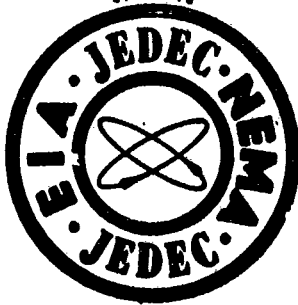


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Recommended Practice for
Measurement & Warning of Radio
Frequency Leakage from
Microwave Tubes

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RECOMMENDED PRACTICE FOR MEASUREMENT

AND

WARNING OF RADIO FREQUENCY LEAKAGE

FROM MICROWAVE TUBES



RECOMMENDED PRACTICE FOR MEASUREMENTANDWARNING OF RADIO FREQUENCY LEAKAGEFROM MICROWAVE TUBES1.0 INTRODUCTION

1.1 Microwave leakage from integral circuit electron tubes is a function of the adequacy of the microwave isolation of tube electrode terminals, the adequacy of closure of the microwave circuits themselves, and the integrity of the microwave connectors associated with input and output circuits. Since microwave tubes are most frequently operated with grounded anode to obtain the consequent reduction in high voltage hazard, the user may now come in such proximity to the tube as to encounter hazard from microwave energy leaking from the tube or system. Thus, means for measurement of such leakage energy are hereby presented for integral circuit tubes. Electron tubes whose circuits are not integrally contained within the vacuum envelope (vis: planar triodes, external cavity klystrons, and co-axial magnetrons with external cavities) may be measured in accordance with these methods except the external circuits and the connections to the interaction region are included. In the case of more conventional tubes, when the circuit is separate from the tube, it becomes impossible to measure those fields associated with the tube alone; here the radiation leakage problem is really one of equipment design.

1.2 Microwave energy leaking from a small aperture in a microwave enclosure radiates in accordance with Maxwell's equations. From a study of the equations governing such leakage, it can be shown that the energy is stored in the media in the vicinity of the leak in two forms: (a) a radiative term whose field intensity varies inversely as the first power of range from the leakage source, and (b) reactive terms whose intensities decrease more rapidly with distance from the source. As the size of the leakage aperture increases and becomes significant relative to the microwave wavelength, the manner of variation of field intensity of the radiative term must also include the effect of the relative phase of excitation from discrete elements within the aperture and the effect of wavefront curvature. Thus, for the large aperture case, the radiative field will not vary inversely with range from the aperture until the range exceeds

$$R = \frac{\lambda^2}{2D}$$

where: D = major dimension of the aperture

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- 1.3 Instruments used may materially influence the indicated magnitude of the field. If the aperture D of the instrument is large enough so that $R = \lambda^2/2D$ is equal to or greater than the range at which the power density is required to be measured, the instrument is unsuited for the measurement. In this case, energy reflected from the instrument will arrive at the leakage aperture in sufficient strength to modify the transmission through the aperture. For example, when measurements were made at $R/3$ for a particular instrument, the power density between the instrument and the leak was increased by an order of magnitude.
- 1.4 The perturbation of the field by the introduction of the instrument may not only result from reflection from the instrument but also because of the energy it absorbs. If the instrument absorbs only a small portion of the energy passing through it (not reflected by it), it must necessarily have a very high impedance relative to the wave impedance. While in a far field this is a very desirable quality in an instrument, in a near field erroneous readings may result.
- 1.5 While it would be highly desirable to be able to measure the total E field, most instrumentation available to-day indicates an "effective" power density and this is usually accepted as the basis of hazard indication.

2.0 PURPOSE AND SCOPE

2.1 Purpose

To obtain the characteristic and level of radio frequency leakage from microwave tubes when these tubes are operated at operating parameters as specified on the Tube Specification Sheet (TSS) without additional shielding.

2.2 Scope

This test method applies to the measurement of unwanted radio frequency energy emitted from electron tubes designed to operate in the microwave region of 100 MHz to 30 GHz. It is assumed that the frequency, location and intensity of the leakage has been generally defined, using broadband equipment, and harmonics of the fundamental frequency and spurious (non-harmonic) leakage have been examined and generally defined.

3.0 APPARATUS

3.1 Instrumentation

Radiation survey instrument that measures leakage directly in terms of effective power density or a field strength measuring instrument, which after suitable calibration, the indicator displays leakage in terms of effective power density.