within equipment rooms, where it may be considered impracticable to follow this practice.

- (f) Antennas or other radiating elements emitting radio-frequency energy are not to be installed in Hazardous areas.
- (g) The routing of cables and the siting of junction boxes, transits, items of field equipment and antennas shall be carefully selected to minimise the likelihood of physical damage.
- (h) The appropriate earthing, screening and bonding measures are universally adopted.
- (j) All relevant Codes of Practice and Standards are followed.

4. ASSOCIATED SYSTEMS

4.1 General

Telecommunication emergency shutdown measures are always initiated by inputs from other systems. The installation or plant Emergency Shutdown and Fire and Gas Systems are always relied on to provide the necessary interfaces which correspond to operational or emergency status. The Telecommunications Emergency Shutdown System will have no separate detectors, sensors or other independent means of determining the status of the installation or plant.

4.2 Emergency Shutdown Systems

All installations or plant will have some form of Emergency Shutdown System for the protection of process, storage and transport facilities and personnel. In the event of some abnormality, failure or disturbance within the protected installation or plant, the shutdown system will effect an orderly and controlled staged shutdown designed to contain and isolate affected areas.

Shutdown actions are usually described in detailed Cause and Effect Diagrams which are particular to each installation or plant. These may differ in basic concepts, items of detail or for site specific considerations. However, although generally they all follow the same basic philosophies and practices, there can be significant differences in shutdown arrangements to suit individual installations. The following descriptions of the main categories of shutdown are provided as an indication of the typical arrangements that can be employed;



(a) Plant Shutdown

This is usually the first level of protection to shutdown and isolate individual items of plant or machinery which have either failed or displayed abnormal operation. This action need not necessarily infer that a hazardous situation has arisen, but it is more to initiate an ordered shutdown sequence such that the incident is isolated and contained and a possible potentially hazardous situation avoided. Shutdown can be initiated by automatic or manual means.

(b) Yellow Shutdown

This can be automatically or manually initiated and usually indicates that localised fire or gas has been detected or that a more serious plant failure has occurred. This normally results in process and production shutdowns. Main generation is usually continued but is subject to shutdown by the Fire and Gas System.

(c) Red Shutdown

Red Shutdown is manually initiated and will usually represent the final stage of shutdown where an incident has escalated to a stage where all production, export and main power generation has to be shutdown and that an evacuation of personnel will either occur immediately or will take place to a prescribed schedule.

(d) Post-Red Shutdown

A Post-Red Condition commences at the instant a Red Shutdown is initiated and its purpose is to maintain in operation only those systems required to support the evacuation process. In some instances, such as would apply to offshore installations, immediate evacuation is not always desirable nor possible at the instant of Red Shutdown. Therefore in such circumstances a requirement exists to maintain personnel at muster points or within a 'safe haven' until evacuation can be effected. In order that the emergency communication and other essential systems can be maintained in operation for Post-Red condition, a dedicated (Post-Red) Fire and Gas system is usually provided to protect those areas where essential control functions (Control Rooms, Radio Rooms etc.) are located and where the equipment to provide these services is housed (Central Equipment Rooms, Telecommunications Equipment Rooms etc.). Should the Post-Red Fire and Gas system operate due to the detection of gas in the protected area, then the Post-Red Shutdown of the equipment located in that area is initiated. Post-Red Fire and Gas systems are generally only active (i.e. powered-up) subsequent to the initiation of a Red Shutdown.

Generally the Telecommunications Emergency Shutdown system will only respond to Yellow and Red Shutdowns and Post-Red Shutdown actions. However it is recommended that all shutdown conditions will require examination on a case-by-case basis.



4.3 Fire and Gas Systems

Fire and Gas systems are installed to protect installations and plant. In the context of direct and automatic Telecommunications Emergency Shutdown actions, gas detection need only be considered. Gas detectors are located throughout hazardous areas and are arranged in zones. Individual gas detectors are tailored to operate at either the 'lower explosive limit' (LEL) or at the 'upper explosive limit' (UEL). To overcome the possibility of false operation, detector control circuits are configured to provide voting of multiple detectors. By this arrangement, an interface signal providing an indication of 'confirmed' detection of gas can be obtained. As the optimum concentration of gas in air is the criteria used in hazard assessments and as this lies between the LEL and UEL, then inputs from the F & G system relating to gas detection should relate to the LEL.

5. SPECIFIC SHUTDOWN ACTIONS

5.1 General

Emergency shutdown systems for Telecommunications are generally more applicable to offshore installations. In such applications telecommunications systems have to co-exist in close proximity to areas which are either formally classified as hazardous or which could be enveloped by a flammable atmosphere in emergencies or other catastrophic circumstances. However due attention should also be given to onshore applications where, in particular, incident power flux density or electric field strength levels may be very much higher than experienced offshore due to proximity of much higher powered transmitters.

5.2 Actions on Gas Detection

A confirmed detection of gas in a plant or installation indicates that a flammable atmosphere is likely to exist and that protection is required against radio-frequency induced ignition hazards. A formal assessment will determine which transmissions would pose such a hazard in such circumstances and arrangements should be made for these to be either shutdown or reduced to safe levels of output power.

All items of portable or semi-portable telecommunications equipment, which are likely to be used in the vicinity of an area where a flammable atmosphere may be present, shall be certified as 'intrinsically safe' and have an output power not in excess of 2 Watts. Such requirements shall also apply to items of Telecommunications Test Equipment unless they are stored permanently or used solely within areas subject to Post-Red Gas detection.

The separation distance between the transmitting antenna and the plant is a critical parameter in making such assessments. Should the plant items be concentrated



closely together, as on an offshore installation, then it is recommended that any localised detection of gas should be considered to apply to the installation as a whole, as a single point of escape could lead quickly to the entire installation being enveloped. In such circumstances a confirmed gas detection anywhere on the installation should initiate the appropriate shutdown actions irrespective of the location of the source.

When considering onshore sites such as refineries or multiple platform offshore installations, the differences in separation distances between transmitting antennas and different areas of the plant may show considerable variation. In such cases, zoned shutdown arrangements should be considered, whereby a transmitter might be shutdown by gas detected in an area close to the transmitter, but not shutdown by gas detected in an area at a safe distance. Such an arrangement is less operationally restrictive, but it adds to the complexity of the shutdown system.

Certain systems or items of equipment operate at output powers in excess of the 2 Watt flammable atmosphere ignition threshold (for gas groups associated with oil and gas operations) and the majority of these would not be able to provide any workable service if their output power was reduced to the 2 Watt level or below. Therefore these should be shutdown completely in such circumstances. However some systems are able to provide a degraded, but still useful, level of service at this reduced power level. In order to maintain as many services as possible in an operational condition, in what may well be an emergency situation, means should be incorporated to automatically reduce the output power to 2 Watts or below on activation of Gas Detection Shutdown.

Other items of portable, mobile or semi-mobile Telecommunications equipment incorporating transmitters may be deployed despite the fact that intrinsically safe or similarly protected versions are not commercially available. In such cases the risks associated with their operation close to either hazardous areas or areas containing flammable atmospheres are outweighed by the benefits derived from their operation, which in the majority of cases will be in emergency situations. Such equipment includes aeronautical and marine vhf transceivers fitted to Survival Craft and Man-OverBoard rescue boats, handheld aeronautical vhf radios for helideck operation and various Search and Rescue radio beacons. However the use of such items shall be strictly regulated by formal operating procedures and by suitable warning notices affixed on or in close proximity to the equipment.

All Telecommunications systems should be subject to the radio-frequency induced ignition hazard assessment procedure to determine which should be shutdown at first confirmed detection of gas. However the typical shutdown arrangements for an manned offshore production platform would be as follows:

- *The Aeronautical Non-Directional Beacon and MF/HF SSB Transmitter to be isolated immediately from its electrical supplies.*
- *The transmitters associated with the following items to have their radio-frequency output power reduced to 2 Watts or below:-*
 - *Marine VHF Transceivers*
 - *Aeronautical VHF Transceivers*
 - *UHF Handportable Base/Repeaters*



5.3 Yellow Shutdown Actions

Generally a confirmed detection of gas will cause a Yellow Shutdown and for the majority of cases there are no additional shutdown measures required for the Telecommunications equipment. However, each installation should be examined to ascertain if any particular shutdown actions are appropriate to the initiation of a Yellow Shutdown.

5.4 Red Shutdown Actions

Red Shutdown should shutdown or reduce the power of the following:-

- (a) All systems and items of equipment that would be shutdown or have their output power reduced as a result of a Gas Detection Shutdown, if this has not already occurred.
- (b) All equipment not certified as being suitable for use in hazardous areas and not protected by a Post-Red Shutdown system shall be shutdown.
- (c) All systems deemed not to be essential subsequent to Red Shutdown.

An audit should be carried out to determine which items meet the above criteria. Agreement should be sought from Operations and Safety representatives. On a typical manned offshore production installation the following systems would be disconnected from all their electrical supplies in the event of a Red Shutdown:

- MF/HF SSB Transmitter
- MF/HF SSB/PABX Patch
- Non-Directional Beacon and Monitor Receiver
- Telecommunications Supervisory System
- Marine Radar System
- Navtex/Weatherfax Receiver
- Fax Machines
- Driller's Intercom
- Entertainment System
- Computer Terminals and Personal Computers
- Workstations
- Telex terminals
- All non-Ex phones
- All other Telecommunications Loads which are not electrically supplied from a UPS or the Emergency Generator (Power-down by virtue of main generation shutdown).

It should be stressed that the items included in the above list only represent a typical solution. Each installation should be considered individually to determine those systems which satisfy the above disconnection criteria and which leave sufficient services available to safely maintain essential services in the Post-Red Shutdown period.



All the above shutdown actions (apart from those caused directly by a the loss of power generation) to be effected by electrical disconnection within areas protected by Post-Red Shutdown systems.

5.5 Post-Red Shutdown Actions

Equipment and systems are maintained in operation and protected by Post-Red Shutdown systems to ensure that they are available for as long as possible during emergency situations. Therefore, as the capacity of the emergency power generation and power storage batteries is limited, only those systems required for mandatory and essential operational reasons are maintained in operation.

On manned offshore production installations it has been recent practice to locate the Central Control Room, Central Equipment Room, Emergency Switch Room and UPS together in the lower part of the Accommodation/Integrated Deck. To provide diversity in Communications and Control Centres for use in emergency situations, the Radio Equipment Room, Telecommunications Equipment Room and in some instances a Helicopter Landing Office are located closely together within the upper parts of the Accommodation/Integrated Deck. Each of these areas would incorporate their own independent Post-Red Fire and Gas Shutdown system.

The following systems on a typical installation would be Post-Red protected:-

- General Alarm/Public Address System
- Standby/Safety Boat Communication Link
- Marine VHF Transceivers (2 Watts Max.)
- Aero VHF Transceivers (2 Watts Max.)
- Inmarsat Terminal
- Main Satellite System/s to Shore
- Line-of-Sight Radio links to adjacent platforms
- UHF Handportable Radio Systems (2 Watts Max.)
- UHF Paging Systems (2 Watts Max.)
- Hot Line Telephone Systems
- PABX and Ex Phones only
- Data Systems and LANs (only those in Post-Red protected areas)
- Telecommunications Shutdown Panels

N.B. All installations should be examined individually to determine which systems can be maintained in operation to provide essential communications services during this period.

Gas detectors are to be located such that they can monitor the immediate vicinity of the Inmarsat, Standby/Safety Boat link and line-of-sight link antennas. Confirmed LEL Gas to isolate any electrical and radio-frequency connections to these antennas. The isolation to be effected within the Post-Red protected area of which the external gas detectors effectively form part (typically this will be the area which includes the Radio Equipment Room).

All cross-connections between the the two (or more) zones to be isolated such as to prevent energy being fed from a Post-red protected zone which is free of gas into



one where the Post-Red system has been activated by the presence of Gas. The isolation to be carried out in the zone still free of gas.

6. DESIGN CONCEPTS

6.1 General

The following engineering practices should be employed in the design, construction, installation and maintenance of Telecommunication Shutdown Systems:-

- (a) When implementing the electrical disconnection of equipment, all poles of the supply, apart from the earth connection, must be isolated.
- (b) Mechanical Relays or Contactors employing the principle of a complete physical break or disconnection shall be used for all electrical isolations (a.c. and d.c.).
- (c) Coaxial Relays shall be used for all radio-frequency coaxial disconnections and power reductions. Waveguide switches shall be used where appropriate.
- (d) Wherever practical all relays, switches and contactors used for shutdown actions should be of the sealed or enclosed type, but preferably they should be of a type which is hermetically sealed.
- (e) Where shutdown devices are located in an area or room, they shall be positioned such that if gas enters that space, it will be the last place it is likely to reach.
- (f) All Telecommunications Shutdown actions shall be configured as 'de-energise to shutdown'.
- (g) The majority of Telecommunications systems derive their electrical supply from Uninterruptable Power Supplies (UPS). When the electrical supply to these UPS fails or is shutdown then the capacity of the UPS should be sufficient to maintain systems in operation for a specified period of time. This 'hold-up' time should be defined for each item of equipment after considering the following factors:-
 - *Statutory requirements related to total evacuation times and classification as systems 'likely to be required in an emergency'. Hold-up times are typically between 1 and 4 hours.*



- The essential or non-essential nature of the equipment
- Constraints related to the maximum capacity of the UPS

Normally, equipment should be left to run until the UPS is exhausted, but individual systems are likely to require that UPS supplies are disconnected well before that stage at a specified minimum supply voltage or frequency limits.

The power supply and UPS arrangements shall be engineered to facilitate an orderly and efficient start-up procedure subsequent to the UPS being either partially or fully exhausted.

7. REGIONAL ANNEXES

This section is supplemental to the foregoing international requirements, to assist with applying this Recommended Practice in the particular regions identified in this section.

7.1 UK Annex

The following are U.K. Regulations, Standards, Guides and Codes of Practice containing sections relevant to the design of Telecommunications Emergency Shutdown Systems and should be referred to for the interpretation and application of this Recommended Practice:-

- (a) [BS 5345](#): Code of Practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)
Part 1 Basic requirements for all parts of the code
Part 2 Classification of hazardous areas

Which is primarily concerned with the classification of hazardous areas and the selection of appropriately certified equipment for those areas;

- (b) [BS 5501](#): Electrical apparatus for potentially explosive atmospheres
Part 1 General requirements
Part 5 Flameproof enclosures
Part 7 Intrinsic Safety 'i'

Describes the requirements for equipment for use in hazardous areas;

- (c) [BS 6656](#): Guide to Prevention of inadvertent ignition of flammable atmospheres by radio-frequency radiation

Revised 1991.

- (d) [The Health and Safety at Work, etc. Act 1974](#)



Current UK legislation requires that employers safeguard their employees and others who may be placed at risk by their activities;

(e) [Factories Act 1961: Regulation 9 of the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972](#)

This legislation places a responsibility on the occupier of any factory to prevent the presence of any means likely to ignite a flammable vapour where such a vapour may exist. In the case of ignition hazards caused by Telecommunications systems there should be some element of cooperation and flow of information between the operators of transmitters and Telecommunications systems and plant operators, since both are subject to the requirements of the The Health and Safety at Work Act.

(f) [Department of Energy: Offshore Installations: Guidance on Design, Construction and Certification](#)

Section 90 gives guidance on equipment and services provided for an emergency and includes requirements related to the radio installation, general alarm and public address systems and emergency shutdown systems. Section 91 gives guidance on emergency shutdown systems.

(g) Mineral Workings (Offshore Installations) Act 1971

1. Offshore Installations (Construction and Survey) Regulations 1974, [SI 1974/289](#)

Prescribes the use of standards for the design and construction of offshore installations and includes requirements relating to equipment to be placed in hazardous areas.

2. Offshore Installations: Guidance on Design and Construction - Department of Energy

Includes guidance on matters relating to certification, emergency shutdown systems and emergency power supplies.

3. Offshore Installations (Life-Saving Appliances) Regulations 1977, [SI 1977/486](#)

Includes specific requirements for General Alarm and Public Address systems.

4. Offshore Installations: Guidance on Life-Saving Appliances - Department of Energy

Expands on the requirement for General Alarm and Public Address systems in SI 486.



5. Offshore Installations (Fire-Fighting Equipment) Regulations 1978, [SI 1978/611](#)

Includes requirements for automatic and manual fire detection and fire fighting equipment.

6. Offshore Installations (Operational Safety, Health and Welfare) Regulations 1976, [SI 1976/1019](#)

Includes requirements for basic communications facilities and radio operators.

7. Offshore Installations (Emergency Procedures) Regulations 1976, [SI 1976/1542](#)

Includes requirements for communications between the installation and the Safety/Standby vessel.

- (h) IEE Recommendations for the Electrical and Electronic Equipment of Mobile and fixed Offshore Installations

A general design guide for electrical and electronic equipment in offshore applications.

- (i) BP Group Standards

BP Group [GS 112-12](#) Requirements for Flame Retardant and Fire Resistant Cables.



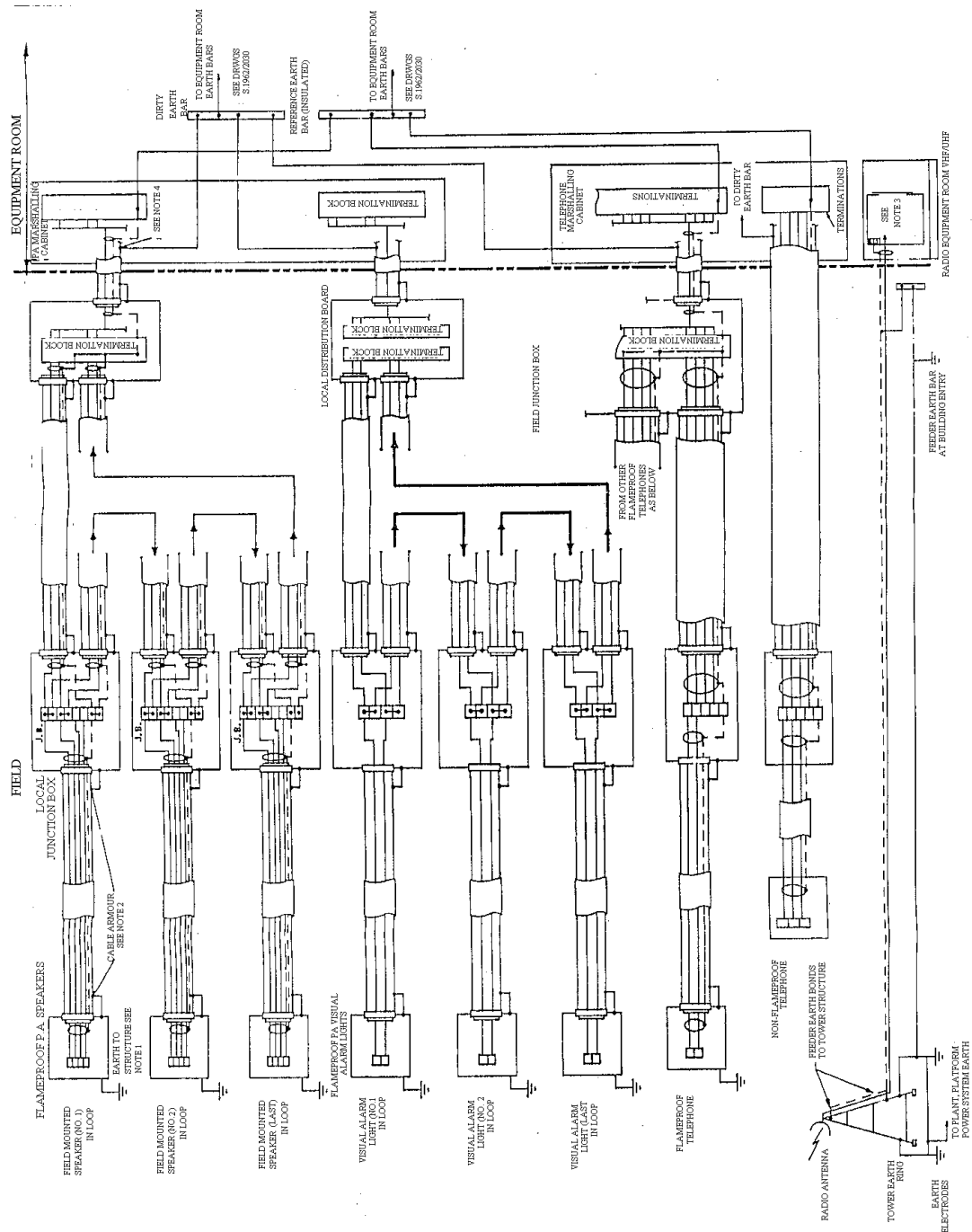


FIGURE 2

TYPICAL EARTHING DIAGRAM FOR TELECOMMUNICATIONS EQUIPMENT

DEFINITIONS AND ABBREVIATIONS**Definitions**

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

Abbreviations

AC	Alternating Current
DC	Direct Current
EED	Electro-Explosive Device
ESD	Emergency Shutdown
Fax	Facsimile
GHz	1 GHz = 1000 MHz
HF	High Frequency (3 MHz to 30 MHz)
IEE	Institution of Electrical Engineers
Inmarsat	International Maritime Satellite Organisation
kHz	1 kHz = 1000Hz
LAN	Local Area Network
LEL	Lower Explosive Limit
MF	Medium Frequency (300 kHz to 3 MHz)
MHz	1 MHz = 1000 kHz
PABX	Private Automatic Branch Exchange
SI	Statutory Instrument
SSB	Single Sideband
UEL	Upper Explosive Limit
UPS	Uninterruptable Power Supply
VHF	Very High Frequency (30 MHz to 300 MHz)



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.

UK

Cochrane, P. and Heatley, D. 'Optical Fibre Systems and Networks in the 21st Century' , Interlink 2000 (Chase Communications Publishing Ltd.) February 1992 , pp 150-154

ERA Technology, 'Report on a Study of the Use of Cells and Batteries under Red Alert Emergency Shutdown Conditions' , ERA Report 4120/06 , ERA Project 4120 (Strictly Confidential - BP)

Tortoishell, G. 'Use of Fibre Optic Systems in Potentially Explosive Atmospheres' , OSCA (UK Optical Sensors Collaborative Association) Doc. No. 85/88, October 1985

