

Section 11

VIBRATION, RESONANCE SEARCH, FATIGUE AND SHOCK TESTS

When required by the Test Specification tests for Vibration, Resonance Search, Fatigue and Shock shall be as follows:-

11.1. Vibration. This test shall be at a frequency of 50 c/s with a minimum acceleration of 2 g for not less than 2 minutes. Tests for Noise and Microphony may be required during or after this treatment (see Section 5, paragraph 5.8.5.). Valves which develop mechanical faults or fail the noise and microphony test shall be rejected.

11.2. Resonance Search Test. This test shall be on a sampling basis.

The valves shall be rigidly mounted on a vibration machine and vibrated at a continuously variable frequency to the limits stated in the Test Specification. The rate of change of frequency shall be:-

- (i) Not exceeding one octave per minute from 25 c/s to 200 c/s
- (ii) Not exceeding 100 c/s per minute between 200 c/s and 500 c/s
- and (iii) Not exceeding 250 c/s per minute between 500 c/s and 2500 c/s.

Where approved high sensitivity recording equipment is being used the rate of sweep shall be not greater than 15 seconds per octave up to 200 c/s and not greater than 45 seconds per octave above 200 c/s and up to 2.5 kc/s.

The time of rise of the indicator to full scale deflection shall be not greater than one fiftieth (1/50) of the sweep time per octave up to 200 c/s and not greater than one hundred and fiftieth (1/150) of the sweep time per octave above 200 c/s and up to 2.5 kc/s.

The acceleration shall be not less than 2 g. The waveform shall be sinusoidal and have not more than 5% harmonic distortion.

The valves shall be vibrated in three mutually perpendicular planes or in a direction at approximately 45° to the three main axes of the valve.

The Test Specification will state, as required:-

- (a) The limits of vibration frequency.
- (b) The electrical operating conditions.
- (c) The limits of noise output in each of the specified frequency bands.
- and (d) The Inspection Level and AQL.

11.3. Fatigue Test. This test shall be on a sampling basis.

The valves shall be rigidly mounted on a vibration machine and shall be vibrated at a frequency not less than 100 c/s. The waveform shall be sinusoidal with not more than 5% harmonic distortion. The valves shall be vibrated in three mutually perpendicular directions successively, one of which shall be along the major axis of the valve. The Test Specification will state the minimum total time of vibration in each direction and the times during each vibration period at which the required test measurements shall be made. If desired for practical convenience the duration of vibration and the stages at which test measurements are made may exceed those specified but for the purpose of acceptance the number of rejects found at these test periods shall count as being found at the specified times.

When required the test specification will state:-

- (a) The acceleration.
- (b) The minimum duration of treatment.
- (c) The electrical operating conditions.
- (d) The tests to be performed after the fatigue treatment has been completed.

and (e) The Inspection Level and the overall AQL values.

11.4. Shock Test. This test shall be done on a sampling basis using a machine designed in accordance with Drawing No. 2, Appendix X, or other approved alternative.

11.4.1. The valve shall be mounted so that the whole of it receives the shock but the shock must not be transmitted via the base pins. Recommended methods of mounting are:-

- (a) In an approved holder; see Drawing No. 3, Appendix X.
- or (b) Moulded in wax contained in a strong metal container rigidly fixed to the shock table.

11.4.2. The valve shall be subjected to five blows in each of the following directions:-

- (a) Across the major axis of the electrodes.
- (b) Across the Minor axis of the electrodes.
- (c) Towards the base.
- and (d) Away from the base.

11.4.3. Valves not constructed with pinned bases shall be tested in both directions along the major axis and in two other mutually perpendicular directions.

11.4.4. The Test Specification will state:-

(a) Either the hammer angle or the minimum peak acceleration and minimum shock duration.

(b) The post shock tests.

and (c) The Inspection Level and AQL values.

11.5. Vibration Test for Cathode Ray Tubes. When the Test Specification requires that tubes be tested for the effects of vibration the test shall be done with a circular motion of 0.008 inch total amplitude applied to the base of the tube and at right angles to the major axis of the tube. The frequency shall be varied over the range 0 to 100 cycles per second. The centre of the screen of the tube shall be prevented from appreciable movement, e.g. by clamping the edge of the faceplate in suitable resilient material. The tube shall be operated at the specified electrode voltages with a circular scan pattern having a diameter not less than 75% of the screen diameter and with the focus control adjusted to give optimum line width. The tube shall be rejected if at any time during the test the apparent line width exceeds twice its initial value.

The tubes under test shall be examined visually and tested in accordance with the relevant Test Specification both before and after the vibration test and will be rejected if, after vibration, any objectionable defect is found or if any of the electrical characteristics have changed by more than a specified amount.

11.6. Heater Resonance and Fatigue. The heater supply frequency which shall be sinusoidal with a distortion not exceeding 10% shall be swept from 40 c.p.s. to 2.7 k/c.p.s. at a rate not exceeding one octave per three minutes. Mechanical resonances are defined as occurring when the output from a detector exceeds the general mean level by three times. They shall be determined with the aid of a piezo-electric transducer, the output from which shall be displayed on a C.R.O. such that the spot displacement is directly proportional to the output of the transducer. The transducer shall be screwed or clamped to the body under test and so placed as to measure maximum response and to cause minimum damping of the resonances. The frequencies of all mechanical resonances shall be noted.

The heater supply frequency shall be held at each resonance within any of the following bands for 250 hours:-

- (i) 45 to 65 c.p.s.
- (ii) 360 to 550 c.p.s.
- (iii) 1440 to 1760 c.p.s.
- (iv) 2160 to 2640 c.p.s.
- (v) 700 to 900 c.p.s.

Any heater supply frequencies shall be replaced by square waves when specified.

11.7. Functional Vibration

11.7.1. Method A

The valve shall be operated under the specified conditions and mounted in an approved clamp, and subjected to vibration in each of three mutually perpendicular directions. The waveform shall be sinusoidal with less than 5% total harmonic distortion. The frequency shall be swept once up and down between the specified limits at a rate not exceeding one octave, per minute. The peak acceleration at each frequency shall not be less than that given by one of the envelope curves obtained by plotting the points in the table below on log. log. paper, and joining the points with straight lines as in Fig. 11.1 of this section:-

(i)	f.c.p.s.	10	30	5000	10000		
	g.	1	10	10	5		
(ii)	f.c.p.s.	10	30	50	5000	10000	
	g.	1	10	10	20	10	
(iii)	f.c.p.s.	10	30	50	100	5000	10000
	g.	1	10	20	30	30	15

11.7.2. Method B

The test conditions as specified in clause 11.7.1. shall apply except that the envelope curve shall be determined by plotting the points in the table below on log. log. paper, and joining the points with straight lines as in Fig. 11.2 of this section:-

(iv)	f.c.p.s.	30	5000		
	g.	10	10		
(v)	f.c.p.s.	30	50	5000	
	g.	10	20	20	
(vi)	f.c.p.s.	30	50	100	5000
	g.	10	20	30	30

11.8. Vibration Life

The test conditions as specified in clause 11.7.1. shall apply. The duration of the test shall be not less than 15 hours.

11.9. Fatigue Vibration

The valve shall be subjected to a sinusoidal vibration having a peak acceleration of not less than 3(g) at 30 c.p.s., rising to 10(g) at 100 c.p.s., and remaining at 10(g) up to 2 k c.p.s. The frequency range 30 c/s to 2000 c/s shall be swept continuously and in each direction at a rate of one octave per minute \pm 10 secs. The duration of the test shall not be less than 100 hours, of which at least 30 hours shall be in each of three mutually perpendicular directions. One direction of vibration shall be along the axis to the cathode. During the test the valve shall be operated intermittently with not less than 12 interruptions in each 24 hours. A minimum 'on' period of 1 hour with an 'off' period of 15 minutes shall elapse between each interruption and the cumulative 'on time' shall be at least 20 hours out of each 24 hour period. The 'on' and 'off' periods shall consist of the immediate application and removal of the heater voltage.

11.10 Functional Shock

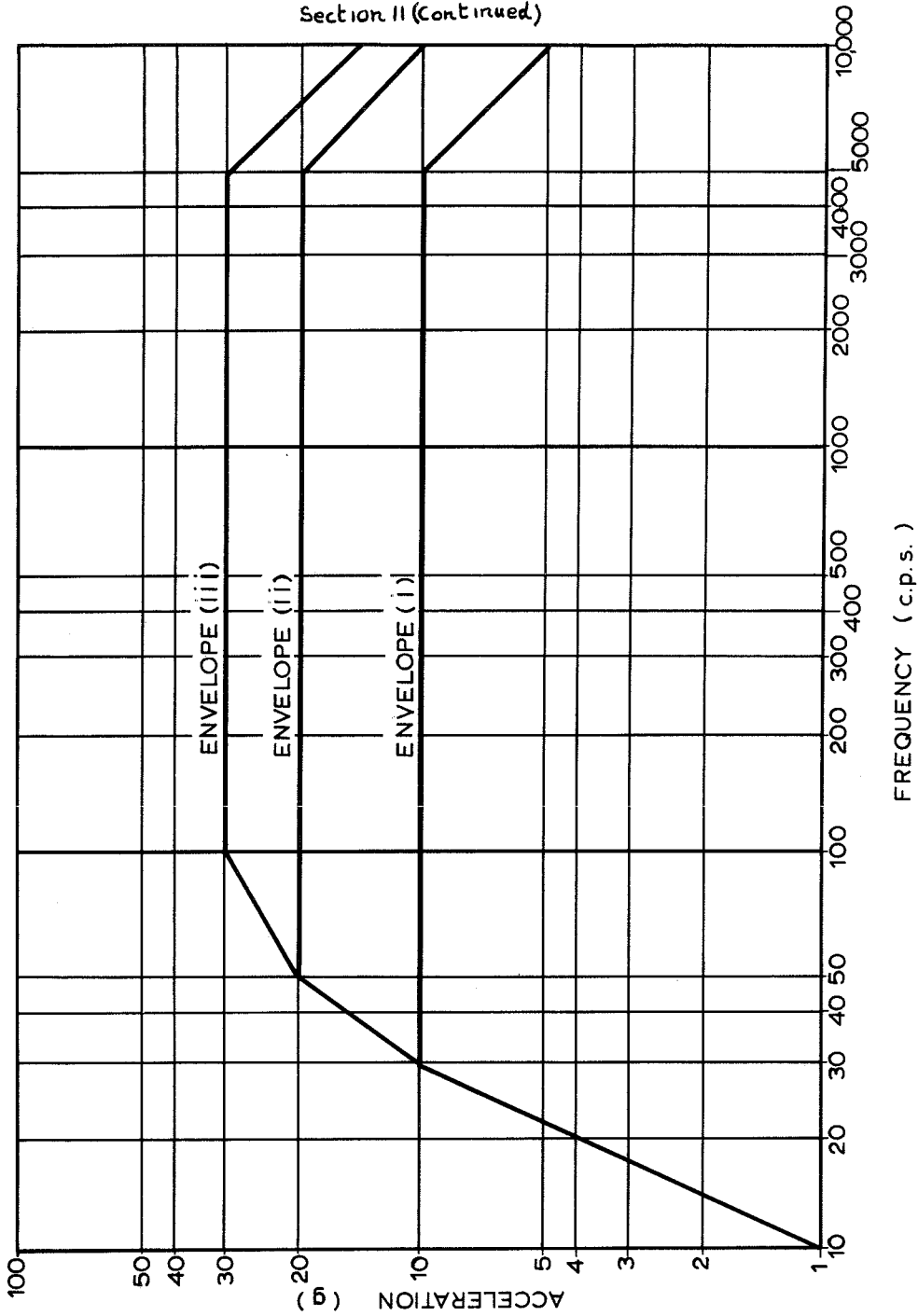
11.10.1. Method A

The valve shall be operated under the specified conditions and subjected to shock along each of three mutually perpendicular axes. Each shock shall have a duration of 6 to 12 milliseconds and a peak acceleration, defined such that the product of the duration in milliseconds and the acceleration in 'g' units shall not exceed 600. The rise time shall be between 0.5 and 1.0 millisecond. The valve shall receive three shocks in each of six directions.

11.10.2. Method B

The valve shall be subjected to shock in the most sensitive direction as determined by the test specified in clause 11.10.1. The test conditions specified in clause 11.10.1 shall apply, the valve shall receive three shocks.

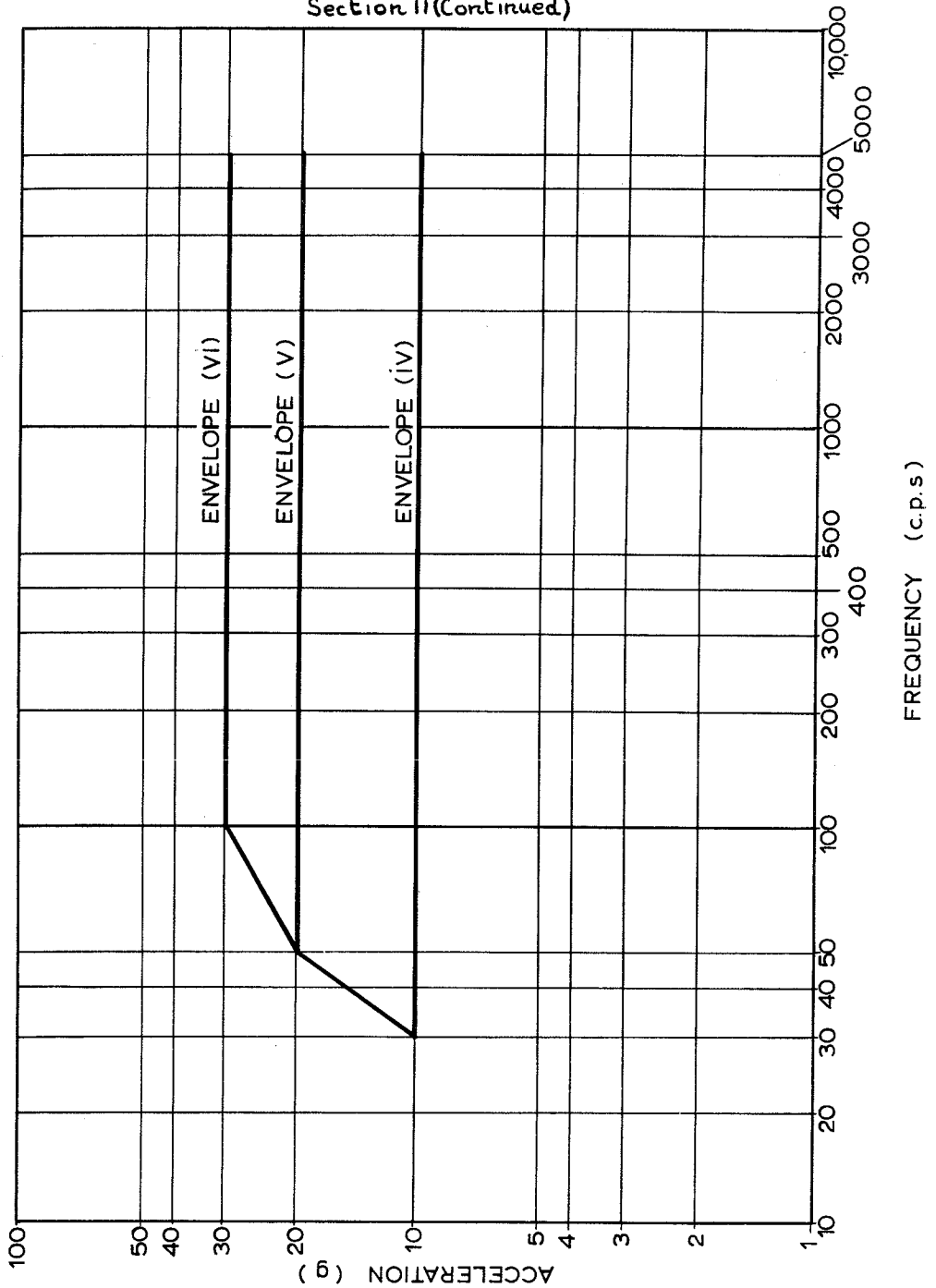
Section 11 (Continued)



GRAPHICAL REPRESENTATION OF FUNCTIONAL VIBRATION TEST. (Para. 11.7.1)

Fig. 11.1

Section II(Continued)



GRAPHICAL REPRESENTATION OF FUNCTIONAL VIBRATION TEST. (Para. 11.7.2)

Fig 11. 2