SECTION 5F

ACCEPTANCE TESTS FOR MAGNETRONS

Unless otherwise stated in the Test Specification, magnetrons shall comply with the following requirements together with those given in the Test Specification and with all other sections of this Specification except 5.2, 5.8, 5A, 5B, 5C, 5D, 5E and 7.

5.F.1. Definitions

5.F.1.1. Pulse Characteristics.

5.F.1.1.1. Pulse Amplitude. The amplitude of a pulse waveform is the peak value of a curve drawn through the average of the deviations on the top of a pulse. Any spike on the leading edge of duration less than 10% of the Pulse Length (5.F.1.1.4) shall be ignored. (See Fig. 5F/1).

5.F.1.1.2. Pulse Voltage. The Pulse Voltage is the Amplitude (5.F.1.1.1) of the voltage pulse.

5.F.1.1.3. Pulse Current. The Pulse Current is the Amplitude (5.F.1.1.1) of the current pulse.

5.F.1.1.4. Pulse Length.

(a) The pulse length is the time during which the current, excluding the effects of capacitance current, exceeds 50% of the Pulse Current (5.F.1.1.3).

(b) When the Inspection Authority agrees, the pulse length may be defined and determined by the following alternative method:-

$$\text{Pulse Length} = \frac{I_m}{I_p \times \text{prf}}$$

I_m = Mean Anode Current.

I_p = Pulse anode current (5.F.1.1.3)

prf = Pulse Repetition Frequency.

5.F.1.1.5. Time of Fall of Voltage. The time of fall of voltage is the time taken for the voltage to fall from 85% to 20% of the Pulse Voltage. (5.F.1.1.2).

5.F.1.2. Warming Up Time

(a) The Warming Up Time is the interval between the commencement of application of heater voltage and the commencement of application of H.T.

(b) For test purposes, it is the time within which the H.T. must be applied.

5.F.1.3. Magnetic Field Strength

The Field Strength is the value at the centre of the magnet gap.

5.F.1.4. Duty Cycle. The Duty Cycle is the proportion of time during which the instantaneous value of the anode current exceeds 50% of the Pulse Current. (5.F.1.1.3).

5.F.1.5. Peak Output Power. (Pulse Operation). The Peak Output Power is defined by the following formula:-

$$\text{Peak Output Power} = \frac{\text{Mean Output Power}}{\text{Duty Cycle (5.F.1.4)}}$$

5.F.1.6. Efficiency. The efficiency is the ratio of the R.F. output power to the anode input power.

5.F.1.7. Frequency of Oscillation. The Frequency of Oscillation of a magnetron is the value of the frequency at which the power output per unit frequency interval is a maximum.

5.F.1.8. R.F. Load. The R.F. load is all that part of the apparatus which receives R.F. power from and constitutes the termination of the specified coupling device or section.

5.F.1.8.1. R.F. Load Mismatch. The Mismatch of the R.F. Load (5.F.1.8) at any frequency is either the voltage reflection coefficient or the voltage standing wave ratio (greater than unity) which would occur in a test section consisting of a straight uniform length of transmission line or waveguide whose cross section has dimensions equal to the nominal dimensions specified for the R.F. Load if it were fed with a C.W. signal of that frequency and terminated at the other end by the Load. Where the dimensions of the load waveguide are not specified, the dimensions of the test section are equal to the nominal dimensions of the output end of the specified coupling device or section.

5.F.1.9. Frequency Pulling. The frequency Pulling is the difference between the extremes of Frequency of Oscillation (5.F.1.7) occurring when the phase of the Load Mismatch (5.F.1.8.1) is varied through 360°.

5.F.1.9.1. Frequency Pulling Figure. The Frequency Pulling Figure is the Frequency Pulling measured with a Load Mismatch of voltage reflection coefficient 0.2.

5.F.1.10. Frequency Pushing. The Frequency Pushing is the change in Frequency of Oscillation (5.F.1.7) per unit change in anode current, excluding the effects of thermal expansion of the electrodes.

5.F.1.10.1. Frequency Pushing Figure. The Frequency Pushing Figure is the Frequency Pushing measured at the specified current in megacycles per ampere.

5.F.1.11. Spectrum Width (R.F. Bandwidth). The Spectrum is the variation of power per unit frequency interval with frequency. The Spectrum Width is the difference in frequency between the most widely separated points at which the power per unit frequency is $\frac{1}{2}$ of the highest value occurring in the spectrum.

5.F.1.12. Stability (Pulse Operation). Stability is the ratio of missing pulses to input pulses. A pulse is considered to be missing when its energy in the specified frequency band is less than some specified fraction of the energy of a normal putput pulse.

5.F.1.12.1. Starting Stability. The Starting Stability is the Stability measured during a specified period commencing with the first application of H.T. after the Holding Period.

5.F.1.13. Cold Impedance (Pulse Operation). The Cold Impedance of a magnetron is the impedance presented by the magnetron during the non-oscillating period between pulses to an applied C.W. signal whose frequency is equal to the Frequency of Oscillation (5.F.1.7).

5.F.1.13.1. Cold V.S.W.R. The Cold V.S.W.R. of a magnetron is the voltage standing wave ratio in a straight and uniform test section of transmission line or waveguide with cross-section having the nominal dimensions specified for the R.F. Load (5.F.1.8) terminated by the magnetron together with the specified coupling device or Section and fed with a signal as specified for Cold Impedance (5.F.1.13).

Where the dimensions of the load waveguide are not specified, the dimensions of the test section are equal to the nominal dimensions of the output end of the specified coupling device or section.

5.F.1.13.2. Position of Minimum. The Position of Minimum is the distance from a specified plane to the appropriate voltage minimum of the standing wave pattern in the test section specified under Cold V.S.W.R. (5.F.1.13.1) the distance being positive towards the magnetron.

Where the appropriate voltage minimum does not lie within the test section, its position is defined as the position of a voltage minimum within the test section plus or minus the appropriate integral number of half-wavelengths (in the test section).

5.F.2. Test Procedures for Magnetrons. The tolerances and limits specified in this section shall only apply where no tolerance or limit is given in the individual Test Specification.

5.F.2.1. Magnetic Field. Magnets used for testing magnetrons other than those with integral magnets shall satisfy the following requirements.

5.F.2.1.1. Magnetic Field Strength. The Magnetic Field Strength (5.F.1.3) shall be within ± 3% of the specified nominal value. When a permanent magnet is specified the field strnegth shall be within ± 5% of the specified nominal value.

5.F.2.1.2. Magnetic Field Polarity. Magnetrons shall be tested with the cathode connection nearest to the north pole of the magnet.

5.F.2.1.3. Magnetic Field Uniformity. Magnets shall have pole tips of soft magnetic material of thickness at least one quarter of the specified gap width, having plane faces parallel within 1^{0} and coaxial within 3% of the gap width and of diameter at least equal to the gap width.

5.F.2.2. Cathode and Heater

5.F.2.2.1. Heater Voltage. For oscillation tests the Heater Voltage shall be within ± 3% of the specified value.

5.F.2.2.2. Heater Current Measurement. The heater current shall be measured when substantially stable, but not whilst anode voltage is applied.

5.F.2.2.3. Warming Up Time. The warming up time shall not exceed 5 minutes.

5.F.2.3. Cooling and Pressurising

5.F.2.3.1. Cooling liquid used during testing shall be clean and demineralised to the satisfaction of the Inspection Authority.

5.F.2.3.2. Cooling and Pressurising Air. Cooling air which may come into contact with components subjected to electric fields, including waveguide windows, output and input seals, shall be dry and clean to the satisfaction of the Inspection Authority.

5.F.2.3.3. Pressurising Test. Where an air-tight pressurising seal is required, the leakage shall not exceed that which gives a fall of pressure of 3 lbs/sq. in. per litre per hour when the appropriate part of the valve forms part of the wall of a vessel containing air at a pressure of 45 lbs. per sq. in. absolute, the other side of the valve being open to the atmosphere.

The minimum duration of the test shall be 10 minutes. Observation shall not commence until after 2 minutes.

NOTE:- The Air temperature must be kept constant during the test.

5.F.2.4. R.F. Load. The R.F. Load (5.F.1.8) or, where there is a Specified Load Mismatch (5.F.3.4.2), that part of the R.F. Load between its input end and the source of the specified mismatch, shall not have a reflection coefficient exceeding 0.2 at any frequency within the range + 20% to -5% of the Frequency of Oscillation (5.F.1.7).

The load shall not set up evanescent modes to a degree which, in the opinion of the Inspecting Authority, might significantly affect the behaviour of the valve.

5.F.2.4.1. Matched Load, Residual Mismatch. Where a Matched Load is specified, the Residual Load Mismatch (5.F.1.8.1) shall be such as to give a reflection coefficient not exceeding .05 at the Frequency of Oscillation (5.F.1.7).

5.F.2.4.2. Load of Specified Mismatch. Where an R.F. Load having a specified mismatch is called for, the load Mismatch (5.F.1.8.1) at the Frequency of Oscillation (5.F.1.7) must not be less than the value stated in the Test Specification at all phases of reflection:-

$$r_{min} = \frac{r_1}{r_o}$$

where: r_{min} = the minimum permissible value of the voltage standing wave ratio expressed as a ratio greater than unity,

r_1 = the specified value of Load Mismatch expressed as voltage standing wave ratio greater than unity,

and r_o = the specified maximum value of Residual Mismatch expressed as a voltage standing wave ratio greater than unity.

Alternatively:

$$k_{min} = \frac{k_1 - k_o}{1 - k_1 k_o}$$

where: k_{min} = the minimum permissible value of the modulus of the voltage reflection coefficient,

k_1 = the specified value of Load Mismatch expressed as the modulus of a voltage reflection coefficient,

and k_o = the specified maximum value of Residual Mismatch expressed as the modulus of a voltage reflection coefficient.

5.F.2.5. Pulse Characteristics. See Appendix XIV

5.F.2.5.1. Modulator Impedance. The output voltage of the test modulator on open circuit shall be not less than 1.3 times the operating voltage and the output current on short circuit shall be at least 1.5 times the operating current measured on isolated pulses.

5.F.2.5.2. Modulator Charging Characteristics. The available energy for every pulse in the period immediately following an arc in the magnetron under test shall not be less than the available energy when the magnetron is operating normally.

5.F.2.5.3. Anode Pulse Current. The Anode Pulse Current shall be within ± 5% of the specified value.

5.F.2.5.4. Anode Voltage. The Anode Pulse Voltage (5.F.1.1.2) shall be measured with the valve operating on Matched Load (5.F.2.4.1).

5.F.2.5.4.1. Anode Voltage Pulse Shape. At no instant shall the anode voltage exceed 1.5 times the Pulse Voltage.

5.F.2.5.5. Rate of Rise of Voltage.

A modulator will be accepted as having a suitable Rate of Rise of Voltage if it is demonstrated to the satisfaction of the Inspecting Authority that the maximum rate of rise of voltage measured lies within the specified limits.

During the measurement of rate of rise the modulator will be adjusted so that it would give the specified operating conditions if any otherwise acceptable magnetron were fitted. For the test the modulator shall be terminated by a capacitor of value equal to the nominal input capacitance of the magnetron. The measurements shall be made over the interval between the point when the voltage first equals 80% and the point where it first equals 100% of the pulse voltage of the magnetron. The value shall not fall after its maximum in this interval to less than 95% of the maximum value.

5.F.2.6. Pulse Repetition Frequency. The Pulse Repetition Frequency shall be within ± 5% of the specified value.

5.F.2.7. Mean Anode Current. The Mean Anode Current shall be within ± 2% of the value specified.

5.F.2.8. Nominal Frequency of Magnetron. The Nominal Frequency of a magnetron is the Frequency of Oscillation (5.F.1.7) measured with the magnetron operating under the specified conditions and with a Load of less than the specified Residual Mismatch (5.F.2.4.1) when the anode temperature, measured at the specified point, lies within the limits specified.

5.F.2.8.1. Frequency Grouping. When magnetrons of an identical type but for adjacent frequency bands are being submitted for acceptance tests under the same contract, a valve may be accepted even though the accuracy of frequency measurement does not enable it to be placed with certainty in any one of the specified frequency bands provided that the range of uncertainty lies entirely within two contiguous bands and that the inaccuracy of frequency measurement is not worse than 5 parts in 10^4.

If (due to the uncertainty arising from the tolerances implicit in the definition of Nominal Frequency (5.F.2.8) together with the inaccuracy of measurement) a valve on re-measurement falls within a different frequency band, action shall be taken according to the extent of the discrepancy of measured Nominal Frequency as follows:-

(a) If the discrepancy is less than 1 part in 10^3, the grouping remains unchanged.

(b) If the discrepancy is greater than 4 parts in 10^3, regroup accordingly.

(c) If the discrepancy is between 1 part and 4 parts in 10^3, take the mean of 3 further measurements, and if this mean shows a discrepancy in excess of 1 part in 10^3, regroup accordingly.

5.F.2.9. Calculation of Efficiency. The Efficiency (5.F.1.6) shall be calculated from measurements as follows:-

$$\text{Efficiency} = \frac{W_m}{Va \times I_m} \times 100\%$$

Where W_m = Mean Output Power.

Va = Pulse voltage (5.f.1.1.2); or D.C. anode voltage for C.W. operation.

I_m = Mean anode current

5.F.3. Low Temperature (Operating)

Where tests are required to be performed at a reduced temperature, the conditions specified in Section 10.4 shall apply.

5.F.3.1. During Qualification Approval testing, the valve shall pass the primary and secondary electrical tests specified in the detail test specification. Any measurement of frequency shall take into account thermal factor.

5.F.3.2. During Production Acceptance testing the valve shall pass the primary electrical tests specified in the detail test specification. Any measurement of frequency shall take into account thermal factor.

5.F.4. High Temperature (Operating)

Where tests are required to be performed at a temperature of 100°C the conditions specified in Section 10.5 shall apply.

5.F.4.1. During Qualification Approval testing, the valves shall pass the primary and secondary electrical tests specified in the detail test specification. Any measurement of frequency shall take into account thermal factor.

5.F.4.2. During Production Acceptance testing, the valves shall pass the primary electrical tests specified in the detail test specification. Any measurement of frequency shall take into account thermal factor.

5.F.5. Operation Life (Normally performed during Q.A. testing only)

When an operation life test at high ambient temperature is required, the conditions specified in Appendix VI/6.2 shall apply. On completion of the test, the valve shall pass the high temperature test end points specified in the detail test specification.

5.F.6. High and Low Temperature Life (Non-Operating) Normally performed during Q.A. testing only.

5.F.6.1. Low Temperature

Where a low temperature storage test is required, the conditions specified in Appendix VI/6.1.2. shall apply. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.6.2. High Temperature

Where a high temperature storage test is required, the conditions specified in Appendix VI/6.1.1. shall apply. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.7. Temperature Cycling

Where a temperature cycling test is required, the conditions specified in Section 10.6 shall apply. The valve shall be non-operating. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.8. Air Pressure Tests. (Normally performed during Q.A. testing only).

5.F.8.1. Low Pressure

Where a low pressure test is required, the conditions specified in Section 10.8.1 shall apply. Where specified the wave guide shall be pressurised. Throughout the test the valve shall pass the primary electrical tests specified in the detail test specification and there shall be no evidence of corona, voltage breakdown or overheating.

5.F.8.2. High Pressure

Where a high pressure test is required, the conditions specified in Section 10.8.2. shall apply. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.9. Moisture Resistance (Normally performed during Q.A. testing only).

Where a test for moisture resistance is required, the conditions specified in Section 10.7 shall apply. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.10. Heater Resonance and Fatigue

Where a test for heater resonance and fatigue is required, the conditions specified in Section 11.6 shall apply. On completion of the test the valve shall pass the specified life test end points.

5.F.11. Functional Vibration

Where a functional vibration test is required, the conditions specified in Section 11.7 shall apply. During the test, missed pulses, frequency shift, change in power output and frequency modulation shall be monitored at specified intervals. On completion of the test the valve shall satisfy the specified primary electrical tests.

Method A shall be used during Qualification Approval testing when the valve shall in addition satisfy the specified secondary electrical tests.

Method B shall be used during Production Acceptance testing.

5.F.12. Vibration Life

Where a vibration life test is required, the conditions specified in Section 11.8 shall apply. During this test, missed pulses, frequency shift and change in output power shall be monitored at specified intervals.

5.F.13. Fatigue Vibration

Where a vibration fatigue test is required, the conditions specified in Section 11.9 shall apply. On completion of the test the valve shall pass the primary electrical tests specified in the detail test specification.

5.F.14. Functional Shock

Where a shock test is required, the conditions specified in Section 11.10 shall apply. Frequency deviation and change in power output shall be measured immediately after completion of the test.

Method A shall be used during Qualification Approval testing.

Method B shall be used during Production Acceptance testing.

MAGNETRON PULSE WAVEFORM

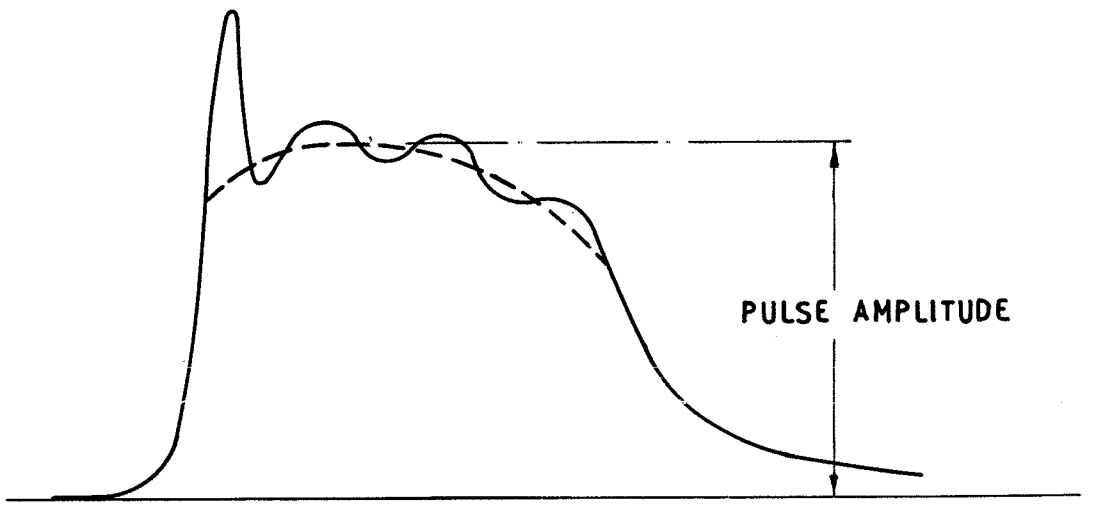

FIG. 5F/1