HEALTH AND SAFETY AUTHORITY

Code of Practice
for Electrical Safety in Quarries

Our vision:

A national culture where all commit to safe and healthy workplaces and the safe and sustainable management of chemicals

Code of Practice
for **Electrical Safety in Quarries**

Contents

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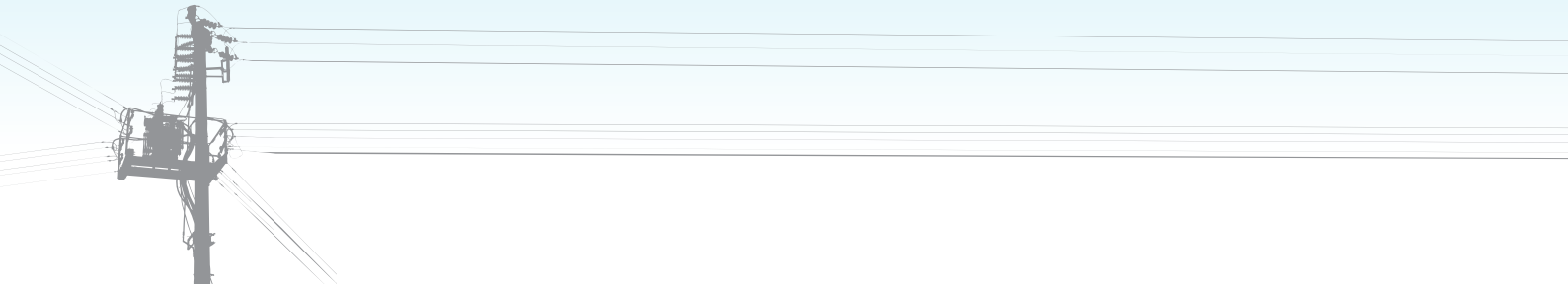


Foreword

The Health and Safety Authority, with the consent of Dara Calleary TD, Minister of State at the Department of Enterprise, Trade and Innovation, and following public consultation, publishes this Code of Practice, titled "Code of Practice for Electrical Safety in Quarries", in accordance with Section 60 of the Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005).

This Code of Practice provides practical guidance on observing the provisions of the Safety, Health and Welfare at Work Act 2005 and the Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299 of 2007) as amended by the Safety, Health and Welfare at Work (General Application) (Amendment) Regulations 2007 (S.I. No. 732 of 2007) for the use of electricity in quarries.

In particular, but not exclusively, this Code of Practice provides practical guidance on observing Part 3 (Regulations 74 to 93) of the General Application Regulations 2007.

This Code of Practice comes into operation on Monday 20th December 2010.

Notice of issue of this Code of Practice was published in the Iris Oifigiúil of Friday 17th December 2010.

On the use of codes of practice in criminal proceedings, Section 61 of the 2005 Act provides as follows:

> "61.—(1) Where in proceedings for an offence under this Act relating to an alleged contraven tion of any requirement or prohibition imposed by or under a relevant statutory provision being a provision for which a code of practice had been published or approved by the Authority under section 60 at the time of the alleged contravention, subsection (2) shall have effect with respect to that code of practice in relation to those proceedings.
>
> (2) (a) Where a code of practice referred to in sub section (1) appears to the court to give practical guidance as to the observance of the requirement or prohibition alleged to have been contravened, the code of practice shall be admissible in evidence.
>
> (b) Where it is proved that any act or omission of the defendant alleged to constitute the contravention
>
> (i) is a failure to observe a code of practice referred to in subsection (1), or
>
> (ii) is a compliance with that code of practice, then such failure or compliance is admissible in evidence.
>
> (3) A document bearing the seal of the Authority and purporting to be a code of practice or part of a code of practice published or approved of by the Authority under this section shall be admissible as evidence in any proceedings under this Act."

This Code of Practice is complementary to the Health and Safety Authority's Guidelines to the Safety, Health and Welfare at Work (Quarries) Regulations 2008 (S.I. No. 28 of 2008), which came into operation on 1 May 2008.

Robert Roe

Assistant Chief Executive Officer and Secretary to the Board

Health and Safety Authority

1.0 Introduction

This Code of Practice is aimed primarily at operators of quarries, designers of quarry electrical installations, electricians, safety and health practitioners, employers, managers, employees, safety representatives and anyone associated with electrical installations in quarries. The Code is designed to give guidance on Part 3 of the Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299 of 2007) as amended by the Safety, Health and Welfare at Work (General Application) (Amendment) Regulations 2007 (S.I. No. 732 of 2007) as it relates to the use of electricity in quarries. Further guidance is available in the **Guide to the Safety, Health and Welfare at Work (General Application) Regulations 2007–Part 3 Electricity** published by the Health and Safety Authority in 2007.

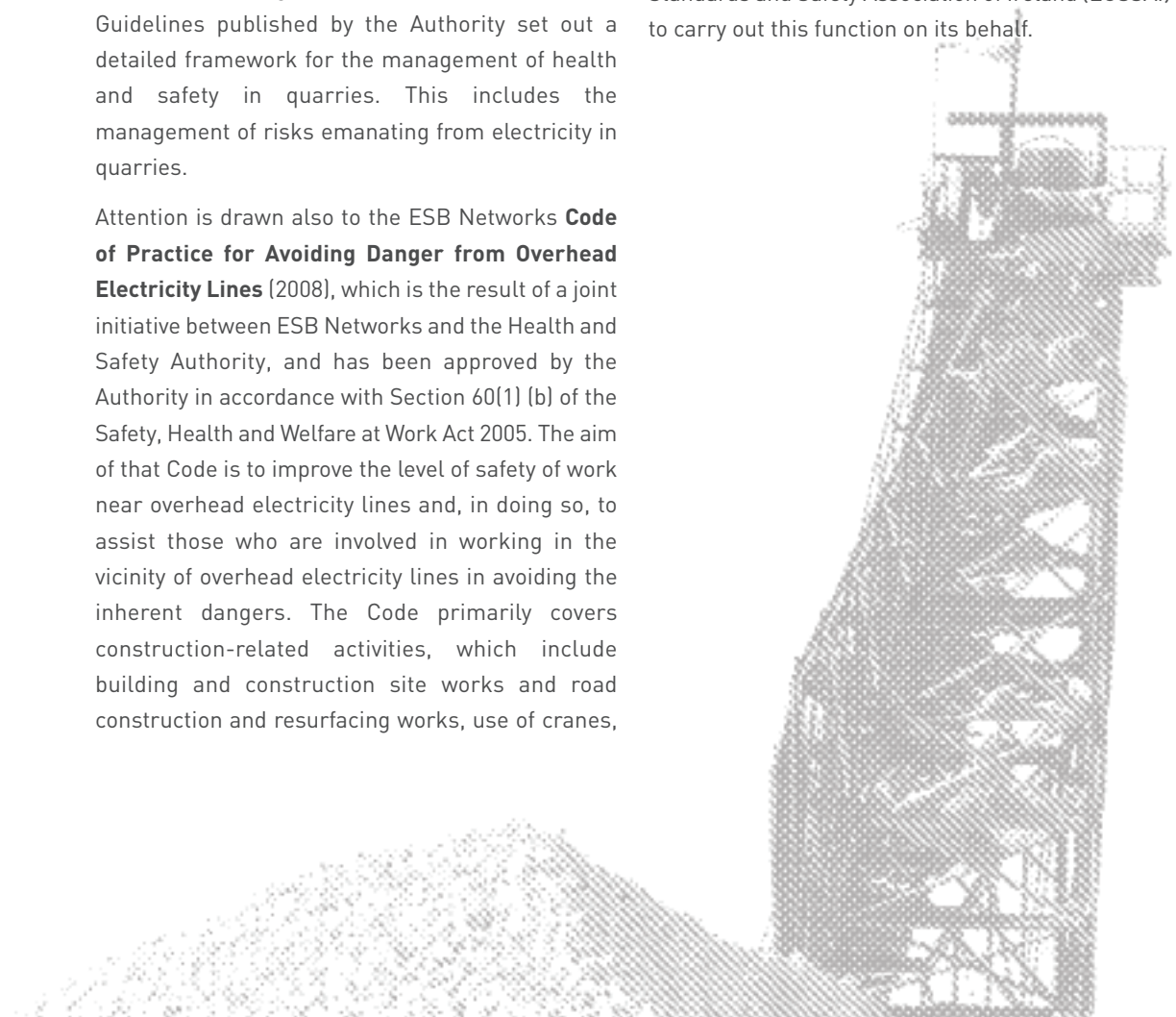
The layout and sequencing of this Code of Practice generally follows the sequencing of Part 3 of the Safety, Health and Welfare at Work (General Application) Regulations 2007. The Safety, Health and Welfare (Quarries) Regulations 2008 and the associated Guidelines published by the Authority set out a detailed framework for the management of health and safety in quarries. This includes the management of risks emanating from electricity in quarries.

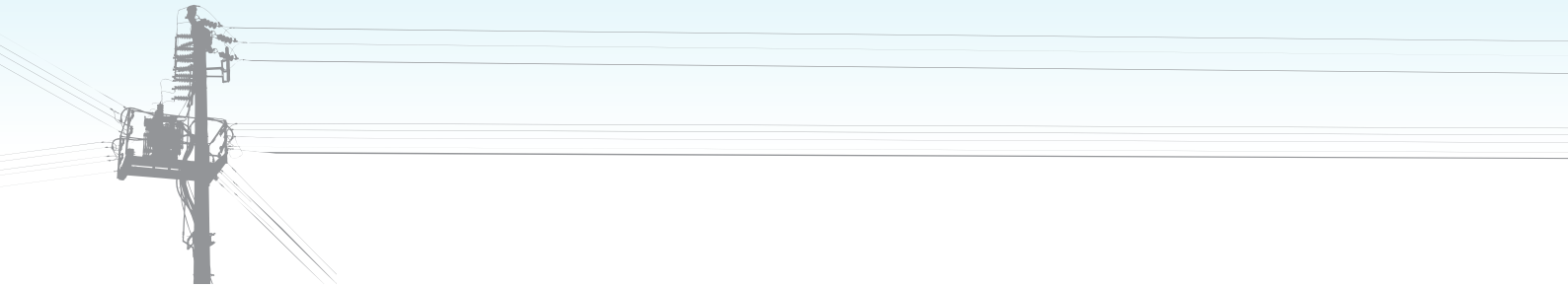
Attention is drawn also to the ESB Networks **Code of Practice for Avoiding Danger from Overhead Electricity Lines** (2008), which is the result of a joint initiative between ESB Networks and the Health and Safety Authority, and has been approved by the Authority in accordance with Section 60(1) (b) of the Safety, Health and Welfare at Work Act 2005. The aim of that Code is to improve the level of safety of work near overhead electricity lines and, in doing so, to assist those who are involved in working in the vicinity of overhead electricity lines in avoiding the inherent dangers. The Code primarily covers construction-related activities, which include building and construction site works and road construction and resurfacing works, use of cranes, mobile elevating work platforms (MEWPs), concrete placing booms, lorry-mounted cranes and other high-reach plant and excavation equipment, and the transporting of high loads by road.

The document ET 101, **National Rules for Electrical Installations** (Fourth Edition) published by the Electro-Technical Council of Ireland (ETCI), contains valuable information on safe electrical installations (albeit that, as a set of rules, ET 101 does not apply to quarries).

Readers should also be aware that, in addition to the Health and Safety Authority, the Commission for Energy Regulation (CER) has a significant role in enforcing electrical safety standards for electrical contractors in Ireland.

The Energy (Miscellaneous) Provisions Act 2006 gives the Commission the legal function of regulating the activities of registered electrical contractors. As of 2010, the Commission has appointed the Register of Electrical Contractors Ireland (RECI) and the Electrical Contractors Standards and Safety Association of Ireland (ECSSAI) to carry out this function on its behalf.





2.0 Definitions

The following definitions apply in this Code:

"authorised person" means a person who is –

(a) competent for the purpose of this Part, in relation to which the expression is used,

(b) either an employer, a self-employed person, or an employee appointed or selected by the employer or self-employed person, and

(c) engaged in work or duties incidental to the generation, transformation, conversion, switching, controlling, regulating, rectification, storage, transmission, distribution, provision, measurement or use of electrical energy;

"circuit" means part of an electrical installation supplied from the same origin, which may be protected against overcurrents by the same protective device;

"circuit breaker" means an electro-mechanical device capable of making, carrying and breaking currents under normal circuit conditions and also capable of making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions such as those of short circuit;

"conductive part" means a part capable of conducting current although not necessarily used for carrying current in normal conditions;

"conductor" means a conductor of electrical energy;

"danger" means risk of personal injury from –

(a) electric shock, electric burn, electrical explosion or arcing,

(b) fire or explosion caused by the use of electricity, or

(c) mechanical movement of electrically driven equipment,

and preventing danger in this Code shall be construed as preventing danger so far as is reasonably practicable;

"earthing" means the connection of the exposed conductive parts of an installation to the conductive mass of the earth;

"electrical equipment" includes any conductor or electric cable and any part of any machine, apparatus or appliance intended to be used or installed for use for the generation, transformation, conversion, switching, controlling, regulating, rectification, storage, transmission, distribution, provision, measurement or use of electrical energy;

"electrical installation" means an assembly of associated electrical equipment fulfiling a specific purpose or purposes and having co-ordinated characteristics;

"ETCI" means the Electro-Technical Council of Ireland;

"higher voltage" means any voltage exceeding:

(a) 1000 volts alternating current, or

(b) 1500 volts direct current;

"isolation" means the disconnection and separation of electrical equipment from every source of electrical energy in such a way that the disconnection and separation is secure;

"live" means electrically energised;

"overcurrent" means any current exceeding the rated value of the electrical equipment concerned;

"overhead line" means any electric line suspended above ground carrying or intended to carry electrical energy at a voltage exceeding 80 volts to earth;

"portable equipment" means equipment, including hand-held portable equipment, which:

(a) because of the manner in which it is to be used, requires to be moved while it is working,

(b) is designed so that it can be moved while it is working, or

(c) is moved from time to time between the periods during which it is working;

"residual current device" means an electro-mechanical switching device intended to disconnect a circuit when the residual current attains a stated value under specific conditions;

"substation" means any building, enclosure or other structure, or any part thereof, which:

(a) is large enough to enable a person to enter after the electrical equipment therein is in position, and

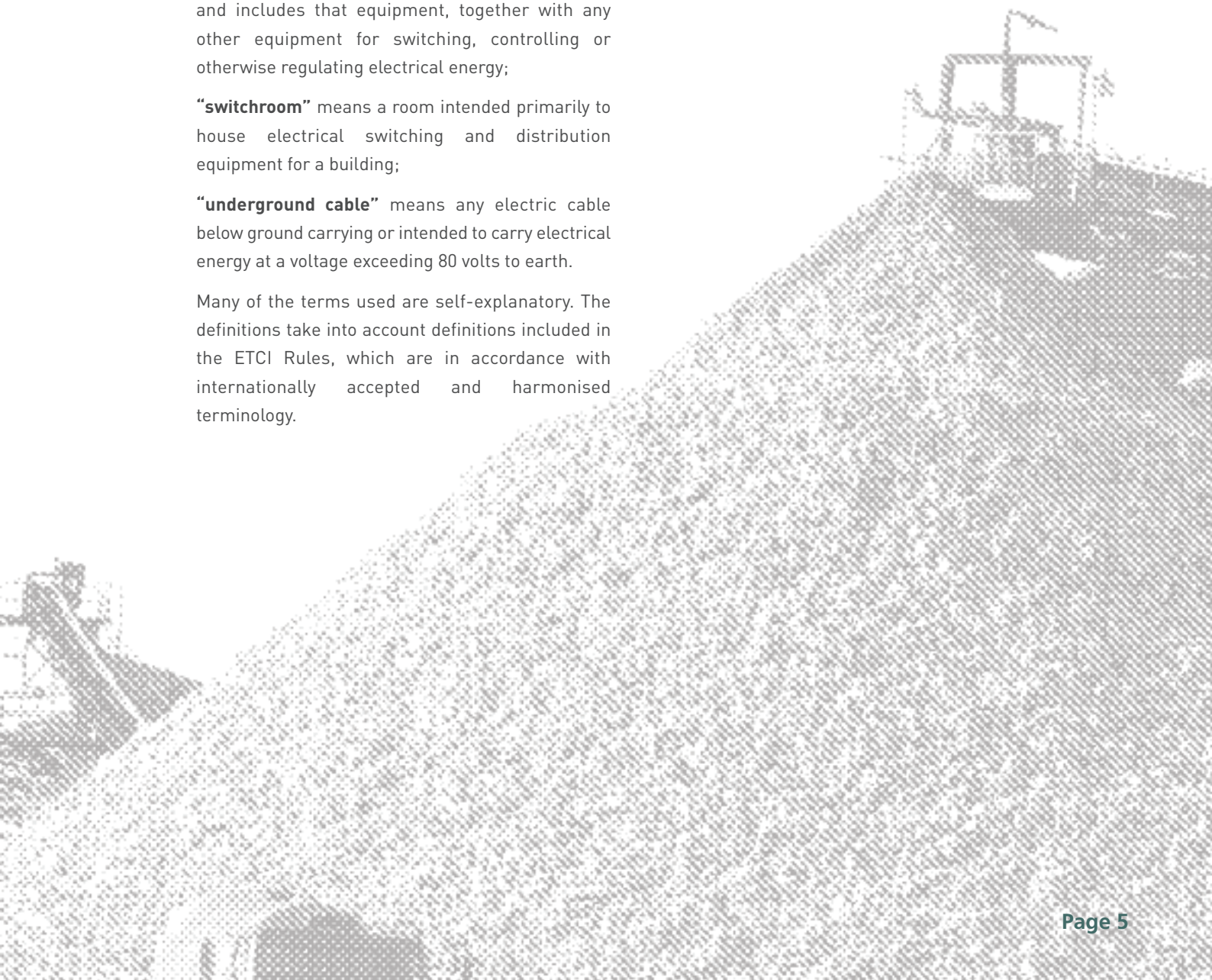
(b) contains equipment for transforming or converting electrical energy either to or from higher voltage (not being equipment for transforming or converting electrical energy solely for the operation of switchgear or instruments),

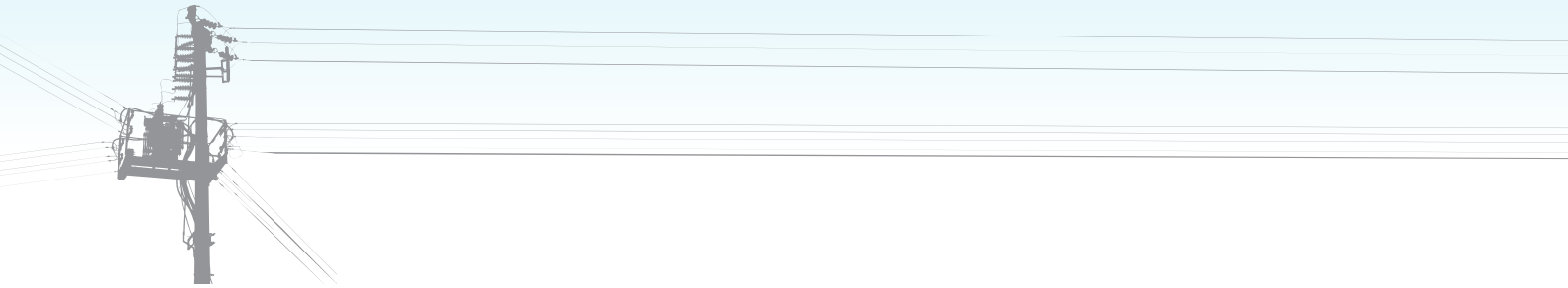
and includes that equipment, together with any other equipment for switching, controlling or otherwise regulating electrical energy;

"switchroom" means a room intended primarily to house electrical switching and distribution equipment for a building;

"underground cable" means any electric cable below ground carrying or intended to carry electrical energy at a voltage exceeding 80 volts to earth.

Many of the terms used are self-explanatory. The definitions take into account definitions included in the ETCI Rules, which are in accordance with internationally accepted and harmonised terminology.





3.0 Safety, Health and Welfare at Work (Quarries) Regulations 2008

3.1 Operating procedures

The Safety Health and Welfare at Work (Quarries) Regulations 2008 (S.I. No. 28 of 2008) deal with occupational safety health and welfare in quarries. Under Regulation 14 the quarry operator has a duty to ensure that operating procedures are drawn up for safe use of equipment. In the context of electricity, these procedures should deal with electrical equipment and the controls associated with that equipment. Copies of all instructions, rules and operating procedures must be kept at the quarry and given to the worker concerned. The quarry operator must prepare a scheme for systematic inspections, maintenance and testing. This is expanded upon in part 15 of this Code.

3.2 Quarry management

In accordance with the 2008 Regulations, a competent person must be appointed as quarry manager to manage the operation of the quarry at all times when work is being undertaken. If the operator is a competent individual, he or she could also be the quarry manager. While the Regulations do not require the quarry manager to have a specific competence in electrical issues, he or she should be in a position to identify competent people who can maintain, safely, the quarry electrical installation. The quarry manager is the operator's representative at the quarry and it is his or her role to advise and assist the operator in fulfiling all legal requirements. The appointment of a quarry manager does not take away the legal duty of the operator to fulfil his or her statutory functions but provides for a point of contact to the contractors, self-employed persons at the quarry and the operator's employees. The quarry manager and other persons in the management structure can be held accountable for their acts or omissions, or any offence committed with their consent, connivance or neglect, under the Safety, Health and Welfare at Work Act 2005 (See sections 80 and 81 of that Act).

4.0 Suitability of Equipment and Installations in Quarries

4.1 General

The quarry operator must have systems in place to ensure:

(a) all electrical equipment and electrical installations in the quarry are:
- (i) designed,
- (ii) constructed,
- (iii) installed,
- (iv) maintained,
- (v) protected, and
- (vi) used

so as to prevent danger, and

(b) all electrical equipment and electrical installations, including distribution boards, sockets, transformers and connections, are suitably protected from ingress of moisture or of particles and foreseeable impacts, as appropriate to the location.

4.2 Design and construction

The safety of electrical equipment and installations depends on the design, selection and construction of equipment appropriate to the work environment in which it is to be used. The quarry is generally a harsh

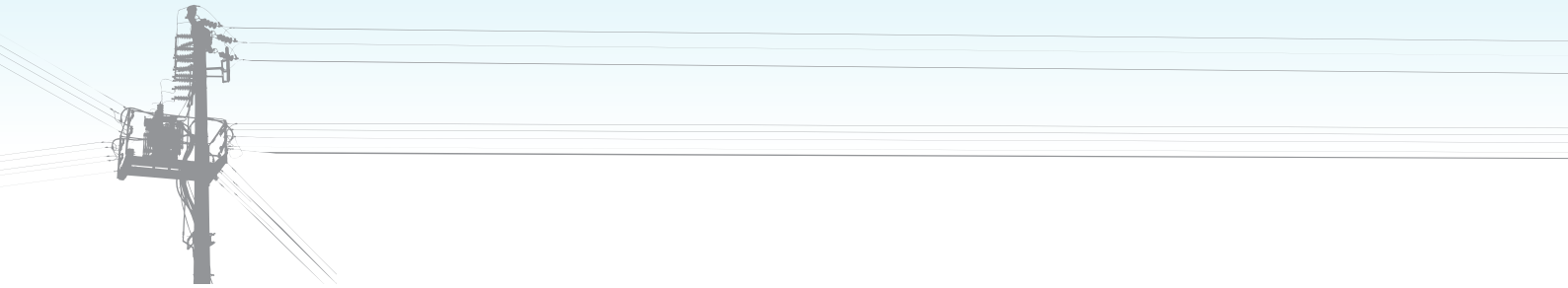
environment including, in many areas, a high risk of ingress of dust and moisture. The equipment must be selected and maintained to cater for this. New machinery or second-hand machinery imported from outside the EU should comply with the Machinery Directive 2006/42/EC, which replaced Directive 98/37/EC from 29 December 2009 and is transposed into Irish law through the European Communities (Machinery) Regulations 2008 (S.I. No. 407 of 2008). New electrical equipment should comply with the Low Voltage Directive (LVD) 2006/95/EC, which is applicable for equipment operating between 50–1000V AC or 75–1500V DC.

Where the electricity supply to the premises is provided by the Distribution System Operator (DSO), it should be clearly established where the electricity supplier's responsibilities end and those of the quarry owner commence (normally the consumer and utility interface). This will help avoid confusion over duties for compliance with these Regulations, and access to equipment, especially in an emergency.

4.3 Ingress protection

Ingress protection is about the protection of the equipment against entry of foreign matter. The ingress protection standard is identified by an "IP rating" that should appear in product literature. It consists of two digits, each signifying a separate characteristic. The IP designation indicates the level of protection against ingress of both solid bodies/dust and water. It does not specifically indicate protection against any "foreign matter" other than water or solid bodies/dust. Higher numbers indicate a better level of protection. For example, in outdoor areas in a quarry, the electrical equipment should have at least an IP54 rating. The first digit refers to particulate ingress. Level 5 indicates dust protection, as well as protection from wire invasion down to 1.0 mm. The second digit refers to moisture. A rating of 4 in the second digit means resistance to water splashed from any direction. This rating should be maintained while the equipment remains in service.

First Number	Second Number	Additional Letter
No protection	No protection	A–Protected against access with the back of the hand
Protected against solid foreign objects larger than 50 mm diameter (back of hand)	Protected against vertically-falling drops of water (condensation)	B–Protected against access with a finger
Protected against solid foreign objects larger than 12 mm diameter (finger)	Protected against drops of water falling at up to 15° from vertical	C–Protected against access with a tool
Protected against solid foreign objects larger than 2.5 mm diameter (tool)	Protected against drops of water at up to 60° from vertical	D–Protected against access with a wire
Protected against solid foreign objects larger than 1 mm diameter (wire)	Protected against projections of water from all directions	
Protected against dust (no harmful deposit)	Protected against jets of water from all directions	
Completely protected against dust	Protected against powerful jets of water	
	Protected against the effect of temporary immersion	
	Protected against prolonged effects of continuous immersion	



4.4 Testing and maintenance

The manner in which the commissioning, testing and subsequent maintenance or other work that may need to be carried out should be assessed at the design stage. Sections 16 and 17 of the 2005 Safety, Health and Welfare at Work Act, as well as the Safety, Health and Welfare at Work (Construction) Regulations 2006, place additional duties on designers and those involved in the construction of electrical installations.

Further requirements for the design and erection of electrical installations are outlined in the ETCI National Rules for Electrical Installations.

Regular maintenance must be carried out to ensure the safety of electrical equipment or installations.

The nature and frequency of maintenance, as decided in the risk assessment process, should be adequate to prevent danger. Regular inspection of equipment should be part of any preventive maintenance programme and should be laid out explicitly in a schedule as part of a risk assessment process. Maintenance records, including the results of tests carried out during the working life of an electrical installation, will enable employers to monitor the effectiveness of maintenance procedures and policies.

4.5 Protection

Protection may be achieved by insulation alone, but, depending on the environment of the installation, further physical protection may be necessary to ensure the continuing integrity of basic insulation (e.g. conduits, trunking, armouring or tough external sheathing on cables).

4.6 Use

Electrical equipment and installations must not be misused by users. There is a particular onus on the quarry operator to ensure that employees are trained to use electrical equipment in a safe way and subject to supervision of that safe use. For example, equipment designed for use in a dry environment should not be used in wet conditions.

4.7: External influences

4.7.1 Equipment shall be selected and erected having regard to all external influences to which it may be subjected, so as to ensure the effectiveness of the protective measures and the correct functioning of the equipment. Such external influences include impact and other mechanical stresses, heat sources, and the presence of water, solid foreign bodies including dust and corrosive or polluting substances.

4.7.2 Where two or more external influences exist concurrently, the respective protective measures against those influences shall be compatible with each other.

4.7.3 Equipment that does not have, by its construction the necessary protection against the external influences of its location shall be provided with appropriate additional protection. Such protection shall not have any adverse effect on the operation of the equipment.

5.0 Identification and Marking

All electrical equipment should be fully identified as per Regulation 78 of the General Application Regulations. This requires the identification of electrical equipment, by way of labelling or otherwise, in order to prevent danger arising from confusion, mistaken identity or some other cause. Identification might also indicate the purpose of switchgear or control gear.

Each quarry should have a detailed up-to-date electrical schematic drawing and general layout drawing to show the location and type of electrical equipment and associated cabling. Drawings and associated wiring systems should be arranged or marked to ensure identification for inspection, testing or monitoring purposes.

Electrical equipment, other than cables and overhead lines, must display the manufacturer's name, together with details of the equipment rating. The IP rating will generally be required in order to assess the suitability of any equipment for a given environment. Each distribution board should also contain a detailed schedule of the equipment being fed from the board. This schedule should be written and protected in a manner that will not deteriorate, taking into consideration the environment in which the schedule is stored.

Cables in this environment may be subjected to adverse conditions such as rough usage and damage caused by traffic. Inferior grades of cable may not withstand these conditions for long, resulting in a dangerous situation. All power cables should comply with a recognised standard and should carry an approval mark from the appropriate approvals organisation (e.g. BASEC, VDE); See Annex 52D of the ETCI National Rules for Electrical Installations.

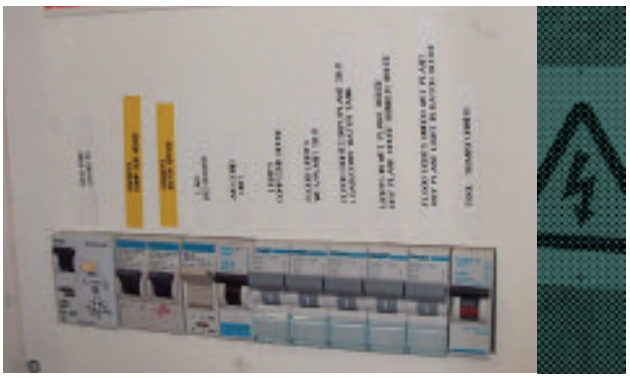


Fig 5.1 Circuit Identification on sub-distribution board

6.0 Protection against Electric Shock

6.1 Normal conditions

The quarry operator, through the employment of competent persons or contractors, must ensure that all live parts are insulated or positioned to prevent danger.

Protection against electric shock in normal conditions (protection against direct contact) can be provided by insulation of live parts. Insulation is, in the majority of cases, the primary and necessary safeguard to prevent danger from electric shock either between live conductors or between a live conductor and earth.

The insulation should be protected, as necessary, so that danger may be prevented. Protection is primarily required to prevent mechanical damage to the insulation, but it is also necessary to protect against the effects of exposure to adverse or hazardous environments as detailed previously. Examples of such protection include the use of steel trunking and conduits or the use of steel-wire armoured cables. Precautions other than basic insulation may be used to protect against direct contact. These may include protection by barriers and enclosures or protection by ensuring that the live part is in an inaccessible position. When deciding whether it is accessible or not, non-routine activities such as maintenance and cleaning must be considered. Strictly controlled working practices, reinforced by written instructions, training, warning notices and restricted access, may also be appropriate, depending on the level of risk involved.

Fig 6.1 Access controlled to high-voltage switch room

6.2 Fault conditions

Precautions must be taken to prevent electric shock where conductive parts which can be touched can become live under fault conditions (protection against indirect contact).

These precautions include:

- earthing and automatic disconnection of supply;
- double insulation;

- equipotential bonding;
- use of safe voltages;
- current/energy limitation;
- use of residual current devices.

Because of the size, spread and types of equipment prevalent in quarries, all electrical conductors should run with an adequately sized, separate, protective earth conductor. The use of multiple earths driven in separate locations should be avoided. This minimises the possibility of excessive voltage differences on adjacent pieces of plant in the event of an earth fault on one piece of plant. The earthing should generally be TN-S (See ETCI National Rules) with separate protective conductors throughout the installation.

7.0 Portable Equipment and Associated Circuitry

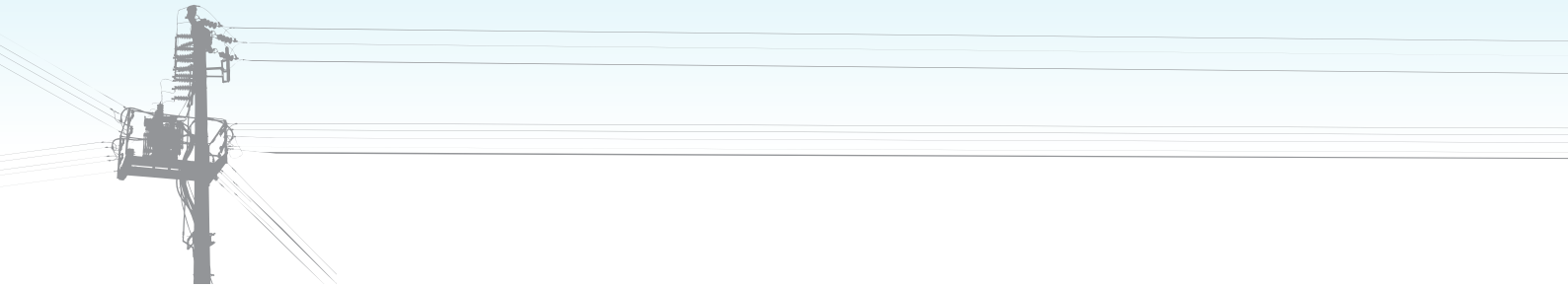
Generally, in the external quarry environment, all circuits supplying portable electrical equipment rated below 2 kilovolt amps (equivalent to a power rating of approximately 2kW) should be supplied at less than 125V (nominally 110V). Portable hand-lamps, that is electric lamps for inspection purposes and suitable for carrying in the hand, used in external workplaces such as quarries, must be supplied at a voltage not exceeding 25V AC or 50V DC. Hand-lamp bulbs are particularly prone to breakage with consequent exposure of live elements. Circuits supplying portable equipment rated at 230 V must be protected by a Residual Current Device (RCD) (sometimes referred to as an Earth Leakage Circuit Breaker).

Fig 7.1 Residual Current Devices (RCDs) (fitted to protect socket circuits)

The blue circular buttons in Figure 7.1 are test buttons which trip the RCD. Pushing these buttons regularly should help ensure that the RCD functions as intended in the event of current leakage.

While the push-to-test routine should ensure that the RCD will operate when required, it should also be functionally tested by a competent person periodically to ensure that it operates for the rated leakage current (e.g. at 30 mA) and within the time permitted (e.g. ← 0.3 seconds). Such testing should form part of the periodic installation tests which are required in accordance with Regulation 89 of the 2007 General Application Regulations.

In addition, electrical equipment, which is subject to deterioration, rated above 125V, must be examined and tested on a regular basis.



If the risk assessment shows that certain portable electrical equipment does require Portable Appliance Testing (PAT) then the following are some of the tests that should be considered:

Earth Bond

This verifies the integrity of the earth on the appliance. For IT equipment a test using reduced test current, which will not damage electronic equipment, may be required.

Insulation Test

The next required test is the Insulation test. This verifies that the insulation on cables and tracks in the appliance is sufficient to isolate the live conductors from each other and from the earthed parts of the appliance.

Earth Leakage Test

This is a further test of the insulation under operating conditions. This can be useful for finding if an appliance is causing nuisance tripping of RCDs.

Polarity Test

This is used to verify the polarity of leads etc.

Run Test

This can be used to ensure that the appliance is not drawing excess current at startup.

Operators should also visually check portable electrically operated equipment (including leads and plug-tops) before they use it. They should visually check for:

- obvious damage on the equipment enclosures and insulation;
- obvious damage to the cable or lead supplying the equipment or evidence of any temporary repairs such as taped connections;
- loose connections or loose cabling;
- damage to the plug tops or sockets;
- scorch or burn marks on the equipment, leads or plug tops.

Employees discovering a defect in portable equipment during these checks should not use the equipment and should report the defect to their supervisor. Employees should be instructed in the carrying out of these checks.

Portable electrical equipment supplied at a voltage less than 125V AC, including much of the electrical equipment used during quarrying activities, is not required to undergo a specific regime involving Portable Appliance Testing. However, this equipment must be maintained in a manner fit for safe use, and should be subject to an appropriate inspection regime by the quarry operator to ensure that this is the case.

8.0 Connections and Cables

All connections in circuit and protective conductors, including connections to terminals, plugs and sockets and any other means of joining or connecting conductors, must be adequate for the purposes for which they are used. This applies equally to temporary and permanent connections. The insulation and conductance of the connections must be suitable, having regard to the conditions of use, including likely fault conditions. The mechanical protection and strength must be such as to ensure the integrity of the insulation and conductance under all conditions of use including likely fault conditions.

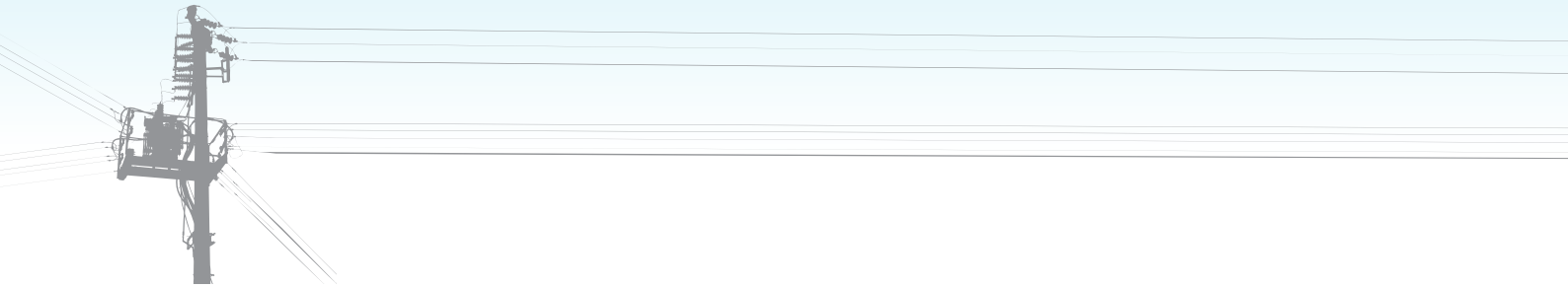
Fig 8.1 Termination of cables including high voltage cable

(Work of this nature will require a high degree of specialist training)

Joints and connections in protective conductors must provide durable electrical continuity and adequate mechanical strength, with protection against direct contact and external influences, and protection against loosening.

Cabling used externally in quarries must be provided with adequate insulation and mechanical protection (such as armouring), bearing in mind the voltage used.

Cables connecting to items of portable equipment should, in addition to being fixed at the terminals, be fixed to prevent putting undue strain directly on the terminals (e.g. the use of secured cord grips). This provision is necessary to deal with the most common failure in plug–cable connections.



9.0 Overcurrent Protection

The quarry operator must ensure (through the use of competent personnel where necessary) that effective means are provided to protect all electrical equipment and electrical installations from overcurrent so as to prevent danger.

Live conductors must be protected by one or more devices which automatically disconnect the supply of electricity in the event of overcurrent where such overcurrent is of a magnitude or duration which could give rise to danger or could damage the electrical equipment or installation. Destructive arcing and heating should be minimised. Protection against overcurrent consists of protection against overload and protection against short-circuit currents, and may be provided by fuses, circuit breakers or other protective devices.

In selecting the means of overcurrent protection, the following factors must be considered:

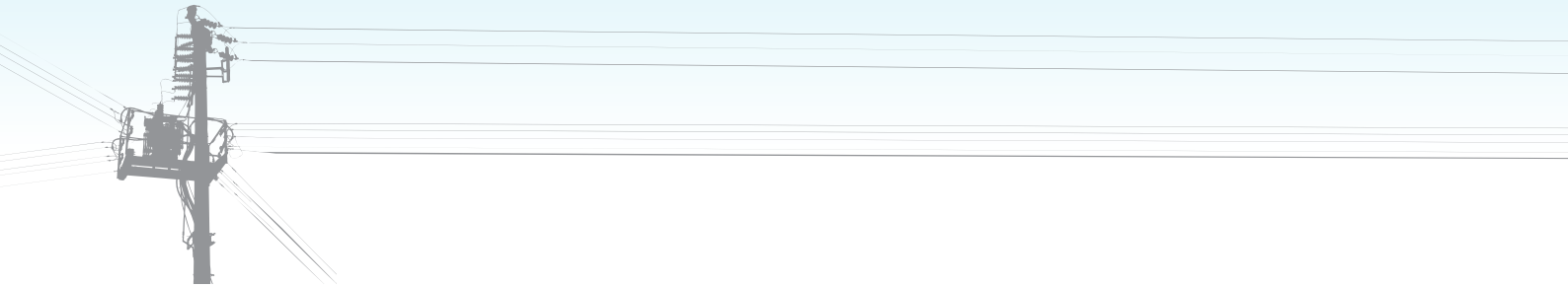
- the nature of the circuits and the type of equipment or installation to be protected;
- the maximum potential short-circuit (fault) current with which the protective device may have to cope;
- the nature of the environment.

10.0 Auxiliary Generator and Battery Supply

Generators and/or battery standby supplies may be used in the quarry to ensure continuity of supply in the event of loss of supply from the Distribution System Operator (ESB or other body).

Fig 10.1 Emergency generator Installation
(To maintain electrical supply in the event of a power cut)

The design, installation, maintenance, transportation and storage of such systems must be carried out in a manner that prevents danger. The design and installation of changeover mechanisms from the normal to the auxiliary supplies must also be carried out in a way that prevents danger. These mechanisms must be put in place in such a way as to prevent danger to persons working on external networks supplying the electrical installation.



11.0 Switching and Isolation for Work on Equipment Made Dead

A number of electrical accidents occur in quarries where equipment is live or becomes live while it is being worked upon. Because of the hostile environment experienced in quarries, motors, leads, cable-joints/ terminations and other electrical equipment are subject to deterioration. As a result, repairs of electrical equipment (including higher voltage equipment) and electrically powered equipment must be undertaken more frequently than might be considered the norm. It is therefore vital that suitable means are provided by which the electricity supply to any piece of equipment can be switched off and kept isolated for the duration of the work. For example, switching can be by direct manual operation, such as physically operating a switch or isolator, or by indirect operation via "stop" buttons in the control circuits of contactors or circuit breakers.

However, to work on equipment, generally it will need to be isolated at a circuit breaker or fuse. The activation of a "stop" button on its own does not provide a sufficient level of isolation, to ensure that the supply will remain switched off and that inadvertent reconnection will be prevented. **NB While working on any element that could expose a person to a live conductor, the circuit should be de-energised and locked at the point of disconnection.**

Where work must be done on or near conductors which have been isolated, the conductors should be proved dead by testing with a suitable monitoring device at the work location before work commences. Written instructions setting out safety isolation procedures including "permits to work" are required to ensure a safe system of work. This is particularly so where higher voltage circuits are involved. Where work is to be carried out on high voltage electrical equipment in its normal operating position, the circuit should first be earthed. Adequate precautions must be taken to prevent danger arising where electrical equipment inadvertently becomes live. Labelling or marking will help prevent inadvertent connection. Danger may also arise from the mechanical movement of electrically driven equipment where a loss of electricity supply has caused plant or machinery to come to a halt and where subsequent restoration of supply automatically sets it in motion again. Under-voltage protective devices must be used to prevent such occurrences and also to prevent danger arising from voltage drops.

The example overleaf shows a typical layout of a permit to work form that might be considered. This will generally be used where secure isolation is needed before work on a particular item of plant or equipment is undertaken. The basic permit may be altered to suit the particular environment or to make it specific to electrical isolation as may be required in a particular location.

Fig 11.1 Electrical supply isolated and padlocked "off"

Fig 11.2 (a) and 11.2(b) Alternative procedure for ensuring safe isolation. Key of isolator padlock locked in cabinet with operatives personal padlocks

A permit to work as described might be used as the systematic control to ensure that an electrical isolator is locked off during maintenance. The physical lock will generally be in the form of a padlock which will be under the control of the person carrying out the works on the circuit.

ABC Quarry Ltd	Permit to Work	Area:	Date Issued:	Permit Number:
Location of work:			**Start Time:**	**Finish Time:**

Type of permit	General		Roof Access		Electrical		Work at height		Hot work		Confined space

Work to be carried out: Approx time required:	Person responsible:	Risk assessment /method statement details:

Safety Precautions		Yes	No	N/A
(To be completed by person responsible for carrying out the work)		(please tick)		
1. Has a risk assessment and method statement been carried out?				
2. Are all the workforce qualified to carry out the task?				
3. Are any emergency arrangements required?				
(Specify additional safety precautions required, see guidance for examples)				

PPE	Yes	No		Yes	No
Goggles			Hard hat		
Gloves			Dust mask/RPE		
Safety footwear			Safety harness		
Hearing protection			High vis clothing		

Services to be isolated			
	Yes	No	Specify arrangements
Fire alarm/zone			
Electrics			
Water			
Gas			
Compressed air			
Steam			
Others			

Chemical Safety	Yes	No
Has appropriate data been supplied for substances to be used?		
Have appropriate precautions been identified and implemented?		
Is work being carried out by lone worker?		
If yes, is monitoring required?		

Issuing Authority: I authorise the work to be carried out and have notified the relevant personnel.		Hand back: I certify that the work has been completed/partially* completed and left in a safe condition (*delete as appropriate). This permit is now cancelled. **Person performing work to complete.**	
Person performing work: I have read and understood the conditions of this permit.		Hand back: I certify that the work has been completed/partially* completed, all guards and safety devices reinstated and the area is safe (*delete as appropriate). **Issuing authority to complete.**	

Switches, circuit breakers and other control devices, where necessary to prevent danger, must:

- clearly indicate whether the circuits they control are switched ON or OFF;
- be readily accessible for operation by authorised persons.

They must be suitably located and lighting must be adequate to ensure correct identification of each switch and its ON/OFF status. Suitability of location depends on the nature of the risks, the availability of persons authorised to operate the means of switching or isolation and the speed at which an operation may be necessary to prevent danger. Access to switches etc must be kept free from obstruction. In some cases computers will have a high degree of control over certain items of plant in the quarrying sector. This could lead to hazardous situations arising, if the operation of the software is used as the sole basis of effecting isolation. Generally it is preferable to physically isolate the electrical supply rather than use the software as the sole means of isolation. Isolation for safety (as distinct from purely functional switching) must be by means of a non-automatic switch. **NB Semiconductor switching or the use of software is not acceptable.**

12.0 Working Space, Access and Lighting

Sufficient working space, suitable access and egress and adequate illumination must be provided while persons are working on, at or near electrical equipment in order that they may work safely. This includes suitable outdoor lighting when required in a quarry environment. Consideration must also be given to the type of artificial lighting if the level of daylight is inadequate. Certain types of luminaires can make it practically impossible to discern colours such as red, yellow, blue and black. If work is to be carried out on electrical installations in artificial light, then the light fitting must be of adequate colour rendering to allow colours to be clearly distinguishable. These requirements are not restricted to those circumstances where live parts are exposed, but apply where any work is being done in circumstances which may give rise to danger.

Where there are dangerous exposed live parts within reach, the working space dimensions should be adequate to allow persons to pull back without hazard, and, if persons need to pass one another, to allow them to do so with ease and without hazard.

Natural light is preferable to artificial light. Where artificial light is necessary (e.g. in an indoor switch room), it should be from a permanent and properly designed installation. Emergency lighting must be provided in all switch rooms.

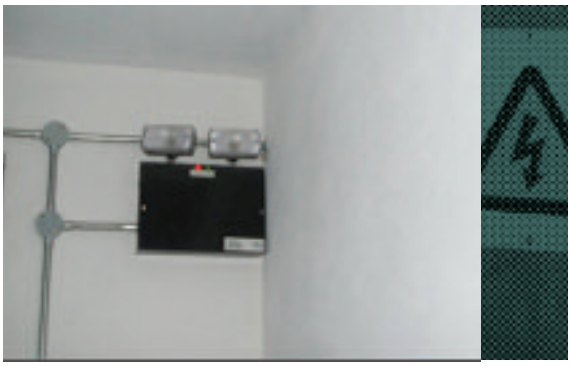


Fig 12.1 Emergency twin-spot fitting in switchroom

13.0 Competence to Prevent Danger

Persons should not be placed at risk because of a lack of skill on their part or the part of others in working with electrical equipment. The quarry operator must ensure that he or she makes reasonable enquiries to ascertain that any person or contractor commissioned to carry out electrical works in a quarry has the requisite competence to carry out the work safely and to leave the installation free of danger on completion of the electrical works.

For the duration of the work, it must be controlled by a person who possesses sufficient technical knowledge and experience or be supervised so as to ensure that danger is prevented. Technical knowledge and experience includes:

- adequate knowledge of electricity;
- adequate experience of electrical work;
- adequate understanding of the installation type to be worked on and practical experience of that class of installation;
- understanding of the hazards which may arise during the work and the precautions which need to be taken;
- ability to recognise at all times whether it is safe for work to continue.

Employees involved in working with electrical equipment likely to cause danger must be trained and instructed to ensure that they understand the safety procedures which are relevant to their work. The primary obligation on the operator, in conjunction with the contractor, is, in all cases, to provide competent persons to carry out electrical work.

However, in some exceptional cases (e.g. during training on specialist equipment) persons may require supervision, to some degree, where their technical knowledge and experience is not sufficient to ensure that they can otherwise undertake the work safely. In such cases, the supervisor must have the requisite technical knowledge and experience.

Those in overall charge must make clear to supervisors the full extent of their responsibilities. Where the complexity of the work warrants it, these responsibilities should be provided in writing to avoid misunderstandings.

14.0 Initial Verification

14.1 General requirements

Every new installation and every major alteration or extension to an existing installation, after completion and before being energised, must be inspected and tested so as to verify that the requirements of the Regulations have been fulfiled. However, certain types of test can only be made after an installation has been made live. Verification and testing must be carried out by a competent person with the necessary knowledge and experience.

All the appropriate information, including diagrams of connections, wiring diagrams, charts, tables, schedules, equipment ratings and the like, must be available to the person or persons carrying out the verification.

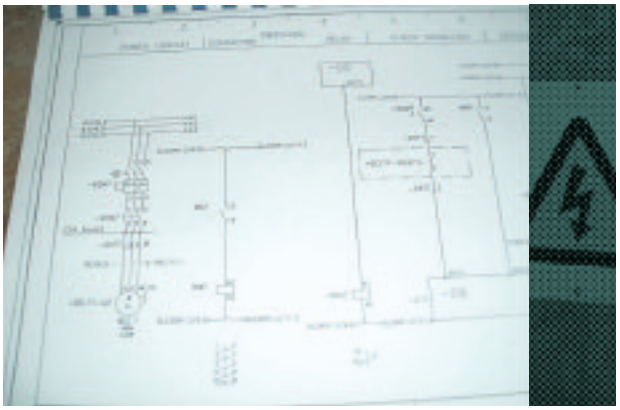


Fig 14.1 Controls schematic for quarry motor controls centre

Precautions must be taken to ensure the safety of persons, and to avoid damage to the installation and equipment during inspection and testing.

Where the installation is an extension or alteration of an existing installation, verification must be obtained that the extension or alteration complies with the Regulations and does not impair the safety of the existing installation.

14.2 Visual inspection

Visual inspection must be made of the completed installation in order to verify compliance. It must precede testing and take place before the installation is made live.

14.3 Testing

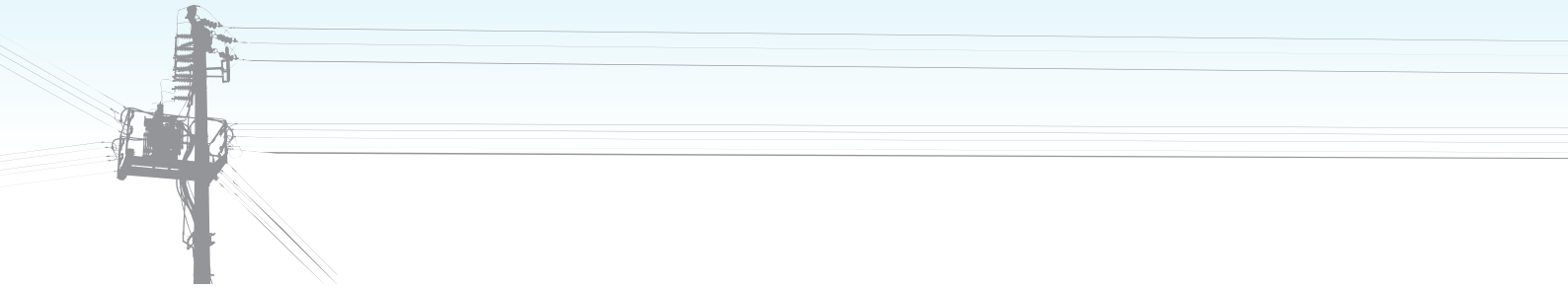
After visual inspection, tests must be carried out on the installation to ensure compliance with the Regulations. This stage must include tests of:

- continuity;
- resistance;
- polarity;
- fault loop impedance;
- operation of RCDs.

Generally, Chapters 61 and 62 of the ETCI National Rules for Electrical Installation (Fourth Edition) set out appropriate guidance for the types of inspection and tests to be undertaken to comply with the Regulations.

14.3 Certification

After the installation has been tested and found to comply, the contractor or other person responsible for the construction of the installation, or a person duly authorised to act on their behalf, must sign a statement to that effect. In addition to the certificate, the quarry operator must retain test record sheets containing the results of tests carried out. The certificate must be completed and signed by an authorised person having adequate technical knowledge and experience.



15.0 Periodic Inspection and Testing

15.1 General installation

Regulation 89(b) of the General Application (Electricity) Regulations 2007 requires that all existing electrical installations in working quarries must be tested from time to time by a competent person and that this competent person must certify that the installations are in compliance with this part of the regulations. The period between inspection and tests must be decided by the operator on the basis of a process of risk assessment, taking account of the nature of the installation, its uses and the quarry environment.

To this end the quarry operator should have in force a scheme for the systematic examination and testing of electrical equipment to prevent danger. The scheme should:

(a) indicate when the tests and examinations should be carried out in accordance with either one of the following alternatives in which:

  (i) installed electrical equipment and circuits are examined and tested at intervals as decided in the risk assessment;

  (ii) the periods between examinations and tests are separately specified for each item of equipment taking into account duty, environment, and manufacturers' recommendations (e.g. portable apparatus and flexible cables will require more attention than fixed equipment and cables);

(b) set out the tests and examinations and the means for their prompt recording;

(c) require copies of the scheme and records to be kept at the quarry office or other suitable place and to be available for inspection;

(d) require the results of major examinations, tests, etc on equipment to be kept for an adequate period of time (normally 3 years) or until the equipment is totally reconditioned.

Where a potentially dangerous fault is found, it should be recorded and action should be taken as swiftly as possible in order to minimise the danger. If repair is not undertaken immediately, safeguards should be implemented: for example, by isolation of equipment and the application of padlocks.

Depending on circumstances, additional tests may be required.

An inspector also has the power under Regulation 89 to require a quarry operator to carry out a test of the electrical installation if the inspector deems such a test to be necessary.

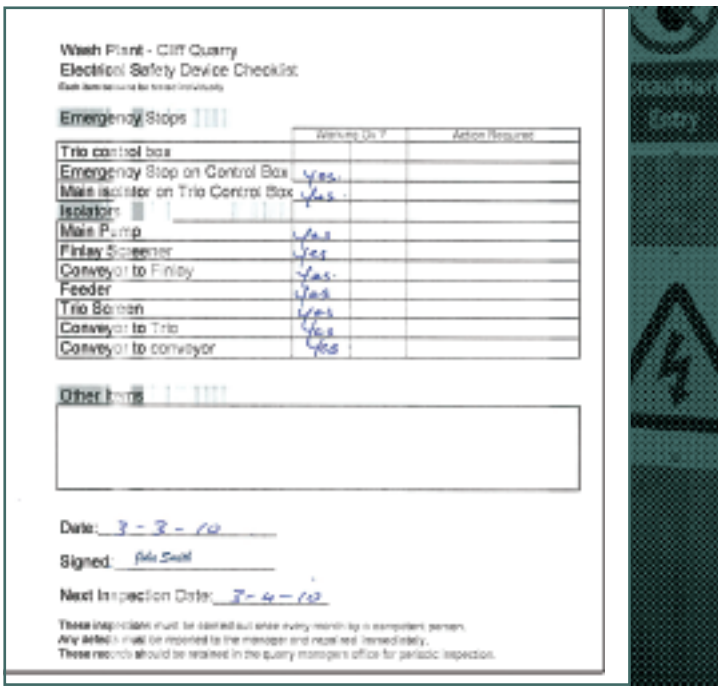
If an inspector, or a competent person that has carried out the above tests, advises of the necessity for further testing of the electrical installation, then the quarry operator must act on this advice. All defects identified in the tests and inspections outlined above must be rectified promptly by the quarry operator so as to prevent danger.

15.2 Testing of safety-critical items

If safety-critical electrical items are not regularly tested and checked they may be prone to malfunction caused by rough environmental factors. Quarry operators should implement documented periodic checks for all safety-critical items at the quarry. The intervals between checks will depend on the risk assessment

but should not be excessively long. A period of a month would be reasonable in many instances but more frequent checks may be deemed appropriate in certain instances. Generally, items such as emergency stops and emergency pull-chords, which are installed along the length of long conveyors, should be checked, and their operation verified in writing.

Fig 15.1 Manual testing of conveyor pull-chord



Wash Plant - Cliff Quarry
Electrical Safety Device Checklist

Emergency Stops

	Working On ?	Action Required
Trio control box		
Emergency Stop on Control Box	Yes.	
Main isolator on Trio Control Box	Yes.	
Isolation		
Main Pump	Yes	
Finlay Screener	Yes	
Conveyor to Finlay	Yes.	
Feeder	Yes	
Trio Screen	Yes	
Conveyor to Trio	Yes	
Conveyor to conveyor	Yes	

Other Items

Date: 3 - 3 - 10

Signed: John Smith

Next Inspection Date: 3 - 4 - 10

These inspections must be carried out once every month by a competent person.
Any defects must be reported to the manager and repaired immediately.
These records should be retained in the quarry managers office for periodic inspection.

Fig 15.2 Typical monthly check-sheet for safety-critical items

16.0 Earth Leakage Protection for Voltages above 230/400 Volts

The quarry operator (in conjunction, if necessary, with a competent person) must ensure that effective means are provided to prevent danger arising from leakage currents to earth in relation to every circuit in which higher voltages are used. Where higher voltage is used, provision must be made to address the risks arising from dangerous earth leakage currents.

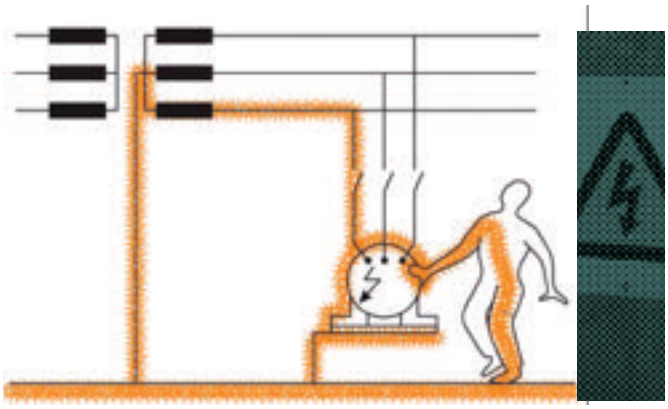


Fig 16.1 Electrical circuit showing earth leakage on a high voltage motor

Effective means must be provided for automatically cutting off the supply of electricity from every circuit in which alternating current at a voltage exceeding 1000V AC is used. The leakage trip level must be set as low as is reasonably practicable, but in any case no higher than 10 percent of the maximum current for which the circuit is designed or 2 amperes, whichever is the greater.

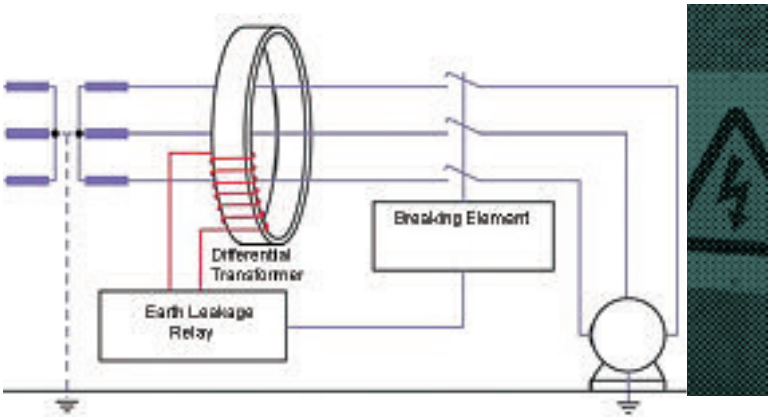


Fig 16.2 Earth leakage protection circuit (including transformer to monitor leakage current)

For all circuits supplied at voltages less than 1000V, the quarry operator must ensure that a risk assessment is carried out by a competent person, to ensure that adequate operational leakage protection is fitted to all appropriate circuits.

17.0 Substation and Main Switch Room

The boundaries of substations and main switch rooms should be substantial and capable of excluding, as far as possible, the entry of all but authorised persons. A main switch room is a switch room where the main switch board is sited and where the cabling from the electricity supplier's switchgear/transformer is terminated. There may be more than one main switch room in larger quarries.

Substations and main switch rooms should be well ventilated and kept dry if under cover. Entry by authorised persons should be through a proper entrance such as a lockable door or gate. Access by other persons must be under the control of an authorised person. Danger areas such as transformers or switchgear cubicles, rooms or compounds should be entered only by an authorised person or a person acting under his or her supervision. Additional information can be obtained in the ETCI National Wiring Rules 2008, Section 539.

18.0 Overhead Electricity Lines and Underground Cables

18.1 Overhead lines

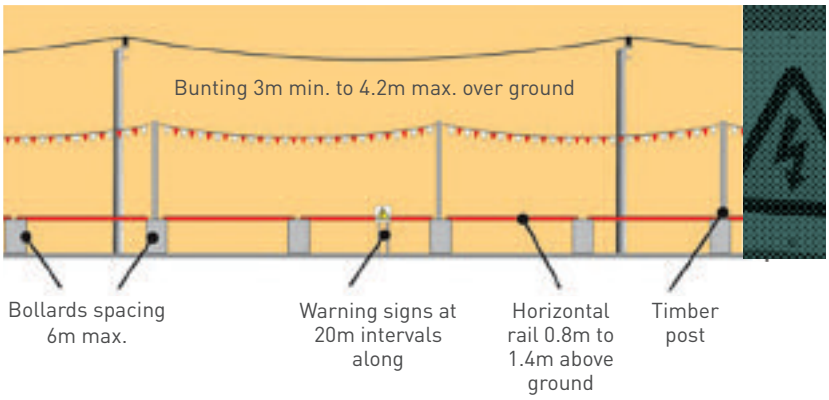
Overhead electricity lines in a quarry will generally be the property of the ESB Networks but may in future be owned by another body. In 2008 ESB Networks produced a **Code of Practice for Avoiding Danger from Overhead Electricity Lines**, which has been approved by the Health and Safety Authority. The quarry operator should make contact with the line owner, with a view to diverting the line, if it poses a risk to quarry personnel or to visitors. If diversion is not feasible at a particular time, then an alternative measure such as raising the height of the line may provide useful protection in reducing the risk of inadvertent contact by vehicles in the quarry In any case, the quarry operator should ensure that there are adequate barriers placed parallel to both sides of the line to minimise the possibility of dangerous contacts(see Figure 18.1 below). Height restricting "Goal Posts" should also be installed where vehicles must travel underneath lines. These would require cranes and other high-rise machines to drop to a safe height before passing under overhead lines. The maximum permissible height for the "Goal Posts" should be agreed in advance with the line owner.

The quarry operator has a duty to prevent danger under or near overhead lines from such hazards as:

- conveyor belts;
- operation of high-rise machines;
- tipping trucks;
- concrete pumps;
- reduced clearance from ground because of site filling/raising or construction underneath the line;
- weakening or undermining of the foundations of the overhead line support structures because of quarrying or other activities;
- the damaging of the support structures, insulators or the overhead line conductors by blasting in the vicinity.

Danger must also be prevented from arising from any live conductor falling or breaking by ceasing activities in the danger zone and reporting the matter to the appropriate person or body(e.g. the Garda Síochána and the line owner).

Elevation



Plan

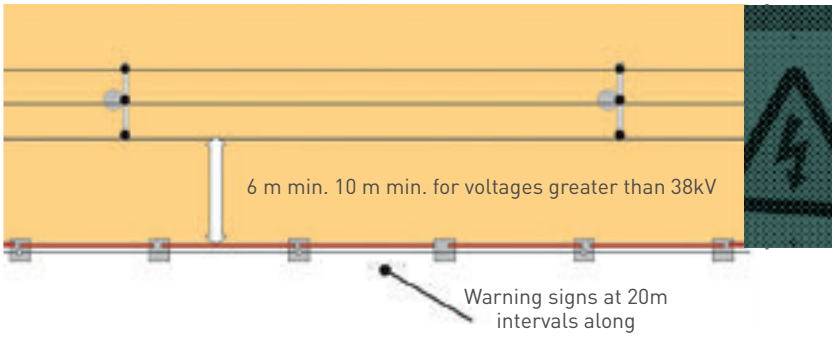
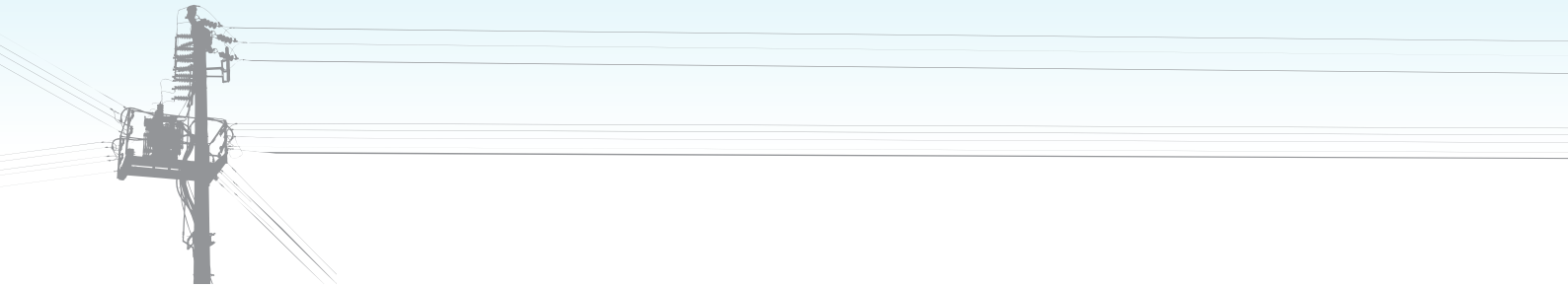


Fig 18.1 Plan and elevation of barriers for overhead electricity lines

Fig 18.2 "Goal Posts" on traffic route to protect against contact with overhead line

18.2 Underground cables

If underground cables are present in the quarry, the operator should ensure that they are mapped on drawings as accurately as possible. These drawings should indicate who owns the cables (ESB Networks, quarry or others), the voltage of the cables and their depth(s). Where a cable is newly laid (other than in concrete ducts or floor voids/slabs), generally, it should be laid in protective impact-resistant ducting. Newly laid ducting for electrical cables must be coloured red, must have a high resistance to mechanical-impact damage and must be covered with suitable warning tape embedded in the ground above the duct. All excavation work in the proximity of known or suspected underground cables must be carried out in accordance with the H.S.A. publication Code of Practice for **Avoiding Danger from Underground Services**, which gives a framework to duty-holders to enable them to put in place systems of work that avoids danger from underground services. See also I.S. 370:2007, **Colour Code for Buried Plastics Piping**.



19.0 Programmable Logic Controllers

Documentation should be kept on site for the written control philosophy of the sequence of operations for devices with Programmable Logic Controllers (PLCs), and a risk assessment carried out to assess the impact and likelihood of a failure or mal-operation of the device.

20.0 Electric Shot-firing Operations

20.1 General

Where electrically triggered explosives are used, the quarry operator must ensure that there is a system in place to protect personnel from the danger of unintentional initiation or misfires caused by the input of electrical energy from sources other than the intended initiating source.

Common procedures which may be used to guard against premature detonation of electrically initiated explosive devices include the following:

(a) The use of adequately insulated initiation cables;

(b) Avoidance of cable joints wherever possible;

(c) Ensuring that joints are staggered in adjacent cores and are mechanically secure and well insulated;

(d) Making the final connection to the initiating device only when the device is about to be used. At all other times the initiating cables should be short-circuited and insulated from earth;

(e) Use of frequency sensitive detonators and initiating devices. Such devices are responsive to high frequency (15 kHz) only and are insensitive to 50 Hz to 60 Hz.

20.2 IT systems which continue to operate under first fault conditions

Electrically initiated explosive devices should not be stored or used in the vicinity of any electrical installation which is permitted to continue to operate under first fault conditions (see 9.5 of BS 6907 : Part 2 : 1988).

20.3 Exposed conductive parts and extraneous conductive parts

To avoid premature initiation from earth fault current during the time taken for the protective device(s) to operate, electrically initiated explosive devices and connecting cables should not be used in the vicinity of exposed conductive parts and extraneous conductive parts.

20.4 Overhead lines

Precautions may be necessary to ensure that stray currents are not induced in electrically initiated explosive devices and connecting cables which could trigger unexpected detonation of the detonator and associated explosives.

20.5 Galvanic action

A galvanic cell may be formed when dissimilar metals contact each other directly, or through a conductive medium (e.g. salt water, alkaline drilling mud). The use of metal liners, metal stemming sticks or other conductive parts should be avoided.

20.6 Cathodic protection

Where pipelines and other structures are provided with cathodic protection, either electrically initiated explosive devices and connecting cables should not be used in the vicinity of the pipelines and structures, or the cathodic protection supply should be isolated during laying and shot-firing operations.

20.7 Electromagnetic radiation

High frequency energy from radio, television, radar, etc can, under certain conditions, cause initiation of electrically initiated explosive devices. It is recommended that portable radio transmitters are not used in the vicinity of electrically initiated explosive devices and connecting cables.

Cognisance should be taken of any fixed transmitting stations in the vicinity.

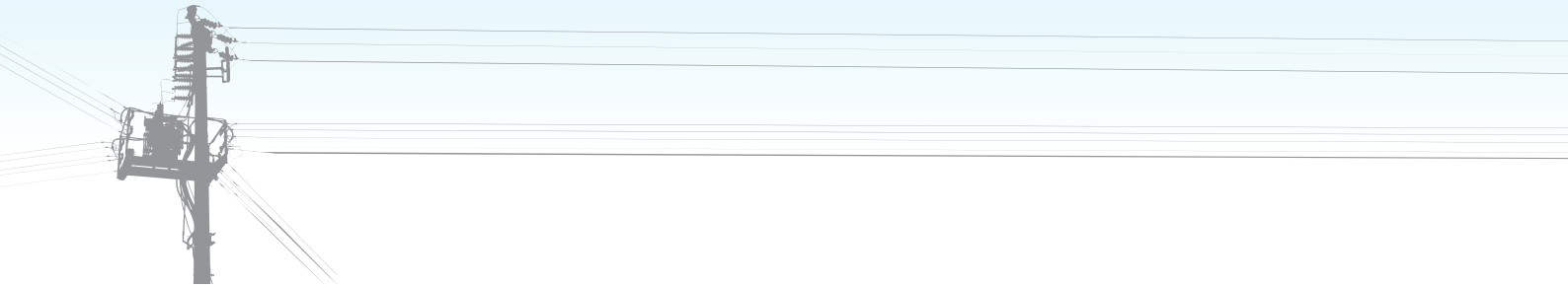
20.8 Static electricity

Static electricity charges may be generated by dust storms, snow storms, moving conveyor systems, pneumatic stemming systems, etc. If generated charges are allowed to accumulate and/or store on a person or object, there is a possible danger of discharge into electrically initiated explosive devices.

It is recommended that shot-firing be suspended during dust storms or snow storms and that accumulation of static charges be avoided by connecting to earth all persons or equipment on which a static charge may accumulate. The electrical resistance of the earth connection should be high enough to restrict current flow, yet low enough to dissipate the static charge (usually a resistance value of 1 MΩ is adequate for this purpose). This recommendation may be achieved by the use of semiconductive products for personal footwear, hoses to pneumatic stemming systems and conveyor belts.

20.9 Lightning

Atmospheric disturbance can initiate electrically initiated explosive devices by inducing a current in the firing circuit. It is recommended that laying or firing operations be suspended, and personnel withdrawn from the relevant areas during lightning storms.



21.0 Additional Precautions

21.1 Precautions during lightning storms

De-energised cables or overhead lines should not be handled nor repairs attempted during lightning storms, where there is a possible hazard from direct strikes or from induced voltages.

21.2 Warning notice

Warning notices should be provided to draw attention to potential hazards and be properly maintained.

21.3 Removal of guards

Protective guards and enclosures should be removed only when absolutely necessary and when appropriate precautions have been taken. Provision should be made for prompt replacement of such guards and enclosures on completion of the work.

21.4 Operations involving long metallic structures

Care should be taken when long metallic structures (e.g. movable conveyors or pipeline systems) are run parallel to overhead lines because of possible hazards from induced voltages.

APPENDIX

Sources of Further Information and Bibliography

This bibliography is not intended to be exhaustive. Dates are current at time of publication. The most recent/current standard/publication should be obtained in each instance.

CENELEC (European Committee for Electrotechnical Standardisation), 17 Avenue Marnix, B-1000 Brussels, Belgium; Tel: +32 2 519 6871; Fax: +32 2 519 6919

International Electrotechnical Commission (IEC), 3 Rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland; Tel: + 41 22 919 0211; Fax: +41 22 919 0300

The **Irish Standards Catalogue** published by the National Standards Authority of Ireland (NSAI) may be purchased from: NSAI, Glasnevin, Dublin 9;

Tel: (01) 857 6730; Fax: (01) 857 6729

- I.S. 370:2007, **Colour Code for Buried Plastics Piping**

Electro-Technical Council of Ireland Ltd (ETCI), ETCI Offices, Unit H12, Centrepoint Business Park, Oak Road, Dublin 12; Tel: 01 429 0088; Fax: 01 429 0090; Website: www.etci.ie

- ET 101: **National Rules for Electrical Installations**, 4th edition 2008
- ET 105: **National Rules for Electrical Installations in Potentially Explosive Atmospheres**, 2nd edition 2001
- ET 202: **Guide to the Selection of Electrical Apparatus for Use in Potentially Explosive Atmospheres** 2001
- ET 206: **Good Practice Guide on the Management of Electrical Safety at Work** 2009
- ET 209: **A Recommended Maintenance & Inspection Routine for Electrical Installations in Potentially Explosive Atmospheres** 2003
- ET 210: **Code of Practice for the Selection and Installation of Low Voltage Generators** 2003

European Communities (Electrical Equipment for Use in Explosive Atmospheres) Regulations 1999 (S.I. No. 83 of 1999)

Health and Safety Authority

- **Code of Practice for Avoiding Danger from Underground Services** 2010

EU Commission

- Low Voltage Directive refers to Directive 2006/95/EC
- Machinery Directive refers to Directive 2006/42/EC, which replaced Directive 98/37/EC from 29 December 2009 and is transposed into Irish law through the European Communities (Machinery) Regulations 2008 (S.I. No. 407 of 2008)

ESB Networks

- **ESB Code of Practice for Avoiding Danger from Overhead Electricity Lines** 2008

Working to create a National Culture where All Commit to Safe and Healthy Workplaces and the Safe and Sustainable Management of Chemicals

HEALTH AND SAFETY AUTHORITY

Tel. 1890 289 389

International Callers

00353 1 6147000

Fax. (01) 6147020

www.hsa.ie

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