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EVALUATION OF JACK SCREW VIBRATION AND SHOCK FIXTURE FOR MC1917 NEUTRON GENERATORS (U)

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T-26187

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EVALUATION OF JACK SCREW VIBRATION AND SHOCK FIXTURE FOR MC1917 NEUTRON GENERATORS

Introduction

Because studs or other mechanical fasteners are not incorporated into most of the components which are employed in the TX-61 system, fixturing these components for mechanical vibration and shock has generally proven to be a problem. Fixturing for many of the components in this system consists of potting the component in paraffin or attaching it to a plate with an adhesive such as dental cement. In the case of the MC1917 neutron generator, however, both of these procedures were unacceptable because of the requirement that the component be subjected to vibration and shock at temperatures of -65°F and +160°F. It was therefore necessary to devise a different method of fixturing for this particular component.

This report deals primarily with an evaluation of a so called "jack screw" fixture which was proposed for use in holding the MC1917 during exposures to mechanical vibration and shock tests. All units furnished for this series of tests carried part number 311867-00.

This test was requested by H. J. Gerwin, 1411, on March 22, 1965. S. D. Meyer, 7332, was the Test Engineer. The test items were received on March 26, 1965, and the test was completed on June 7, 1965.

Summary

Mechanical vibration tests performed on a dummy MC1917 with the jack screw fixture indicated that the response (accelerometer on fixture) was lower than the input (accelerometer on dummy) by a maximum of 15 percent. This occurred at a frequency of 2000 cps. Up to a frequency of 1500 cps the transmissibility deviated very little from 1:1. Results of vibration tests with an actual unit indicated that the coupling between the jack screw fixture and the component provided better transmissibility than did a previously attempted fixturing procedure in which the component was clamped between rubber pads in a box-type fixture. The jack screw fixturing technique also compared favorably with dental cementing. The control accelerometer was mounted on the component rather than on the fixture during the vibration tests so that a direct comparison could be made between these results and those obtained during test T-29429.

During mechanical shock tests, in which a dummy component was employed, the nominal input to the fixture was 1500g, 3.0 msec. The pulse shape was a parabolic cusp. The response waveforms which were measured on

the dummy were very similar to the input waveforms during all nine of the drop tests. The maximum deviation between the indicated input and response shock accelerations was 100g. The maximum deviation between the indicated input and response shock pulse durations was 0.5 msec. with the mean deviation being 0.25 msec.

Loosening of one jack screw occurred during the first vibration cycle on the dummy component. No further problems of this type occurred during subsequent vibration or shock testing.

Procedure and Results

Evaluation of the Jack Screw Fixture in Vibration - The jack screw fixture which was used during the vibration and shock tests is shown in Figures 1 and 2.

The initial phase of the fixture evaluation involved the vibration of a dummy component, with the same weight (2 lb 10 oz) and outside dimensions as the actual unit. Figure 3 illustrates the assembly of the dummy component in the jack screw fixture. The following test procedure was followed during this initial phase of fixture evaluation.

1. The control accelerometer was attached to the curved surface of the dummy. The control accelerometer was mounted on the dummy rather than on the fixture so that a direct comparison of results could be obtained between this and previous tests. (Refer to report T-29429.)

2. The dummy was then positioned in the fixture with the top of the dummy in contact with the bottom of the fixture and the large sides of the dummy component adjacent to the fixture sides having the jack screws.

3. The side jack screws were then torqued to 140 pound-inches. (This corresponds to a pressure of 100 psi distributed over the face of the jack screws.)

4. The lid was then bolted onto the fixture in a position which allowed the greatest contact area between the lid jack screw and the dummy. The lid jack screw was torqued to a value of 140 pound-inches.

5. The fixture and dummy were subjected to four 15-minute cycles of vibration from 10-2000-10 cps in each of the three mutually perpendicular axes. Refer to Figure 4 for a definition of axes. As

previously mentioned, the input was controlled with an accelerometer mounted on the curved surface of the dummy. The inputs were .036 inch DA from 10-74 cps and 10g from 74-2000 cps.

6. The outputs of the control accelerometer and an accelerometer mounted on the fixture were plotted during the first and last cycles in each axis. Refer to Figure 2 for the location of the accelerometers on the fixture.

7. The jack screw torque was checked and the jack screws were retorqued if necessary after each axis of vibration.

The input and response curves during this phase of the fixture evaluation are shown in Figures 5 through 10. Run No. 1 identifies the data obtained during the first fifteen-minute cycle and Run No. 2 identifies the data obtained during the last fifteen-minute cycle in each axis of vibration.

The lid jack screw "backed-off" during the first fifteen-minute cycle of vibration in the X-axis. This may have been the reason for the relatively large discrepancy between the input and response curves above 500 cps shown in Figure 5. It should be noted that the jack screw which backed off was not clamping in the direction of shake. The lid jack screw was retorqued prior to further vibration in the X-axis. This backing off of the jack screws did not occur again in any axis.

As may be seen from Figures 5 through 10, in those cases where the jack screws remained tight the minimum fixture acceleration was 8.5g when the component acceleration was 10g. This minimum occurred at a frequency of 2000 cps and appeared to be common to all axes. Overall, however, the ability of the fixture to transmit a given input to the dummy appeared to be quite satisfactory. The similarity of the plots made during the first and last fifteen-minute cycle in each axis indicates that there was no change in response ratio between the dummy and the fixture as a result of the elapsed cycling time.

The second phase of the fixture evaluation consisted of repeating the procedure previously outlined after substituting an actual component for the dummy component previously used.

Figures 11 through 16 illustrate the input and response data which were obtained in the first and last 15-minute cycle during the one hour test in each axis. Due to the fact that the actual component did not behave as a rigid body as well as did the dummy, the response ratios between the component and the fixture begin to deviate appreciably from 1:1 in

the X-axis at 900 cps, in the Y-axis at 700 cps, and in the Z-axis at 800 cps. It should also be noted, however that there was no significant difference between the response curves which were plotted during the first and last 15-minute cycles of vibration in a given axis. This is a good indication that the jack screws did not loosen during the one hour vibration cycling in a given axis.

The unfiltered fundamental wave form was visually monitored during the tests in which both the dummy and the actual unit were used. There was some harmonic distortion present from 1000-1200 cps, but no high frequency distortion was detected and the wave form in general appeared clean. Also, the unfiltered transverse motion did not exceed 60 percent of the filtered input at any time during the test.

Runs were also made in the Y and Z axes with an MC1917 dental cemented to a flat plate. The input was again controlled from the component and was 0.2 inch double amplitude from 10-22 cps and 5g from 22-2000 cps. An accelerometer was also mounted on the flat plate. The output of this accelerometer along with the control accelerometer was recorded using an X-Y plotter. These tests were performed to determine if the responses obtained using the jack screw fixture were due to component resonance or if they were peculiar to the jack screw fixture.

As may be seen in Figures 17 and 18 the transmissibility deviated from 1:1 when the component was dental cemented to the flat plate. This indicates that the component itself is going into resonance inasmuch as the dental cement joint is known to be rigid throughout the frequency range in question. This leads one to conclude that the resonances observed during use of the jack screw fixture were due to component response rather than a peculiarity of the fixture.

<u>Evaluation of the Jack Screw Fixture in Mechanical Shock</u> - Evaluation of the fixture for mechanical shock was performed using the dummy component described earlier in this report.

The procedure was planned so that response measurements could be made for each of three possible ways in which force could be transmitted from the fixture to the unit. The conditions were (1) from the fixture into one of the large sides of the unit, (2) from the fixture into one of the small sides of the unit, and (3) from the fixture into the upper or lower surface of the unit. These three conditions correspond to the directions of acceleration designated in Figure 4 as +X, +Z and +Y, respectively.

It should be noted at this point that at no time was acceleration to be applied to the unit through a jack screw. In order for this to be true, it is necessary to reposition a unit in the fixture once during a test procedure such as that described above.

The test procedure listed below was followed during the evaluation of the jack screw fixture in mechanical shock.

1. A response accelerometer was mounted on the inner surface of the dummy component in the location designated in Figure 3 as "Response Accelerometer Location 1."

2. The dummy component was then placed in the fixture so that the bottom surface of the component was in contact with the bottom of the fixture and the large sides of the component were adjacent to the sides of the fixture having the jack screws.

3. The side jack screws were then torqued to the value of 140 pound-inches.

4. The fixture lid was then bolted onto the fixture in a position which allowed the greatest contact area between the lid jack screw and the dummy. The lid jack screw was also torqued to the 140 pound-inches value.

5. The fixture was then mounted on a 12-foot accelerated shock machine (Machine No. 5) and subjected to three mechanical shocks which were each applied to the unit in the +Z direction shown in Figure 4. During each of the impacts, the input to the test fixture and the output from the response accelerometer (which had been mounted in the direction of applied acceleration) were recorded. (Amplitudes and durations of the input and output pulses will be discussed later.)

6. The unit was then repositioned in the fixture so that the small sides of the unit were adjacent to the sides of the fixture having the jack screws. This step was necessary in order that the unit could be subjected to mechanical shock in the +X direction without applying the acceleration through a jack screw. After the unit had been repositioned, the side and lid jack screws were retorqued to 140 pound-inches.

7. The fixture was then subjected to three mechanical shocks which were, in this case, applied to the unit in the +X direction shown in Figure 4. Input and response measurements as described above were again made during each mechanical shock.

8. The fixture lid was then removed and the response pickup was mounted in the location designated in Figure 3 as "Response Accelerometer Location 2." The fixture lid had been drilled to accommodate this mounting location.

9. The fixture was reassembled, retorqued, and subjected to three mechanical shocks, each of which were applied to the unit in the +Y direction shown in Figure 4. Again, input and response measurements were made during each mechanical shock.

The input level for the mechanical shock test was to be 1500g in amplitude with a duration of 3 milliseconds. This level was chosen since it basically simulates a mechanical shock test specified in paragraph 4.3.3.7 of PS-311867, Issue 3 for the MC1917 units. This document does not specify a pulse shape, therefore the pulse which was a characteristic of the shock facility at this level was accepted. In this case, each input pulse had the shape of a parabolic cusp.

The following table lists the amplitude and duration of each input pulse and corresponding output pulse recorded during the mechanical shock test.

Direction of Applied Acceleration	Input Pulse Amplitude (g)	Input Pulse Duration (ms)	Output Pulse Amplitude (g)	Output Pulse Duration (ms)
+Z	1500	3.3	1450	3.5
+Z	1500	2.8	1450	3.1
+Z	1550	2.8	1500	3.1
+X	1500	3.4	1450	3.5
+X	1500	2.8	1450	3.2
+X	1550	2.9	1500	3.4
+Y	1500	3.2	1450	3.1
+Y	1500	2.8	1450	3.1
+Y	1550	3.0	1450	3.0

The input for the first three shocks was measured from the surface of the shock table. During the last six shocks the input was measured from an accelerometer mounted directly on the test fixture.

Typical input and response pulses recorded during the series are shown in Figure 19.

The high frequency noise present on these pulses could not be accounted for at the time of testing. Various mounting locations for the input accelerometer indicated that this noise was a characteristic of the test setup as a whole.

The relatively close agreement of numerical values obtained from input and output pulses along with the similarity of the pulse shapes indicate that this fixture will satisfactorily transmit a given mechanical shock input to an MC1917 unit. This appears to be true for each of the three conditions listed earlier. The close agreement of results obtained from the first and third shock in a given direction also indicates that the jack screws did not loosen or back off during shock.

Test Measurements and Methods - All vibration tests were performed on Vibration Machine No. 7 which has a frequency range of 5 to 2500 cps and a maximum sine wave force output of 10,000 pounds. Input and response curves during vibration were plotted using a dual pen X-Y plotter.

All shock testing was performed on Shock Machine No. 5 which is a 12-foot shock cord accelerated facility.

Conclusions and Recommendations

In comparing the results of these vibration tests with those obtained during tests in which the MC1917's were clamped between rubber pads in a box-type fixture (refer to report T-29429), it may be concluded that the jack screw technique provides much better fixture-to-component coupling during vibration than does the other method. This was true even though the loads exerted on the units by the jack screws were only one-half to one-fifth as great as the loads exerted on the units when they were clamped between rubber pads. The results obtained during mechanical shock evaluations indicated that the jack screw fixture would be acceptable for use as a means for securing the MC1917 during the required mechanical shock tests. It is therefore recommended that the jack screw fixturing technique be employed for shock and vibration tests on the MC1917 neutron generator.

In view of the fact that all of the evaluations performed in this test series were carried on at room temperature, it is recommended that the jack screw fixture be evaluated at +160°F and -65°F as specified in PS-511867. This work will be carried on under T-29699.

It is also recommended that in carrying on future vibration tests, input should be controlled from the fixture rather than from the component and component response should be limited to 20g. It is felt that a more repeatable test can be obtained by controlling from the fixture. The 20g limit on response is consistent with the philosophy which is discussed in section D1 of SC-4451(M). Also, based on a 3g input to the TX-61 short case (refer to T-10359) the 20g response appears to be a reasonable limit.

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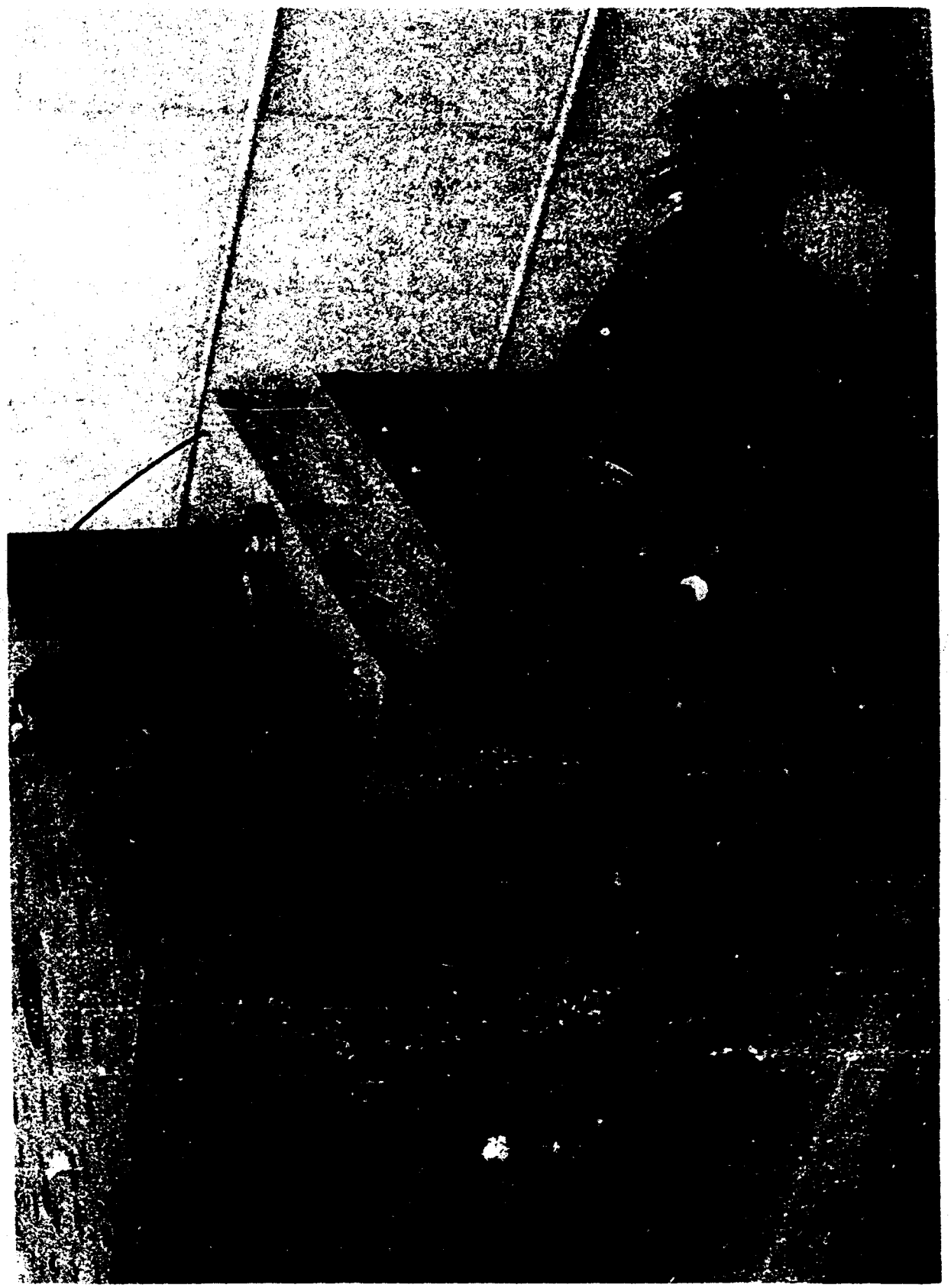

Figure 1 - Back Screw Fixture Which Was Used During Mechanical Shock and Vibration Tests on MX912 Neutron Generator

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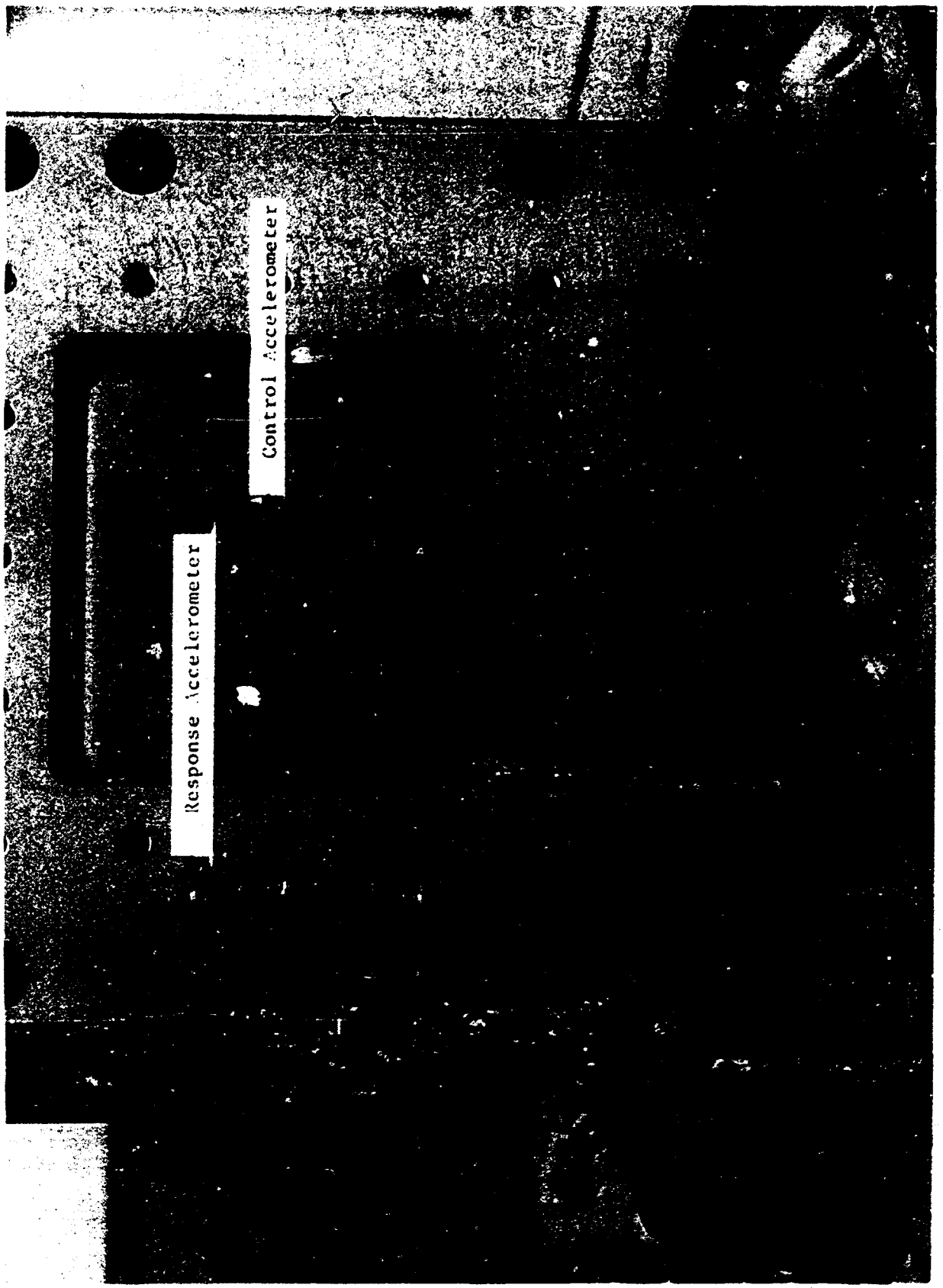

Figure 2 -- Illustration of Position of MC1917 Inside Jack Screw Fixture and Location of Accelerometers

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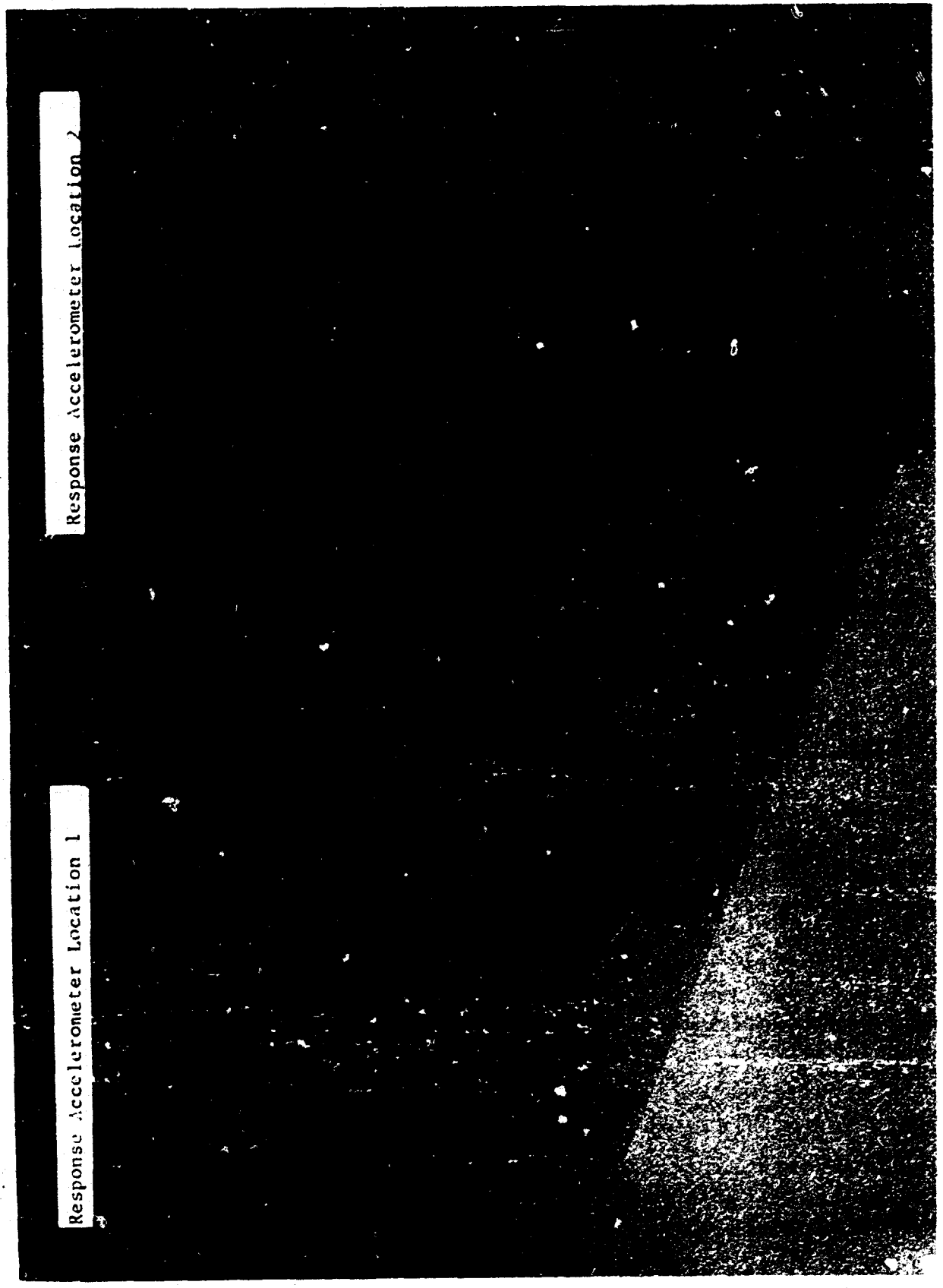

Figure 3 -- Illustration Showing Dummy MC1917 Unit in Jack Screw Fixture

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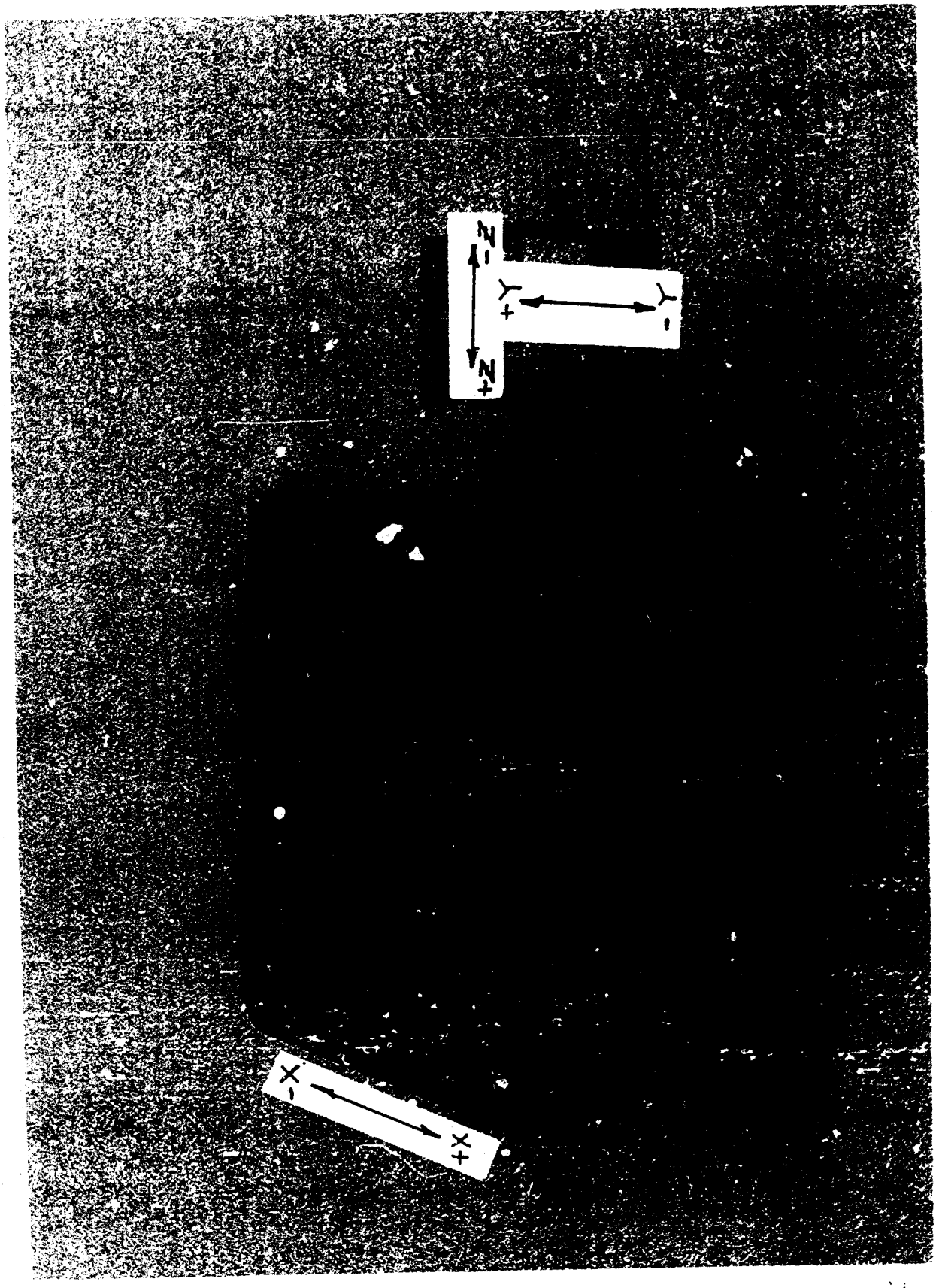

Figure 4 -- Definition of Axes for Shock and Vibration Tests and Location of Control Accelerometers for Vibration Test on MC1917

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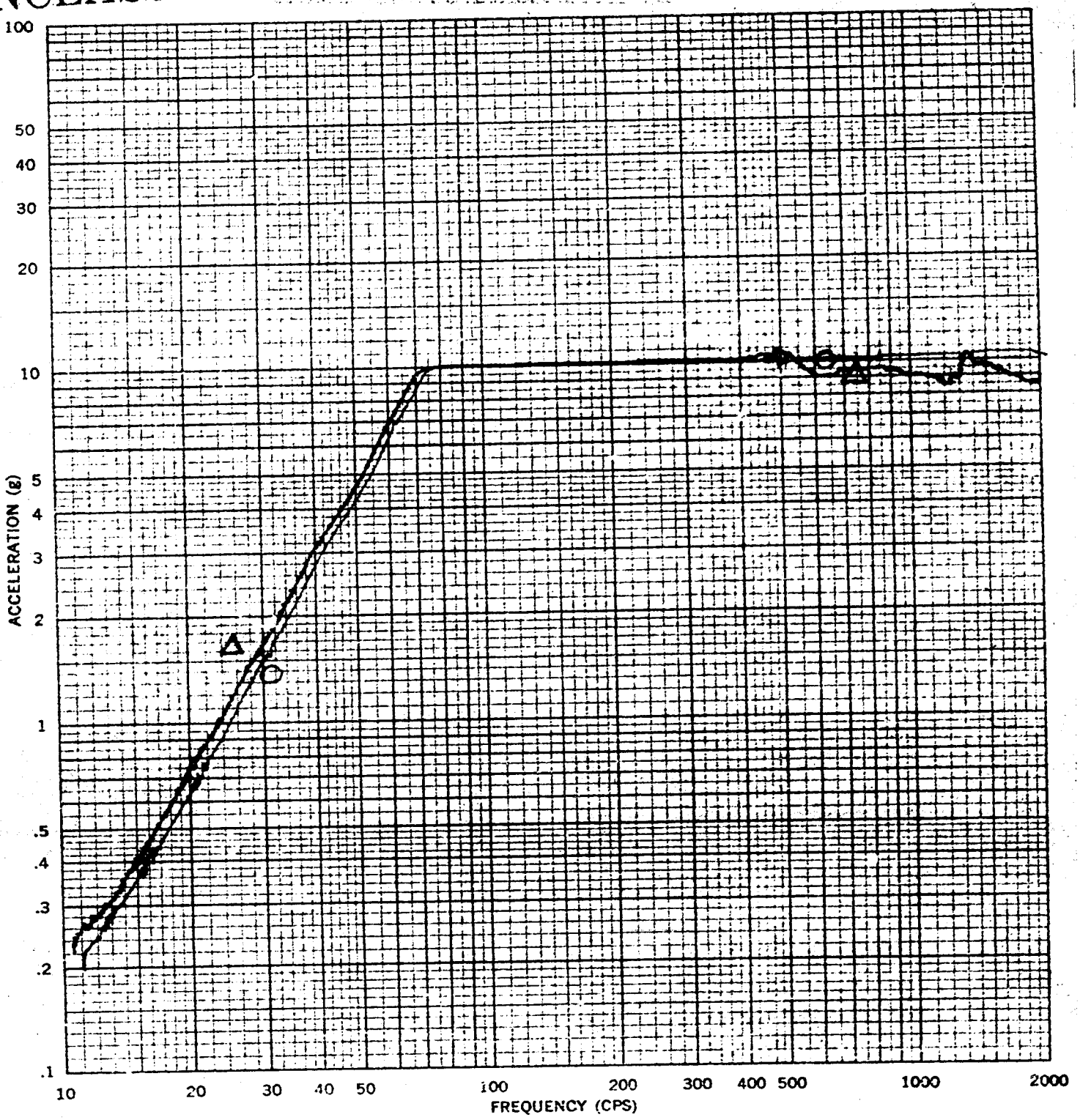

VIBRATION TEST OF Dummy MC1917 Run #1

WITH INPUT ALONG THE X AXIS, AT Room temp °F T. 26187

ACCEL. LOCATION O MC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS X FIGURE 5

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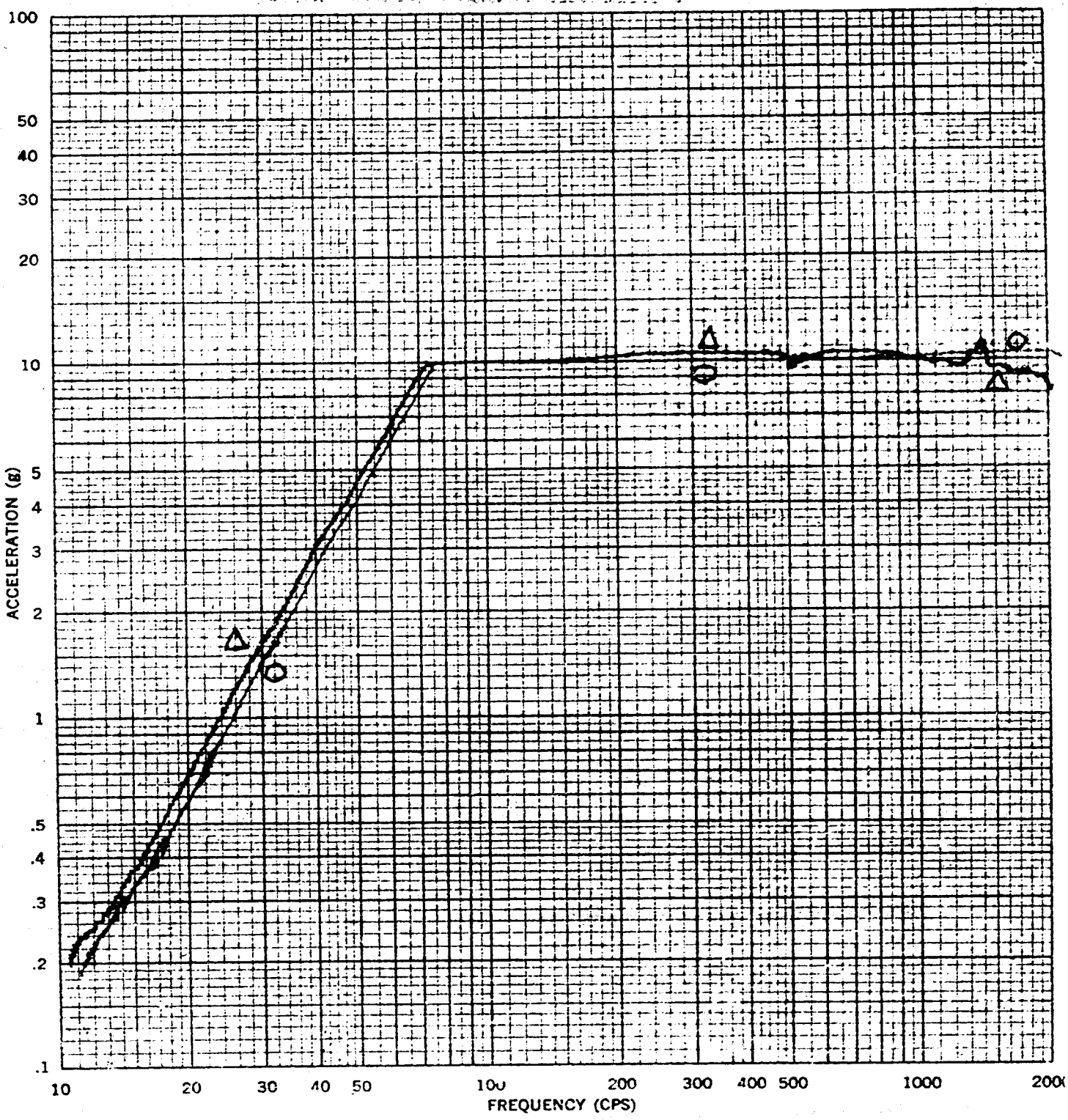

VIBRATION TEST OF Dummy MC1917 Run #2

WITH INPUT ALONG THE X AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION O MC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS X FIGURE 6

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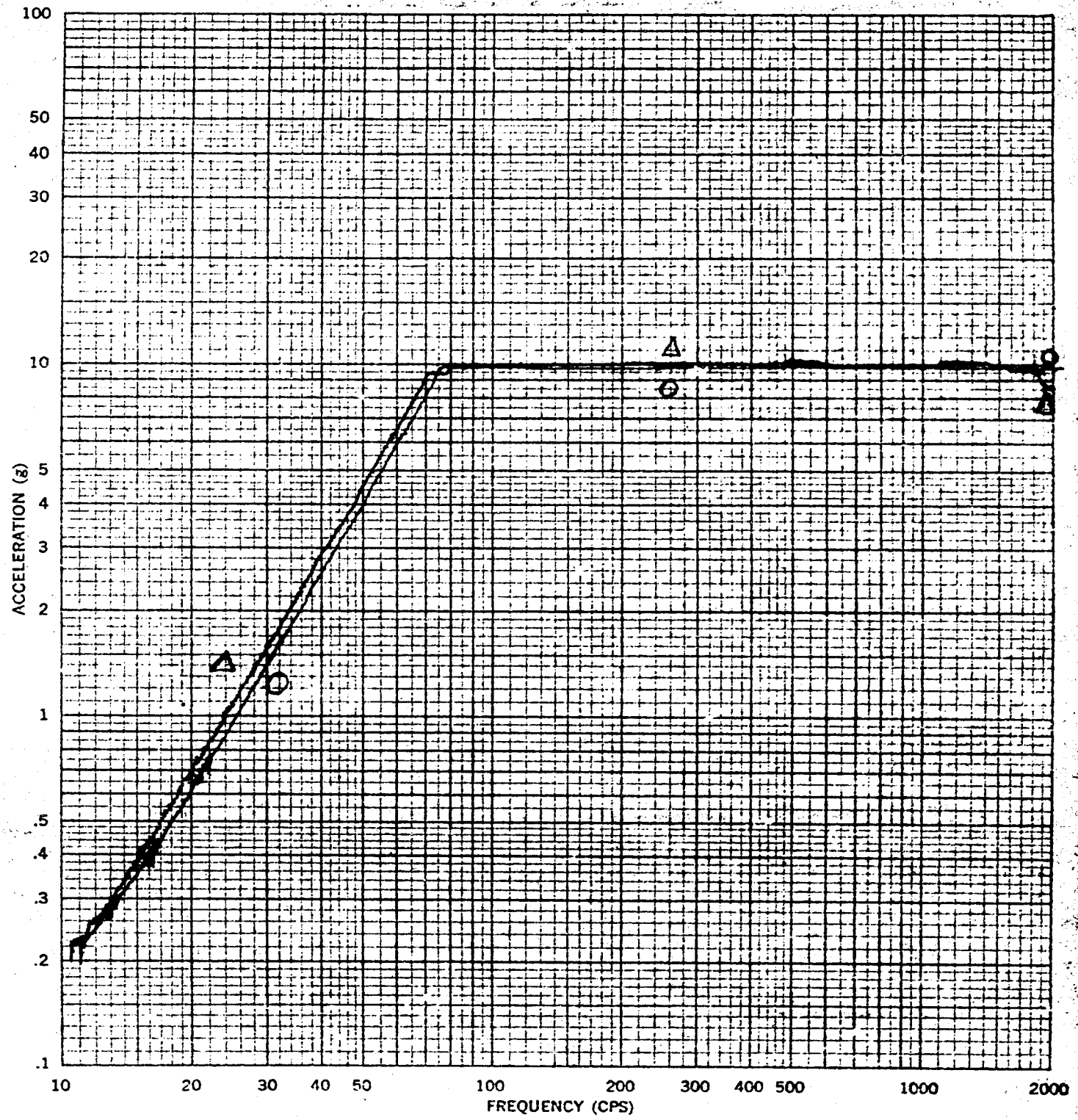

VIBRATION TEST OF Dummy MC1917 Run #1

WITH INPUT ALONG THE Y AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION O MC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Y FIGURE 7

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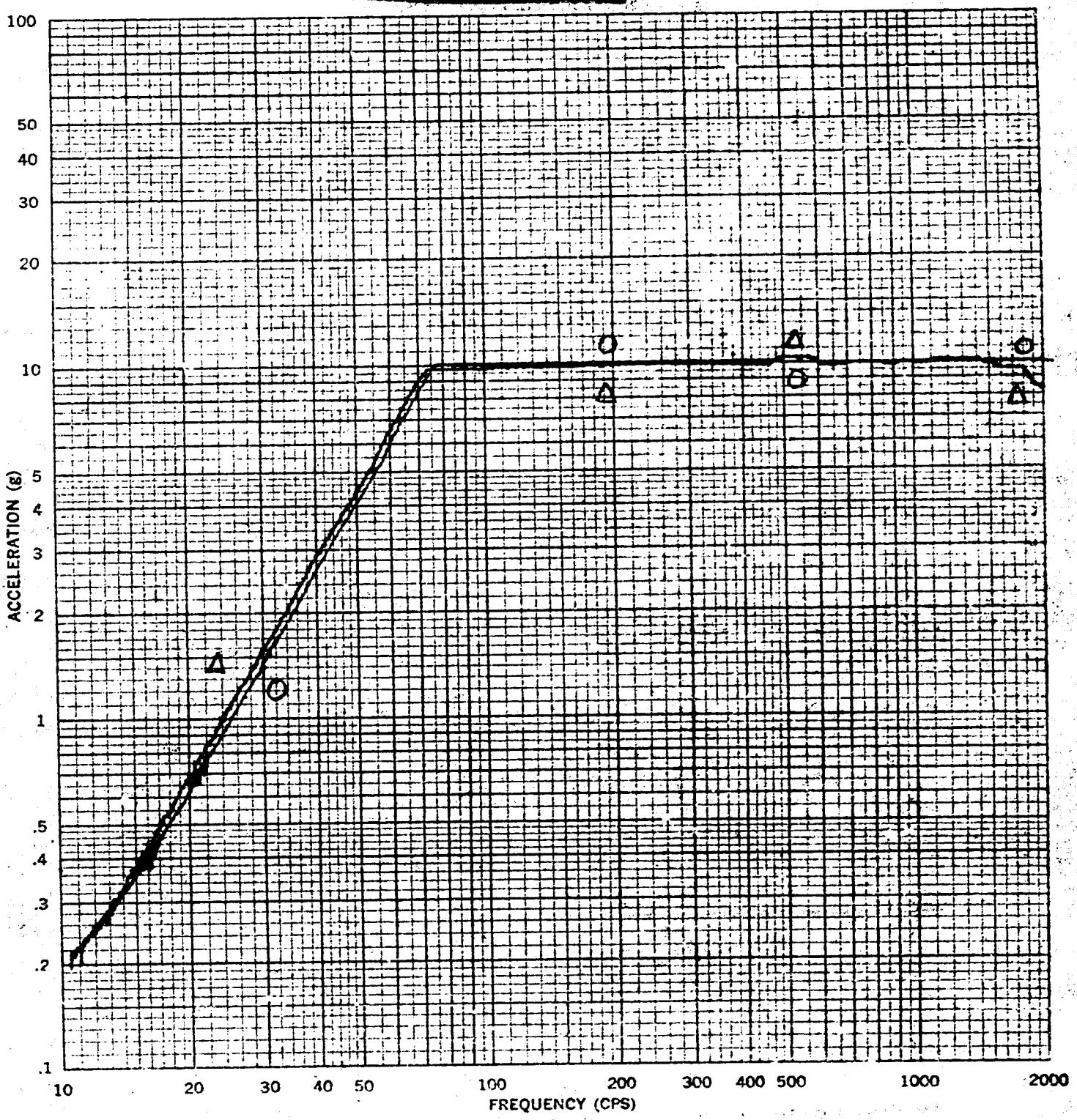

VIBRATION TEST OF Dummy MC1917 Run #2

WITH INPUT ALONG THE Y AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION O MC-1917 Input Δ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Y FIGURE 8

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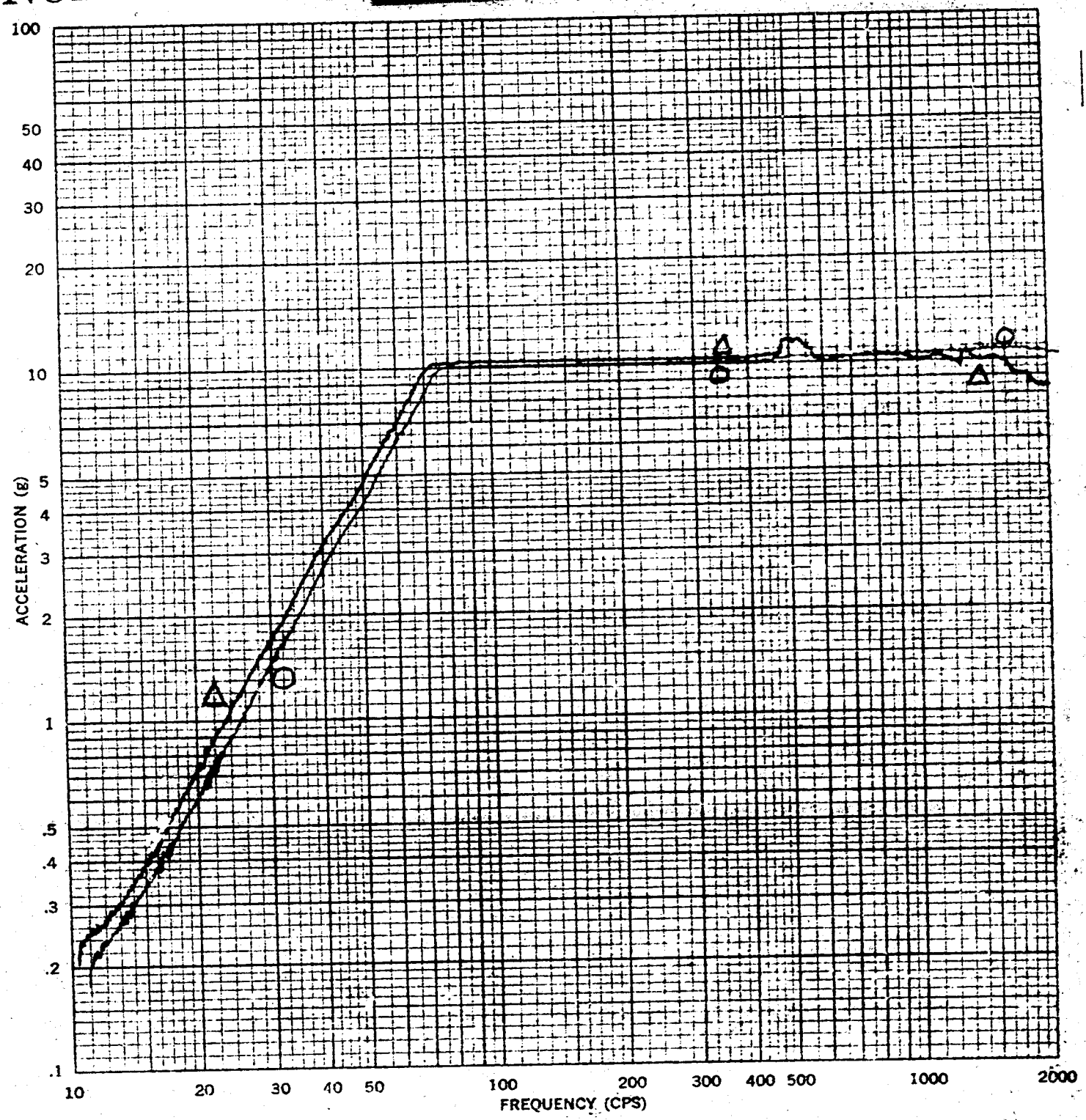

VIBRATION TEST OF Dummy MC1917 Run #1

WITH INPUT ALONG THE Z AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION ○ MC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Z FIGURE 9

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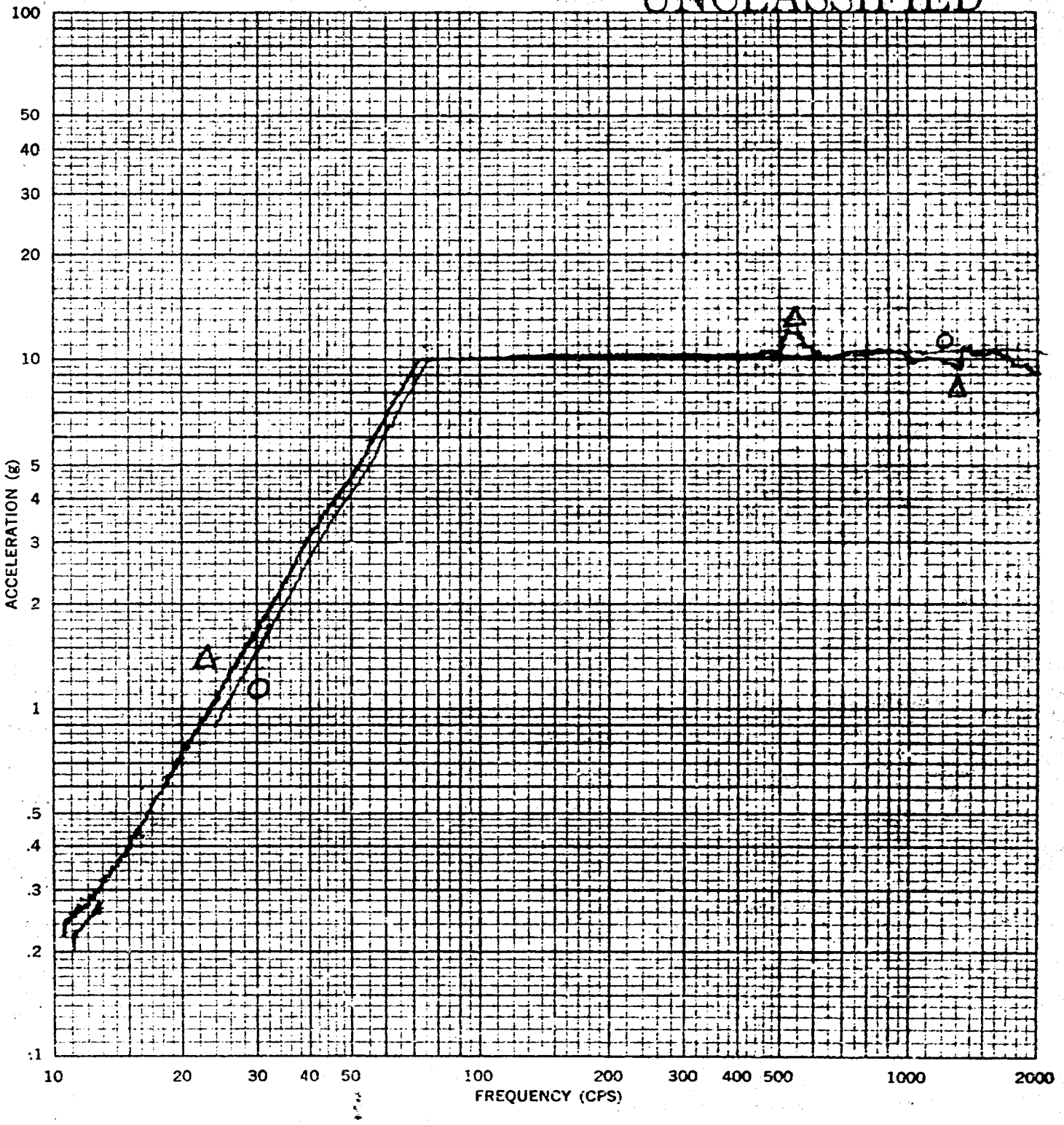

VIBRATION TEST OF Dummy MC1917 Run #2

WITH INPUT ALONG THE Z AXIS, AT Room temp °F T- 26167

ACCEL. LOCATION ○ MC-1917 Input. △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Z FIGURE 10

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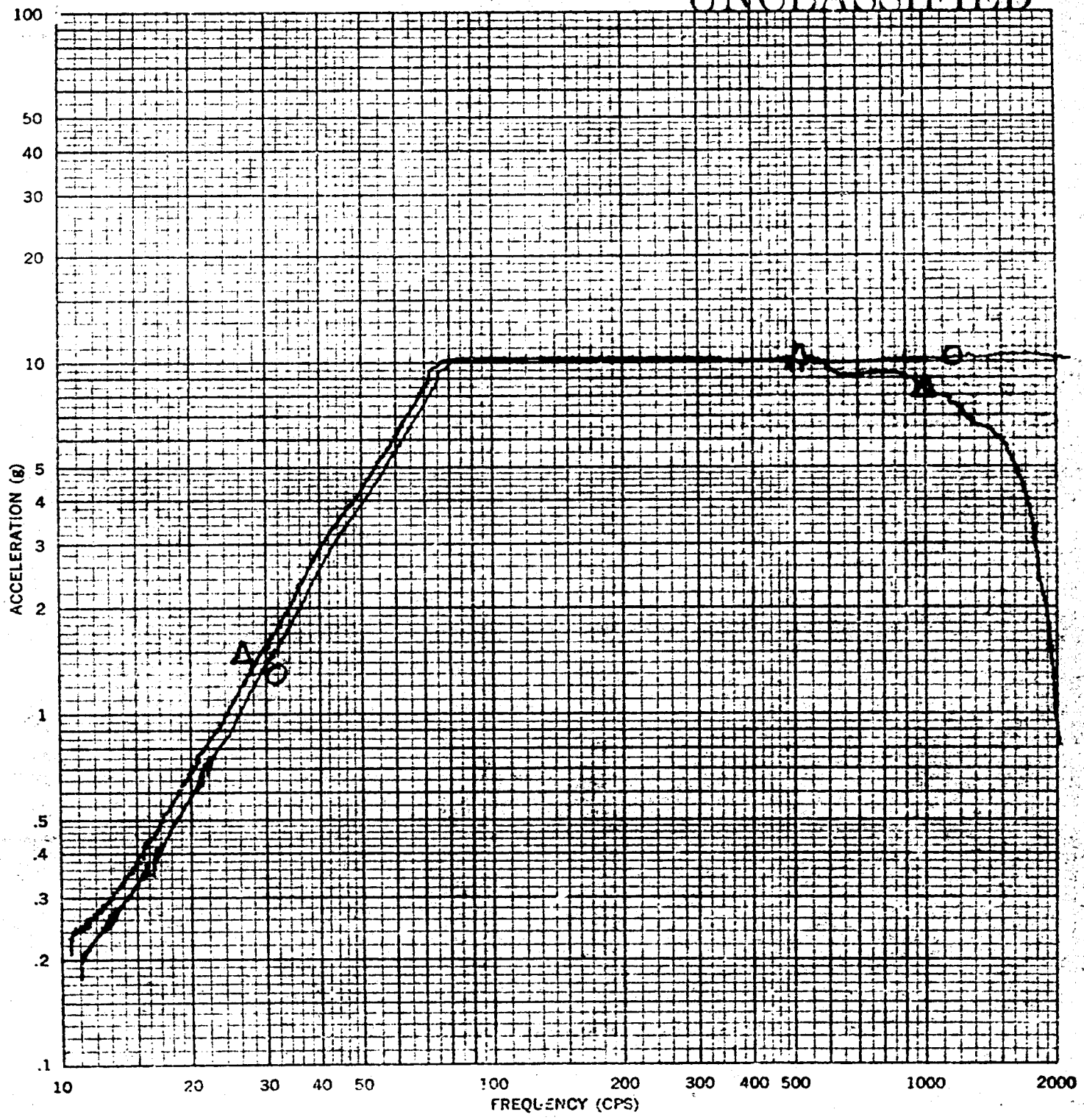

VIBRATION TEST OF MC1917 Neutron Generator Run #1

WITH INPUT ALONG THE X AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION ○ XMC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS X FIGURE 11

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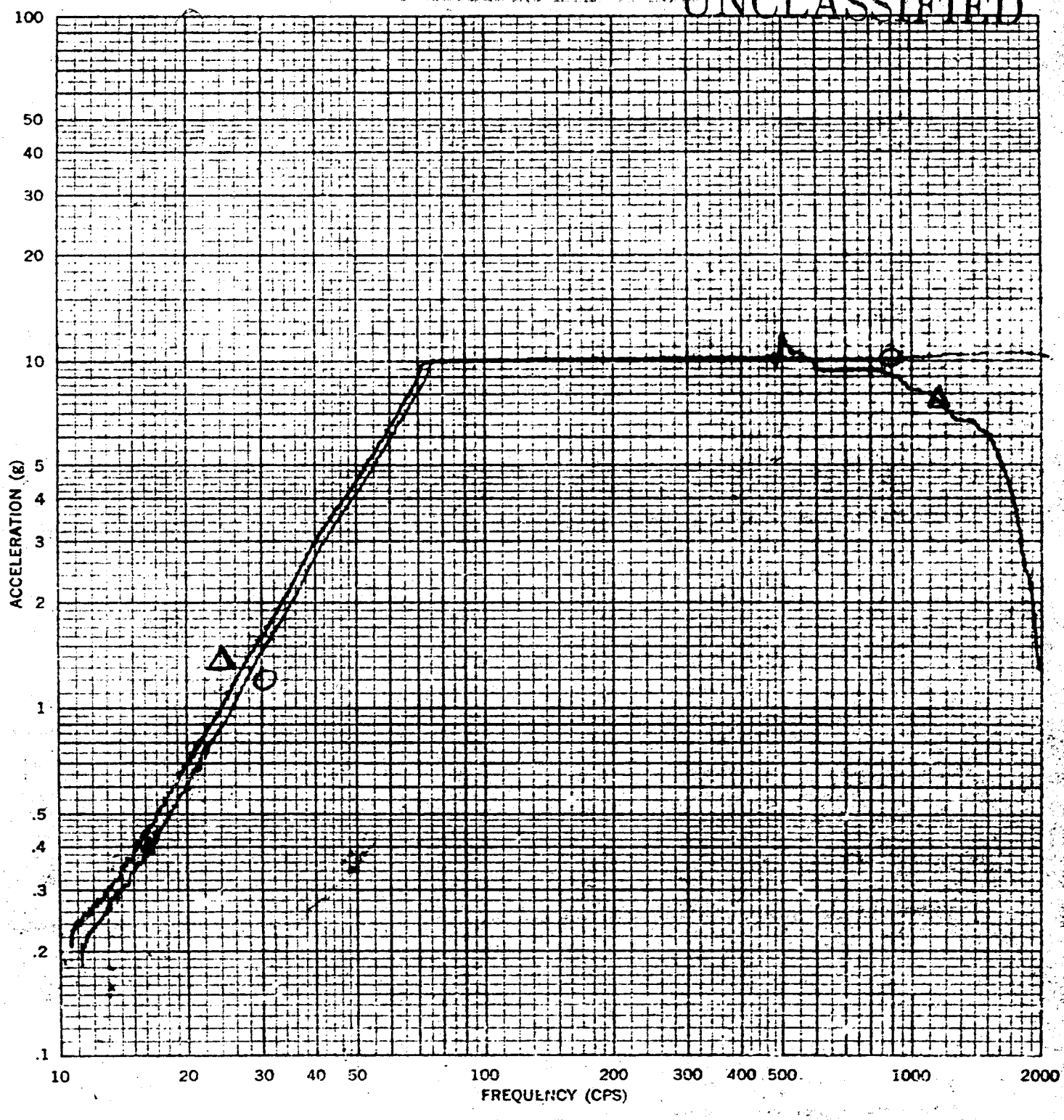

VIBRATION TEST OF MC1917 Neutron Generator Run #2

WITH INPUT ALONG THE X AXIS, AT Room temp °F T-26187

ACCEL. LOCATION ○ XMC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS X FIGURE 12

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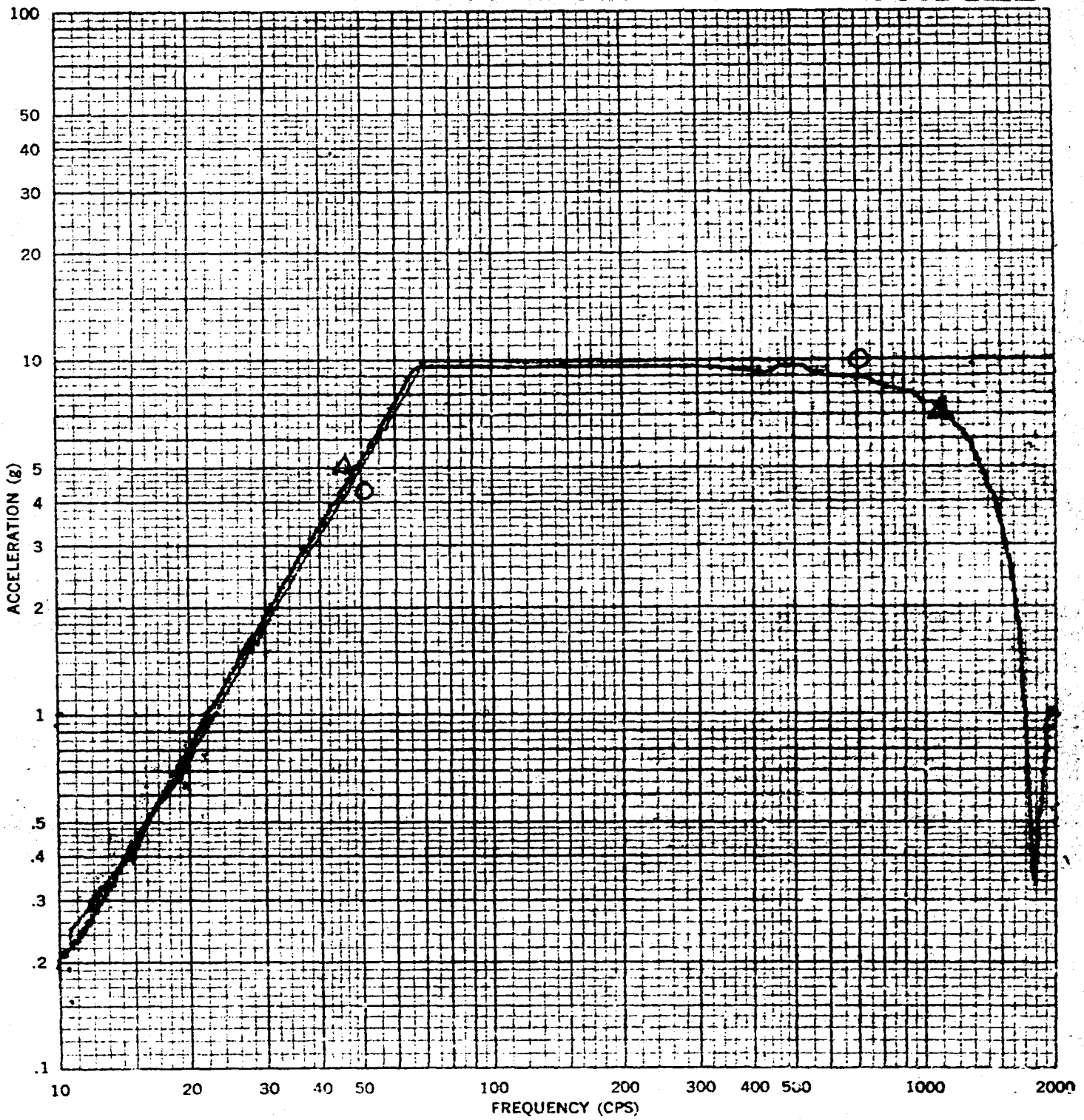

VIBRATION TEST OF MC1917 Neutron Generator Run #1

WITH INPUT ALONG THE Y AXIS, AT Room temp. °F T- 26187

ACCEL. LOCATION ○ XMC 1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Y UNCLASSIFIED FIGURE 13

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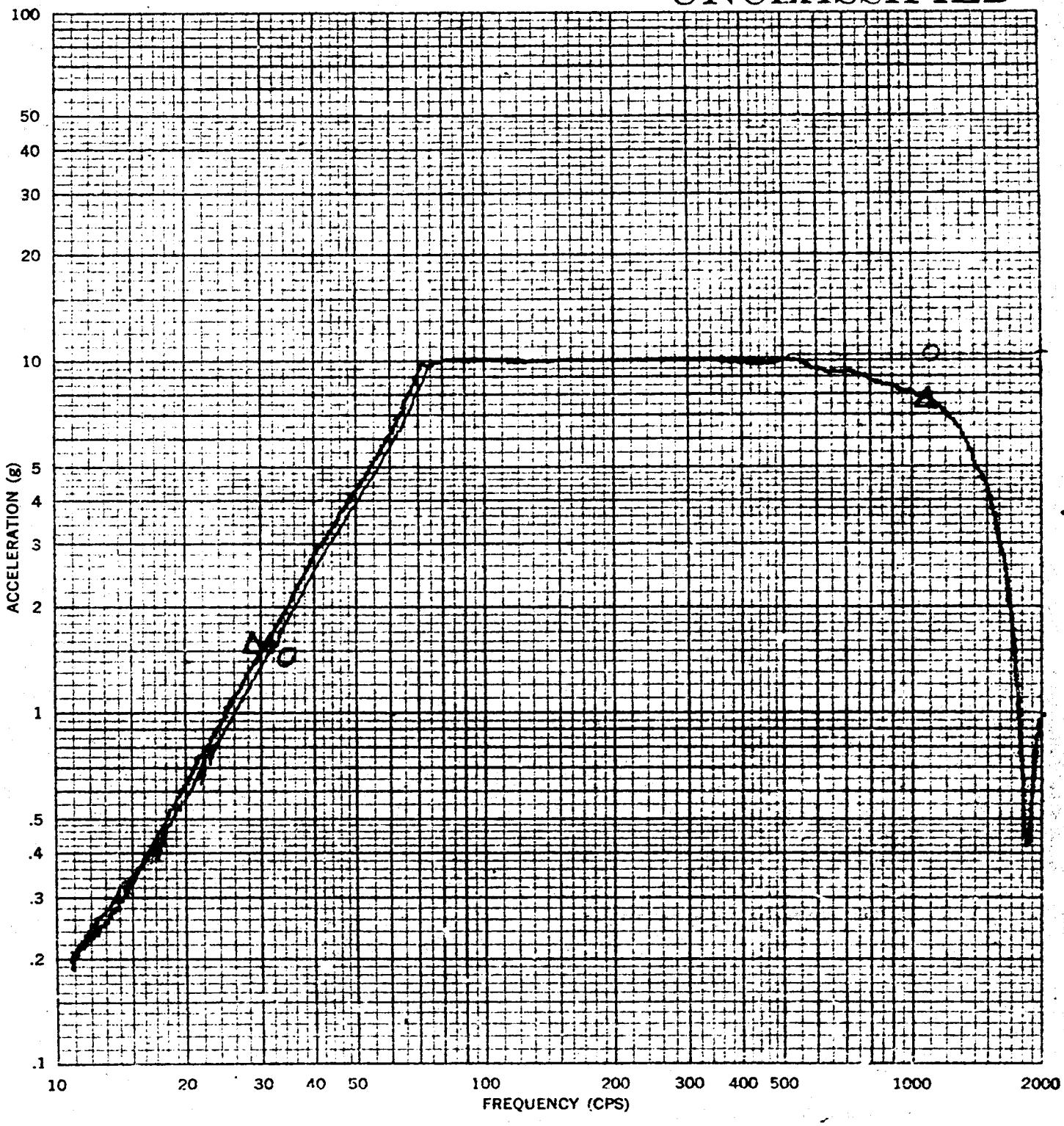

VIBRATION TEST OF XMC1917 Neutron Generator Run #2

WITH INPUT ALONG THE Y AXIS, AT Room temp °F T- 26187

ACCEL. LOCATION ○ XMC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Y FIGURE 14

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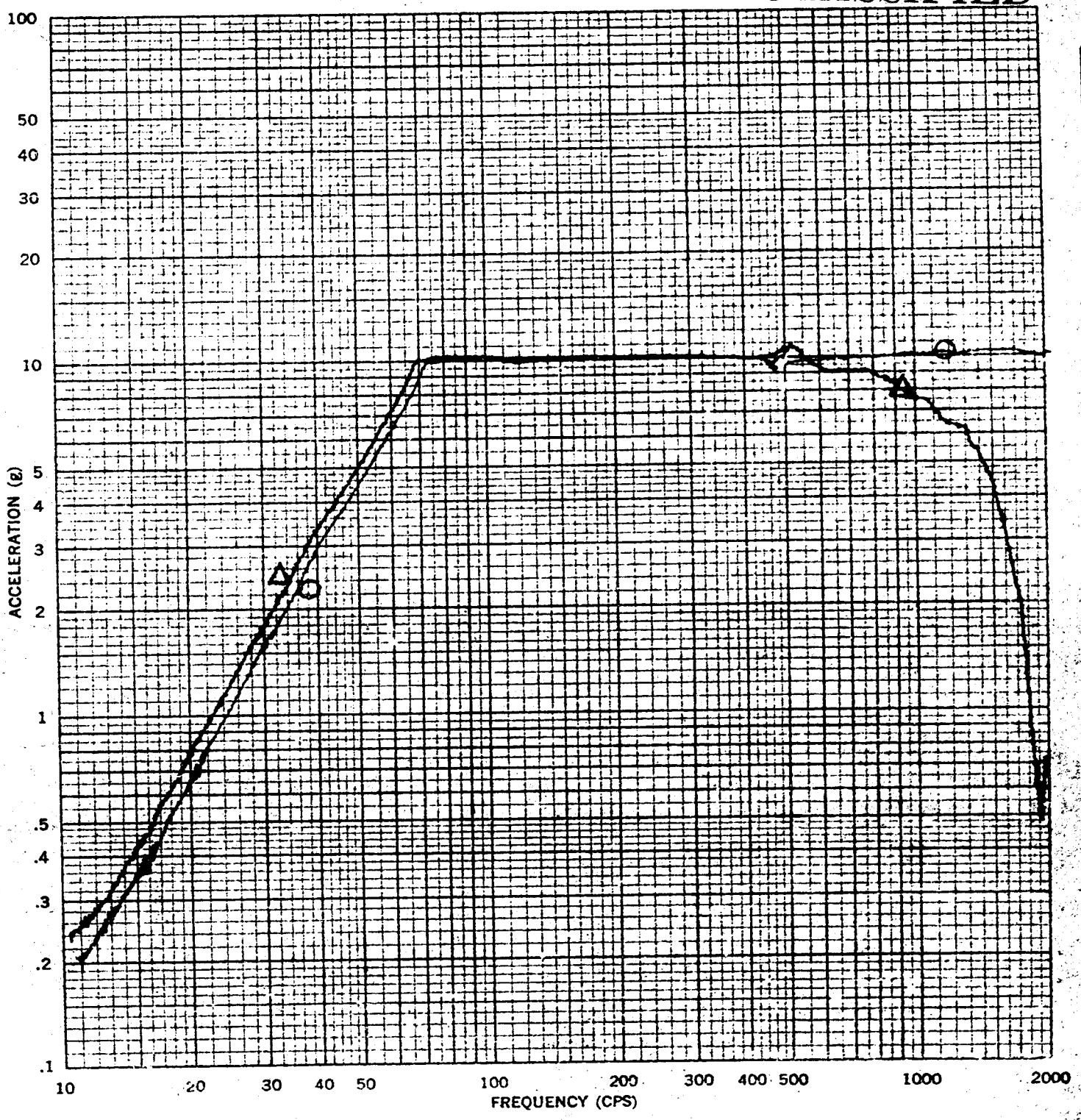

VIBRATION TEST OF MC1917 Neutron Generator Run #1

WITH INPUT ALONG THE Z AXIS, AT Room temp °F T-26137

ACCEL. LOCATION O XMC-1917 Input, Δ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Z FIGURE 15

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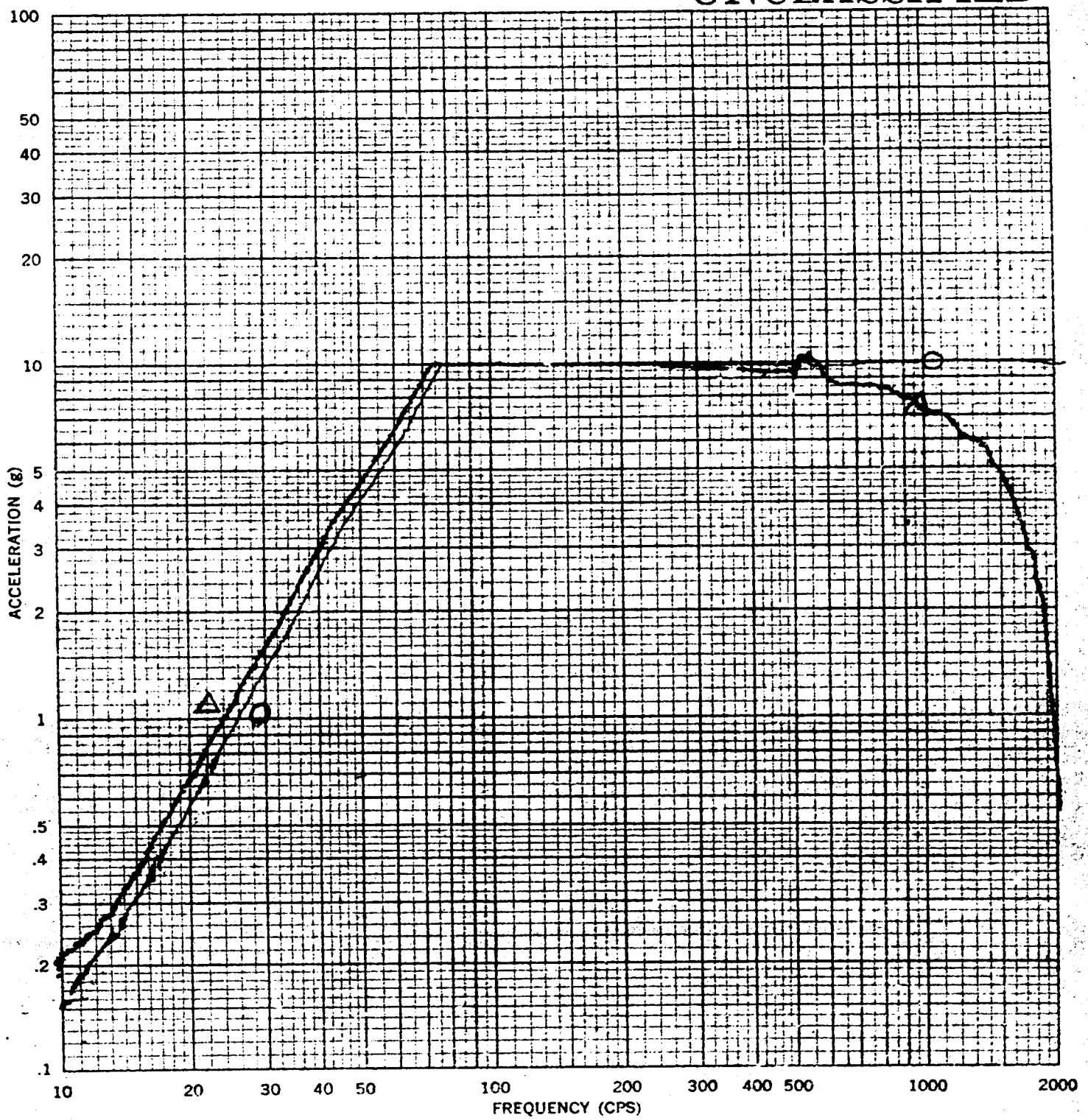

VIBRATION TEST OF MC1917 Neutron Generator Run #2

WITH INPUT ALONG THE Z AXIS, AT Room temp. °F T- 26187

ACCEL. LOCATION ○ XMC-1917 Input, △ Fixture Response REF. SYM.

FIGURE REFERENCE Figure 3 TEST DATE

AXIS Z FIGURE 16

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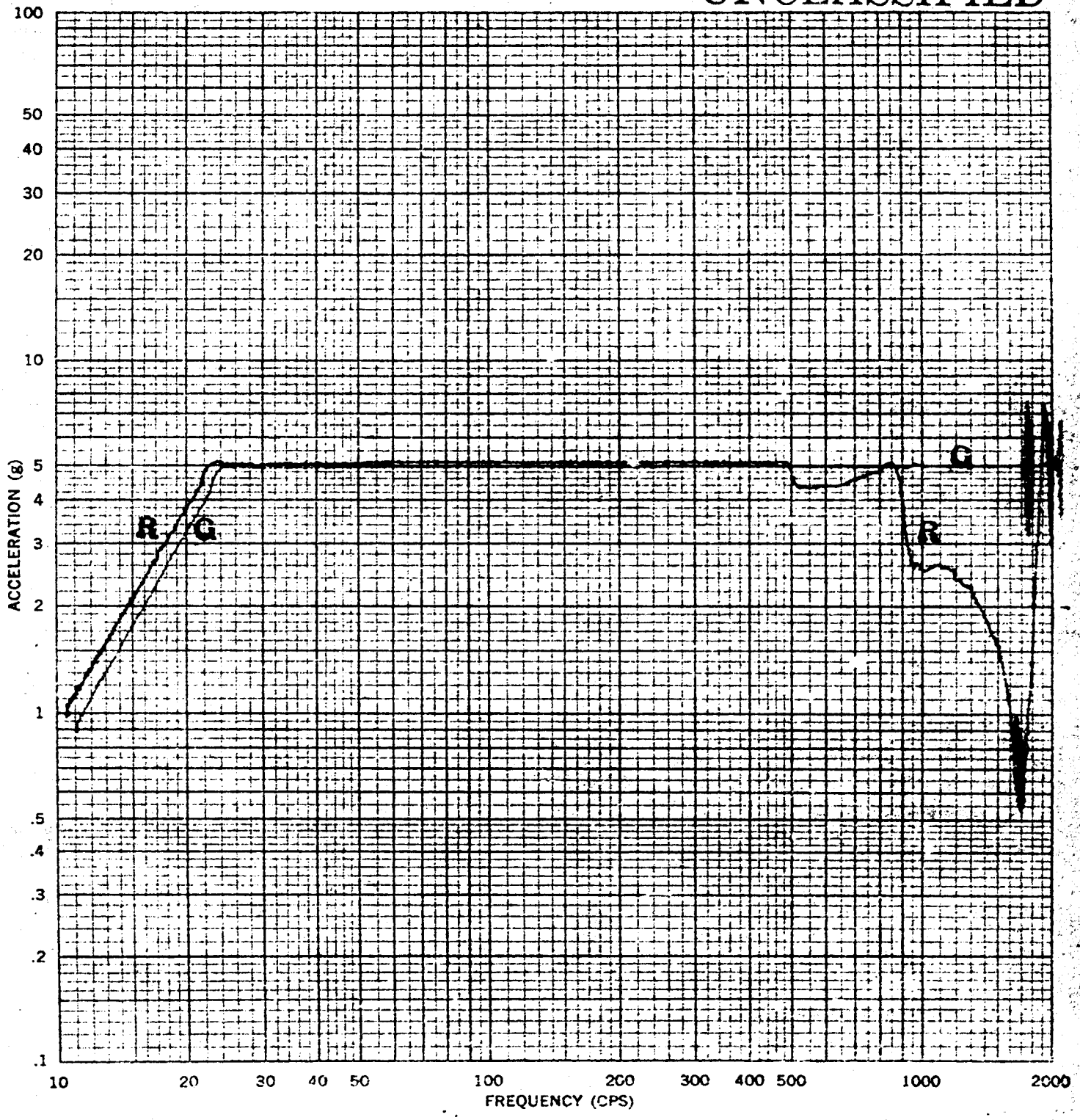

VIBRATION TEST OF MC1917 Neutron Generator (Flat Plate)

WITH INPUT ALONG THE Y AXIS, AT Room °F T- 26187

ACCEL. LOCATION G - MC 1917 R - Fixture REF. SYM.

FIGURE REFERENCE 3 TEST DATE

AXIS Y FIGURE 17

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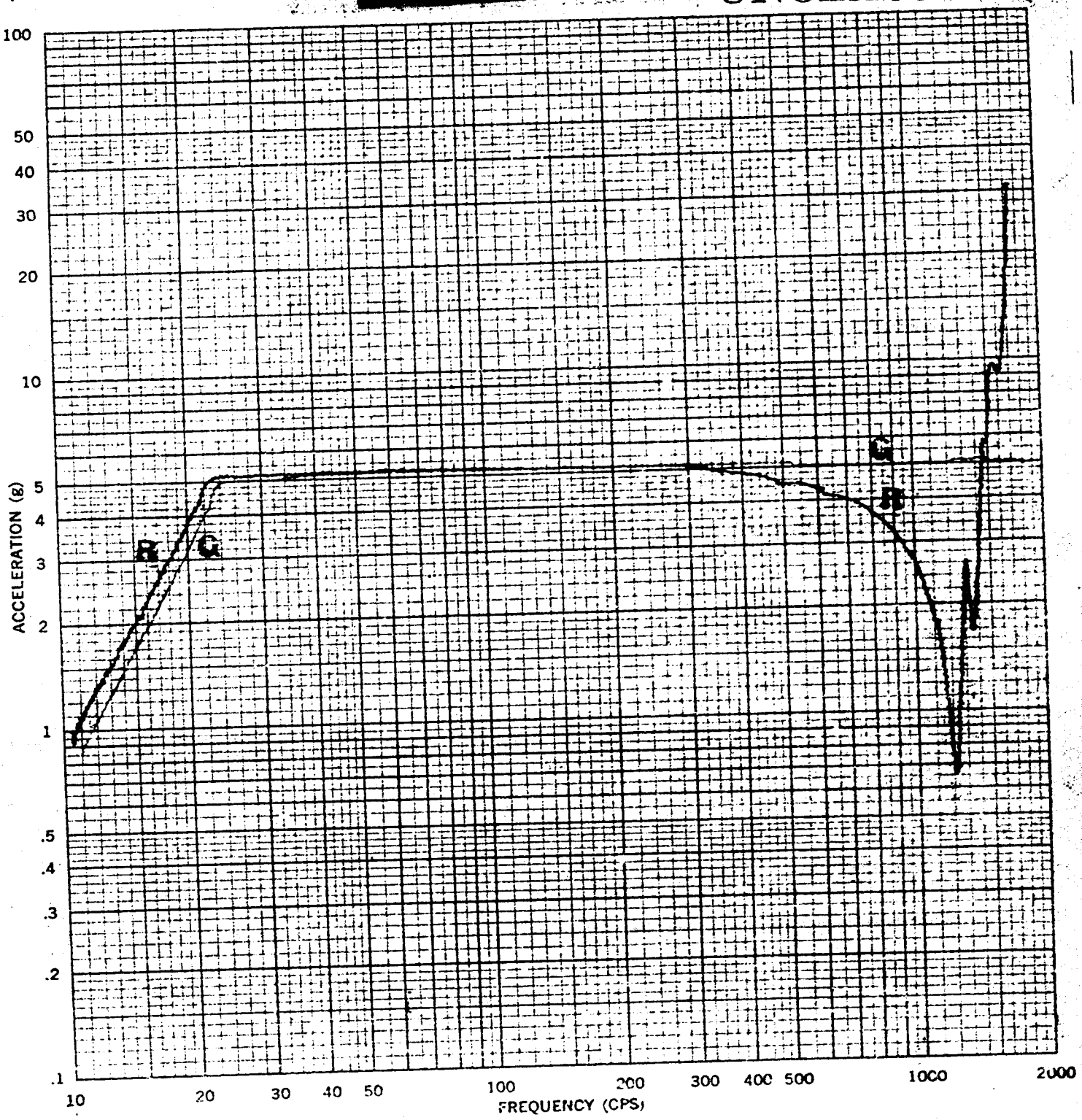

VIBRATION TEST OF MC1917 Neutron Generator (Flat Plate)

WITH INPUT ALONG THE 2 AXIS, AT Room °F T- 26187

ACCEL. LOCATION G - MC 1917 R - Fixture REF. SYM.

FIGURE REFERENCE 3 TEST DATE

AXIS Y Z FIGURE 18

FILTER BANDWIDTH CPS PAGE 27

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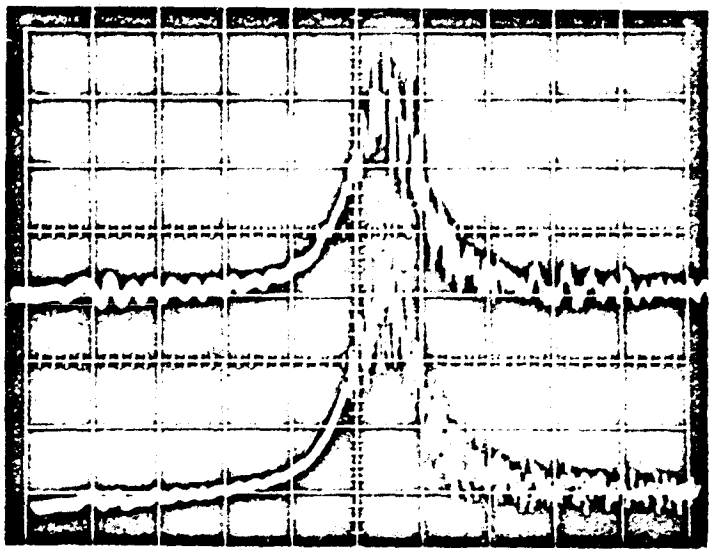
Calibrations: T-26187

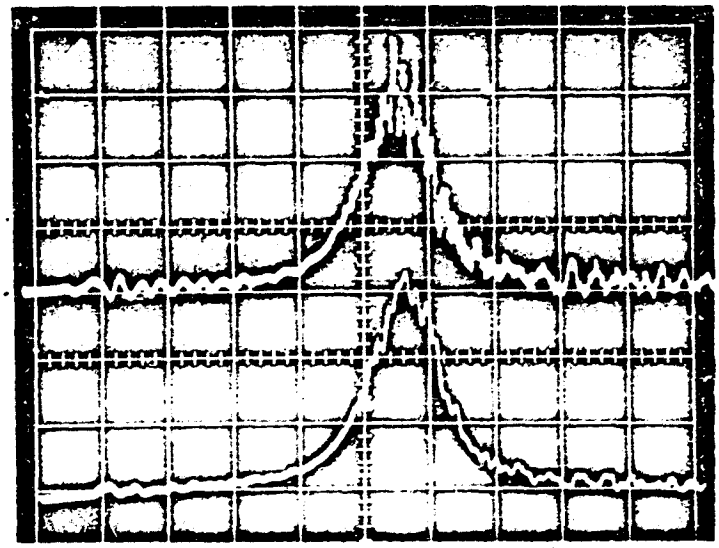
Vertical -- 500g/Major Division
Horizontal -- 1 millisecond/Major Division



Output Pulse

Input to Fixture

Time



Output Pulse

Input to Fixture (5 kc filter)

Figure 19 -- Typical Input and Response Pulses Recorded During Evaluation of Jack Screw Fixture in Mechanical Shock

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