

## Electricity, Electrical and Electronic Equipment Safety

### The Electricity at Work Regulations 1989

The Electrical Safety Advisory Committee (ESAC) is tasked with advising the Physics Management Committee (PMC) on the implementation of these Regulations within Physics. This section of the handbook describes the implementation of the Regulations within Physics as authorised by the PMC.

The ESAC will meet at appropriate intervals, nominally six monthly, to review matters of electrical safety within Physics. The membership is listed in the Statement of Safety Organisation.

### Electrical Safety Organisation

The following have special roles with regards to electrical safety:

#### Executive roles

Electrical safety supervisor	Role fulfilled by the Electrical Safety Advisory Committee (ESAC) via Mr J Fopma	Advise on all matters relating to electrical safety, and compliance with University policy and legislation. Without detracting from the duty of the person in control of danger, departmental designs for apparatus which are to use electricity (except for class A and B) are verified by a person appointed by ESAC before construction. Verification aims to ensure that all procedures set out in <a href="#">S4/10</a> have been observed. An appointed person on behalf of ESAC also verifies safety before first use of departmentally designed equipment.
PAT Testing Manager	Mr J Fopma	Manager responsible for arrangements for electrical safety testing (including PAT testing) of electrical appliances used in the department.
Area electrical safety supervisors	Mr T Harris Mr G A S Clack	Advise the DSO, PASOs, Building Safety Officers and other members of the department on electrical safety matters relevant to their area of responsibility.

#### Advisory roles

Electrical safety	Mr T Harris	Building electrical installations, general electrical safety
High voltage	Mr R Wastie	Electrical work >650V
High current	Mr M Jones	Electrical work >100A
Electrical safety/Electronics (AOPP)	Mr G A S Clack	General electrical safety and electronics (AOPP)

The DSO, ASOs and Building Safety Officers are the main points of contact for safety queries, they will refer queries to the above executives and advisors as necessary.

### Hazard Classes

The ESAC has found that even within British or equivalent international Standards and Codes of Practice there were differences in the thresholds defining safe and hazardous electrical circuits. Listed below are a number of hazard classes considered appropriate to Physics and which are based on current British Standards and Codes of Practice. Six classes are defined, namely:

Class A. Extra-Low Voltage.

Class B. Limited Current.

Class C. Hazardous Low Voltage.

Class D. High Voltage.

Class E. High Current.

Class F. Building Wiring.

The definitions for each of the above classes are stated in the Annex.

The particular hazards presented by Class D, high voltage, and Class E, high current, require specialised knowledge. Therefore High Voltage and High Current Supervisors have been appointed as detailed above.

All defined hazard classes except Classes A, Safety Extra-Low Voltage, and B, Limited Current, require an ability to recognise the potential dangers inherent in working on such systems. Consequently work on systems in all classes except classes A and B must be carried out by, or supervised by, competent professional or technical staff known as Electrical Supervisors. All Electrical Supervisors appointed after January 2007 must be formally approved in writing by a competency panel nominated by ESAC. The panel will base its approval on the candidate's demonstrated electrical/electronic training, practical experience and ability to recognise potential electrical and other related dangers.

In cases of dispute between an Electrical Supervisor and any other staff, student or visitor regarding electrical safety, the Competency Panel will arbitrate and provide a ruling.

### **Competence to Work on Electrical/Electronic Systems**

#### **Extra-Low Voltage and Limited Current (Class A and B)**

These systems are assessed as non-hazardous under British Standard 7002 and therefore no specialist electrical knowledge is required to work on such systems. All academic, research support and technical staff plus all students, after having received initial basic electrical safety instruction, are permitted to work on systems that have been assessed by an Electrical Supervisor as meeting the criteria as detailed in the Annex. A suitable initial training course supported by written guidance notes on Physics Electrical Safety procedures will be provided.

#### **Hazardous Low Voltage (Class C)**

Low voltage systems can present hazards. Personnel working on such systems require an ability to recognise the potential dangers. Various levels of competency have been defined to cover the following activities on Hazardous Low Voltage systems:

- a. Supervision.
- b. Inspection.
- c. Testing.
- d. Testing under Supervision.
- e. Repair and Maintenance.
- f. User Replacement.
- g. Design.

Original manufacture is considered non-hazardous since the potential for danger would not exist until power is applied and the design will require approval by a competent person under the safeguards listed in the Competence to Work on Electrical/Electronic Systems in Hazard Classes C, D, E section below, this details the limits of electrical activities to be undertaken by Physics personnel.

## **High Voltage (Class D)**

Due to the higher risks associated with high voltage equipment, in addition to the safeguards for Hazardous Low Voltage further precautions are necessary, as follows:

- All high voltage equipment designs to be approved by the High Voltage Supervisor or Deputy prior to manufacture.
- All high voltage systems to be inspected and passed as safe by the High Voltage Supervisor or Deputy prior to the initial application of power.
- The initial application of power to be observed by the High Voltage Supervisor or Deputy.
- Written operating and emergency procedures to be compiled for each high voltage system and be approved by the High Voltage Supervisor or Deputy. These procedures to be clearly displayed adjacent to the apparatus to which they refer and the master copy is to be lodged with the Area Safety Officers.
- Written maintenance procedures to be drawn up and approved by the High Voltage Supervisor or Deputy for each high voltage system and the master copy held by the Physics Area Safety Officers.

## **High Current (Class E)**

Whilst the risks associated with high currents are similar to that those presented by high voltage the systems are sufficiently different for a separate High Current Supervisor and Deputy to be appointed. Otherwise the procedures detailed in High Voltage above will be implemented but with the word “current” substituted for “voltage”.

## **Building Wiring (Class F)**

Building lighting circuits and the power distribution wiring in all Physics buildings is the responsibility of the University Estates Services. It is the responsibility of the University Electrical Engineer on behalf of the University Estates Services to determine the competence of personnel who work on building wiring and any precautions necessary to ensure work may be carried out safely. Although specific Physics Building Services staff may be approved to undertake work on building wiring such work may only be done after the authority of the University Electrical Engineer has been given for each individual task.

## **Competence to Work on Electrical/Electronic Systems in Hazard Classes C, D, E**

Physics personnel are only permitted to undertake electrical/electronic work within the limits defined below:

### **a. Supervision, b. Inspection and c. Testing.**

Only Electrical Supervisors as detailed are allowed to undertake these activities.

### **d. Testing under Supervision.**

All academic and research support staff, all electrical/electronic and laboratory technicians and all graduate students are considered competent to test under supervision. Undergraduates assessed as competent by an Electrical Supervisor may also carry out this activity in Hazard Class C only. Supervision may require verbal or written instructions and/or intermittent, regular or constant physical supervision. It is the responsibility of the appropriate supervisor to determine the necessary level of supervision taking account of the skill and experience of the tester and the level of hazard involved.

### **e. Repair and Maintenance.**

Whenever possible repair and maintenance work is to be carried out with the equipment isolated from the power source and fully discharged to earth. In many cases, e.g. VDUs and circuits incorporating large capacitors, specialist electrical knowledge is necessary to recognise the potential hazards and render the equipment safe before repair can begin. Consequently repair is treated in the same way as “Testing under

Supervision” and the same competency criteria apply. Repair or maintenance that involves working live must be kept to the absolute minimum and only carried out in a designated area incorporating the necessary safety precautions if at all practicable. Competent electrical personnel who consider that the repair or maintenance necessitates working live must obtain written permission from the appropriate Electrical Supervisor.

**f. User Replacement.**

All staff are permitted to fit normal replacement items, e.g. bulbs and externally accessible fuses, without supervision but the equipment must be switched off prior to replacement. Other items designed for user replacement or modification, e.g. computer expansion boards, may also be incorporated without supervision provided that the equipment is rendered safe and isolated from the power source. However specialist knowledge may be required to render the equipment safe, see above, in which case an appropriate level of supervision must be sought in such cases.

**g. Design.**

Electrical or electronic equipment design should consider the safety aspects of the circuit, physical layout, the specification of components and the need to include safety devices. Electrical Supervisors are permitted to design circuits and equipment without further approval. However, when designing major new equipment or significant modifications the need for an independent review should be carefully considered. All other personnel must submit their designs to an Electrical Supervisor for approval. In assessing the design the Electrical Supervisor should only consider the safety requirements of the design and limit any comments to these features only.

**Live working**

- (i) Live working is any testing, repair, modification or maintenance carried out on or in the vicinity of electrical apparatus when the apparatus has not been isolated from the power source, has not been fully discharged to earth and live or potentially live conductors or components are exposed. Live working on Hazard Class A or B circuits would not present a safety problem but could result in damage to the apparatus and should be avoided. Live working on or in the vicinity of Hazard Class C or above presents safety problems which are potentially lethal.
- (ii) Live working on systems in Hazard Class C or above is only to be undertaken in exceptional circumstances when it has been proved to the satisfaction of an Electrical Supervisor that the work requires that the apparatus should remain live and it would be unreasonable for the work to be carried out in any other way. Live working on Hazard Class C or above may only be carried out by electrically competent personnel in designated live working areas incorporating all the necessary safety precautions and procedures.
- (iii) In cases where it is impractical to remove the equipment to a designated live working area it may be necessary to carry out live working in-situ on systems in Hazard Class C. In these circumstances the Area Electrical Supervisor must authorise the in-situ live working by issuing a permit after ensuring that all necessary safety precautions have been detailed and that the personnel who will do the work are electrically competent and are aware of any particular problems. The permit must be given to the person in charge of the work prior to any work beginning and a copy of the Issue certificate is to be retained by the issuing supervisor. When the work has been completed, suspended or the permit is time expired the clearance certificate must be signed by the person in charge of the live working and the permit returned to the issuing supervisor. The issuing supervisor will then cancel the permit and retain it for a period of three months.

- (iv) Live working on High Voltage or High Current systems may only be authorised by the appropriate Supervisor or deputy after carrying out the procedure for Hazard Class C above.
- (v) Often it is necessary to take experimental measurements or readings and make adjustments with apparatus connected to its power source. Experimental apparatus should be designed or modified to permit these activities without exposing live conductors or components. Any design or modification of experimental apparatus must be authorised under the procedures detailed in part g. of the section Competence to Work on Electrical/Electronic Systems in Hazard Classes C, D, E. If the apparatus does not conform to these requirements all such experimental activities will constitute live working and the procedures in (ii), (iii) and (iv) will apply.

### **Work for Outside Agencies**

If the Department of Physics is required to provide electrical or electronic equipment to an outside agency either under a formal contract or otherwise, the normal response is to provide equipment in compliance with the electrical principles stipulated in the Electrical Equipment (Safety) Regulations 1994. These Regulations require electrical equipment to be safe and constructed in accordance with good engineering practice. Written instructions for safe operation of the equipment must also be provided for the intended recipient.

If the Department is required to meet some other standard then the specification must be referred to Central Electronics, or the group who would undertake the work, who must indicate their agreement prior to the Department accepting the task.

### **Testing of Portable Electrical Equipment**

- Portable electrical equipment is defined as any electrically powered equipment, irrespective of size, weight or ease of mobility, which is connected to its power source via a plug and socket connection.
- The Electrical Safety Advisory Committee requires that all electrical equipment supplied by a plug is safety inspected/tested before being brought into use and regularly thereafter. Normally such equipment would enter Physics through the Clarendon or DWB stores. Following any booking in and inventory procedures the equipment should either be inspected /tested in Stores or delivered to Central Electronics or an electrical safety test technician for initial inspection/test. Only after the equipment has been passed as safe and a retest date established will it be passed to the user. Electrical safety testing and visual safety inspection methods and frequencies should be determined by the designated electrical safety test technician and should be in accordance with the current IEE 'Code of Practice for In-service Inspection and Testing of Electrical Equipment'; the University Policy Statement [S4/10](#) and published HSE guidance.
- Internally manufactured portable electrical equipment, equipment collected direct from the supplier or otherwise introduced into Physics would not necessarily pass through the stores. As for all other safety matters it is the responsibility of Group Leaders and others as nominated in the Physics Statement of Safety Organisation to ensure that all electrical equipment in use within their area of responsibility is tested prior to initial use and retested at the appropriate intervals thereafter.
- The Regulations do not differentiate between Physics-owned portable electrical equipment and portable electrical equipment owned by others but operated in the Department. Private portable electrical equipment may not be used in Physics unless it has been tested and passed as safe by an electrically competent person in Physics. Private portable electrical equipment will be tested by Physics free of charge provided that:
  - a. Permission is given by the owner.

- b. Physics is not held responsible for any damage resulting from the testing nor for the repair of any faults discovered.
  - c. The results of the test are not used by the owner as an indication of the condition of the equipment other than at the time and place of the test.
- Portable electrical equipment owned by other organisations with a recognised testing regime and provided for use in Physics need not be tested unless the period of use exceeds the normal Physics testing interval for such equipment. Where such equipment remains in use for a period in excess of the normal Physics testing interval it will be treated as Physics equipment for the purposes of electrical safety.
  - Portable electrical equipment owned and used by outside contractors will be the responsibility of the contractors.

### **Equipment Procurement and Review of Existing Equipment**

All research groups must procure commercial electrical/electronic equipment conforming to British Standards, European Standards, or if purchased outside the EU must be verified as electrically safe by the importer or supplier and be CE marked. Any items of equipment built in-house and outside of these standards must be subject to risk assessment prior to first use by an electrical safety panel nominated by ESAC. It would be normal for this panel to issue any additional written safety procedures and/or measures.

A rolling programme of inspection of existing equipment has been instituted to minimise risks and bring systems and equipment up to the latest standards so far as it is practicable to do so.

### **Additional Information**

Additional information on electrical safety is contained in the following documents. If detailed guidance is required personnel must consult these references.

- University Policy Statement [S4/10](#) Working Safely with Electricity.
- British Standard BS 60204-1:2006+A1:2009, Safety of machinery. Electrical equipment of machines. General requirements.
- British Standard PD 5304:2005 Guidance on safe use of machinery.
- British Standard BS EN 61010-1:2001, Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements.
- British Standard BS EN 60950-1:2006+A2:2013, Information technology equipment. Safety. General requirements.
- British Standard 6626:2010 Maintenance of electrical switchgear and control gear for voltages above 1 kV and up to and including 36 kV. Code of practice.

The above list is not exhaustive and if required further information must be sought from the appropriate Electrical Supervisor who is to contact the University Safety Office as necessary.

### **Annex. Definitions of Hazard Classes**

#### **Class A. Safety Extra-Low Voltage**

Circuits operating at <42.4V peak a.c. or <60V d.c. and where no likely fault will cause a transient to exceed 65V or the operating voltages for >0.2 seconds. Stored energy to be <20J and available power to be <240VA.

#### **Class B. Limited Current**

Circuits operating below the Class D limits where no hazardous currents flow in normal or likely fault conditions. Currents up to 2mA d.c. or 0.7mA peak a.c. up to 1kHz rising linearly with frequency to 70mA peak a.c. at 100kHz are permissible. In circuits operating at <450V the circuit capacity is to be <0.1 microfarad. In circuits operating at >450V the circuit capacity is to be <0.05 microfarad.

**Class C. Hazardous Low Voltage**

Circuits operating at <650V peak a.c. or <1000V d.c. which fail to meet the Class A or Class B definitions.

**Class D. High Voltage**

Circuits operating at >650V a.c. or >1000V d.c.

**Class E. High Current**

Circuits operating at >100A and all pulsed magnet systems producing peak fields >0.1 Tesla.

**Class F. Building Wiring**

All building lighting circuits and all power distribution circuits designed as part of the building services and terminating in a socket or equivalent termination.

**NOTES**

- Class A and Class B are considered non-hazardous and Class B is specifically defined to permit extension of voltage limits where current is severely restricted.
- The Committee has defined Class A and Class B to be consistent with British Standard BS EN 60950.
- The Committee has defined the demarcation between Class C and Class D to be consistent with British Standard 6626:1985.

