



Electrical safety in quarries

**Quarries Regulations
(Northern Ireland) 2006**

GUIDANCE

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Introduction

1. Electricity kills! Every year many people at work suffer electric shocks and burns. Other injuries, such as falls, are caused as a result of a shock. The risk of electric shock is greater in quarries because cables or equipment may be exposed to wet conditions, damaged by plant (e.g. overhead power lines) or falling objects; or dug up during excavation.
2. This leaflet gives practical guidance on electrical safety in higher risk areas in quarries. It does not cover offices or other low risk parts of quarries. The guidance is intended for quarry management, rather than electrical experts. It replaces the Approved Code of Practice (HSA 54), which has been withdrawn.

Health and safety document

3. Quarry operators must have a health and safety document^{*}. Among other things this must identify the significant electrical risks and explain the safeguards. The safeguards include ensuring the suitability, design, installation, maintenance and inspection of equipment and systems, and the competence of those involved in this work, or operating the equipment and systems. The health and safety document must be kept up to date. The management structure[†] described in it must detail the duties of those involved in electrical work, including those of key contractors.

Suitability of equipment

4. Electrical equipment used at a quarry must be suitable and safe for:
 - (a) its intended use;
 - (b) the people who will use it;
 - (c) the operating voltage, current, and other equipment it is to be used with;
 - (d) the environment – will it get wet? Will vehicles drive over, or could they strike it? Could it be dug up? Could it be at risk from vandalism or damage from animals? Is it exposed to flammable vapours, mists or dust[‡]?
5. It must be designed and constructed to allow safe inspection and maintenance. It is strongly recommended that the design, construction and installation follows relevant British and/or International standards[§].

^{*} Quarries Regulations (Northern Ireland) 2006 – regulation 7.

[†] Quarries Regulations (Northern Ireland) 2006 – regulation 8.

[‡] British Standards BS 5501, BS EN 50014, BS EN 50015, BS EN 50016, BS EN 50017, BS EN 50018, BS EN 50019, BS EN 50020, BS EN 60079 – all deal with specifications for electrical equipment for use in potentially explosive atmospheres and its selection.

[§] In particular see BS 7671: 2001 – Requirements for Electrical Installations and BS 6907: 1988 – Electrical Installations for open-cast mines and quarries.

Installation

6. All electrical equipment must be designed and installed by competent* persons. The installed system should:
- (a) be properly documented and labelled (individual conductors may need to be marked so that they can be readily identified, e.g. from drawings). Modifications to circuits also need to be documented;
 - (b) ensure that all appropriate parts of the installation can be isolated by readily accessible switchgear that is clearly marked to show the circuits or equipment it controls;
 - (c) provide appropriate protection against excess current (fuses or circuit breakers) and, where appropriate, against earth leakage. (Residual current devices (RCD) with a rated tripping current of 30 mA are needed if provided for personal protection against shock[†] but higher rated RCDs may be used for plant protection.);
 - (d) facilitate safe inspection, testing, fault finding and maintenance (e.g. interiors of control panels should be built to reduce the risk of contact with live conductors when opened for testing, etc. by constructing to a degree of ingress protection not less than – IP XXB or IP 2X[‡]);
 - (e) be enclosed or placed so that direct contact with live conductors at dangerous voltages (normally over 50V AC) is not possible in normal use. Equipment that needs to be opened regularly also needs to be mechanically interlocked to prevent removal of covers or the opening of access doors until the supply of electricity has been cut off, unless the interior parts are protected – see (d) above;
 - (f) be sited to minimise the risks due to impact or environmental conditions, and where this can't be achieved, protected to minimise these risks, for example by using suitably armoured cable, appropriate explosion protected equipment or mechanically robust enclosures;
 - (g) have interlocks, and other controls, that are constructed and installed so that any failure causes the system to fail to safety;
 - (h) include conductors and connections of adequate electrical and mechanical strength, with sufficient support where necessary, for any likely stresses;

* Quarries Regulations (Northern Ireland) 2006 – regulation 9; Electricity at Work Regulations (Northern Ireland) 1991 – regulation 16.

[†] British Standards BS 4293, BS 7288, BS 7071, BS EN 61008, BS EN 61009 Specifications for residual current-operated circuit-breakers. RCDs and RCDs with integral overcurrent protectors (RCBOs).

[‡] British Standard BS EN 60529. Specifications for degrees of protection provided by enclosures (IP Code).

- (i) restrict the access to areas such as switchrooms, substations or high voltage equipment to authorised persons; and
- (j) be commissioned and tested to verify that it is safe to use. A handover certificate should be issued to the operator to confirm that it is safe to use, following significant work.

Earthing

7. All electrical equipment which may become live in the event of a fault must be adequately earthed unless it is double or all insulated. For installations that rely on earthing and bonding for electrical safety and protection the effectiveness of the earthing and bonding needs to be checked across the whole installation. Protective multiple earth (PME) supplies are not suitable for quarries because it is not possible to ensure that the electrical bonding of all metalwork is always in place.

Safe voltages

8. As a general rule the lower the voltage used the lower the risk of a serious electric shock. Where reasonably practicable hand held equipment should operate at 110V, or less, with a centre tapped transformer, or use a 50V SELV* system. This will virtually eliminate the risk of fatal electric shock if a cable supplying such voltage is damaged. Lower voltages are, however, necessary where the conditions are very wet or when working inside a confined, conductive space, e.g. a metal tank. Hand lamps operating at 12 or 24V are suitable for most work, while the output voltage of open circuit arc welding handsets should be limited to 85V.

9. Where higher voltages (e.g. 230V AC) need to be used then the risk posed should be carefully assessed and additional safeguards, for example the use of suitable residual current devices at the point of supply, and/or armoured cable should be used where necessary.

10. The risk is greater when working on high voltage systems (e.g. 11kV AC) and those who do so need a high level of competence, and so should be explicitly authorised to carry out such work.

Overhead electric lines

11. Overhead power lines are likely to pose a significant risk, unless vehicles and mobile plant cannot approach them. Vehicles and mobile plant do not need to strike the conductors of the overhead line for injury to occur – electricity can arc through a surprising distance depending on the voltage and conditions. Overhead lines should be re-routed, if necessary, away from areas where they pose a risk.

12. Precautions such as those illustrated in the Quarries Approved Code of Practice[†] (fig. 9, p. 84) are required if a vehicle or mobile plant can reach

* SELV systems – see BS 7671 Chapter 41 clause 411-02 for details.

[†] Health and Safety at Quarries – HSE; L118; ISBN 0 7176 2458 7. This Code of Practice (except Part V “Explosives”) has also been approved for use with the Quarries Regulations (Northern Ireland) 2006.

the danger zone around the overhead line. Assessment of the risk must take account of the possibility of tipper lorries travelling with the tipper portion in the raised position.

Buried cables

13. The routes of all buried cables should be located when planning an excavation. This information should be recorded in the health and safety document. Cables should be diverted, if necessary, but all cables and their routes should be clearly marked. Other cables should be marked when they are installed or discovered to minimise the risk of them being accidentally dug up. Cables do not need to be broken to cause danger, high voltage cables can explode violently if they are struck or bent sharply*.

14. Even where cable runs are known, areas should be checked using cable location devices before any excavation work is started. Careful hand digging is often necessary to precisely locate the cable.

Flexible cables

15. Cables that may be moved while energised must be suitable for that purpose†. Systems using flexible cables need to be designed and installed carefully, paying particular attention to the risk of mechanical damage and the importance of maintaining the integrity of the earthing. Earth monitoring systems are useful when the risk, in the event of earth failure, is high. Cables with conducting flexible screens or armouring should be used where the risk of damage is significant.

Explosives and explosive atmospheres

16. Electrical installations in explosives stores need to be designed and constructed to a high standard‡. Radio frequency transmitters, electrically powered plant and overhead power lines can create a risk of accidental initiation with certain detonators. The electrical installation should be designed to minimise such risks when explosives are to be used at a quarry. Electrical equipment which is liable to be exposed to explosive atmospheres, for example methane from landfill, must be suitable for use in such conditions§ (see relevant British Standards).

17. Switchrooms, or substations, should not be used as a storage area, particularly of flammable or explosive substances (including gases)

* Avoiding danger from underground services – HSE; HSG 47; ISBN 0 7176 1744 0 and Avoidance of danger from overhead electric power lines – HSE; GS 6; ISBN 0 7176 1348 8.

† Electricity at Work Regulations (Northern Ireland) 1991 – regulations 5, 6 and 7.

‡ Security of licensed explosives stores and registered premises, obtainable from HSE's Local Authority Unit (020 7717 6433). See also HSE's Guidance Note PM 82 – The selection, installation and maintenance of electrical equipment for use in and around buildings containing explosives.

§ Electricity at Work Regulations (Northern Ireland) 1991 – regulation 6.

Maintenance

18. All electrical equipment must be maintained in a safe condition*. All electrical systems must be subject to appropriate inspection, examination, testing and preventative maintenance by competent people. (For simplicity, on this page, the word "maintenance" includes inspection, examination and testing which is required to identify any deterioration and the necessary remedial work to keep electrical equipment and systems safe.) Good visual inspection will pick up a large percentage of common faults, but some faults cannot be found solely by such an inspection.

Written scheme

19. The operator must have a written scheme for the systematic maintenance of electrical equipment.[†] This must include electrical safeguards which form part of machinery guarding, for example, interlocks, trip wires, and emergency stops. The scheme should:

- (a) specify the maintenance to be carried out and the frequencies – preventive maintenance should normally be in accordance with the designers/manufacturer's recommendations, taking into account the conditions of use;
- (b) set out the methods to be used, the record keeping, and the skills necessary for the people who will do the work;
- (c) set out the action to be taken if an imminent risk of serious personal injury is discovered, to safeguard those at risk; and
- (d) set out the arrangements for auditing the scheme.

20. People carrying out maintenance need:

- (a) drawings of the electrical installation, including modifications;
- (b) a list of equipment to be maintained; and
- (c) other relevant information, including design specifications and previous test results.

21. They also need to use suitable test equipment in accordance with the manufacturer's recommendations. Such equipment must be properly maintained to ensure that it is safe, the results are reliable and that trends can be identified. It is useful to mark equipment which has been maintained with a tag or clear mark indicating the next due date for maintenance, so that any equipment that has been overlooked can be easily identified.

22. Inspection and other reports must be in a format that is suitable for the person who has to act on them. Any significant faults should be pointed out clearly using the minimum of technical jargon.

* Electricity at Work Regulations (Northern Ireland) 1991 – regulation 4(2).

[†] Quarries Regulations (Northern Ireland) 2006 – regulation 12.

Scope

23. The following need to be covered by the scheme:

- external inspection;
- internal inspection;
- conductivity of circuits;
- earth fault loop impedance;
- effectiveness of electrical protection;
- insulation resistance of circuits;
- insulation resistance of apparatus;
- prospective fault current;
- residual current device operation;
- effectiveness of earthing and bonding;
- portable apparatus;
- polarity;
- earth electrode resistance;
- inspection, test and examination frequency.

24. The frequency of inspection, etc. should be set to enable faults to be identified and corrected before they pose a significant risk. The frequency will depend on:

- (a) the type of equipment and installations;
- (b) where they are used, for example if they are wet or at risk of physical damage;
- (c) if they are fixed or mobile; and
- (d) frequency of use (e.g. 24 hours a day or once a year).

25. The chosen frequencies need to be reviewed regularly in the light of experience. Some commonly used frequencies, for LV equipment operating at 110V and above, are set out below:

Visual inspections	Frequency
Hand held tools — including plugs and sockets cables, etc.	Daily or before use.
Other portable equipment.	3-monthly.

Visual inspections	Frequency
More detailed inspection/Examination	
External parts of the installation.	6-monthly.
Accessible internal parts of electrical equipment.	Yearly.
All other parts of the electrical installation, including normally inaccessible parts, e.g. internal parts of switchboard, motor terminal boxes and connection boxes.	5-yearly.
Tests	
Effectiveness of earthing and bonding high risk movable apparatus.	Monthly.
Other systems.	Every 6 months or yearly if risk of deterioration is low.
Re-validation of the line resistance.	3-yearly.
Earth Electrode Resistance.	Yearly – in warm dry periods.
Insulation Resistance.	Every 6 months or yearly if risk of deterioration is low.
Earth Fault Loop Impedance.	Every 6 months, or yearly if risk of deterioration is low.
Disconnection times for the protective devices (calculated).	Following earth loop impedance tests.
Residual current devices (fixed).	3 monthly using the test button every 6 months – timing test.
Polarity.	10 yearly (different 10% each year).
Portable apparatus – see HS(G) 107.	3-monthly to yearly.
Preventive maintenance	As recommended by the manufacturer/designer, taking account of conditions of use.

Working methods

26. Safe working practices are especially important when inspecting, testing or repairing electrical equipment. Working on electrical equipment often means removing covers or dismantling the equipment, removing safeguards built into the equipment which increases the risk of injury. Anyone doing such work must be competent for the work they do. High risk work should normally be carried out under a permit to work system^{*}, but much work can be done safely using good isolation procedures – see below[†].

Live working

27. Work may only be carried out on or near exposed live conductors when, in all the circumstances, it is:

- (a) unreasonable for it to be dead; and
- (b) it is reasonable for the work to be done live; and
- (c) suitable precautions have been taken to prevent injury[‡].

ALL these conditions must be met before work can be done on or near exposed live conductors.

28. In practice there are few occasions when work cannot be carried out with the equipment dead. A decision to work live should usually not be left solely to the discretion of the person carrying out the work. The operator should set out in the rules[§], the conditions under which any live work is permitted and the precautions that should be in place. If live working e.g. diagnostic testing, is justified it needs careful planning to minimise the risk of injury. This may involve the use of temporary barriers or insulating screens to prevent accidental contact, insulating mats and protective clothing. Test equipment and tools also need to be designed, used and maintained to minimise risks^{**}. Such work should only be carried out by persons who are competent to carry out such work.

29. It is good practice to specify in the site rules that live working, at dangerous voltages, other than testing is not allowed. If necessary work should be scheduled outside normal working hours, at weekends, during holidays or maintenance shutdowns. Live working cannot be justified simply because it is inconvenient to switch off the system.

Isolating equipment

30. Isolation must be carried out carefully to ensure that the equipment is actually dead before work on it begins and that it cannot be accidentally

* Quarries Regulations (Northern Ireland) 2006 – regulation 18.

† Electricity at Work: Safe working practices – HSE; HS(G) 85; ISBN 0 7176 0442 X.

‡ Electricity at Work Regulations (Northern Ireland) 1991 – regulation 14.

§ Quarries Regulations (Northern Ireland) 2006 – regulation 10.

** Electrical Test Equipment for Use by Electricians – HSE; GS 38; ISBN 0 7176 0845.

reconnected. It is not sufficient to switch off the circuit. Isolation needs to be planned carefully to ensure that all ways in which the circuit can be made live are properly isolated and secured.

31. Isolation can often be achieved by padlocking switches in the open position. Keys should be unique and kept by the person doing the work with any spare keys kept securely. Removing and retaining the fuses for the duration of the work is only acceptable if, in addition:

- (a) there is no chance of someone putting in a spare fuse; or
- (b) the fuseway is secured with adhesive tape with appropriate warnings printed on it; or
- (c) the fuseway can be secured with a locking fuse carrier; or
- (d) the enclosure using the fuseway is secured.

After a circuit has been isolated it must always be tested carefully, to prove the circuit is dead, before attempting any work to it. A permit to work may be required to ensure clear understanding of the isolation and scope of the work in complex situations e.g. where there is more than one source of supply to the point of work.

High voltage (HV) equipment

32. Work on or near high voltage (HV)* equipment presents a higher risk which requires careful assessment and should be carried out in accordance with the Permit to Work (PTW) system†. Only competent persons, fully trained and experienced in this particular work, and authorised in writing, should be allowed to implement the permit system and operate the HV switchgear.

33. Before any work is carried out on or near HV equipment, precautions must be taken to avoid risks from the HV system. The risks, and the action to avoid them should be set out in a PTW before work begins. In general circuits should be isolated, tested to ensure they are dead and earthed and secured in the earthed position i.e. locked. Additional precautions in the form of portable earths may be required in particular circumstances e.g. for work on overhead lines. Caution notices should be posted at points of isolation and danger notices posted on adjacent live equipment.

Competency

34. All persons required to carry out work on electrical equipment must be competent to carry out those duties.‡ This means that maintenance and installation staff must have sufficient knowledge and experience to carry out their duties. It also means that staff who operate electrical equipment must be competent to carry out their tasks safely and

* High voltage is defined as: any voltage exceeding 1000 V AC or 1500 V DC.

† Quarries Regulations (Northern Ireland) 2006 – regulation 18.

‡ Quarries Regulations (Northern Ireland) 2006 – regulation 9.

understand the limits of their particular duties and competence. Persons not competent to work on their own, for example, trainees, should be adequately supervised. Consideration should be given to the qualities and experience of persons selected to fulfil supervisory duties.

35. In some instances greater engineering expertise than that available on site may be required to assess the results of inspections or to carry out electrical projects. Access to this expertise should be made available when necessary.

36. Ways of having confidence in the competence of inspection personnel is to use inspection bodies who are either accredited by UKAS to BS EN 45004:1995 for the scope of RG 103 (Electrical Installations in Quarries) or are members of a recognised trade association and have experience of this type of work in quarries.

Further reading

Memorandum of Guidance on the Electricity at Work Regulations 1989 – HSR 25 ISBN 0 11 883963 2.

Electrical safety on construction sites – HS (G) 141; ISBN 0 7176 1000 4.

Avoidance of danger from overhead electrical lines – GS6; ISBN 0 11 885668 5.

Avoiding danger from underground services – HS (G) 47; ISBN 0 7176 0435 7.

Maintaining portable and transportable electrical equipment – HS (G) 107; ISBN 0 7176 0715 1.

British Standard BS 7430 – Code of practice for earthing.

Guidance on periodic testing and examination of fixed low voltage electrical installations at quarries. (Produced by SAFED Assessment Federation Ltd., Nutmeg House, 60 Gainsford Street, Butlers Wharf, London SE12 2NY. Tel. 020 7403 0987, Fax. 020 7403 0137.) SAFed/BtB/500/XII 99.

BS 6626: 1985 – British Standard Code of Practice for Maintenance of Electrical Switch gear and Control gear for Voltages above 1 kV and up to and including 36 kV.

BS 6423: 1983 – British Standard Code of Practice for Maintenance of Electrical Switch gear and Control gear for Voltages up to and including 1 kV.

BS 6907: Electrical Installations for Open-cast Mines and Quarries.

Guidance note 3 on BS 7671 Testing.

Code of Practice for In-service Inspection and Testing of Electrical Equipment published by the IEE – ISBN 0 85296 776 4.

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