University Code of Practice for Electrical Safety

PART B - Design and Construction of Electrical Equipment within the University

The purpose of this part of the Code of Practice is to assist Departments and Schools in ensuring that the hazards arising from electrical equipment are properly considered during the design and construction phase of the equipment.

Part B particularly applies to systems greater than 50 volts a.c. and 120 volts d.c. Systems designed and constructed for lower voltages need to be covered by a risk assessment.

B1 Regulations

The precautions to be observed are defined by the Electricity at Work Regulations 1989. Equipment designed and constructed "in house" should comply with the requirements of these Regulations.

Technical guidance on how to achieve the above general requirements is contained within the 17th Edition of the Institute of Electrical Engineers (IEE) Wiring Regulations.

It should be noted however that there are additional provisions relating to such equipment which is supplied to a third party by way of a transaction with accrues a benefit to the University, i.e. sale, or exchange.

The Electrical Equipment (Safety) Regulation 1994, cover this situation with a requirement for construction in accordance with relevant standards, for marking that the equipment is safe and preparing a written declaration of conformity with these standards along with supporting technical documentation.

B2 Requirements of Regulations

B2.1 General Requirements

In order to ensure that people are not placed at risk due to a lack of skills on the part of themselves or others in dealing with electrical equipment, work on electrical systems should be undertaken only by suitably competent people. For a person to be deemed competent the Electricity at Work Regulations 1989 require that they possess relevant technical knowledge or experience, including; adequate knowledge of electricity; adequate experience of electrical work; adequate understanding of the system to be worked on and practical experience of that class of system; understanding of the hazards which may arise during the work and the precautions which need to be taken; the ability to recognise at all times whether it is safe for work to continue.

In practice this means that electrical works should be undertaken only by a qualified, apprenticed electrical tradesperson/technician that will typically be in the employ of the Estate Office, School or Department or an approved contractor.

The Electricity at Work Regulations 1989 specify a general requirement that electrical and electronic systems (this term includes equipment which uses electricity) are so constructed as to prevent electrical danger. The term "construction" has a wide application which includes the physical condition of the equipment and the arrangement of the components within it at any time during its life. It also includes the design of the equipment and the design and build quality of systems comprising a number of related pieces of equipment. These Regulations also consider specific aspects relevant to the design and construction of electrical equipment, namely:

- The strength and capability of electrical equipment;
- Suitability for use in adverse or hazardous environments;
- The insulation, protection and location of conductors;
- Earthing or other measures to protect against dangerous faults;
- Electrical and mechanical strength of connections in conductors;
- Over-current protection;
- Means for interrupting and isolating from the electrical supply.

How these objectives are to be achieved is not defined in the Regulations. They can be satisfied however by adherence to harmonised European standards (Euronorms, i.e. ENXXX) or national or international standards (e.g. British Standard or EC or ISO Standards). (Where European Standards have been adopted as a British Standard these are noted BS EN XXX).

B2.2 Outline of minimal construction standards

Appendix 1 to this part lists some of the more significant standards concerning electrical safety in relation to the type of electrical/electronic equipment, which might be constructed "in house". There is also a considerable range of detailed constructional standards to which certain components or pieces of equipment should be constructed or selected for incorporation into the final product.

B2.3 Strength and capability of electrical equipment

The equipment should withstand the foreseeable demands to be placed upon it, including faults, pulses and transients. The ability of the equipment to withstand the thermal, electromagnetic, electrochemical or other effects arising from it electrical use should be anticipated in its design and construction.

B2.4 Adverse or hazardous environments

A knowledge of the environments in which the equipment may be used will be required to ensure adequate protection against damage. The effects of the weather, natural hazards, temperature or pressure; the effects of wet, dirty or corrosive conditions, or the effects of any flammable or explosive substance, including dusts, vapours or gases must be considered. This enables the selection of appropriately designed and constructed components to be incorporated into equipment under construction. The

principle standards for electrical equipment operating in these environments are contained in Appendix 1.

B2.5 Insulation, protection and placing of conductors

Circuit conductors should either be insulated or physically shielded such that they are inaccessible. Fire and explosion hazards arising from contacts between conductors, or between a conductor and earth, need consideration along with the potential for electric shock. Conductors may be the mains supply to an experimental rig or simple wiring within electronic equipment which may be at a dangerous potential.

B2.6 Protection against electrical faults

Equipment should be designed and constructed to prevent any accessible conductive parts of the equipment from becoming charged in the event of an electrical fault.

The earth conductors and equipment casing should be designed and constructed so as to be able to cope with any foreseeable fault condition and thereby enable fuses or circuit breakers to operate. They must also be mechanically strong enough to withstand likely wear and tear and physically protected if necessary.

Particular care-needs to be exercised if long supply cables are envisaged. These may introduce an impedance into the earthing circuit with the consequence that in the event of a fault energised parts of the equipment may be raised to a dangerous potential above earth. For this reason long supply cables should be avoided and the equipment located in reasonable proximity to a mains outlet in the building's fixed installation. No devices should be incorporated into the earth conductor which could either break the electrical continuity or introduce a high impedance, e.g. switches, fuses, thyristors, transistors, if that earth conductor is relied upon for electrical safety.

B2.7 Connections

All connections in the electrical system should have sufficient mechanical strength and electrical insulation to prevent failure under the likely conditions of use and fault. For example, wires twisted together and protected with insulation tape would not be adequate on either count as a 240 V mains supply. No relaxation in the requirement is allowed for temporary installations.

B2.8 Overcurrent protection

Protection against faults and overloads should be provided in the incoming supply by way of fuses or circuit breakers etc. Further protection within the equipment should be provided if the rating of the conductors forming the branch circuit is less than that of the conductors from which it is drawing power and danger could thereby result.

B2.9 Interruption and isolation of the supply

Equipment should be provided with mains input switches which are conveniently located for use by the operator. The "On" and "Off" positions should be clearly identified. Where

more than one phase is used all phases should be disconnected by the operation of the switch.

If the equipment cannot be isolated by unplugging the incoming supply, then the supply should be made through an isolator which is capable of being secured in the "Off ' position, for example by the use of padlocks.

B2.10 Operating and maintenance instructions

The equipment should have written instructions describing the procedure for its safe operation. These should also state whether it has been designed for any higher risk working environments, e.g. wet or flammable environments. Any limitations on its use should similarly be described.

The instructions should also describe any precautions which have been taken against electrical hazards, e.g. interlocking of access covers where there is a need for routine access into areas where exposed conductors would otherwise be energised to dangerous voltages.

Instructions for maintenance of the equipment should also be provided. These should include the nature and frequency of any inspections or tests which due to the nature of the equipment or its intended use are needed over and above the general maintenance considerations as described in Part A of this Code. A further example would include routine cleaning where failure to do so could again result in danger e.g. overheating of a motor due to the accumulation of dust which would be expected in an environment in which it is intended to be use.

B2.11 Enquiries prior to design and construction of the equipment

European Standard EN60204-1: 1998 contains at Appendix B an enquiry form for the electrical equipment of machines. A derivative of this form, which is more suitable for use within the University, is attached to this part of the Code as Appendix 2. Workshops engaged in this type of activity may find this useful during discussions with the end user to assist in covering all the aspects involved.

Appendix B1

List of certain principle electrical standards

European Standard EN60204-1: 1998, "Safety of Machinery - Electrical Equipment of Machines, Part 1: General Requirements"

British Standard BSEN60601: 2002, "Medical Electrical Equipment - General Requirements for Safety"

British Standard BSEN60309-2: 1999, "Plugs, socket outlets and couplers for industrial purposes" (NB BS4343:1968 "Specification for industrial plugs, socket outlets and couplers for AC and DC supplies" has been replaced by this Standard but remains current).

British Standard BS5501, Parts 1-9, 1977-1988, "Electrical apparatus for potentially explosive atmospheres" (partially replaced by BSEN50014:1992)

British Standard BSEN50014: 1998, "Electrical apparatus for potentially explosive atmospheres general requirements"

British Standard BS4683:1971, "Specification for electrical apparatus for explosive atmospheres"

British Standard BS6467, Parts 1 and 2, 1985 and 1988, "Electrical apparatus with protection by enclosure for use in the presence of combustible dusts".

British Standard BSEN61010-1 "Safety requirements for electrical equipment for measurement, control and laboratory use".

BS 7671: 2008. The 17th edition IEE Wiring Regulations (BS 7671) are the UK national standard to which all domestic and industrial wiring must conform.

Appendix B2

Enquiry form for the electrical equipment of machines (derived from BSEN 60204-1:1992)

Appendix B2 is now available as a separate Word document to enable editing of the form.

Appendix B2 – Word