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Code of practice for

Maintenance of electrical switchgear and controlgear for voltages up to and including 1 kV

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- Association of Short Circuit Testing Authorities
- Association of Supervisory and Executive Engineers
- BEAMA Transmission and Distribution Association
- British Railways Board
- Control and Automation Manufacturers' Association (BEAMA)
- Copper Development Association
- Department of the Environment, Property Services Agency
- Electrical Installation Equipment Manufacturers' Association (BEAMA)
- Electricity Supply Industry in England and Wales
- ERA Technology Ltd.
- Health and Safety Executive
- National Coal Board
- National Economic Development Office

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- British Gas Corporation
- British Steel Corporation
- Engineering Equipment and Materials Users' Association

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Foreword

This code of practice has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It is a revision of those clauses of CP 1011:1961 and BS 5405:1976 covering the low-voltage apparatus. BS 6626 and BS 6867 cover the high-voltage clauses and both CP 1011 and BS 5405 have therefore been withdrawn.

This code of practice represents a standard of good practice and takes the form of recommendations.

Attention is drawn to the following:

The Health and Safety at Work etc. Act 1974

The Electricity Supply Regulations 1988 and the amending Regulations 1990

The Factories Act 1961

The Electricity at Work Regulations 1989

The memorandum of Guidance on the Electricity at Work Regulations 1989

Approved Code of Practice — The use of Electricity at Quarries

Approved Code of Practice — The use of Electricity at Mines

The Coal and other Mines (Electricity) Order 1956 — Regulation 6(2) is revoked.

The Coal and other Mines (Mechanics and Electricians) Regulations 1965 — Regulation 11(3) is revoked.

It is essential that all persons responsible for electrical work or operations make themselves acquainted with the appropriate statutory requirements.

It has been assumed in the drafting of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people for whose guidance it has been prepared.

NOTE Some factors that affect the performance and safe operation of equipment are dependent on the initial design, associated equipment, environment, location and installation. These should be considered at the appropriate stage.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 30, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

0 Introduction

The purpose of this code of practice is to provide, in a convenient form, guidance on those matters which technical knowledge and experience have shown to be important in keeping equipment in an acceptable condition. It is intended for the guidance of those actually carrying out the maintenance work as well as for administrative personnel. It is therefore strongly recommended that this code, together with manufacturer's instructions for each specific item, be made readily available for all concerned.

The normally quiescent state of electrical switchgear and some controlgear does not automatically draw attention to incipient faults, deterioration or danger resulting from neglect and the consequent need for maintenance. It follows therefore that an organized system of routine maintenance will facilitate continued safe and acceptable operation of an electrical system with the minimum risk of breakdown and consequent interruption of supply.

1 Scope

This code of practice gives recommendations for the maintenance of electrical switchgear and controlgear having rated voltages up to and including 1 kV.

Special maintenance requirements relating to explosion-protected switchgear and controlgear are excluded from this code of practice (see CP 1003 and BS 5345). Nevertheless this code gives useful information relating to general maintenance aspects of such apparatus.

Recommended procedures for maintenance of the principal components of equipment are included and guidance is also given concerning replaceable parts but in each instance the item manufacturer's data should be used in making decisions.

Reference is made to the precautions to be observed in order to secure safety of personnel whilst maintenance is in progress. Guidelines to assist in the formulation of safe isolation procedures for work on systems operating at voltages up to and including 1 kV are also included in Appendix A.

NOTE The titles of the publications referred to in this code of practice are listed on the inside back cover.

2 Definitions

For the purposes of this standard the following definitions apply, together with those given in BS 4727-2:Group 06. The definitions of switchgear and controlgear given in BS 4727-2:Group 06 are repeated here for convenience.

2.1 switchgear

a general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment and also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric power

2.2 controlgear

a general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, and also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for the control of electric power consuming equipment

2.3 equipment

electrical switchgear and controlgear

2.4 item

any part of equipment, including a composite unit, that can be individually considered

2.5 acceptable condition

the condition in which an item is able to meet the requirements of the relevant specification and perform its required functions (See also Appendix B.)

2.6 failure (breakdown)

the termination of the ability of an item to perform its required function; failure can be gradual, sudden, partial or complete (See also Appendix B.)

2.7 maintenance

a combination of any actions carried out to retain an item in, or restore it to, an acceptable condition

2.8**routine maintenance**

maintenance organized and carried out in accordance with a predetermined policy or plan to prevent breakdown or decide the likelihood of an item failing to meet an acceptable condition

2.9**non-routine maintenance**

unplanned maintenance that is not the result of a breakdown

2.10**preventive maintenance**

maintenance carried out with the objective of preventing breakdown and which may include routine or non-routine maintenance (See also Appendix B.)

2.11**repair or corrective maintenance**

maintenance necessary to restore an item to an acceptable condition

2.12**emergency action**

action that has to be taken immediately to avoid serious consequence

2.13**post-fault maintenance**

maintenance which may be necessary after a fault protective device has operated and, on switchgear, after a specified number of fault clearance operations

2.14**inspection (inspect)**

a maintenance action comprising careful scrutiny of an item carried out without dismantling and using all the senses as required to detect anything which causes the item to fail to meet an acceptable condition. This may include an operational check (see 2.17)

2.15**examination (examine)**

an inspection with the addition of partial dismantling as required, supplemented by means such as measurement and non-destructive tests, in order to arrive at a reliable conclusion as to the condition of an item

2.16**overhaul**

maintenance of an item including examination and replacement or rebuilding as required. Overhaul can be further categorized into:

a) **minor overhaul or servicing.** An overhaul that is limited to lubrication and/or replacement of consumables.

b) **major overhaul.** An overhaul that includes major dismantling and/or replacement of items to complete the maintenance.

2.17**operational check**

an action carried out to determine whether an item functions correctly

2.18**test**

a measurement carried out to determine the condition of an item

2.19**diagnostic test**

a comparative measurement carried out to monitor the conditions of an item

3 Relevant acts and regulations

A list of some relevant acts and regulations is given in the foreword to this code of practice.

Section 2. Safety

4 General

All persons employed on maintenance of equipment should conduct their work in accordance with the appropriate statutory requirements.

The recommended housekeeping and operational actions detailed in this section should be the basis of all maintenance and associated functions.

Hazards other than those of a purely electrical nature may exist during maintenance. Such hazards should be considered in the overall safety aspects of the maintenance described in this code of practice.

5 Responsibility

The Health and Safety at Work etc. Act 1974 (HSW Act) makes provisions for securing the health, safety and welfare of persons at work whether or not in premises subject to the Factories Act 1961.

The responsibility for ensuring safe methods of working and operating electrical equipment rests primarily on the occupier or employer, but it is not confined to him. He should ensure that precise instructions are issued setting out the procedures for safe working in the handling, maintenance and testing of electrical equipment together with arrangements for monitoring to ensure that these procedures are effectively carried out.

Employers should be aware of the responsibilities laid on them by the relevant acts and regulations concerned with safety. The extent of responsibility may differ according to the nature of the work.

The employer or occupier has general overall responsibility for the premises and work activities. There is also an obligation on all agents, workmen and persons employed to conduct their work in accordance with the statutory requirements. The degree of responsibility for complying with these requirements will vary according to the level of responsibility of the person concerned and the nature of the management structure.

An employee should cooperate with his employer as far as is necessary to enable the employer to carry out his statutory duties. He should also take reasonable care for the health and safety of himself and others who may be affected by his acts or omissions at work. No person should intentionally or recklessly interfere with or misuse anything provided under a statutory provision in the interests of health, safety or welfare.

Those concerned with the maintenance of equipment should familiarize themselves with the plant controlled and report any changes that may affect the equipment. Incorrect application of equipment may result in failure and/or create safety hazards.

Equipment manufacturers and suppliers should supply equipment that is so designed and constructed as to be safe when properly used, together with the necessary information to enable such use, which includes maintenance, to be carried out safely.

Where an item is intended to be maintained, the manufacturer should supply maintenance instructions with relevant drawings (preferably of the exploded view type) and spare parts list. See also Appendix D.

6 Rules or procedures

Safety in the control, operation and maintenance of switchgear and controlgear is best achieved by observing a simple code of safety rules or procedures having regard also for non-electrical hazards. It is recommended that in all premises the management should formulate a set of safety rules or procedures, appropriate to the type of electrical installation, covering the operation of and work to be carried out on the equipment on the premises.

(See the guidelines in Appendix A.)

It may also be necessary to use a "permit to work" system.

The policy to be followed when preparing safety rules or procedures should be to attempt to foresee any danger that can or may develop and to institute procedures and methods that will prevent danger so far as is reasonably practicable.

The basic principle should always be that no electrical conductor should be regarded as being dead unless it has been proved to be so. Particular attention should be paid to conductors associated with interlocking circuits that may become live from the functioning of other equipment.

The attention of all personnel should be drawn to the need to follow warning signs or instruction on any cover or access plate.

Since factors that affect the safe operation of equipment may change during the life of the installation, safety provisions should be subject to routine review and should be revised as necessary.

The best rules and procedures are of no avail unless all persons operating or working on the equipment are thoroughly conversant with them and with the relevant statutory requirements. Strict compliance with safety rules should be required of all personnel.

7 Emergency exits

Emergency exits should be inspected prior to maintenance work on electrical equipment and should be kept clear.

8 Fire extinguishing equipment

All personnel carrying out maintenance on equipment when there is a fire risk should have available some means for fire fighting, either by appliances permanently in the premises or by appliances provided during the period of work, and should be trained in the use of such appliances and know how to summon skilled help.

The type of fire extinguishing equipment provided for use on electrical equipment should be compatible with the equipment and not dangerous to use in the situation, e.g. water fire extinguishers are not generally suitable for use on oil fires and can also be a shock hazard if the electrical equipment has not been isolated before the extinguishers are used. Water may also cause further damage to the equipment. Fire fighting equipment should be maintained regularly to the manufacturer's instructions. The equipment should be labelled, installed and maintained in accordance with BS 5306.

Where automatic fire extinguishing installations are provided this fact should be prominently indicated by a notice outside the room, which should also show the procedure to cancel the automatic feature. Where necessary, procedures should be used to safeguard personnel against danger when entering rooms fitted with automatic fire extinguishing equipment, or when in rooms in which fire extinguishing equipment has operated.

9 First aid

A notice giving instructions for the treatment of persons suffering from electric shock should be affixed in a prominent position in the vicinity in which work on electrical installations will be carried out. First aid equipment should be available for the treatment of personnel. The address and telephone number of the nearest doctor, first aid centre or hospital should also be prominently displayed.

It is strongly recommended that all electrical maintenance personnel be trained in the application of resuscitation and know how to summon medical help.

10 Lighting

Adequate lighting either fixed, portable, or a combination of both, should be provided as necessary to ensure safe access and working.

11 Instructions, notices and labels

Established safety rules should be issued or available to all persons operating or working on electrical switchgear and controlgear. Such persons should be familiar with the method of operation, and with the safety precautions established for the premises.

Instructions for the treatment of persons suffering from electric shock should be displayed. A notice indicating the action to be taken in the event of fire should be displayed. In premises subject to the requirements of the Factories Act 1961, a copy of the relevant statutory regulations is to be displayed and any person working with electrical equipment should have a copy of these regulations available to him. A diagram of the electrical apparatus and relevant protection details of the installation should be available.

Adequate quantities of safety locks together with caution notices should be available for immediate use to facilitate safe working and prevent conductors from being accidentally or inadvertently electrically charged when persons are working thereon. Danger notices to warn of the presence of live conductors should also be available for immediate use.

Essential labels should be legible, prominently displayed, made from durable material and maintained up-to-date.

Emergency exits should be clearly labelled as such inside and outside.

12 Access

Where the enclosure (cubicle or room) of electrical equipment is designed to prevent unauthorized access and interference by unauthorized persons, inspections should be made to see that security and IP degree of protection (see BS 5420) is maintained.

Working space and access ways provided to apparatus and equipment that is to be worked upon or operated should be properly maintained and kept free from obstruction. When equipment is located in a general work area special attention should be paid to preventing damage, or access by unqualified personnel, whilst covers are open.

Spare parts, tools and instruments associated with the equipment installed should be housed in proper receptacles provided for the purpose, access to which should not be impeded by articles unrelated to nearby electrical installations.

Portable ladders etc. should be of non-conducting material.

13 Isolation before maintenance work (see also Appendix A)

Whenever it is possible to do so, equipment should be isolated before maintenance work commences.

Isolation procedures should ensure that:

- a) accidental or inadvertent re-energization is prevented;

- b) the equipment is proved dead using a suitable voltage indicator.

NOTE In mines and quarries isolation and making dead is a mandatory requirement except where stated otherwise in the relevant regulations.

Special attention should be paid to the following.

- 1) Where provision is made for so doing, the disconnectors should be locked in the OFF position and/or caution notices should be exhibited at the points of isolation.
Any shutters covering live or potentially live isolating contacts should be locked closed or other precautions taken to ensure safety.
- 2) Removal and retention of fuse links or bolted links should only be used as a means of isolation when adequate precautions are taken to prevent duplicates being inserted.
- 3) Contactors should never be considered as a means of isolation.
- 4) Reliance should never be placed on control circuit isolation, switching or electrical interlocks to prevent accidental or inadvertent re-energization of the main or other auxiliary circuits.
- 5) As it is not always possible to observe the contacts of a device used as a disconnector, the operation of an external handle or control should not be assumed to have opened all or any of the contacts as cases of mechanical failure have been known to occur. In particular this may happen when a handle is operated against a mechanical interlock. Tests using suitably designed voltage indicators should be carried out prior to maintenance. These should include tests between phases and to earth to guard against the possibility of wrong connection. Voltage indicators should always be proved before and after use.
- 6) Equipment enclosures frequently contain circuits having some sources of supply different from those of the main circuits. Examples of these are alarm and sequence interlocks, heating and lighting circuits, battery supplies etc. Such circuits are not always isolated when the main disconnector is in the OFF position. These should be shrouded to prevent inadvertent contact and identified with warning notices and isolation details. Particular care should be taken to avoid danger from reverse energization of voltage/control transformers or the open circuiting of current transformer secondaries.

- 7) Where one person isolates and another does the work, the person responsible for isolating should demonstrate effectively to the other that the equipment is in fact dead and safe and that there are adequate safeguards to prevent re-energization.

14 Observing and working on live equipment

In view of the risk of accident and the severity of injuries that can occur due to electric shock and burns associated with accidents during observation and work on or near live equipment, such activities should not be undertaken unless there is good and adequate reason. Where it is decided that there is an adequate justification for observation or work to proceed while the conductors are live, special precautions need to be observed. These precautions should include the provision of written guidance.

The special precautions to be observed will depend on the design of the equipment and the nature of the task, which should be performed only by a person who is competent to do so. The procedure to be adopted, the precautions to be observed and whether the competent person is to be accompanied, should be made known to the person before work is commenced. Where accompaniment is required, the accompanying person should know how to protect his own safety and what action to take in case of an accident.

NOTE Observation and work on live equipment with covers removed is not generally permitted in mines and quarries.

15 Avoidance of contamination

The ingress of moisture, dust, vermin, etc. into electrical equipment can cause malfunction and danger. During all maintenance operations an inspection should be carried out for evidence of these, including after a period out of service or changes in ambient or load conditions, and if these are observed, suitable remedial action and precautions against recurrence should be taken.

16 Insulating equipment

Permanent and/or portable insulating stands or screens, insulated tools and insulating gloves should be provided and used where necessary. All these items should be maintained in sound condition and periodically inspected.

The person responsible for the maintenance task should verify, prior to use, that all these items and any test equipment needed are suitable and serviceable.

17 Earthing equipment

Earthing equipment, where required, should always be readily available and maintained in good working order.

18 Voltage indicators

Commercially available voltage indicators should be used and, when deciding on the suitability of a particular type, consideration should be given to the range of voltages of the indicator and the fault level of the system on which it will be utilized. The fault protection of the indicator should be as close as possible to the point from which the measurements are to be taken (see also item 5) of clause 13).

19 Capacitively stored electrical energy

Equipment containing or connected to capacitance (e.g. cables, capacitors) should receive special attention to ensure voltages are not present and cannot develop (see the warning note in clause 54).

20 Associated plant

Care should be taken when function testing controlgear that danger is not caused by inadvertently starting (or stopping) machines and processes with which that controlgear is associated. It may be necessary to disconnect mechanically motors, valves, etc. If the machinery or process requires special knowledge, it may be necessary to involve appropriate personnel in function testing.

21 Portable electric tools and lamps

Portable electric tools and inspection lamps should be operated on low voltage. System voltages not greater than 110 V with either the star point of three-phase or the mid point of single-phase transformer low voltage winding earthed are recommended. In confined conducting spaces, apparatus on 25 V to earth or lower should be used. Where mains voltage portable tools are used, they should be of all-insulated or double-insulated construction. Reference should be made to BS 2769 in relevant instructions. The use of trailing cables should be minimized and any such cable should be of adequate construction and efficiently protected. Cable connectors should be designed for the environment in which they are operating. All portable electrical equipment should be regularly inspected and tested. It is a good practice for the user to inspect portable electrical equipment before each occasion of use.

22 Containment of faults

The maintenance of electrical equipment should include inspection of any fire resisting barriers or seals provided on cable access points and any other provision made to prevent the passage of flame, smoke, gas or liquid.

23 Testing

23.1 General. Care should be used when applying test voltages to ensure that these are the lowest value required for the purpose with the minimum current output. Where equipment is capable of storing a charge this should be safely discharged after every test.

NOTE 1 Further advice on electrical testing is available; one such publication is Health and Safety Series Booklet No. HSG(13) "Electrical Testing" available from HM Stationery Office.

NOTE 2 Electrical equipment may be damaged by the application of test voltages and currents of incorrect value and polarity. Some electronic equipment is particularly vulnerable. (See clause 54.)

23.2 Use of test instruments

(oscilloscopes etc.). Instruments should be of a type suitable for the measurements that are to be made so that a malfunction or the introduction of transients and/or reversed polarities into the connected circuits is avoided. The manufacturer's instructions should be observed.

An earthed instrument lead may create danger if it is applied to an active signal circuit that is normally floating. It is recommended that the instrument casings are earthed at all times but, where the nature of test precludes this, specific care should be taken by the operator to secure his own safety and that of others by the adoption of a safe system of work. It is recommended that suitably protected test leads be used at all times.

24 Disposal of scrap

Care is needed in the disposal of removed items or materials since some give rise to danger unless properly handled. In case of doubt, reference should be made to the manufacturer's instructions or the relevant enforcing authority.

It is particularly recommended that every care be taken to prevent re-use of defective or potentially defective parts. This requirement should be included in relevant safety rules and indicated on the appropriate labels for containers of scrap material or defective parts.