23High Voltage Electrical Equipment

Scope

1. This Chapter details the requirements for protection of persons from ionising radiations emitted by high voltage (HV) equipment. The scope of the Chapter does not extend to the requirements for protection against non-ionising radiofrequency radiation that may also be present and provide an additional hazard (see Chapter 35). Nor does the scope extend to other items such as radioactive electronic valves, gaseous tritium light sources or smoke detectors which may also be associated with the electrical equipment. Such items are addressed in separate chapters.

2. Under certain circumstances, ionising radiation in the form of X-rays may be emitted by HV electrical equipments not specifically designed to produce such radiation. Charged particles (electrons) acquire high energy when accelerated under the influence of HV – the energy lost by these electrons on striking a target material may be emitted in the form of X-rays known as adventitious or parasitic X-rays. Where the HV involved exceeds 5 kV, the Ionising Radiations Regulations 2017 (IRR17) apply to work involving the equipment. This Chapter describes the resulting ionising radiation safety requirements for work with such equipment.

3. The most commonly found components producing parasitic X-rays are klystrons, magnetrons, high voltage valves, travelling-wave tubes and cathode ray tubes, although there are many other components capable of producing them in equipment such as high voltage rectifiers, display units and radar / electronic warfare equipment.

Statutory Requirements

4. In addition to the general requirements of the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, the following specific legislation applies directly:

   a. Ionising Radiations Regulations 2017 (IRR17).

Duties

5. Duties as detailed in Chapter 39 apply. In addition, the following duties also apply.

Workplace Supervisor (X-ray) (WPS (X-ray))

6. In units operating or maintaining high voltage equipment capable of emitting parasitic X-rays but where it is not necessary to appoint an RPS, a WPS (X-ray) is to be appointed with duties to ensure that work is carried out in accordance with the local orders which are to include the requirements of this Chapter.

Hazards

7. Parasitic X-rays are a by-product arising from many types of high voltage equipment (>5 kV). They may be emitted from klystrons, magnetrons, high voltage valves, travelling-wave tubes, cathode ray tubes and many other components such as high voltage rectifiers, display units and radar / electronic warfare equipment.

Risk Assessments for High Voltage Equipment

Risk assessment at procurement

8. In the acquisition of equipment which may emit ionising radiation, safety and environmental management is to begin at the *requirements definition* stage of procurement and is to be carried forward through service to disposal. All aspects of maintenance and operation (including military service) are to be taken into account. Those managing the procurement process and specification development of the equipment which may emit ionising radiation are to assess the risk areas and recommend solutions to reduce the risks to as low as reasonably practicable (ALARP) (see Chapter 1 and Chapter 2). Where it is possible to produce a generic risk assessment, this is to be carried out and made available to users.

Risk assessment for users

9. A radiation risk assessment (RRA) is to be carried out by the unit or establishment in consultation with the radiation protection adviser (RPA) before undertaking any new activity involving high voltage equipment that may generate parasitic X-rays. This risk assessment is to take into account the generic risk assessment carried out at the procurement stage (if available) and the recommended solutions to reduce risk provided by the acquisition process and the local conditions of use. Details of the form of the risk assessment and the actions to be taken arising from it are described in Chapter 2. Risk assessments are to be reviewed as detailed in Chapter 2.

10. The following are key inputs into the risk assessment:

a. advice from the manufacturer and information from the Project Team;

b. RPA information and advice – the Dstl RPA Body (Dstl) may be able to provide detailed hazard and risk assessment information on the equipment;

c. radiation survey information – estimated dose rates when operating and during maintenance (if carried out);

d. planned systems of work and routine operation profile e.g. continuous, intermittent, 1 hour per day etc. Routine maintenance profile e.g. 8 hour per week at operating voltage;

e. personnel access and occupancy of areas subject to levels of ionising radiation;

f. assessment of reasonably foreseeable fault conditions and resultant dose rates; and

g. assessment of the impact of reasonably foreseeable accidents / incidents / occurrences.

Design of Equipment

11. All high voltage electrical equipment is to be provided, where reasonably practicable, with shielding to ensure that beams or fields of radiation do not produce accessible dose rates in excess of 1 µSv/hr in the working area. If this is not reasonably practicable, other control measures may be necessary and are to be determined in consultation with the RPA.

12. The equipment is to, by design, or by the provision of safety devices prevent anyone reaching inside to an area where the dose rate exceeds 7.5 µSv/hr. Where practicable, the safety devices are to be fail-safe.

13. Where access to the inside of any equipment is permitted, protective covers providing shielding to components producing parasitic X-rays are to be incorporated into the design.

Installation

14. The installer of equipment operating at more than 5 kV and where ionising radiation could be emitted has a number of duties imposed by IRR17, in particular:

a. they must carry out a critical examination of the way in which the equipment has been installed ensuring that safety features and warning devices operate correctly and that there is sufficient protection for persons from exposure to ionising radiation;

b. they must consult with their RPA or with the operator's RPA with regard to the extent of the critical examination and in regard to the results of that examination; and

c. they must provide the employer (the employer being the operator of the equipment e.g. the CO, Head of Establishment) with adequate information about proper use, testing and maintenance of the equipment.

15. The employer must consult their RPA regarding the plans for installing the equipment in relation to engineering controls, design features, safety features and warning devices. They are also to consult the RPA regarding the acceptability of the test results of the critical examination and the requirements and results of any further commissioning tests or radiation surveys.

16. The employer is to ensure that they understand the information provided by the manufacturer and installer and that a radiation survey is carried out prior to first use.

17. The equipment is not to be operated until any deficiencies identified in the initial inspection have been repaired by a suitably qualified person, and the equipment has been re-inspected and monitored.

Protection against Parasitic X-Ray Emissions

18. X-ray emissions identified by a unit or establishment that are not referred to in the equipment handbook are to be reported to the equipment sponsor, the appropriate TLB safety authority and the RPA (Dstl).

19. Sponsors of equipments producing parasitic X-ray emissions are, where reasonably practicable, to introduce modifications to minimise the hazard to personnel. This may be by the provision of shielding around the equipment or part of the equipment which generates the parasitic X-rays.

20. Where removable radiation shielding is provided, it is to be used as directed in the equipment handbook. Such shielding is to be marked to indicate the presence of an increased radiation hazard if it is removed. Equipment's with removable shielding are to, whenever practicable, be fitted with engineered controls e.g. interlocks to prevent the equipment from operating when the shielding is removed.

Increased Ionising Radiation Hazard during Maintenance

21. Where users carry out maintenance or inspection tasks which require the equipment to be powered up, account must be taken of the increased hazard faced by maintainers. The increased hazard may be due to the need for access to components which are normally shielded or due to the need for a maintainer to be positioned closer to the source of ionising radiation than is necessary during normal operation. These issues must be carefully considered in the risk assessment and appropriate measures to restrict exposure introduced. Such measures must be described in local orders for radiation safety (see Chapter 16) and must also be included in the training of maintainers.