

BS 6423:2014



BSI Standards Publication

Code of practice for maintenance of low-voltage switchgear and controlgear

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Documents

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 November 2014. It was prepared by Technical Committee PEL/17/3, *Low-voltage switchgear and controlgear assemblies* under the authority of Technical Committee PEL/17, *Switchgear, controlgear, and HV-LV co-ordination*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This British Standard supersedes BS 6423:1983, which is withdrawn.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- The structure has been revised to include separate clauses on preventive maintenance, corrective maintenance and post-fault maintenance.
- A new clause on fitness for purpose assessment and corrective actions has been added.
- A new clause on device substitution has been added.

The purpose of this standard is to provide guidance on the maintenance of low-voltage switchgear and controlgear where technical knowledge and experience are important in ensuring equipment is kept in an acceptable condition. It is intended to be suitable for people involved in all stages of the maintenance process, including those responsible for instigating work, establishing procedures for undertaking work and those actually completing the maintenance work. It also provides guidance on replacing devices within assemblies and on the administrative process required to achieve a successful outcome. It is strongly recommended that this standard is used, together with specific manufacturer's instructions, to develop a coherent maintenance strategy.

The normally quiescent state of electrical switchgear and controlgear does not automatically draw attention to incipient faults, deterioration or the potential danger that can result from neglect. The need for maintenance is often overlooked. An organized system of preventive maintenance will facilitate continued safe and acceptable operation of an electrical system with the minimum risk of breakdown and consequent interruption of supply.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard gives recommendations and guidance for the maintenance of low-voltage switchgear and controlgear having a rated voltage up to and including 1 000 V a.c. or 1 500 V d.c.

This standard is applicable to stationary and movable switchgear and controlgear with or without an enclosure. It is also applicable to switchgear and controlgear for use under special service conditions, possibly with additional recommendations, for example in ships and rail vehicles.

This standard also gives recommendations on safety precautions for personnel carrying out maintenance. Guidance on the levels of maintenance necessary for and also procedures for the maintenance of the principal components within equipment is included. Guidance is also given on the assessment of the on-going suitability of equipment.

It also gives recommendations on the direct replacement of parts and, where this is not possible, guidance on device substitution.

This standard is not applicable to switchgear and controlgear used in potentially explosive atmospheres.

NOTE Inspection and maintenance of electrical apparatus in explosive gas atmospheres is covered in BS EN 60079-17.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7671:2008+A2:2013, *Requirements for electrical installations – IET Wiring Regulations. Seventeenth edition*

BS EN 60422, *Mineral insulating oils in electrical equipment – Supervision and maintenance guidance*

BS EN 60947-4-1:2010+A1:2012, *Low-voltage switchgear and controlgear – Part 4: Contactors and motor starters. Section 1: Electromechanical contactors and motorstarters*

BS EN 61439-1:2011, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

BS EN 61439-2:2011, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

BS EN 61439-3, *Low-voltage switchgear and controlgear assemblies – Part 3: Distribution boards intended to be operated by ordinary persons (DBO)*

BS EN 61439-4, *Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)*

BS EN 61439-5, *Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks*

BS EN 61439-6, *Low-voltage switchgear and controlgear assemblies – Part 6: Busbar trunking systems (busways)*

IEC 60050-441:1984, *International Electrotechnical Vocabulary – Part 441: Switchgear, controlgear and fuses*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 switchgear and controlgear

general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures

[IEC 60050-441:1984; 441-11-01]

3.2 switchgear

general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, 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 energy

[IEC 60050-441:1984; 441-11-02]

3.3 controlgear

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

[IEC 60050-441:1984; 441-11-03]

3.4 low-voltage switchgear and controlgear assembly

combination of one or more low-voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, with all the internal electrical and mechanical interconnections and structural parts

[BS EN 61439-1:2011]

3.5 equipment

low-voltage switchgear, controlgear and switchgear and controlgear assemblies

3.6 item

any part of the equipment that can be individually considered

3.7 maintenance

combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

3.8 preventive maintenance

maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item

NOTE Also known in the industry as preventative maintenance.

3.9 corrective maintenance

maintenance carried out, after recognition of a failure, which intends to put an item into a state in which it can perform its required function

3.10 post-fault maintenance

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

3.11 predictive maintenance

maintenance activity used to anticipate failures and allow corrective actions to be implemented on a planned basis

3.12 inspection

maintenance action comprising careful scrutiny of equipment or an item carried out without dismantling, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of an item

3.13 examination

maintenance action comprising careful scrutiny of equipment or an item carried out with the addition of partial dismantling as required, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of an item

3.14 overhaul

maintenance of an item including examination and replacement or rebuilding

NOTE Overhaul can be categorized as:

- a) *minor overhaul or servicing that is limited to lubrication and/or replacement of consumables;*
- b) *major overhaul that includes major dismantling and/or replacement of items.*

3.15 operational check

inspection and/or operational test carried out to determine whether an item functions correctly

3.16 failure

termination of the ability of the equipment or an item to perform its required function

NOTE Failure can be gradual, sudden, partial or complete.

3.17 duty holder

person who is responsible for the organisation, control or execution of maintenance activities on equipment

NOTE 1 Attention is drawn to the Electricity at Work Regulations [1] which place certain legal obligations on a 'duty holder'.

NOTE 2 Elements of this responsibility may be delegated to others as required.

3.18 instructed person

a person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create

[BS 7671:2008+A2:2013]

3.19 skilled person

a person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create

[BS 7671:2008+A2:2013]

3.20 competent person

a person who possesses sufficient technical knowledge, relevant practical skills and experience for the nature of the electrical work undertaken and is able at all times to prevent danger and, where appropriate, injury to him/herself and others

NOTE Several years of practice in the relevant technical field may be taken into consideration in assessment of professional training.

[BS 7671:2008+A2:2013]

4 Safety

NOTE Attention is drawn to the Electricity at Work Regulations 1989 [1], the Work at Height Regulations 2005 (as amended) [2], and the Manual Handling Operations Regulations 1992 [3]. See also BS EN 50110-1 and BS EN 50110-2.

4.1 Appropriate skill level for maintenance

The duty holder should put in place a system to ensure that maintenance tasks are carried out by people with the appropriate level of competency, i.e. by instructed persons (see 3.18), skilled persons (see 3.19) or competent persons (see 3.20), as applicable.

4.2 Rules and procedures for establishing a safe working environment

NOTE 1 Attention is drawn to the Management of Health and Safety at Work Regulations 1999 [4], which require risk assessment.

A risk assessment should be carried out prior to commencing work.

For maintenance activities on equipment there should be a written system of rules and procedures. Everybody involved with maintenance activities should be aware of their existence. The level of detail and complexity of the rules and procedures should be dependent on the organisation, personnel, working environment and equipment in use.

The risk assessment process should be used to ensure that hazards specific to maintenance activities have been adequately addressed in the development of the associated rules and procedures. For example, different working practices and competencies are required for work on d.c. systems than are required for a.c. systems.

NOTE 2 Different systems of work might be required for older equipment where equipment within a compartment might not be protected to Level IP2X, in accordance with BS EN 60529, and so present an increased risk of accidental contact with live parts.

Safety rules should set out the principles and practices expected clearly and in a format that can be understood by those expected to use them.

The rules and procedures should reflect the requirements of an overall electrical safety policy. In most circumstances a policy for work on electrical equipment requires equipment to be isolated and proven dead prior to work commencing. Safety rules might need to address specific issues such as circuits associated with:

- interlocked supplies;
- auto-reclosing devices;
- alternative supplies, including generators;
- mechanically stored energy;
- capacitively stored energy;

- battery supplies;
- photo-voltaic (PV) generator; and/or
- control supplies (a.c. and d.c.).

All personnel should be made aware of the need to take notice of warning signs and follow instructions provided by the equipment manufacturer.

NOTE 3 Factors that affect the safe operation of equipment might change during the life of an installation. The rules and procedures should be reviewed regularly and revised when necessary.

NOTE 4 Attention is drawn to the Management of Health and Safety at Work Regulations 1999 [4], which require that risk assessments are reviewed if there has been a significant change to the hazards associated with the equipment.

Where there are significant risks or where the control measures necessary for safety are complex or require careful co-ordination, it might be appropriate to use a Permit to Work system.

NOTE 5 For guidance on permit to work systems see HSG 85 [5].

4.3 Emergency exits

Emergency exits should be checked prior to carrying out maintenance work to ensure that they are clear.

4.4 Fire extinguishing equipment

When carrying out maintenance on equipment where there is a fire risk, fire-fighting equipment should be available. Training should be provided in the use of such appliances and people made aware of the limitations of their use. People should be made aware of how to raise the alarm and summon 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.

Where automatic fire extinguishing installations are provided, systems should be in place to safeguard people against danger from the extinguishing medium when entering the protected area.

Where maintenance is planned on electrical switchgear or controlgear connected to the electrical supply to the fire-fighting installation, attention should be paid to the possible impact of that maintenance on the availability of the fire-fighting equipment. Where necessary, additional fire-fighting equipment should be provided.

4.5 First aid

Rapid action can save life in the event of electric shock. A person working in the vicinity of exposed live parts should normally be accompanied by someone who has the necessary competence to avoid injury and sufficient knowledge to be able to disconnect the supply. People carrying out maintenance should be aware of how to obtain assistance and who to contact in the event of an emergency.

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. The training of electrical maintenance personnel or those who might accompany them in resuscitation is recommended.

NOTE A poster Electric shock: First Aid Procedures [6] is available from the Health and Safety Executive.

Arrangements should be in place to ensure immediate attention is available in the event that someone is taken ill or injured at work. As a minimum a suitably stocked first aid kit should be available. It is important that the arrangements for seeking assistance or calling the emergency services are understood.

4.6 Lighting

Lighting should be provided to ensure safe access and working. Temporary lighting, either battery powered or from generators, should be provided where normal supplies are not available.

4.7 Access

Working space and access ways should be kept free from obstruction. Particular consideration should be given where there may be exposed live conductors within the work environment. There should be space to allow people to move away from the conductors without hazard and if necessary for people to pass one another.

Where equipment to be worked on is located in a general work area, special attention should be paid to preventing access by unqualified personnel, especially whilst covers are open.

4.8 Isolation before and during maintenance work

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) equipment is proved dead using a suitable voltage indicator.

Any switch, disconnect or other device used to provide disconnection should be secured. The use of "safety locks" i.e. a lock having a unique key controlled by those undertaking the work should be used to secure the point of disconnection. A notice or label should be applied at the place of isolation to inform others who might also be performing maintenance work that someone is working on the equipment.

The following recommendations should be followed.

- 1) Disconnectors should be intended for isolation.
NOTE Appropriate isolators are usually marked in accordance with BS EN 60947-1:2007+A1:2011, 5.2.
- 2) Where provision is made for so doing, disconnectors should be locked in the OFF position and/or caution notices should be exhibited at the points of isolation.
- 3) Where possible, devices with earthing facilities should be placed in EARTH position and locked.
- 4) Any shutters covering live or potentially live isolating contacts should be locked closed or other precautions taken to ensure safety.
- 5) Safety locks should be used and a system put in place to ensure that locks and notices are available and that the keys to locks in use are controlled.
- 6) Removal and retention of fuse links or bolted links should only be used as a means of isolation when precautions have been taken to prevent duplicates being inserted.
- 7) Contactors should never be considered as a means of isolation.
- 8) 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, i.e. emergency stops.

- 9) It is not always possible to observe the contacts of a device used as a disconnecter and the operation of an external handle or control should not be assumed to have opened all contacts of the connected device. Tests using voltage indicator should be carried out prior to working on any equipment made dead. These should include tests between phases and to earth to guard against the possibility of wrong connection. Voltage indicators should be proved before and after use. See HSE Guidance Note GS 38 *Electrical test equipment for use by electricians for suitable types of voltage proving instruments* [7].
- 10) Equipment enclosures might contain circuits having sources of supply different from those of the main circuits. Examples include alarm and sequence interlocks, heating and lighting circuits, battery supplies etc. Such circuits are not always isolated when the main disconnecter is in the OFF position. These should be identified with warning notices and ideally shrouded to prevent inadvertent contact. Particular care should be taken to avoid danger from reverse energization of voltage/control transformers or the open circuiting of current transformer secondaries.

4.9 Working on live equipment

The increased risk of accident and the severity of injuries that can occur due to electric shock and burns when undertaking work on or near live equipment are such that live working should rarely be permitted.

NOTE 1 Attention is drawn to Regulation 14 of the Electricity at work Regulations 1989 [1].

Where it is decided that it is unreasonable for equipment to be made dead, special precautions need to be observed. The special precautions depend on the design of the equipment, the nature of the task and the outcome of a risk assessment. The person carrying out the work should be competent to do so. The level of supervision required and the need for accompaniment should be taken into account.

NOTE 2 Further guidance can be found in HSE publication HSG85 Electricity at work. Safe working practices [5].

4.10 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.

4.11 Earthing equipment

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

4.12 Stored electrical energy

Measures should be taken to discharge sources of stored energy, such as cables or capacitors and to ensure that they do not become charged during the execution of maintenance work. Suitably designed equipment should be used to discharge stored energy. Earth leads might be required to prevent charge accumulating during the work activity.

4.13 Associated plant

When performing functional testing on switchgear and controlgear care should be taken to ensure that danger is not caused by energizing the connected load. It might be necessary to disconnect motors or other items of mechanical plant before testing the functionality of the control equipment. Advice should be sought from the plant operator.

4.14 Portable electric tools and lamps

Portable electric tools and inspection lamps should be operated at extra-low-voltage. System voltages not greater than 110 V with either the star point of three phase or the midpoint of single phase transformer earthed are recommended. In confined conducting spaces, apparatus with an operational voltage of 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 and protected by a residual current device with an operating current not exceeding 30mA and an operating time not exceeding 40ms at a residual current of five times the operating current.

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.

4.15 Testing

CAUTION. Electrical equipment can be damaged by the application of test voltages and currents. Some electronic equipment is particularly vulnerable.

Care should be taken 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 Further advice on electrical testing is given in Health and Safety General Guidance Leaflet INDG 354 Safety in electrical testing at work available from the Health and Safety Executive [8].

4.16 Use of test instruments

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 followed.

An earthed instrument lead can 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 their own safety and that of others by the adoption of a safe system of work. Suitably protected test leads should be used at all times.

The calibration of all measuring instruments used for preventive maintenance should be traceable to national or international standards of measurement which, in the UK, are the responsibility of the National Physical Laboratory (NPL).

NOTE Calibration laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting calibration laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.