

ESTATES OPERATIONS

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ELECTRICAL SAFETY
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Please Note – the guidance provided in this Code of Practice pertains only to the Estates Operations Group and its operations. For Imperial College's Health & Safety policies and Codes of Practice go to: <http://www.imperial.ac.uk/safety>.

INTRODUCTION

This Code of Practice sets down the standards for safe management of electrical equipment, lighting and portable appliance equipment i.e. maintenance, servicing, testing, use etc. It is intended to assist in meeting the requirements of current legislation and sets out procedures on how to achieve safe systems of work.

Over and above the general duty of care owed by the College to its staff, students and others under the Health and Safety at Work etc. Act 1974, all work related to electrical equipment tasks are legislated by The Electricity at Work Regulations 1989 and The Electrical Equipment (Safety) Regulations 1994. Further information is contained within the BS7671: Wiring Regulations 2008 (17th Edition) document. Workplace lighting is covered by the Workplace (Health, Safety and Welfare) Regulations 1992.

This Code of Practice provides the following:

- A definition and the scope of the applicable Regulations
- The duties imposed on the employer / employees / other
- Responsibilities of duty holders and employees
- Competence / Self Certification

1. Overview and Introduction to Electrical Equipment Safety

The Electricity at Work Regulations 1989 places duties on any person who uses, supervises, manages or has any control of electrical equipment or services. The Electricity at Work Regulations 1989 came into force on 1 April 1990. The purpose of the Regulations is to require precautions to be taken against the risk of death or personal injury from electricity in work activities. The Regulations are made under the Health and Safety at Work etc Act 1974 (HSW Act). The HSW Act imposes duties principally on employers, the self-employed and on employees, including certain classes of trainees. The Regulations impose duties on people) in respect of systems, electrical equipment and conductors, and in respect of work activities on or near electrical equipment.

Workplace (Health, Safety and Welfare) Regulations 1992 Employers have a general duty under section 2 of the Health and Safety at Work etc Act 1974 to ensure, so far as is reasonably practicable, the health, safety and welfare of their employees at work. People in control of non-domestic premises have a duty (under section 4 of the Act) towards people who are not their employees but use their premises. The Regulations expand on these duties and are intended to protect the health and safety of everyone in the workplace, and ensure that adequate welfare facilities are provided for people at work.

BS 7671: Wiring Regulations 2008 (17th Edition) is the British Standard for electrical installations in the United Kingdom; it is a non-statutory document. The purpose of the Wiring Regulations is to protect persons, property and livestock from harm which could arise from the use or presence of electricity. BS 7671:2008 should be referred to for all new installations, and any additions and alterations to existing installations; it must be remembered that installations which were installed using earlier editions of BS 7671 will not become noncompliant unless alterations or additions are carried out on them.

2. Duties Imposed on the Employer/Employees/Others

The Electricity at Work Regulations 1989 introduced requirements for the safe provision, maintenance and use of electrical equipment. Regulation 4 of The Electricity at Work Regulations 1989 requires that all electrical equipment and services are thoroughly examined by a competent person at regular intervals. The College has a responsibility to ensure that all operations involving electrical equipment that could result in injury are assessed and adequately controlled.

Therefore we will ensure that;

- A suitable and sufficient risk assessment is carried out by a competent person involving work on and near electrical equipment. See [Appendix 2](#) to the rear of this Code of Practice for further guidance. Estates Operations have produced a [Code of Practice on Risk Assessment](#) which must be followed.
- The suitability of electrical equipment and systems are assessed.
- Control of risks arising from the use of portable electrical equipment should be based on a risk assessment. Testing and inspection frequencies can be found in [Appendix 1](#) to the rear of this Code of Practice.
- Suitable and sufficient maintenance is carried out upon all electrical equipment and services by a competent person with records held to reflect this.
- Work equipment should be inspected if the risk assessment identifies any significant risk (for example, of major injury) to operators and others from the equipment's installation or use. The result of the inspection should be recorded and this record should be kept at least until the next inspection of that equipment. Records do not have to be made in writing but, if kept in another form (e.g. on a computer), these should be held securely and made available upon request by any enforcing authority.
- Work equipment that requires inspection should not be used, unless the inspection has taken place.
- Any portable appliance equipment bought on to site by a member of staff is to be PAT tested prior to its use.

Suitability of Electrical Installations

In assessing the suitability of the construction of electrical systems, consideration should be given to all likely or reasonably foreseeable conditions of actual application or use of the electrical equipment in the system. This will include the testing, commissioning, operation and maintenance of the equipment throughout the life of the system.

In particular, consideration should be given to:

- the manufacturer's assigned or other certified rating of the equipment;
- the likely load and fault conditions;
- the need for suitable electrical protective devices;
- the fault level at the point of supply and the ability of the equipment and the protective devices to handle likely fault conditions;
- any contribution to the fault level from the connected loads such as from motors;
- the environmental conditions which will have a bearing on the mechanical strength and protection required of the equipment;

- the user's requirements of the installation;
- the manner in which commissioning, testing and subsequent maintenance or other work may need to be carried out.

Maintenance

All electrical equipment and installations should be maintained to prevent danger. It is strongly recommended that this includes an appropriate system of visual inspection and, where necessary, testing. By concentrating on a simple, inexpensive system of looking for visible signs of damage or faults, most of the electrical risks can be controlled. This will need to be backed up by testing as necessary.

It is recommended that fixed installations are inspected and tested periodically by a competent person.

The frequency of inspections and any necessary testing will depend on the type of equipment, how often it is used, and the environment in which it is used. Records of the results of inspection and testing can be useful in assessing the effectiveness of the system.

Work on Electrical Systems

In the case of work of an electrical nature it is preferable that the conductors be made dead before work starts. In such cases it is essential that the equipment be isolated and the conductors proved dead at the point of work before the work starts. Where a test instrument or voltage indicator is used for this purpose this device should itself be proved preferably immediately before and immediately after testing the conductors. Please refer to the Estates Operations' [Code of Practice on Electrical Lock-outs](#) for further guidance.

Proper safe systems of work incorporating safety isolation procedures are important for work upon equipment which is to be made dead before work starts. Some work, such as fault finding and testing, or live jointing by the electricity supply industry, may require electrical equipment to remain energised during the work. In these cases if there may be danger from live conductors, regulation 14 makes particular requirements and regulation 4(4) of The Electricity at Work Regulations 1989 is also likely to be relevant in terms of the protective equipment which may need to be provided.

The operation, maintenance and testing of electrical systems and equipment should be carried out only by those people who are competent for the particular class of work.

Disused Electrical Equipment and Systems

Before electrical equipment is decommissioned or abandoned for any reason it should be disconnected from all sources of supply and isolated. Isolation requires taking effective steps to ensure that it is dead and cannot become inadvertently re-energised or charged by induction or capacitance effects. Suitable labels or notices to bring people's attention to the state of the equipment are likely to be necessary to prevent inappropriate re-energisation.

Portable Electrical Equipment

User checks (visual)

The person using the equipment should be encouraged to look at it critically and check for signs that it may not be in sound condition, for example:

- damage (apart from light scuffing) to the cable sheath;
- damage to the plug, for example the casing is cracking or the pins are bent;
- inadequate joints, including taped joints in the cable;
- the outer sheath of the cable is not effectively secured where it enters the plug or the equipment. Obvious evidence would be if the coloured insulation of the internal cable cores were showing;
- the equipment has been subjected to conditions for which it is not suitable, eg it is wet or excessively contaminated;
 - Cracked casing and damaged cable sheath

- Cable damage covered with tape
- damage to the external casing of the equipment or there are some loose parts or screws;
- evidence of overheating (burn marks or discoloration).

These checks also apply to extension leads and associated plugs and sockets. The user should make visual checks when the equipment is taken into use and during use. Any faults should be reported to Estates Operations management and the equipment taken out of use immediately. Estates Operations must then take effective steps to ensure that the equipment is not used again until it is repaired by a person competent to carry out the task (e.g. the defective equipment could be labelled as 'faulty' and its mains plug removed).

Formal visual inspections

The most important component of a maintenance regime is usually the formal visual inspection, carried out routinely by a trained person. Such inspections can pick up most potentially dangerous faults and the maintenance regime should always include this component.

To control the risks and to monitor the user checks, a competent person should carry out regular inspections that include visual checks similar to those described above but undertaken in a more formal and systematic manner. Additional checks could include:

- removing the plug cover and ensuring that a fuse is being used (e.g. it is a fuse not a piece of wire or a nail etc);
- checking that the cord grip is effective;
- checking that the cable terminations are secure and correct, including an earth where appropriate, and there is no sign of internal damage, overheating or ingress of liquid or foreign matter.

Further guidance on formal visual inspections is contained in [Appendix 2](#) to the rear of this Code of Practice.

Combined inspection and tests

The checks and inspections outlined in the previous paragraphs will, if carried out properly, reveal most (but not all) potentially dangerous faults. However, some deterioration of the cable, its terminals and the equipment itself can be expected after significant use. Additionally, the equipment itself may be misused or abused to the extent that it can give rise to danger. Some of these faults, such as loss of earth integrity (e.g. broken earth wire within a flexible cable), or deterioration of insulation integrity, or contamination of internal and external surfaces, cannot be detected by visual inspection alone. Periodic combined inspection and testing is the only reliable way of detecting such faults, and should be carried out to back up the checks and inspection regime. Testing is likely to be justified:

- whenever there is reason to suppose the equipment may be defective (but this cannot be confirmed by visual inspection);
- after any repair, modification or similar work;
- at periods appropriate to the equipment, the manner and frequency of its use and the environment in which it is used.

The inspection carried out in conjunction with testing should usually include checking:

- the correct polarity of supply cables;
- correct fusing;
- effective termination of cables and cores;
- that the equipment is suitable for its environment.

Further guidance on combined inspection and tests can be found in [Appendix 2](#).

Lighting at Work

The College has a duty to ensure that lighting is safe and does not pose a health risk to employees and others who may use their premises.

The Management of Health and Safety at Work Regulations 1999 (MHSW) require employers to have arrangements in place to cover health and safety. This includes lighting which needs to be suitable and adequate to meet the requirements of the Workplace (Health, Safety and Welfare) Regulations 1992.

The College needs to identify priorities and set targets for improvement. For example, they will need to assess whether the lighting design is suitable and safe for the type of work being done. They also need to consider any future changes in the work conditions as this may require different lighting design. The costs and benefits of different lighting design will then need to be considered together with the suitability of lighting for the workplace.

Under the Management of Health and Safety at Work Regulations 1999 employers must assess possible risks in the workplace. In practice, this includes considering whether work lighting arrangements are satisfactory, or whether they pose any significant risks to staff using the workplace. Where there is a possible risk to employees, action needs to be taken to remove, reduce or control the risk.

To ensure lighting is suitable and sufficient, several aspects of lighting and the workplace need to be considered. These include:

- lighting design;
- type of work;
- the work environment;
- health aspects;
- individual requirements;
- lighting maintenance, replacement and disposal;
- emergency lighting.

Both interior and exterior lighting need to achieve a reasonable uniform illuminance in all relevant working areas, ie illuminance across any given task area needs to be uniform.

Lamps/luminaires need to be kept clean and replaced, as illuminance levels decline with age. How often they are maintained and replaced depends on the type of lamp/luminaire and the environmental conditions. For example, if the lamp/luminaire is out of reach and therefore infrequently cleaned, and is in a dirty, corrosive environment, it will need to be replaced more often than the same equipment in a typical office environment. Also, there needs to be safe and easy access to remote luminaires that require cleaning, repairing or replacing.

The illuminance needed depends on how much detail needs to be seen. It also depends on the age of the worker, and the speed and accuracy by which the task needs to be performed. [Appendix 3](#) at the rear of this Code of Practice sets out recommended illuminance for different types of work. It makes recommendations for average illuminance for the work area as a whole and for minimum measured illuminance at any position within it. Using only the average illuminance may result in lower illuminance in certain areas. This may endanger the safety of workers. The minimum measured illuminance is the lowest illuminance recommended in the work area for health and safety.

3. Responsibilities of Duty Holders and Employees

The College has a responsibility to ensure that all operations involving electrical equipment and services that could result in injury are assessed and adequately controlled. To this end the Estates Operations should appoint a suitably competent person to carry out the actions below.

- maintaining the electrical equipment and systems so that they are safe to use;
- selecting and instructing the competent person;

- ensuring that the electrical equipment and systems are examined at statutory intervals or in accordance with an examination scheme drawn up by a competent person;
- keeping the competent person informed of any changes in the electrical systems conditions which may affect the risk assessment;
- making relevant documentation available to the competent person, e.g. manufacturer's instructions and maintenance records;
- acting promptly to remedy any defects;
- provide suitable information, instruction and training to employees;
- ensuring that all documentation complies with the Regulations; and
- record keeping.

Employees and students have a responsibility not to undertake any activities in relation to electrical equipment and systems that may cause themselves or others harm and adhere to the information, instruction and training provided. They must immediately bring instances having the potential to cause harm to the attention of their immediate line manager.

Appendix 1 – Portable Electrical Equipment Testing and Inspection

Deciding on the frequency of inspection and testing is a matter of judgement by the duty holder, and should be based on an assessment of risk. This can be undertaken as part of the assessment of risks under the Management of Health and Safety at Work Regulations 1999.

[Table 1](#) below can help Estates Operations staff decide how often to carry out a formal visual inspection as well as combined inspection and testing, particularly where a maintenance regime has not previously existed. Alternatively, seek advice from a competent person who has the knowledge and experience to make the necessary judgement, e.g. manufacturers or suppliers of equipment, or relevant trade associations.

Factors to consider when making the assessment include the following:

- type of equipment and whether it is hand-held or not;
- manufacturer's recommendations;
- initial integrity and soundness of equipment;
- age of the equipment;
- working environment in which the equipment is used (e.g. wet, dusty) or likelihood of mechanical damage;
- frequency of use and the duty cycle of the equipment;
- foreseeable abuse of the equipment;
- effects of any modifications or repairs to the equipment;
- analysis of previous records of maintenance, including both formal inspection and combined inspection and testing.

[Table 1](#) below sets out the suggested frequency of formal visual inspections and combined inspections and electrical tests for portable and transportable electrical equipment. It gives suggested starting intervals when implementing a maintenance programme. Where one figure is given, this is a guide for anticipated average use conditions; more demanding conditions of use will require more frequent formal visual inspections, and/or combined inspections and tests. Where a range is shown, the small interval is for more demanding conditions of use and the longer interval is for less demanding ones. It is up to the duty holder, with appropriate advice where necessary, to assess the conditions affecting equipment, which may lead to potential damage and/or deterioration and should determine the maintenance regime.

Formal Visual Inspection

The formal visual inspection should not include taking the equipment apart. This should be confined, where necessary, to the combined inspection and testing.

The trained person can normally be a member of staff who has sufficient information and knowledge of what to look for, and what is acceptable, and who has been given the task of carrying out the inspection. To avoid danger, trained people should know when the limit of their knowledge and experience has been reached. Simple, written guidance relating to the visual inspection can be produced that summarises what to look for and which procedures to follow when faults are found or when unauthorised equipment is found in use. This guidance can also help users of the equipment.

The formal visual inspections should be carried out at regular intervals. The period between inspections can vary considerably, depending on the type of equipment, the conditions of use and the environment. For example, equipment used frequently on a construction site or in a heavy steel fabrication workshop will need much more regular inspection than infrequently used office equipment. In all cases, however, the period between inspections should be reviewed in the light of experience. Faulty equipment should be taken out of service and not used again until properly repaired. If necessary, it should be tested.

Combined Inspection and Testing Regimes

Combined inspection and testing requires a greater degree of competence than that required for inspection alone, because the results of the tests may require interpretation and appropriate electrical knowledge will be needed. However, it can often be carried out by a competent employee.

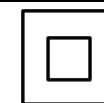
People carrying out testing of portable electrical equipment should be appropriately trained for this work. It is the employer's duty to ensure that they are competent for the work they are to carry out. Basically, there are two levels of competency.

The first level is where a person not skilled in electrical work routinely uses a simple 'pass/fail' type of portable appliance tester (PAT), where no interpretation of readings is necessary. The person would need to know how to use the PAT correctly. Providing the appropriate test procedures are rigorously followed and acceptance criteria are clearly defined, this routine can be straightforward.

The second level is where a person with appropriate electrical skills uses a more sophisticated instrument that gives actual readings requiring interpretation. Such a person would need to be competent through technical knowledge or experience related to the type of work.

Table 1

Type of business	User checks	Formal visual inspection	Combined inspection and test
Equipment hire	N/A	Before issue/after return	Before issue
Construction (For indication only. See Electrical safety on construction sites for more detail)	110 Volts – Weekly 230 V mains – Daily/every shift	110 V – Monthly 230 V mains – Weekly	110 V – Before first use on site then 3-monthly 230 V mains – Before first use on site then monthly
Light industrial	Yes	Before initial use then 6-monthly	6 – 12 months
Heavy industrial/high risk of equipment damage	Daily	Weekly	6 – 12 months
Office information technology, e.g. desktop computers, photocopiers, fax machines	No	1 – 2 years	None if double-insulated, otherwise up to 5 years
Double-insulated equipment not hand-held, e.g. fans, table lamps	No	2 – 3 years	No
Hand-held, double-insulated (Class II) equipment, e.g. some floor cleaners, kitchen equipment and irons	Yes	6 months – 1 year	No
Earthed (Class I) equipment, e.g. electric kettles, some floor cleaners	Yes	6 months – 1 year	1 – 2 years
Equipment used by the public, e.g. in hotels	By member of staff	3 months	1 year
Cables and plugs, extension leads	Yes	1 year	2 years



Symbol for double insulation

Appendix 2 – Risk Assessment and controlling the risk

When carrying out a risk assessment:

- identify the hazards;
- decide who might be harmed, and how;
- evaluate the risks arising from the hazards and decide whether existing precautions are adequate or more should be taken;
- if you have five or more employees, record any significant findings;
- review your assessment from time to time and revise it if necessary.
- The risk of injury from electricity is strongly linked to where and how it is used. The risks are greatest in harsh conditions, for example:
 - in wet surroundings - unsuitable equipment can easily become live and can make its surroundings live;
 - out of doors - equipment may not only become wet but may be at greater risk of damage;
 - in cramped spaces with a lot of earthed metalwork, such as inside a tank or bin - if an electrical fault developed it could be very difficult to avoid a shock.

Some items of equipment can also involve greater risk than others. Extension leads are particularly liable to damage - to their plugs and sockets, to their electrical connections, and to the cable itself. Other flexible leads, particularly those connected to equipment which is moved a great deal, can suffer from similar problems.

Reducing the risk

Ensure that the electrical installation is safe

- install new electrical systems to a suitable standard, e.g. BS 7671 Requirements for electrical installations, and then maintain them in a safe condition;
- existing installations should also be properly maintained;
- provide enough socket-outlets - overloading socket-outlets by using adaptors can cause fires.

Provide safe and suitable equipment

- choose equipment that is suitable for its working environment;
- electrical risks can sometimes be eliminated by using air, hydraulic or hand-powered tools. These are especially useful in harsh conditions;
- ensure that equipment is safe when supplied and then maintain it in a safe condition;
- provide an accessible and clearly identified switch near each fixed machine to cut off power in an emergency;
- for portable equipment, use socket-outlets which are close by so that equipment can be easily disconnected in an emergency;
- the ends of flexible cables should always have the outer sheath of the cable firmly clamped to stop the wires (particularly the earth) pulling out of the terminals;
- replace damaged sections of cable completely;
- use proper connectors or cable couplers to join lengths of cable. Do not use strip connector blocks covered in insulating tape;
- some types of equipment are double insulated. These are often marked with a 'double-square' symbol. The supply leads have only two wires - live (brown) and neutral (blue). Make sure they are properly connected if the plug is not a moulded-on type;
- protect lightbulbs and other equipment which could easily be damaged in use. There is a risk of electric shock if they are broken;
- electrical equipment used in flammable/explosive atmospheres should be designed to stop it from causing ignition. You may need specialist advice.



Symbol for double insulation

Reduce the voltage

One of the best ways of reducing the risk of injury when using electrical equipment is to limit the supply voltage to the lowest needed to get the job done, such as:

- temporary lighting which can be run at lower voltages, e.g. 12, 25, 50 or 110 volts;
- where electrically powered tools are used, battery operated are safest;
- portable tools are readily available which are designed to be run from a 110 volts centre-tapped-to-earth supply.

Provide a safety device

If equipment operating at 230 volts or higher is used, an RCD (residual current device) can provide additional safety. An RCD is a device which detects some, but not all, faults in the electrical system and rapidly switches off the supply. The best place for an RCD is built into the main switchboard or the socket-outlet, as this means that the supply cables are permanently protected. If this is not possible, a plug incorporating an RCD, or a plug-in RCD adaptor, can also provide additional safety.

RCDs for protecting people have a rated tripping current (sensitivity) of not more than 30 milliamps (mA).

- an RCD is a valuable safety device, never bypass it;
- if the RCD trips, it is a sign there is a fault. Check the system before using it again;
- if the RCD trips frequently and no fault can be found in the system, consult the manufacturer of the RCD;
- the RCD has a test button to check that its mechanism is free and functioning. Use this regularly.

Appendix 3 – Lighting levels

Activity	Typical locations/Types of work	Average illuminance (lux) 1x	Minimum measured illuminance (lux) 1x
Movement of people, machines and vehicles	Lorry park, corridor, circulation routes	20	5
Movement of people, machines and vehicles in hazardous areas; rough work not requiring any perception of detail	Construction site clearance, excavation and soil work, loading bays, bottling and canning plant.	50	20
Work requiring limited perception of detail	Kitchens, factories assembling large components, potteries	100	50
Work requiring perception of detail	Offices, sheet metal work, book binding	200	100
Work requiring perception of fine detail	Drawing offices, factories assembling electronic components, textile production	500	200

Appendix 4 - Guidance Documents Available

Electrical safety

Further guidance and information on electrical safety in the workplace can be accessed by the below link to the HSE website:

<http://www.hse.gov.uk/electricity/index.htm>

Portable Appliance Testing

The following link provides further guidance on undertaking portable appliance testing:

<http://www.hse.gov.uk/electricity/faq-portable-appliance-testing.htm>