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MILITARY SPECIFICATION

ENVIRONMENTAL TESTING, AERONAUTICAL AND ASSOCIATED EQUIPMENT, GENERAL SPECIFICATION FOR

This specification has been approved by the Department of the Air Force and by the Navy Bureau of Aeronautics.

1. SCOPE

1.1 General.- This specification establishes generally applicable procedures for testing aeronautical and associated equipment under simulated and accelerated climatic and environmental conditions. Procedures prescribed herein are to be utilized in subjecting equipment to simulated and accelerated environmental conditions in order to insure satisfactory operation and to reduce deterioration when the equipment is operated or stored in any global locality. In the case of any particular item of equipment, test procedures are to be followed to the extent specified in the applicable equipment specification.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

Military

JAN-S-44	Shock-Testing-Mechanism for Electrical-Indicating Instruments (2-1/2 and 3-1/2 Inch, Round, Flush-Mounting, Panel-Type)
MIL-S-901	Shockproof Equipment; Class HI (High Impact), Shipboard Application, Tests for
MIL-S-4456	Shock, Variable Duration, Method and Apparatus for
MIL-G-5572	Gasoline, Aviation, Grades 80/87, 91/96, 100/130, 115/145
MIL-S-5705	Structural Criteria, Piloted Airplanes, Fuselage, Booms, Engine Mounts and Nacelles

MIL-C-7951	Chamber; Altitude, Humidity and Temperature Test
MIL-S-8484	Seals and Seal Testing Procedure for Electronic Enclosures
MIL-C-8811	Chamber, Rain Testing
MIL-C-9435	Chamber, Explosion-Proof Testing
MIL-C-9436	Chamber, Sand and Dust Testing
MIL-C-9452	Chamber, Fungus Resistance Testing

STANDARDS

Federal

Fed. Test Method Std. No. 151	Metals; Test Methods

(Copies of documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. GENERAL INSTRUCTIONS

3.1 Selection of test limits.- Where an option in test limits is permitted the applicable equipment specification shall specify the condition letter of the test limits.

3.2 Test facilities.-

3.2.1 General.- The apparatus used in conducting tests shall be capable of producing and maintaining the test conditions required, with the equipment under test installed in the chamber and operating or non-operating as required. Changes in test chamber conditions may be the maximum permitted by the test chamber, but shall not exceed the applicable equipment specification requirements.

3.2.2 Volume.- The volume of the test facilities shall be such that the bulk of the equipment under test shall not interfere with the generation and maintenance of test conditions.

3.2.3 Heat source.- The heat source of the test facilities shall be so located that radiant heat shall not fall directly on the equipment under test, except where application of radiant heat is one of the test conditions.

3.2.4 Standard conditions.- Conditions for conducting the equipment operational test shall be as follows:

a. Temperature: 25 ±10° C (77° ±18° F)
b. Relative humidity: 90 percent or less
c. Barometric pressure: Local standard (Correct to 28 to 32 inches Hg if so specified in the applicable equipment specification.)

3.3 Measurements.- All measurements shall be made with instruments the accuracy of which conforms to acceptable laboratory standards, and which are appropriate for measurement of environmental condition concerned. If tests are conducted at the contractor's plant, the accuracy of the instruments and test equipment shall be verified periodically by the contractor to the satisfaction of the procuring activity.

3.3.1 Tolerances.- The maximum allowable tolerances on test conditions shall be as follows:

a. Temperature: Plus or minus 2° C (3.6° F). (Exclusive of accuracy of instruments.)
b. Altitude: Plus or minus 5 percent (in feet).
c. Relative humidity: Plus 5 percent minus 0 percent (of R.H. value).
d. Vibration amplitude: Plus or minus 10 percent.
e. Vibration frequency: Plus or minus 2 percent.
f. Additional tolerances: Additional tolerances shall be as specified.

3.4 Test sequence.- Unless otherwise specified in the applicable equipment specification, it is recommended that the appropriate test sequence be selected from 5.4.1.

3.5 Performance record.- Prior to conducting any of the tests specified herein, the equipment shall be subjected to a comprehensive operational test under standard conditions and a record made of all data necessary to determine compliance with the applicable equipment specification. These data shall provide the criteria for checking satisfactory performance of the equipment during or after environmental tests. Where the applicable equipment specification establishe the level of acceptable performance for the test procedure, a detailed pre-exposure performance record need not be made. Equipment in this latter category shall be operated prior to test to insure that no malfunction exists.

3.6 Installation check.- Following installation in the test facility and prior to test, the equipment shall be operated sufficiently to insure that no malfunction or damage was caused due to faulty installation procedure or handling.

3.7 Criteria for failure.- Deterioration or change in performance of any components which could in any manner prevent the equipment from meeting functional maintenance and service requirements during service life shall provide reason to consider the equipment as having failed to comply with the conditions of the test to which it was subjected.

3.8 Evaluation of equipment.- When so directed in individual test procedures, the equipment undergoing test shall be operated to permit performance data to be obtained, or inspected for evidence of deterioration. The performance data of the equipment under test conditions of following test shall be satisfactorily comparable to that obtained in compliance with 3.5. Any deterioration observed shall not exceed that defined in 3.7.

4. TEST PROCEDURES

4.1 High temperature tests.-

4.1.1 Procedure I.- Discontinued, use Procedure II.

4.1.2 Procedure II.- The equipment shall be placed within the test chamber. The internal temperature of the chamber shall then be raised to 71° C (160° F) unless otherwise directed in the applicable equipment specification. (See 5.5.1.) The equipment item shall be exposed to that temperature for a period of 48 hours, or for the period of time required by the applicable equipment specification. A relative humidity of not more than 15 percent shall be maintained in the test chamber throughout the exposure period. At the conclusion of the exposure period and while still at the test temperature, the equipment shall be operated in accordance with 3.8. The equipment temperature shall then be returned to that of standard conditions and the equipment again operated and inspected visually as specified in 3.8.

4.2 Low temperature tests.-

4.2.1 Procedure I.- The equipment shall be placed within the test chamber and the chamber cooled to and maintained at a temperature of -54° C (-65° F) until stabilization of the equipment temperature is reached. (See 5.4.2.) While at this temperature, the equipment shall be operated in accordance with 3.8. The test item shall then be returned to that of standard conditions and the item operated and inspected visually as specified in 3.8.

4.2.2 Procedure II.- The equipment shall be placed within the test chamber and the chamber cooled to and maintained at a temperature -62° C (-80° F) for a period of 72 hours, at which time the equipment shall be inspected in accordance with the requirements of 3.8. The temperature of the chamber shall then be raised to -54° C (-65° F) and maintained for an additional 24-hour period or until stabilization of equipment temperature is reached (see 5.4.2), whichever is the longer. At the conclusion of this exposure period and while at this temperature, the equipment shall be inspected and operated in accordance with 3.8. The test item temperature shall then be returned to that of standard conditions and the item operated and inspected visually as specified in 3.8.

4.3 Temperature shock tests.-

4.3.1 Procedure I.- The equipment to be tested shall first be placed within a test chamber wherein, unless otherwise directed in the applicable equipment specification, a temperature of 85° C (185° F) is maintained. (See 5.5.1). The equipment shall be exposed to this temperature for a period of 4 hours, at the conclusion of which, and within 5 minutes, unless otherwise specified, the equipment shall be transferred to a chamber having an internal temperature of -40° C (-40° F). The equipment shall be subjected to this temperature for a period of 4 hours. This constitutes 1 cycle. The number of complete cycles shall be three. The duration of exposure at each extreme temperature shall not be less than that specified and may be extended to overnight exposure to prevent interruption of the transfer sequence. At the conclusion of the third cycle, the equipment shall be removed from the test chamber, returned to standard temperature, and within a period of 1 hour operated and inspected as directed in 3.8.

4.3.2 Procedure II.- Discontinued, use Procedure I, 4.3.1.

4.4 Humidity tests.-

4.4.1 Procedure I.- The equipment shall be placed in the test chamber and set up to simulate installed conditions. The test chamber shall be vented to the atmosphere to prevent the build-up of pressure. Prior to the starting of the test period, the chamber temperature shall be between 20° and 38° C (68° and 100° F) with uncontrolled humidity. During the first 2-hour period, the temperature shall be gradually raised to 71° C (160° F) unless otherwise specified in detail test requirements. (See 5.5.2.) The temperature selected shall be maintained during the next 6-hour period. The velocity of the air throughout the test area shall not exceed 150 feet per minute. During the following 16-hour period, the temperature in the chamber shall be gradually reduced to 20° to 38° C (68° to 100° F) which constitutes one cycle. The relative humidity throughout the cycle shall be 95 percent. Steam or distilled water having a pH value between 6.5 and 7.5 at 25° C (77° F) shall be used to obtain the desired humidity. The cycle shall be repeated a sufficient number of times to extend the total time of the test to 240 hours (10 cycles) or as specified by the applicable equipment specification. At the conclusion of the 240-hour period, the equipment shall be returned to standard conditions. If so specified, moisture shall be removed by turning the equipment upside down or wiping. Drying by air blast or in an oven will be permitted only if so specified. The equipment shall then be operated and inspected within 1 hour as directed in 3.8.

4.4.2 Procedure II.- Discontinued, use Procedure I.

4.4.3 Procedure III.- The equipment shall be placed in the test chamber and setup to simulate installed conditions; the temperature and relative humidity in the chamber shall be +49° C (+120° F) and 95 percent, respectively. The test conditions shall be maintained for 360 hours. At the conclusion of this period, the equipment shall be returned to standard conditions. If so specified, moisture may be removed by turning the equipment upside down or wiping. Drying by air blast or in an oven will be permitted only if so specified. The equipment shall then be operated and inspected within 1 hour as directed in 3.8.

4.5 Altitude tests.-

4.5.1 Procedure I.- Discontinued, use Procedure VI, Condition A, 4.5.6.

4.5.2 Procedure II.- Discontinued, use Procedure VI, Condition C, 4.5.6

4.5.3 Procedure III.- Discontinued, use Procedure II, 4.14.2.

4.5.4 Procedure IV.- Discontinued, use Procedure II, 4.14.2.

4.5.5 Procedure V.- Discontinued, use Procedure VI, Condition D, 4.5.6.

4.5.6 Procedure VI.- The equipment shall be placed in the test chamber and the internal chamber temperature reduced to -54° C (-65° F). The internal pressure of the chamber shall be reduced to Condition A, B, C, D, E, or F below.

Condition	Pressure (In. Hg.)	Altitude (Ft.)
A	23.98	6,000
B	20.58	10,000
C	3.44	50,000
D	1.32	70,000
E	0.82	80,000
F	0.32	100,000

The equipment shall be maintained under these conditions for 1 hour or as specified in the applicable equipment specification. At the conclusion of this period and while altitude and temperature conditions are maintained, the equipment shall be operated within 1 hour as specified in 3.8.

4.6 Salt spray tests.-

4.6.1 Procedure I.- The procedure shall be in accordance with Federal Test Method Standard No. 151, Method 811, except as otherwise specified herein. The length of the salt spray test shall be not less than 168 hours, unless otherwise specified. At the end of the test period, the equipment shall be operated and inspected within 1 hour as directed in 3.8. Salt deposits resulting from the exposure conditions may be removed by rinsing with tap water prior to operation. Equipment shall again be operated and inspected 48 hours later, as directed in 3.8.

4.7 Vibration tests.-

4.7.1 Procedure I.- Discontinued, use Procedure XII.

4.7.2 Procedure II.- This procedure applies to items of equipment which mount directly to reciprocating engines except generators and attenuators which are covered by Procedure VIII. The test specimen shall be mounted on the apparatus in a position dynamically similar to the most severe mounting likely to be used in service. Resonant frequencies of the test specimen shall be determined by varying the frequency of applied vibration slowly through the specified frequency range at vibratory accelerations not exceeding those shown in figure 1. Individual resonant frequency surveys shall be conducted with vibration applied along each of any set of three mutually perpendicular axes of the test specimen. Whenever practicable, the functioning of the test specimen shall be checked concurrently with the operation of scanning the frequency range for resonant frequencies. If resonant frequencies are encountered, the test specimen shall be vibrated successively along each of three mutually perpendicular axes for 4 hours at the resonant conditions with the applied double amplitude or vibratory acceleration shown in figure 1. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be carried out at the most severe resonance, or the period may be divided uniformly among the resonant frequencies, whichever procedure is considered most likely to produce failure. When clearly defined resonant frequencies are not encountered within the specified frequency range, the test specimen shall be vibrated for 12 hours along each of its mutually perpendicular axes at an applied double amplitude of 0.018 inch and a frequency of 150 cycles per second. The test specimen shall be functioning in accordance with the provisions of the detail specification during the entire test period whenever practicable. At the end of the test period, the test specimen shall be inspected thoroughly for damage or defects resulting from the vibration tests.

4.7.3 Procedure III.- Discontinued, use Procedure XIII, 4.7.13.

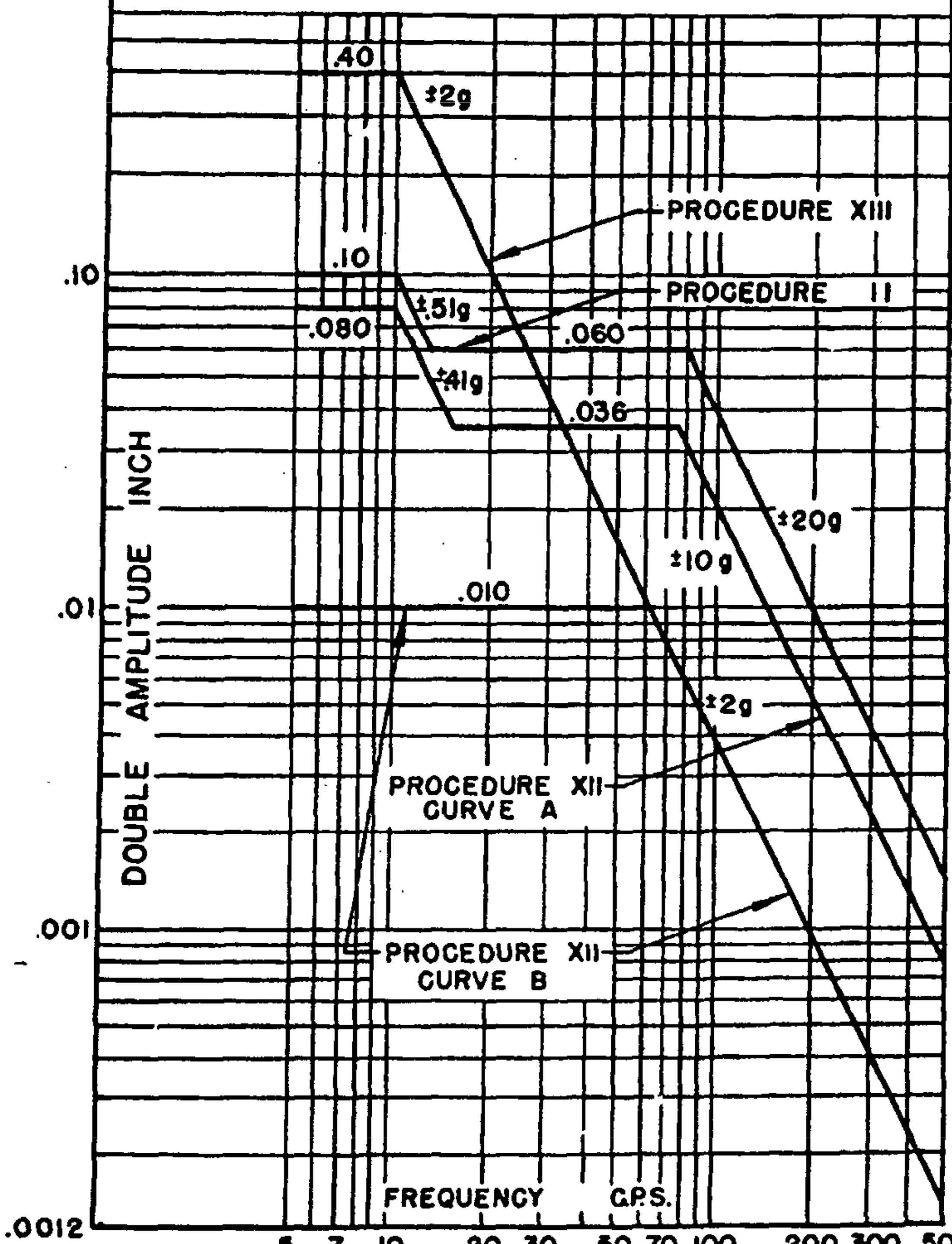
4.7.4 Procedure IV.- This procedure applies to the determination of vibration errors in panel-mounted aircraft instruments of reciprocating engine type aircraft. The instrument shall be mounted on the apparatus in its normal operating position. While being operated in accordance with the detail specification the item shall be vibrated with circular motion in a plane inclined 45 degrees to the horizontal plane with one of the following diameters of circular motion as specified in the specification for the item under test: 0.009 to 0.011 inch. The frequency of applied vibration shall be varied slowly from 5 to 50 cycles per second. No condition of applied vibration shall cause vibration errors involving pointer oscillation or variation in excess of the tolerance outlined in the detail specification.

4.7.5 Procedure V.- This procedure constitutes a vibration failure test to detect faulty constructional details in panel-mounted aircraft instruments of reciprocating engine type aircraft. The instrument shall be mounted on the apparatus in its normal operating position. While being operated in accordance with the detail specification, the instrument shall be vibrated with circular motion of 0.018 to 0.020 inch diameter in a plane inclined 45 degrees to the horizontal plane and the frequency of vibration shall be varied uniformly from 5 to 50 cycles per second and return once each hour for a 3-hour period. At the completion of this test, the instrument shall be operated and the results compared to the data obtained in accordance with 3.5. A visual inspection shall be made in accordance with 3.8.

4.7.6 Procedure VI.- Discontinued.

4.7.7 Procedure VII.- This procedure applies to the determination of the resonant frequency in the fundamental bending mode of generators and alternators mounted directly on aircraft engines. The alternator or generator shall be mounted on the test apparatus in such a manner that sufficient rigidity is obtained so that the fundamental bending resonance of the alternator or generator does not induce appreciable flexure in the mounting. A frequency survey through the frequency range of 100 to 500 cycles per second shall be made to determine the resonant frequency in the fundamental bending mode. The applied vibratory accelerations at the base of the alternator or generator shall not exceed ±10g. The resonant frequency shall be above the minimum frequency specified in the detail specification.

FIGURE I
RANGE CURVES FOR VIBRATION TESTS



4.7.8 Procedure VIII.- This procedure constitutes a vibration endurance test to detect mechanical and functional weaknesses of alternators or generators which are mounted directly on aircraft engines. Vibration pick-ups shall be mounted at the following stations: On the base of the alternator or generator, at a point approximately 10 inches from the base of the alternator or generator and at a point on the opposite side of the engine. Two pick-ups shall be located at each station with their sensitive axes mutually perpendicular and normal to the armature axes of the generator or alternator. The alternator or generator shall be mounted on apparatus which will accommodate an engine accessory section and which will produce circular vibration at the mounting pad of the generator or alternator through the frequency range of 90 to 200 cycles per second with a vibratory acceleration up to ±15g. In addition, appropriate means shall be provided to vibrate the accessory section with conical motion which simulates engine "whirling modes". The mode or apex of the conical motion shall be approximately 18 inches forward from the mounting surface of the accessory section. Resonance of the installed generator or alternator shall be so adjusted that the flexural double amplitude of the generator or alternator at the station 10 inches from the base shall be 0.030 inches with respect to an imaginary rigid body motion at the same point determined by the pick-ups at the other two stations. A vibration endurance test shall be conducted maintaining this condition for 24 hours. During the vibration endurance test, functional tests shall be conducted according to the requirements of the detail specification. There shall be no mechanical failure due to vibration.

4.7.9 Procedure IX.- Discontinued. Use Procedure XII, 4.7.12.

4.7.10 Procedure X.- Discontinued. Use Procedure XII, 4.7.12.

4.7.11 Procedure XI.- Discontinued. Use Procedure XII, 4.7.12.

4.7.12 Procedure XII.- This procedure applies to equipment assemblies (including any resilient mounting subassemblies) which mount directly on gas-turbine engines or on the structure of aircraft powered by reciprocating, turbojet or turbo-propeller engines. This procedure also applies to equipment installed in missiles powered by turbojet engines. Procedure XII represents a standard of performance. More severe requirements in regard to frequency range and acceleration level than those herein stipulated may be necessary where equipment is to be installed in extreme environments such as might exist, for example, near intense jet and assist rocket engine exhaust noise sources and on fuselage sidewalls in propeller plane areas. Equipment which meets this standard generally is suitable for:

a. Installation in existing types of aircraft.
b. Installation in most locations on the aircraft structure.
c. Applications on new aircraft.

The specimen shall be attached to a rigid fixture capable of transmitting the vibration conditions specified herein. Attachment of the specimen to the fixture shall be made through the service mounting which represents dynamically the most adverse of alternate service mounting possible. The test specimen shall be functioning in accordance with the provisions of the detail specification during the resonance search. Unless otherwise specified in the applicable equipment specification, half of each resonant and cycling period shall be conducted at room temperature. The other half of the periods shall be conducted at the applicable high temperature selected from 5.5.1 alternatively. If required by the applicable equipment specification, each resonant and cycling period shall be divided into three equal parts, the first part being conducted at -54° C (-65° F), the second part at room temperature, and the third part at the applicable high temperature selected from 5.5.1. Tests shall be conducted under both the resonant and cycling conditions specified herein. The order in which the resonance and cycling tests are performed may be specified in the equipment specification. Otherwise the order shall be optional. The detail specification shall specify the operating requirements and tolerances for the vibration test. The amplitude of applied vibration shall be monitored on the text fixture near the specimen mounting points. At the end of the test period, the test specimen shall be evaluated in accordance with 3.8.

TABLE I

Vibration test schedule

(Times shown refer to one axis of vibration)

Number of resonances	0	1	2	3	4
Total vibration time at resonance*	-	30 Min	1 hr	1-1/2 hr	2 hr
Cycling time	3 hr	2-1/2 hr	2 hr	1-1/2 hr	1 hr

* 30 minutes at each resonance

4.7.12.1 Resonance.- Resonant modes of the test specimen shall be determined by varying the frequency of applied vibration slowly through the specified range at vibratory accelerations not exceeding those shown in figure 1, curve A. Individual resonance surveys shall be conducted with vibration applied along each axis of any set of three mutually perpendicular axes of the test specimen. The test specimen shall be vibrated at the indicated resonant conditions for the periods shown in the Vibration Test Schedule and with the applied double amplitudes of vibratory accelerations in figure 1, curve A. The vibratory acceleration applied to specimens weighing more than 50 pounds may be decreased by ±1g for each 10-pound increment of weight above 50 pounds to a value no lower than ±5g, if so approved by the procuring activity. These periods of vibration shall be accomplished with vibration applied along each of the three mutually perpendicular axes of vibration. When more than one resonance is encountered with vibration applied along any one axis, each resonance shall be sustained for the period shown in the applicable portion of the vibration test schedule. If more than four resonances are encountered with vibration applied along any one axis, the four most severe resonances shall be chosen for test.

4.7.12.2 Cycling.- The specimen shall be vibrated under the cycling conditions specified herein for the applicable periods listed in the vibration test schedule (table I). The frequency shall be cycled between 5 and 500 cps in 15-minute cycles at an applied double amplitude of 0.036 inch or an applied acceleration of ±10g whichever is the lower value. The rate of change of frequency shall be logarithmic. When there is no provision for logarithmic cycling, other automatic cycling rates of frequency change may be used.

4.7.12.3 Supplementary test, electronic assemblies.- In addition to the resonance and cycling tests, electronic assemblies shall be removed from their external resilient mountings rigidly installed on the vibrator, and subjected to the following tests to demonstrate a minimum structural resistance to vibration, With the equipment operating, vibration frequency shall be varied between 5 and 500 cps at a double amplitude of 0.010 inch or an applied vibratory acceleration of ±2g whichever is the lower value. The rate of frequency cycling shall be logarithmic or other automatic cycling rates and such that 15 minutes is required to proceed from 5 to 500 back to 5 cps. When there is no provision for logarithmic cycling, other means of automatic frequency change shall be used. The test shall be sustained for two complete cycles along each of three mutually perpendicular axes. All resonance points shall be noted. In addition to this cycling test, each resonant condition shall be sustained for 10 minutes at the vibratory double amplitude or acceleration shown in figure 1, curve B. The equipment need not be operating during the resonance test. At the end of the test period the equipment shall be evaluated in accordance with 3.8.

4.7.13 Procedure XIII.- This procedure applies to equipment subassemblies intended for installation on resiliently-mounted assemblies such as instrument panels, equipment racks, etc, and is employed only when the main resiliently-mounted assembly is not available for the vibration test. The specimen shall be attached rigidly to the vibrator and shall be functioning in accordance with the provisions of the detail specification during the entire test period whenever practicable. Tests shall be conducted under both the resonant and cycling conditions specified herein. The order in which the resonance and cycling tests are performed may be specified in the equipment specification. Otherwise the order shall be optional. The detail specification shall specify the operating requirements and tolerances for the vibration test. The amplitude of applied vibration shall be monitored on the test fixture near the specimen mounting points. At the end of the test period, the equipment shall be evaluated in accordance with 3.8.

4.7.13.1 Resonance.- Resonant modes of the test specimen shall be determined by varying the frequency of applied vibration slowly through the specified range at vibratory accelerations or double amplitudes not exceeding those shown in figure 1. Individual resonance surveys shall be conducted with vibration applied along each axis of any set of three mutually perpendicular axes of the test specimen. Whenever practicable, functioning of the test specimen shall be checked concurrently with the operation of scanning the frequency range for resonant frequencies. If resonant modes are encountered, the test specimen shall be vibrated at the indicated resonant conditions for the periods shown in table I, vibration test schedule, and with the applied double amplitude or vibratory acceleration specified in figure 1 (Procedure XIII). These periods of vibration shall be accomplished with vibration applied along each of the three mutually perpendicular axes of vibration. When more than one resonance is encountered with vibration applied along any one axis, each resonance shall be sustained for the time period shown in the applicable portion of the vibration test schedule, table I. If more than four resonances are encountered with vibration applied along any one axis, the four most severe resonances shall be chosen for test.

4.7.13.2 Cycling.- The specimen shall be vibrated under the cycling conditions specified herein for the applicable periods listed in the vibration test schedule table I. The frequency shall be cycled betwean 5 and 500 cps in 15-minute cycles at an applied acceleration as specified by figure 1. Rate of frequency change shall be logarithmic. When there is no provision for logarithmic cycling other automatic cycling rates of frequency change may be used.

4.7.14 Procedure XIV.- This procedure applies to equipment which mounts within 245° cone around the exhaust area of a turbo-jet aircraft engine or on the structure of missiles propelled or launched by high-thrust rocket engines. Although the tests are of comparatively short duration, they are based upon the most severe conditions likely to be encountered in missiles, and should be adequate for most applications, provided that, where possible, consideration is given to location so as to avoid extreme environmental conditions. If necessary the limits herein specified may be varied for particular applications on the basis of available data and analyses of all conditions involved. More severe requirements in regard to magnitude of acceleration level may be necessary when equipment is installed near intense jet and rocket engine exhaust noise sources. The specimen shall be attached to a rigid fixture capable of transmitting the vibration conditions specified herein. Attachment of the specimen to the fixture shall be dynamically similar to the most adverse of service mountings possible. The amplitude of applied vibration shall be monitored on the test fixture near the specimen mounting points. The specimen shall be functioning in accordance with the detail specification during test. Operating requirements and tolerances shall be as specified by the detail specification. At the end of the test period, the specimen shall be evaluated in accordance with 3.8.

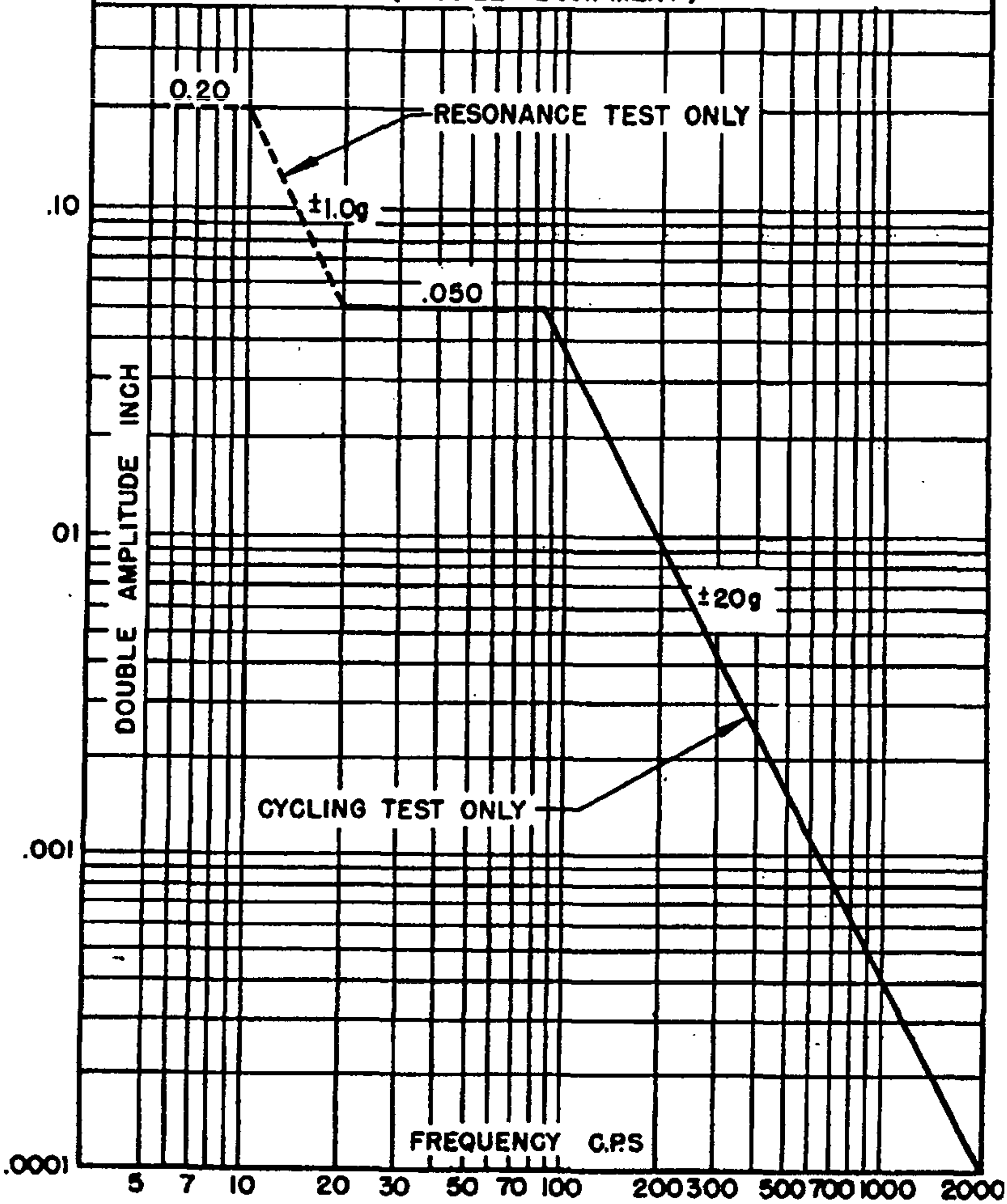
4.7.14.1 Cycling.- The specimen shall be subjected to cycling vibration according to the amplitudes and accelerations outlined by figure 2. The rate of change of frequency shall be logarithmic and such that 1 hour is required to proceed from 20 to 2,000 back to 20 cps. When there is no provision for logarithmic cycling, other automatic cycling rates of frequency change may be used. The cycling test period for each of the 3 mutually perpendicular axes shall be 2 hours, making total test time of 6 hours.

4.7.14.2 Resonance.- The specimen shall be surveyed for resonance in the 5 to 20 cps frequency range by slowly varying the applied frequency at a vibratory double amplitude or acceleration shown in figure 2. This shall be accomplished in turn, along each of 3 mutually perpendicular axes of the specimen. If resonances are encountered each resonance shall be sustained for a period of one minute.

FIGURE 2

RANGE CURVE FOR VIBRATION TEST PROCEDURE XIV

(MISSILE EQUIPMENT)



4.8 Fungus resistance tests.-

4.8.1 Procedure I.- Four groups of fungi are listed below and one species of fungus from each group shall be used. In preparing the spore suspension, distilled water (having a pH value between 5.8 and 7.2 at a temperature between 22° C and 32° C (72° F and 89° F) shall be utilized. Approximately 10 ml. of the solution shall then be introduced directly into a tube culture of the fungus and the spores brought into suspension by vigorous shaking or by gentle rubbing of the spore layer with an innoculating loop without disturbing the agar surface. This process shall be repeated for each species of fungus. The separate spore suspensions from the four types of fungi shall be mixed together to provide a composite suspension. Actively growing cultures between 7 to 21 days old after initial innoculation shall be used for the preparation of the spore suspension. After preparation, the spore suspension will not be kept for more than a 24-hour period at temperatures from 22° C to 32° C (72° F to 89° F) or not more than 48 hours at temperatures from 2° C to 7° C (35° F to 45°.F). The equipment, including applicable external connections, shall be placed in a mold chamber equal to MIL-C-9452, maintaining an internal temperature of 30° ±2° C (86° ±3.6° F) and a relative humidity of 95 ±5 percent, and sprayed with the suspension of mixed spores. The test period shall be 28 days. At the end of the test, the parts shall be visually examined in accordance with 3.8. If so specified, the equipment shall be operated and inspected as directed in 3.8.

4.8.1.1 Organism.-

Group I	-	Chaetomium globosum	6205
		Myrothecium verrucaria	9095
Group II	-	Memenoniella echinata	9597
		Aspergillus niger	6275
Group III	-	Aspergillus flavus	10836
		Aspergillus terreus	10690
Group IV	-	Penicillium citrinum	9849
		Penicillium ochrochloron	9112

4.8.1.2 Stock culture designation and source.- When ordering cultures, request the cultures by name and serial number. The serial numbers of the cultures remain the same regardless of source.

Source - American Type Culture Collection, 2112 M Street, N.W., Washington 6, D. C.

4.9 Sunshine test.-

4.9.1 Procedure I.- The equipment shall be mounted within the test chamber in the manner prescribed by the applicable equipment specification and subjected to radiant energy at the rate of 100 to 140 watts per square foot. Fifty to 84 watts per square foot shall be in wavelengths above 7,800 angstrom units and four to eight watts per square foot shall be in wavelengths below 3,800 angstrom units. The test chamber temperature shall be maintained at 45° C (113° F) during the course of the test. The duration of the test shall be 48 hours unless otherwise specified by the applicable equipment specification. Performance tests shall be conducted on mechanical and electrical equipment in accordance with the applicable equipment specification while under test conditions. The performance of the equipment shall be compared with the performance record prior to test as directed in 3.8. Upon completion of the test the equipment shall be examined in accordance with 3.8.

NOTE: 1 watt-hour = 3.413 BTU

4.10 Rain tests.-

4.10.1 Procedure I.- Discontinued, use Procedure II, 4.10.2.

4.10.2 Procedure II.- A test chamber equal to MIL-C-6811 shall be used and the equipment mounted therein to simulate installed conditions. The rain test chamber temperature shall be uncontrolled except as regulated by water introduced as rain, throughout the test period. A simulated rainfall of 4 ±1 inch per hour as measured at the surface of the equipment by a U. S. Weather Bureau type gauge shall be produced by means of a water spray nozzle of such design that the water is emitted in the form of droplets having a minimum diameter of 1.5 millimeters. The temperature of the water shall be uncontrolled if the water supply temperature is between 11° to 20° C (51.8° to 68° F). The direction of rainfall shall be capable of variation up to 45° from the vertical. The rainfall shall be dispersed uniformly over the test area within the limits as specified above. Each of the four sides of the equipment shall be exposed to the simulated rainfall for a period of 30 minutes, for a total test duration of 2 hours. At the completion of the test, the equipment shall be operated and then examined for evidence of water penetration or deterioration, as directed in 3.6.

4.11 Sand and dust tests.-

4.11.1 Procedure I.- The equipment shall be placed in a test chamber equal to MIL-C-9436 and the sand and dust density raised and maintained at 0.1 to 0.5 grams per cubic foot within the test space. The test chamber shall be vented to the atmosphere. The relative humidity shall not exceed 30 percent at any time during the test. Sand and dust used in the test shall be of angular structure and shall have characteristics as follows (see 5.4.3):

a. 100 percent of the sand and dust shall pass through a 100-mesh screen, U. S. Standard Sieve Series.

b. 98 ±2 percent of the sand and dust shall pass through a 140-mesh screen, U. S. Standard Sieve Series.

c. 90 ±2 percent of the sand and dust shall pass through a 200-mesh screen, U. S. Standard Sieve Series.

d. 75 ±2 percent of the sand and dust shall pass through a 325-mesh screen, U. S. Standard Sieve Series.

e. Chemical analysis of the dust shall be as follows:

SUBSTANCE	PERCENT BY WEIGHT
SiO_2	97 to 99
Fe_2O_3	0 to 2
Al_2O_3	0 to 1
TiO_2	0 to 2
MgO	0 to 1
Ign losses	0 to 2

Part I: The internal temperature of the test chamber shall be maintained at 25° C (77° F) for a period of 6 hours with sand and dust velocity through the test chamber between 100 and 500 feet per minute, (2,500 ±500 feet per minute if so required by the applicable equipment specification).

Part II: After 6 hours at the above conditions, the temperature shall be raised to and maintained at 71° C (160° F). These conditions shall be maintained for 6 hours. At the end of this exposure period, the equipment shall be removed and allowed to cool to room temperature. Accumulated dust shall be removed by brushing, wiping, or shaking, care being taken to avoid introduction of additional dust into the equipment. Under no circumstances shall dust be removed by either blast or vacuum cleaning. The equipment shall be operated and inspected as directed in 3.8.

4.11.2 Procedure II.- Discontinued, use Procedure I, Part I, 4.11.1.

4.11.3 Procedure III.- The general procedure and the sand and dust used shall be the same as Procedure I, but the dust concentration shall be 0.1 to 0.25 grams per cubic foot, the temperature shall be 25° C (77° F), the air velocity shall be 2,500 ±500 feet per minute and the duration of the test shall be 3 hours.

4.12 Immersion (leakage) tests.-

4.12.1 Procedure I.- The equipment shall be immersed in a suitable liquid, such as boiled ethylene glycol or water. The water temperature shall be uncontrolled if the supply temperature is between 11° and 20° C (51.8° to 68° F). The absolute pressure of the air above the liquid shall then be reduced to approximately 1 inch of mercury and maintained for 1 minute, or until air bubbles substantially cease to be given off by the liquid, whichever is the longer. The absolute pressure shall then be increased to 2-1/2 inches of mercury. Any bubbles coming from within the equipment case shall be considered as leakage. Bubbles which are the result of entrapped air on the various exterior parts of the case shall not be considered as leaks. A helium leak detector or other means of test, equal or superior in sensitivity to the immersion test method described above, may be used upon approval by the procuring activity.

4.13 Explosion tests (see 5.3 and 5.4.4).-

4.13.1 Procedure I.- Discontinued, use Procedure III, 4.13.4.

4.13.2 Procedure II.- Discontinued, use Procedure IV, 4.13.5.

4.13.3 Apparatus.- An explosion chamber equal to MIL-C-9435 shall be utilized for conducting explosion-proof tests.

4.13.3.1 Fuel.- Fuel used shall be gasoline, grade 100/130, conforming to MIL-G-5572.

4.13.4 Procedure III.-

4.13.4.1 Purpose.- The following procedure shall be used to determine the explosion producing characteristics of items of equipment not equipped with cases designed to prevent flame or explosion propagation.

4.13.4.2 Preparation for test.-

a. The equipment to be tested shall be installed in the test chamber in such a manner that normal electrical operation is possible and mechanical controls may be operated through the pressure seals from the exterior of the chamber. All external covers of the test item shall be removed or opened to insure adequate circulation of the explosive mixture. Large equipment may be tested one or more units at a time by extending electrical connections through the cable port to the balance of the equipment located externally.

b. The equipment shall be operated to determine that it is functioning properly and to observe the location of any sparking or high temperature components which may constitute potential explosion hazards.

c. Mechanical loads on drive assemblies and servomechanical and electrical loads on switches and relays may be simulated when necessary if proper precaution is given to duplicating the normal load in respect to torque, voltage, current, inductive reactance, etc. In all instances it shall be considered preferable to operate the equipment as it normally functions in the system during service use.

4.13.4.3 Test procedures.-

a. A test shall be conducted as follows:

(1) The test chamber shall be sealed and the ambient temperature within shall be raised to +71 ±3° C (+160 ±5° F), or to the maximum temperature to which the equipment is designed to operate (if

lower than 160° F). The temperature of the test item and the chamber walls shall be permitted to rise to within 11° C (20° F) of that of the chamber ambient air, prior to introduction of the explosive mixture.

(2) The internal test chamber pressure shall be reduced sufficiently to simulate an altitude approximately 10,000 feet above the desired test altitude. The weight of fuel necessary to produce an air-vapor ratio of 13 to 1 at the desired test altitude shall be determined from consideration of chamber volume, fuel temperature and specific gravity, chamber air and wall temperature, test altitute, etc. (see 5.4.4.4). A time of 3 ±1 minutes shall be allowed for introduction and vaporization of the fuel. Air shall be admitted into the chamber until a simulated altitude of 5,000 feet above the test altitude is attained. At this time the potential explosiveness of the resulting air-vapor mixture shall be verified by a sampling method which has been approved by the procuring activity.

(3) Operation of the test item shall at this time be commenced, all making and breaking electrical contacts being actuated. If high temperature components are present, a warm-up time of 15 minutes shall be permitted. If no explosion results, air shall be admitted into the chamber so as to steadily reduce the altitude down past the desired test altitude to an elevation 5,000 feet below that altitude or as close thereto as permitted by local ground level altitude. The operation of the test item shall be continuous throughout this period of altitude reduction and all making and breaking electrical contacts shall be operated as frequently as possible.

(4) If by the time the simulated altitude has been reduced to 5,000 feet below the test altitude, no explosion has occurred as a result of operation of the equipment under test, the potential explosiveness of the air-vapor mixture shall again be verified by a sampling method which has been approved by the procuring activity. If the air-vapor mixture is not found to be explosive at this time, the test shall be considered void and the entire procedure repeated.

b. The above-described test shall be accomplished at simulated test altitudes of local ground level to 5,000 feet, 10,000, 20,000, 30,000, 40,000, and 50,000 feet, unless an explosion is caused by the test item during a test, in which case the item shall be considered to have failed to pass the test and no further trials need be attempted.

4.13.5 Procedure IV.-

4.13.5.1 Purpose.- The purpose of this procedure is to determine the flame and explosion arresting characteristics of equipment cases designed to prevent the propagation of internal case explosions.

4.13.5.2 Preparation for test.-

a. The case, with the equipment in position within, shall be installed in the explosion chamber. Testing shall be accomplished without consideration of the equipment operating characteristics, so the equipment need not be operated. Adequate circulation of the explosive mixture throughout the case shall be provided by optional means.

b. If it is necessary to drill the case for insertion of a hose from a blower, adequate precaution must be taken to prevent ignition of the ambient mixture by backfire or release of pressure through the supply hose. The case volume shall not be altered by more than ±5 percent by any modification to facilitate the introduction of explosive vapor.

c. A positive means of igniting the explosive mixture within the case shall be provided. The case may be drilled and tapped for the spark gap or the spark gap may be mounted internally.

4.13.5.3 Procedure.-

a. A test shall be accomplished as follows:

(1) The chamber shall be sealed and the internal pressure reduced sufficiently to simulate an altitude between local ground level and 5,000 feet. The ambient chamber temperature shall be at least 25° C (77° F). An explosive mixture shall be obtained within the test chamber and the explosiveness verified by the procedure outlined in 4.13.4.3 a. (2), except that it shall not be necessary to evacuate the chamber to 10,000 feet above the selected test altitude.

(2) The internal case ignition source shall be energized, in order to cause an explosion within the case. The occurrence of an explosion within the case may be detected by use of a thermocouple inserted in the case and connected to a sensitive galvanometer outside the test chamber. If ignition of the mixture within the case does not occur immediately, the test shall be considered void and shall be repeated with a new explosive charge.

(3) At least five internal case explosions shall be accomplished at the test altitude selected. If the case being tested is small (not in excess of one-fiftieth of the test chamber volume) and if the reaction within the case upon ignition is of an explosive nature without continued burning of the mixture as it circulates into the case, more than one internal case explosion but not more than five may be produced without recharging the entire chamber. Ample time must be allowed between internal case explosions for replacement of burnt gases with fresh explosive mixture, within the case. If the internal case explosions produced did not cause a main chamber explosion, the explosiveness of the fuel-air mixture in the main chamber shall be verified by a sampling method which has been approved by the procuring activity. If the air-vapor mixture in the main chamber is not found to be explosive the test shall be considered void and the entire procedure repeated.

b. The above-described test shall be accomplished three times at altitudes between local ground level and 5,000 feet.

4.14 Temperature-altitude test.-

4.14.1 Procedure I.- The equipment shall be placed in the test chamber in a manner similar to that in which it would be used in service, and such electrical and mechanical connections and instrumentation as may be necessary shall be completed. The temperature-altitude condition schedule as outlined in figure 3 shall be followed in the manner as outlined in the following steps. Temperature and pressure change rates shall be as high as chamber construction permits, except that the rates shall not exceed 1° C (1.8° F) per second and 0.5 inches of mercury per second respectively. The change from room temperature to -62° C (-80° F) shall not exceed 4 hours.

Step 1.- The internal temperature of the test chamber shall be reduced to -62° C (-80° F) and the equipment stabilized and maintained for at least 1 hour at this temperature. The pressure within the chamber during this period shall be atmospheric. The equipment shall be nonoperative. Where it is possible without changing the temperature condition, a visual inspection of the equipment shall be made to determine whether or not deterioration which would impair future operation has occurred (see 3.7).

Step 2.- The internal temperature of the test chamber shall then be raised to -54° C (-65° F) and maintained until the equipment has stabilized at -54° C. The pressure within chamber shall be atmospheric. The equipment shall then be operated and the results compared to those obtained under prevailing room conditions (see 3.5).

Step 3.- The equipment shall be turned off and the internal atmospheric pressure of the chamber reduced to 50,000 feet. The chamber temperature shall be maintained at -54° C (-65° F). Upon reaching the specified altitude the equipment shall be turned on and operated, and the results compared to those obtained under prevailing room conditions (see 3.5).

NOTE: Step 3 shall be performed only if specified by the detail equipment specification.

Step 4.- The equipment shall then be turned off and internal temperature of the chamber raised to -10° C (+14° F) and maintained until the equipment stabilizes at this temperature. The internal pressure of the chamber shall be adjusted to atmospheric pressure if Step 3 has been performed, or held at atmospheric if not. The test chamber door shall then be opened in order that frost will form on the equipment. The door shall remain open until the frost has melted, but not long enough to allow the moisture to evaporate. The door shall then be closed and the equipment operated and the results again compared to those obtained under prevailing room conditions (see 3.5).

Step 5.- With the equipment nonoperating, the chamber temperature shall be raised to +85° C (185° F). The chamber pressure shall be atmospheric. The equipment shall be stabilized at this temperature, and maintained in the stabilized condition for 2 hours. At the conclusion of the 2-hour period, the equipment may be visually inspected to determine the extent of deterioration, if any, which has taken placed(see 3.7).

Step 6.- The chamber temperature shall then be reduced to +71° C (160° F) with the pressure remaining atmospheric. The equipment shall be stabilized at this temperature and then operated for a period of 30 minutes. During this period the equipment shall be checked for satisfactory operation (see 3.5).

Step 7.- The chamber temperature shall then be reduced to +55° C (130° F). The pressure within the chamber shall be atmospheric. The equipment shall be stabilized at this temperature. The equipment shall be operated for a minimum of 4 hours. The equipment shall be turned on and off at least three times during this period and the results of each cycle of operation shall be compared with those obtained under prevailing room conditions (see 3.5).

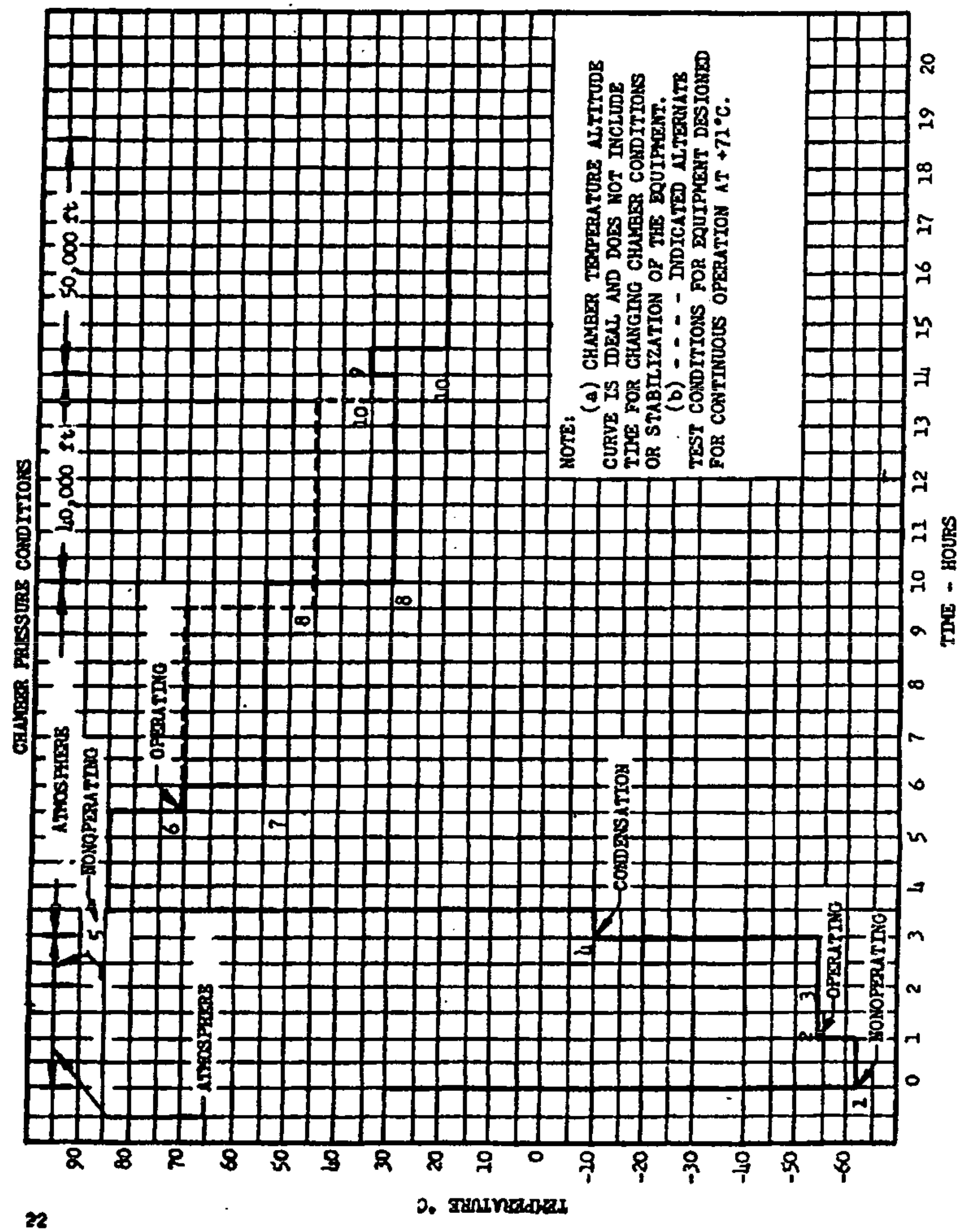


FIGURE 3. Temperature - Altitude Versus Time Curve.

Step 8.- The internal temperature of the chamber shall then be reduced to +30° C (+86° F) and the pressure to that of 40,000 feet altitude. When the chamber conditions have stabilized, the equipment shall be operated for a minimum of 4 hours. The equipment shall be turned on and off at least three times during this period and the results of each cycle of operation compared with those obtained under prevailing room conditions (see 3.5).

Step 9.- The internal conditions of the test chamber shall then be changed to +35° C (95° F) and 50,000 feet altitude. When the internal conditions of the chamber have stabilized, the equipment shall be turned on and operated for a period of 30 minutes. Operational results shall be compared to those obtained under prevailing room conditions (see 3.5).

Step 10.- The internal pressure of the chamber shall be maintained at 50,000 feet; however, the temperature shall be reduced to +20° C (68° F). When the internal conditions of the test chamber have stabilized at these conditions, the equipment shall be operated for a minimum of 4 hours. The equipment shall be turned on and off at least three times during this period and results of each cycle of operation compared to those obtained under prevailing room conditions (see 3.5).

NOTE: If the equipment is designed for continuous operation at 71° C, then Steps 6 and 9 should be deleted and the following modifications made in Steps 7, 8, and 10:

Step 7	Change +55° C to +71° C
Step 8	Change +30° C to +46° C
Step 10	Change +20° C to +35° C

4.14.2 Procedure II.- The equipment shall be installed in a test chamber equal to MIL-C-7951 in a manner as similar to that employed in service use as possible. If the equipment requires cooling air from a source other than the compartment ambient, appropriate ducting shall be installed to provide air in volume, temperature range, and density as necessary. The internal temperature and pressure of the chamber shall then be adjusted to any desired combination within the design limitations of the equipment. The selected combination of conditions shall be maintained and the equipment operated for a sufficient length of time to insure thermal stabilization before operational checks are made. Operational checks shall be made in like manner, in any desired sequence, at a sufficient number of succeeding check points to adequately portray operational capabilities of the equipment. When testing within limits of the continuous operating capabilities of the equipment, the equipment may continue to operate while chamber conditions are being changed from one test point to another, in order to reduce time required to attain thermal stability. For intermittent and short time operation the temperature-altitude limits, exposure time, duty cycle and operational checks shal. be as required by the applicable equipment specification. Following the chosen sequence of exposures, the equipment shall be inspected and operated in accordance with 3.8.

4.15 Shock tests.-

4.15.1 Procedure I.- Discontinued, use Procedure IV, 4.15.4.

4.15.2 Procedure II.- Discontinued, use Procedure V, 4.15.5.

4.15.3 Procedure III.- A high impact, shock testing machine designed and fabricated according to MIL-S-901 shall be set up to produce the magnitude and duration of shock specified in the applicable equipment specification. The number of shocks and position of the test specimen shall be as specified in the applicable equipment specification. Functional tests shall be conducted during shock application according to the requirements of the applicable equipment specification. There shall be no mechanical failures due to the applied shocks.

4.15.4 Procedure IV.- A shock testing machine designed and fabricated according to JAN-S-44 or equivalent, shall be used to produce the impacts required by this procedure. In applying each shock, the carriage shall be arrested after the initial rebound. The specimen together with other sufficient weight shall be secured rigidly to the test carriage to amass a combined weight (carriage weight included) which will produce a shock having the time duration specified in the detail specification. The time duration (t, in milliseconds) of the half sine-wave shock is obtained from the combined weight (W, in pounds) and the plate spring constant (K, in pounds per inch) as follows:

$$t = 159 \sqrt{\frac{W}{K}}$$

Three resilient impacts shall be applied, in turn, in each direction along each of the three orthogonal axes of the specimen, by dropping the carriage from a suitable drop height. Height of drop shall be specified by the detail specification, or may be determined (for K = 5250 lb./in.) from figure 4 when the acceleration is specified by the detail specification. Where a detail specification does not choose values, a 50g peak acceleration with a time duration of 8.5 milliseconds shall be employed.

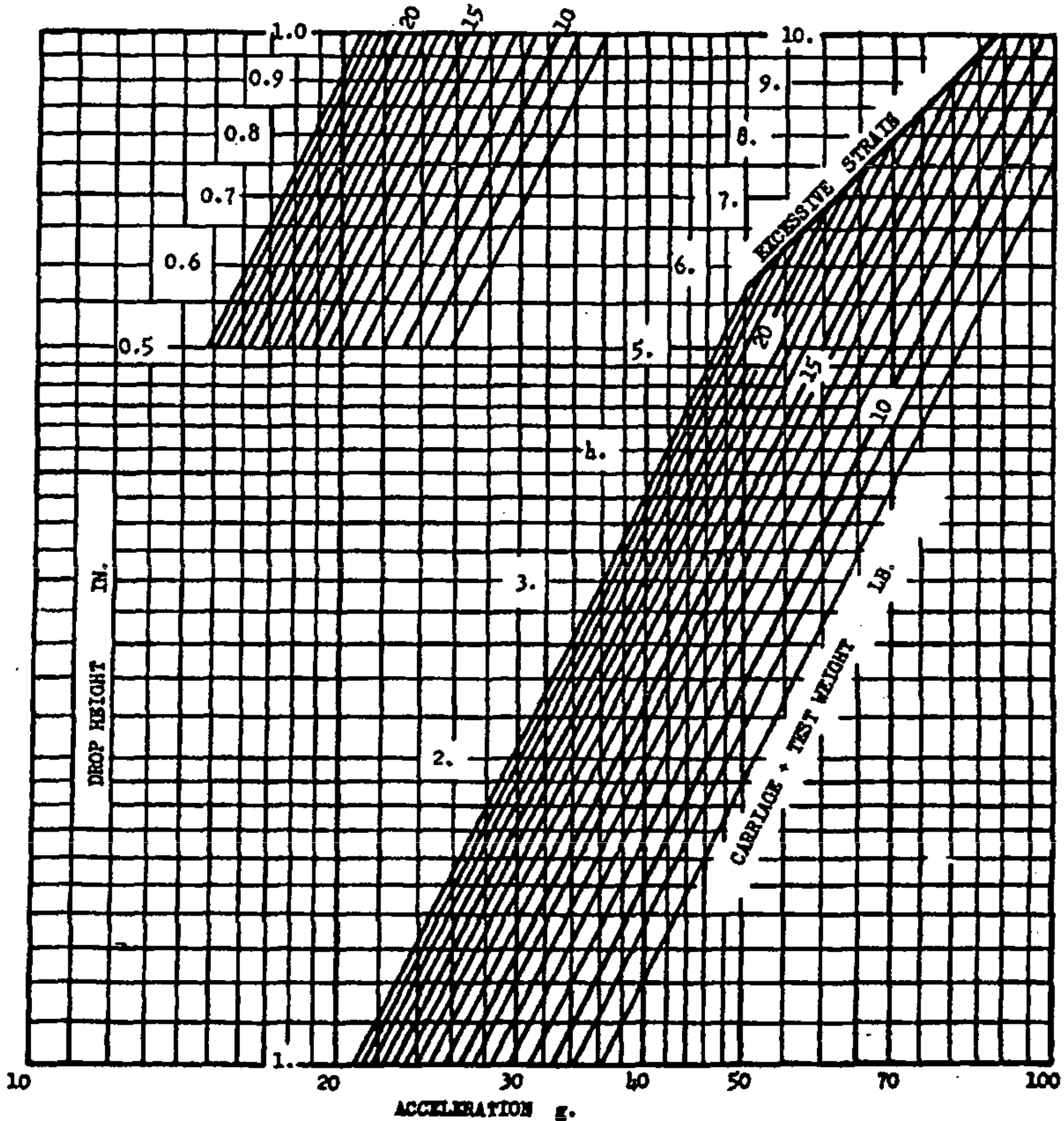
4.15.5 Procedure V.- This procedure shall be used to determine the equipment operating characteristics as well as its structural integrity under conditions of shock. The equipment, as normally mounted in service, including any resilient mounting, shall be subjected to the shock conditions specified herein. The shock testing machine, designed and fabricated according to MIL-S-4456, or equivalent, shall be used.

FIGURE 4

DROP HEIGHT DETERMINATION

FOR JAN-S-44 SHOCK TESTING MACHINE

SPRING CONSTANT 5250 LB/IN.



4.15.5.1 Equipment operation.- The test specimen shall be subjected to 18 impact shocks of 15g acceleration, each shock impulse having a time duration of 11 ±1 milliseconds. The intensity shall be within ±10 percent when measured with a filter having a band width of 5 to 100 cycles per second. The maximum acceleration shall be reached in approximately 5-1/2 milliseconds. The shock shall be applied in the following directions:

a. Vertically, 3 shocks in each direction.

b. Parallel to the major horizontal axis, 3 shocks in each direction.

c. Parallel to the minor horizontal axis, 3 shocks in each direction.

The test specimen shall not suffer damage or subsequently fail to provide the performance specified by the detail specification.

4.15.5.2 Equipment crash-safety.- The structural integrity of the mounting base and isolators shall then be determined with either the equipment of dummy load in place, as specified by the detail specification. If mounting bases and isolators are not normally used in service, then the equipment attached by its normal points of attachment shall be tested. The test specimen shall be subjected to the procedure as described above, except that the intensity of shock shall be 30g in lieu of 15g and the number of shocks in each direction will be two. Bending and distortion shall be permitted. There shall be no failure of the attachment joints, and the equipment or dummy load shall remain in place (see 5.2.1).

4.16 Acceleration tests.-

4.16.1 Procedure I.- The test specimen shall be mounted on the apparatus (centrifuge) in the position specified in the applicable equipment specification. The centrifuge shall be brought up to the rotational speed required to produce the radial acceleration required in the applicable equipment specification and this acceleration shall be stabilized and maintained for a period of not less than 1 minute. The specimen shall then be rotated 90 degrees about a vertical axis while the radial acceleration is maintained. The test specimen in this new position shall be subjected to the same acceleration for a period of not less than 1 minute. Functional tests shall be conducted in accordance with requirements of the applicable equipment specification during application of the acceleration. There shall be no mechanical failures or malfunctions due to the applied acceleration.

4.16.2 Procedure II.- Discontinued, use Procedure III, 4.16.3.

4.16.3 Procedure III.- This procedure is to be used as a general test method for simulating unidirectional acceleration incident to aircraft maneuver. Acceleration shall be applied by a centrifuge. The test specimen shall be subjected to one minute of steady acceleration, in turn, in each direction along each of its three orthogonal axes. If the orientation of the specimen is not restricted with respect to the aircraft, the specimen shall be subjected to an acceleration of 14g in each direction along each of the orthogonal axes of the specimen. If the orientation of the specimen is restricted to one position with respect to the aircraft, the acceleration applied may be as follows: 14g for the specimen position where the inertia load is directed vertically downward with respect to the aircraft; 6g for all other positions. If special axes are considered significant with respect to acceleration effects, they shall be defined and the acceleration shall be specified by the detail specification. The accelerations specified apply to the geometric center of the specimen. The centrifuge arm (measured to the geometric center of the specimen) shall be at least five times the dimension of the specimen (measured along the arm). During application of the acceleration, functional tests shall be conducted in accordance with the requirements of the specification for the item under test. There shall be no mechanical failures or malfunctions due to the applied accelerations.

5. NOTES

5.1 Intended use.- This specification is intended to prescribe conditions to be followed in subjecting aeronautical items to simulated and accelerated environmental conditions in order to insure satisfactory operation and to reduce deterioration when the item is operated or stored in any global locality. Included are environmental conditions expected in high performance aircraft and some categories of missiles. Excluded are environmental conditions inherent to nuclear-powered aircraft or missiles.

5.2 Vibration.- Equipment will be subjected to vibration incident to its installation in the aircraft resulting from any of the following: reciprocating engine gas pressure and inertial forces; resonant burning, inlet turbulence, and rotor unbalances in gas turbine engines; propeller unbalances, gun firing, aerodynamic disturbances, and sonic excitation. Every effort shall be made to maintain the specified double amplitude or acceleration at each mounting point. However, if it is impracticable to achieve this condition the specified double amplitude or acceleration shall not be exceeded at any mounting point. Vibration at high or low temperatures shall be omitted unless specifically required by the detail specification. In the event that the equipment must operate at temperature extremes, all or part of the vibration test must be accomplished at the temperature extremes as specified in the applicable specification.

5.2.1 Shock.- Equipment will be subjected to shocks incident to maneuvering, gusts, gunfiring, landings, nearby explosions, handling, transportation, etc. Procedure V of the shock tests is two-fold in purpose in that it includes first a test for equipment damage and operation after shock and secondly to determine the integrity of the mounting under crash conditions. MIL-S-5705 is also considered applicable in regard to static strength of equipment and its supporting fittings.

5.3 Definitions.-

5.3.1 Explosion-proof aeronautical equipment.- Explosion-proof aeronautical equipment is that which when operated at any design load will not ignite an explosive mixture in the equipment or, if an explosion does occur within the equipment, this explosion will not cause any explosion or fire outside of the equipment.

5.3.2 Unsealed enclosure.- An unsealed enclosure is one having closure joints the seals of which do not conform to the requirements of MIL-S-8484.

5.3.3 Temperature stabilization.- Temperature stabilization has been reached when the temperature of the largest internal, centrally-located mass of the equipment does not change during a period of 15 minutes.

5.4 General application.-

5.4.1 Test sequences.- Suggested test sequences for ground support equipment, aircraft equipment, and guided missile equipment are presented in tables II, III, and IV, respectively. Prior to referencing testing procedures in the detail equipment specification, the anticipated environmental and climatic conditions should be considered carefully. It is intended that only those conditions that reflect actual service usage and which could adversely affect the item should be taken into account. When this analysis has been completed, suitable test procedures to represent applicable conditions should be selected and referenced in the detail equipment specification.

5.4.2 Determination of temperature stabilization.- Temperature stabilization of equipment may be checked by a thermal measuring device in good thermal contact with the largest, centrally located internal mass.

5.4.3 Sand and dust.- The sand and dust specified for use in Procedures I and III is commercially known as "140-mesh silica flour". Sand and dust (140-mesh silica flour) produced by the Fenton Foundry Supply Company, Dayton, Ohio, and Ottawa Silica Company, Ottawa, Illinois, or equal, is satisfactory for use in the performance of these tests.

5.4.4 Explosion-proof aeronautical equipment.- Under this specification, sealed equipment, connecting wire, and cables shall be considered explosion-proof and require no test.

5.4.4.1 When necessary, large items of electrical equipment, such as motors, large relays, etc, shall be prepared for explosion-proof testing by drilling and tapping openings in the case for inlet and outlet connections to the fuel vapor air mixture circulating system and for mounting a spark plug. This spark plug is used only for igniting the vapor air mixture in the equipment to insure the presence of an explosive mixture inside the equipment on test. Small items of equipment such as switches, circuit breakers, etc. shall not be drilled and tapped for mounting a spark plug when it is not practicable.

5.4.4.2 When the explosion-proof test of Procedure III, 4.13.4, is being performed, dust or other auxiliary covers not intended to be explosion-proof may be removed or loosened to facilitate penetration of the explosive mixture.

5.4.4.3 The equipment to vaporize the gasoline fuel for use in the explosion-proof test should be so designed that a small quantity of air and gasoline vapor will be heated together to a temperature such that the gasoline vapor will not condense as it is drawn from the vaporizer into the chamber.

5.4.4.4 In illustration of the procedure for calculating the weight of 100/130 octane gasoline required to produce the desired 13 to 1 air-vapor ratio, the following sample problem is presented:

Required information:

a. Chamber air temperature during test: 80° F.

b. Fuel temperature: 75° F.

c. Specific gravity of fuel at 60° F: 0.704.

d. Test altitude: 20,000 feet (P = 6.75 lbs/in. 2)

e. Air-vapor ratio (desired): 13 to 1.

Step 1. Employing the following equation, calculate the apparent air vapor ratio:

$$AAV = \frac{A\text{-}V\ (DESIRED)}{1.04\ \frac{P}{14.696} - .04} = \frac{13}{1.04\ \frac{6.75}{14.696} - .04} = 29.68$$

Where AF = Air fuel ratio

AAV = Apparent air vapor ratio

AV = Desired air vapor ratio

P = Pressure equivalent of altitude, lbs/in. 2

NOTE: At or above 10,000 feet altitude, with chamber air temperature above 60° F and at A-V ratio of 5 or greater, Air vapor ratio = Air fuel ratio for 100/130 octane fuel. Since the conditions of the explosion test under consideration will always be well above these values AV will equal AF in all cases.

Step 2. Since AV = AF, use figure 5 to determine weight of air and divide by AAV to obtain uncorrected weight of fuel required.

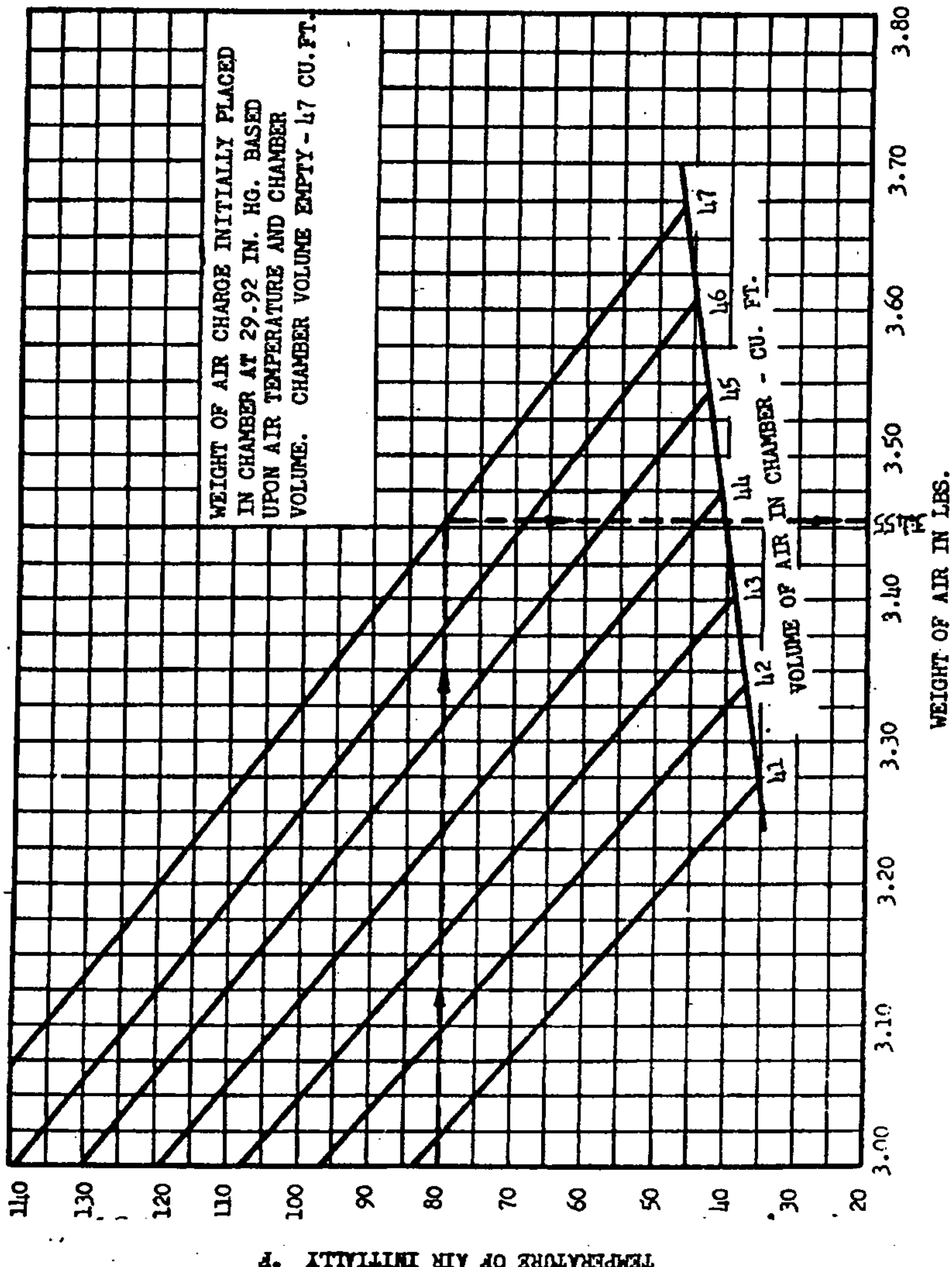
$$W_{FU} = \frac{Wa}{29.68} = \frac{3.455}{29.68} = 0.116 \text{ lbs, fuel weight (uncorrected)}$$

Step 3. Knowing fuel temperature and specific gravity at 60° F use figure 6 to determine specific gravity at given temperature.

Step 4. Using figure 7 read from specific gravity determined under Step 3 for the correction factor k. Apply factor.

$$W_{FC} = W_{FU} \times k = 0.116 \times 1.01 = 0.0117 \text{ lbs, fuel weight(corrected)}$$

NOTE: Figure 6 pertains to a specific test chamber and may not be used for all such test facilities. It is utilized herein for illustration of the method of employment only. Each test chamber must have its own chamber volume chart.


WEIGHT OF AIR CHARGE INITIALLY PLACED IN CHAMBER AT 29.92 IN. HG. BASED UPON AIR TEMPERATURE AND CHAMBER VOLUME. CHAMBER VOLUME EMPTY - 47 CU. FT.
VOLUME OF AIR IN CHAMBER - CU. FT.
41
42
43
44
45
46
47
WEIGHT OF AIR IN LBS.
3.00
3.10
3.20
3.30
3.40
3.50
3.60
3.70
3.80
TEMPERATURE OF AIR INITIALLY °F
140
130
120
110
100
90
80
70
60
50
40
30
20

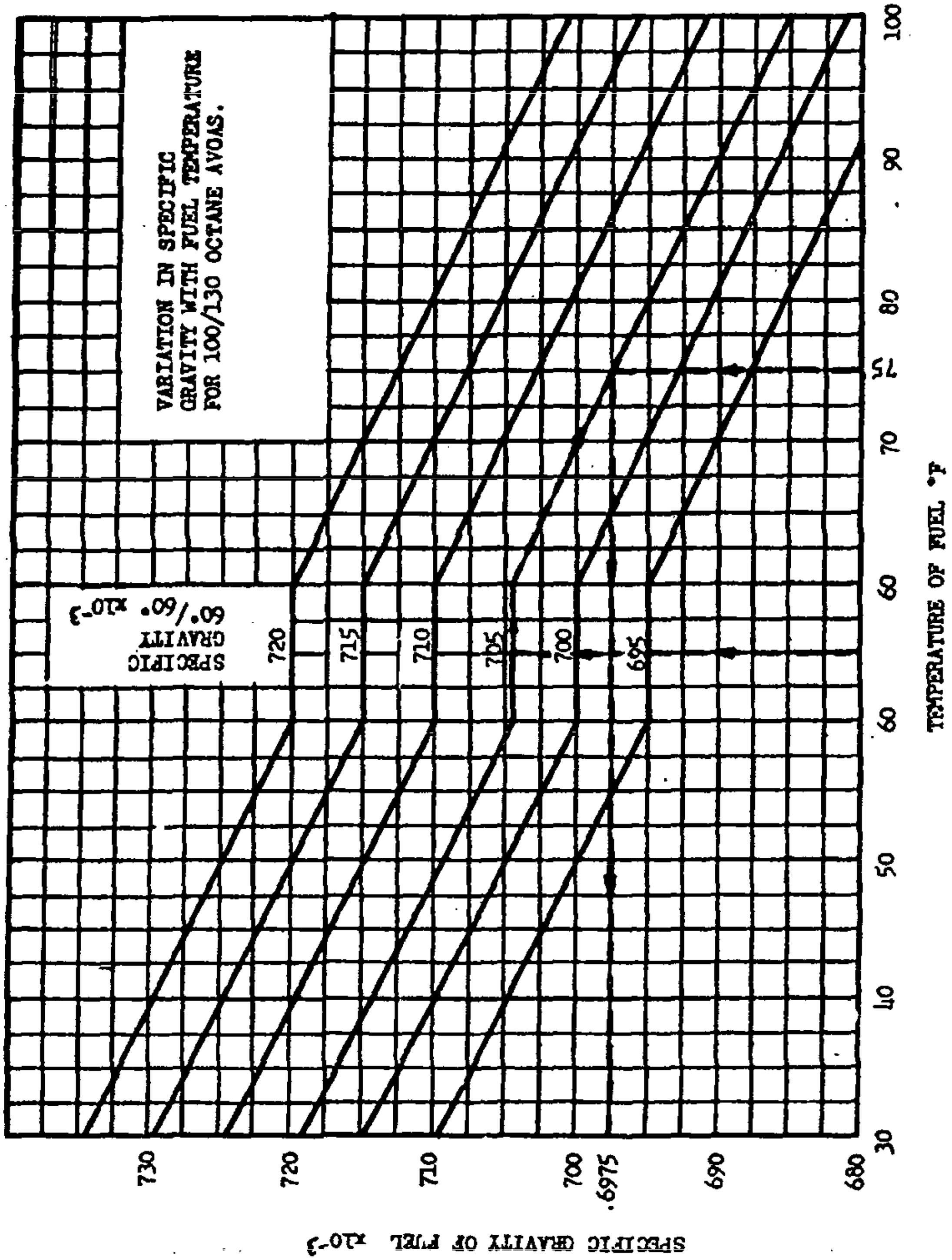


Figure 6. Determining specific gravity.

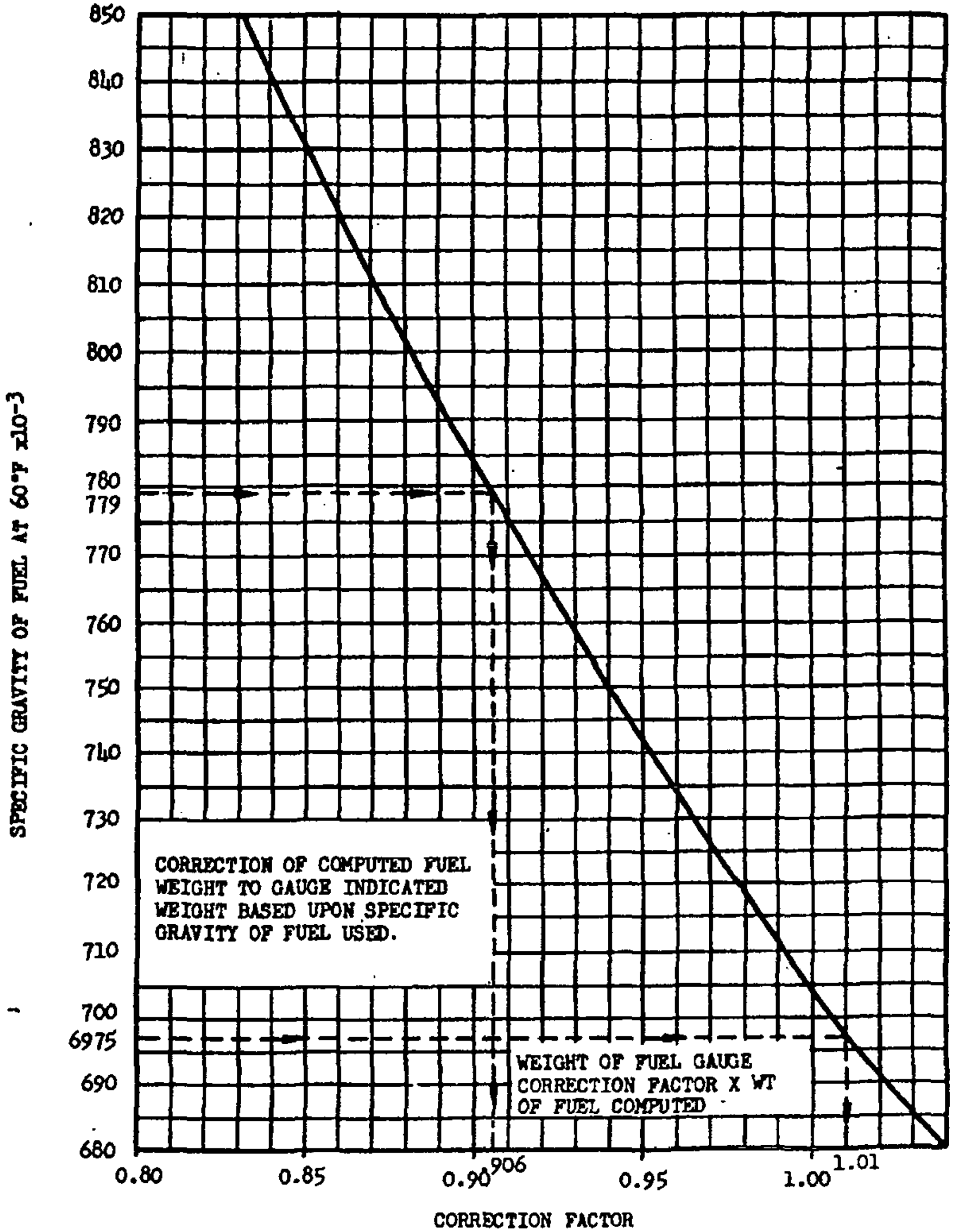


Figure 7. Correction factor.

TABLE II

SUGGESTED SEQUENCE, MIL-E-5272C ENVIRONMENTAL TESTS, GROUND SUPPORT EQUIPMENT

Tests (Per MIL-E-5272C)	General Base		A/C and Missile Support	Communications and Electronics	
	Sheltered	Unsheltered		Sheltered	Unsheltered
Temperature and pressure					
Low pressure	1*	1*	1*	1*	1*
High temperature	2	2	2	3	2
Low temperature	3	3	3	2	3
Sunshine	-	4*	-	-	4*
Corrosion and erosion					
Rain	-	6	5	-	10
Humidity	4	7	6	7	11
Fungus	5*	8*	7*	8*	12*
Salt spray	6	9	8	9	13
Sand and dust	-	5	4	-	9
Mechanical					
Acceleration	-	-	-	-	-
Explosion	-	-	9	-	5*
Shock (to 15g)	7	10	10	4	6
Vibration	8	11	11	5	7
Shock (over 15g)**	9	12	12	6	8

*When required

**If shock tests up to 15g can be run on same machine and with same set up as shock tests over 15g, all shock tests should be run consecutively in order of increasing severity as the last tests in the "mechanical" portion of the sequence.

TABLE III

SUGGESTED SEQUENCE, MIL-E-5272C ENVIRONMENTAL TESTS, AIRCRAFT EQUIPMENT

Tests (per MIL-E-5272C)	Liquid systems	Gas systems	Electrical systems	Mechanical systems	Auxiliary Power Plants	Auto-pilots	Instruments	Armament	Photographic	Communications & electronics
Temperature and pressure										
High temperature	1	1	3	1	1	1	1	1	1	2
Low temperature	2	2	1	3	2	2	3	2	2	1
Temperature shock	4*	4*	5*	2*	3*	5*	2	4	5*	5*
Altitude	3*	3*	2*	4*	4*	3*	4*	3*	3*	3*
Temperature-altitude	5	5	4*	5*	5*	4*	5	5	4	4
Sunshine	-	-	-	-	-	-	6*	-	-	-
Corrosion and erosion										
Immersion	-	-	-	-	-	-	8*	-	-	-
Rain	7*	7*	7*	7*	-	-	-	7*	-	-
Humidity	8	8	8	8	7	7	9	8	7	12
Fungus	9*	9*	9*	9*	8*	8*	10*	9*	8*	13*
Salt spray	10	10	10	10	9*	9	11	10	9	14
Sand and dust	6	6	6	6	6	6	7	6	6	11
Mechanical										
Acceleration	11	11	11	11	10	10	12	11	10	6
Explosion	-	-	12	-	11	11*	13*	12*	11*	7
Shock (to 15g)	12	12	13	12	12	12	14	13	12	8
Vibration	13	13	14	13	13	13	15	14	13	9
Shock (over 15g)**	14	14	15	14	14	14	16	15	14	10

* When required

** If shock tests up to 15g can be run on same machine and with same set up as shock tests over 15g, all shock tests should be run consecutively in order of increasing severity as the last tests in the "mechanical" portion of the sequence.

TABLE IV

SUGGESTED SEQUENCE, MIL-E-5272C ENVIRONMENTAL TESTS, GUIDED MISSILE EQUIPMENT

Tests (per MIL-E-5272C)	Liquid systems	Gas systems	Electrical systems	Mechanical systems	Auxiliary power plants	Gyro and guidance	Instruments & sensors	Armament	Photographic	Communi-cations & electronics
Temperature and pressure										
High temperature	1	1	3	1	1	1	1	1	1	2
Low temperature	2	2	1	3	2	2	3	2	2	1
Temperature shock	4	4	5	2	3	5	2	4	5	5
Altitude	3*	3*	2*	4*	3*	3*	4*	3*	3*	3*
Temperature-altitude	5	5	4	5	5	4	5	5	4	4
Sunshine	-	-	-	-	-	-	6*	-	-	-
Corrosion and erosion										
Immersion	-	-	-	-	-	-	8*	-	-	-
Rain	7*	7*	7*	7*	-	-	-	7*	-	-
Humidity	8	8	8	8	7	7	9	8	7	12
Fungus	9*	9*	9*	9*	8*	8*	10*	9*	8*	12*
Salt spray	10*	10*	10*	10*	9*	9*	11*	10*	9*	14*
Sand and dust	6	6	6	6	6	6	7	6	6	11
Mechanical										
Acceleration	11	11	11	11	10	10	12	11	10	6
Explosion	-	-	12	-	11	11*	13*	12	11*	7
Shock (to 15g**)	12	12	13	12	12	12	14	13	12	8
Vibration	13	13	14	13	13	13	15	14	13	9
Shock (over 15g)	14	14	15	14	14	14	16	15	14	10

* When required

** If shock tests up to 15g can be run on same machine and with same set up as shock tests over 15g, all shock tests should be run consecutively in order of increasing severity as the last tests in the "mechanical" portion of the sequence.

5.5 Suggested additional test limits.-

5.5.1 High temperature and temperature shock temperatures.- In the event that the temperature specified is considered inadequate and temperature requirements are not stipulated in the applicable equipment specification, it is suggested that one of the following test temperatures be selected:

95° C (199° F)
125° C (257° F)
150° C (302° F)
200° C (392° F)
250° C (482° F)

The temperature selected should be that most closely approximating the maximum service temperature anticipated.

5.5.2 Humidity temperatures.- If the temperature specified is in excess of that which the equipment involved will tolerate, and specific temperature requirements are not included in the applicable equipment specification, it is suggested that one of the following test temperatures be selected, on the basis of the maximum temperature which can be withstand by the equipment.

50° C (122° F)
65° C (149° F)

Custodians:
Navy - Bureau of Aeronautics
Air Force