



MAKING KNOWLEDGE WORK

ELECTRICAL SYSTEMS POLICY

Estates and Facilities

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SECTION ONE – LEGISLATION AND GUIDANCE

1.1 RESPONSIBILITY

This document covers all electrical services on the University Campus and it is the responsibility of all staff and external contractors employed by the University working on electrical service or equipment to comply with this document.

1.2 PURPOSE

This document forms part of the University's Health and Safety Policies and Procedures. It details the policy and safe work practices relating to electrical services and equipment in use on University's premises.

1.3 GUIDANCE

The Department of Estates and Facilities is responsible for the provision of safe electrical supplies within the fabric of University buildings, up to and including isolators and outlet sockets. Beyond the electrical outlet, each Planning Unit is responsible for all equipment connected thereto, unless the equipment is initially supplied and connected by the Department of Estates and Facilities. A supplementary convector heater would be one such example. Connections to the three-phase supply should only be carried out by the Department of Estates and Facilities or by an appointed contractor approved by the Department of Estates and Facilities. Written records should be maintained by the Department of Estates and Facilities of all such work.

If any person has concerns about the safety of connections to the electrical supply, the Department of Estates and Facilities will give advice. Flexible leads should not be clipped to walls to form quasi-permanent extensions to the electrical installation. Where Planning Units wish to extend the fixed wiring system within a University building, this must be done by, or in consultation with, Estates and Facilities.

If any doubt exists about the safety of a piece of electrical equipment, it must be taken out of service immediately and labelled 'Not for Use'. It should be removed immediately from the area concerned and repaired, or disposed of safely. A report must be made to a responsible person, such as a laboratory technician.

Electrical accidents are not the most common type of occupational accident. However, the proportion of electrical accidents that cause loss of life is very high compared to the proportion of fatalities resulting from other types of occupational accident, and electrical faults are the second main cause of industrial fires in the United Kingdom. The majority of electrical accidents involve equipment that is defective due to internal insulation failure, inadequate earthing, inappropriate fusing or incorrect wiring. These defects pose a threat to personal safety by causing electric shocks, burns, explosions and fires.

Electricity does not alert the human senses; it cannot be seen, heard or smelt. The potential hazards posed by electricity and defective electrical equipment are electric shock, burns, fire, explosion, injury from involuntary reaction to otherwise harmless shocks, such as falls, and radiation injury from radiation in the microwave and ultra violet ranges.

Electric shocks affect the nervous system and can cause muscular contraction including the inability to let-go thus increasing the period of contact and the possibility of a fatality. If the current passes through the heart it upsets its pumping action and

can cause death. In certain circumstances the electrical shock itself might not be serious, but may cause a reaction resulting in loss of balance and a subsequent fall which could have serious consequences leading to injury and death.

1.4 ELECTRICITY AND THE LAW

The Electricity at Work Regulation, 1989, apply wherever the Health and Safety at Work Act, 1974, applies and wherever electricity may be encountered. The Regulations are primarily concerned with the prevention of danger from electric shock, electric burns, electrical explosion or arcing, or from fire explosion initiated by electrical energy. The Regulations are supported by a Memorandum of Guidance (ISBN 0 11 883963 2) and Planning Units where the use of electrical systems and electrical equipment forms a major part of the work of the Planning Unit (area) should have a copy of the Memorandum available, for relevant staff to consult.

The Regulation does not distinguish between systems of different voltages; they apply equally at all voltages, including batteries and are constrained only by what might be appropriate to prevent danger or injury.

1.5 THE ELECTRICITY AT WORK REGULATIONS 1989

The Electricity at Work Regulations 1989 require every employer to comply with the provisions of the Regulations in so far as they relate to matters which are within their control and in particular:

- a)** All systems shall at all times be of such construction as may be necessary to prevent danger, so far as is reasonably practicable.
- b)** All systems shall be maintained, so far as is reasonably practicable, so as to prevent danger.
- c)** Every work activity, including operation, use and maintenance of a system and work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger.
- d)** Any equipment provided under these Regulations for the purpose of protecting persons at work on or near electrical equipment shall be suitable for the use for which it is provided, and be maintained in a condition suitable for that use, and be properly used.

Note: Any proceedings against the University or individuals in relation to The Electricity at Work regulations 1989 will be regarded as being **criminal**.

1.6 DEFINITIONS

1.6.1 "Electrical equipment" is defined as anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy.

1.6.2 "Live" means that the equipment in question is at a voltage, by being connected to a source of electricity as, for example, in normal use. This implies that, unless

otherwise stated, the live parts are exposed so that they can be touched either directly or indirectly by means of some conducting object and that they are either live at a dangerous potential in dry conditions; or at a dangerous energy level.

1.6.3 “Charged” means that the item has acquired a charge either because it is live or because it has become charged by other means such as by static or induction charging, or has retained or regained a charge due to capacitance effects even though it may be disconnected from the rest of the system.

1.6.4 “Live work” is defined as work on or near conductors which are accessible and which are 'live' or 'charged';

1.6.5 “Dead” means not electrically 'live' or 'charged'.

1.6.6 “Disconnected” is used to describe equipment, or a part of an electrical system, which is not connected to any source of electrical energy.

1.6.7 “Isolated” is used to indicate equipment, or part of an electrical system, which is disconnected and separated by a safe distance (the isolating gap) from all sources of electrical energy in such a way that the disconnection is secure, and cannot be re-energised accidentally or inadvertently.

1.6.8 “Low voltage” is regarded as a voltage exceeding 50v AC or 120v DC between conductors or earth, but not exceeding 1000v AC or 1500v AC between conductors or 600v AC or 900v DC between any conductor and earth. Extra-low voltage is normally deemed as not exceeding 50V.AC or 120v DC between conductors or to earth.

1.6.9 “High voltage” is regarded internationally as being in excess of 1000 volts. However certain precautions have been applied in the UK to systems energised at over 650 volts. To maintain the same degree of safety this guidance uses the term 'high voltage' where the voltage exceeds 650 volts.

1.6.10 “Authorised” is a person(s) or organisation that has passed some selection or competency criteria appropriate to the work to be carried out.

1.6.11 “Authorised Contractor” is a contractor holding NICEIC or ECA accreditation appropriate to the work being carried out.

1.7 DUTY HOLDERS

1.7.1 Authorised Persons (Electrical Services) - Employees of the University who have been approved by the Department of Estates and Facilities to authorise work to be carried out on the University electrical services up to the point of supply.

1.7.2 Competent Persons (Electrical Services) Employees of the University who are trained as electricians in accordance with the Electricity at Work Regulations (1989).

1.8 COMPETENT PERSONS

Persons carrying out the testing and/or repair of electrical equipment, or carrying out experimental work on electrical equipment or its associated connections must have appropriate technical knowledge, training and information to enable them to work safely.

General guidelines for competence are set out below:

- i. Practical experience in working with electricity and an adequate knowledge of hazards.
- ii. Knowledge of current safety standards and a clear understanding of the precautions required to avoid danger.
- iii. The ability to recognise whether it is safe for work to continue, particularly in respect of unfamiliar equipment and unfamiliar locations.

It is recognised that many persons will have acquired a basic competence in connecting plugs, selecting fuses and noting faults in plugs and cables.

This basic competence will be sufficient, in general, for such individuals to carry out the inspection of portable electrical equipment.

It is for the Head of Planning Unit to decide whether a particular individual is competent to carry out work with electrical equipment, on the basis of assessment of the task, the experience of the individual and the particular job

1.9 PERMIT TO WORK

1.9.1 The following works carried out on electrical equipment located on University Premises shall be subject to a permit-to-work:

- a)** Switching off any switchfuse, distribution board, or mains circuit board that may affect critical systems, the safety of staff, students or any other person working on or visiting the University premises.
- b)** Work on live electrical apparatus.
- c)** Work on electrical distribution systems that need the installed safety systems/barriers defeated or removed.
- d)** Work on electrical distribution systems that expose personnel to shock hazards.
- e)** Work on remote and automatically controlled low voltage switch-gear.
- f)** Work on any earthing system whilst the supply is still live.

1.8.2 All Permits to Work for work on electrical equipment shall be issued by an Authorised Person (Electrical Services) in accordance with the University's procedures for Permit-to-Work.

1.8.3 Keys providing access to High Voltage equipment shall only be issued via the Estates and Facilities storekeepers on production of a valid HV work permit issued by an Authorised Person (Electrical Services) and a record of all issues shall be kept at the Estates Offices.

SECTION TWO - GENERAL ELECTRICAL WORK

2.1.1 A Permit-to-work is **not** required for the following work if it is carried out by a competent Person (Electrical Services) or authorised contractor.

- a) Isolation of electrical distribution systems and equipment to make them safe.
- b) Replacement of electrical outlets, fittings equipment and fuses that have been made safe
- c) Installation of new electrical fittings, outlets and equipment

2.1.2 The replacement of electrical lamps may be carried out by Electrical Assistants provided that they have the appropriate technical knowledge, training and information to enable them to work safely.

2.2. SAFE SYSTEM OF WORK

2.2.1 All work carried out on University Premises including work carried out by authorised contractors shall be subject to risk assessment.

2.2.2 The results of Risk Assessments for work on electrical equipment shall be documented and shall include detailed method statements that records:

- a) The steps that will be taken to ensure and verify that there is adequate means of access/egress, adequate lighting and adequate safe work space at all electrical equipment on which work is being performed.
- b) The means by which the electrical equipment to be worked on shall be disconnected from every source of electrical energy.
- c) The steps that will be taken to ensure that electrical equipment to be worked on has been made dead.
- d) The precautions that will be taken to prevent electrical equipment, which has been made dead becoming electrically charged during work.
- e) The personal safety equipment and tools that are required to prevent injury and death.
- f) The steps that will be taken to ensure that electrical equipment is re-instated in a safe manner.

2.3 PLANNING WORK ON ELECTRICAL EQUIPMENT

2.3.1 All work on electrical equipment shall be planned both in advance and while the work progresses. When planning work the following factors shall be considered:

- a) The work to be done

- b) The hazards of the system or equipment to be worked on
- c) The people doing the work and the level of supervision necessary.
- d) The precautions to be taken.
- e) The system of work to be employed.

2.3.2 All work on electrical equipment that may have an effect on safety or critical systems shall be notified in advance.

2.3.3 Notifications shall set out:

- a) The work to be carried out.
- b) The effect that it will have.
- c) The duration of the work.

2.3.4 Authorised Persons (Electrical Services) shall ensure that notification is sent to any Planning Unit, or contractor who may be affected by the work.

2.4 PROCEDURE FOR WORKING ON DEAD ELECTRICAL EQUIPMENT

2.4.1 The Competent Person (Electrical Services) shall ensure before any work is carried out on electrical equipment that may give rise to danger that there is:

- a) Adequate working space
- b) Adequate means of access/egress
- c) Adequate lighting.

2.4.2 All necessary steps shall be taken to protect against inadvertent contact with other live parts nearby. This shall be done wherever practicable by the erection of physical barriers and/or the use of temporary insulation.

2.4.3 No person shall work on electrical equipment on the University's premises if they are unsure of the requirements of the safe working procedures set out in the safety method statement for the work.

2.4.4 Before disconnecting or isolating any electrical equipment, the circuit to be worked on, or near, shall be identified. Electrical equipment shall where ever practicable be physically identified. Wherever possible this process should be aided by the use of appropriate drawings, diagrams and other written information. Labelling on circuits and equipment may be used to assist in the identification process, it must however **never** be assumed that labelling is correct.

2.4.5 Once the circuit or equipment to be worked on or near has been identified it shall be disconnected from every source of electrical energy.

2.4.6 Adequate precautions shall be taken to prevent electrical equipment, which has been made dead, from becoming electrically charged during that work. Wherever

practicable this should be carried out by locking off all isolators. Where such facilities are not available, the removal of fuses or links is permissible.

2.4.7 Fuses or links shall be labelled and kept in safe keeping away from the isolator by an Authorised Person (Electrical Services) or Competent Person (Electrical Services). Under no circumstances must the fuses or links be left unattended by or near the isolator.

2.4.8 If a plug has been withdrawn, steps shall be taken to ensure that it cannot be reconnected to the electrical supply while work is taking place on the circuits or apparatus.

2.4.9 Once isolated a notice or label shall be put at the place of disconnection identifying the distribution board references of the circuits been worked on. This should be supplemented by 'danger' notices adjacent to the place of work indicating nearby apparatus that is still energised.

It is the duty of all employees and students to observe those parts of the University Health and Safety Policy that are relevant to their work as well as observing any additional local rules and regulations on health and safety published at Planning Unit level.

2.4.10 Having isolated the circuit, equipment and all parts to ensure that they are dead, even if the isolation has been achieved automatically through an interlocking system. If it is a three-phase system or equipment with more than one supply, prove that all supply conductors are dead. The device used for proving dead shall itself be proved immediately before and after testing.

2.4.11 To ensure that the risk to personnel is minimised, even if the above precautions fail, all conductors should be earthed using properly designed earthing devices or earthing leads, usually applied to all points where the circuit or equipment is isolated from the supply. Additional earths at the point of work may also be necessary if this is remote from the point of isolation, but these should be applied only after proving dead at the point of work. These procedures are essential for high voltage apparatus and stored energy equipment. The earthing conductors and their connections should be suitable for the energy that may flow in the event of a failure of the above precautions. Earthing low voltage equipment is particularly desirable if there is a risk of re-energisation. In other low voltage equipment, however, it may be physically impractical to apply earths, or the risk of short circuit from introducing an earth near adjacent live parts may outweigh the benefit of earthing the apparatus being worked on.

2.5 EXCAVATION WORK IN THE VICINITY OF ELECTRICAL POWER SUPPLIES

2.5.1 Prior to commencement of **any** excavation works – external services drawings must be located either from the University or the utility company. If drawings are not available it shall be assumed unless proved otherwise by investigation that power cables are present.

The area to be excavated shall be thoroughly scanned [irrespective of whether drawings exist] and the precise location of cables accurately marked.

When cables have been uncovered they must be clearly marked “Danger Live Cables” and protected to prevent damage.

2.6 SAFETY LOCKS, CAUTION NOTICES AND DANGER NOTICES

2.6.1 Caution notices shall be fixed on all switchgear controlling the apparatus on which work is to proceed.

2.6.2 Safety locks (differing from any standard locks) of the system shall be used to lock-off switches at points where the circuit on which work is to be carried out can be energised.

2.6.3 Danger notices shall also be fixed where applicable, on or adjacent to live apparatus.

2.6.4 Safety warning tags are to be attached to each caution and danger notice.

2.6.5 Keys for safety locks shall be retained in the possession of the Competent Person (Electrical Services) or authorised contractor carrying out the works.

2.6.6 Where locks and notices are fixed to electrical apparatus or switch-gear and a Permit-to-Work is required an Authorised Person (Electrical Services) shall fix and remove locks and notices.

2.6.7 When the circuit is controlled only by fuses or links, a Competent Person (Electrical Services) or authorised contractor shall remove, retain in a safe place and replace the fuses, links and carriers.

2.6.8 Notices shall be placed on distribution boards (origin of circuit) clearly stating which circuit(s) have been isolated – warning personnel not to re-energise the circuits(s) without verifying it is safe to do so. The person placing the notice shall indicate on the notice date of isolation and contact details.

2.7 OPERATION OF HIGH OR LOW VOLTAGE SWITCHGEAR

2.7.1 The following items of high or low voltage switchgear shall be normally in the service position and operated only by Authorised or Competent Persons (Electrical Services) or authorised contractors:

- a)** Building HV supply transformers circuit breakers/isolators/switchgear
- b)** LV bus-section switch on main switch boards
- c)** Standby generators switchgear connected (via switchgear) to the low voltage switchboards.
- d)** Uninterruptible power supplies.

2.7.2 High voltage substations and switchgear shall be normally in the service position and shall be operated only by authorised contractors or suitably qualified University personnel with the prior agreement of the Director of Estates and Facilities or his nominated deputy. The area/compound containing the high voltage substations and switchgear shall be signed over to the authorised contractor before work commences and signed back to the University on completion of the work. For work on high voltage substations and switchgear a Permit to Work system shall be operated by the authorised contractor. No work on high voltage substations and

switchgear shall be carried out by University Employees unless they are suitably qualified and authorised.

2.8 REMOTE AND AUTOMATICALLY CONTROLLED SWITCHGEAR

2.8.1 Before work is carried out on remote or automatically controlled equipment, remote control and automatic features must be rendered inoperative.

2.9 LIVE WORKING

2.9.1 Work on or near live conductors shall only be permitted in exceptional circumstances and only when authorised by the Director of Estates and Facilities or his nominated deputy. In all other circumstances live working shall be strictly forbidden.

2.9.2 Routine testing and adjustment of control circuits is permitted if a Risk Assessment proves that minimal hazards exist and are acceptable. The following requirements still apply:

- a) No lone working
- b) Only trained, qualified and skilled persons are used to carry this out
- c) Evaluation of potential area hazards must take place to ensure safe working conditions
- d) A suitable communication device is available to summon help in an emergency.

SECTION THREE - GUIDE TO SAFE WORKING WITH ELECTRICITY

3.1 GENERAL GUIDANCE

In order to safeguard University staff, students, visitors and property against these potential electrical hazards, this guide/section has been prepared to advise Planning Units on the procedures and precautions that should be employed to maintain electrical equipment in a safe condition.

The responsibility derives from the Health and Safety at Work etc. Act 1974. It is the duty of all Heads of Planning Units to ensure that all aspects of the University's Health and Safety Policy are complied with, within their area of responsibility.

Each Head of Planning Unit, must take appropriate measures to ensure that all electrical equipment is safe and suitable for the purpose intended. All relevant persons should be made aware of the associated hazards and of the requirements to adopt working procedures designed to keep the risks to their health, and to the health of other persons, as low as reasonably achievable.

The University Health and Safety Policy on the safe use of electrical equipment must be supplemented by local Planning Unit (area) rules relating to the specific activities of the Planning Unit (area), so that when read in conjunction with this part of the Policy, the two documents form an effective means of securing the safe use of

electrical equipment. Where appropriate, written records of action taken should be maintained. Computerised record keeping is acceptable.

3.2 GENERAL SAFETY PRECAUTIONS

The risk of sustaining an electric shock can be reduced by adopting the following practices:

- A Permit-to-Work system shall always be in place and operate, to ensure the effective isolation of hard-wired equipment before repair or maintenance work commences – refer to section 1.8.
- Care must always be exercised when switching off mains power supplies to ensure that only the intended circuits are isolated. Lock-off systems must be used, where necessary – refer to section 2.5.
- Switch off and withdraw the plug on items of portable electrical equipment prior to making any alterations to the equipment or modifying any circuitry.
- Do not handle any equipment with wet hands and do not work in close proximity to water supplies or other earthed metal work where there may be a risk of putting one hand on earthed metal and the other on live equipment. If equipment is suspected of being live, switch off, and have its electrical status tested by a competent person. Record the test.
- The external metal casing of electrical apparatus and associated cables and conduits must be earthed as a legal requirement. Water and gas pipes, however, must not be used as earth points. Such pipes must be effectively bonded, to ensure that they remain at an equal electrical potential. Checks should be carried out at least every five years and prior and after work to electrical systems, to ensure that this continues to be the case.
- On no account must a three-phase socket outlet be used to supply single-phase apparatus.
- Where supplies to low voltage experimental equipment are obtained from terminals, these must be insulated and a control/emergency switch must be close by.
- Standard types of electrical fittings, such as 3-pin plugs, sockets and switches, should always be used as specified by manufacturers and in accordance with good practice (e.g. switches must not be mounted upside down and single pole switches must not be wired into the neutral lead).
- If it is possible to do so, always use low voltage equipment.
- The use of high voltage equipment must be strictly controlled and suitable assessments of risk, and control features, prepared prior to use.
- When working off scaffolding or at high level external investigation shall be made to ensure the precise location of overhead cables and that suitable safeguards are implemented to ensure that tools or persons can not come into contact with overhead power cables.

Class 1 electrical equipment is provided with one layer of insulation over the live conductors, and exposed metalwork is bonded to earth so that it cannot become live in the event of an insulation failure. The external metal casing of any item of electrical equipment must be earthed as a legal requirement. With correctly earthed supply installations and equipment, the risk of electric shock is virtually nil.

Note: Certain metal bodied kettles, manufactured to British Standard, do not require the metal body to be earthed. Such kettles should carry the British Electrotechnical Approvals Board Mark (BEAB).

In practice, the most common instances of faulty earthing are:

- i. Earth connections broken accidentally or corroded through age.
- ii. Earth connections incorrectly made.
- iii. Earth connections not made at all.
- iv. Earth connections removed for some specific purpose and not reinstated.

The external casings or screens of all electrical equipment must be secured so that it is impossible to touch electrically live parts. If the equipment is disconnected from earth, a notice must be attached which makes this quite evident to any unsuspecting person. Only persons with appropriate knowledge and experience, e.g. competent persons, may work on unearthed equipment.

Care must be exercised when using electrical equipment in high earth leakage areas such as cold rooms, washing up rooms, and in medical/biological laboratories where “wet” experiments are often in progress.

3.3 RESIDUAL CURRENT DEVICES (RCD)

The application of a Residual Current Device (previously known as Earth Leakage Circuit Breaker) to a conventionally earthed system should be considered where it is vital to provide an additional back-up protection against failure of the primary earthing system.

As a general rule, an RCD will prevent a person from being subjected to a lethal shock from a fault current to earth by limiting the magnitude of the shock to 30mA and the duration of the shock to a maximum of 40 ms. An RCD will give no protection from a live to neutral contact.

RCD units are packaged either as fixed installations fitted to the incoming supply or are available in the form of a power breaker 13 Amp fused plug or adaptor. Every RCD unit is fitted with a test button which should be operated regularly to prove breaker operation.

3.4 DOUBLE INSULATED EQUIPMENT

Class 2 electrical equipment has all exposed metalwork separated from the conductors by two layers of insulation, so that the metalwork cannot become live. There is no earth connection and the operator’s safety depends upon the integrity of the two layers of insulation.

3.5 PLUGS

Plugs which are incorrectly wired, or in which the connections have been broken, can cause serious accidents. All plugs must be wired by a competent person who should observe the following requirements:

- The earth wire, striped green and yellow, is connected to the terminal marked E; this should be the longest of the three wires so that it is the last to become detached if the cable is strained.
- The live wire (brown) is connected to the terminal marked L.

- The neutral wire (blue) is connected to the terminal marked N.
- The bared ends of the wires should be hidden under the retaining screws which should be screwed down tightly and no un-insulated wires should be visible in the plug top.
- The cable should be firmly attached in place by clamping the outer insulating cover of the cable.
- Never connect two items of electrical equipment to one plug.

Equipment which is double insulated, or has an insulated exterior, is connected by 2-core cable, without an earth lead.

3.6 FUSES

Fuses are intended to protect equipment against current overload. Other measures are necessary to protect against electric shock (see Residual Current Devices).

The fuse must be located in the live conductor and must be of the correct rating, which is usually the lowest rating that will carry the appliance current continuously. Fuses in fixed distribution boards must **only** be replaced by University Electricians or authorised contractors..

The reason for a fuse “blowing”, or a circuit breaker tripping, must always be investigated by a competent person (Electrical Services) or authorised contractors and replacement fuses must always be of the correct rating.

Under no circumstances shall anybody that has not trained to work on electrical services replace fuses.

3.7 ADAPTORS AND EXTENSION SOCKETS

Multipoint adaptors should not be used unless absolutely necessary, and then should only be of a type authorised by the Department of Estates and Facilities. No more than one such adaptor may be used at any one mains outlet.

Extension sockets or plug strips should preferably be to British Standard design and should be individually fused, each should be mounted off the floor, so that it is not damaged by kicking or routine cleaning operations. Non-standard extension sockets made up by Planning Unit staff or students living in University residences must **never be used**. Never use a lighting socket to power electrical equipment.

3.8 CABLES AND EXTENSION CABLES

Cables on old or Non-UK equipment which are not colour-coded as the EC Convention must be replaced by a competent person before bringing the equipment into use. Cables must be chosen so that their rating is sufficient to carry the current which will flow through them in both normal and abnormal conditions.

Cables carrying power to and from equipment must be fitted with connecting plugs and sockets which do not leave bare live pins on disconnection, and insulating grommets must be used to secure cables passing through holes in metal chassis. As a further safeguard, flexible leads to portable equipment should be as short as

possible; they should not cross gangways either to be walked on or run over by trolleys. Under no circumstances are flexible leads to be taken under doors or routed through water or other liquids. Wherever possible, trailing cables should be located within an appropriate cable duct, in order to achieve good housekeeping standards. Rubber and plastic covered cables should be kept well away from hot surfaces.

Never use a coiled extension cable without first fully unreeling the cable. The heat generated in a coiled cable carrying power can lead to the insulation melting and a resulting fire. If there is no alternative to taking cables across a floor, then they should be protected with a cable guard. Mains cables/leads with telephone and/or computer cables should not be run in the same cable guard as this can corrupt data.

3.9 SAFEGUARDS AGAINST FIRE

Fires are caused by overloaded or defective electrical circuits but, if equipment is wired properly, with the cable adequately rated and the fusing is correct, the risk of fire is slight. However, explosions and fire can result from standard equipment sparking in the presence of highly flammable gases, vapours and dusts. Specially designed flameproof and explosion proof electrical equipment,— adequate ventilation, must be used in areas where these risks are present. (Refer to: Refrigerators and Freezers). Always switch off equipment with the proper switch and never by pulling out the plug.

Planning Unit rules for switching off unused electrical supplies, particularly in unoccupied rooms, should be formulated and observed. Where it is necessary to leave equipment operating unattended, the controlling switch must be clearly identified by using the standard University notice, available from the Department of Estates and Facilities, clearly posted on the room door. Where possible, additional safety features should be incorporated to reduce the risk of fire. Information on action(s) to be taken in the event of an emergency should be included on this notice. The Security and Emergency Services should be notified of any equipment that is left running and emergency contact numbers of the responsible persons given.

3.10. INSPECTION AND TESTING OF ELECTRICAL EQUIPMENT

3.10.1 HARD WIRED EQUIPMENT

The periodic maintenance of hard wired electrical equipment should be undertaken by professionally qualified electrical engineers, either University staff or a contract engineer. Guidance on maintenance is given in the IEE Wiring Regulations BS 7671 : 1992. The engineer or manufacturer responsible for a piece of equipment will normally be in a position to specify what periodic inspection and maintenance (including tests for electrical safety) is required and which of these functions, if any, can be carried out by the user. Careful consideration must always be given to the means of isolating such equipment from the supply system prior to testing.

3.10.2 PORTABLE EQUIPMENT

The term “portable” is not restricted to equipment which is normally moved around; it refers to all equipment which can be attached to an electrical system by a cable and plug.

All Planning Units are responsible for testing their own portable equipment within University buildings, No privately owned electrical equipment shall be connected to the electrical supply (plugged in equipment or hard wired) without the prior consent of

the Department of Estates and Facilities. Following approval being given persons using items of privately owned electrical equipment within University buildings shall ensure that each item is maintained in good working order and condition, inspected and tested for electrical safety on a minimum twelve monthly cycle.

Students bringing personal items of equipment into residential accommodation must ensure that the equipment is suitable for UK use and the item, including the cable, is not mechanically damaged and that the plug is correctly wired and fused. Cables on Non-UK equipment which are not colour-coded as the EC Convention must be replaced by a competent person before bringing the equipment into use. If in doubt, refer to a competent person.

3.10.3 INSPECTION OF PORTABLE EQUIPMENT

Inspections are visual checks of parts of the equipment and are mainly concerned with the cables and plugs. A check list for Inspection is set out in Appendix 2.

Testing can be carried out by “third party” companies. However, any company employed to perform portable appliance testing must be properly accredited and belong to one of the following trade association: NAPIT, ECA or NICEIC.

All work must be carried out in accordance with the Institute of Electrical Engineers (IEE) document “Code of Practice for in-service Inspection and testing of Electrical Equipment 2001 Edition”.

Annual inspections of portable electrical equipment are recommended. However, more frequent inspections may be advisable if the equipment is being used in an environment where there is a high probability of damage, for example, in workshops and in fieldwork, etc.

Hand held power tools, which users have to grip strongly, should be checked before each use. A check list for inspection is set out in Appendix 3. It is recommended that, wherever possible, this type of equipment is operated from a power breaker residual current protected safety plug, or similar device.

3.10.4 TESTING OF PORTABLE EQUIPMENT

Testing involves making measurements of some electrical properties of the equipment. Portable appliance testers are available to carry out a number of different tests but normally only two tests will be required. These two tests are:

1. Earth bond resistance test.
2. Insulation resistance test.

Earthed Class 1 equipment has a conductive, usually metal, outer casing and the earth lead of its cable is connected to this casing. The earth bond test checks that the resistance of this connection to earth is sufficiently low.

Double insulated Class 2 equipment has no need of an earth conductor. It has two sets of insulation to prevent the outer casing becoming live in the event of an electrical fault.

Both Classes of equipment require an insulation test. Only Class 1 can be tested for earth bond resistance.

Other tests offered by certain portable appliance testers include a flash test which is a more stringent test of the insulation and can provide an early warning of insulation problems, a load test to measure the load resistance between live and neutral to ensure that it is not too low for safe operation, an operation test which ensures that an excessive current level is not drawn by the appliance, an earth leakage test which provides a further test of the insulation under its true working conditions and is useful to ensure that appliances are not responsible for nuisance tripping of RCD's, and a fuse test which ensures that the fuse is intact.

Flash tests are optional and great care must always be taken not to damage sensitive equipment with this test. Equipment with solid state circuitry should never be subjected to a flash insulation test.

3.10.5 RECORDING THE RESULTS

The Electricity at Work Regulations requires that the results of electrical safety tests are recorded.

It is necessary to identify each piece of Planning Unit equipment with a unique number. It may be convenient to label the equipment with its number but it is not necessary to do this, provided that each test result can be **unmistakably** be connected to the piece of equipment.

Inspections will also require to be recorded and it may be most convenient to do this in the same format used for the tests. Alternatively, it may be more convenient to rely on the system for labelling equipment as a means of recording inspection. Suitable labels are available for this purpose from commercial suppliers.

All "failed" equipment should be labelled as such and removed immediately for repair or disposal and marked with a "Not For Use" label.

3.11 SPECIAL RISKS IN LABORATORIES AND WORKSHOPS

3.11.1 EXPERIMENTAL USE OF ELECTRICAL EQUIPMENT

Many experiments carried out personally by postgraduates or in the undergraduate teaching class call for the use of electrical equipment which is continually being altered and improved. It is recognised that there will be circumstances where it will be necessary and justifiable for work to proceed either on or near to exposed live conductors, such as terminals, switches and controllers, etc.

Clearly those who have supervisory duties over students must assure themselves that the risk of such work is consistent with the degree of competence of those involved, and that all possible steps have been taken to minimise the risks. For undergraduate work a high degree of supervision and a stringent regard for safety and limitation of danger is essential. Undergraduate experiments must be designed to ensure that any risks to students are minimal. It is also important to inculcate a safety-conscious attitude in undergraduates, and those who prepare and demonstrate experiments should point out the measures which have been taken to ensure that the apparatus is safe.

It is recommended that the academic member(s) of staff in charge of this type of work should prepare and retain a written statement which justifies the necessity for

work on or near to live conductors, specifies the training, provision of information and supervision appropriate to the work, and specifies the protective measures necessary for the development of safe systems of work or instruction.

All electrical systems and equipment used for live work in teaching or research must be so constructed that it is clear to all when the system and/or equipment is live, and live conductors should only be accessible by deliberate contact and never accessible by accidental contact.

In undergraduate teaching laboratories with this type of equipment, there should be no lone working. If the apparatus is energised, there should be two people present in line of sight and they should be able to hear one another. If the noise level is such that normal speech is unintelligible, the two people must maintain communication and watch out for each other's safety.

3.11.2 ELECTRONIC AND ELECTRICAL TEST WORKSHOPS

It is the responsibility of the workshop manager to identify and assess all hazardous operations in the workshop. In workshops where electronic and electrical apparatus is being developed and tested, work on live equipment may only be carried out where there is no reasonably practicable alternative. It is appreciated that there will be many circumstances where work with live equipment cannot be avoided, and in such cases the following basic conditions should apply:

- i. The entrance to such locations must display a notice warning visitors that the workshop is a hazardous area.
- ii. The floor of the workshop should be covered with an insulating material. Benches should be of non-conducting material and where personnel are working back-to-back the space between benches, should not be less than 1.5 metres.
- iii. All socket outlets must be supplied with a Residual Current Device and the whole laboratory must be provided with an easily identifiable mains isolation switch.

As far as is practicable, equipment should fail safe. Access to live parts should not be possible without removing a screwed-down cover. Mains leads should be of the correct current carrying capacity, and be mechanically secured with a clamping grommet. Where an instrument or piece of apparatus has been supplied with a mains lead of non-standard colour code, this should be removed and replaced with standard cable.

Where 3-cored mains lead is used, the earth lead should be either soldered or crimped to an earth tag and firmly screwed to an earth terminal on the chassis. The earth terminal should not be used for securing other components. All accessible metal parts should be constructed so that they are provided with a permanent and reliable earth continuity path to the main earth terminal.

Internal wiring and other live conductors should be secured and the inner surfaces of exposed metal parts should be insulated to prevent any possibility of live conductors coming into contact with them in the event of an accidental disconnection. Leads used to carry the power to portable apparatus or from one chassis to another must be arranged so that connecting plugs or sockets do not leave bare live pins when disconnected.

Care should be taken in selecting the correct value of fuse for protection against insulation failure or overload. When connecting mains plugs to commercial equipment, reference should always be made to the manufacturer's handbook before fitting the recommended value and type of fuse.

Portable tools and hand inspection lamps should be operated from isolating transformers. A double wound transformer, centre tapped to earth, 50V (or less) for lighting and 100V for portable tools, should be used. As an alternative, connection via a suitable RCD, or use of battery operated tools, would be acceptable. Soldering irons should not be used without an earth connection and should preferably be of a low voltage type, with an on/off indicator light.

3.11.3 GENERAL WORKSHOPS

In general workshops where electrical equipment is being repaired, rather than developed, it should not usually be necessary to carry out work on live equipment. However, if there is no reasonably practicable alternative, work on live equipment can be carried out, by competent persons only. Continuity tests on simple equipment such as thermostats and pressure switches at mains voltage are not only unnecessary and unsafe procedures but are illegal under the Electricity at Works Regulations.

3.12 HAZARDOUS EQUIPMENT

3.12.1 ELECTROPHORESIS EQUIPMENT

The potential for injury from electrophoresis equipment is due to the large quantities of electrical energy involved, and to the supporting medium being commonly immersed in either saline or buffer solution.

A safe system of work for electrophoresis requires that power supplies to the tanks are always switched off before the lid of the tank is opened. In addition, supplementary protection by interlocking the power supply is necessary to ensure that anyone who forgets to switch off is not at risk. Effective interlocking can be achieved by arranging for the leads from the power supply to terminate in well shrouded sockets which are separated from the corresponding pins inside the tank by the action of removing the lid. Thus, opening the tank lid automatically removes the power. Leads from the power supply must never terminate in un-shrouded pins.

Alternatively, power interlocking using positive mode safety switches on a tank with a hinged lid arranged to break the AC supply to the power pack when the lid is open, is also acceptable. Simple control interlocking, by using a safety switch to operate a contactor or relay which breaks the AC supply to the power pack when the lid is opened, is not recommended. The risk with this system is the possibility of a contactor or relay sticking in the closed position.

3.12.2 REFRIGERATORS AND FREEZERS:

Domestic refrigerators and freezers must not be used for the storage of flammable solvents. The electrical systems of domestic refrigerators and freezers present a fire and explosion hazard if they are used for the storage of flammable solvents. Under these circumstances, any escape of flammable vapour from stored materials can be ignited by the operation of internal light switches, thermostat contacts and door seal heaters.

Specially adapted intrinsically safe fridges and freezers are commercially available for the storage of small quantities of flammable materials.

3.12.3 AUTOTRANSFORMERS (VARIACS)

It is important to ensure that one side of the output supply from an autotransformer is taken from the same side of the winding as the neutral input supply, otherwise the whole connected apparatus may be raised to live potential with respect to earth. Always ensure that unshielded screw terminals on Variacs are insulated prior to use.

3.12.4 CAR BATTERIES / ACCUMULATORS

If car batteries, or equivalent accumulators, are used as low voltage supplies, the terminals and connections must be protected in order to avoid the danger of short circuit, which may lead to explosion of the battery or burns, as a result of conducting materials accidentally falling on to the batteries. Do not wear metal watch straps or jewellery when working with battery supplies. Conventional car batteries and accumulators should be charged only in well ventilated areas which are free of ignition sources, as hydrogen gas is produced during the charging process. The corrosive nature of battery acid should also be noted.

Car batteries should be disposed of carefully, utilising the Local Disposal Scheme, in conjunction with environmental policy/university disposal policies and the law.

3.12.5 EQUIPMENT USED IN HAZARDOUS AREAS

Electrical hazards are associated with fieldwork and work in buildings which have damp, wet or corrosive conditions with non-insulated structures and flooring. The dangers are those of shock and short circuit. All equipment in use in such areas must be designed for the purpose; it must be waterproof or protected to ensure that it does not get wet or damp.

Wiring should be mechanically protected, toughened and double insulated. Where extension cables are used, these should be as short as possible and mechanically robust. Protection is particularly important where animals may cause damage by chewing. Connections must be waterproof and secure and good earth connections are particularly important. Equipment must be inspected and tested at intervals of not more than six months, with full written records maintained.

Equipment should be protected by Residual Current Devices and/or isolating transformers. Where possible, low voltage equipment should always be used. Never use equipment which is wet unless it is of a waterproof construction. Locally constructed or extensively modified equipment must always be inspected by a competent person, such as an electronics technician or electrician, before being put into service.

3.12.6 COLD ROOMS

Cold rooms present special problems. Whilst the atmosphere in a cold room is frequently very dry, condensation can occur on equipment when it is removed from the room. Permanent wiring within cold rooms should be waterproof and power sockets safeguarded by Residual Current Devices. If the cold room is to be used as a laboratory, it is usually not possible to ensure that only waterproof equipment is used. However, great care needs to be taken not to use equipment removed from

the cold room until it has time to warm up and dry out, which can take several hours. Where possible, equipment should be low voltage.

3.12.7 FLAMMABLE/EXPLOSIVE ATMOSPHERES

Hazardous areas where flammable or explosive atmospheres may exist require specially selected electrical equipment to take account of the particular hazard, e.g. flameproof, explosion proof, etc. Adequate earth protection is essential. Normal electrical apparatus must never be used under such operating conditions. Any work within these defined areas must take account of the following:

- i. Installations should be designed and constructed in accordance with British Standard 5501: 1977 entitled, "Electrical Apparatus for Use in Potentially Explosive Atmospheres".
- ii. Precautions must always be taken to prevent the ignition of flammable atmospheres by the discharge of static electricity.
- iii. Most electrical equipment is unsuitable for use in oxygen enriched atmospheres.

Selection of equipment for use in these areas must only be carried out by competent personnel.

3.12.8 MEDICAL ELECTRICAL EQUIPMENT:

All medical electrical equipment must be constructed and installed to the general requirements of British Standard 5724: Part 1: 1979, "Safety of Medical Electrical Equipment". All such equipment must be operated under the jurisdiction of qualified persons to the standards described in the British Standard.

3.12.9 STATIC ELECTRICITY

The electric shock that can sometimes be experienced by touching a metal door handle after walking across a synthetic carpet is due to static electricity. A similar electric charge can be generated during the rapid movement of powders and liquids, sometimes sufficient to cause a spark, which can ignite a dust cloud of an organic powder (e.g. icing sugar, grain, chemical, polymer.) or a flammable vapour.

When pouring flammable liquids or conveying organic powders, use metal containers and/or metal pipework, making sure that all the metal work is bonded and earthed. Plastic materials used in the manufacture of drums, kegs, funnels, syphons, etc become charged, and should not be used for flammable liquids or powders.

SECTION FOUR – RATIFICATION

4.1 RATIFICATION

This guideline was developed by Estates and Facilities in association with Health and Safety Services and approved by the Health and Safety Committee on 8 November 2005.

APPENDIX ONE: RECOMMENDED FREQUENCIES FOR INSPECTION AND TESTING FOR PORTABLE EQUIPMENT

EQUIPMENT	INSPECTION FREQUENCY	TESTING FREQUENCY
Hand held Power tools (drills, etc.)	6 Monthly	6 Monthly
Cleaning equipment (Vacuum cleaners, polishers, etc.)	6 Monthly	12 Monthly
Most equipment in laboratories and workshops	12 Monthly	12 Monthly
Flexible task lighting, kettles and irons, etc.	12 Monthly	12 Monthly
Most equipment in offices, libraries and similar accommodation	12 Monthly	24 Monthly
All double insulated equipment	12 Monthly	48 Monthly

APPENDIX TWO: CHECK LIST FOR INSPECTION OF PORTABLE ELECTRICAL EQUIPMENT:

These checks are concerned with the visually accessible parts of the equipment and its cable, plug and any extension cable. The only exception to this is the recommendation that the inside of the plug be examined. Check for the Following Points on these items:

Cable

- Signs of mechanical damage, overheating or corrosion
- Hardening of outer insulation
- Kinking of cable
- Coiling of long lengths of cable
- A situation where future mechanical damage or corrosion is likely

Plug

- Signs of mechanical damage or corrosion
- Signs of overheating, e.g. discolouration or distortion
- Wires connected to correct terminals and of the correct length
- Un-insulated ends of wires completely covered by the screws
- Securing screws suitably tight
- Cable clamp holding cable securely
- Fuse of correct rating fitted

The Equipment

- Metal casing damaged
- Grommet, or other protection at place where cable passes through the casing, damaged or missing
- Plastic casing of double insulated equipment damaged
- Damaged or defective switches

APPENDIX THREE: VISUAL CHECKS ON HAND-HELD PORTABLE EQUIPMENT BEFORE USE:

The commonest type of equipment in this category is electric drills. If a dangerous fault makes the casing live a prolonged electric shock occurs because of the difficulty in letting go. It is therefore recommended that this type of equipment is operated from a "Powerbreaker" Residual Current Device protected safety plug, or similar device, and that this equipment is fully inspected and tested every six months.

It is further recommended that the following checks be made by the user every time before the equipment is used.

- Is the outside of the plug undamaged?
- Is the outside of the plug free from signs of overheating?
- Is the cable free from kinking and other mechanical damage?
- Is the same true of any extension cable and accessories?
- Is the cable securely clamped into the plug at one end and securely attached at the other?
- Is the casing of the tool free of obvious damage?
- Is there a label to say that the tool has been electrically tested within the past six months?
- If a Residual Current Device, or other device is fitted, does the test button (which simulates a fault condition) operate correctly?

RS/SL/Electrical Equipment

Guideline 19
Revision 0