OUTPUT TUBE EMISSION CHARACTERISTICS OF OPERATIONAL RADARS

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During the past several years, the Radio Spectrum Measurement System (RSMS) of the National Telecommunications and Information Administration (NTIA) has measured the emission spectra and other characteristics of many radars operating in the government frequency bands. This report contains the emission spectra of 19 different types of radars, selected to show the different emission spectrum characteristics produced by a variety of radar output tube technologies. The radars include examples of ground-based search, airport surveillance, weather, and height-finding radars operating in L-band, S-band, or C-band.

The RSMS, contained within a mobile van, is described, along with the measurement techniques used for obtaining radar emission characteristics. The emission limits imposed by the Radar Spectrum Engineering Criteria (RSEC) are displayed with each emission spectrum.

Key words: Radar, Emission Spectrum, Magnetron, Radar Measurements.

1. INTRODUCTION

Since 1973, the Radio Spectrum Measurement System (RSMS) has been making measurements of the emission spectra of a large number of radars. About 200 radar spectra have been measured in a nominal fashion as part of the general spectrum occupancy measurements which the RSMS has made throughout the country. Possibly 75 radar spectra have been measured in greater detail, with additional dynamic range and frequency range. These radar measurements were begun under the Office of Telecommunications Policy (OTP) and have continued under the National Telecommunications and Information Administration (NTIA) as part of on-going studies of radar band usage (Hinkle et al., 1976). These measured radar spectra represent a considerable source of data which might be helpful in reaching optimum decisions for spectrum engineering in the radar bands. Since many of the measured radar spectra are not available in widely circulated publications, this report has been prepared as a summary of radar spectra which we believe are pertinent to the problem of spectrum conservation in radar bands. The Federal Government radio spectrum contains many frequency bands allocated to radars, and several of these are severely crowded. Several types of radar output tubes are relatively miserly in their use of the spectrum and would substantially relieve the present crowding; some are outrageous spectrum spendthrifts. In many cases, good spectrum qualities

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may be outweighed by features which are disadvantegeous to specific mission requirements. Therefore, the choice of a high-power output tube is not straightforward, but represents a series of tradeoffs to see what type of radar technology is best for a particular circumstance.

This report is not to imply that spectrum conservation should outweigh other operational and economic considerations in the choice of a radar output tube; but, to emphasize that spectrum conservation must be considered--along with other factors--and that considerable data are available on radar spectra to aid in the considerations.

We have made no attempt in this report to rank the desirability of output tube characteristic in any manner. On the contrary, this report contains spectrum data in as unbiased a form as possible. A Radar Spectrum Engineering Criteria (RSEC) limit has been plotted on the individual radar spectra. Even this October 1977 RSEC (NTIA, 1980) should not be regarded as a value judgment on a particular radar spectrum, because the particular radar many not be subject to the limits implied by that RSEC. The same RSEC limit was drawn on all of the radar spectra--regardless of what RSEC limits actually apply to that radar--to provide a single technical reference for comparison between radars. This RSEC contains some measurement bandwidth correction factors, described in a later section, which must be included if a valid comparison is to be made between radars. Merely observing the amplitude of the sidebands relative to the peak will often give misleading interpretation of these spectrum data.

We have selected an assortment of radar spectra for this report that give a representative view of the emission spectra available from various currently operational output tube technologies. In some cases, the selected radar spectra were chosen from among many examples of measurements made on a particular nomenclature. In these cases, the spectra were selected to show a spread of characteristics that were encountered. In other cases, we have only a very few (even single) examples of a spectrum. from a particular nomenclature. We would have no way of evaluating the degree to which these spectra are typical; however, we have not knowingly selected atypical data for inclusion here.

2. MEASUREMENT TECHNIQUES

2.1. The Radio Spectrum Measurement System (RSMS)

The RSMS is a computerized multi-stage superheterodyne receiver, tunable between 100 kHz and 18 GHz, that is integrated into a motorhome-type van for easy transportation and operation at remote sites. The van contains environ-