



OPERATING HAZARDS

**READ THIS SHEET
AND TAKE ALL
SAFETY
PRECAUTIONS**

GENERAL CONDITIONS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO MICROWAVE VACUUM ELECTRON DEVICES (VEDs) ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH DEVICES. MICROWAVE POWER PRODUCTS, INC. (MPP) PROVIDES INFORMATION ON ITS PRODUCTS AND ASSOCIATED HAZARDS, BUT IT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES. DEVICE FAILURES MAY OCCUR; TAKE APPROPRIATE ACTION THROUGH REDUNDANCY OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM THE CONSEQUENCES OF PRODUCT FAILURE. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO MICROWAVE VEDs OR EQUIPMENT THAT UTILIZES SUCH DEVICES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

OPERATING INSTRUCTIONS

This sheet, the Test Performance Sheet, and the Operating Instructions can help you to operate this device safely and efficiently. READ THEM. The Test Performance Sheet is a record of individual product test conditions and test results at the factory. Special operating considerations and precautions are found in the Operating Instructions. Uninformed or careless operation of this device can result in poor performance, damage to the device or other property, serious bodily injury, and possibly death.

Address written questions regarding product operation to MPP Marketing at the address on the bottom of this sheet.

WARNING — SERIOUS HAZARDS EXIST IN THE OPERATION OF MICROWAVE DEVICES

The operation of microwave VEDs 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.

- HIGH VOLTAGE** — Normal operating voltages can be deadly.
- RF RADIATION** — Exposure to rf radiation can cause serious bodily injury, possibly resulting in blindness or death. Cardiac pacemakers may be affected.
- X-RAY RADIATION** — High-voltage devices can produce dangerous, possibly fatal, X-rays.
- BERYLLIUM OXIDE POISONING** — The dust or fumes from beryllium oxide (BeO) ceramics used in microwave VEDs are highly toxic and can cause serious injury or death.
- CORROSIVE AND POISONOUS COMPOUNDS** — If a dielectric gas is used in the external waveguide or around the high-voltage bushing portions of microwave VEDs, highly toxic or corrosive compounds may be produced by either rf voltage breakdown or high-voltage dc breakdown.
- FC-75 TOXIC VAPOR AND FLUID** — Decomposition products of the FC-75 coolant are highly toxic and can cause serious injury or death.

- IMPLOSION HAZARD** — Ceramic windows in microwave VEDs can shatter on impact or crack in use, possibly resulting in injury from flying particles or from beryllium oxide dust or fumes.
- HOT COOLANT AND/OR STEAM** — The electron collector and water used to cool it reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.
- HOT SURFACES** — Surfaces of air-cooled collectors and other parts of VEDs can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.
- Read the labels on your device for the specific product hazards that apply. Additional specific information about microwave device hazards are as follows:

HIGH VOLTAGE

Many microwave devices operate at lethal high voltages. To prevent electrical shock, equipment utilizing these devices must be designed to prevent personnel from coming into 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 device is required.

RADIO-FREQUENCY (RF) RADIATION

EXPOSURE OF PERSONNEL TO RF RADIATION SHOULD BE MINIMIZED. PERSONNEL SHOULD NOT BE PERMITTED IN THE VICINITY OF OPEN, ENERGIZED WAVEGUIDES 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. Although an absolute safe exposure limit is not defined, 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–300 GHz should be limited to average power densities as represented in Figure 1.

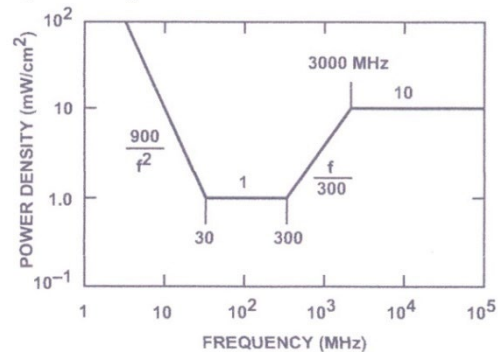


Figure 1. ANSI/IEEE MAXIMUM PERMISSIBLE EXPOSURE FOR CONTROLLED ENVIRONMENTS (IEEE C95.1-1991)

It is also generally agreed that exposure should be reduced in working areas where temperatures are above normal. This has been adopted as a guideline by several U.S. Government agencies, including the

Occupational Safety and Health Administration (OSHA), as the standard of protection for employee workplaces.

ALL INPUT AND OUTPUT RF CONNECTIONS, WAVEGUIDE FLANGES, AND GASKETS MUST BE RF LEAKPROOF. NEVER OPERATE A MICROWAVE DEVICE WITHOUT A PROPERLY MATCHED RF-ENERGY-ABSORBING LOAD ATTACHED. NEVER LOOK INTO OR EXPOSE ANY PART OF THE BODY TO AN ANTENNA OR OPEN WAVEGUIDE WHILE THE DEVICE IS ENERGIZED. MONITOR THE DEVICE AND RF SYSTEM FOR RF RADIATION LEAKAGE AT REGULAR INTERVALS AND AFTER SERVICING.

X-RAY RADIATION

As voltages increase beyond 15 kilovolts, metal-body devices are capable of producing progressively more dangerous X-ray radiation. Provide adequate X-ray shielding on all sides of these devices, particularly the cathode and collector ends, as well as the modulator and pulse-transformer tanks. Check X-ray levels. NEVER OPERATE HIGH-VOLTAGE DEVICES WITHOUT ADEQUATE X-RAY SHIELDING IN PLACE. MONITOR THE DEVICE AFTER SERVICING AND AT REGULAR INTERVALS FOR POSSIBLE CHANGES IN X-RAY RADIATION LEVELS DUE TO AGING.

DANGER — BERYLLIUM OXIDE, LEAD, AND COBALT

Some microwave devices contain beryllium oxide (BeO) ceramics, usually in the output waveguide window or around the gun. Most coupled-cavity VEDs contain BeO in loss elements distributed throughout the interaction cavities and, in some cases, in the collectors and waveguide windows. Lead is another material used in microwave devices, usually as an X-ray shield around the collector area of high-power microwave devices. Cobalt is a constituent in samarium-cobalt magnets used in certain microwave devices. Do not perform any operations on parts containing BeO, lead, or cobalt that produce dust or fumes; for example, sand or grit blasting, grinding, cutting, or acid cleaning.

CHRONIC EXPOSURE TO THE HIGHLY TOXIC DUST AND FUMES OF BERYLLIUM OXIDE, LEAD, AND COBALT CAN RESULT IN SERIOUS, LONG-TERM HEALTH EFFECTS.

WARNING

THIS PRODUCT MAY CONTAIN BERYLLIUM OXIDE, A CHEMICAL COMPOUND DETERMINED BY THE STATE OF CALIFORNIA TO CAUSE CANCER. THIS PRODUCT MAY CONTAIN LEAD, A CHEMICAL DETERMINED BY THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM. (Note: California law requires this warning.)

Devices containing beryllium oxide should be appropriately handled and disposed of in a manner consistent with any and all applicable federal, state, and local laws and regulations.

BERYLLIUM OXIDE WINDOWS

If a broken window is suspected, carefully remove the device from its waveguide and seal the output flange with tape. Because BeO warning labels may be obliterated or removed, we urge you to contact MPP before performing any work on ceramics in any MPP microwave VED. Some devices have BeO ceramics internal to the vacuum envelope. Take precautions to protect personnel working in the disposal or salvage of devices containing BeO and lead. All such personnel should be made aware of the hazards involved and the necessity for great care and attention to safety precautions.

CORROSIVE AND POISONOUS COMPOUNDS

External output waveguides and cathode high-voltage bushings of microwave VEDs are sometimes operated in systems that use a dielectric gas to impede microwave or high-voltage breakdown. If breakdown does occur, the gas may decompose and combine with

impurities, such as air or water vapor, to form highly toxic and corrosive compounds. Examples are Freon gas, which may form LETHAL PHOSGENE, and sulfur hexafluoride (SF₆) gas, which may form highly toxic and corrosive sulfur or fluorine compounds such as BERYLLIUM FLUORIDE. When breakdown does occur in the presence of these gases, VENTILATE THE AREA TO OUTSIDE AIR, AVOID BREATHING ANY FUMES OR TOUCHING ANY LIQUIDS THAT DEVELOP, AND TAKE PRECAUTIONS APPROPRIATE FOR BERYLLIUM COMPOUNDS AND FOR OTHER HIGHLY TOXIC AND CORROSIVE SUBSTANCES before permitting personnel to perform any work on or near the device. If a coolant other than pure water is utilized, follow the precautions supplied by the coolant manufacturer.

DANGER — FC-75 — TOXIC VAPOR AND FLUID HAZARD

Decomposition products of FC-75 are highly toxic. Decomposition may occur through exposure to temperatures above 200°C, to liquid fluorine or alkali metals (lithium, potassium, or sodium), or to ionizing radiation. Known thermal decomposition products include perfluoroisobutylene (PFIB; [CF₃]₂C = CF₂), which is highly toxic in small concentrations. If FC-75 has been exposed to temperatures above 200°C through fire, electric heating, or prolonged electric arcs or has been exposed to alkali metals or strong ionizing radiation, avoid any contact with the FC-75 and thoroughly ventilate the area; strictly avoid breathing any resulting fumes or vapors. Under such conditions, promptly replace the FC-75, and handle and dispose of the contaminated FC-75 as a toxic waste.

IMPLOSION HAZARD

Due to the internal vacuum in microwave VEDs, the glass or ceramic output window can shatter inward (implode) if struck with a hard object or subjected to mechanical shock. Flying debris could result in bodily injury, including cuts and puncture wounds, and, if made of BERYLLIUM OXIDE ceramic, produce highly toxic dust or fumes. DO NOT BREATHE SUCH DUST OR FUMES.

HOT COOLANT AND/OR STEAM

Extreme heat occurs in the electron collector portion of microwave VEDs during operation. Coolant channels also reach high temperatures (as high as boiling, 100°C or above), and the hot coolant is under pressure (typically as high as 100 psi). Some collectors are cooled by boiling the coolant and forming steam. A rupture of the coolant channel, the coolant or steam line, or other contact with hot portions of this device could scald or burn. Carefully check the security of all fittings and connections, and monitor backpressure for changes in cooling-system performance. Replace any defective fittings, and tighten any loose fittings or connections. If backpressure increases above normal operating values, shut down the system and clear the restriction.

HOT SURFACES

The electron collector portion of microwave VEDs is often air cooled or conduction cooled. The air-cooled external surface normally operates at a high temperature (typically 200°C to 300°C). Other portions of the device 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 device is shut off. To prevent serious burns, take care to avoid any bodily contact with these surfaces, both during and for a reasonable cool-down period after device operation.

STRONG MAGNETIC FIELD

Some microwave devices have strong permanent magnets that can disrupt pacemakers and other medical implants. To prevent such disruptions, maintain a safe distance from the microwave device so that exposure to its magnetic field is < 5 Gauss. To determine a safe distance, it is important to perform a magnetic-field measurement on each microwave device because magnetic strengths may vary.