

SAFETY WARNINGS TO END USERS

RISKS ASSOCIATED WITH ELECTRON TUBES

This document draws the attention of equipment makers and users to the possible risks associated with electron tubes, so that the necessary personnel protection measures can be taken.

Electron tubes present a certain number of potential risks, by the very nature of the physical principles included in their manufacture or operation, and because of the materials used to make these tubes.

The operation of electron tubes under appropriate conditions, either due to lack of care or knowledge, can lead to grave risks to the life and limb of personnel, independent of the risk of tube destruction and/or equipment damage.

Equipment manufacturers and end users bear the responsibility for informing themselves, for protecting against these risks, and for respecting local safety laws and regulations.

It is the user's responsibility to refer to the specifications and recommendations for electron tube use, as well as to the documents provided by the manufacturers of systems incorporating these tubes.

WARNING

The following list is not exhaustive. The main known risks, which may or may not be associated, are described. The relative importance of each risk depends on the type of tube.

ELECTRICAL RISKS

The high voltages necessary for electron tube operation can be deadly. Solely qualified personnel, specifically trained for these operations, must perform all operations. This precaution applies to all tube families, and becomes increasingly important as the energy levels present increase.

Interlocks, grounding poles, etc. must prevent access to zones under voltage. Arrangements must also be made for capacitor discharge, e.g. bleeders, automatic grounding etc. all shutdowns.

In fact, an electron tube itself constitutes such a capacitor, and the appropriate measures must be taken to prevent handling of a tube until it has been completely discharged.

NON-IONIZING RADIATION

The exposure of personnel to the electromagnetic fields produced by electron tubes, even at low frequencies must be limited to the minimum possible. Direct exposure of the eyes to strong fields can lead to blindness. Never look into an operating wave guide, antenna, or the end of a coaxial line.

RF radiation can also affect the operation of pacemakers.

Avoid all electromagnetic leakage. Special care must be taken with connections, wave-guide, joint, coupling etc. Never operate a tube without it being connected to a suitable matched load.

IONIZING RADIATION (X-rays)

The harmful effects of the X-rays that may be generated by an electron tube increase as the applied operating voltage reaches 10 kV. This is especially true for metal tubes. The greater the tube current, the more dangerous the X-rays are.

In certain types of tubes, (magnetrons), the hardness of the X-rays emitted corresponds to a voltage two or three times greater than that actually applied to the tube.

The envelope of certain tubes can act as a screen or shield. In general, however, provision must be made for external X-ray shielding either around the tube only (in particular, the cathode and the collector of microwave tubes), or around the pan of the equipment in which the tube is installed.

The glass used in making the faces of cathode ray tubes in general contains sufficient lead or other heavy metals to ensure that the small amounts of X-rays generated in these tubes are absorbed. The residual doses thus are below the detection thresholds of ordinary measuring instruments, and in any case well within the limits imposed by the regulations or law.

In practice, no detectable radiation appears for voltages of less than 20 kV. Special operating modes can, however, lead to the appearance of measurable doses. We suggest in all cases to take readings so that adequate protective measures can be defined and implemented.

For those tubes whose operation leads to this production of X-rays (for example, high power klystrons), Thales Electron Devices has designed shielding enabling the most common exposure rules to be respected.

Nevertheless, we recommend that periodic checks be made, since tube aging can lead to modifications in the quantity of radiation emitted, it is also advisable, in general, for personnel to carry dosimeters or wear film badges. X-ray image intensifiers used in medical and industrial radiology are designed to be placed in the direct path of the X-rays emitted by a source, X-ray tubes are designed to radiate X-ray, these tubes must nevertheless have shielding defining the active zone and limiting the radiation present outside this zone to the accepted values. Equipment manufacturers are responsible for complying with regulation. Thales Electron Devices supplies certain tube types conforming to the US DHHS (Department of Health and Human Services) regulation in force.

IONIZING RADIATION (Radioactive materials)

Certain tubes contain small amounts of radioactive material essential to their operation. In most of these tubes, the resulting activity is so weak that no special regulations apply. These tubes are, however, marked with the international radioactivity symbol. The disposal instructions are found enclosed in the packaging.

In handling a broken tube, we recommend that rubber gloves be worn. Afterwards, wash any part of the skin that may have come into contact with the internal tube parts.

A limited number of tube types are subject to special regulation. These tubes can only be obtained, kept, stored, and destroyed in accordance with rules that must be respected by all parties concerned. These risks are summarized in a Thales Electron Devices publication. These products are marked in compliance with said rules.

IMPLOSION

Electron tubes are high-vacuum devices and the larger the area of their envelopes, the greater the force of the atmospheric pressure applied to the envelope is. The insulating and radiation transparent parts, made of glass or ceramics, are less mechanically resistant than those parts made of metal. In the event of blows or strains, whether externally caused or spontaneous, they can break and implode violently, projecting dangerous debris.

Therefore, it is very important not to scratch the glass and Ceramic parts of a tube, nor subject them to mechanical or thermal stress.

Cathodes Ray Tubes (CRTs) which have at least a glass face (which can be of large dimensions), and X-ray Glass Tubes must always be stored and transported in their original packaging, No strain must be placed on the tube neck. In general, a CRT will be placed temporarily face down on a soft and flexible surface, free of abrasive particles or on a Thales Electron Devices approved support, Same care shall be taken for X-Ray Glass Tubes.

Equipment must be designed to continuously protect the personnel in its vicinity,

The use of "intrinsically safe" CRTs (with bonded safety faceplates or pre-stressed belts) considerably reduces the risk of implosion to the unlikely event of implosion this considerably reduces its consequences. Handling and equipment design thus are made much simpler,

When handling these tubes which have not been self-protected, (due to at the customer's special request), personnel must wear protective equipment (apron, mask, goggles, gloves).

Never attempt to open a vacuum tube, whatever the type. This will liberate the strains created at tube fabrication and will have the same effects as an accidental implosion.

HIGH TEMPERATURES

High-power tubes dissipate very large amounts of heat. The corresponding energy is evacuated by circulation of air, oil or water, or by the generation of vapor, the cooling liquid can be at temperatures higher than 100° and under several bars of pressure in the case of water.

The volume, temperature, flow rate, and pressure characteristics generally do not require that the tube and the using equipment be subject to special regulations. The equipment maker and user are responsible for checking that a given installation conforms to the applicable regulations,

However, the untimely opening or break in a line can release very hot oil, water or steam, which can cause serious burns.

In the case of tube cooling by circulating air, surface temperatures can reach several hundred degrees centigrade. Certain tube parts, not directly cooled, can also reach a temperature of several hundred degrees centigrade.

Temperature elevation can sometimes continue after tube shutdown, due to thermal inertia, Therefore, it may be necessary to continue cooling the tube for a certain time after shutdown.

Precaution and instructions must be established to prevent personnel from coming into contact with insufficiently cooled tubes,

BERYLLIUM OXIDE (BeO)

Some tubes, notably microwave tubes, have beryllium-oxide (BeO) parts in their structures, Solid pieces of BeO present no danger, as long as they remain whole and unaltered, but BeO -laden dust, fumes, and particles of BeO are extremely toxic if inhaled. To prevent the penetration of BeO into the body through cuts or scratches, tube parts made of beryllium-oxide must never be touched with bare hands.

In the event of contact, the hands and skin contaminated must be washed thoroughly before eating or smoking.

When collecting accidentally broken parts made of BeO, place used adhesive tape, sponges, cloth, etc. in thick plastic bags which must be tightly closed and labeled : DANGER Beryllium oxide. Have these bags removed from the premises by a qualified disposal agency.

Never make any mechanical or chemical operations on the BeO parts, such as grinding, sanding, scraping, etching etc, only a few Thales Electron Devices Tubes have external structural parts made of beryllium, oxide. These ceramic parts are always marked with colored rings or have a bulk coloring (blue). A protective cardboard covering is printed with a safety warning. (All such coverings must be removed before operating a tube),

Tubes having internal structural parts made of BeO (or other beryllium based compounds) are marked with a Thales Electron Devices warning label. Since this label could be masked or torn off, however, we strongly recommend that our microwave tubes never be opened by a user or original equipment manufacture (OEM).

MISCELLANEOUS

In using microwave tubes, equipment manufacturers (OEMs) may find it necessary to pressurize the associated wave-guides with such gases as Freon or sulphur hexafluoride, which can give rise to highly toxic and corrosive byproducts (such as phosgene or beryllium fluoride), in the case of an electrical discharge has occurred in the presence of these gases. All precautions must be taken before authorizing access to the tube,

Some tubes (mercury vapor Thyatron contain mercury, which is a toxic substance. Be very careful to ensure that no mercury leaves the sealed tube. Disposal of these tubes must be handled by a specially accredited organization.

In certain equipment, the tube operating systems can cause disagreeable and possibly tiring noise, including infra and ultrasound. This is especially true in the case of pulsed operation of high-power tubes, recurrent scanning of CRTs at high frequency, disruptive discharges, etc,

Some electron tubes have powerful permanent magnets or electromagnets associated with them, which may cause various disturbances. These tubes and their packing materials carry informative and warning labels,

Some tubes are heavy, and therefore require the use of lifting machines, and various accessories, that come to close contact with the tubes. These machines and accessories must be inspected periodically.

The information appearing on a CRT may be unstable or flickering due to the design or faulty circuits. This may result in operator eyestrain or headache. Incorrect setting of contrast and intensity controls by the user or inappropriate installation may lead to similar problems.