Hazardous electrical equipment in laboratories

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 unshrouded pins.

Alternatively, power interlocking using a positive mode safety switch 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.

Refrigerators and freezers

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.

It is possible to modify domestic refrigerators and freezers for uses involving the storage of flammable solvents by removing the interior light and door switch, as well as disconnecting any defrost and/or anti-stick door seal heaters, and fitting an external solid state circuit between the power source from the compressor and the thermostat. The switching current must be reduced to around 50µA.

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, no one should work alone. 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 for each other's safety.

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.

Car Batteries

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, and hence burns, arising from conductors which accidentally fall 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 free of ignition sources, since hydrogen can be produced, and the dangers from battery acid should also be noted.

Car batteries should be disposed of carefully, in accordance with the University's Waste - Code of Practice.

Equipment used in hazardous areas

The electrical hazards associated with fieldwork and work in greenhouses and animal houses are those of 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.

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.

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:

1. Installations should be designed and constructed in accordance with British Standard 5501:1977 entitled, "Electrical Apparatus for Use in Potentially Explosive Atmospheres".
2. Precautions must always be taken to prevent the ignition of flammable atmospheres by the discharge of static electricity.
3. 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.

Medical electrical equipment

All medical electrical equipment must be constructed and installed to the general requirements of BS EN 60601-1:2006+A12:2014, "Medical electrical equipment. General requirements for basic safety and essential performance". All such equipment must be operated under the jurisdiction of qualified persons to the standards described in the British Standard.

Radiation hazards

Some specialised electrical equipment may be capable of emitting either ionising or non-ionising radiations. Adventitious X-rays may be produced by electrical equipment operating at high voltage, above 5000V, including electron microscopes, electron beam welders and some HV gas filled tubes.

Equipment operating at frequencies below 10GHz may emit significant levels of radiofrequency or microwave radiations and exposure should be minimised. Further guidance on radiation hazards may be found on the Radiation Protection website at http://www.ed.ac.uk/health-safety/radiation-protection/policy-guidance.

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) 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 become charged, and should not be used.