UNIVERSITY OF SUSSEX

SAFETY PROCUDERES AND GUIDANCE SPG-13-09

NOTES OF GUIDANCE FOR THE IMPLEMENTATION OF THE ELECTRICITY AT WORK REGULATIONS 1989

SECTION A - INTRODUCTION

In the following notes, the Regulations are stated. Each stated Regulation is followed by brief comments and notes of actions to be taken by members of the University.

It is important that all members of the University, including students and visitors, are made aware of the need to comply with the requirements of the Regulations via a risk assessment of the activity and that **managers and supervisors** take such steps as are necessary to ensure that electrical work is carried out only by **competent persons** who are in receipt of effective **supervision**. Procedures and Guidance to enable this requirement to be met are given in Section C of this document.

The guidance notes are aimed to assist electrical engineers technicians, postgraduates and their supervisors including all who become involved in the design, construction, operation or maintenance of electrical systems and/or equipment.

Advice, including HSE guidance may be obtained from the Safety Office. Further professional advice can be obtained from the Estates Division.

Particularly valuable advice is contained in the HSE publication Memorandum of Guidance on the Electricity at Work Regulations 1989 ISBN 0-7176-6228 and in the IEE regulations.

The objectives of the Regulations are to prevent danger and to prevent injury. The Regulations will be enforced by the Health and Safety Executive (HSE), whose inspectors will expect managers and supervisors within the University to demonstrate compliance with the Regulations by keeping records of the construction and maintenance of equipment and of the competence and training of all persons working to the Regulations.

SECTION B - NOTES OF GUIDANCE

Reg 3. Persons on whom duties are imposed by the Regulations

It shall be the duty of every employer and self employed person working in University premises to comply with the provisions of the Electricity at Work Regulations 1989 in so far as the provisions relate to matters which are within his control.

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It shall be the duty of every employee while at work to co-operate with his employer so far as is necessary to enable any duty placed on that employer by the provisions of the Electricity at Work Regulations to be complied with; and to comply with the provisions of the Regulations in so far as they relate to matters which are within his control.

Note: Students and visiting research workers are regarded as employees.

The above persons are all regarded by the enforcing authority (the Health and Safety Executive) as 'Duty Holders'.

Duties may be either, **So Far As Is Reasonably Practicable** or **Absolute** - where SFAIRP is **not** indicated, an absolute duty is implied.

Reasonably practicable

This is a balance of level of risk and costs in terms of time, trouble, expense required to minimise or eliminate the risk. Where risk is death by electrocution and precautions are clear and simple, e.g. insulation level, the duty approaches an absolute duty. The greater the level of risk, the less weight can be given to the cost of measures needed to prevent that risk. This comparison does not include the financial standing of the duty holder.

Note also that, if prosecuted for failure to comply with a duty SFAIRP, it is for the accused to show the court that it was not reasonably practicable to comply. See section 40, Health and Safety at Work Act 1974.

Reg 4. Systems, work activities and protective equipment

"Systems" (including permanent and temporary systems) include conductors, earth wires, transformers and any equipment which, whether energised or not, may at some point in time be connected to a common source of electrical energy, e.g. a circuit isolated by fuses or double pole switches is still part of a system. "Danger" = risk of injury from electricity. Injury may include injuries caused by electric shock burn, fire, arcing or explosions initiated by electrical energy.

(1) All systems shall at all times be constructed, so far as is reasonably practicable, to prevent danger.

(2) All systems shall SFAIRP be maintained to prevent danger.

(3) Every work activity, including operation, use and maintenance of a system, and work near a system shall be carried out in a manner not to give rise, SFAIRP, to danger.

(4) Equipment provided, under these regulations, to protect persons at work on or near electrical equipment shall be suitable for that use, and maintained in a condition suitable for that use, and shall be properly used. (e.g. rubber gloves for electrical purposes, rubber mats for electrical purposes).

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The HSE have advised that records of maintenance will enable the conditions of the equipment and the effectiveness of maintenance policies to be monitored. Without effective monitoring, duty holders cannot be certain that the requirement for maintenance has been complied with. Maintenance schedules will require judgement, e.g. test portable tools every 3-6 months.

Reg 5. Strength and capability of electrical equipment

No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

"Strength and capability" means the ability of the equipment to withstand the thermal, electromagnetic, electrochemical, or other effects of electric currents.

"Electrical equipment" includes every type of electrical equipment from 400kV power lines to battery hand lamps. No voltage limits appear in the regulations. In a flammable gas atmosphere the hand lamp could cause danger, i.e. an explosion.

Reg 6. Adverse or hazardous environments

If it is foreseeable that electrical equipment may be exposed to:

(a) mechanical damage

(b) effect of weather, natural hazards, temperature or pressure (or radiation)

(c) effects of wet, dirty, dusty, corrosive conditions or

(d) flammable or explosive substances including dust, vapours or gases,

then it shall be of such construction or adequately protected to prevent SFAIRP any danger arising from such exposure.

Note: Here the need is to ensure that equipment to be installed in potentially explosive atmospheres is selected in accordance with appropriate HSE Guidance Notes and British Standards. Where static electricity may ignite gases or vapours, the design of electrical equipment needs to be such that ignition is prevented, e.g. lighting and extract systems in solvent stores or fume cupboards.

Reg 7. Insulation, protection and placing of conductors

All conductors in a system which may give rise to danger shall either

(a) be suitably covered with insulating material and as necessary protected so as to prevent SFAIRP danger; or,

(b) have such precautions taken in respect of them as will prevent, SFAIRP, danger.

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The IEE Wiring Regulations give advice for fixed installations up to 1000V. Note the IEE 'regulations' also require that insulation must be protected SFAIRP to prevent mechanical damage to the insulation.

Where protection from danger is achieved by suitable strategic positioning, e.g. railway conductor rails or overhead power lines (in both cases uninsulated) there will usually need to be further measures taken, e.g. warning notices, barriers, special training of persons at risk.

Reg 8. Earthing or other suitable precautions

Precautions shall be taken, whether by earthing or by other suitable means, to prevent danger arising when any conductor, (other than a circuit conductor), which may reasonably foreseeably become charged as a result of either the use of a system or through a fault in a system. For the purposes of complying with this regulation, a conductor shall be regarded as earthed when it is connected to the general mass of earth by conductors of sufficient strength and current-carrying capability to discharge electrical energy to earth.

In this regulation 'conductor' may mean metal parts of equipment which can be touched, and which may become live under fault conditions.

The requirements of Reg 8 may be met in several different ways e.g.:

(i) ensuring that the conductors do not become charged

(ii) ensuring that, if the conductors do become charged, the value of voltage and current and the duration are such that danger will not arise

(iii) ensuring that if the conductors become charged the environment is such that danger will not arise, e.g. by use of separated or isolated systems, see IEE Wiring Regulations.

Techniques for achieving (i), (ii) and (iii) above include:

(a) double insulation

(b) earthing

(c) connection to a common voltage reference point

(d) equipotential bonding

(e) use of safe voltages

(f) earth free non conducting environments

(g) current/energy limitations e.g. Residual Current Devices

(h) separated or isolated systems (e.g. isolating transformer).

Reg 9. Integrity of referenced conductors

If a circuit conductor is connected to earth or to any other reference point, nothing which might

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reasonably be expected to give rise to danger by breaking the electrical continuity or introducing high impedance shall be placed in that conductor unless suitable precautions are taken to prevent that danger.

The most common situation in which this regulation is relevant is in systems having a central point which is earthed. This is true of most power distribution systems where the reference point is earthed by a connection to earth at the generator or at the distribution transformer. The regulation permits bolted links, removable links, manually operated knife switches, but excludes fuses, thyristors or transistors being introduced into the conductor.

Reg 10. Connections

Where necessary to prevent danger, every joint and connection in a system shall be mechanically and electrically suitable for use.

Plug and socket connections should prevent accidental contact with conductors live at dangerous voltages. This will usually be achieved by selecting appropriate equipment, but may be achieved by operator skill and/or training in some circumstances.

Reg 11. Means for protecting from excess of current

Efficient means, suitably located, shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger.

The regulation aims to protect against faults and overloads. Protection will usually be by fuses or circuit breakers.

Reg 12. Means for cutting the supply and for isolation

(1) Where necessary, (subject to paragraph (3) below), to prevent danger suitable means (including where appropriate, methods of identifying circuits) shall be available for

(a) cutting off the supply of electrical energy to any electrical equipment and

(b) the isolation of any electrical equipment.

(2) In paragraph (1) above, isolation means the disconnection and separation of the electrical equipment from every source of electrical energy in such a way that the disconnection and separation is secure.
In areas of high risk, or areas where access to the isolation switch is restricted it is advised that the provision of remote emergency OFF switches should be considered at the design stage of research and teaching apparatus, or systems.

(3) Paragraph (1) shall not apply to electrical equipment which is itself a source of electrical energy, but in this case precautions shall be taken to prevent danger.

It is important to note the need not only for switching off the electrical energy to a system, but also

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the need to ensure that it cannot be re-energised if, for example, someone is working on that system, e.g. by locking off.

Paragraph (3) recognises the impracticability of switching off a battery, or generator, or a large capacitor.

Reg 13. Precautions for work on equipment made dead

Adequate precautions shall be made to prevent electrical equipment which has been made dead in order to prevent danger while work is carried out on or near that equipment from becoming electrically charged during that work if danger may thereby arise.

This regulation would normally be met via disconnection, by switching/isolation and locking off. Where this switching and locking off is not available removal of fuses or links, and these being held in safe keeping, may be acceptable. Where there is risk of electrical energy still being present (e.g. by electromagnetic induction, mutual capacitance or stored electrical energy), systems may have to be protected by applying temporary earth connections.

Where work is to be done on or near isolated conductors, these conductors should be tested and proved to be dead before working starts. The test instrument used should itself be proved immediately before and immediately after testing the isolated conductor.

Details of safety isolation procedures should be incorporated into the Safety Procedures and Guidance for University employees working with electrical equipment. Isolating advice must be included in the Permit to Work document whenever it is deemed appropriate. Managers will need to exercise judgement on the need for a Permit to Work. For example, repairs of equipment which can be unplugged may not always require a permit to work - but where whole laboratory circuits are to be isolated, e.g. to allow building alterations, then clearly a Permit to Work must be raised. In the case of equipment which may become dangerous if it is re-energised whilst being repaired, e.g. X ray sets, a permit to work will be required. Isolation must in these cases include warning notices and removal of the fuses if the equipment is to be left unattended.

When electrical systems are decommissioned effective steps must be taken to ensure that it cannot become re-energised. This may normally be achieved by locking off and labelling the lock or by warning notices and removal of a significant length of connecting cable. In this case cable ends must be effectively insulated, e.g. by securing them in an insulating block so that they can never make contact with live terminals.

Reg 14. Work on or near live conductors

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless,

(a) it is unreasonable in all the circumstances for it to be dead, and

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(b) it is reasonable and necessary in all the circumstances for them to be at work on or near it while it is live, and

(c) suitable precautions (including where necessary the provisions of suitable protective equipment/clothing) are taken to prevent injury.

Note: Not to 'prevent danger' - but to 'prevent injury'. The presence of danger in this part of the regulation is recognised.

Work, wherever practicable, should normally be undertaken only if the conductors threatening danger are made dead.

Reg 14 recognises however that in some circumstances it may not be practicable for the conductors to be made dead; this particularly applies to the electricity supply industry. It may also be necessary for live working when repairing/testing some electronic equipment.

Only properly trained competent persons may be permitted to work on live conductors. See Reg 16.

Suitable precautions for live working should include as appropriate:

- provision of adequate information about the live conductors, the associated electrical system and the foreseeable risks;
- use of suitable insulated tools equipment and protective clothing;
- use of suitable insulated barriers or screens;
- use of suitable instrument, or test probe;
- accompaniment by another person (but **only** if that person could contribute significantly to ensuring that injury was prevented);
- control o£ the area to prevent unauthorised access.

(Risk assessments of the work may also require the availability of Local and/or mobile First Aiders to be available such as out of hours maintenance work).

See HSE Guidance Notes for precautions to be taken where work is to be on or near underground power cables and/or overhead power lines.

Reg 15. Working space, access and lighting

For the purpose of preventing injury, adequate working space, adequate means of access and adequate lighting shall be provided at all electrical equipment on which or near which work is being done in circumstances which may give rise to danger.

This regulation applies to all electrical work whether live conductors are exposed or not. There must be space for persons to pull away from conductors without hazard, and space for persons to

pass one another with ease and without hazard.

Reg 16. Persons to be competent to prevent danger and injury

No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent danger or injury unless they possess such knowledge or experience or is under such degree of supervision as may be appropriate having regard to the nature of the work.

The technical knowledge or experience may include:

(a) adequate knowledge of electricity;

(b) adequate experience of electrical work;

(c) adequate understanding of the system to be worked on and practical experience of that system;

(d) understanding the hazards which may arise and the precautions to be taken;

(e) the ability to recognise at all times whether it is safe for work to continue.

See Section C for further detailed guidance to assist compliance with Regulation 16.

Reg 29. Defence

In any proceedings for an offence consisting of a contravention of Regulations 4(4), 5, 8-16, it shall be a defence for any person to prove that he took all reasonable steps and exercised all due diligence to avoid the commission of that offence.

Reg 30. Exemption certificates

The HSE can exempt some activities and some named persons from any of the regulations if the HSE so wishes.

SECTION C - PROCEDURES REQUIRED BY REGULATION 16 TO ENSURE THAT PERSONS ARE COMPETENT TO PREVENT DANGER AND INJURY

Only persons who are themselves competent, as assessed by a risk assessment, (i.e. are certified as having the technical knowledge to prevent danger or injury), OR persons who are under an appropriately qualified supervisor, may engage in any electrical work activity.

Hence, staff or postgraduate students (or undergraduate students in some cases, e.g. Electrical Engineering students) must be, or have been, trained and instructed to ensure safety, and

effectively supervised, particularly where they may not themselves have the competence to work safely. Management must make sure that a safe system of work is always established and followed. The responsibilities of those undertaking supervision must be clearly stated to them by those Managers allocating the supervisory duties. This particularly applies to Academic supervisors of students where they must ensure the students are informed of the safe systems of work and ensure any demonstrators are trained.

Where risks are low, these responsibilities can be outlined verbally. Where risks are higher, the responsibilities should be stated in writing

Supervision requires judgement. It does not necessarily mean being present at the work location at all times.

THE ELECTRICAL WORK IN THE UNIVERSITY FALLS INTO FOUR AREAS:

This sections highlighted below to be check and reviewed by the Safety Office and Estates DSU section.

(1) High Voltage Distribution System (11kV)

Competency for working on the HV distribution system shall follow the requirements of the University's Code of Practice and Safety Rules for Work on High Voltage Plant This work is restricted to those Estates staff and Maintenance Section staff defined as 'Authorised Persons' within the terms of University's Code of Practice and staff authorised by SEEBOARD. All Authorised Persons are given a written authorisation issued by the Estates Manager or his Deputy.

Work on the HV distribution system can only be initiated by:

Authorised Persons in Charge: These persons are appointed from Senior Engineers employed by the Estates and Maintenance Section who have undertaken a SEEBOARD or other approved course in High Voltage Plant Operation.

Authorised Persons to Switch High Voltage: These persons are appointed from Engineers and Senior Craftsmen employed in the Estates and Maintenance Section, who have undergone a SEEBOARD or other approved course in High Voltage Plant Operation. Names of Authorised Persons in Charge and Authorised Persons to Switch are kept by the estates division.

(2) Low Voltage installations to the point of supply (e.g. socket outlet, local 415V 3-phase breaker)

This work is only to be undertaken either by contractors authorised by the Estates Manager, his Deputy or the Services Engineer, or by competent Estates Department electricians who must be qualified to the level required by the Joint Industry Board for the Electrical Contracting Industry for appointment as an electrician and so appointed by the Estates Manager, his Deputy or the Services Engineer.

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Supervision of University electricians will be provided through the Estates and Maintenance Section management chain. This will ensure that all Works Orders are referred to an appropriate level of management so that hazards may be assessed and, where appropriate, written safety advice can be given and signed for.

Note: It is essential that all excavation work and all work near (within 20m of) high voltage power lines is referred to the Services Engineer so that arrangements can be made (if necessary) to disconnect the supply whilst this work is being undertaken. In these cases the Services Engineer or his delegated representative will assess the risks and, if appropriate, provide a written safe system of work and satisfy himself that the work receives an effective level of supervision.

(3) High Voltage DC or AC (over 415V) plant or equipment not forming part of the 11kV distribution system

(a) Estates and Maintenance Section Staff

This work may only be undertaken by Estates and Maintenance Section staff who have a level of competence recognised by the Estates Manager, his Deputy or the Services Engineer. Those members of the Estates and Maintenance Section qualified to work on HV (DC or AC systems) must be given a written authorisation for the level of work they are able to undertake. This authorisation must be provided by the Estates Manager, his Deputy or the Service Engineer. The Estates Manager the Deputy Estates Manager or the Services Engineer are responsible for ensuring that these "High Voltage Authorised Staff" receive an appropriate level of supervision, e.g. by an Assistant Services Engineer or by the Foreman Electrician. It is advised that in all High Voltage work on plant or equipment not forming part of the High Voltage distribution system, the Estates Department must liaise with the Building User or his representative.

(b) Science Faculty Technicians and Students

Some plant or equipment in Science Buildings will be used by staff and students. This should present no problem whilst the equipment is insulated or protected within an enclosure.

However, any repairs or testing of this equipment with covers removed, must only be undertaken by authorised persons deemed to have appropriate technical qualifications, experience and training, e.g.: BTec or equivalent or higher qualification in Electrical Engineering (or related subject). Where a Manager does not have relevant qualifications in Electrical Engineering these approvals may need to be made by a responsible member of faculty, e.g. from the School of Engineering. In this case the Head of School would provide the responsible member of faculty with a written statement of appointment.

Members of faculty or technicians deemed capable of working on High Voltage plant or equipment not forming part of the 11kV distribution system must be given a written statement of authorisation, which defines the limitations of their work, and which is issued

on behalf of the Head of School by a "Responsible Member of Faculty" (who must be a qualified Electrical Engineer) who has been appointed by the Head of School.

In some circumstances students may need to work on High Voltage plant or equipment. They may only do so under the direct supervision of a graduate electrical engineer or a member of faculty whose level of knowledge, training and experience has been approved in writing by the Responsible Member of Faculty acting on behalf of the Head of School.

(4) Low Voltage (defined for this document as 415V or less) installations past the point of supply

(a) Work on dead equipment

Persons approved as in (2) above may work on Low Voltage installations past the point of supply.

In addition, Low Voltage work may be undertaken by staff and students provided that the following conditions are met:

i) A risk assessment has been undertaken for the activity

ii) Assured means of isolation of the equipment from any source of electrical energy are provided and any residual charge within the equipment is removed by a suitably qualified authorised person.

iii) Work must only be undertaken by persons with sufficient knowledge, training and experience to take the appropriate precautions and with sufficient technical skill to provide the necessary standard and quality of workmanship required to prevent danger.

iv) It is the responsibility of managers and supervisors who authorise work on Low Voltage installations past the point of supply to make sure that their staff or students have the necessary expertise for this work. Where appropriate managers and supervisors must seek expert advice to ensure that the work required is undertaken to an acceptable standard. Where the risks involved are low, verbal instructions are likely to be adequate. As the risk or complexity increases, written procedures must be given.
This matter will require careful judgement to be made by managers and supervisors.

v) Individuals undertaking Low Voltage work past the point of supply must recognise their responsibility for completing work to an acceptable standard of safety. They must also recognise their limitations and, where appropriate, seek help and advice from a person having the appropriate level of technical knowledge or experience, as defined in the Health and Safety Executive Approved Code of Practice.

No written authorisation is needed for individuals who undertake this work. However, all work on non-live (dead) equipment or apparatus must, where appropriate, be checked by someone who is electrically competent and a risk assessment undertaken before that

equipment is made live.

(b) Work on live equipment

All live work on Low Voltage systems beyond the point of supply must only be undertaken either by Low Voltage Authorised Persons·(authorised as in Sections (2) or (3)), who have the necessary technical knowledge or experience, or by persons who are under the direct supervision of members of faculty or technicians who have been authorised by their Head of School or his representative, e.g. a Technical Manager/Supervisor, to supervise live working.

Low Voltage Authorised Persons must possess either the qualifications required to satisfy the Joint Industry Board for the Electrical Contracting Industry for appointments as an Electrician, an equivalent qualification, or be graduates in Electronics/Electrical Engineering or must be persons judged by their Technical Manager/Supervisor, or responsible member of faculty, as having the appropriate level of qualification and experience to work safely with live equipment.

All Low Voltage Authorised Persons must have been informed of the risk assessment and instructed in the safe system of work for live working, and have signed the risk assessment. The risk assessment must also be signed by the activity supervisor, and for high risk activities by the appropriate Safety Advisor/specialist appointed person, see section (3) above.
It is expected that the Manager or his Representative will consult with either an electrically qualified member of faculty or with his Technical Services Manager to make sure that the person has the appropriate level of technical knowledge and experience.

Standards of Work:

ALL work must be undertaken in accordance with the requirements of the Electricity Supply Regulations (1988) and the current edition of the IEE Regulations. Also, wherever appropriate, persons undertaking electrical work must ensure that their work will follow the standards given in the Approved Code of Practice and to these Safety Procedures and Guidance notes.

Lists of Authorised Persons

It is strongly recommended that the Estates and Maintenance Section Services Engineer retain lists of Authorised Persons within their organisation and that they exchange copies of these lists to enable authorised persons to be consulted for guidance by members of other Schools or Sections.

Note (1): It is important that in all letters of authorisation or appointment, the limits of the responsibility of each individual must be clearly defined.

Note (2): Direct current work - Persons allocated to work on high current DC equipment must be suitably qualified and the risks assessed.

Note (3): Car batteries and electrical systems are included within the 1989 Regulations, so staff dealing with vehicle electrics must be suitably qualified and experienced.

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