

OPERATING HAZARDS
READ THIS SHEET AND TAKE ALL
SAFETY PRECAUTIONS

CAUTION - KEEP THIS SHEET WITH TUBE UNTIL INSTALLED IN EQUIPMENT

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS WHO INCORPORATE THE TUBE INTO EQUIPMENT AND USERS OF SUCH TUBES AND EQUIPMENT. THE SUPPLIER OF THIS POWER TUBE PROVIDES INFORMATION ON ITS PRODUCTS AND ASSOCIATED HAZARDS, BUT IT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES. LIMITED LIFE AND RANDOM FAILURES ARE INHERENT CHARACTERISTICS OF ELECTRON TUBES. TAKE APPROPRIATE ACTION THROUGH REDUNDANCY OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM TUBE FAILURE.

ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

OPERATING INSTRUCTIONS

This Operating Hazards Sheet, any packing and unpacking instructions, installation instructions, operating instructions, and relevant test data which may be included with this Power Tube can help you to operate this tube safely and efficiently. READ THEM. The Technical Data Sheet for this power tube provides operating specifications for individual products and other application information. Uninformed or careless operation of this tube can result in poor performance, damage to the tube or property, serious bodily injury, and possibly death.

Questions regarding tube operation or safety matters should be addressed to the Applications Engineering Department.

WARNING - SERIOUS HAZARDS EXIST IN THE OPERATION OF POWER TUBES

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

- a. **HIGH VOLTAGE** - Normal operating voltages can be deadly. See below for additional information.
- b. **RF RADIATION** - Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness or death. **Cardiac pacemakers may be affected.** See below for additional information.
- c. **X-RAY RADIATION** - High voltage tubes can produce dangerous, possibly fatal X-rays. See below for additional information.
- d. **BERYLLIUM-OXIDE POISONING** - Dust or fumes from BeO ceramics used as thermal links with some conduction cooled power tubes are highly toxic and can cause serious injury or death. See below for additional information.
- e. **GLASS EXPLOSION** - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully. See below for additional information.
- f. **HOT WATER** - Water used to cool tubes reaches scalding temperatures. Touching or rupture of the cooling system can cause serious burns. See below for additional information.
- g. **HOT SURFACES** - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched. See below for additional information.

Additional specific information about power tube hazards:

HIGH VOLTAGE

Many power tubes operate at voltages high enough to kill through electrical shock. Design equipment utilizing these tubes to prevent personnel contact with high voltages. Securely attach prominent hazard warnings. Personnel should always break the primary circuits of the power supply and discharge high voltage capacitors when direct access to the tube is required.

RADIO FREQUENCY RADIATION

EXPOSURE OF PERSONNEL TO RF RADIATION SHOULD BE MINIMIZED. PERSONNEL SHOULD NOT BE PERMITTED IN THE VICINITY OF OPEN ENERGIZED RF GENERATING CIRCUITS, OR RF TRANSMISSION SYSTEMS (WAVEGUIDES, CABLES, CONNECTORS, ETC.), OR ENERGIZED ANTENNAS. It is generally accepted that exposure to "high levels" of rf radiation can result in severe bodily injury including blindness. **Cardiac pacemakers may be affected.**

The effect of prolonged exposure to "low level" rf radiation continues to be a subject of investigation and controversy. While there continues to be support for lower limits, it is generally agreed among official standard-setting groups in the U.S. that prolonged exposure of personnel to rf radiation at frequencies of 10 MHz-100 GHz should be limited to average power densities of ten milliwatts per square centimeter (10 mW/cm²) or lower, using any possible one tenth of an hour (.1 hour)

as the averaging period. It is also generally agreed that exposure should be reduced in working areas where personnel heat load is above normal. The 10 mW/cm² average level has been adopted by several U.S. Government agencies including the Occupational Safety and Health Administration (OSHA) as the standard or protection guide for employee work places.

Rf energy must be contained properly by shielding and transmission lines. ALL INPUT AND OUTPUT RF CONNECTIONS, SUCH AS CABLES, FLANGES AND GASKETS MUST BE RF LEAKPROOF. NEVER OPERATE A POWER TUBE WITHOUT A PROPERLY MATCHED RF ENERGY ABSORBING LOAD ATTACHED. NEVER LOOK INTO OR EXPOSE ANY PART OF THE BODY TO AN ANTENNA OR OPEN RF GENERATING TUBE OR CIRCUIT OR RF TRANSMISSION SYSTEM WHILE IT IS ENERGIZED. MONITOR THE TUBE AND RF SYSTEM FOR RF RADIATION LEAKAGE AT REGULAR INTERVALS AND AFTER SERVICING.

X-RAY RADIATION

As operating voltages increase beyond 15 kilovolts, power tubes are capable of producing progressively more dangerous X-ray radiation. Dangerous X-ray radiation is more likely from high-power transmitting tubes, many pulse-modulator tubes, high-vacuum rectifier tubes, and all older high voltage tubes that may have undergone changes in emission characteristics with aging and gradual deterioration. Provide adequate X-ray shielding on all sides of these tubes, particularly around the anode as well as the modulator and pulse transformer where these are used. Check X-ray levels. NEVER OPERATE HIGH VOLTAGE TUBES WITHOUT ADEQUATE X-RAY SHIELDING IN PLACE. MONITOR THE TUBE AFTER SERVICING AND AT REGULAR INTERVALS FOR POSSIBLE CHANGES IN X-RAY LEVELS DUE TO AGING.

DANGER:

BERYLLIUM OXIDE CERAMICS (BeO) - AVOID BREATHING DUST OR FUMES

BeO ceramic material is used as a thermal link to carry heat from the tube to a heat sink in a number of conduction cooled power tubes. The BeO thermal link may be brazed to the anode section of the power tube, or may be a separate accessory. Do not perform any operation on any BeO ceramic which might produce dust or fumes, such as grinding, grit blasting, and acid cleaning. **BERYLLIUM OXIDE DUST OR FUMES ARE HIGHLY TOXIC AND BREATHING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH.** Because BeO warning labels may become obliterated or removed, you are urged to contact your tube supplier before performing any work which might affect any external thermal link on any conduction-cooled power tube.

When BeO ceramics are to be salvaged or disposed of, special precautions must be taken to protect personnel. All such personnel must be made aware of the deadly hazards involved and the necessity of great care and attention to safety precautions. Any tube with a BeO thermal link, or any separate BeO thermal link will be disposed of without charge, provided it is returned freight prepaid to the supplier from which it was purchased with a written request for disposal. The supplier will then return it to the manufacturer for proper disposal.

GLASS EXPLOSION

Every power tube is pumped to a very high vacuum, which, in some cases, is contained by a glass envelope. When handling glass tubes, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage can cause an implosion, which will result in an explosive scattering of flying glass particles and fragments. Serious personal injury can result. The larger the tube envelope, the greater the potential hazard. When handling such tubes, safety glasses (or even better, a face shield), heavy clothing and leather gloves should be worn for protection.

HOT WATER

EXTREME HEAT occurs in the anode portion of power tubes during operation. Water channels used for cooling also reach high temperatures (as high as boiling, 100°C or 212°F. or above) and the hot water is under pressure (sometimes as high as 100 PSI). A rupture of the water channel or other contact with hot portions of this tube could scald or burn. Take precautions to prevent and avoid such rupture or contact.

HOT SURFACES

The anode portion of power tubes is often air-cooled or conduction-cooled. The air-cooled external surface normally operates at a high temperature (up to 200° to 300°C). Other portions of the tube may also reach high temperatures, especially the cathode insulator and the cathode/heater surfaces. All hot surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to prevent and avoid any bodily contact with these surfaces both during and for a reasonable cool-down period after tube operation.