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AERO-SPACE DIVISION LAUNCH SYSTEMS BRANCH

THE BOEING COMPANY
AERO-SPACE DIVISION
LAUNCH SYSTEMS BRANCH

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REV. SYM. A.

CHANGE RECORD

REV. SYM.	SECT.	PAGES REVISED	PAGES ADDED	PAGES DELETED	REV. SYM.	SECT.	PAGES REVISED	PAGES ADDED	PAGES DELETED
A	-	Complete Revision							
B		6,7,8,9, 10,14,15, 17, 11,19, 3, i, ii, iii							

REV. SYM. B

REVISIONS			
REV. SYM.	DESCRIPTION	DATE	APPROVED
A	Revised to provide test procedures compatible with the environments of D5-11649-1 in accordance with MSFC Technical Directive 1-V-S-10-159.	8-5-64	Wayne R. Crumpton
B	Correct Paragraph callout on pg 14, paragraph 5.1 Revise Text to agree with IN-P & VE-S-63-2, Revision of Sept. 11, 1964 in accordance with TD 1-V-S1C-159 and TD 1-V-S1C-249.	3-1-65	Herman Neumann ETR

REV. SYM.: B

CONTENTS

LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

1.1 SCOPE

This document provides vibration, shock and acoustic test requirements and procedures for qualification of the S-1C stage components.

1.2 DOCUMENT USAGE

The qualification test requirements and procedures contained in this document shall be used when vibration, shock and/or acoustic tests are specified for S-1C stage components. Personnel using these requirements and procedures in another document shall coordinate with the Structures Technology Vehicle Dynamics and Loads Group to insure that the requirements and procedures are used correctly. Environmental levels to be used with this document are contained in D5-11649-1. ▷

1.3 TEST ASSISTANCE

This document cannot provide detailed procedures for every test. Therefore, a test engineer will be appointed to assist the test agency when the test procedures are not detailed in this document or when variations in the test procedures are required. The test engineer will also monitor the actual test if necessary. The test engineer will be a qualified representative of The Boeing Company, Structures Technology Vehicle Dynamics and Loads Group.

2.0 GENERAL TEST REQUIREMENTS AND PROCEDURES

The test procedures described in this section are generally applicable to vibration, shock and acoustic tests.

2.1 TEST SPECIMEN

The test specimen shall be a component that is in accordance with the specification control drawing and representative of the production article.

2.2 TEST FIXTURE

The test fixture used to attach the test specimen to the vibration or shock machine shall be designed to eliminate or minimize fixture resonances in the test frequency range. The test fixture shall be approved by the test engineer (reference paragraph 1.3). If possible the same fixture should be used for both the vibration and shock tests.

▷ Environmental Design Data for the Saturn S-1C Stage; Vibration Shock and Acoustic Noise, Boeing Document D5-11649-1, 18 Feb. 1964.

2.3 DYNAMIC SIMILARITY

Whenever feasible, the test specimen shall be supported in a manner which duplicates or simulates the vehicle installation as closely as possible in order to achieve dynamic similarity. The method of support shall be indicated in the specification control drawing.

2.4 TEST AXES

Testing shall be conducted in three mutually perpendicular axes unless otherwise specified. The test axes and their relationship to the stage axes shall be shown in the specification control drawing. The S-1C stage axes are shown in Figure 1.

2.5 TEST LEVELS

Test levels shall be called out in the specification control drawing. All test levels represent inputs to the test specimen or test specimen support (reference paragraph 2.3) unless otherwise specified.

2.6 TEST CONDITIONS

Unless otherwise specified all measurements and tests shall be made at room ambient temperature, atmospheric pressure and relative humidity. Actual ambient test conditions should be recorded periodically during the tests and noted in the test report. If ambient conditions must be closely controlled to obtain reproducible results, a reference temperature of 23°C(73°F), a relative humidity of 50%, and an atmospheric pressure of 30 inches of mercury shall be used. If conditions other than room ambient are required during a vibration, shock or acoustic test, the conditions and associated procedures shall be specified in the specification control document.

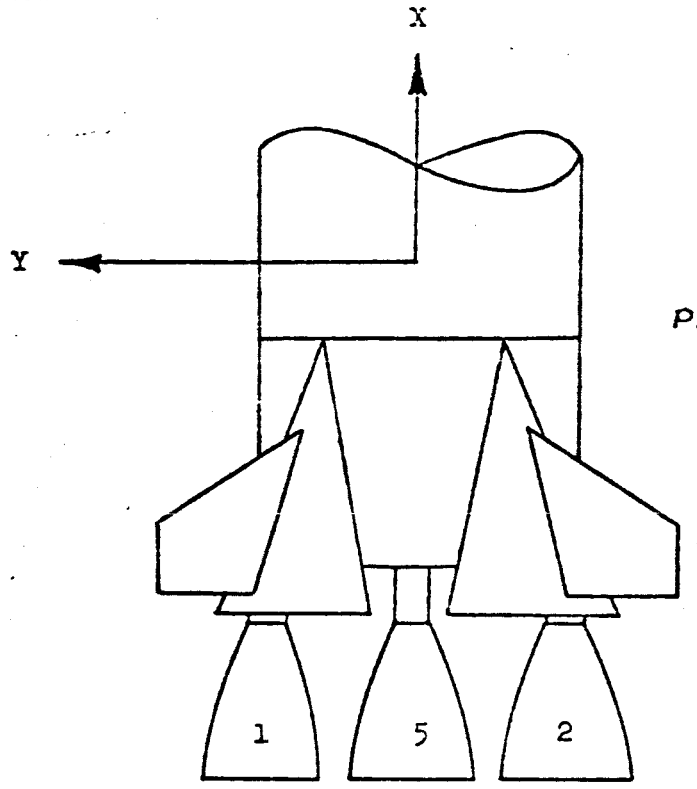
2.7 TEST SPECIMEN PERFORMANCE

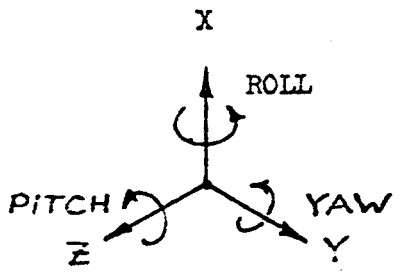
If the test specimen is electronic or mechanical operating then it must be operated before, during, and after the test as applicable. Test specimen operation requirements and tolerances shall be contained in the specification control drawing.

If the test specimen is non-operating then it must be able to support the design load before, during and after the test. Requirements for determining the ability of the structure to support the design load will be contained in the specification control drawing.

2.8 DEFINITION OF FAILURE

Failure of electronic and mechanical operating components is defined as non-operation or out-of-tolerance operation before, during or after the test. Evidence of mechanical damage before, during or after the test shall also be considered a failure.





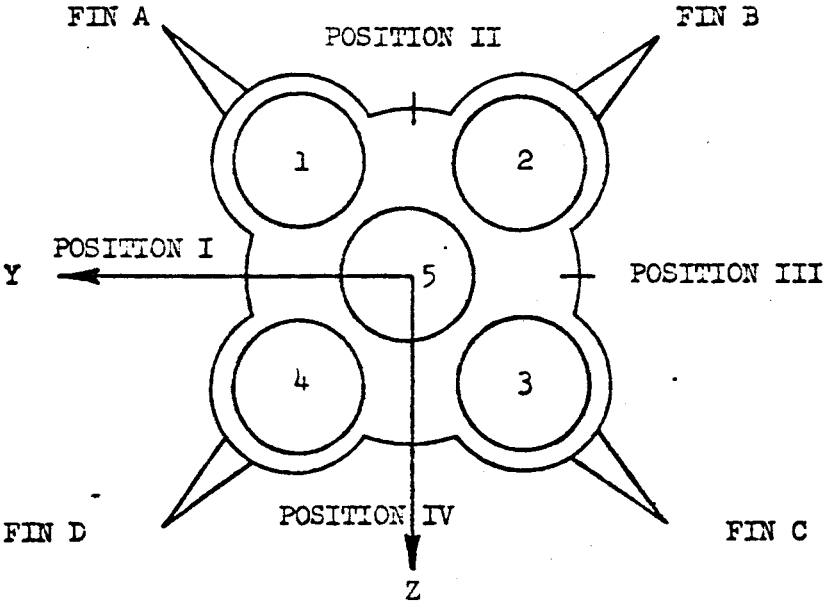


FIGURE 1

S-IC STAGE AXES

2.8 DEFINITION OF FAILURE (Cont'd)

Failure of non-operating components is defined as inability of the component to withstand the applied environmental load as evidenced by mechanical damage, and/or inability to support the design static load before, during or after the test.

2.9 INSTRUMENTATION AND CALIBRATION

The test laboratory shall provide and calibrate instrumentation necessary to control or monitor the test parameters. The accuracy of the instrumentation shall be verified periodically, preferably every six months but atleast once a year. All instrumentation used in a test shall:

(1) conform to laboratory standards whose calibration is no more than two steps removed from the prime standards at the U. S. Bureau of Standards;

(2) be appropriate for measuring the environmental conditions concerned

(3) have an accuracy of approximately one-fifth the tolerance for the variable to be measured with the following exceptions. Accelerometers shall have an accuracy of at least ±5% over the applicable frequency range. Microphones shall have an accuracy of at least ±0.5db over the applicable frequency range.

2.10 SPECTRUM ANALYSIS

The test laboratory shall verify random vibration test spectrums and acoustic test spectrums by use of a wave analyzer. The wave analyzer and analysis procedures to be used in verifying the test spectra shall be approved by the test engineer (paragraph 1.5). The following information shall be supplied to the test engineer for evaluation. The same information shall be included in the test report.

(1) Analyzer manufacturer and model number
(2) Type of analyzer (parallel filter, sweep type, etc.)
(3) Bandwidths and center frequencies of the filters
(4) Scan rate if applicable
(5) Tape loop length if applicable
(6) Analyzer time constant
(7) A brief description of the procedures which will be used to perform the spectrum analysis.

2.11 TEST REPORT

The testing laboratory shall prepare a report describing the test and test results. The type of information to be included in the

2.11 TEST REPORT (Cont'd)

test report is specified throughout this document.

2.12 TEST DEVIATION

Any deviations from the procedures of this document or the specification control drawing shall be submitted to the Structures Technology Dynamics and Loads Group for approval. Copies of the request for deviation and the deviation approval shall be included in the test report.

2.13 DISPOSITION OF TEST SPECIMEN

Qualification tests are of such severity that damage, either hidden or apparent, is expected. Therefore, specimens subjected to qualification tests shall not be installed on test or flight vehicles.

3.0 VIBRATION TEST REQUIREMENTS AND PROCEDURES

3.1 TEST APPLICABILITY AND TEST SEQUENCE

Components shall be subjected to the following tests in the order indicated unless otherwise specified in the specification control drawing; sinusoidal sweep (paragraph 3.2), sinusoidal resonance (paragraph 3.3) and random vibration (paragraph 3.4).

Generally, all vibration testing shall be completed in one test axis before proceeding to another axis. This sequence may be varied if it will reduce set-up and/or test time.

3.2 SINUSOIDAL SWEEP TEST

3.2.1 Test Specimen Installation

The test specimen shall be attached to the vibration exciter in accordance with paragraphs 2.2 and 2.3.

3.2.2 Test Axes

Test Axes shall be in accordance with paragraph 2.4.

3.2.3 Test Levels

The vibration test levels shall be in accordance with paragraph 2.5. Test levels will be expressed in terms of inches double amplitude displacement or peak acceleration (g's) of a sine wave for the frequency range of 5 to 2000 cps.

3.2.4 Test Duration

The test duration shall be the time required to perform a logarithmic

3.2.4 Test Duration (Cont'd)

sweep from 5 cps to 2000 cps to 5 cps at rate of one octave per minute. This time is approximately 17,5 minutes.

3.2.5 Test Procedure

3.2.5.1 General

The test levels specified in paragraph 3.2.3 shall be applied in each test axis with the test specimen installed on the vibrator and operating in accordance with paragraphs 3.2.1 and 2.7, respectively. The sweep test shall commence at a frequency of 5 cps. The frequency shall then be varied from 5 cps to 2000 cps to 5 cps at a rate of one octave per minute. Test conditions shall be in accordance with paragraph 2.6.

3.2.5.2 Vibration Input Measurement

The vibration input shall be measured at one or more points in each test axis by vibration pickups located on the test fixture near fixture-to-specimen attachment points. The vibration pickups shall be attached to the test fixture by bolts, studs or non-elastic cement, with sensing axes parallel to the direction of applied vibration. If the vibration levels at the various measurement points are not equal, the input shall be taken as the average of the levels read from each pickup. If one of the vibration pickups is within ±10% of the average value, it may be used as the control pickup. The output of the vibration pickups or control pickup shall be recorded throughout the sweep test in order to maintain the vibration level of paragraph 3.2.3 within the tolerances of paragraph 3.2.6. Photographs or sketches showing the pickup locations and recordings of vibration input versus frequency shall be included in the test report.

Vibration resulting from operation of the test specimen, excitation or higher harmonics, or other sources shall not cause distortion of the vibration input. The control pickup waveform shall be monitored on an oscilloscope to determine if distortion is present. If necessary, a tracking filter shall be used in the control circuit to eliminate or minimize distortion.

3.2.5.3 Required Test Data

During the sweep test the test specimen shall be closely observed and all frequencies, mode shapes, magnification factors, changes in performance, noises, and any other information indicative of test specimen resonances shall be noted in each test axis and included in the test report.

Vibration pickups used to measure the test specimen response shall be located to provide maximum information concerning test specimen

3.2.5.3 Required Test Data (Cont'd)

resonances. Sketches and/or photographs showing the location of these pickups and recordings of response versus frequency shall be included in the test report.

3.2.5.4 Test Specimen Performance

The test specimen performance shall be in accordance with paragraph 2.7. Performance records shall be included in the test report.

3.2.5.5 Post Test Inspection

Upon test completion the test specimen shall be inspected for failure in accordance with paragraph 2.8. The inspection results shall be included in the test report.

3.2.6 Tolerances

Test tolerances shall be as follows using instrumentation in accordance with paragraph 2.9.

Acceleration and Displacement Amplitude	±10%
Frequency	±5%
Test Duration	+10%, -0%

3.3 SINUSOIDAL RESONANCE TEST

3.3.1 Test Specimen Installation

The test specimen installation shall be identical to that used for the sinusoidal sweep test, paragraph 3.2.1.

3.3.2 Test Axis

Test axes shall be identical to those specified for the sinusoidal sweep test, paragraph 3.2.2.

3.3.3 Test Levels

The vibration test levels shall be in accordance with paragraph 2.5. Test levels shall be expressed in terms of inches double amplitude displacement and peak acceleration (g's) of a sine wave for the frequency range of 5 to 2000 cps.

3.3.4 Test Duration

The test duration shall be 5 minutes at each major resonant frequency in each test axis.

3.3.5 Test Procedure

3.3.5.1 General

The test levels specified in paragraph 3.3.3 shall be applied at each resonant frequency in each test axis for 5 minutes with the test specimen installed on the vibrator and operating in accordance with paragraphs 3.3.1 and 2.7, respectively. Test conditions shall be in accordance with paragraph 2.6.

3.3.5.2 Determination of Resonant Frequencies

Resonant frequencies shall be determined during the sinusoidal sweep tests, reference paragraph 3.2.5. However, the reasonant frequencies shall be verified using the levels of paragraph 3.3.3 and any change in the resonant frequency or test speciment performance shall be noted in the test report. During the test the vibrator frequency shall be adjusted to follow any change in the test specimen resonant frequency.

Only major resonant frequencies should be tested. The selection of major resonants frequencies must be approved by the test engineer. (paragraph 1.3). A description of any deleted resonances and reasons for the deletions shall be included in the test report.

3.3.5.3 Vibration Input Measurement

The vibration input shall be measured by one or more vibration pickups located on the test fixture near fixture-to-specimen attachment points. The pickup(s) shall be in the same location(s) and attached in the same manner as those used during the sweep test (paragraph 3.2.5). The output of the vibration pickup(s) shall be recorded throughout the resonance test in order to maintain the applicable vibration level of paragraph 3.3.3 within the tolerances of paragraph 3.3.6.

Information relative to the location and output of the input vibration pickup(s) shall be included in the test report. Similar information shall also be included in the test report for vibration pickups used to monitor the test specimen response.

3.3.5.4 Test Specimen Performance

The test specimen performance shall be in accordance with paragraph 2.7. Performance records shall be included in the test report.

3.3.5.5 Post Test Inspection

Upon completion of each resonance test the test specimen shall be inspected for failure in accordance with paragraph 2.8. The inspection results shall be included in the test report.

3.3.6 Tolerances

Test tolerances shall be as follows using instrumentation in accordance with paragraph 2.9.

Acceleration and Displacement Amplitude	±10%
Frequency	±5%
Test Duration	+10%, -0%

3.4 Random Vibration Test

3.4.1 Test Specimen Installation

The test specimen installation shall be identical to that used for the sinusoidal sweep test, paragraph 3.2.1.

3.4.2 Test Axes

Test axes shall be identical to those specified for the sinusoidal sweep test, paragraph 3.2.1.

3.4.3 Test Levels

The vibration test levels shall be in accordance with paragraph 2.5. Random test levels shall be expressed in terms of acceleration power spectral density (g^2/cps) over the frequency range of 5 to 2000 cps and an overall root mean square acceleration. The vibrator shall be capable of producing amplitudes up to three times the overall rms acceleration. A sinusoidal level superimposed on the random level shall be expressed as a peak acceleration over a specified frequency range or at discrete frequencies.

3.4.4 Test Duration

The test duration shall be 15 minutes in each test axis for Zone 1 environments and 5 minutes in each text axis for Zones 2 through 7.

3.4.5 Test Procedure

3.4.5.1 General

The test levels specified in paragraph 3.4.3 shall be applied in each test axis with the test specimen installed on the vibrator and operating in accordance with paragraphs 3.4.1 and 2.7, respectively. Test conditions shall be in accordance with paragraph 2.6.

3.4.5.2 Establishment of the Random Vibration Test Spectrum

The random vibration test spectrum shall be established with the test specimen installed on the vibrator in accordance with paragraph 3.4.1. The vibration input shall be measured at the same location(s) used for the sine sweep test, reference paragraph 3.2.5.

3.4.5.2 Establishment of the Random Vibration Test Spectrum (Con'd)

The vibration system (vibrator, test fixture and test specimen) shall be equalized in each test axis to obtain the specified vibration spectrum shape. Sinusoidal equalization techniques or automatic equalization equipment may be used. After the vibration system has been equalized the full random vibration level shall be applied and a spectrum analysis performed to determine that the test levels are in accordance with paragraph 3.4.3 and within the tolerances of 3.4.6. If the input spectrum and overall acceleration are not within tolerance the procedure shall be repeated until the specified test levels are obtained.

A record shall be kept of the time full level vibration is applied while the test spectrum is being established. This time may be considered as part of the test duration (paragraph 3.4.4) if approved by the test engineer (paragraph 1.3). If the time required for equalization approaches one-quarter of the specified test duration and the specified test spectrum has not been obtained consideration should be given to replacing the test specimen with a dynamically similar dummy until the desired spectrum is obtained.

3.4.5.3 Establishment of the Random Vibration Test Spectrum with a Superimposed Sine

The random vibration and sinusoidal vibration inputs shall be established separately in accordance with paragraph 3.2.5 and 3.4.5.2.

3.4.5.4 Test Performance

When the test spectrum has been established in accordance with paragraph 3.4.5.2 or 3.4.5.3 the vibration level shall be raised to that specified in paragraph 3.4.3, and the test run for the time specified in paragraph 3.4.4 less any time used in establishing the test spectrum (paragraph 3.4.5.2).

When a superimposed sine wave is required (paragraph 3.4.3) it shall be applied throughout the random test duration by dwelling at the frequency(s) indicated or by sweeping over the specified frequency range. The sweep rate shall be as stated in the specification control drawing. The sweep shall commence at the lower specified frequency, increase logarithmically to the upper specified frequency, then decrease logarithmically to the lower frequency. Repeat the sweep procedure as many times as necessary during the test duration.

3.4.5.5 Test Specimen Performance

Test specimen performance shall be in accordance with paragraph 2.7. Records of the test specimen performance shall be included in the test report.

3.4.5.6 Verification of the Test Spectrum

The test spectrum shall be verified by spectral analysis for each test axis at the beginning of the test (reference paragraph 3.4.5.2) and at least once during the test. In addition, the overall root mean square acceleration shall be monitored continuously throughout the test. The spectra and the overall acceleration shall be obtained from the output of the vibration pickup(s) used to establish the test spectrum (paragraphs 3.4.5.2 and 3.4.5.3). The measurements shall be within the tolerances of paragraph 3.4.6. The spectra analyses and a recording of the overall root mean square acceleration shall be included in the test report. The test laboratory shall comply with paragraphs 2.9 and 2.10 relative to instrumentation and spectrum analysis requirements.

3.4.5.7 Post Test Inspection

Upon completion of the test the test specimen shall be checked for failure in accordance with paragraph 2.8. The post test inspection results shall be included in the test report.

3.4.6 Test Tolerances

Test tolerances shall be as follows using instrumentation in accordance with paragraph 2.9.

Overall Root Mean Square Acceleration	±10%
Acceleration Power Spectral Density	+100% - 30%

NOTE:
1. These acceleration power spectral density tolerances are for use with analyzers having bandwidths of 25 cps or less. However, the filter bandwidths available shall be noted in accordance with paragraph 2.10 and bandwidths greater than 25 cps may be used with the test engineers approval.
2. These acceleration power spectral density tolerances apply to the frequency range from 20 to 2000 cps. Below 20 cps, tolerances are at the discretion of the test engineer.

Sinusoidal Acceleration	±10%
Frequency	± 5%
Test Duration	+10%, -0%

4.0 SHOCK TEST REQUIREMENTS AND PROCEDURES

4.1 TEST SPECIMEN INSTALLATION

The test specimen shall be attached to the shock machine in accordance with paragraphs 2.2 and 2.3.

4.2 TEST AXES

The test axes shall be in accordance with paragraph 2.4.

4.3 TEST LEVEL, DURATION AND TOLERANCES

The applied shock shall be a half sine wave with a time duration of 10 ±2 milliseconds (see Figure 2). The magnitude of the shock in terms of acceleration units (g's) shall be called out in the specification control drawing. A tolerance of ±15% is allowable on the shock magnitude.

4.4 NUMBER OF SHOCKS

The test specimen shall be subjected to three shocks in each direction in each test axis, (a total of eighteen shocks) unless otherwise specified in the specification control drawing.

4.5 TEST PROCEDURE

4.5.1 General

The shock input and number of shocks specified in paragraphs 4.3 and and 4.4, respectively, shall be applied with the test specimen installed in accordance with paragraph 4.1. The test specimen shall be operating in accordance with paragraph 4.5.3. Test conditions shall be per paragraph 2.6.

4.5.2 Establishment of the Shock Input

The shock specified in paragraph 4.3 shall be established in each direction of each test axes with the test specimen or a dynamically similar dummy installed on the shock machine in accordance with paragraph 4.1. The use of a dynamically similar dummy is preferable in order to avoid damaging the test specimen. The shock input shall be measured by one or more accelerometers located on the test fixture near a fixture-to-specimen attachment point(s). The accelerometer(s) shall be attached to the test fixture by bolts, studs or non-elastic cement. The accelerometer(s) output shall be recorded on an oscillograph or a photograph taken from an oscilloscope. If more than one accelerometer is used to measure the shock input, the locations and measured values from the various accelerometers shall be included in the test report.

When the shock input has been established within the tolerances called out in paragraph 4.3, the test specimen shall be subjected to the number of shocks specified in paragraph 4.4.

4.5.3 Test Specimen Performance

Test specimen performance shall be in accordance with paragraph 2.7 with the following exception. Components which are not required to

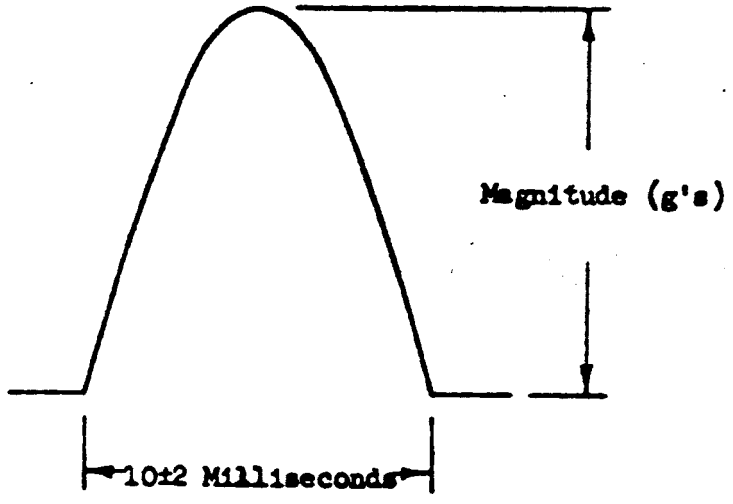


FIGURE 2

SHOCK PULSE

4.5.3 Test Specimen Performance (Cont'd)

operate in service during ignition, thrust buildup and release, engine cutoff or staging must operate before and after but not during the shock input. Records of the test specimen performance shall be included in the test report.

4.5.4 Shock Input Verification

The shock input shall be verified by recording the test fixture accelerometer(s) output on an oscillograph or photograph taken from an oscilloscope for each shock input. The recorded shock inputs shall be in accordance with paragraph 4.3. Copies of the recorded shock inputs shall be included in the test report. Instrumentation shall be in accordance with paragraph 2.9.

4.5.5 Post Test Inspections

The test specimen shall be checked for failure in accordance with paragraph 2.8 after each series of three shock inputs in each direction in each axis. The results of the post test inspection shall be included in the test report.

5.0 ACOUSTIC TEST REQUIREMENTS AND PROCEDURES

5.1 APPLICABILITY

Generally, components which require acoustic testing shall be tested in a reverberation room as outlined in paragraph 5.2. However, structural panels, flush mounted antennas or similar components which are exposed to the external acoustic environment shall be subjected to progressive wave test as outlined in paragraph 5.3. In the event that reverberant test facilities are not adequate, components requiring reverberant testing may be qualified using progressive wave techniques if approved by the test engineer.

5.2 REVERBERATION CHAMBER TEST

5.2.1 Reverberation Chamber Requirements

The reverberation chamber shall be suitably formed and proportioned to produce, as clearly as possible, a diffuse sound field above 50 cps with a uniform sound energy density throughout the chamber. Acute angles of adjacent chamber walls shall be avoided whenever possible.

5.2.2 Test Specimen Installation

The test specimen shall be suspended in the reverberant chamber by soft springs or installed in the chamber in accordance with paragraph 2.3. If the specimen is suspended by soft springs the natural frequencies of the significant modes of suspension shall be less than 25 cps. The test specimen shall be centrally located in the test chamber so that all surfaces are exposed to the sound field.

5.2.2 Test Specimen Installation (Cont'd)

The distance between the specimen and the chamber walls shall be measured and noted in the test report. The volume of the test specimen shall be not more than ten percent of the test chamber volume. No major surface of the test specimen shall be parallel to the test chamber wall.

5.2.3 Test Level

The acoustic test level shall be called out in the specification control drawing. The test level shall be expressed as a sound pressure level spectrum and an overall sound pressure level. Acoustic levels shall be stated in decibels referenced to 0.0002 microbars (2 X 10^{-9} newtons/square meter).

5.2.4 Test Duration

The test duration shall be as specified in the specification control drawing.

5.2.5 Test Procedure

5.2.5.1 General

The test levels specified in paragraph 5.2.3 shall be applied with test specimen installed in the reverberation chamber and operating in accordance with paragraphs 5.3.1 and 2.7, respectively. Test conditions shall be in accordance with paragraph 2.6. If both a high level and a low level test spectrum are specified, the high level shall be run first followed immediately by the low level.

5.2.5.2 Establishment of the Test Spectrum

The noise test spectrum shall be established with the test specimen mounted in the test chamber. The overall sound pressure level, reduced by six decibels, shall be established in the test chamber and adjusted to obtain the specified spectrum shape. The sound pressure level shall be measured near each major surface of the test specimen using one or more microphones located approximately 18 inches from the test specimen surface. These measurements shall be averaged to determine the acoustic spectrum in the chamber. The individual measurement locations, extreme values and the average value shall be included in the test report. The time required to obtain these measurements should be kept as short as possible and recorded in the test report. In the event the time required to establish the test spectrum approaches one-quarter of the specified test duration a geometrically similar dummy test specimen may be used.

5.2.5.3 Test Performance

When the test spectrum has been established as outlined in paragraph 5.2.5.2, the overall sound pressure level shall be raised to that specified in paragraph 5.2.3, and the test run for the time specified

5.2.5.3 Test Performance (Cont'd)

in paragraph 5.2.3. The overall sound pressure level and the test spectrum shall be within the tolerances specified in paragraph 5.2.5.

5.2.5.4 Test Specimen Performance

Test specimen performance shall be in accordance with paragraph 2.7. Records of the test specimen performance shall be included in the test report.

In the event of malfunction or out-of-tolerance operation during the test, but satisfactory operation following the test, a discrete frequency acoustic test shall be applied. The discrete frequency test shall consist of subjecting the operating test specimen to a sinusoidal noise level which is varied logarithmically over the test frequency range at a rate of one octave per minute. This test shall be repeated using various noise levels until the malfunction or out-of-tolerance operation is obtained. The noise level(s) and frequency(s) at which the malfunction or out-of-tolerance operation occurs shall be noted in the test report.

5.2.5.5 Verification of the Test Spectrum

The overall sound pressure level shall be monitored continuously throughout the test. The test spectrum shall be verified before and at least five times during the test using a one-third octave band analyzer. The overall sound pressure level and the test spectrum shall be obtained from one of the microphones used during establishment of the test spectrum and shall be within the tolerance specified in paragraph 5.2.5. The spectrum analyses and recording of the overall sound pressure level taken throughout the test shall be included in the test report. The [illegible] shall comply with paragraphs 2.9 and [illegible] relative to [illegible] and spectrum analysis requirements.

5.2.5.6 Post Test Inspection

Upon completion of the test the test specimen shall be checked for failure in accordance with paragraph 2.8. The results of the post test inspection shall be included in the test report.

5.2.6 Test Tolerances

Test tolerances shall be as follows using instrumentation in accordance with paragraph 2.9.

5.2.6 Test Tolerances (Cont'd)

Overall sound pressure level	+4 db -0 db
One-third octave band sound pressure levels with geometric mean frequencies between 25 and 10,000 cps	+4 db -0 db
Test Duration	+10%, -0%

Simulation of specified test spectrum below 25 cps is not required.

5.3 PROGRESSIVE WAVE TESTS

5.3.1 Test Specimen Installation

The test specimen shall be installed in one wall of the test section in order to obtain grazing wave acoustic incidence. The test specimen boundaries shall duplicate or simulate the vehicle as closely as possible. Otherwise, rigid boundaries shall be provided. The type of test specimen boundary to be used for the test shall be indicated in the specification control drawing. The effective cross sectional area of the test section should be at least 1.5 times the test specimen surface area exposed to the acoustic environment. The effective cross sectional area is the product of the test section height and the test specimen width. The ratio of these areas shall be noted in the test report.

5.3.2 Test Level

The acoustic test level expressed as a one-third octave band sound pressure level and an overall sound pressure level shall be called out in the specification control drawing. Acoustic levels shall be stated in decibels referenced to 0.0002 microbars (2×10^{-5} newtons/square meter).

5.3.3 Test Duration

The test duration shall be as stated in the specification control drawing.

5.3.4 Test Procedure

5.3.4.1 General

The test levels specified in paragraph 5.3.2 shall be applied with the test specimen installed in the progressive wave test section and operating in accordance with paragraphs 5.3.1 and 2.7, respectively. Test conditions shall be in accordance with paragraph 2.6. If both a high level and a low level test spectrum are specified, the high level shall be run first followed immediately by the low level.

5.3.4.2 Establishment of the Test Spectrum

The noise test spectrum shall be established with the test specimen

5.3.4.2 Establishment of the Test Spectrum (Cont'd)

installed in the test section. The overall sound pressure level, reduced by six decibels, shall be established in the test section and adjusted to obtain the specified spectrum shape. The sound pressure level shall be measured at several locations in the test section to determine that the levels throughout the test are within the tolerances specified in paragraph 5.3.5.

These measurements shall be averaged to determine the acoustic spectrum in the test section. The individual measurement locations, extreme values and the average value shall be included in the test report. In the event the time required to establish the test spectrum approaches one-quarter of the specified test duration a geometrically similar dummy test specimen may be used.

5.3.4.3 Test Performance

When a test spectrum has been established as outlined above, the overall sound pressure level shall be raised to that specified in paragraph 5.3.2 and the test run for the time specified in paragraph 5.3.3. The overall sound pressure level and the test spectrum shall be within the tolerances specified in paragraph 5.3.5.

5.3.4.4 Test Specimen Performance

Test specimen performance shall be in accordance with paragraph 2.7. Records of the test specimen performance shall be included in the test report.

In the event of malfunction or out-of-tolerance operation during the test, but satisfactory operation following the test, a discrete frequency acoustic test shall be applied. The discrete frequency test shall consist of subjecting the operating test specimen to a sinusoidal noise level which is varied logarithmically over the test frequency range at a rate of one octave per minute. This test shall be repeated using various noise levels until the malfunction or out-of-tolerance operation is obtained. The noise level(s) and frequency(s) at which the malfunction or out-of-tolerance operation occurs shall be noted in the test report.

5.3.4.5 Verification of the Test Spectrum

The overall sound pressure level shall be monitored continuously throughout the test. The test spectrum shall be verified before and at least five times during the test using a one-third octave band analyzer. The overall sound pressure level and the test spectra shall be obtained from one of the microphones used during establishment of the test spectrum. The overall sound pressure level and the test spectra shall be within the tolerances specified in paragraph 5.3.5. The spectrum analyses and a recording of the overall sound pressure level taken throughout the test shall be included in the

5.3.4.5 Verification of the Test Spectrum (Cont'd)

test report. The test laboratory shall comply with paragraphs 2.9 and 2.10 relative to instrumentation and spectrum analyses requirements.

5.3.4.4 Post Test Inspection

Upon completion of the test the test specimen shall be checked for failure in accordance with paragraph 2.8. The results of the post test inspection shall be included in the test report.

5.3.5 Test Tolerances

Test tolerances shall be as follows using instrumentation in accordance with paragraph 2.9.

Overall sound pressure level	+4 db -0 db
One-third octave band sound pressure levels with geometric mean frequencies between 25 and 10,000 cps	+4 db -0 db
Test duration	+10%, -0%

Tolerances of specified test spectrum below 25 cps are at the discretion of the test engineer.