Health and Safety Executive **Information Document**
HSE 730/11

TEMPORARY ELECTRICAL INSTALLATIONS IN SHIPBUILDING AND SHIP REPAIRING

CONTENTS OF INFORMATION DOCUMENT

References Technical notes on residual current devices and reduced low voltage systems

FOREWORD

1 The guidance in this document addresses the provisions made for temporary electrical installations used in the shipbuilding and ship-repairing industries. It contains internal guidance which has been made available to the public. The guidance is considered good practice but is not compulsory. You may find it useful in deciding what you need to do to comply with the law. However, the guidance may not be directly applicable in all circumstances and any queries should be directed to the appropriate enforcing authority.

2 The guidance is intended to:

(1) clarify some of the practical issues involved;

(2) advise on policies which may be employed to provide safe systems of work in relation to danger from electricity; and

(3) assist in the development of standards of electrical equipment and installations for use in shipbuilding and ship repair.

3 The Health and Safety Executive would welcome comments on this guidance from shipyard operators or any other interested parties.

INTRODUCTION

4 During the course of work in shipbuilding and ship-repair yards it is likely that a temporary electrical supply will be required to supplement the build and repair programmes. An electricity supply is needed for the operation of equipment such as welding apparatus, extraction systems, and other electrically powered plant and tools.

5 It is essential that the installed electrical system is safe and without risks to health during operation, use and maintenance. The arduous nature of the industry imposes a significant burden on the condition of the temporary electrical installations used in shipbuilding and repair, this will need to be borne in mind when planning and designing the electrical system.

6 Recommendations described in this guidance reflect good practice which should be followed in the specification, design, installation, use and maintenance of the electrical system to provide a safe standard for temporary electrical services. Furthermore, particular emphasis is given to planning activities to ensure the integrity and safety of the system during the lifetime of a build and repair programme regardless of its duration.

7 A further objective is to give guidance on the practical aspects of legislative requirements, particularly of the Electricity at Work Regulations 1989, with regard to electrical systems used in shipbuilding and repair.

8 Whilst this guidance does not specifically deal with ignition hazards from cathodic protection systems on jetties and ships, it is recommended that the good practice outlined in BS 7361: Part 1: 1991 Code of Practice for land and marine applications is followed. In particular, ship repairers intending to work on vessels which have carried flammable cargoes should be aware that switching off the cathodic protection does not affect the hazard at non-degassed holds. To safeguard against ignition complete electrical isolation or insulation between ship and shore is required.

TEMPORARY DISTRIBUTION OF ELECTRICITY

9 This is the cabling system and equipment installed to distribute electricity to points of use at the various locations within the building or repair facility during the construction or repair process. The temporary electrical installation is always removed on completion of the work on site as it is then no longer required. Removal may begin on completion and commissioning of all or parts of the vessel's permanent, fixed installation. Although the installation may be only temporary, the harsh conditions at the building or repair facility require that it should be to a high standard. Equipment must be adequately protected against damage and contamination.

Primary distribution equipment and installation

10 Electrical supply distribution in shipbuilding and repair yards is typically arranged in a ring main circuit which feeds substations located in positions adjacent to building berths and construction facilities, referred to as dockside substations. The electrical supply to these substations may be at voltage ratings in the range 400 volts to 11,000 volts 3 phase and neutral.

11 The cables of these ring main circuits are typically of the steel wire armoured type which are further protected by placing in ducts, or by similar measures to prevent inadvertent damage by dockside vehicles or plant.

12 At the substation, the neutral of an incoming 400 volt cable may be connected directly to the system earth such that separate neutral and protective conductors are utilised throughout the yard's installation. This arrangement may be classified as a TN-S system in accordance with BS 7671: 1992 Requirements for electrical installations (see Appendix 1 para 1 for further details), where the wire armouring of the cables supplying the installations may form the protective conductor.

13 The function of these substations is for supply transformation, switching and isolation. The equipment in the substation comprises protective apparatus and switchgear, in addition to supply transformers. The transformers rated at up to 1000 kVA step down the high voltage input to give supply distribution at a nominal 400 volts. Clearly, where the ring main circuit supply is at 400 volts the requirement for further transformation may be unnecessary, except for 110 volt or lower voltage supplies.

Dockside distribution

14 Distribution of the electrical supply for work at the building berth or construction facility should be arranged from these dockside substations.

15 The distribution voltages to the working areas from the dockside substations are normally at 400 volts ac 3 phase and neutral, 230 volts ac single phase and 110 volts ac single phase. The system protection for these electrical supplies may include devices such as miniature circuit-breakers and sensitive earth leakage protection which are typically housed in the distribution substation.

Protective equipment and switchgear

16 Protective equipment refers to items such as fuses, earth fault relays and overcurrent relays that operate under overload and fault conditions. The rating of protective equipment and switchgear must be selected to embrace the worse case fault conditions which are anticipated at that point in the electrical installation. It is normal for this equipment to be specified to a national and international product standard, for example, the BS EN 60947 series Specification for low-voltage switchgear and control gear.

17 Selection of this type of protective apparatus and switchgear may help to mitigate against the need to perform detailed system analysis of prospective fault levels and protective discrimination. It is, however, the responsibility of technically competent persons in shipbuilding and repair yards to provide adequate setting and discrimination of this equipment to prevent danger arising from use of the temporary electrical installation.

18 The electrical system should be designed so as to avoid installation and maintenance work whilst live, unless this is essential.

Generators

19 If a mains voltage supply is not available and an ac generating set is to be used during the construction or repair process particular care is needed to ensure that it is installed safely:

(1) generators need to be earthed, by bonding the neutral to the frame and connecting to earth;

(2) the impedance of the bonding needs to be low enough to ensure correct operation of protective devices (fuses, circuit breakers etc); and

(3) sensitive earth fault protection may be necessary if earthing conditions are difficult.

20 Portable generators which are used in a particular location for short-time work (eg less than one day) need not be earthed provided that they are only used in conjunction with Class II (double insulated or all-insulated) tools or apparatus.

21 Small 110 volt portable generators need not be earthed but should be bonded if all the equipment in use is of double insulated construction or if they supply only one item of 'earthed' equipment.

22 Generators must be connected and operated in such a way that operation in parallel with the public supply system is not possible unless prior agreement has been obtained in writing from the electricity supplier. (See the Electricity Association's Recommendation for the connection of embedded generating plant to the requirements of the electrical companies' distribution system (Appendix 1 paragraph 2).

Liaison with supply authority

23 When use is made of electrical systems and services under the control of other duty holders, such as a port authority, adequate information which details the available protective apparatus and any restrictions on the electrical supply, should be available to allow the temporary electrical installation to be used safely.

Shore to ship electrical distribution

Planning and design of the temporary electrical installation

24 At the time of design and planning of the build or repair programme it is necessary to balance work activity and loading requirements by distributing the electrical supply to the vessel under construction or repair to pre-defined areas where work is to take place. This approach, should make full use of distribution points which are located in close proximity to the building berth or construction facilities.

25 In grouping and segregating the electrical supply for the various work activities, eg welding supplies located in one area, it is recommended that electrical supply cables are located away from areas where damage is foreseeable. This may involve:

(1) the use of ducting in the berthside;

(2) additional protection by covers or barriers; and

(3) arranging the cable runs on the side of the vessel under repair or construction to where plant access (craneage, etc) is restricted.

Figures 1 and 2 show practical examples of cable protection for work in shipyards.

26 Additional factors which should be considered when planning and designing a temporary electrical installation for a build or repair programme are:

(1) allow for extension of the system which minimises disruption and can be carried out safely;

(2) the capability of the electrical equipment;

(3) the need for maintenance during the lifetime of the programme; and

(4) the placing of cables and distribution outlets on decks and gangways to prevent obstruction.

27 It is recommended that the supply is derived from an onshore source where protection and isolation is available. The use of isolators which are lockable in the 'off' position should be employed as part of the safe systems of work on the electrical system in the yard.

Distribution cables and connections

28 All connections should be mechanically and electrically suitable for use, including protection against dust, the ingress of water and the effects of corrosion in salt-enriched environments. For example, plug and socket assemblies which comply with BS 4343:1968 Specification for industrial plugs, socket-outlets and couplers for ac and dc supplies, or equivalent standards.

29 Electrical supplies, at 400 volts or above, should be made using flexible armoured cables. These should incorporate a neutral conductor where necessary to provide compatibility of shore-based and vessel systems when running auxiliary machinery. An assessment of the voltage which may occur at extraneous conductive parts under earth fault conditions should be made and earth leakage and/or insulation monitoring devices provided as necessary.

Electrical supply requirements

30 Electrical equipment used on board the vessel during building and repair, including plant and tools, is likely to operate at various supply voltages which may be obtained by direct supply from a dockside substation or by subsequent transformation via a distribution point. A restriction on auxiliary machinery and plant operation may occur if 50 Hz and 60 Hz systems are necessary.

31 However, it may be permissible to operate 60 Hz apparatus safely from a 50 Hz supply providing an adequate derating factor is applied. For example, equipment requiring 440 volt 60 Hz should be energised at a maximum of 380V from a 50 Hz mains supply.

Provision of electrical supplies on board the vessel

32 On most vessels it is usual to find a shore connection box which is capable of adapting flexible supply cables to allow supply distribution for lighting and other equipment through the vessel's own power distribution system. The shore connection box will, in general, comprise all the necessary equipment for protecting the ship's electrical system beyond this point and may include phase sequence checking of the shore-based supply.

33 It is strongly recommended that the shore connection box is used as the connection point and distribution to the various work activities in the vessel be made through the ship's power distribution system. This approach may allow for diversity of supply to electrical equipment in the vessel or systems which have been assigned as essential for the safe progression and completion of the build and repair programme.

34 An earth conductor solidly connected to the earth of the shore-based electrical supply system should be taken to the vessel and terminated at an appropriate earth connection adjacent to the power connection point. It is good practice to provide secondary safety earths in this manner, which should be securely fastened to the vessel's steel hull. As a rule of thumb there should be one such connection for each 50 m of vessel or fabricated construction.

35 The earth conductors should be of the same size and rating as the phase conductors to ensure currents may be safely discharged in the event of a fault condition.

Use of vessel's own electrical supplies

36 In general, exclusive use of the vessel's own sources of electrical supply is not normally practiced during repair or construction work. This is because of the potential for incompatibility between voltage ratings of on-board apparatus and equipment used in the temporary electrical installation.

37 For this reason the approach described at paragraphs 30 and 31 should be taken where on-board apparatus is derated to attain compatibility with the onshore supply.

38 A further shortcoming when making use of the vessel's own electrical supplies is the available knowledge and expertise with regard to the full extent of the vessel's sources of electrical supply. Clearly, work should only proceed on this basis if there is sufficient information available to the yard operators from the ship's crew, for example in the form of diagrams, schematics and details of protection, to allow for safe working during the repair activities.

39 There are likely to be situations where use of shipboard supplies may be adopted when shipboard equipment and machinery is commissioned after re-fit, repair or installation, this may include computer apparatus. Also, emergency lighting systems may be employed during repair work on a vessel to improve safe working arrangements with an adequate level of illumination in holds.

40 The vessel's own emergency lighting is battery supplied. These batteries are trickle charged during normal operation of a generator set to provide between 4-12 hours emergency supply.

41 Further details of on-board installations can be obtained from the reference at Appendix 1 paragraph 3.

LIGHTING REQUIREMENTS

Introduction and definitions

42 Adequate lighting is essential during the build or repair programme. It may be used inside fabrications which are located in construction halls or in the repair/construction areas, and can be used to supplement fixed permanent lighting.

43 Precautions must be taken against the danger of electric shock and barriers should be used as appropriate to prevent secondary effects such as falls which may result from an electric shock injury. In addition, safeguards should be used in cases of failure of the lighting and from the dangers of electrical fires and explosions which may include earth leakage monitoring.

44 For the purpose of this guidance, normal duty lighting circuits are those used to illuminate working areas which do not contain a potentially explosive atmosphere due to, for example solvent vapours, or escape of gas from welding equipment.

45 Normal duty lighting circuits are installed to provide adequate illumination to allow work and movement to proceed safely during the construction or repair of a vessel. The installation should include supports and fittings to allow cables to be routed in areas which minimise obstruction and inadvertent mechanical damage.

46 Hazardous area lighting is discussed at paragraphs 62-65 of this guidance.

Normal duty lighting equipment and circuits

47 Lighting circuits are normally, although not universally, supplied from an ac source and good installation practice recommends that as safe a level of voltage is used as practicable. It is strongly recommended that 110 volts ac single phase be used, obtained from a double-wound transformer to BS 4363: 1991 Specification for distribution assemblies for electricity supplies for construction and building sites, in which the secondary windings are centre tapped to earth, ie the shock voltage to earth under fault conditions is restricted to 55 volts.

48 This approach has evolved from assessment of the risks of injury to yard personnel from electric shock and consideration of illumination levels in working areas. It should be noted that voltage levels of less than 110 volts which would provide an even greater level of safety are not normally practicable in shipbuilding and repair due to loads and lengths of supply cables. Lower voltage, eg 25 volt handlamps may however be necessary in confined conducting locations, supplied from a step-down transformer close to the point of use.

49 In circumstances which require direct current supplies for lighting purposes, typically older installations and equipment, the recommended supply voltage is 110 volts dc.

50 Recommended values for illumination of an area of the construction facility or vessel may be obtained from the reference at Appendix 1 paragraph 4.

Safe installation of normal duty lighting circuits

51 A principal safeguard to allow work to proceed on the vessel is that the design of the temporary electrical installation includes provision for diversity of supply to lighting circuits. The circuits should be arranged such that failure of a single element in the electrical distribution scheme will not result in the 'blacking out' of an entire ship area.

52 For each area this may be achieved by having a minimum of 2 lighting festoons supplied from separate sources. However, a number of approaches have been adopted in construction and repair yards which may be used to achieve an acceptable standard of lighting diversity:

(1) supplementary use of the vessel's own emergency lighting system;

(2) 'safety' lights installed at each hold, tank or other space which is not serviced by the vessel's emergency lighting system;

(3) adequately protected handlamps which are constructed in accordance with the reference at Appendix 1 paragraph 5.

53 Handlamps with a trailing lead may be acceptable providing flexible cables are adequately protected against inadvertent mechanical damage throughout their entire length. It is preferred that individual handlamps should operate at voltages of 24 volts ac, or below, and are of double or all-insulated construction.

Lighting festoons

54 Flexible pvc or elastomeric insulated cables are widely employed for lighting festoons. These cables should be run in the manner described at paragraphs 24 and 29.

55 Fittings for use with tungsten filament lamps, typically 100 watt rated, for normal duty lighting should preferably be constructed in polycarbonate or a similar impact resistent attached wire guard, wherever they are accessible or may be subject to foreseeable mechanical damage. The wire guard should either be adequately earthed or fitted in such a way that there is no possibility of it becoming charged either by contact with live parts or by leakage currents under fault conditions.

56 It is strongly recommended that only festoon lighting systems with lampholders bonded or moulded to the cable are used and, where necessary, the bulb is protected by a wire cage or other means of protection.

57 This standard of lighting festoons are recommended for normal duty applications only.

Confined spaces

58 The use of lighting circuits supplied at a safe extra low voltage, normally not exceeding 50 volts ac or 120 volts dc, is recommended for working in confined spaces, for example, inside double bottoms where workers adopt a cramped position and contact with temporary electrical equipment may occur. The risk of damage to cables and equipment in such spaces is increased and consideration should be given to safe systems of work, including reduced voltage levels, to prevent danger.

Maintenance of normal duty lighting equipment

59 On completion of the build or repair programme all cables, including those of the lighting circuits, should be removed and their condition thoroughly examined.

60 Interim inspection of supply cables at regular intervals during the lifetime of the installation should be undertaken as an essential part of the preventive maintenance regime. Schemes of cable tagging are likely to assist in providing an acceptable level of maintenance.

61 All plugs, sockets and interconnection components should be arranged as paragraph 28.

Temporary lighting equipment for use in potentially flammable atmospheres

62 In areas which are classified as hazardous due to the potential for a flammable or explosive atmosphere to occur during the construction or repair of a vessel, the use of normal duty lighting equipment and circuits should be prohibited, particularly when working with solvent-based fluids. It is a requirement to only use lighting equipment which is suitably constructed, or as necessary protected, to allow safe working in a flammable or explosive atmosphere.

63 Lighting equipment for use in flammable atmospheres should meet the requirements of the standards specified in Certificate of Approval F2511 issued under the Shipbuilding and Ship-Repairing Regulations 1960. Examples of suitable standards which may form part of the safe systems of work in shipbuilding and repair activities include the relevant parts of the BS 5501 series and their equivalent European standards such as EN 50020, which are included at Appendix 1 paragraph 6.

64 It is not possible to demonstrate suitability of non-certified lighting equipment for hazardous areas without subjecting the equipment to tests akin to certification

standards. Consequently, the use of lighting equipment which does not conform to these standards is not recommended and should be prohibited.

65 It is recommended that the connection of the temporary lighting equipment used in potentially flammable atmospheres complies with the following:

(1) plugs and sockets which are used in hazardous areas should be suitable for use in that particular zone of risk;

(2) plugs and sockets should have mechanical and/or electrical interlocking to prevent danger during insertion or removal of the plug;

(3) the type of cable should be suitable for rough usage and other adverse environmental conditions, eg presence of solvents;

(4) the cable should also be suitable for the circuit protective arrangements, eg where earth monitoring is used, the cable should include the appropriate number of conductors; and

(5) where the apparatus needs to be earthed, the cable may include an earthed flexible metallic screen in addition to the earth conductor.

PORTABLE AND TRANSPORTABLE ELECTRICAL EQUIPMENT

Introduction and definition

66 During the lifetime of a repair or build project it is likely that numerous items of portable and transportable electrical equipment will be used to assist in work activity. This equipment can take many forms including:

(1) welding equipment;

(2) extraction systems incorporating ventilation fans;

(3) drills; and

(4) grinders.

67 The quantity of such equipment in use will vary considerably depending on the size of the fabrication hall, building berth or vessel size and complexity.

Supply and loading considerations

68 It is common practice to co-locate welding equipment together and provide a supply from multi-operator transformers, typically rated at up to 380 kVA, or from smaller single operator units which have ratings not normally exceeding 50 kVA. For example, a shore located 400 volts 3 phase supplied welding transformer, rated at 164/365 kVA maximum, may be used to provide power to a 6-person welding team with a supply voltage at 110 volts ac single-phase.

69 The variation in the quantity and supply requirements of the portable and transportable electrical equipment will mean that supplies of varying capacity are included in the specification of the temporary electrical installation. These electrical loading constraints should be considered during planning (see paragraphs 24-27).

70 Circuit and system protection against overcurrent and earth fault conditions by adequately constructed and rated fuses, circuit-breakers and isolator switches should be used, as necessary, to satisfy the duties involved.

71 It is important to recognise that residual current devices (RCDs) should never be used as a substitute for a properly installed and protected electrical system with an efficient earth. RCDs for protecting people have a rated sensitivity of not more than 30 mA (and a rated operating time of 200 milliseconds at a test current of 30 mA and 40 milliseconds at 150 mA).

72 The earthing of welding equipment requires special consideration, and recommendation of good practice is made at Appendix 1 paragraphs 7 and 8. This requires that the insulated neutral of the welding transformer is connected to the workpiece using conductors of sufficiently low impedance and that extraneous conductive parts, unless part of the workpiece, do not form part of the welding circuit. In addition, the casings of welding current regulators should also be earthed if constructed of metal.

73 Portable hand-held electric tools such as drills, linishers and grinders are normally operated from a low voltage supply. Good practice observed at shipbuilding and repair yards is a 110 volt single phase supply obtained from a double wound transformer which conforms with BS 4363: 1991, or an equivalent standard. Further details of the 110 volt system are given at Appendix 2.

74 The construction of portable electric tools should provide protection against harsh conditions of use and moisture ingress. Typically, the degree of enclosure protection for tools used outside at vessels under construction or repair is IP55 (see Appendix 1 paragraph 9).

75 Plug and socket connections for portable and transportable apparatus should be arranged as at paragraph 28.

76 Additional methods which are available to ensure safety of operation and the safe use of electricity with portable and transportable equipment include:

(1) the use of flexible armoured cables;

(2) high sensitivity earth fault protection;

(3) earth monitoring circuits; and

(4) Class II (double-insulated) or all-insulated equipment.

Maintaining portable and transportable electrical equipment

77 HSE Booklet HS(G) 107 Maintaining portable and transportable electrical equipment (Appendix 1 paragraph 10) gives detailed general advice on the electrical safety aspects of maintaining portable apparatus. At shipbuilding and repair facilities the risks from damaged or faulty electrical equipment are high, and need to be managed and controlled by setting up an appropriate maintenance system. The maintenance system will need to include both formal visual inspections on a regular basis and also checks by the user. These should be backed up by combined inspection and electrical testing.

78 The most important maintenance precaution is the formal visual inspection because this can detect about 95% of faults or damage. Yard management should ensure that regular visual inspections are carried out by competent members of staff. Such staff should be given sufficient training to enable them to detect signs of faults or damage. Time should be allocated to enable them to carry out the inspections.

79 The following faults can be seen easily and will be picked up during formal visual inspections (and the checks by the user):

(1) any visible bare wires;

(2) damage to cables such as cuts and abrasions (excluding light scuffing);

(3) damage to the case of the equipment, or loose covers or fixings;

(4) damage to plugs and sockets such as cracked casing, bent pins, or signs of overheating;

(5) unsuitable cable joints or repairs; and

(6) cable sheath not securely gripped at the cable termination.

80 Users can be given basic training so that they can visually check the equipment they are using. It is recommended that they look at 230 volt equipment and RCDs every day or at the start of every shift (if the yard is in use 24 hours/day).

81 Testing can detect faults such as loss of earth continuity, deterioration of the insulation and internal or external contamination by dust, water etc. All of these faults are likely to occur at a shipbuilding or repair yard because of the arduous environment. They could result in electrocution or cause a fire. Therefore, it is

important that testing is carried out by a competent person at a frequency appropriate to the type of equipment and the risks.

82 In addition to routine testing as part of the planned maintenance programme, it is recommended that combined inspection and testing is also carried out:

(1) where there is reason to suspect the equipment may be faulty,damaged or contaminated but this cannot be confirmed by visual inspection; and

(2) after any repair, modification or similar work to the equipment, when its integrity needs to be established.

83 The following table gives guidance on the suggested frequencies of user checks, planned formal visual inspections and combined visual inspection and testing. It is based on practical experience and is designed to assist those setting up a maintenance regime for the first time. The frequencies should be appropriate to the risks at the yard. They should be reviewed occasionally, using the results of previous inspections and tests to see whether the frequency can be decreased or should be increased.

SUGGESTED INSPECTION AND TEST FREQUENCIES FOR ELECTRICAL EQUIPMENT AT A SHIPBUILDING OR SHIP REPAIR YARD

EQUIPMENT/APPLICATION	VOLTAGE	USER CHECK	FORMAL VISUAL INSPECTION	COMBINED INSPECTION AND TEST
Battery operatated power tools and torches	Less than 20v	No	No	No
25v Portable hand lamps (confined or damp situations)	25v Secondary winding from transformer	No	No	No
50v Portable hand lamps	Secondary winding centre tapped earth (25v)	No	No	Yearly
110v Portable and hand held tools, extension leads, yard lighting, movable wiring systems and associated switchgear	Secondary winding centre tapped earth (55v)	Weekly	Monthly	3 Monthly*
230v Portable and hand held tools, flood lighting and extension leads	240v mains supply through 30mA RCD	Daily/Every Shift	Weekly	Monthly*
230v Fixed (non-moveable equipment)	240v sSupply fuses or MCBs	Weekly	Monthly	3 Monthly*

RCDs		Daily/Every Shift	Weekly	**
Equipment in offices	240v office equipment	Monthly	6 Monthly	12 Monthly

*And when returned from a build/repair project or moved to another build/repair project location.

**It is recommended that fixed RCDs are tested on a 3-monthly basis, while portable RCDs are tested monthly.

84 Higher risk equipment (230 volts or above) needs more frequent checking, inspection and testing than lower risk equipment (110 volts or less).

85 Damaged equipment should be taken out of service immediately and labelled as defective. Users should not attempt makeshift repairs. Repairs should be carried out by competent people.

TESTING AND MAINTENANCE OF THE TEMPORARY ELECTRICAL INSTALLATION

86 The temporary electrical installation, regardless of its condition or extent, should be maintained in order to ensure the safety of the system. The quality and frequency of this maintenance should be sufficient to prevent danger so far as is reasonably practicable.

87 Shipyards will normally have the facilities available to carry out their own maintenance on practically all aspects of repair, calibration, inspection and test to both heavy current and electronic equipment.

88 As a general rule, inspection and testing of the temporary electrical installations should be undertaken in accordance with the reference at Appendix 1 paragraph 1. This approach includes considerations for initial verification, alterations and additions to installations, periodic inspection and testing, and certification and reporting.

89 The tests which are to be performed should include:

(1) visual inspection for defects;

(2) continuity of protective conductors;

(3) insulation resistance;

(4) site applied insulation;

(5) dielectric tests;

(6) earth fault loop impedance;

(7) polarity; and

(8) proof testing of residual current devices, whenever appropriate.

90 It is recommended that this work is carried out on a planned preventive basis which incorporates regular inspection of equipment. The use of techniques such as equipment labelling and tagging may assist in determining effective maintenance scheduling. The frequency of inspection and testing should be made against practical experience of use, and is a matter for the judgement of the technically competent person. Information obtained from records of similar electrical installations and equipment manufacturers may be employed to determine the initial frequency, which then can be subsequently adjusted to match practical experience.

91 Test and inspection of the completed installation on board the vessel should be performed in accordance with the reference at Appendix 1 paragraph 3.

March 1996

APPENDIX 1
(paras 12, 22, 41, 50, 52(3), 63, 72, 74, 77, 88 and 91)

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BS 4533: Part 102: Section 102.8: 1990 Specification for handlamps.

BS 5501: Part 1: 1977 Electrical apparatus for potentially explosive atmospheres. General requirements.

BS 5501: Part 2: 1977 Oil immersion 'o'

BS 5501: Part 3: 1977 Pressurized apparatus 'p'

BS 5501: Part 4: 1977 Powder filling 'q'

BS 5501: Part 5: 1977 Flameproof enclosure 'd'

BS 5501: Part 6: 1977 Increased safety 'e'

BS 5501: Part 7: 1977 Intrinsic safety 'i'

BS 5501: Part 8: 1977 Encapsulation 'm'

BS 5501: Part 9: 1982 Specification for intrinsically safe electrical systems 'i' .

Also, reference may be made to European Standards EN 50014-EN 50020 which correspond to BS 5501 Parts 1-7 respectively.

Additionally, BS EN 50014: 1992 Electrical apparatus for potentially explosive atmospheres. General requirements partially replaces BS 5501: Part 1: 1977.

1 BS 638: 1966 Arc welding power sources, equipment and accessories.

British Standards may be obtained from British Standards Institution, 389 Cheswick High Road, London, W4 4AL.

2 HS(G) 118 Electrical safety in arc welding (withdrawn)

3 BS EN 60529: 1992 Specification for degrees of protection provided by enclosures (IP code).

4 HS(G)107 Maintenance of portable and transportable electrical equipment HSE Books 1994 ISBN 07176 0715 1.

5 IEE Code of practice for in-service inspections and testing of electrical equipment. Available from: The Institution of Electrical Engineers, Hitchen, Hertfordshire SG5 1RS.

6 HS(G)85 Electricity at work - safe working practices HSE Books 1993 ISBN 07176 0442 X.

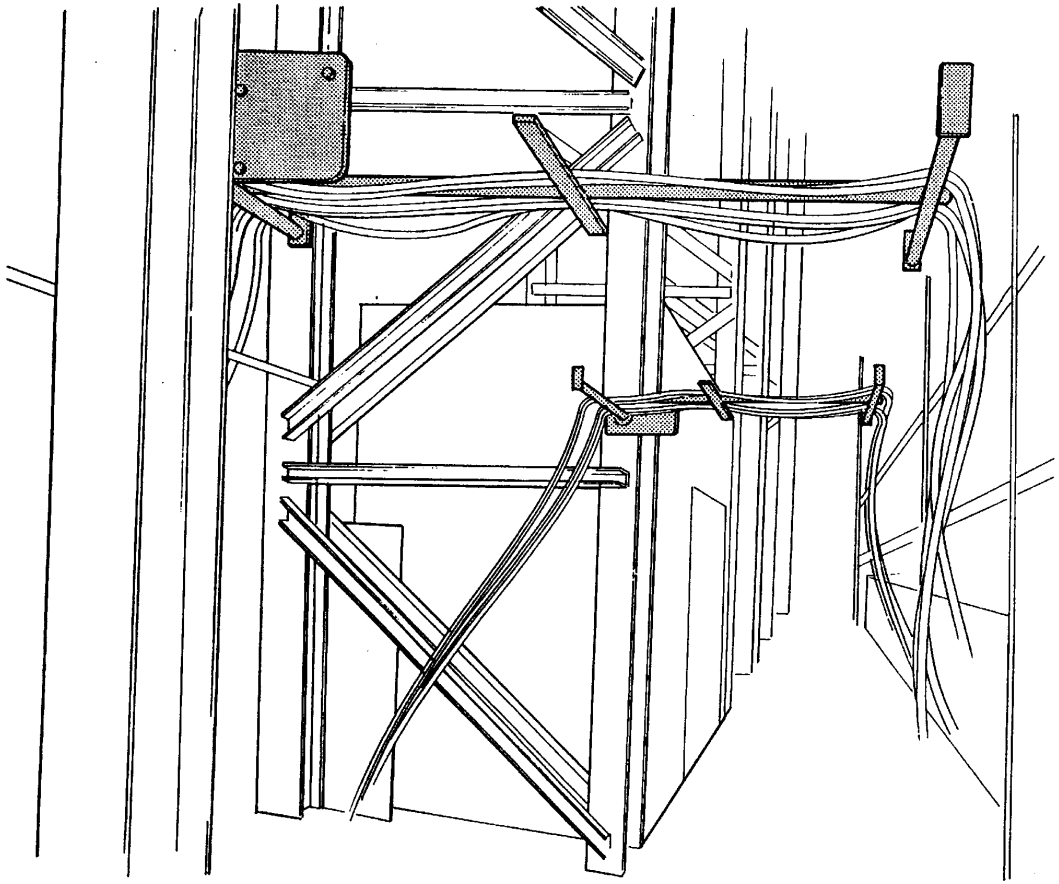

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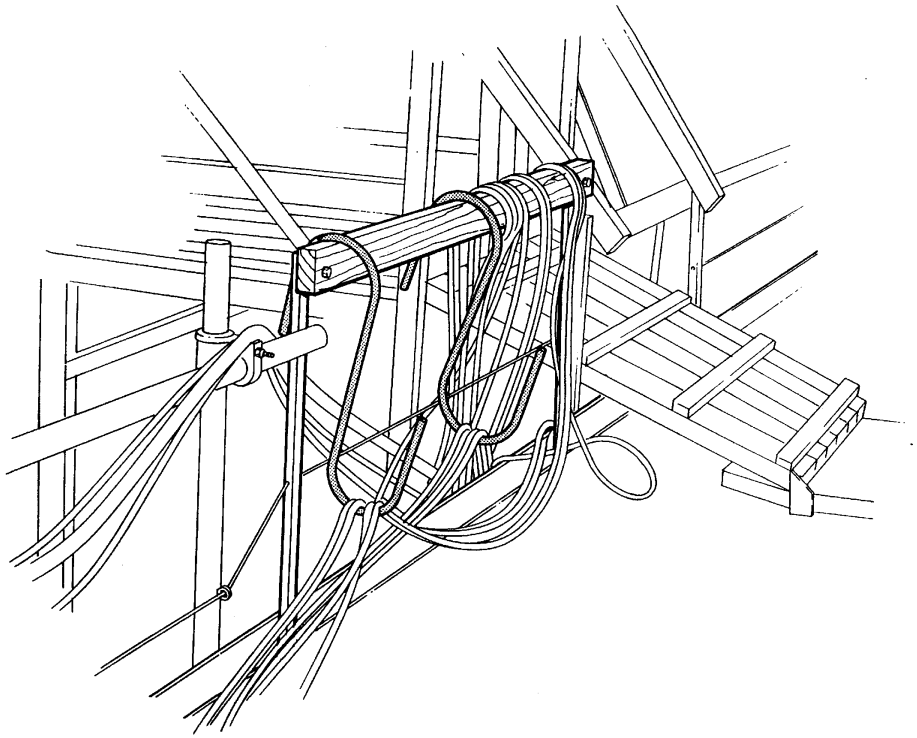
Figure 1 (para 25) Cantilevered support arms for carrying services over workshop walkway



35VA11-2 **Figure 2 (para 25) Simple 'S' hooks made from bent tubing used to route services along handrails**

APPENDIX 2
(para 73)

TECHNICAL NOTES ON RESIDUAL CURRENT DEVICES AND REDUCED LOW VOLTAGE SYSTEMS

RESIDUAL CURRENT DEVICES (RCDS)

1 An RCD is an electro-mechanical device which may be likened to a current balance. It compares the current flowing into the system with the current flowing out of the system. When the system is fault free, these values are the same, and the RCD continues to allow the current to flow. When the levels differ by a pre-set value (the rated tripping current value of the device) or more, then the RCD will open rapidly, thus interrupting the electrical supply.

2 The RCD is sensitive to very small currents. It does not limit the current flowing in the event of shock, it limits the time for which that current flows thus minimising injury. If an RCD fails to operate the current will continue flowing, possibly dangerously.

3 RCDs can also be subject to 'nuisance tripping'. This is where the RCD trips frequently in the absence of a detectable fault. The cause may be an intermittent fault, or may be due to 'leakage' currents from items such as information technology equipment. The resulting loss of supply causes inconvenience to users of the system, and increases the likelihood of the device being defeated in some way, so rendering the system without protection.

REDUCED LOW VOLTAGE SYSTEMS

4 These are electrical supply systems in which the maximum voltage to earth that can occur in the event of a fault or damage to the system, is reliably limited to a value which is unlikely to cause danger to persons. Unlike RCDs, reduced low voltage systems are passive systems in that they do not rely on the operation of a sensitive electomechanical device to ensure safety.

5 Cordless (battery operated) hand-held tools are on example of reduced low voltage equipment, but these have limitations on power output and duration of operation.

6 Safety extra low voltage (SELV) systems limit the voltage available to a maximum of 25 volts. These systems are often used for lighting circuits or similar low power requirement situations, but the low voltages make the system less useful for use with power tools and more general application.

7 The reduced low voltage system in most common use at UK shipbuilding and repair yards for general applications is that which is 110 volt centre tapped to earth. In this system the source of the electrical supply is usually a double wound transformer with an earthed screen between the primary and secondary windings of the transformer. In addition, the star point or neutral of a 3-phase transformer is

connected to earth, and the centre point of a single phase or 2 pole winding is connected to earth (see figures 1 and 2). It is possible to use generators to supply these systems and these should be configured to provide the same features.

Reduced low voltage

A system in which the nominal phase-to-earth voltage does not exceed 63.5V and the nominal phase-to-phase voltage does not exceed 110V.

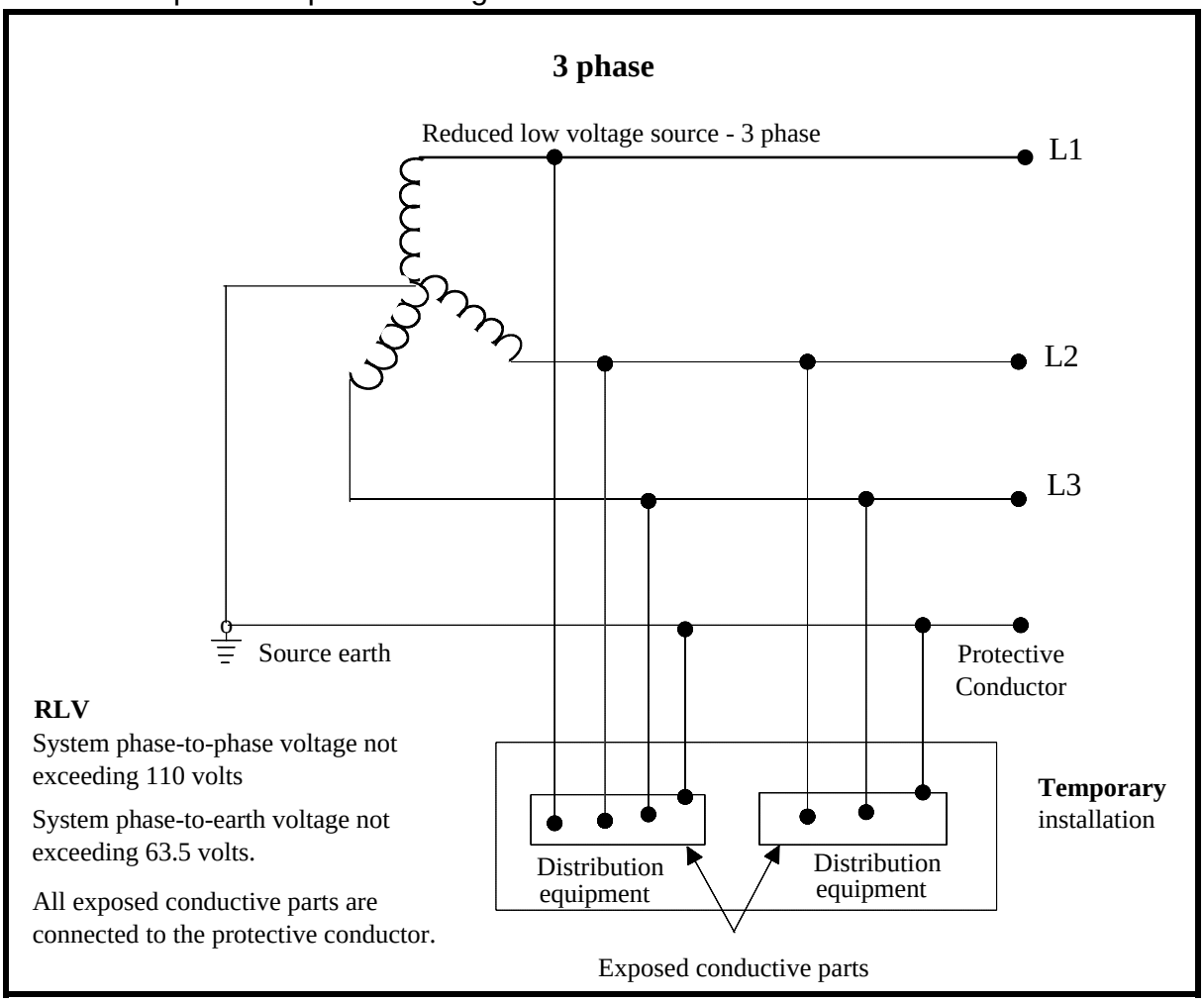


Figure 1

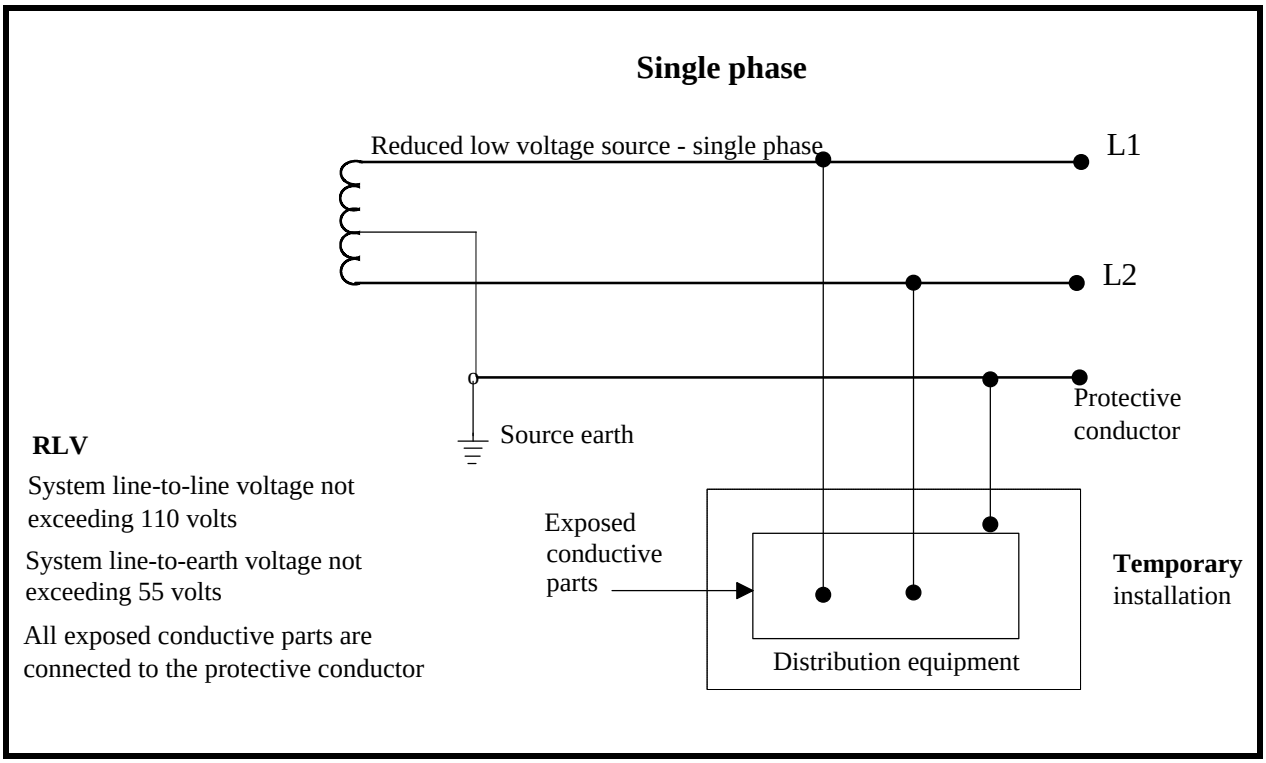


Figure 2

8 The phase to phase (for 3-phase supplies) and the pole to pole (for single-phase supplies) voltages on the secondary output does not exceed 110 volts. The corresponding phase to earth and pole to earth voltages will then not exceed 63.5 volts and 55 volts respectively at the transformer output terminals.

9 In this way, the system is able to supply 110 volts to tools or equipment in use at the yard, whilst technical investigation has shown that the maximum indirect contact touch voltage from one of these systems does not exceed 40 volts. This can be a steady state condition and it does not exceed the limits for electric shock protection set out in the protection curves for normal human body impedance, as shown in IEC publications 479-1 and 2.