

Avoidance of danger from overhead electric power lines



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Contact with live overhead lines kills people and causes serious injuries every year.

This document sets out procedures which, if adopted, will reduce the number of these tragedies and the associated costs of repairs and lost production due to interrupted supplies.

The advice is aimed at those in control of any kind of work under or near to overhead electric lines including those lines serving any part of railway systems. It is particularly relevant to agriculture, construction and quarrying, and covers all work where long or high plant or equipment, such as scaffold poles, vehicles, cranes, irrigation equipment etc, are operated or moved under or near these lines.

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Introduction

- 1 Contact with live overhead lines kills people and causes serious injuries every year. A high proportion — about one third — of inadvertent line contacts prove fatal. This document sets out procedures which, if adopted, will reduce both the number of these tragedies and the associated costs of repairs and lost production due to interrupted supplies.
- 2 The advice is aimed at those in control of any kind of work under or near to overhead electric lines including those lines serving any part of railway systems.
- 3 It is particularly relevant to agriculture, construction and quarrying and covers all work where long or high plant or equipment, such as scaffold poles, vehicles, cranes, irrigation equipment etc, are operated or moved under or near to these lines.

The risk

- 4 Contact with overhead electric lines can be lethal whether they are carrying a voltage as high as 400 000 V or as low as 230 V.
- 5 Overhead lines consist usually of bare (uninsulated) conductors (sometimes called cables) supported via insulators by wooden poles or metal towers and structures. Many people mistake overhead power lines carried on wooden poles for telephone wires.
- 6 If a crane jib, tipper lorry, excavator, scaffold pole, ladder, agricultural sprayer or similar object makes contact with or approaches near to these lines, an electric current can flow with a risk of fatal or severe shock and burns to any person in the immediate vicinity.
- 7 This can also occur with objects made from materials such as wood or plastic, which are normally regarded as electrical insulators. If damp or dirty, these may also be capable of transmitting sufficient current to cause dangerous or fatal electric shocks.

Note: Actual contact with a power line is not necessary to result in electric shock. A close approach to the line conductors may allow a 'flashover' or arc to take place. The risk of flashover increases as the line voltage increases.

Legal obligations

- 8 The Health and Safety at Work etc Act 1974 requires that employers provide 'systems of work that are, so far as is reasonably practicable, safe and without risks to health'.

The Management of Health and Safety at Work Regulations 1999 require a risk assessment to be carried out to identify the necessary precautions and to implement them.

The Construction (Design and Management) Regulations 1994 place obligations on clients, designers, those planning the work and contractors to prevent or reduce risks in those places where these Regulations apply. These obligations include risks from working near overhead lines.

The specific requirements for safety of work on or near overhead electric lines are set out in the Electricity at Work Regulations 1989:

- (a) regulation 4(3), which requires all work on or near an electrical system to be carried out so as to prevent danger, so far as is reasonably practicable; and
- (b) regulation 14 which places particular safety requirements on work on or near live electrical conductors.

See Annex A for further information on the Electricity at Work Regulations.

Avoidance of danger

9 The Approved Code of Practice which supports the Management of Health and Safety at Work Regulations 1999 sets out a hierarchy of precautions to take in order to control risks. For work at or near overhead power lines, application of this hierarchy suggests the following actions:

- (a) find out if the work has to be carried out under or near overhead lines (can it be avoided altogether) or, if this cannot be done;
- (b) divert all overhead lines clear of the work area or, if it is not reasonable for this to be done;
- (c) make lines dead while the work is in progress or, if this cannot be done;
- (d) work around the live overhead lines using the precautions outlined in this guidance.

In some cases it may be necessary to use suitable combinations of these measures, particularly where overhead lines pass over permanent work areas.

Work near overhead lines

10 Pre-planning of safe working procedures is important. The first step in avoiding danger is to find out whether there is any overhead electric line;

- (a) within or immediately adjoining the work area, or
- (b) across any route to it.

Information may be available from the local electricity supplier about location of their lines.

If any such lines are found it should be assumed that they are live unless or until this has been proved otherwise by their owners.

11 If there are any electric lines over the work area, near the site boundaries, or over access roads to the work area, consult the owners of the lines so that the proposed plan of work can be discussed. Allow sufficient time for the line to be diverted or made dead, or for other precautions to be taken as described below.

12 If the lines can only be made dead for short periods, then the passage of tall plant and, as far as is possible other work around the lines, should be scheduled at these times.

13 Liaison between the persons responsible for the work and the owner(s) of the lines should be continued until the work has been completed.

Precautions

14 The precautions depend on the nature of the work at the site. It is strongly recommended they are taken even when work near the line is of short duration. There are three broad categories of this work.

- (a) Work areas where there will be no scheduled work or passage of plant under the lines. Here barriers can prevent close approach, particularly for construction or quarrying work.
- (b) Work areas where plant will pass under the lines. Here defined passageways should be made.
- (c) Work areas where work will be carried out beneath the lines. Here further precautions must be taken in addition to the erection of barriers with passageways.

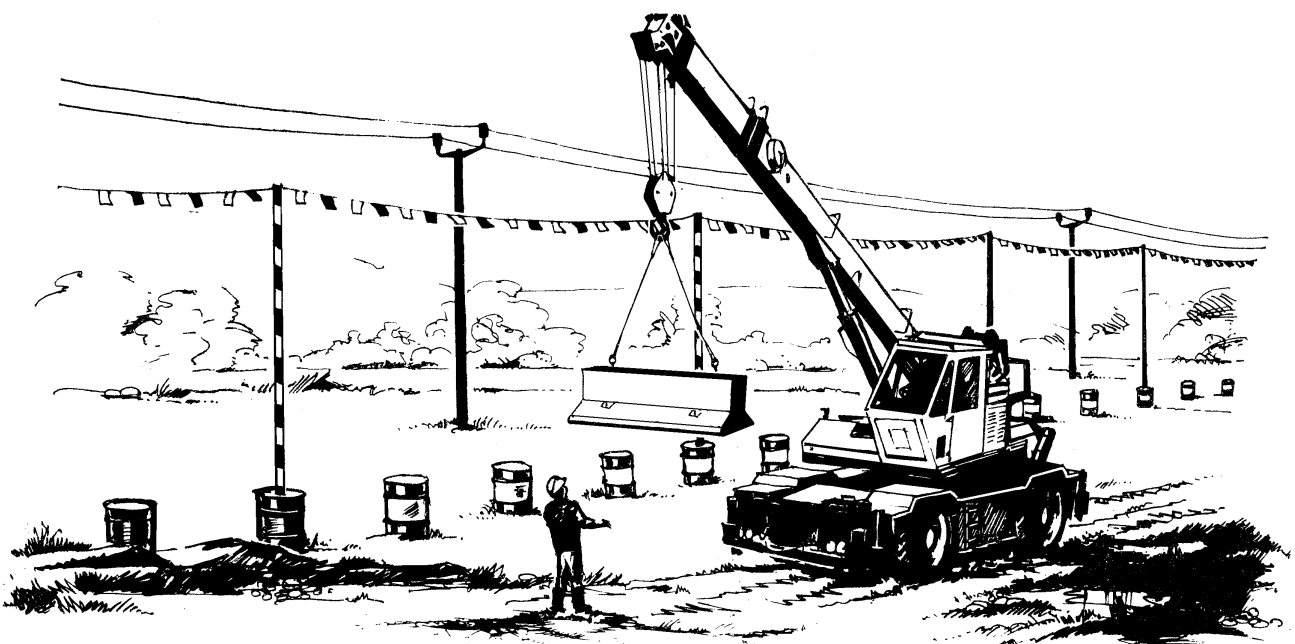
For work which regularly takes place around some lines (eg agricultural work) precautions are described in paragraphs 32 to 40.

Work areas where there will be no work or passage of plant under the lines

15 Danger can be reduced by erecting ground level barriers parallel to the overhead line to prevent any part of the mobile plant approaching too close to the line (see Figure 1). The recommended minimum distance from a barrier to the position, projected vertically onto the ground, of the conductor nearest to that barrier is 6 metres.

Note: The owner of the line(s) may advise a minimum distance greater than 6 metres, depending on the voltage of the overhead line. In certain cases, particularly where high voltage lines with long spans are involved, allowance should be made for lateral swing of the conductors, to maintain the safe distance from barriers to the overhead line at all times.

Figure 1 Sites where there will be no work or passage of plant under lines. Example of ground level barriers and high level bunting. Similar precautions apply to line supported on steel towers



16 Where this minimum distance could be encroached upon by parts of mobile plant (eg crane jibs, excavator buckets etc), it is recommended that the plant operators are given an additional indication of the position of the barriers. A line of coloured plastic flags or 'bunting', mounted at a height of from 3 to 6 metres above ground level immediately over the barriers, could be used. Where bunting etc is provided at heights of 6 metres, the supports for the bunting should be sited at least 9 metres from the position of the nearest conductor to the barrier when projected vertically onto the ground. Care is necessary when erecting bunting and flags to avoid contact or approach near to the conductors.

17 Where plant such as a mobile crane is used, the recommended minimum horizontal distance of the ground level barriers from the path of the overhead lines is 6 metres plus the length of the crane jib or other overhanging part of the plant.

Note: The owner of the line may recommend a greater distance than this if the nature of the line requires it. In such cases the supplementary flags or bunting need not be provided.

18 Measurements should be made horizontally, from underneath the nearest conductor in the line, at ground level only. It is **extremely dangerous** to attempt to take vertical measurements.

19 Where there will only be access on one side of the line, a barrier on this side only will suffice, but if the overhead line crosses the site, barriers will be required on both sides of it. If there is danger to people carrying metal scaffold poles, ladders or other conducting objects, then the barrier should be so arranged to prevent access by both people and mobile plant.

20 It is recommended that ground level barriers should be substantial enough that they are not easily moved. Examples are:

- (a) a stout post and rail fence; or
- (b) a tension wire fence earthed at both ends, having flags on the wire, the earthing arrangements of the fence being agreed in consultation with the electricity supplier; or
- (c) large steel drums, for example 182 litre (40 gallon) oil drums filled with rubble and placed at frequent intervals; or
- (d) an earth bank not less than 1 metre high and marked by posts to stop vehicles; or
- (e) substantial timber baulks or concrete blocks to act as wheel stops.

Fences, posts, oil drums etc should be made as visible as possible, for example by being painted with red and white stripes. Alternate red and white plastic warning flags may be hung on or immediately above any fence line to improve their visibility.

21 It is strongly recommended that the storage of materials in the area between the overhead line(s) and any ground level barrier is prohibited.

Work areas where plant will pass under lines

22 Where passage is required under the overhead line either along an access road or from one part of the work area to another, it is recommended that the danger area should be made as small as possible. This should be achieved by restricting the width of the passageway to the minimum needed for the safe crossing of plant. It is safest if the passageway crosses the route of the line at right angles (see Figure 2).

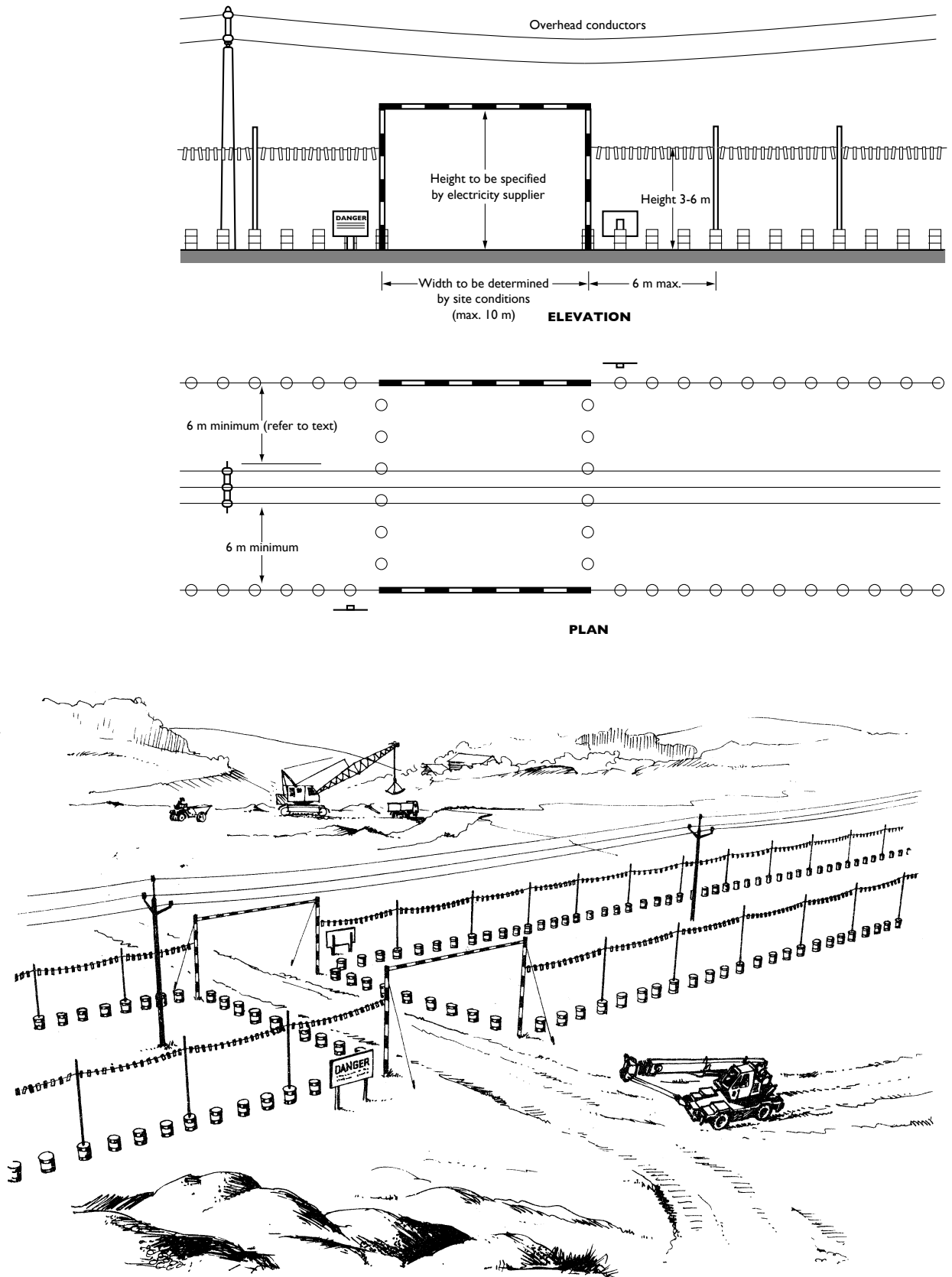


Figure 2 Sites where plant will pass under the line. Example of rigid goal posts and barriers. Similar precautions apply to lines supported on steel towers

The following precautions are recommended:

- (a) The number of such passageways should be kept to a minimum.
- (b) The passageway should be fenced to define its route, and goal posts erected at each end to act as gateways in the barriers running parallel to the overhead line.
- (c) The goal posts should be constructed from rigid, non-conducting material such as suitable timber or plastic pipe and distinctively marked in, for example, red and white stripes.
- (d) At either side of the passageway, on or near the goal posts, there should be warning notices giving the cross-bar clearance height and instructing drivers to lower jibs, tipper bodies etc and keep below this height while crossing.
- (e) On sites where work continues after dark the notices and cross-bars should be lit. It has also been found that illuminating the conductors is useful. The light fittings used for this illumination should be sited at ground level projecting the light upwards towards the conductors.
- (f) Additional warning notices should be erected on the approaches to the crossing, say about 30 metres away.
- (g) The surface of the passageway should be levelled, firmed up and well maintained to prevent undue tilting or bouncing of the equipment when under the overhead line.

23 Carefully consider the speed and stopping distance of the vehicles and plant when determining the layout and location of goal posts and warning signs. This will assist in positioning the goal posts sufficiently far from the overhead line(s) to prevent any vehicle or plant coming to rest beneath the line(s), if the goal posts are struck.

24 In situations where passage under the line cannot be confined to a single track (eg road construction), it may not be possible to restrict the passageway to a width which can be spanned by a rigid non-conducting goal post. In these cases, tensioned steel ropes or plastic ropes may have to be used (see Figure 3). It is recommended that such ropes are sited on both sides of the line at least 12 metres horizontally from the path of the outer conductor. This increased distance is essential to reduce danger from loss of safety clearance due to the possibility of ropes being stretched by cranes and other appliances moving towards the line. Where steel ropes are used, they should be effectively connected to earth at each end. Coloured 'bunting' can be attached to the tensioned rope to make it more easily visible.

Work areas where work will be done beneath the line (other than in agriculture)

25 If work beneath live overhead lines cannot be avoided, barriers, goal posts and warning notices should be provided. However, they will not prevent danger from upward movements of cranes, excavators or other appliances, nor will they prevent direct contact by workers where buildings or structures are being erected beneath the lines.

Work at ground level only (eg pipe laying)

26 The following precautions are recommended:

- (a) The safe clearance required beneath the overhead lines should be ascertained from the owner of the line(s).
- (b) Plant, equipment or hand tools that could reach beyond the safe clearance limit should not be taken under the line.
- (c) Plant such as cranes and excavators should be modified by the addition of suitable physical restraints so that it cannot reach beyond the safe clearance limit. Restraining devices may be fitted to the derricking or slewing mechanism, or both,

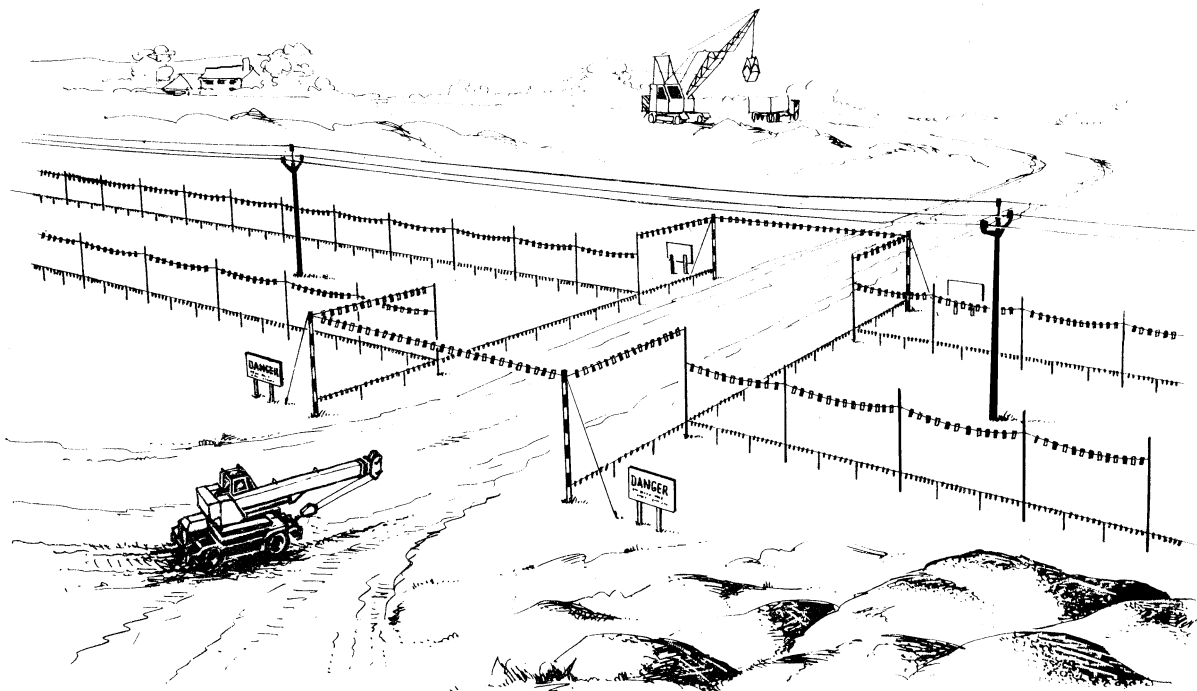
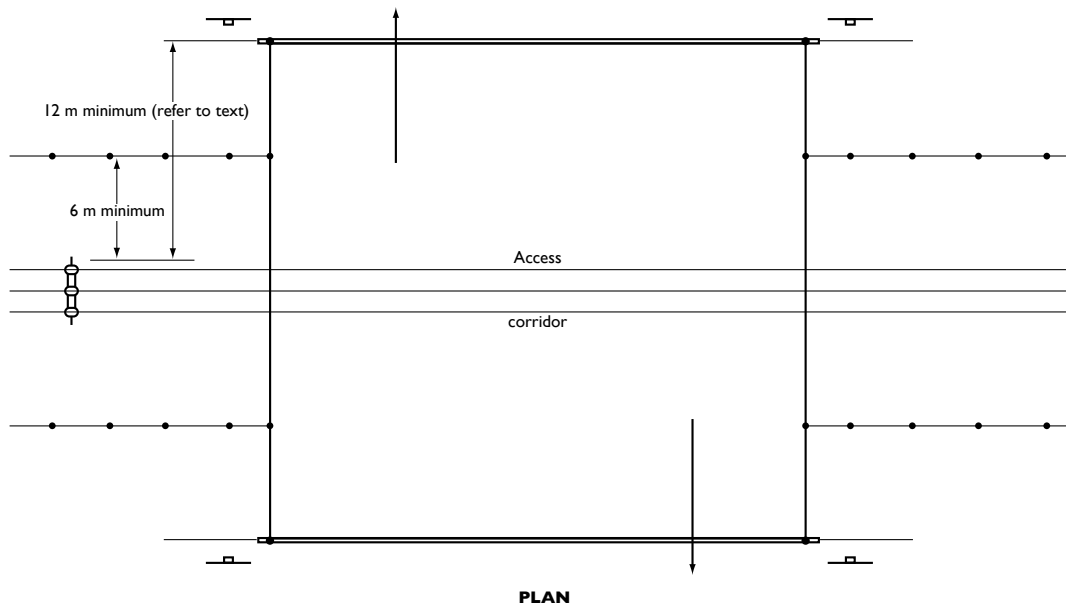
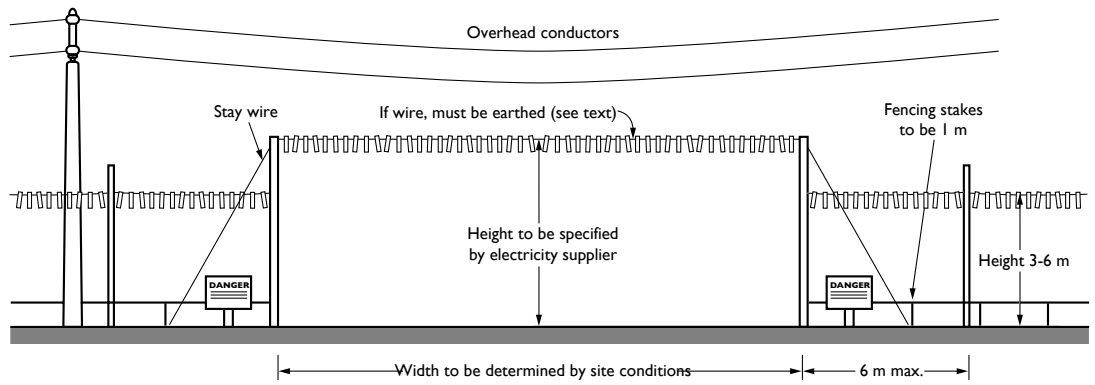


Figure 3 Sites where plant will pass under the line. Example of the use of tensioned ropes across wide access points. Similar precautions apply to lines supported on steel towers

as required. They may take the form of mechanical stops, or of limit switches for electrically driven cranes, or oil or fuel valves respectively for engine driven cranes with hydraulic or mechanical transmission.

- (d) Cranes with telescopic or fly jibs may need additional restraining devices to prevent alteration in length of jib or angle of fly jib.
- (e) Access for plant and materials and the working of plant should be under the direct supervision of a suitable person appointed to ensure that safety precautions are observed.

Erection of buildings or structures underneath an overhead line

27 In cases where buildings or structures are to be erected under overhead lines (and for those occasions when work has to be done at or from an existing building) increased risks will arise because of the chance of safe clearances being reduced by the proximity of the works and by provision of the required access above ground level.

28 If the lines cannot be diverted or made dead as described in paragraphs 9 to 12, the following precautions are strongly recommended:

- (a) The owner(s) of the line(s) should be consulted about proposed working methods.
- (b) The work should be carried out under the direct supervision of a suitable person, familiar with the risk, and appointed for the purpose of ensuring that safety precautions are observed.
- (c) The use of tools or items of equipment, eg scaffold poles, ladders etc, which can reach high enough to touch the overhead line (or going close enough to it to cause a flashover to take place), should be avoided.
- (d) A horizontal barrier of timber or other insulating material should be erected beneath the live conductors to form a roof over the construction area. Alternatively, in some cases, an earthed steel net may be used. In either case this work should be carried out only after agreement with the owner(s) of the line(s) and it may be necessary to enable safe erection or dismantling of the barrier to have the line(s) temporarily made dead.

Use of insulating guards and proximity devices

29 The use of insulating guards to protect conductors from being contacted by jibs, scaffold poles, tipper lorries etc and/or proximity warning devices without other safety precautions are not accepted.

Blasting

30 Danger arises from flying fragments that might damage or sever the line conductors, damage the insulators, or damage supporting structures with possible risk of collapse. Any of these events may cause the pole or tower, or the surrounding ground, to become live.

31 The following precautions should be adopted as appropriate:

- (a) Where blasting is necessary under, or in the vicinity of, overhead lines, the owner(s) of the line(s) should be given adequate warning with a view to having the line(s) made dead, if this is practicable.
- (b) One method of reducing the effect of flying fragments is to provide damping mats.
- (c) To prevent damage to the foundations of towers and poles, or to any associated underground cables or other apparatus, shot firing holes should not be drilled in the immediate vicinity of such foundations.

- (d) Non-electric firing systems should be used for detonators whenever possible. This will avoid problems with unintentional initiation of the detonators due to induced currents from overhead power lines.
- (e) When this is not possible and electric firing is necessary, special precautions will need to be taken. The suppliers of the explosives and detonating system should be consulted about the suitability of the system chosen.
- (f) When the detonators are electrically fired, danger can also arise if the shot firing cables are thrown into contact with the overhead line conductors. They may then become live, and hence make the apparatus to which they are connected live. The risk can be reduced by pegging or weighting the shot firing cables to the ground at about 1 metre intervals, taking care to avoid damaging the cables.

Agriculture and horticulture

32 Where field work is taking place it is impractical to erect barriers and goal posts around the overhead lines. Such devices are more appropriate for use at gateways, on tracks and at access points to farm yards. For field work the following measures are recommended:

Planning

- 33 Identify all overhead lines crossing or present on the land in question and mark them on a suitable plan or the farm map. This should be kept available at all times.
- 34 Check with the owner(s) of the line(s) what the maximum safe working height is for any sections that tall equipment may approach.
- 35 Find out the maximum height and vertical reach of plant and machinery. Remember to take into account any aerials or other similar projections beyond the designed working height of the plant and machinery. This includes vertical folding boom spraying equipment.

Training

- 36 Everybody who works near overhead lines with a machine or equipment needs to know what the dangers are and the precautions to take.

Visitors (including contractors)

- 37 Instruct contractors about the presence and dangers of the overhead lines. Make sure they know where the lines are and tell them the precautions they need to take. Routes can be marked with safety signs to warn all visitors of the dangers.

Use of machinery

38 The following activities should not be carried out within 9 metres horizontal distance of overhead power lines supported on wooden poles and 15 metres for those supported on metal towers and structures:

- (a) stacking bales, potato boxes or similar;
- (b) folding sprayer booms;
- (c) tipping trailers or lorries;
- (d) operating materials handlers;
- (e) working on top of combines or other high machinery.

39 Risks can be reduced by;

- (a) establishing loading and unloading areas away from overhead lines so that there is less chance of contact;
- (b) not storing long objects such as irrigation pipes or ladders near or under overhead lines;

- (c) carrying long objects horizontally using two people;
- (d) considering the provision of a buried pipeline under the line so that there is no need to manipulate irrigation pipework under or near the line;
- (e) not storing materials near to line support poles in the farm yard.

40 Where overhead lines cross farm yards and access routes, diversion of the overhead lines is to be preferred. Where this is not possible, consider creating alternative access points or routes. If this cannot be done, provide suitable warning signs and goal posts and barriers.

Forestry and arboriculture

41 It is recommended the following precautions are taken:

- (a) When tree felling near to overhead power lines, a clearance distance of at least two tree lengths on either side of each line should be established before felling is started.
- (b) The line of trees delineating this area will need to be suitably marked so that they are easily recognised.
- (c) Felling within the clearance distance, ie within two tree lengths of the line, should only take place after consultation with the owner of the overhead power line.
- (d) During arboriculture work, if any part of the tree is within 15 metres of a power line supported on metal towers or 9 metres of a line supported on wooden poles, consult the owner of the line before work is started.
- (e) Follow any code of practice issued by the owner of the line for establishing and maintaining clearances between trees and overhead power lines.

42 Further guidance can be obtained from the Forestry and Arboriculture Safety and Training Council (FASTCo), 231 Corstorphine Road, Edinburgh EH12 7AT
Tel: 0131 314 6193 Fax: 0131 316 4344.

Railways and other transport systems with overhead conductors

43 The following precautions are recommended to reduce the risk of accidents:

- (a) All railway, or other electrified transport system, traction (power) supplies, whether overhead or at ground level, must be treated as being live/energised at all times, unless or until this has been proved otherwise by the owners.
- (b) Where work is to take place alongside or over railway tracks with overhead conductors, it is essential that no object or plant is permitted to approach near any overhead conductor.
- (c) This is best achieved by ensuring that no object or item of plant is permitted to cross the boundary of the railway system or project over any bridge parapet.
- (d) Where it is likely that boundaries may need to be crossed or may be crossed accidentally, then the railway authority should be consulted before work commences.
- (e) The owners of other transport systems, eg trams, metro-rail, should be consulted before any work is undertaken that may require approach near to overhead conductors or their supports.
- (f) The negotiation of public or private level crossings with long overhanging or high loads requires great care.

44 It should be noted that some electrified railways employ conductor rail systems at ground level which pose similar dangers if contact or close approach takes place. You are advised to seek guidance from the owners of the railway system.

Annex A: Electricity at Work Regulations

- 1 Regulation 4(3) of the Electricity at Work Regulations 1989 requires that:

“Every work activity, including ... work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger”.

- 2 Regulation 14 deals with work near live conductors and says:

“No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless (a) it is unreasonable in all the circumstances for it to be dead and (b) it is reasonable in all the circumstances for him to be at work on or near it while it is live and (c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury”.

Guidance on these Regulations can be found in the *Memorandum of Guidance on the Electricity at Work Regulations 1989* HSR25 HSE Books 1989 ISBN 0 7176 1602 9

Annex B: References

AIS8(rev 2) *Working safely near overhead power lines (Third edition)* HSE Books 2000

Management of health and safety at work. Management of Health and Safety at Work Regulations 1999. Approved Code of Practice L21 (Second edition) HSE Books 2000 ISBN 0 7176 2488 9

Leaflet and video

Shock horror: Safe working near overhead power lines in agriculture Leaflet HSE Books 2003 (single copy free or priced packs of 10 ISBN 0 7176 2764 0)

Video: available from HSE Books 1993 ISBN 0 7176 1973 7

Further information

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