

Guidance Notes on Safety at Work for Maintenance of Low Voltage Electrical Switchgears



This Guidance Notes is prepared by
the Occupational Safety and Health Branch,
Labour Department

This edition July 2004

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Table of Contents

1. Introduction	2
2. Duties of Proprietors and Workers	4
3. Hazards and Risk Assessment	6
4. General Safety Issues	9
5. Safety Before Work	14
6. Safety During Work	15
7. Safety After Completion of Work	16
8. Emergency Preparedness	17
9. Information, Instruction and Training	18
Useful information	21

1. Introduction

- 1.1 Proper maintenance of low voltage electrical switchgears ("electrical switchgear") is essential in preventing the equipment failures that cause interruption of power supply to customers and users. However the maintenance work itself, if not done properly and in a safe manner, may lead to accidents causing serious bodily injuries or even deaths to the workers.
- 1.2 Without implementing and following a safe system of work, workers engaged in electrical switchgear maintenance work are vulnerable to various safety and health hazards.
- 1.3 This Guidance Notes is intended to provide general practical guidance to electrical contractors, electrical workers, supervisors and other workers engaged in electrical switchgear maintenance work to carry out the work in a safe and healthy manner. Proprietors should note that the work task, working environment and working constraints etc. may vary from time to time. They should therefore make use of this Guidance Notes to develop their own safe systems of work that best suits the specific work tasks and work conditions.
- 1.4 Readers' attention is also drawn to the relevant legislative requirements under the provisions of the Occupational Safety and Health Ordinance (Cap. 509) and Factories and Industrial Undertakings Ordinance (Cap. 59) and their subsidiary regulations, in particular the Factories and Industrial Undertakings (Electricity) Regulations (Cap. 59W), administered by the Labour Department. Readers should also pay attention to the requirements of the Electricity Ordinance (Cap. 406) and the subsidiary regulations administered by and the Code of Practice for the Electricity (Wiring) Regulations issued by the Electrical and Mechanical Services Department.
- 1.5 This Guidance Notes covers the maintenance work of low voltage electrical switchgears. For high voltage installations, it involves much more stringent safety requirements due to the higher operating voltage of the installations and will not be covered in this Guidance Notes.

Remark:

"extra low voltage" (特低壓)

- means any voltage not exceeding 50 volts alternating current or 120 volts direct current whether between conductors or to earth.

"high voltage" (高壓)

- means any voltage normally exceeding low voltage.

"low voltage" (低壓)

- means any voltage normally exceeding extra low voltage but not exceeding 1000 volts alternating current or 1500 volts direct current between conductors or 600 volts alternating current or 900 volts direct current between conductors and earth.

2. Duties of Proprietors and Workers

Overview

- 2.1 Securing the safety and health at work for the electrical switchgear maintenance work requires the full commitment and co-operation of everyone concerned, from the proprietors to the workers.

Duties of proprietor

- 2.2 It is the duty of every proprietor to ensure, so far as is reasonably practicable, the safety and health at work of all workers. The proprietor, including contractor should demonstrate the commitment in managing safety and health and bear the final responsibility and accountability for the safety and health in the workplace.
- 2.3 The duties of a proprietor include, but not limited to, the following:
- (a) to manage safety and health in the workplace, and to provide the necessary resources;
 - (b) to ensure that the responsibilities for managing safety and health are appropriately assigned, and the duties are effectively carried out by the staff concerned;
 - (c) to assess the risk at work, and to establish appropriate safety measures for the work;
 - (d) to provide suitable and safe plant and equipment for the work, and to ensure that the plant and equipment are regularly checked and properly maintained;
 - (e) to establish safety rules and safe working procedures for the work;
 - (f) to provide necessary information, instructions and training to the workers and to ensure that they follow the safety rules and safe working procedures at work strictly;
 - (g) to ensure that only electrical contractors registered under the Electricity Ordinance (Cap. 406) are appointed to carry out any electrical work;

- (h) to ensure that only workers who are qualified and, by reason of their knowledge, training and practical experience, competent, e.g. registered electrical workers, are selected to carry out electrical work. In assessing the qualification and competence of a worker, reference should be made to the legislative requirement under the Electricity Ordinance (Cap. 406); and
 - (i) to establish emergency response plans and conduct drills regularly.
- 2.4 The proprietor often employs management personnel such as managers, engineers, safety personnel, foremen or supervisors to act on his behalf for managing safety and health in the workplace. The management personnel should effectively discharge their supervisory and management duties to ensure the safety and health at work of the workers. In this regard, the authority and responsibility of each management personnel should be precisely set out and made known to all persons concerned.

Duties of Workers

- 2.5 Workers are required to take reasonable care for the safety and health of themselves and of others who may be affected by their acts or omissions at work. They are also required to co-operate with their proprietors or the management personnel so far as is necessary to enable them to comply with the legal duties imposed on them.
- 2.6 The duties of a worker include, but not limited to, the following:
- (a) to understand and act in accordance with the safety rules, safe working procedures and emergency response plan;
 - (b) to make full use of the safety equipment and personal protective equipment provided, and to report any equipment defect to the management/ supervisor immediately;
 - (c) to provide feedback to the management/supervisor on the effectiveness of safety measures, safe working procedures and emergency response plans; and
 - (d) to report to the management/ supervisor all hazards observed, defects identified or accidents incurred at work.

3. Hazards and Risk Assessment

The hazards

3.1 The hazards in electrical switchgear maintenance work can be broadly grouped into the following major categories:

- (a) Electrical shock hazards;
- (b) Fire and explosion hazards; and
- (c) Other related hazards.

3.2 **Electrical shock hazards:**

- (a) The workers are vulnerable to electric shock hazard whilst working on the conductive parts of the electrical switchgear which has not been properly isolated from the power source. Electric shock hazard also arises from the improper application of high voltage test on the electrical switchgear.
- (b) Electric shock can cause serious injury or even death to the worker due to cardiac arrest, respiratory arrest or body burn.

3.3 **Fire and explosion hazards:**

- (a) Fire and explosion in electrical switchgear maintenance work can be caused by accidental short-circuit of live parts and earthed parts by, say, metal hand tools, substandard testing equipment, loosen parts detached or foreign objects left inside the switchgear after work.
- (b) Fire and explosion of the switchgear can cause serious injury or even death to the workers due to severe body burn caused by the hot gas mass or molten metal, inhalation of smoke caused by the fire or eye injury caused by the intensive light and ultra-violet radiation generated by electric arcing.

3.4 **Other related hazards:**

There are other hazards that relate to electrical switchgear maintenance work. These include, but not limited to, the following:

- (a) hazards related to the falling from height of workers when working on electrical switchgear installed at high levels;

- (b) tripping hazards due to tangling of electric wires of portable tools or loose hand tools placed on the floor; and
- (c) musculoskeletal problems resulting from manual handling of heavy objects such as air circuit breakers or prolonged periods of awkward postures.

Risk assessment

- 3.5 Risk assessment in electrical switchgear maintenance work is an evaluation process to assess the likelihood of causing harms by the hazards mentioned in Sections 3.1 to 3.4 and the severity of those harms. This provides the necessary information for establishing the appropriate safety measures, safe working procedures and emergency response procedures before commencing the maintenance work. The scale and depth of the risk assessment depend on the working environment and the complexity of the work.
- 3.6 The basic steps in risk assessment include the following:
- (a) to identify the hazards;
 - (b) to consider who may be affected and how;
 - (c) to evaluate the risks arising from the hazards, and to consider whether the existing safety measures are adequate or more should be done;
 - (d) to record the findings; and
 - (e) to review the assessment from time to time and to revise if necessary.
- 3.7 Risk assessment should be specific to the required task. Factors to be considered in assessing risks associated with electrical switchgear maintenance work include, but not limited to, the following:
- (a) the type of electrical switchgear to work on;
 - (b) the type of work to be carried out;
 - (c) whether the electrical switchgear to work on is isolated, energised or partially energised;

- (d) the working environment, including
 - (i) whether access to and egress from the workplace are safe, suitable and adequate;
 - (ii) whether lighting and ventilation of the workplace are sufficient and suitable;
 - (iii) whether the workplace is congested or restrictive;
 - (iv) whether working at height is necessary;
 - (v) whether there are combustible/flammable materials nearby;
 - (vi) whether the workplace is hot, damp, dusty or the environment is corrosive, etc; and
- (e) The strength of the working team and the competence of team members.

- 3.8 The risk assessment should be conducted by a competent person with the appropriate knowledge, experience and relevant training to enable him to assess the risks arising from the work. The person should have good understanding of the work as well as good knowledge of the safe practices and safety measures required.
- 3.9 Risk assessment should be reviewed regularly. Whenever there has been a significant change in the working conditions, working environment or the particulars of the work, risk assessment should be re-conducted.

4. General Safety Issues

- 4.1 Failure to suitably and adequately plan for the work ahead is the cause of many electrical accidents. Adequate information, including manufacturer's manuals and diagrams about the electrical switchgear, should be made available to facilitate the planning and development of a safe system of work for the electrical switchgear maintenance work.
- 4.2 The system of work should include a set of safety rules and procedures commensurate with the type of electrical switchgears to work on and the maintenance work to be carried out. The safety rules or procedures may also incorporate a 'permit-to-work' system. The established safety rules or procedures should be made available to all workers engaged in the maintenance work. It has also to ensure that they do understand and follow the rules and procedures at work.
- 4.3 The appropriate engineering controls and administrative controls should be taken to ensure that the work is safe and without risk to health. Any electricity sources, including the mains power supply, temporary power supply and backup power supply, if any, should be fully isolated before the commencement and during the course of work.
- 4.4 The workers and their supervisors, the building management and the users should be well informed ahead of any scheduled interruption of power supply to facilitate the maintenance work.
- 4.5 Accidents usually happen when workers are in a hurry. Therefore, notwithstanding that there is usually a pressing need to resume power supply to the users, do allow sufficient time for the workers to carry out the maintenance work. When compared with in-house staff, external contractor and workers should be allowed more time for the work as they are less familiar with the working environment and the switchgear to work on.
- 4.6 It has to ensure that the workers are always physically fit for the work. One may become tired and hard to concentrate when working overnight or after a prolonged period of work. Breaks should be allowed for the workers to take sufficient rests.

- 4.7 It may be required to carry out pre-inspection/checking at site in the planning of work. That is particularly important for old installations where diagrams, drawings and manuals of the installations may not be available.
- 4.8 Only workers who have received proper training and have the relevant knowledge, experience and understand the safety rules and procedures should be assigned to carry out the maintenance work. It has to ensure that all workers always comply with the safety rules or procedures strictly at work.
- 4.9 The workers should be supplied with tools, materials and equipment suitable for the work, and other necessary information as laid down in the safety rules and procedures. Suitable safety equipment such as insulated tools, insulation mats, insulation stands etc., should be provided and used in exceptional situation where not the whole switchgear/switchboard is isolated for work.
- 4.10 Sufficient working space should be allowed. Furthermore access ways should be properly maintained and kept free from obstructions.
- 4.11 There should be effective communication amongst the workers and clear order of command at work to prevent accidents. The supervisor should carry out regular checks on the work to ensure that the workers adhere to the laid-down safety rules or procedures. If non-registered electrical workers are employed, they should be continuously under the direct and close supervision of registered electrical workers and the supervisor.
- 4.12 Good housekeeping in the workplace is important in preventing accidents. Loose materials or tools should be placed in boxes or proper containers instead of leaving on the floor freely.
- 4.13 The workplace should always be dry and clean. The switchroom and meter room should not be used as a storeroom.
- 4.14 Adequate and suitable lighting should be provided and maintained for illumination of the workplace and the equipment to work on.
- 4.15 Suitable and adequate ventilation of the workplace should also be provided and maintained.

- 4.16 The temporary power supply provided for lighting and the work should be proper and safe. If diesel generator is used to provide temporary electricity supply for the workplace, the generator should be placed in a well-ventilated place where the engine exhaust gas could be properly dispersed. The power extension cables should be properly placed to avoid damage or tripping hazard. The power socket circuit should be completed with a residual current device of 30 mA tripping current.
- 4.17 Suitable and adequate fire extinguishers should be made available. It should be noted that water type fire extinguisher is not suitable for an electric fire. Carbon dioxide or dry power type fire extinguisher should be used instead.
- 4.18 Cleaning is a common task in the maintenance of electrical switchgear/switchboard. Non-flammable and non-toxic solvents and materials should be chosen for the work. Otherwise, suitable and adequate precautions, including the provision and use of suitable personal protective equipment, against fire and toxic effects caused by the solvents/materials should be taken.
- 4.19 Where practicable, work on low voltage electrical switchgear should be carried out only after the electrical switchgear has been properly isolated, locked out and verified dead by suitable testing equipment or voltage indicator. Before using the testing equipment and voltage indicator, they should be checked first to verify that they operate properly.
- 4.20 For main electrical switchboards, it should be noted that switching off the main switch or the main circuit breaker could isolate only the load side of switch, e.g. the main busbar and the downstream circuits, whereas the source side of switch is still energised. The workers would be vulnerable to electric shock hazard when they work on or in the vicinity of the source side of the main switch. In that respect, one should as far as reasonably practicable, make prior arrangement with the power company to isolate the mains power supply connected to the main switchboard so as to render dead the whole switchboard including the source side of the main switch. It is not warranted to omit this step just for saving of time or convenience.

- 4.21 Control fuses should be removed too to isolate also the control circuit of the electrical switchgear/switchboard.
- 4.22 For some electrical installations, there are emergency generators or uninterrupted power supply system (UPS) used as backup power supply source. One has also to safely isolate and lock off those generators and UPS to render the electrical switchgear dead before working on it.
- 4.23 Where serious inconvenience would arise from isolating circuits, adequate precautions should be taken to avoid danger from work involving the handling of energised parts or working within touchable distance, direct or indirect, of energised parts at low voltage. The following precautions are to be taken:
- (a) work on energised low voltage equipment should be done only by registered electrical workers, or in their presence, who has been authorized by the responsible person for such work;
 - (b) screen or other means to avoid danger from inadvertent contact with energised conductors should be provided; and
 - (c) fixing warning notices for repair, barriers and screens.
- 4.24 Where danger cannot be avoided for working on energised equipment the electrical equipment should be isolated and verified dead with a suitable testing equipment or voltage indicator; a permit-to-work should be issued.
- 4.25 Where work is to be done on dead low voltage electrical equipment controlled by a circuit breaker or switch, the circuit breaker or switch should be locked off where practicable and a warning notice for repair affixed. The keys for locks used to lock off circuit breaker or switch should be kept under the control of a responsible person.
- 4.26 In case there is any unavoidable live work, it should minimize the duration and extension of the live work to minimize the risk the workers exposed to. Once the unavoidable live work is finished, the involved electric circuit should be isolated and verified dead and with the power supply locked out before proceeding with the remaining work.

4.27 A permit-to-work system should be adopted in situations where the risk at work is to be properly controlled. Typical situations include, but not limited to, the following:

- (a) the nature of work is complicated;
- (b) the scope of work is wide; or
- (c) there are energised parts in the switchgear/switchboard when the work is carried out.

5. Safety Before Work

- 5.1 Prior to the commencement of work, an on-site briefing should be provided to all the workers so that everyone understands the overall scope of work to be done, the works programme, job duties of the individuals, special points to note, the safety rules or procedures, etc. Preferably there should be a briefing form containing all the items briefed and it should be signed by all workers attended the briefing session.
- 5.2 Before start working, it should check that the working environment is safe, e.g. the ingress/egress paths are clear, lighting and ventilation are in order, fire fighting appliances are available, etc.
- 5.3 When the work starts, the electrical switchgear to work on should first be isolated and proved dead according to the laid-down safety rules or procedures. The relevant switch/isolator should also be locked out, or if it is unlockable, be properly fenced off, so that the power supply will not be restored inadvertently. A suitable warning notice should also be attached to or placed close to the switch/isolator.
- 5.4 Before working on the conductive parts of an electrical switchgear/switchboard, one has also to safely discharge any possible electrical energy stored in the installation, e.g. that from the power factor correction capacitor banks.
- 5.5 In exceptional situation that the work has to be done on a partly live electrical switchboard and the workers are liable to work not far away from the exposed live parts, then suitable and adequate safety precautions, e.g. keeping a safe clear distance from the live parts, erecting physical barriers around the live parts and posting of warning notices, etc. should be taken to prevent inadvertent contact with the live parts. Those live parts should be well identified. Also a permit-to-work system should be adopted.

6. Safety During Work

- 6.1 It is important to prevent unauthorized personnel from encroaching on the area of work, in particular when the electrical installation is live or testing on the electrical installation is on-going.
- 6.2 It is not uncommon that during the course of work, part of the switchgear/switchboard would be re-energised for testing or a voltage/current be applied to the switchgear/switchboard for testing. It is important that all workers should be informed of the test and kept off from the switchgear/switchboard during the test.
- 6.3 If the switchgear/switchboard has been re-energised for testing, then after the completion of the tests and before proceeding to further work on the installation, it is important to isolate the installation and verify it is dead again using suitable testing equipment or voltage indicator before allowing the workers to continue with the work.
- 6.4 If it is unavoidable to work on or near a live electrical installation, in addition to the other safety precautions to be taken as described in this Guidance Notes, workers should also use protective equipment, such as insulated gloves, insulated mats, insulated screens, insulated clothing etc., of the suitable type and grade for the work. Hand tools for work such as spanner, screwdriver etc., should also be of the insulated type.

7. Safety After Completion of Work

- 7.1 Upon the completion of work and before re-energising the electrical switchgear/switchboard and putting them back to service, it has to ensure that:
- (a) the equipment, meters, devices, etc. of the switchgear/switchboard are restored to correct working conditions and settings;
 - (b) all tools, equipment and materials for work have been removed from the electrical switchgear/switchboard;
 - (c) all parts of the switchgear have been tightened and there are no loosened parts;
 - (d) all covers, panels and doors of the switchgear/switchboard are replaced properly and locked tight;
 - (e) except the one who carries out the switching work, all persons should keep clear of the switchgear/switchboard before it is re-energised. It is desirable to have only minimal number of workers staying in the switchroom during switching of the switchgear/switchboard; and
 - (f) no person except the work-in-charge should order for switching on the switchgear/switchboard and only the designated competent person should carry out the switching operation.
- 7.2 In case tools or materials are found missing after the switchgear/switchboard are energised, do not try to re-open the switchgear doors/panels straight away to look for the missing tools/materials. Report the incident to the supervisor immediately to arrange for shutting down of power supply to the switchgear/switchboard.

8. Emergency Preparedness

- 8.1 Emergency response procedures should be established for the workers and other staff to follow in case of emergency. The procedures should include guidance for the workers that explains when and how they should react and include the evacuation from the workplace in extreme situations.
- 8.2 The location of emergency exits and evacuation paths in case of emergency should be made known to all members of the working team. Those exits and evacuation paths should always be kept clear and well lit. Any exit door should be unlocked.
- 8.3 Suitable fire extinguishing appliances should be made available at the workplace. The workers should be trained on the use of such appliances.
- 8.4 Adequate devices, e.g. telephone, should be made available for calling the emergency services in the workplace or its vicinity. The workers should be provided with such devices or be informed of where to get such devices quickly.
- 8.5 Workers should be well informed of and trained in the safe procedures to follow to isolate the power supply to the workplace, both permanent and temporary, in case of emergency.
- 8.6 It is preferred for, at least some, members of the working team be given training in first aid and cardio-pulmonary resuscitation (CPR) to give timely treatment to victims in the unfortunate event of electric shock or explosion.

9. Information, Instruction and Training

Overview

- 9.1 The proprietor should ensure that the workers, including electrical workers of appropriate grade registered with the Electrical & Mechanical Services Department and others, undertaking electrical switchgear maintenance work should possess, by virtue of relevant training and experience, the competence that commensurate with the assigned task. The training and experience should cover not only the techniques of electrical switchgear maintenance work but also the selection and safe use of proper equipment as well as the safety and health aspects of the work.
- 9.2 The safety and health training should include general induction and more specific training, and may be met by a mixture of on-the-job and off-the-job training, and should involve demonstrations and practical exercises. It should embrace good trade practices, constituents of a safe workplace and information on the particular working conditions.
- 9.3 Notwithstanding that the workers have been trained in the general safety and health aspects of electrical switchgear maintenance work, the proprietor should provide appropriate information, instruction and training to the workers on the safety and health aspects specific to the assigned task.
- 9.4 The information, instruction and training should appropriately cover, but not limited to, the following:
 - (a) safety and health rules established in the workplace;
 - (b) safe working procedures for the assigned task;
 - (c) proper selection and use of equipment and materials;
 - (d) proper selection, proper use and limitations of personal protective equipment;
 - (e) emergency response procedures and evacuation plan; and

- (f) specific safety and health consideration, such as working on isolated circuit or under energised conditions, working within touchable distance of energised parts, working at height, manual handling of large workpieces, use of solvents, etc.

9.5 When there are significant changes in the working environment, the proprietor should review the new situation and provide sufficient information, instruction and appropriate training to workers to perform the task in the new environment in a safe and healthy manner.

General safety and health training

9.6 All persons involved in the electrical switchgear maintenance work should be fully trained in the safety and health aspects of the work under normal operation as well as in emergencies. The general safety and health training should cover:

- (a) hazards in electrical switchgear maintenance work;
- (b) relevant legislation and responsibilities of the persons concerned;
- (c) equipment and safety devices for the work, including their uses and limitations;
- (d) safety measures, including the selection and use of safety equipment and personal protective equipment, and their limitations;
- (e) general safe practices for the work;
- (f) emergency response and procedures including evacuation plan;
- (g) general examination and maintenance of equipment, pre-use and after-use equipment checks; and
- (h) build up good co-ordination with other workers and the awareness of taking care of other persons during their course of work.

Task-specific safety and health training

9.7 In addition to the general safety and health training in electrical switchgear maintenance work, task-specific training should be provided to the workers for each and every electrical switchgear maintenance work. This is particularly important if the workers are to carry out the maintenance work at workplaces they are not familiar with. The training is to enable the workers to:

- (a) understand clearly that particular work task, the work programme and the safe systems of work in place;
- (b) understand and identify all potential hazards in the working environment and the necessary precautions to be taken; and
- (c) identify factors affecting their individual capabilities in the work, and etc.

Useful Information

If you wish to enquire about this guidance notes or require advice on occupational safety and health, please contact the Occupational Safety and Health Branch of the Labour Department through:

Telephone : 2559 2297 (auto-recording after office hours)
Fax : 2915 1410
E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet. Address of our Home Page is <http://www.labour.gov.hk>.

Information on the services offered by the Occupational Safety and Health Council can also be obtained through hotline 2739 9000.