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(See 6.5)

MILITARY SPECIFICATION

TESTING, ENVIRONMENTAL, AIRBORNE ELECTRONIC AND ASSOCIATED EQUIPMENT

This specification has been approved by the Naval Air Systems Command, Department of the Navy

1. SCOPE

1.1 This specification contains the procedures for testing airborne electronic and associated equipments under environmental conditions to demonstrate compliance with MIL-E-5400, MIL-T-21200, other general design specifications, and applicable detailed equipment specifications.

1.2 The procedures contained herein specify, modify as necessary, and provide the required detail data for the applicable test method of MIL-STD-810 for Navy airborne electronic and associated equipment.

1.3 List of Tests - Procedures for the following tests are included herein. When all tests are to be run on a single sample of equipment and unless specified otherwise, the tests shall be conducted in the order listed.

(Sequence of testing optional after applicable tests of paragraphs 4.1 through 4.6 have been accomplished.)

1.3.1 Multiple Test Samples - When tests are to be divided between two samples and unless specified otherwise by the detail equipment specification or the procuring agency, the applicable tests shall be divided and performed in the order listed.

Test Item No. 1	Test Item No. 2
(a) Temperature-Altitude	(a) Humidity
(b) Vibration	(b) Salt Fog
(c) Shock	(c) Explosion-Proof
(d) Sand and Dust	(Use either test item for tests (d) through (k). Sequence optional after applicable tests (a) through (c) have been accomplished.)
(e) Fungus	
(f) Temperature Shock	
(g) Bench Handling	
(h) Drip-Proof	
(i) Watertight	
(j) Drop	
(k) Acoustical Noise	

2. APPLICABLE DOCUMENTS

2.1 The following documents, of issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-E-5400	Electronic Equipment, Airborne, General Specification for
MIL-G-5572	Gasoline, Aviation Aircraft, General Specification for
MIL-T-21200	Test Equipment for use with Electronic and Electrical Equipment, General Specification for

STANDARDS

MIL-STD-108	Definition of and Basic Requirements for Enclosures for Electronic and Electrical Equipment
MIL-STD-810	Environmental Test Methods

(Copies of specifications and standards required by suppliers in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 Other Publications - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids form a part of this specification to the extent specified herein.

American National Standards Institute

S1.4-1961	General Purpose Sound Level Meters
S1.11-1966	Octave, Half-Octave, and Third-Octave Band Filter Sets

(Applications for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, New York 10016.)

3. REQUIREMENTS

3.1 Environmental Limits and Conditions - The environmental tests, test procedures, and test limits of this specification are designed to determine that the equipment will operate satisfactorily under the environmental conditions set forth in MIL-E-5400 or MIL-T-21200, as applicable. See 6.3.3 for test applicability as function of a particular class of equipment.

3.2 Modification of Test Limits or Conditions - The limits and test conditions specified herein correspond to the environmental conditions specified in MIL-E-5400 or MIL-T-21200, as applicable. If the detail equipment specification modifies these limits or conditions, the limits or conditions specified herein shall be modified to correspond to the limits or conditions specified in the detail equipment specification.

3.3 Supplemental Procedure - The procedure specified herein shall be supplemented by a procedure outlined in detail by the contractor. This procedure shall state the exact conditions under which measurements are to be made and shall be worded to avoid the possibility of misinterpretation. The procedure shall include details for test of all electrical, mechanical, and performance characteristics as specified for the particular equipment,

including provisions for indicating all variations in characteristics measured during the test procedure. This supplemental procedure is subject to the approval of the procuring agency.

3.4 Test Facilities and Apparatus - The apparatus used in conducting tests shall be capable of producing and maintaining the required test conditions and limits with the equipment under test either operating or non-operating as required.

3.4.1 Test Chamber -

3.4.1.1 Volume of Test Chamber - The volume of the test chamber shall be such that the item under test will not interfere with the generation and maintenance of test conditions.

3.4.1.2 Heat Source - The heat source of the test facility shall be located such that radiant heat will not fall directly on the test item, except where application of radiant heat is one of the test conditions.

3.4.1.3 Location of Temperature Sensors - Unless otherwise specified, thermocouples or equivalent temperature sensors utilized to determine and/or control the specified chamber temperature shall be centrally located within the test chamber where possible. The sensors shall be shielded from radiation from both the chamber heater elements and test items.

3.5 Standard Test Conditions - Unless otherwise specified all measurements and tests shall be made at standard ambient conditions. Standard ambient conditions are:

Temperature . . . . . 23° ±10° C (73° ±18° F)

Relative Humidity . . . . . 50% ±40%

Atmospheric Pressure . . . . . 725 +50/-115 mm of mercury (28.5 +2.0/-4.5 inches of mercury)

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

(a) Temperature: ±1.4° C (2.5° F) at control sensor. Temperature gradient across the cross-sectional area occupied by the test item shall not exceed 0.3° C (0.5° F) per foot in any direction.

(b) Altitude: When measured by devices such as manometers, ±5 percent or ±1.5 mm (0.059 inch) of mercury, whichever provides the greatest accuracy. When measured by devices such as ion gages, ±10 percent to 10^{-5} Torr.

(c) Humidity (relative): +5 percent, -0.0 percent.

(d) Vibration levels: ±10 percent.

(e) Vibration frequency: ±2 percent or ±1/2 Hz below 25 Hz.

(f) Additional tolerances: Additional tolerances shall be as specified.

3.6 Measurements - All measurements shall be made with instruments whose accuracy has been verified. The accuracy of instruments and test equipment used by contractors shall be verified periodically to the satisfaction of the procuring agency. All instruments and test equipment used shall:

(a) Conform to laboratory standards whose calibration is traceable to the prime standards at the U.S. Bureau of Standards.

(b) Have an accuracy of at least one-third the tolerance for the variable to be measured. In the event of conflict between this accuracy and a requirement for accuracy in any one of the test procedures of this specification, the latter shall govern.

(c) Be appropriate for measuring the test parameters.

3.7 Temperature Stabilization of Test Item -

3.7.1 Equipment Non-Operating - Unless otherwise specified, temperature stabilization has been reached when the temperature of the part of the test item having the longest thermal lag does not differ more than 2° C (3.6° F) from the ambient temperature.

3.7.2 Equipment Operating - Unless otherwise specified, temperature stabilization will have been attained when the temperature of the part of the test item considered to have the longest thermal lag does not change more than 2.0° C (3.6° F) per hour.

3.8 Performance of Test

3.8.1 Pretest Performance Record (Reference Run) - Prior to proceeding with any of the test methods, the test item shall be operated under standard ambient conditions (See 3.5) and a record made of all data necessary (including high and low input voltage/frequency conditions as applicable) to determine compliance with required performance. This data shall provide the criteria for checking satisfactory performance of the test item either during, or at the conclusion of the test, or both, as required.

3.8.2 Installation and Check of Test Item in/on Test Facility - The equipment, with appropriate instrumentation, shall be installed in/on the test facility in a manner approximating service use. The equipment shall be operated and checked as required in 3.8.1 and such data recorded as is necessary to verify that the operational and performance characteristics have not been altered during installation in/on the test facility.

3.8.3 Performance Check During Test - When operation of the test item is required during the test exposure, the operation and performance checks shall be of sufficient duration or shall be repeated at appropriate intervals (including a performance check at the conclusion of the test) to insure a record of comprehensive comparative data for comparison with data recorded under standard ambient conditions, specified in paragraph 3.8.1. When operation during the test exposure is not required, the equipment shall be visually inspected, operated, and comprehensive comparative data recorded immediately after the exposure.

3.8.4 Failure Criteria - Variations of operational and performance characteristics outside of the limits permitted by the detail equipment specification are reason to consider the equipment having failed the test. Deterioration and material failure of any part or material which could in any manner prevent the equipment from meeting operational, performance, and reliability requirements during service life shall provide reason to consider the equipment as having failed the test.

3.9 Test Data - Test data shall include complete identification of all test equipment and accessories. The data shall include the actual test sequence used and ambient test conditions recorded periodically during the test period. The test record shall contain a signature and data block for certification of the test data by the test engineer.

4. TEST PROCEDURES

4.1 Temperature and Altitude Tests -

4.1.1 General - This test procedure is in composite form and is to be used for both airborne and ground equipment. The applicable test schedule of table II in conjunction with 4.1.2 shall be used for the appropriate class of equipment to be tested.

4.1.1.1 Temperature Measurements - Thermocouples or equivalent temperature sensors shall be installed such that a thermal profile of the equipment may be developed. The measurement points shall be:

(a) One or more sensors in the ambient air within each major unit.

(b) On the largest transformer or inductor (except radio frequency inductors) or other large mass in each major unit.

(c) On the component(s) where the highest operating temperature is expected, except for vacuum tubes.

(d) On the component(s) whose temperature rise is likely to limit equipment performance.

4.1.2 Test Procedure - The test item shall be placed in the test chamber in accordance with paragraph 3.8.2, making connections and attaching instrumentation as necessary. In general, the testing schedule outlined in table II shall be followed. However, each step in table II represents a condition which the test item may encounter in service, therefore, each step may be applied independently of the others. For operating conditions other than those specified in table I, the applicable temperature-altitude conditions in figures 1, 2, 3, or 4 shall be used. When changing chamber conditions from those required for any step to those required for any other step, in the sequence given in table II or in any sequence, the rates of temperature and pressure changes may be the maximum attainable by the chamber, but these rates shall not exceed 1° C (1.8° F) per second for airborne equipment (10° C (18° F) per minute for ground equipment) and 0.5 inch of mercury per second.

(Ground Equipment Only)	Step 1a - With the test item non-operating, adjust the chamber temperature to that specified for step 1a of table II. After the test item has stabilized the altitude shall be adjusted to that specified and maintained for at least 1 hour. At the conclusion of this period the test item shall, to the extent practicable, be visually inspected to determine whether or not deterioration which would impair future operation has occurred.

(All Equipment)

Step 1b - With the test item non-operating, adjust the chamber conditions to those specified for step 1b in table II. The test item temperature shall be stabilized and maintained for at least 2 hours. Where it is possible without changing the temperature condition, a visual inspection of the test item shall be made to determine whether or not deterioration which would impair future operation has occurred.

Step 2 - With the test item non-operating, adjust the chamber conditions to those specified in step 2 in table II. After the test item temperature has stabilized, the test item shall be turned on at the lowest specified input voltage. The test item shall operate satisfactorily within the specified warm-up time. The test item shall then be turned off and restabilized at the temperature specified for step 2 in table II. The operation shall be repeated 2 more times (See Notes (a) and (b)). The chamber temperature shall be maintained at the temperature specified for step 2 in table II. Operation of the test item shall be continued, and during this period shall be checked to determine satisfactory operation and results recorded.

Step 3 - With the test item non-operating, permit the test item to stabilize at the temperature specified in step 3 of table II. The test item shall then be turned on and the altitude adjusted to that specified. Upon reaching the specified altitude, an operational and performance check shall be made at the highest specified input voltage and the result recorded.

NOTE: (a) Satisfactory operation within the specified warm-up time shall be determined by checking to see if the visual or aural presentation or other performance characteristics appear normal.

(b) All characteristics which are likely to be affected by low temperatures shall be checked first. Should the time required to check the test item exceed 15 minutes beyond the warm-up time, the test item shall again be stabilized at the temperature specified for step 2 in table II and the operational check continued.

Step 4 - With the test item non-operating, adjust the chamber conditions to those specified for step 4 in table II. After test item temperature has stabilized the test chamber door shall be opened and frost permitted to form on the test item. The door shall remain open long enough for the frost to melt but not long enough to allow the moisture to evaporate. (See Note (c)). The chamber door shall be closed and the test item turned on at the highest specified input voltage to see if it operates satisfactorily within the specified warm-up time. The test item shall be turned on and off at least three times. (See Notes (a) and (d).)

Step 5 - With the test item non-operating, adjust the chamber conditions to those specified for step 5 in table II. The chamber temperature shall be stabilized and maintained for at least 16 hours. At the conclusion of this period the test item shall, when practicable, be visually inspected to determine the extent of any deterioration.

Step 6 - With the test item non-operating, adjust the chamber conditions to those specified for step 6 in table II. After the chamber conditions and the test item temperature have stabilized, turn the test item on at the highest specified input voltage and permit it to operate continuously for 4 hours. Thermocouple readings of the test item shall be recorded at least every 30 minutes. At the end of the specified period of operation, and still at the specified chamber conditions, continue to operate the test item until it has been checked for satisfactory operation and results recorded.

NOTE: (c) When the chamber door is opened it is intended that frost will form; however, should the relative humidity of the air be such that frost will not form, artificial means shall be used to provide the relative humidity necessary to have frost form.

(d) After completion of the cold test (steps 1, 2, 3, and 4), and prior to starting the high temperature tests, a reference run shall be made in accordance with paragraph 3.8.1. The reference run shall be made at the highest specified input voltages and data obtained compared with that of the reference run made prior to step 1.

Step 7 - With the test item non-operating, adjust the chamber conditions to those specified for step 7 in table II. After the chamber conditions and the test item temperature have stabilized, the test item shall be operated at the highest specified input voltage for four time periods as specified by table II. Each of the four periods of operation shall be followed by a 15 minute off period. The test item shall be checked for satisfactory operation during the first and last period of operation and results recorded. The thermocouple readings of the test item shall be recorded at least every 10 minutes.

Step 8 - With the test item non-operating, adjust the chamber conditions to those specified for step 8 in table II. After the chamber conditions and the test item temperature have been stabilized, the test item shall be operated for four 10 minute periods at the highest specified input voltage. Each of the four periods of operation shall be followed by a 15 minute off period. The test item shall be checked for satisfactory operation during the first and last periods of operation and the results recorded. Thermocouple readings of the test item shall be recorded at the beginning and end of each operating period.

Step 9 - With the test item non-operating, adjust the chamber temperature to that specified for step 9 of table II. After the test item temperature has stabilized, the test item shall be turned on at the highest specified input voltage and the altitude shall be adjusted to that specified. Following altitude stabilization, the test item shall be operated at the highest specified input voltage for 4 hours. Thermocouple readings of the test item shall be recorded at least every 30 minutes. At the end of the specified operating period, continue to operate the test item until it has been checked for satisfactory operation and results recorded.

Step 10 - With the test item non-operating, adjust the chamber temperature to that specified for step 10 of table II. After the test item temperature has stabilized, the test item shall be turned on at the highest specified input voltage and the altitude shall be adjusted to that specified. Following altitude stabilization, the test item shall be operated at the highest specified input voltage for four time periods as specified by table II. Each of the four periods of operation

shall be followed by a 15 minute off period. The test item shall be checked for satisfactory operation during the first and last period of operation and results recorded.

Step 11 - With the test item non-operating, adjust the chamber temperature to that specified for step 11 of table II. After the test item temperature has stabilized, the test item shall be turned on at the highest specified input voltage, and the altitude shall be adjusted to that specified. Following altitude stabilization, the test item shall be operated at the highest specified input voltage for 4 hours. Thermocouple readings of the test item shall be recorded at least every 30 minutes. At the end of the specified operating period, continue to operate the test item until it has been checked for satisfactory operation and results recorded.

Step 12 - With the test item non-operating, adjust the chamber temperature to that specified for step 12 of table II. After the test item temperature has stabilized, the test item shall be turned on at the highest specified input voltage and the altitude shall be adjusted to that specified. Following altitude stabilization, the test item shall be operated at the highest specified input voltage for four time periods as specified by table II. Each of the four periods of operation shall be followed by a 15 minute off period. The test item shall be checked for satisfactory operation during the first and last period of operation and results recorded.

Step 13 - With the test item non-operating, adjust the chamber temperature to that specified for step 13 of table II. After the test item temperature has stabilized, the test item shall be turned on at the highest specified input voltages and the altitude shall be adjusted to that specified. Following altitude stabilization, the test item shall be operated at the highest specified input voltage for four 10 minute periods. Each of the four periods of operation shall be followed by a 15 minute off period. The test item shall be checked for satisfactory operation during the first and last period of operation and results recorded.

Step 14 - With the test item operating, adjust the chamber conditions to standard ambient conditions. When the chamber and test item conditions have stabilized, an operational and performance check shall be made on the test item and results compared with the data obtained in paragraph 3.8.1.

NOTE (e) In order to expedite the stabilization of the test item temperatures, chamber temperatures other than those listed in table II may be used.

(f) The steps listed herein include certain essential test points on the operational requirement curves of figures 1 through 4. These curves define the required temperature-altitude operational envelopes for the applicable classes of equipment. In addition to the essential test points listed, any combination of conditions, in any sequence, within the design limitation envelopes as defined by the class of equipment or as modified by the equipment specification, may be chosen as additional operational test points.

(g) Following those steps where a change in temperature at low pressure is specified, the pressure may be increased to ambient before changing the temperature and then returned to the specified altitude following temperature stabilization.

(h) This note is applicable to ground equipment only and may be implemented when specifically approved by the procuring agency. Steps 6 and 9 may be combined into a single 4 hour exposure provided that the most stringent envelope requirements are combined to provide a worst case condition. That is, step 6 would be omitted and step 9 would be conducted at 55° C at a simulated altitude of 10,000 feet. However, should the results of such combined testing indicate a temperature-associated failure, then both steps 6 and 9 may necessarily have to be repeated as specified by table II. Steps 7 and 10 may be combined in a similar manner and under the same conditions.

T A B L E I

Temperature Range for Various Equipment Classes

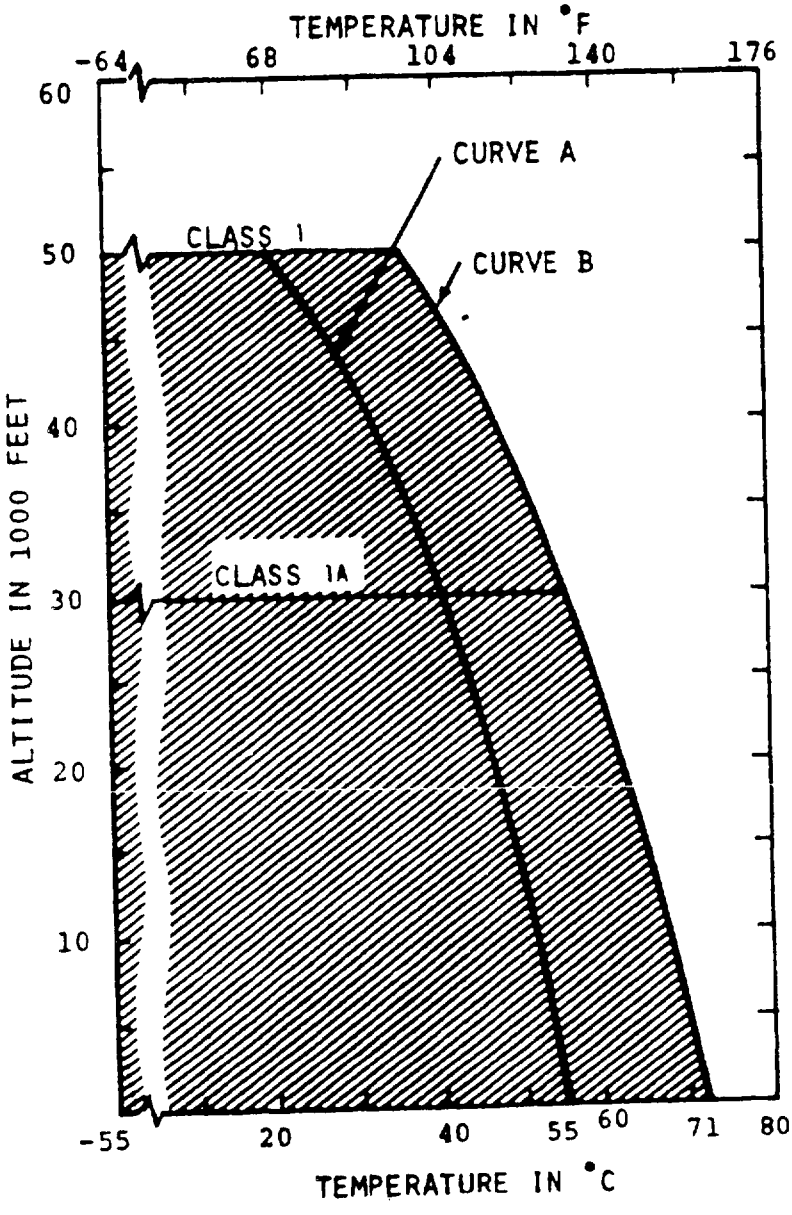
EQUIPMENT CLASSES			EQUIPMENT MODE				TEMPERATURE (°C)
			OPERATING			NON-OPERATING	
	NO.	ALTITUDE RANGE (FT)	CONTINUOUS	INTERMITTENT	SHORT-TIME		
MIL-E-5400	1	SEA LEVEL TO 50,000	X	X		X	-54 TO 55 55 TO 71 -62 TO 85
	1A	SEA LEVEL TO 30,000	X	X		X	-54 TO 55 55 TO 71 -62 TO 85
	2	SEA LEVEL TO 70,000	X	X		X	-54 TO 71 71 TO 95 -62 TO 95
	3	SEA LEVEL TO 100,000 (95°C CONTINUOUS SEA LEVEL OPERATION)	X	X	X	X	-54 TO 95 95 TO 125 125 TO 150 -62 TO 125
	4	SEA LEVEL TO 100,000 (125°C CONTINUOUS SEA LEVEL OPERATION)	X	X	X	X	-54 TO 125 125 TO 150 150 TO 260 -62 TO 150
MIL-T-21200	1	SEA LEVEL TO 50,000	X	X		X	-54 TO 55 55 TO 71 -62 TO 85
	2	SEA LEVEL TO 10,000	X	X		X[1]	-40 TO 55 55 TO 71 -62 TO 85
	3	SEA LEVEL TO 10,000	X			X[1]	0 TO 55 -62 TO 85

[1] Air transportation to 60,000 ft.

TABLE II

Test Chamber Conditions for Temperature-Altitude Tests

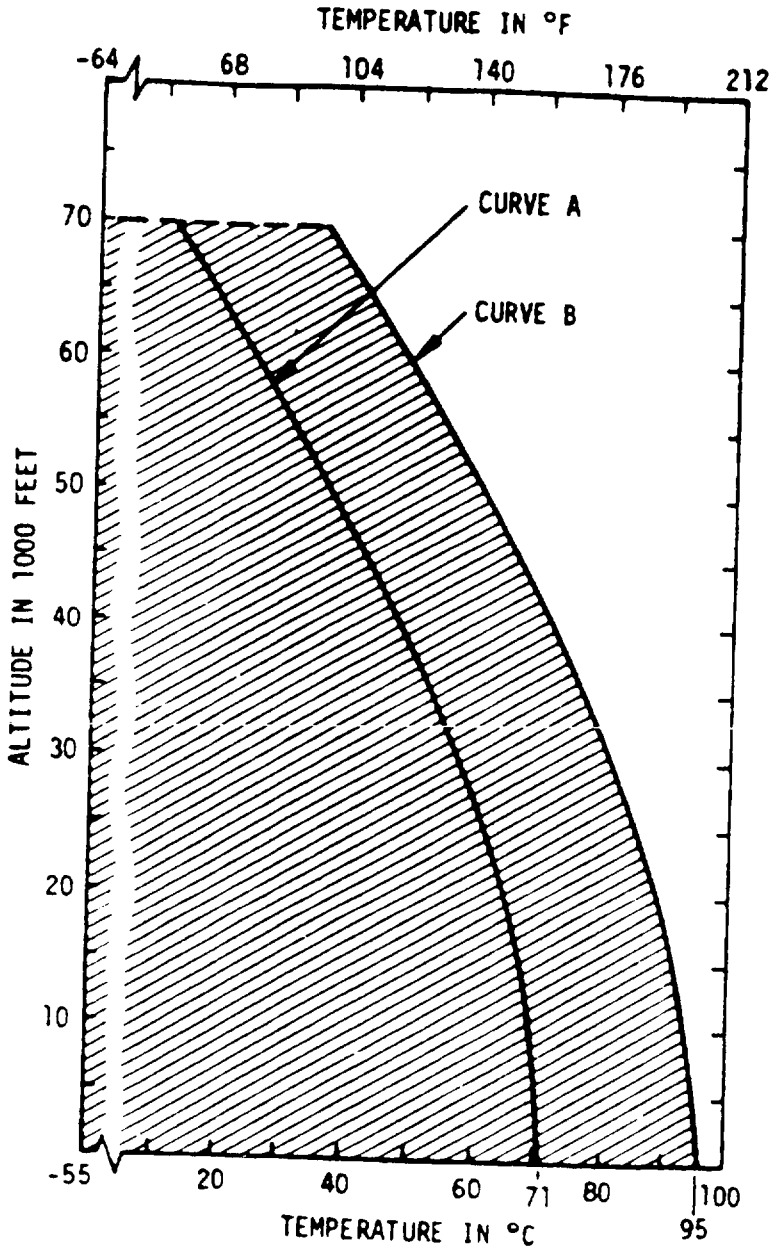
	CLASS	STEP	1a	1b	2	3	4	5	6	7	8	9	10	11	12	13	14
MIL-E-5400	1	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 50,000 ---	-10 ATM ---	85 ATM 16 HR	55 ATM 4 HR	71 ATM 30 MIN	OMIT	30 40,000 4 HR	47 40,000 30 MIN	20 50,000 4 HR	35 50,000 30 MIN	OMIT	STANDARD AMBIENT CONDITIONS
	1A	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 30,000 ---	-10 ATM ---	85 ATM 16 HR	55 ATM 4 HR	71 ATM 30 MIN	OMIT	48 20,000 4 HR	64 20,000 30 MIN	40 30,000 4 HR	57 30,000 30 MIN	OMIT	
	2	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 70,000 ---	-10 ATM ---	95 ATM 16 HR	71 ATM 4 HR	95 ATM 30 MIN	OMIT	36 50,000 4 HR	60 50,000 30 MIN	10 70,000 4 HR	35 70,000 30 MIN	OMIT	
	3	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 80,000 ---	-10 ATM ---	125 ATM 16 HR	95 ATM 4 HR	125 ATM 30 MIN	150 ATM 10 MIN	60 50,000 4 HR	90 50,000 30 MIN	-10 100,000 4 HR	20 100,000 30 MIN	45 100,000 10 MIN	
	4	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 80,000 ---	-15 ATM ---	150 ATM 16 HR	125 ATM 4 HR	150 ATM 30 MIN	260 ATM 10 MIN	90 50,000 4 HR	115 50,000 30 MIN	25 100,000 4 HR	50 100,000 30 MIN	155 100,000 10 MIN	
MIL-T-21200	1	TEMP (°C) ALT (FT) TIME	OMIT	-62 ATM 2 HR	-54 ATM ---	-54 50,000 ---	-10 ATM ---	85 ATM 16 HR	55 ATM 4 HR	71 ATM 20 MIN	OMIT	30 40,000 4 HR	47 40,000 20 MIN	20 50,000 4 HR	35 50,000 20 MIN	OMIT	STANDARD AMBIENT CONDITIONS
	2	TEMP (°C) ALT (FT) TIME	25 50,000 1 HR	-62 ATM 2 HR	-40 ATM ---	-40 10,000 ---	-10 ATM ---	85 ATM 16 HR	55 ATM 4 HR	71 ATM 20 MIN	OMIT	52 10,000 4 HR	68 10,000 20 MIN	OMIT	OMIT	OMIT	
	3	TEMP (°C) ALT (FT) TIME	25 50,000 1 HR	-62 ATM 2 HR	0 ATM ---	0 10,000 ---	OMIT	85 ATM 16 HR	55 ATM 4 HR	OMIT	OMIT	52 10,000 4 HR	OMIT	OMIT	OMIT	OMIT	



NOTES:

1. *Curve A - Design and Test Requirements for continuous operation.*
2. *Curve B - Design and Test Requirements for intermittent operation.*
3. *Operational requirements for class 1A same as for class 1 except the altitude limit is 30,000 feet.*

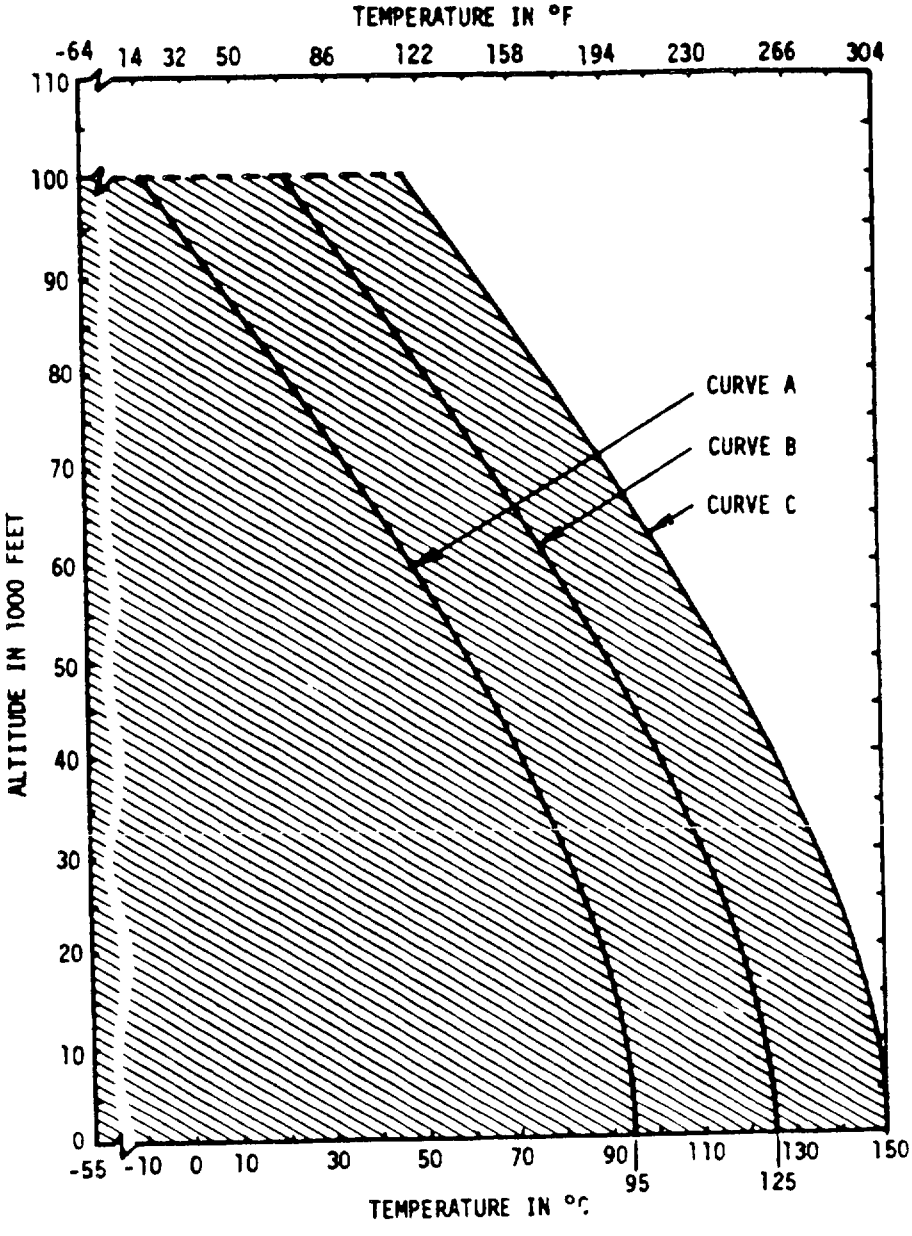
FIGURE 1 - Operational Requirements for Class 1 and 1A Aerospace Electronic Equipment. Temperature Versus Altitude



NOTES:

1. Curve A - Design and test requirements for continuous operation.
2. Curve B - Design and test requirements for intermittent operation.

FIGURE 2 - Operational Requirements for Class 2 Aerospace Electronic Equipment. Temperature Versus Altitude



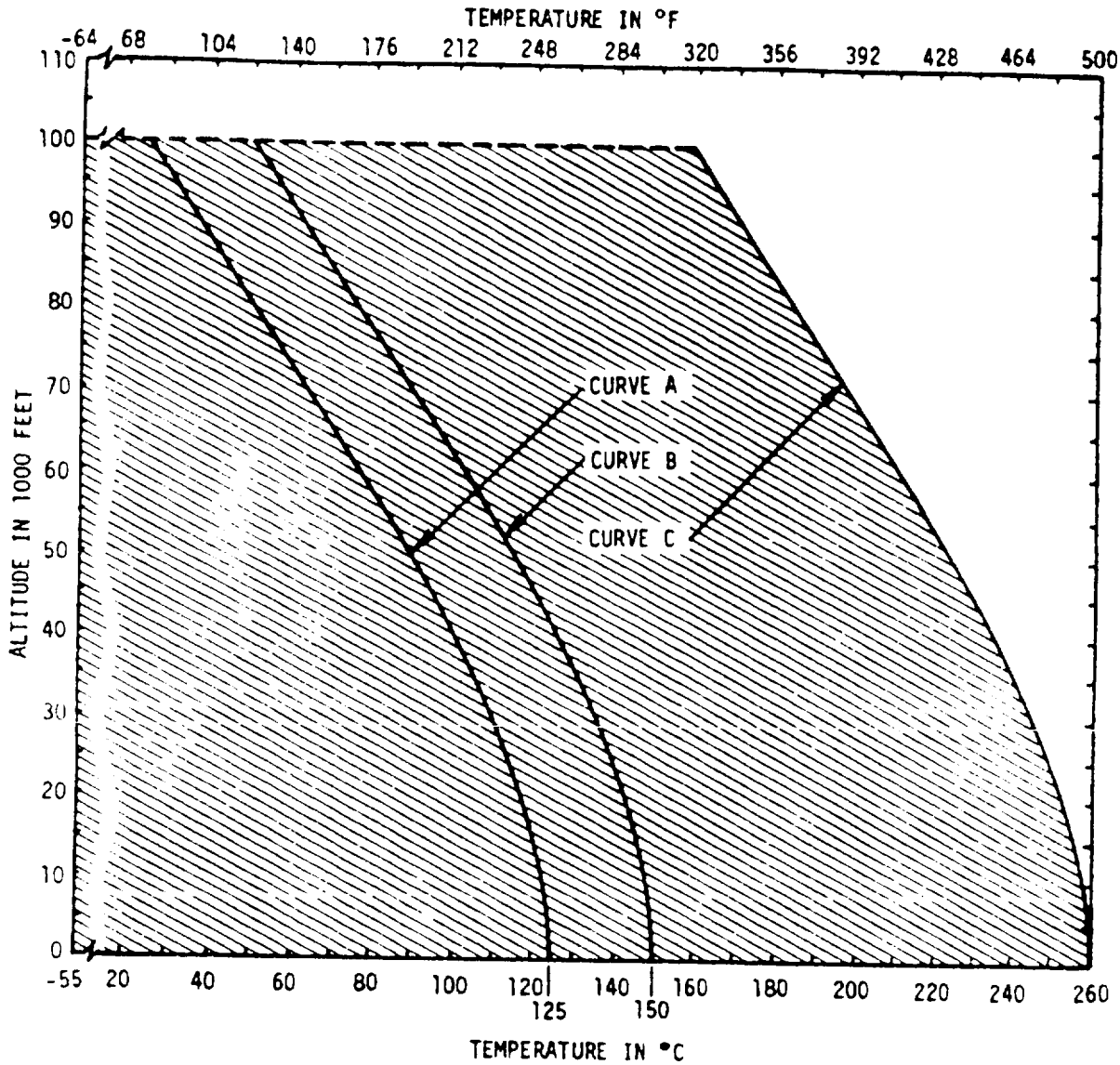
NOTES:

1. *Curve A - Design and test requirements for continuous operation of electronic equipment designed to operate at 95°C at sea*

2. *Curve B - Design and test requirements for intermittent operation of electronic equipment designed to operate continuously at 95°C at sea level.*

3. *Curve C - Design and test requirements for short time operation of electronic equipment designed to operate continuously at 95°C at sea level.*

FIGURE 3 - Operational Requirements for Class 3 Aerospace Electronic Equipment. Temperature Versus Altitude



NOTES:

1. *Curve A - Design and test requirements for continuous operation of electronic equipment designed to operate at 125°C at sea level.*
2. *Curve B - Design and test requirements for intermittent operation of electronic equipment designed to operate continuously at 125°C at sea level.*
3. *Curve C - Design and test requirements for short time operation of electronic equipment designed to operate continuously at 125°C at sea level.*

FIGURE 4 - Operational Requirements for Class 4 Aerospace Electronic Equipment. Temperature Versus Altitude

4.2 Vibration Tests -

4.2.1 General - Three vibration test procedures are specified herein. Procedures I and III, which includes both cycling and resonance dwell, are to be used for airborne and associated ground equipment, respectively. Procedure II, which includes cycling only but with higher input vibration levels for endurance steps may be used in lieu of Procedure I only when specifically authorized by the procuring agency.

4.2.1.1 Method of Attachment - The test specimen shall be attached directly to the vibration table or to an intermediate structure which is so designed as to be capable of transmitting the specified magnitudes of vibration to the points of specimen attachment throughout the required test frequency range.

4.2.1.2 Transducer Mounting - The input monitoring transducer(s) shall be rigidly attached to the vibration table or to the intermediate structure if used at or as near as possible to the attachment point(s) of the test specimen.

4.2.1.3 Input Control - The vibratory levels of the specified test curve shall be maintained at the points of specimen attachment or as indicated in 4.2.1.2. For large test specimens having appreciable distance between attachment points, a transducer shall be used to monitor the input at each point. Regardless of the number of input transducers used, the average value of the absolute scalar magnitudes of all input transducer levels, monitored continuously and simultaneously, shall be that of the specified test curve. A tracking filter may be used in the control loop as necessary to maintain proper control accuracy when the control signal is noisy.

4.2.1.4 Resonant Modes - A resonant mode shall be considered to be any frequency-dependent mechanical disturbance which can be detected visually, aurally or by means of other sensing devices. A resonant mode exists at any frequency at which the ratio of specimen response level to input level is at a peak such that both an increase and a decrease in the excitation frequency will produce a decrease in the specimen response level. The disturbance may also exhibit itself as an erratic sharp waveform, and in the specimen as erratic operation, deviation from required performance, or complete malfunction.

4.2.1.5 Weight Compensation - Unless otherwise specified for items weighing more than 80 pounds, the vibratory acceleration may be reduced by 1g for each 20 pound increment of weight over 80 pounds. However, the vibratory acceleration shall in no case be less than 50 percent of the specified curve level. When a test item performance test is required during the vibration test and the duration of the performance test is greater than the duration of the vibration test, the performance test shall be abbreviated accordingly.

4.2.1.6 Sweep Rate - For cycling tests, the rate of frequency change shall be logarithmic and shall be such that a complete cycle (5-500-5; 5-55-5) hertz (Hz) or (5-2000-5) Hz, will consume 15 or 20 minutes, respectively.

4.2.1.6.1 Increments - For cycling tests where a complete cycle is (5-55-5) Hz and logarithmic cycling is not available, the test shall be performed in three increments with the following linear rates. The cycle (5-15-5) Hz shall take 7 minutes, the cycle (15-25-15) Hz shall take 3 minutes, and the cycle (25-55-25) Hz shall take 5 minutes.

4.2.1.7 Cross Talk - The transverse motion of the input monitoring point(s) shall be minimized, and shall be limited to 100 percent of the input motion.

4.2.1.8 Operational Requirements - The equipment shall be operating during the vibration tests. The equipment shall provide specified performance during all steps except where noted.

4.2.2 Procedure I - This procedure consists of two parts:

Part I - Equipment normally mounted (with vibration isolators in place, if any).

Part II - Vibration isolated equipment only, with external isolators removed.

Tests shall be conducted only under ambient room conditions unless the detail equipment specification requires the tests also be conducted at high and/or low temperature. If a test is required at other than room ambient conditions then Part I of the procedure shall be repeated at the temperature specified in the detail equipment specification. When other than room ambient test is required, the time specified in table III shall be divided equally between the tests. Part II of this test shall be conducted only at room ambient conditions. The time specified for Part II is not included in table III.

4.2.2.1 Part I - Equipment Normally Mounted - The equipment shall be mounted in accordance with paragraph 4.2.1.1. The mounting shall simulate service installation including all vibration mounts and other holding devices.

Step 1 - Resonance Survey- Resonant modes of the equipment shall be determined by varying the frequency of applied vibration slowly through the specified range along one of the three major mutually perpendicular axes at amplitudes not exceeding those for which the equipment is to be tested (See Notes (a) and (b)).

TABLE III

Vibration Test Schedule for Procedure I, Part I
(Time shown refers to one axis of vibration)

No. of Resonances	0	1	2	3	4
Total Time at Resonance 1/	-	30 min.	1 hr	1-1/2 hr	2 hr
Cycling Time 1/	3 hr	2-1/2 hr	2 hr	1-1/2 hr	1 hr

1/ 30 minutes at each resonance, except that if more than four resonant modes are noted for any one axis, the time for each mode shall be 120/N minutes, where N is the number of modes. However, in no case shall the time for each mode be less than 20 minutes, nor shall the cycling time be less than one hour.

Step 2 - Resonance Dwell Vibration - The equipment shall be vibrated along the selected axis at each of the resonant mode frequencies determined in step 1 and at the amplitude indicated by the applicable curve of figures 5 or 6 (See Notes (a) and (b)). The time duration shall be as specified in table III. During each resonant mode, a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure. If a change in the resonant frequency occurs during the test, its time of occurrence shall be recorded and immediately the frequency shall be adjusted to maintain the peak resonance condition. The final resonant frequency shall be recorded.

NOTE: (a) If the detail equipment specification does not clearly specify the applicable curve, then Curve I of figure 5 shall apply unless the equipment is designed to 2000 hertz, in which case Curve Ia of figure 6 shall apply. For console controls located in the cockpit area, Curve I or Ia shall apply as above except the acceleration shall be limited to 5g.

(b) Step 1 may be completed for all three axes before proceeding with step 2 if desired.

Step 3 - Cycling - The equipment shall be vibrated along the axis chosen for steps 1 and 2 with the frequency varying through the specified range, at the amplitudes indicated by the applicable curve of figures 5 or 6 (See Note (a)). The sweep rate shall be as specified in paragraph 4.2.1.6. The test shall continue for the time specified in table III. During the cycling test a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure.

Step 4 - Steps 1, 2, and 3 shall be repeated along one of the remaining major axes.

Step 5 - Steps 1, 2, and 3 shall be repeated along the third major axis. At the completion of this step, a performance check shall be made and the results recorded.

4.2.2.2 Part II - Vibration Isolated Equipment Only, with Isolators Removed - The equipment shall be mounted directly to the vibration table with external vibration isolators removed or blocked, but including any other holding devices, in accordance with paragraph 4.2.1.1.

Step 1 - Resonance Survey - Step 1 of Part I of this test shall be repeated at amplitudes not exceeding those indicated by Curve II of figure 5 or Curve IIa of figure 6.

Step 2 - Resonance Dwell Vibration - The equipment shall be vibrated along the selected axis at each of the resonant mode frequencies determined in step 1 and at the amplitude indicated by Curve II of figure 5 or Curve IIa of figure 6. The test shall continue for 10 minutes at each of the resonant modes. During each mode of vibration, a performance check shall be made and the results recorded. At the completion of each mode of vibration, the equipment shall be closely inspected for any evidence of mechanical failure.

Step 3 - Cycling - The equipment shall be vibrated along the axis chosen for steps 1 and 2 with the frequency varying through the specified range at the amplitudes indicated by Curve II of figure 5 or Curve IIa of figure 6. The sweep rate shall be as specified in paragraph 4.2.1.6. The test shall continue for two cycles, i.e., 30 minutes for the (5-500-5) Hz range or 40 minutes for the (5-2000-5) Hz range.

During the cycling test a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure.

Step 4 - Steps 1, 2, and 3 shall be repeated along one of the two remaining major axes.

Step 5 - Steps 1, 2, and 3 shall be repeated along the third major axis. At the completion of this step, a performance check shall be made and the results recorded.

4.2.3 Procedure II - This procedure may be used in lieu of Procedure I for airborne equipment when specifically approved by the procuring agency. This procedure shall consist of three parts:

Part I - Operating test for equipment normally mounted (with vibration isolators in place, if any).

Part II - Endurance test for equipment normally mounted (with vibration isolators in place, if any).

Part III - Operating endurance test for vibration isolated equipment only, with external isolators removed.

Tests shall be conducted only under ambient room conditions.

4.2.3.1 Vibration Level Curves - Figure 5 or figure 6 shall be used for part I. Figure 7 or figure 8 shall be used for Parts II and III. Each of the curves of figures 5 and 6 has an endurance level counterpart in either figure 7 or figure 8. The endurance curve(s) to be applied shall depend upon the operation level curve selected, in accordance with table IV.

TABLE IV

PROCEDURE II VIBRATION CURVE SELECTION
(See Figures 5 and 7 or 6 and 8)

PART I With Operation Level Curve		PART II AND III Use Endurance Level Curve
I	→	V
II	→	VI
III	→	VII
IV	→	VIII
Ia	→	Va
IIa	→	VIa
IIIa	→	VIIa
IVa	→	VIIIa

4.2.3.2 Part I - Operating Test for Equipment Normally Mounted - The equipment shall be mounted in accordance with paragraph 4.2.1.1. The mounting shall simulate service installation including all vibration mounts and other holding devices. The equipment shall be operating during the test.

Step 1 - The equipment shall be vibrated along one of the three major mutually perpendicular axes through the applicable frequency range at the amplitudes indicated by the applicable curve of figure 5 or figure 6 (See Note (a)). The sweep rate shall be as specified in paragraph 4.2.1.6. During this step a performance check shall be made and the results recorded. The time duration shall be at least two complete sweeps (5-500-5) Hz or (5-2000-5) Hz, as applicable. At the completion of this step the equipment shall be closely inspected for any evidence of mechanical failure.

NOTE: (a) If the detail equipment specification does not clearly specify the applicable curve, then Curve I of figure 5 shall apply unless the equipment is designed to 2000 hertz, in which case Curve Ia of figure 6 shall apply. For console controls located in the cockpit area, Curve I or Ia shall apply as above except the acceleration shall be limited to 5g.

(b) For any given axis, Part II or III may be completed after Part I prior to changing to the next required axis.

Step 2 - Step 1 shall be repeated along one of the two remaining major axis.

Step 3 - Step 1 shall be repeated along the third major axis.

4.2.3.3 Part II - Endurance Test for Equipment Normally Mounted - The equipment shall be mounted as in Part I.

Step 1 - The equipment shall be vibrated along one of the three major mutually perpendicular axes through the applicable frequency range at the amplitudes indicated by the applicable curve of figure 7 or figure 8 (See table IV and Note (a) on next page). The sweep rate shall be as specified in paragraph 4.2.1.6. The time duration shall be 4 hours.

The equipment need not be monitored for specified performance during this portion of the step, but it shall be observed for catastrophic failures.

At the completion of the four hours, one additional sweep in accordance with the requirements of Part I shall be performed and the item checked for satisfactory performance and results recorded.

NOTE: (a) For console controls located in the cockpit area, Curve V or Va, as applicable, shall apply except the acceleration shall be limited to 7g.

Step 2 - Step 1 shall be repeated along one of the two remaining major axes.

Step 3 - Step 1 shall be repeated along the third major axis. At the completion of this step, a performance check shall be made and the results recorded.

4.2.3.4 Part III - Operating Endurance Test for Vibration Isolated Equipment Only, with Isolators Removed - The equipment shall be mounted directly to the vibration table with external vibration isolators removed or blocked, but including any other holding devices in accordance with paragraph 4.2.1.1.

Step 1 - The equipment shall be vibrated along one of the three mutually perpendicular axes through the applicable frequency range at the amplitudes indicated by Curve VI of figure 7 or Curve VIa of figure 8. The sweep rate shall be as specified in paragraph 4.2.1.6. This test shall continue for 2 hours. During this test, a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure.

Step 2 - Step 1 shall be repeated along one of the two remaining axes.

Step 3 - Step 2 shall be repeated along the third major axis. At the completion of this step, a performance check shall be made and the results recorded.

4.2.4 Procedure III - This procedure is applicable for ground equipment which is used in the vicinity of the aircraft or in the shop on land and on board ship. The test item, less transit case, if any, shall be secured to the vibration table by suitable holding devices which are so designed to allow transmission of the specified magnitude of vibration to the test specimen throughout the required frequency range. Tests shall be conducted only under ambient room conditions.

Step 1 - Resonance Survey - Resonant modes of the equipment shall be determined by varying the frequency of applied vibration slowly through the specified range along one of the three major mutually perpendicular axes at amplitudes not exceeding those for which the equipment is to be tested. See figure 9. This may be completed for all three axes before proceeding to step 2 if desired.

Step 2 - Resonance Dwell Vibration - The equipment shall be vibrated along the selected axis at each of the resonant mode frequencies determined in step 1 and at the amplitude indicated by the curve of figure 9. The time duration shall be as specified in table V. During each resonant mode, a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure. If a change in the resonant frequency occurs during the test, its time of occurrence shall be recorded and immediately the frequency shall be adjusted to maintain the peak resonance condition. The final resonant frequency shall be recorded.

TABLE V

Vibration Test Schedule for Procedure III
(Time shown refers to one axis of vibration)

No. of Resonances	0	1	2	3	4
Total Time at Resonance 1/	-	15 min	30 min	45 min	1 hr
Cycling Time 1/	3 hr	2-3/4 hr	2-1/2 hr	2-1/4 hr	2 hr

1/ 15 minutes at each resonance, except that if more than four resonant modes are noted for any one axis, the time for each mode shall be 60/N minutes, where N is the number of modes. However, in no case shall the time for each mode be less than 10 minutes, nor shall the cycling time be less than two hours.

Step 3 - Cycling - The equipment shall be vibrated along the axis chosen for steps 1 and 2 and with the frequency varying through the specified range, at the amplitudes indicated by the curve of figure 9. The sweep rate shall be as specified in paragraph 4.2.1.6. The test shall continue for the time specified in table V. During the cycling test a performance check shall be made and the results recorded. At the completion of this step, the equipment shall be closely inspected for any evidence of mechanical failure.

Step 4 - Steps 1, 2, and 3 shall be repeated along one of the remaining major axes.

Step 5 - Steps 1, 2, and 3 shall be repeated along the third major axis. At the completion of this step, a performance check shall be made and the results recorded.

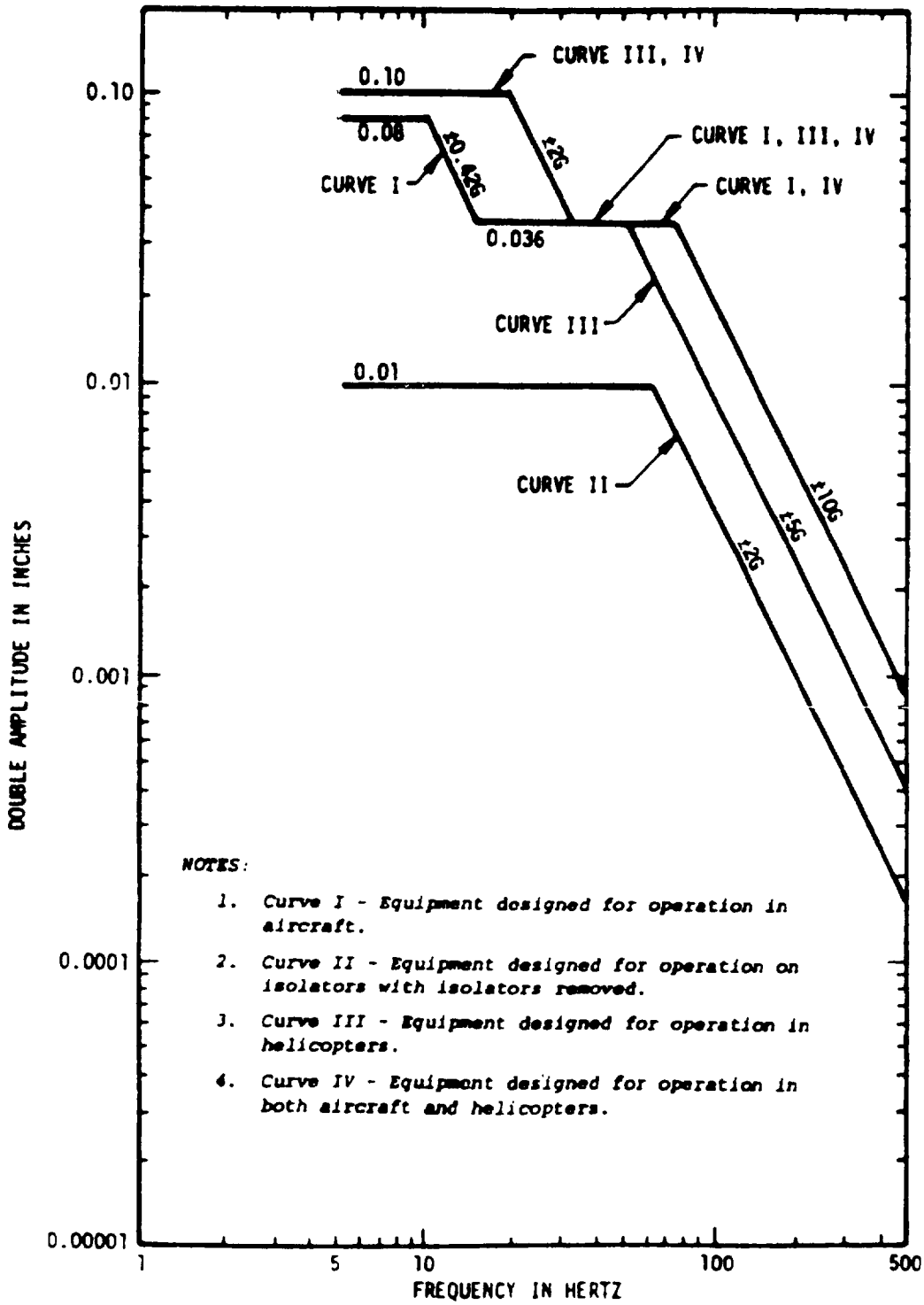


FIGURE 5 - Vibration Level Curve

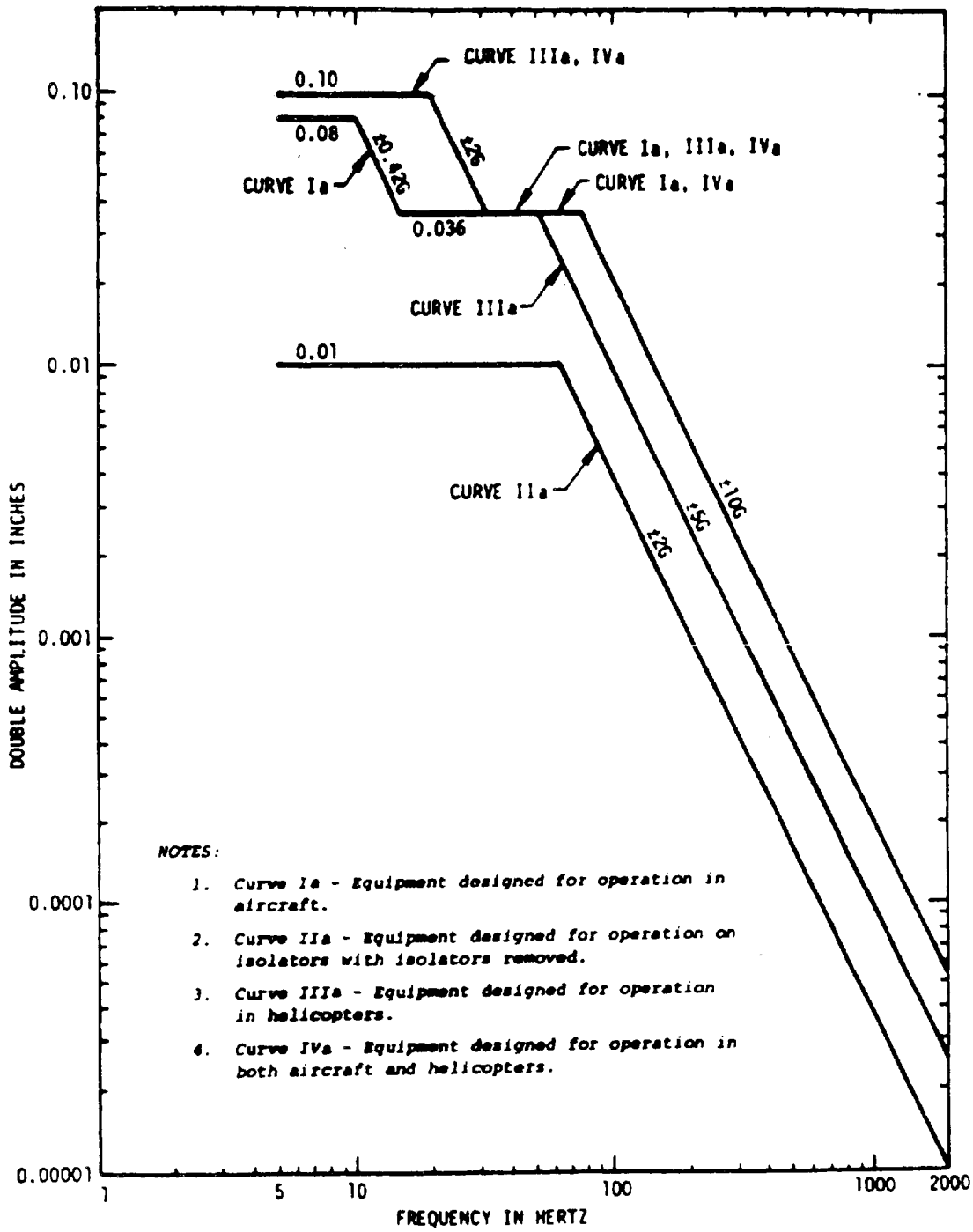


FIGURE 6 - Vibration Level Curve

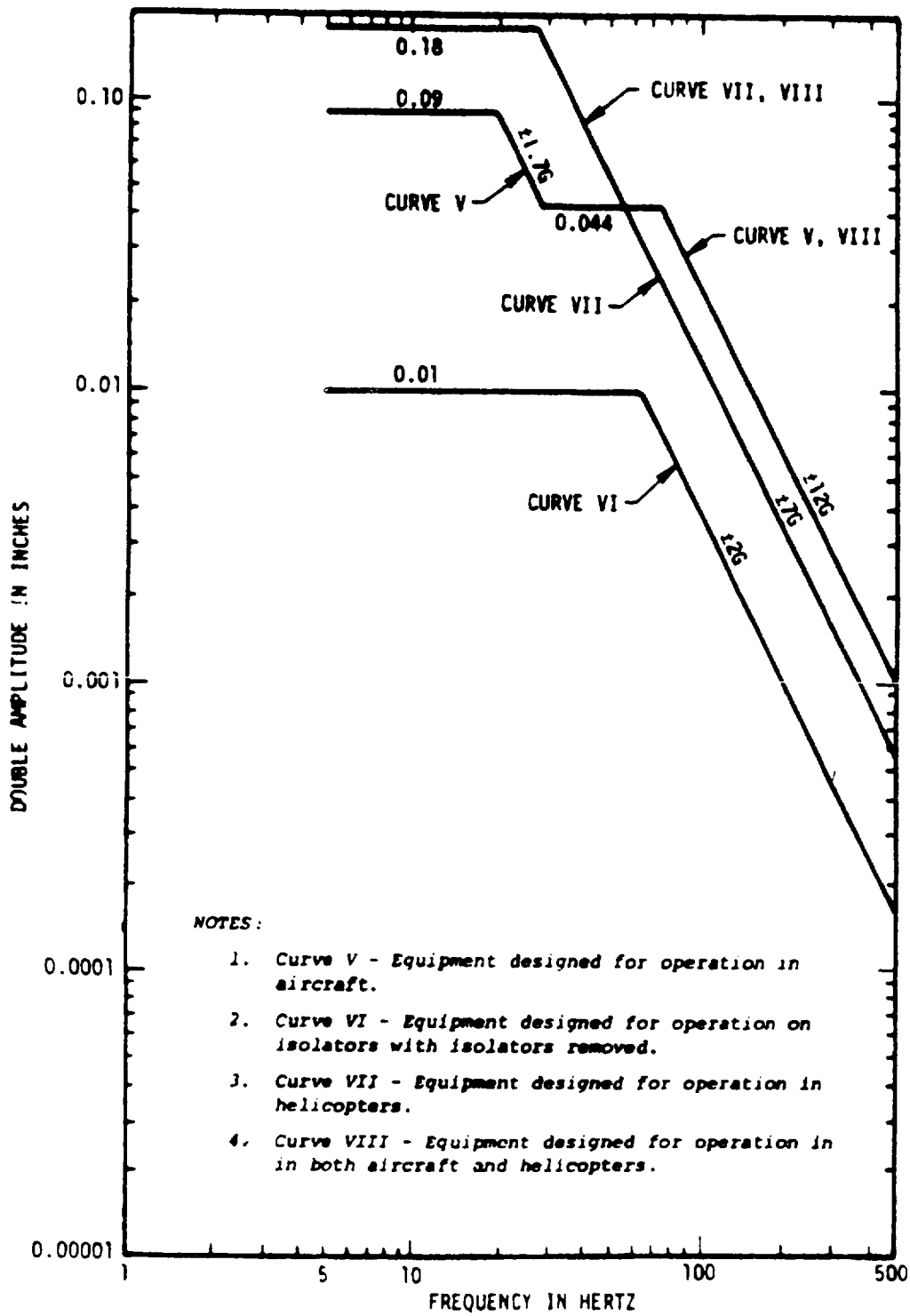


FIGURE 7 - Vibration Level Curve

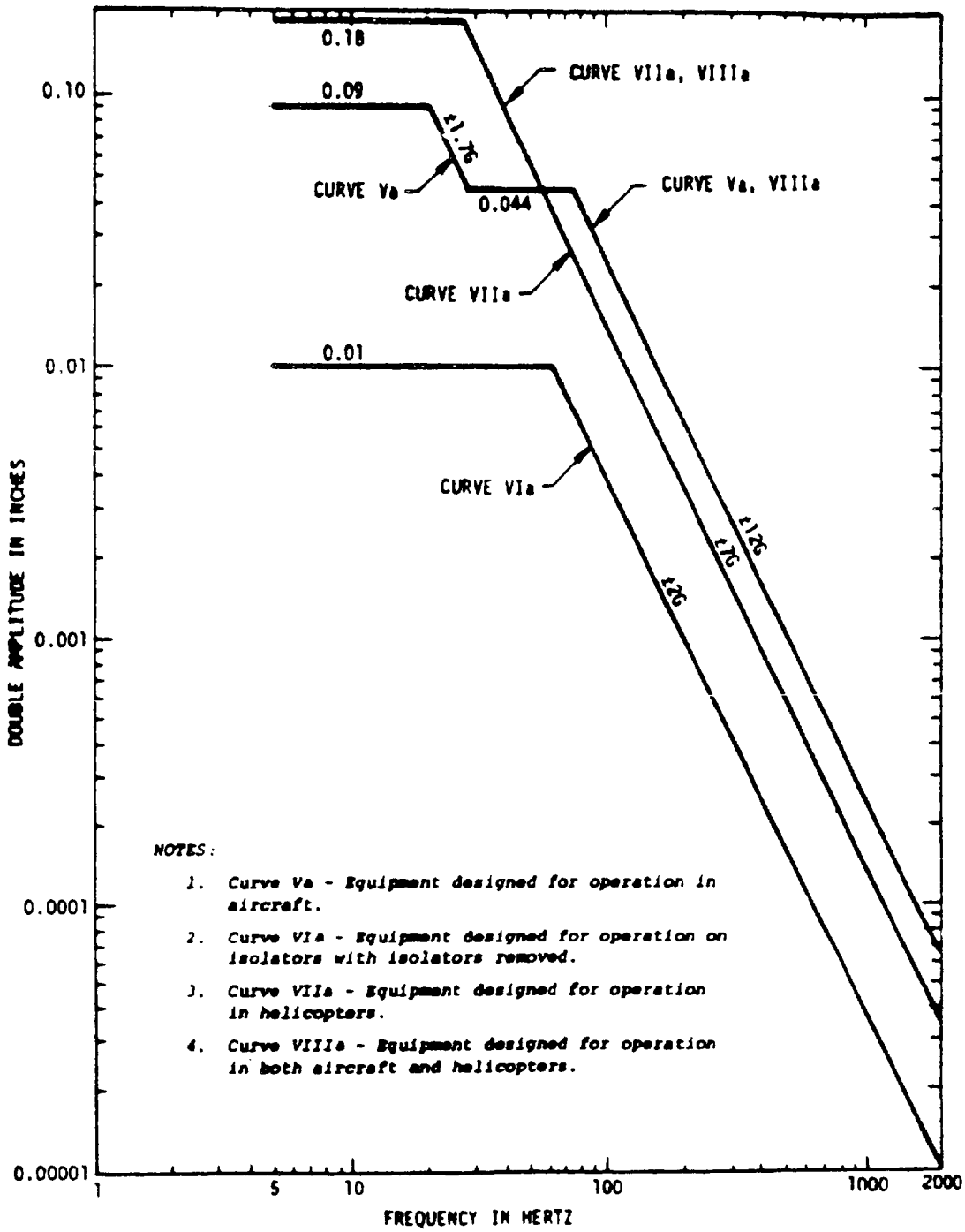


FIGURE 8 - Vibration Level Curve

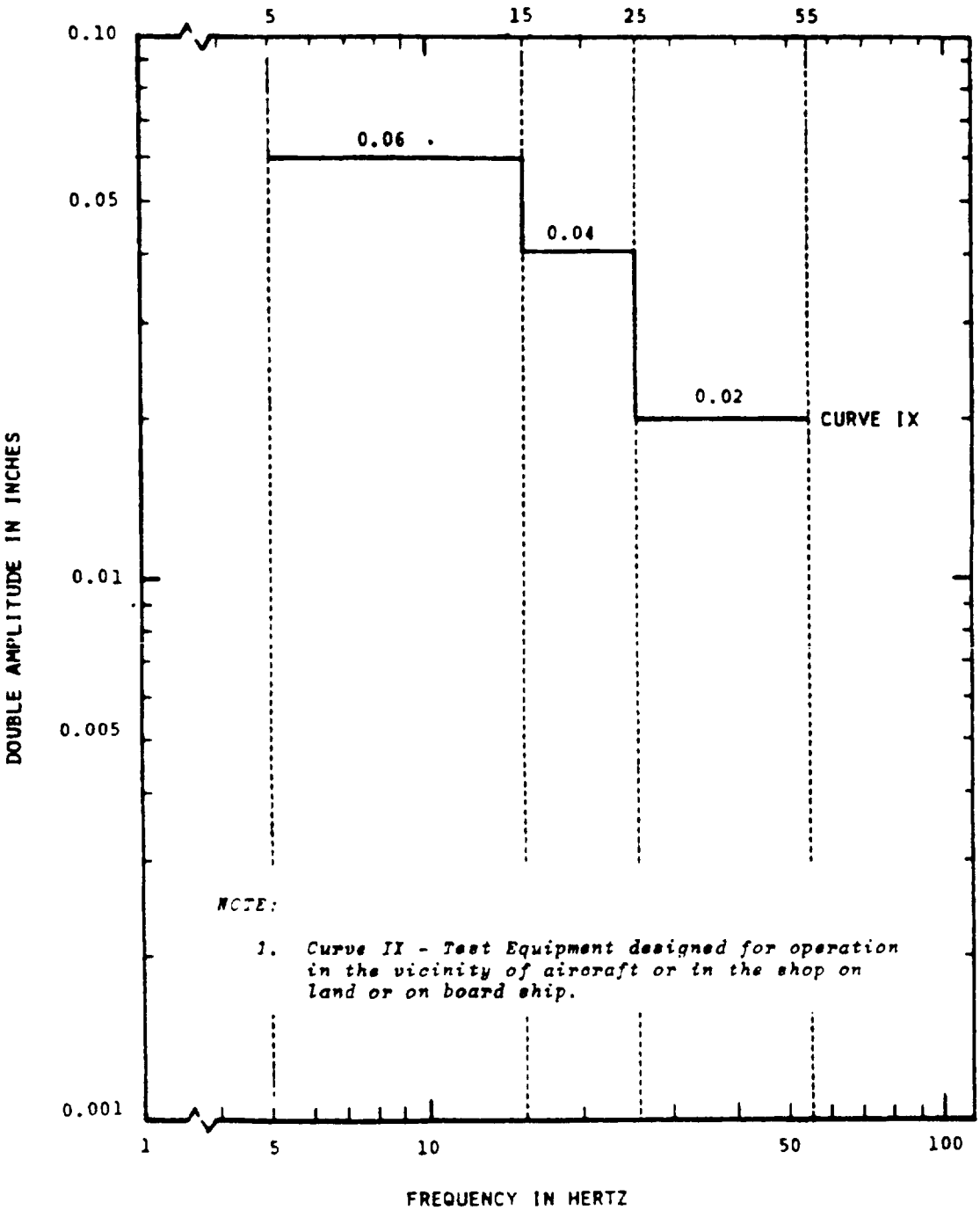


FIGURE 9 - Vibration Level Curve

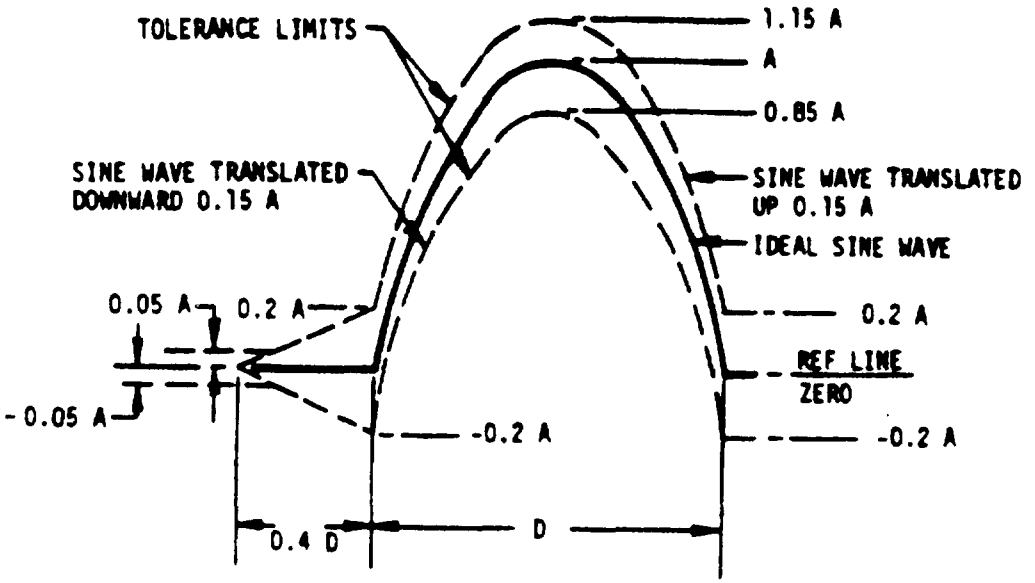
4.3 Shock Test -

4.3.1 General - This test consists of two parts; Part I - Basic Design Test is utilized to determine the structural integrity of the item or equipment under the conditions of service use, and Part II - Crash Safety Test is utilized to determine the ability of an airborne mounting base and other holding devices to withstand a crash situation.

4.3.2 Test Procedure -

4.3.2.1 Part I - Basic Design Test - The test item (less transit case, if any, for ground equipment) shall be rigidly attached to the shock machine or to an intermediate structure which is so designed as to be capable of transmitting the specified shock to the test item attachment points. (In the case of portable ground equipment, the test item shall be secured to the shock machine by suitable holding devices which are so designed to allow transmission of specified shock to the test item.) The test item shall be mounted in a manner simulating the service mounting insofar as possible. Whenever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads. Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test item (total of 18 shocks). If the test item is normally mounted on vibration isolators, the isolators shall be functional during the test. The shock pulse shape, amplitude, and time duration shall be as specified in figure 10. The test item shall be operated during the impacts and critical performance parameters monitored in accordance with 3.8.3 unless specifically not required by the detail equipment specification or the procuring agency. At the conclusion of the test, the test item shall be operated and the results compared with the data obtained in accordance with paragraph 3.8.1. The test item shall then be closely inspected for any evidence of mechanical failure.

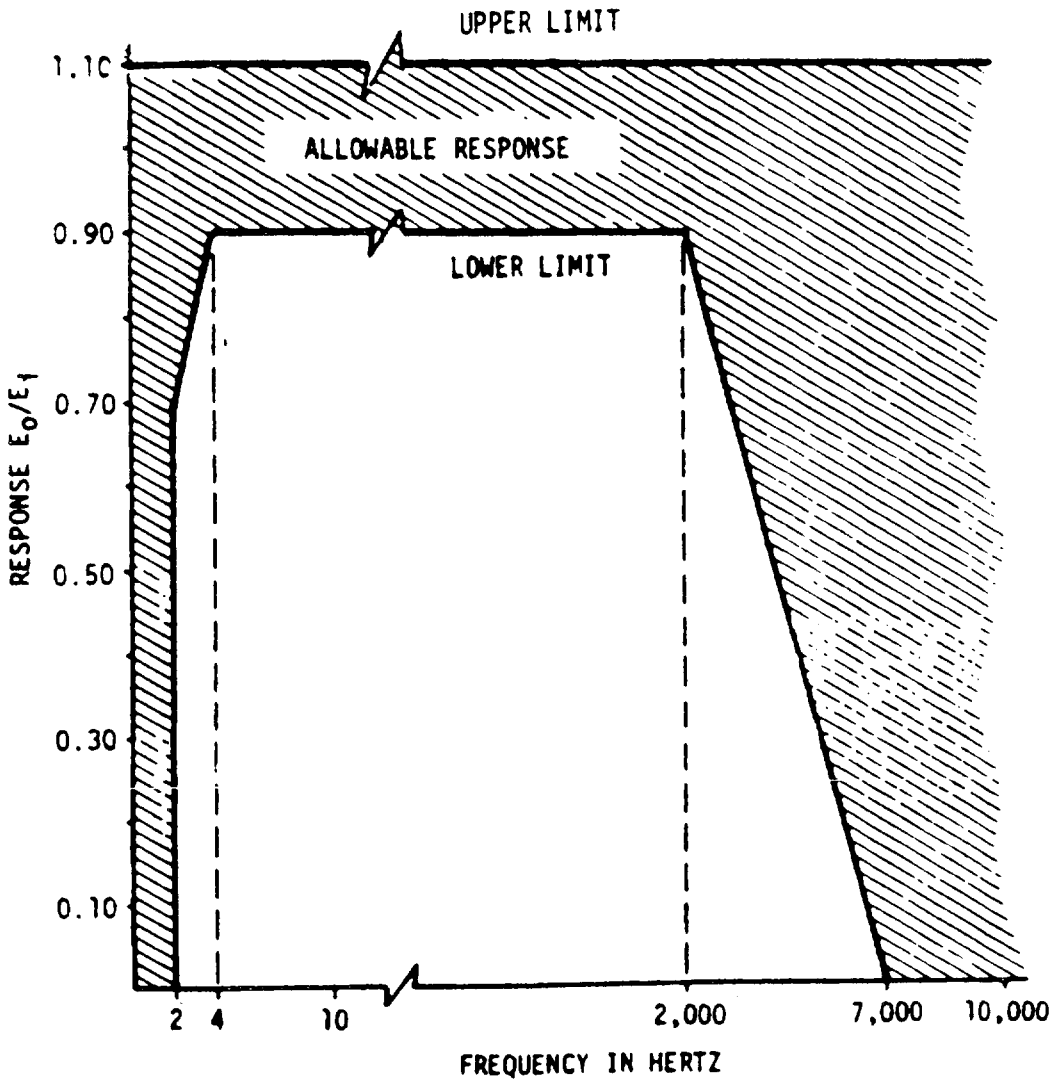
4.3.2.2 Part II - Crash Safety Test - This test is conducted to determine the structural integrity of airborne equipment mounting means. The test item or dummy load shall be attached by its normal points of attachment. The test item or dummy load shall be subjected to two shocks in each direction along the three mutually perpendicular axes of the equipment (total of 12 shocks). The shock pulse shape, amplitude, and time duration shall be as specified in figure 10. There shall be no failure of the mounting attachment and the test item or dummy load shall remain in place and not create a hazard. However, bending and distortion shall be permitted.



PART	TEST	PEAK VALUE (A) G'S	NOMINAL DURATION (D) MS (ALL TESTS)
I	BASIC DESIGN	15	11 ±1
II	CRASH SAFETY	30	11 ±1

The oscillogram shall include a time about 3D long with a pulse located approximately in the center. The acceleration amplitude of the ideal half sine pulse is A and its duration is D. Any measured acceleration pulse which can be contained between the broken line boundaries is acceptable. The instrumentation utilized to measure the above shock pulse shall have the frequency response as shown in figure 11.

FIGURE 10 - Half Sine Shock Pulse Configuration and its Tolerance Limits



The specified frequency response shall be obtained with the input and output circuits of the instrumentation system terminated by the input/readout devices used during the test.

FIGURE 11 - Instrumentation System Frequency Response

4.4 Humidity Test -

4.4.1 General - The humidity exposure shall be conducted with the test item nonoperating unless specifically required otherwise by the detail equipment specification or the procuring agency. (For the majority of applications, it is intended that demonstration of satisfactory equipment operation within one hour from the completion of the 10th humidity cycle will, for practical purposes, satisfy the operational requirement of MIL-E-5400 and MIL-T-21200.)

4.4.1.1 Precondition of Equipment - Prior to subjecting the test item to this test, it shall be preconditioned by stabilizing and maintaining the test item at the applicable extreme temperature conditions in accordance with steps 1 and 5 of the temperature-altitude test and table II. If the test item has been subjected to the temperature-altitude test of paragraph 4.1 then preconditioning has been satisfied.

4.4.1.2 Humidity Cabinet - The chamber and accessories will be constructed such that the generation of humidity shall introduce no contaminants, including water droplets and entrainments, into the test exposure area. The required increases in moisture vapor content shall be accomplished by low pressure steam or vapor from distilled, deionized or demineralized water having a pH value of 6.0 to 7.2 measured at 23° C (74° F). The air velocity throughout the test exposure area shall not exceed 150 feet per minute except at a wet bulb sensor where the velocity across the wick shall be not less than 900 feet per minute. The test exposure area shall be maintained at the prevailing local atmospheric pressure.

4.4.3 Test Procedure -

Step 1 - Place the test item in the test chamber in accordance with paragraph 3.8.2. Prior to starting the test, the internal chamber temperature shall be at standard ambient with uncontrolled humidity.

Step 2 - Gradually raise internal chamber temperature to 71° C (160° F) and the relative humidity to 95 percent over a period of 2 hours.

Step 3 - Maintain the final condition of step 2 for not less than 6 hours.

Step 4 - Maintain 85 percent, or greater, relative humidity and reduce internal chamber temperature in 16 hours to 28 ±10° C (82° ±18° F).

Step 5 - Repeat steps 2, 3, and 4 for 10 continuous cycles (not less than 240 hours). Figure 12 is an outline of the humidity cycle for this procedure.

Step 6 - Within 1 hour following the completion of the 10th cycle, operate the test item and compare results with the data obtained in accordance with paragraph 3.8.1. The test item shall then be inspected for corrosion or other forms of deterioration. (See Notes (a) and (b)).

NOTE: (a) Excessive moisture may be removed from the exterior surfaces of the test item prior to measurements by wiping the external surfaces only. The test item shall not be turned upside down.

(b) The test item shall also be examined for evidence of entrapped moisture. Presence of entrapped moisture may be cause to consider the test item has failed the test provided such entrapment could adversely affect the equipment. See 3.8.4.

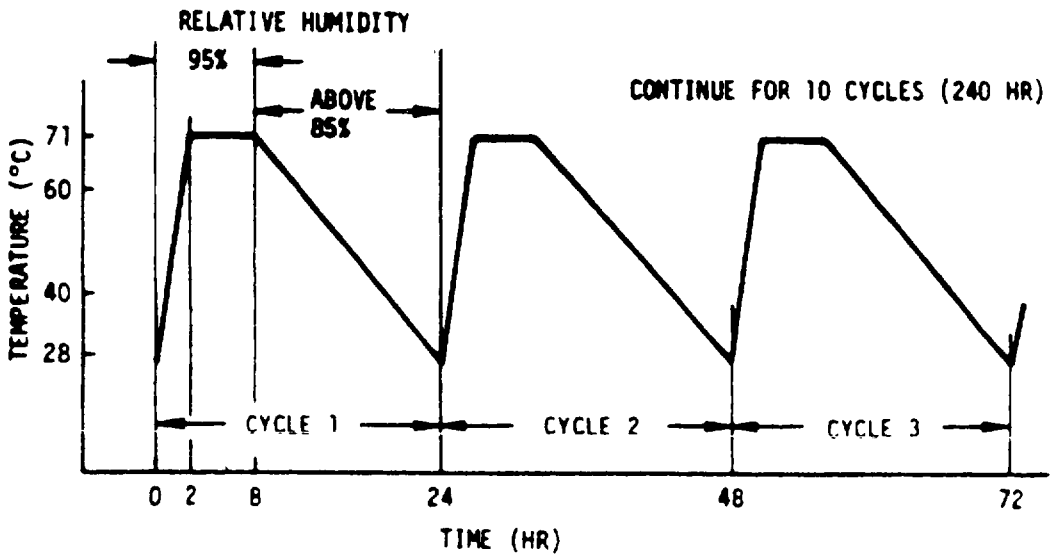


FIGURE 12 - Humidity Cycle

4.5 Salt Fog Test -

4.5.1 General - This test is intended to determine the resistance of equipment to the general effects of a salt atmosphere. The equipment shall be placed in the test chamber with an orientation similar to its normal installed position. All covers and inspection plates shall be in place except when such covers would normally be removed for service use. The test item shall not be energized during the actual salt fog exposure. (This test is not required by MIL-T-21200 for Class 3 equipment.)

4.5.2 Test Procedure -

4.5.2.1 Temperature - The test shall be conducted with a temperature in the exposure zone maintained at 35° C (95° F). Satisfactory methods for controlling the temperature accurately are by housing the apparatus in a properly controlled constant temperature room, by thoroughly insulating the apparatus and preheating the air to the proper temperature prior to atomization, or by jacketing the apparatus and controlling the temperature of the water or of the air used in the jacket. The use of immersion heaters within the chamber for the purpose of maintaining the temperature within the exposure zone is prohibited.

4.5.2.2 Atomization - Suitable atomization has been obtained in chambers having a volume of less than 12 cubic feet with the following conditions:

(a) Nozzle pressure shall be as low as practicable to produce fog at the required rate.

(b) Orifices between 0.02 and 0.03 inch in diameter.

(c) Atomization of approximately 3 quarts of salt solution per 10 cubic feet of chamber volume per 24 hours.

When using large size chambers having a volume considerably in excess of 12 cubic feet, the conditions specified may require modification to meet the requirements for operating conditions.

4.5.2.3 Placement of Salt Fog Collection Receptacles - The salt fog conditions maintained in all parts of the exposure zone shall be such that a clean fog collecting receptacle placed at any point in the exposure zone will collect from 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 centimeters diameter) based on an average test of at least 16 hours. A minimum of two receptacles shall be used, one placed nearest to any nozzle and one farthest from all nozzles. Receptacles shall be placed so that they are not shielded by test items and so no drops of solution from test items or other sources will be collected.

4.5.2.4 Preparation of Salt Solution - The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent sodium iodide and not more than 0.2 percent of total impurities. Unless otherwise specified, a 5 ±1 percent solution shall be prepared by dissolving 5 parts by weight of salt in 95 parts by weight of distilled water. The solution shall be adjusted to and maintained at a specific gravity between the limits shown on figure 13 by utilizing the measured temperature and density of the salt solution.

4.5.2.4.1 Adjustment of pH - The pH of the salt solution shall be so maintained that the solution atomized at 35° C (95° F) will be in the pH range of 6.5 to 7.2. Only dilute C.P. hydrochloric acid or C.P. sodium hydroxide shall be used to adjust the pH. The pH measurement shall be made electrometrically, using a glass electrode with a saturated potassium chloride bridge, or by a colorimetric method, such as bromothymol blue, provided the results are equivalent to those obtained with the electrometric method. The pH shall be measured when preparing each new batch of solution.

3.5.2.4.2 Filter - A filter fabricated of noncorrosive materials, figure 14, shall be provided in the supply line and immersed in the salt solution reservoir as shown in figure 15.

4.5.2.5 Preparation of Test Item - The test item shall be given a minimum of handling, particularly on the significant surfaces, and shall be prepared for test immediately before exposure. Unless otherwise specified, uncoated metallic or metallic coated devices shall be thoroughly cleaned of oil, dirt, and grease as necessary until the surface is free from water break. The cleaning methods shall not include the use of corrosive solvents nor solvents which deposit either corrosive or protective films, nor the use of abrasives other than a paste of pure magnesium oxide. Test items having an organic coating shall not be solvent cleaned. Those portions of test items which come in contact with the support and, unless otherwise specified in the case of coated devices or samples, cut edges and surfaces not required to be coated, shall be protected with a suitable coating of wax or similar substance impervious to moisture.

4.5.2.6 Performance of Test - The test item shall be placed in the test chamber in accordance with paragraph 3.8.2 and exposed to the salt fog for a period of 48 hours or as specified in the detail equipment specification. At the end of the exposure period the test item shall be removed from the test chamber and operated. Such initial operation shall be conducted within 2 hours from the completion of the exposure period and the results compared with the data obtained in accordance with paragraph 3.8.1. The test item shall be then closely inspected for evidence of corrosion in accordance with paragraph 3.8.4. If necessary to aid in examination, a gentle wash with running water not warmer than 38° C (100° F) may be used. The test item shall then be stored in an ambient atmosphere for a minimum

of 72 hours or as specified in the detail equipment specification for drying. At the end of the drying period, the test item shall be again operated and the results compared with the data obtained in accordance with paragraph 3.8.1. The test item shall then be closely inspected for evidence of corrosion or other deterioration. See 3.8.4.

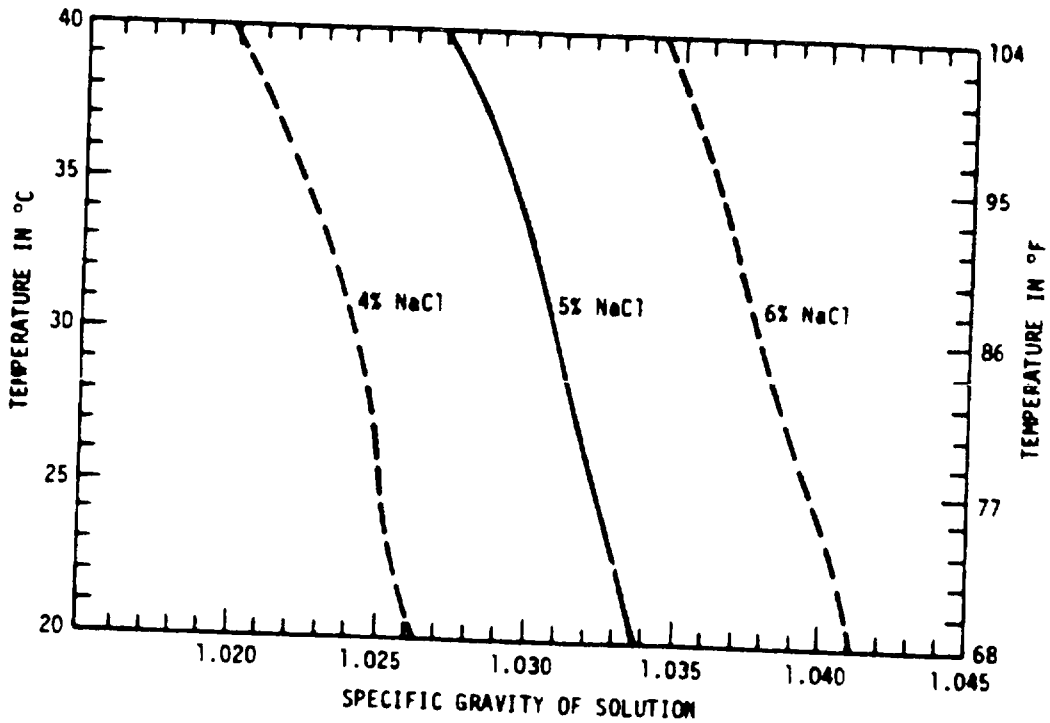


FIGURE 13 - Variations of Specific Gravity of Salt (NaCl) Solution with Temperature

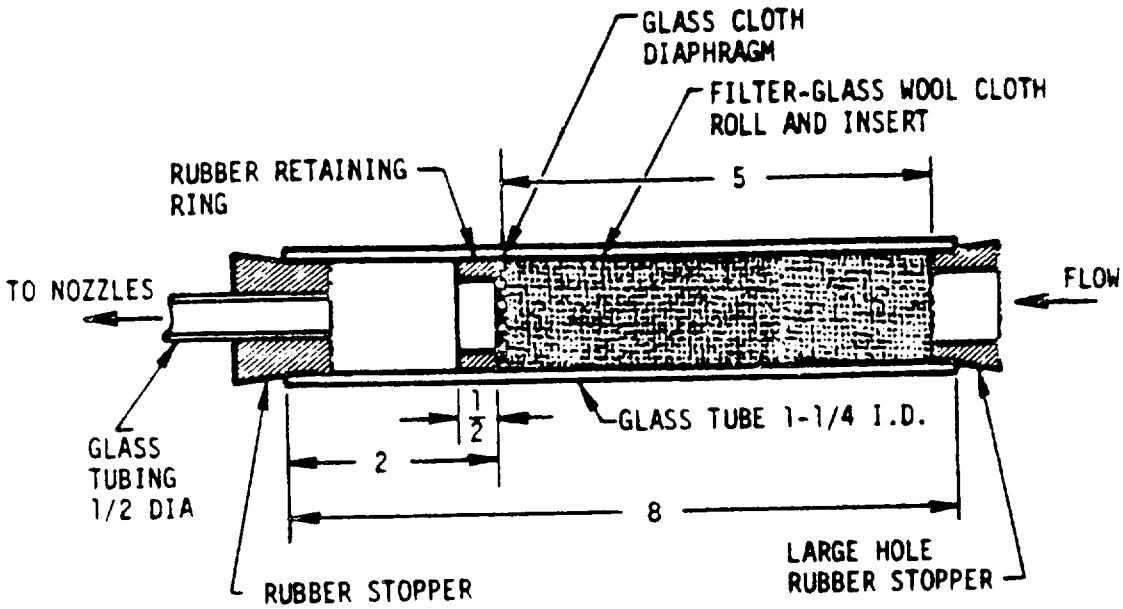


FIGURE 14 - Salt Solution Filter

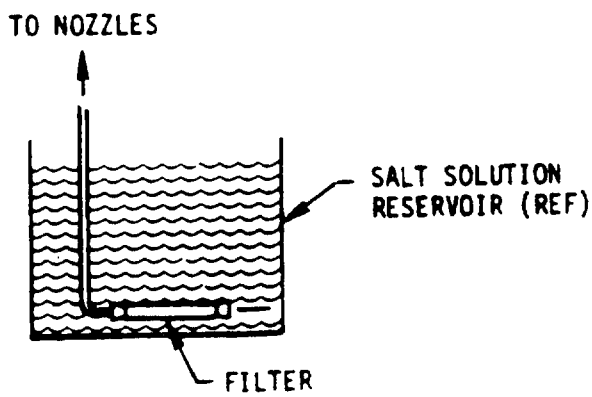


FIGURE 15 - Location of Salt Solution Filter

4.6 Explosion Test -

4.6.1 General - This test is composed of the following two procedures. The applicable procedure shall be used.

I Procedure for determining explosion producing characteristics of items of equipment not hermetically sealed and not contained in cases designed to prevent flame and explosion propogation.

II Procedure for determining the flame and explosion arresting characteristics of cases designed for that purpose.

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

4.6.3 Test Procedure I -

4.6.3.1 Preparation for Test -

(a) The test item shall be installed in the test chamber in accordance with 3.8.2 and 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 test item 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 test item as it normally functions in the system during service use.

4.6.3.2 Procedure - The test shall be conducted as follows at simulated test altitudes of ground level to 5,000, 10,000, 20,000, 30,000, 40,000, and 50,000 feet as limited by the maximum operating altitude requirements of Table VI for the appropriate class of equipment to be tested.

Step 1 - The test chamber shall be sealed and the ambient temperature within shall be raised to 71° ±3° C (160 F) or to the maximum temperature to which the test item is designed to operate (if lower than 71° C, 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.

Step 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 altitude, etc. (See 6.4.) 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.

Step 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 warmup 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 but not to exceed a pressure of 1 atmosphere. 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 deemed practicable.

Step 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 test item, the potential explosiveness of the air-vapor mixture shall be verified by igniting a sample of the mixture with a spark gap or glow plug. If the air-vapor mixture is not found to be explosive, the test shall be considered void and the entire procedure repeated.

4.6.3.3 Failure Criteria - If the item causes explosion at any of the test altitudes, it shall be considered to have failed the test and no further trials need be attempted.

4.6.4 Test Procedure II -

4.6.4.1 Preparation for Test -

(a) Preparation of Test Item Case or Item Enclosure - When necessary, the test item case or item enclosures shall be prepared for explosion-proof testing by drilling and tapping openings in the case or enclosure for inlet and outlet hose connections to the fuel vapor air mixture circulation system and for mounting a spark gap device. The case volume shall not be altered by more than ±5 percent by any modification to facilitate the introduction of explosive vapor.

(b) Hose Installation - When inserting a hose from a blower, adequate precaution shall be taken to prevent ignition of the ambient mixture by backfire or the release of pressure through the supply hose.

(c) Spark Gap Device - A spark gap device for igniting the explosive mixture within the case or enclosure shall be provided. The case or enclosure may be drilled and tapped for the spark gap device or the spark gap device may be mounted internally.

(d) The case or enclosure with either the test item or a model of the test item of the same volume and configuration in position within the case or enclosure shall be installed in the explosion chamber as specified in 3.8.2.

4.6.4.2 Procedure - The test shall be accomplished three times at altitudes between ground level and 5,000 feet as follows:

Step 1 - A test altitude shall be selected, the chamber shall be sealed and the ambient chamber temperature shall be stabilized at a temperature between 25° C (77° F) and 71° C (160° F).

Step 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 altitude, etc. (See 6.4.) 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.

Step 3 - 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.

Step 4 - At least five internal case explosions shall be accomplished at the test altitude selected. If the case 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 shall 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. 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.

4.6.4.3 Failure Criteria - If the internal case explosion causes a main chamber explosion, the test item shall be considered to have failed the test and no further trials need be attempted.

TABLE VI

Explosion Test Altitudes vs. Various Equipment Classes

Equipment Classes	No.	Maximum Operating Altitude (ft)	Explosion Test Altitude Trials Required (ft)					
			5,000	10,000	20,000	30,000	40,000	50,000
MIL-E-5400	1	50,000	X	X	X	X	X	
	1A	30,000	X	X	X			
	2	70,000	X	X	X	X	X	X
	3	100,000	X	X	X	X	X	X
	4	100,000	X	X	X	X	X	X
MIL-T-21200	1	50,000	X	X	X	X	X	
	2	10,000	X[1]					
	3	10,000	X[1]					

[1]For MIL-T-21200 classes 2 and 3 equipments the chamber altitude shall be increased to 15,000 feet with the equipment nonoperating. The charge shall be admitted to the chamber while the altitude is being reduced to 10,000 feet. The equipment shall then be energized and the explosion test conducted as the chamber altitude is reduced to ground ambient.

4.7 Sand and Dust Test -

4.7.1 General - The sand and dust test may be deleted unless specifically required by the detail equipment specification or by the procuring agency.

4.7.1.1 Apparatus - The test facility shall consist of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust laden air. In order to provide adequate circulation of the dust laden air, no more than 50 percent of the cross-sectional area (normal to air flow) and 30 percent of the volume of the chamber shall be occupied by the test item(s). The chamber shall be provided with a suitable means of maintaining and verifying the dust concentration in circulation. A minimum acceptable means for doing this is by use of a properly calibrated smoke meter and standard light source. The dust laden air shall be introduced into the test space in such a manner as to allow it to become approximately laminar in flow before it strikes the test item.

4.7.1.2 Dust Requirements - The dust used in this test shall be a fine sand (97-99% by weight SiO_2) of angular structure, and shall have the following size distribution as determined by weight, using the U.S. Standard Sieve Series.

(a) 100 percent of this dust shall pass through a 100-mesh screen.

(b) 98 ±2 percent of the dust shall pass through a 140-mesh screen.

(c) 90 ±2 percent of the dust shall pass through a 200-mesh screen.

(d) 75 ±2 percent of the dust shall pass through a 325-mesh screen.

"140-mesh silica flour" as produced by the Ottawa Silica Company, Ottawa, Illinois, or equal, is satisfactory for use in the performance of these tests.

4.7.2 Test Procedure - Place the test item in the chamber, positioned as near the center of the chamber as practicable, in accordance with paragraph 3.8.2. If more than one item is being tested, there shall be a minimum clearance of 4 inches between surfaces of test items or any other material or object capable of furnishing protection. Also, no surface of the test item shall be closer than 4 inches from any wall of the test chamber. Orient the item so as to expose the most critical or vulnerable parts to the dust stream. The test item orientation may be changed during the test if specifically required by the detail equipment specification or the procuring agency.

Step 1 - Set the chamber controls to maintain an internal chamber temperature of 23° C (73° F) and a relative humidity of less than 22 percent. Adjust the air velocity to 1750 ±250 feet per minute. Adjust the dust feeder to control the dust concentration at 0.3 ±0.2 gms per cubic foot. With test item nonoperating, maintain these conditions for 6 hours. (See Note.)

Step 2 - Stop the dust feed and reduce the air velocity to 300 ±200 feet per minute. Raise the internal chamber air temperature to 63° C (145° F) and adjust humidity control to maintain a relative humidity of less than 10 percent. Hold these conditions overnight (approximately 16 hours).

Step 3 - While holding chamber temperature at 63° C (145° F) adjust the air velocity to 1750 ±250 fpm. Adjust the dust feeder to control the dust concentration at 0.3 ±0.2 gms per cubic foot. With the test item nonoperating, maintain these conditions for 6 hours.

Step 4 - Turn off all chamber controls and allow the test item to return to standard ambient conditions. Remove accumulated dust from the test item by brushing, wiping, or shaking, care being taken to avoid introduction of additional dust into the test item. Under no circumstances, shall dust be removed by either air blast or vacuum cleaning.

Step 5 - Operate the test item and compare the results with data obtained in accordance with paragraph 3.8.1.

Step 6 - Test items containing bearings, grease seals, lubricants, etc. shall be carefully examined for the presence of dust deposits.

NOTE: The test specimen may be operating during either or both of the 6-hour test periods (step 1 or 3) if specifically required by the detail equipment specification or the procuring agency.

4.8 Fungus Test -

4.8.1 General - The fungus resistance test may be deleted unless specifically required by the detail equipment specification or the procuring agency.

4.8.1.1 Apparatus - The apparatus required to conduct this test consists of chambers or cabinets together with auxiliary instrumentation capable of maintaining the specified condition of temperature and humidity. Provisions shall be made to prevent condensation from dripping on the test item. There shall be free circulation of air around the test item and the surface area of fixtures supporting the test item shall be kept to a minimum.

4.8.2 Test Procedures -

4.8.2.1 Preparation of Mineral-Salts Solution - The solution shall contain the following:

Potassium dihydrogen orthophosphate (KH_2PO_4)	0.7 g
Potassium monohydrogen orthophosphate (K_2HPO_4)	0.7 g
Magnesium sulphate ($MgSO_4 \cdot 7H_2O$)	0.7 g
Ammonium nitrate (NH_4NO_3)	1.0 g
Sodium chloride ($NaCl$)	0.005 g
Ferrous sulphate ($FeSO_4 \cdot 7H_2O$)	0.002 g
Zinc sulphate ($ZnSO_4 \cdot 7H_2O$)	0.002 g
Maganous sulphate ($MnSO_4 \cdot 7H_2O$)	0.001 g
Distilled water	1000 ml

Sterilize the mineral-salts solution by autoclaving at 121° C (250° F) for 20 minutes. Adjust the pH of the solution by the addition of 0.01 normal solution of NaOH so that after sterilization the pH is between 6.0 and 6.5. Prepare sufficient salts solution for the required tests.

4.8.2.2 Purity of Reagents - Reagent grade chemicals shall be used in all tests. Unless otherwise specified, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.

4.8.2.3 Purity of Water - Unless otherwise specified, references to water shall be understood to mean distilled water or water of equal purity.

4.8.2.4 Preparation of Mixed Spore Suspension - The following test fungi shall be used:

Fungi	ATCC No.[1]	NLABS No.[2]
Aspergillus niger	9642	386
Aspergillus flavus	9643	380
Aspergillus versicolor	11730	432
Penicillium funiculosum	9644	391
Chaetomium globosum	6205	459

1. American Type Culture Collection, 12301 Parklawn Drive, Rockville, Maryland 20852.

2. Pioneering Research Division, U.S. Army Natick Laboratories, Natick, Massachusetts 01760.

Maintain cultures of these fungi separately on an appropriate medium such as potato dextrose agar. However, the culture of Chaetomium globosum shall be cultured on strips of filter paper on the surface of mineral-salts agar. (Mineral-salts agar is identical to mineral-salts solution described in 4.8.2.1 but contains in addition 15.0 g of agar per liter.) The stock cultures may be kept for not more than 4 months at 6 ± 4° C (43° F). Use subcultures incubated at 29° C (84° F) for 7 to 20 days in preparing the spore suspension.

Prepare a spore suspension of each of the five fungi by pouring into one subculture of each fungus a sterile 10-ml portion of water or of a sterile solution containing 0.05 g per liter of a nontoxic wetting agent such as sodium dioctyl sulfoscuccinate. Use a sterile platinum or nichrome inoculating wire to scrape gently the surface growth from the culture of the test organism. Pour the spore charge into a sterile 125-ml glass-stoppered Erlenmeyer flask containing 45 ml of sterile water and 10 to 15 solid glass beads, 5 mm in diameter. Shake the flask vigorously to liberate the spores from the fruiting bodies and to break the spore clumps.

Filter the shaken suspension through a thin layer of sterile glass wool in a glass funnel into a sterile flask in order to remove mycelial fragments.

Centrifuge the filtered spore suspension aseptically, and discard the supernatant liquid. Resuspend the residue in 50 ml of sterile water and centrifuge.

Wash the spores obtained from each of the fungi in this manner three times. Dilute the final washed residue with sterile mineral-salts solution in such a manner that the resultant spore suspension shall contain 1,000,000 ±200,000 spores per ml as determined with a counting chamber.

Repeat this operation for each organism used in the test and blend equal volumes of the resultant spore suspension to obtain the final mixed spore suspension.

The spore suspension may be prepared fresh each day or may be held at 6° ±4° C (43° F) for not more than 4 days.

4.8.2.5 Viability of Inoculum Control - With each daily group of tests place each of three pieces of sterilized filter paper, 1 in. square, on hardened mineral-salts agar in separate Petri dishes. Inoculate these with the spore suspension by spraying the suspension from a sterilized atomizer[1] so that the entire surface is moistened with the spore suspension. Incubate these at 29° C (84° F) at a relative humidity not less than 85 percent and examine them after 14 days' incubation. There shall be copious growth on all three of the filter paper control specimens. Absence of such growth requires repetition of the test.

4.8.2.6 Control Items - In addition to the viability of inoculum control, a number of known susceptible substrates shall be inoculated along with the test item to insure that proper conditions are present in the incubation chamber to promote fungus growth. The control items shall include three pieces each of preservative free vegetable tanned leather and protein-glue bonded cork.

4.8.2.7 Inoculation of Test and Control Items -

(a) Mount the test and control items on suitable fixtures or suspend from hangers.

(b) Precondition the chamber and its contents at 29° C (84° F) and 95 percent R.H. for at least 4 hours.

(c) Inoculate the test and control items with the mixed fungus spore suspension (4.8.2.4) by spraying it on the test and control items in the form of a fine mist from a previously sterilized atomizer or nebulizer until they are thoroughly wet with the spray. External covers of the test item shall be removed or opened to facilitate inoculation. Incubation is to be started immediately following the inoculation.

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1. *DeVilbiss No. 154 atomizer or equivalent has been found satisfactory for this purpose.*

4.8.2.8 Incubation -

(a) Maintain the test chamber at 29° C (84° F) and 95 percent R.H. (minimum) during the life of the test. Keep the test chamber closed during the incubation period except during inspection or for addition of other test items.

(b) After 14 days, inspect the control items. They should show an abundant growth of fungus. If the control items do not show an abundant growth, the entire test shall be repeated.

(c) If the control items show satisfactory fungus growth, continue the test for a period of 28 days from the time of inoculation or as specified in the equipment specification.

4.8.3 Criteria for Passing Test - At the end of the incubation period, the test item shall be removed from the test chamber and inspected. Any evidence of fungus growth on or within the test item will be considered as a failure to pass the fungus test. If specifically required by the detail equipment specification or the procuring agency the test item shall be operated following the visual examination and the results compared with those obtained in accordance with paragraph 3.8.1. Should these results indicate a degradation of performance, an analysis shall then be made to ascertain that the failure mechanism(s) are other than growth of fungus.

4.9 Temperature Shock Test -

4.9.1 General - The temperature shock test may be deleted unless specifically required by the detail equipment specification or the procuring activity. The temperature shock test is conducted to determine the effects of sudden changes in temperature of the atmosphere surrounding the equipment. The test item shall not be energized during the actual temperature shock exposure.

4.9.2 Temperature Shock Chambers - A high temperature chamber and a low temperature chamber shall be used to complete the temperature shock test requirements. When applicable, a multizone temperature shock chamber may be utilized for this test.

4.9.3 Test Procedure -

Step 1 - The test item shall be placed in the high temperature chamber in accordance with paragraph 3.8.2. The internal chamber temperature of the chamber shall be raised to 71° C (160° F) and maintained for a period of not less than 4 hours.

Step 2 - At the conclusion of the time period described in step 1, the test item shall be transferred, within 5 minutes, to a low temperature chamber with an internal chamber temperature of -54° C (-65° F). (When authorized by the procuring activity, a large or heavy test item shall be transferred from one chamber to the other in the minimum practical time.)

Step 3 - The test item shall be exposed to the low temperature for a time period not less than 4 hours.

Step 4 - At the conclusion of the time period described in step 3, the test item shall, within 5 minutes, be returned to the high temperature chamber at 71° C (160° F).

Step 5 - The test item shall be exposed to the high temperature for a period of not less than 4 hours. (The test may, for convenience purposes, be interrupted during this step if desired. This is accomplished by returning the test item to ambient conditions after an exposure at high temperature of 2 hours minimum. To continue the steps that follow, it is required that step 1 be repeated.)

Step 6 - Repeat steps 2 through 5.

Step 7 - Repeat steps 2 and 3.

Step 8 - Return the test item to standard ambient conditions and allow to stabilize.

Step 9 - Operate the test item and compare the results with the data obtained in accordance with paragraph 3.8.1. The test item shall then be inspected for deterioration. See 3.8.4.

4.10 Bench Handling Test -

4.10.1 General - The bench handling test may be deleted unless a requirement of the applicable revision of MIL-E-5400 (or MIL-T-21200) or specifically required by the detail equipment specification or the procuring agency. The test item shall not be energized during the actual simulated handling tests.

4.10.2 Test Procedure - The chassis and front panel assembly shall be removed from its enclosure, as for servicing, and placed in a suitable position for servicing on a horizontal, solid wooden bench top at least 1-5/8 inches thick. The test shall be performed, as follows, in a manner simulating shocks liable to occur during servicing.

Step 1 - Using one edge as a pivot, lift the opposite edge of the chassis until one of the following conditions occurs (whichever occurs first):

(a) The chassis forms an angle of 45 degrees with the horizontal bench top.

(b) The lifted edge of the chassis has been raised 4 inches above the horizontal bench top.

(c) The lifted edge of the chassis is just below the point of perfect balance.

Let the chassis drop back freely to the horizontal bench top. Repeat using other practical edges of the same horizontal face as pivot points, for a total of four drops.

Step 2 - Repeat step 1, with the test item resting on other faces until it has been dropped for a total of four times on each face on which the test item could be placed practicably during servicing. At the conclusion of the test, the test item shall be operated and the results compared with the data obtained in accordance with paragraph 3.8.1. The test item shall then be closely inspected for evidence of mechanical failure.

4.11 Drip-Proof Test -

4.11.1 General - This test procedure is applicable for MIL-T-21200 class 2 equipment housed in combination cases unless specifically not required by the detail equipment specification or the procuring agency.

4.11.2 Test Procedure - The test item with the cover removed shall be subjected to a drip-proof test in accordance with the procedures of MIL-STD-108. Fifteen degree (15°) inclination shall apply unless specified otherwise by the detail equipment specification or the procuring agency. Immediately following the exposure, and prior to removing the instrument from the case, the test item shall be operated and the results compared with the data obtained in accordance with paragraph 3.8.1. The test item shall then be examined for evidence of water leakage into the enclosure. Failure of the equipment to operate satisfactorily or accumulation of water within the enclosure shall be cause to consider the equipment has failed this test.

4.12 Watertight Test -

4.12.1 General - This test procedure is applicable for MIL-T-21200 transit and combination cases unless specifically not required by the detail equipment specification or the procuring agency. (This test is normally performed in conjunction with the drop test of paragraph 4.13.)

4.12.2 Test Procedure - The transit or combination case, with cover locked in place to simulate service use configuration, shall be subjected to a watertight test in accordance with procedures of MIL-STD-108. The submergence method shall apply unless specified otherwise by the detail equipment specification or the procuring agency. Leakage of water into the case shall be cause to consider the case has failed this test.

4.13 Drop Test -

4.13.1 General - This procedure is used to determine the structural and sealing integrity of a transit or combination case to withstand impacts that could be induced by loading and unloading equipment. This test is applicable for MIL-T-21200 transit or combination cases unless specifically not required by the detail equipment specification or the procuring agency.

4.13.2 Test Procedure -

Step 1 - Prior to initiation of the impacts, the transit or combination case shall have been subjected to a watertightness test in accordance with paragraph 4.12. Satisfactory completion (no leakage) of this step as a sealing reference is a necessary pre-requisite prior to proceeding to step 2.

Step 2 - The test equipment or a dummy of the size, weight distribution, and shape of the test equipment shall be placed in the case as to simulate service use configuration and the cover locked in place. The case shall then be dropped 14 times, from a height as specified by figure 16, on a concrete surface with a minimum thickness of 2 inches. One drop shall be made on each of the eight corners and on each of the six faces of the case.

Step 3 - The case shall then be examined for mechanical damage or malfunction. There shall be no evidence of damage to the case, such as openings, or cracking of the case material. Any partial or total opening of the catches shall also be reason to consider the case has failed this test.

Step 4 - The case shall again be subjected to a watertightness test in accordance with step 1. The case shall function in the same manner as prior to the drop test. Leakage shall be reason to consider the case has failed this test.

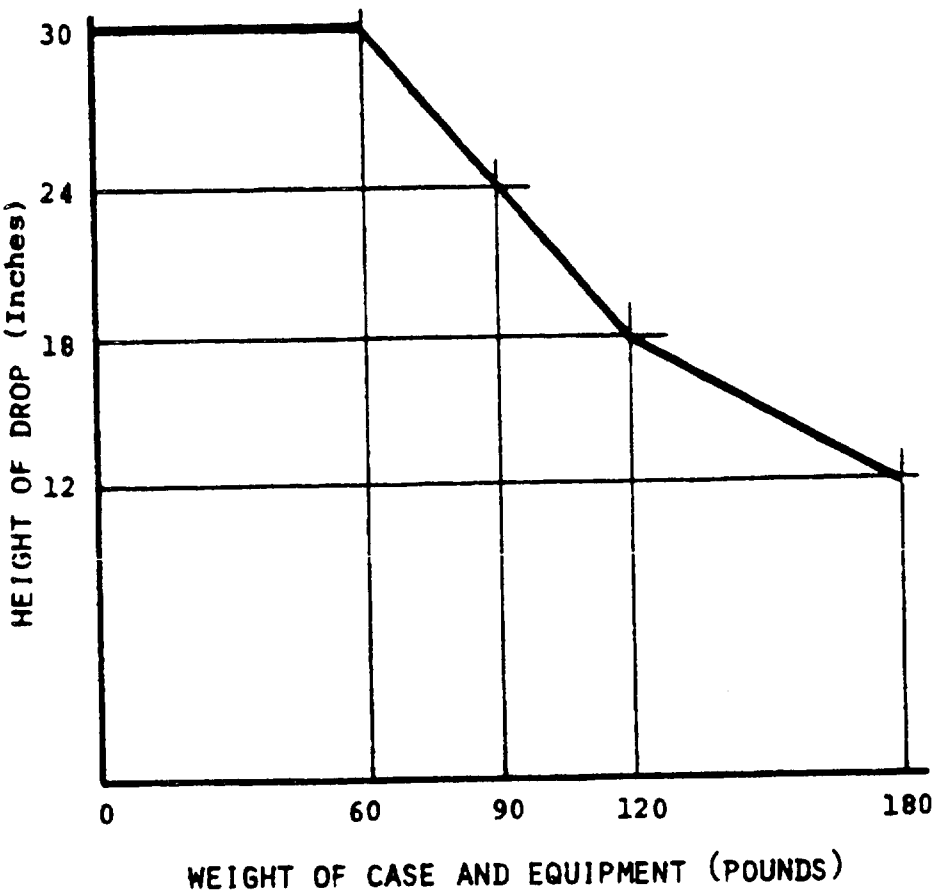

Figure 18 - Drop Height vs Weight

4.14 Generated Acoustical Noise Test -

4.14.1 General - This test may be deleted unless specifically required by the detail equipment specification or the procuring agency. (This procedure is applicable for MIL-T-21200 equipment when the test item is to be installed in an enclosed area such as in ships or trailer vans which include human occupancy and the design incorporates such noise generating devices as blowers, generators, etc.)

4.14.2 Apparatus - Apparatus shall consist of an anechoic type test chamber, suitably formed and proportioned to produce, as close as possible, a diffuse sound field, the sound energy density of which is very nearly uniform throughout the enclosure. A pentagonal chamber configuration is recommended. Acute angles of adjacent chamber walls shall be avoided whenever possible. Acoustical generation reproduction and measuring equipment shall be suitable to accomplish these tests.

4.14.3 Test Procedure - Noise levels at the "Operator's position" shall be measured by slowly moving the measuring microphone in a 2-foot diameter circle centered on the most probable position for an operator. The average noise levels in each octave band, determined by an arithmetic average of the minimum and maximum sound pressure levels found on the circle, shall not exceed the noise level criteria for the "Operator's position" specified in Table VII. Noise levels on the "25-foot radius circle", centered on the geometric center of the test equipment, shall be measured at head level (5 feet, 8 inches) at 12 positions equally spaced every 30 degrees. The maximum sound pressure levels in each octave band at each of these measurement positions shall not exceed the noise level criteria for the "25-foot radius circle" specified in Table VII. If any dimensions of the test equipment exceed 25 feet, increase the radius of the measurement circle from 25 feet to 50 feet and reduce the noise level criteria for the "25-foot radius circle" by 6 decibels in each octave band. The criteria for the "Operator's position" will remain unchanged. All noise measurements shall be made with a sound level meter and an octave band filter set meeting the requirements of S1.4-1961 and S1.11-1966 respectively. The "C" weighting network (flat frequency response) of the sound level meter shall be used in making all measurements. Ambient background noise levels shall be at least 10 decibels below the octave band noise levels produced by the test equipment at all measurement positions.

TABLE VII

Noise Level Criteria

Octave band center frequencies (Hz)	Octave band sound pressure levels (decibels ref, 0.0002 dynes/cm^2)	
	Operator's position	25 foot radius circle
63	76	66
125	70	60
250	64	54
500	60	50
1000	57	47
2000	55	45
4000	53	43
8000	52	42

5. PREPARATION FOR DELIVERY

5.1 Not Applicable.

6. NOTES

6.1 Intended Use - This specification is intended to provide standard test procedures to be followed in subjecting airborne electronic and associated 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.

6.2 Definitions -

6.2.1 Explosion-Proof Equipment - Explosion-proof equipment is that which, when operated at any design load, will not ignite 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.

6.2.1.1 Hermetically Sealed and Pressurized Equipment - Under this specification, hermetically sealed or pressurized equipment, cables and interconnecting wires shall be considered explosion-proof and require no test.

6.2.2 Hermetically Sealed - A hermetically sealed enclosure is one, the walls of which are glass, glazed ceramic, or metal, and the closure of which is a fused joint of the appropriate material which so seals the enclosure that it shall not breathe under any combination of environmental conditions.

6.2.3 Transit Case (MIL-T-21200) - A transit case is a case designed to house and protect an instrument case (not built in) having a compartment for accessories, or having provisions for accessory stowage in its cover. The transit case is designed to protect the instrument case and accessories during usage and storage, and is not intended for shipment by common carrier without additional packaging.

6.2.4 Instrument Case (MIL-T-21200) - An instrument case is a case designed to protect the instrument proper, and is part of the instrument. For example, a dust cover may be part of an instrument case, and is not intended for shipment by common carrier without additional packaging.

6.2.5 Combination Case (MIL-T-21200) - A combination case combines features of the transit case and instrument case. The combination case is designed to protect the instrument and accessories during usage and storage, and may need additional packaging when shipped by common carrier.

6.3 General Application -

6.3.1 Deterioration - Deterioration or corrosion of any internal or external component which could in any manner prevent the equipment from meeting operational requirements during service life shall provide reason to consider the equipment as having failed to meet the test to which it was subjected.

6.3.2 Environmental Limits - Equipment, in general, must be capable of performing satisfactorily in the environmental conditions specified in Specifications MIL-E-5400 or MIL-T-21200, as applicable. Modifications of these requirements may be necessary for certain types of equipment which, because of location or function, require modified operating environmental limits. Then such limits will be specified in the detail equipment specification.

6.3.3 Test Applicability - Certain fundamental environmental tests contained herein are made applicable without further reference when this specification is envoked unless specifically not required by the detail equipment specification or the procuring agency. Other more conditional environmental tests contained herein are not made applicable unless specifically required by the detail equipment specification or the procuring agency. Table VIII contains a general summary of environmental test requirements vs. appropriate equipment classes.

6.3.4 Fungus Cultures - When ordering cultures from any of the available sources, the serial number of the culture should be used as they remain the same regardless of agency.

TABLE VIII

Environmental Test vs. Equipment Classes

Test	Procedure Page No.	Equipment Class per MIL-T-21200			Equipment Class per MIL-E-5400				
		1	2	3	1	1A	2	3	4
Temperature-Altitude	7	a	a	a	a	a	a	a	a
Vibration	19	a	a	a	a	a	a	a	a
Shock	33	a	a	a	a	a	a	a	a
Humidity	36	a	a	a	a	a	a	a	a
Salt Fog	39	a	a	c	a	a	a	a	a
Explosion	44	a	a	a	a	a	a	a	a
Sand and Dust	49	b	b	c	b	b	b	b	b
Fungus	51	b	b	b	b	b	b	b	b
Temperature Shock	55	c	c	c	b	b	b	b	b
Bench Handling	57	c	c	c	c	c	c	c	c
Drip-Proof	58	c	a[1]	c					
Watertight	59	a[2]	a[2]	a[2]					
Drop	60	a[2]	a[2]	a[2]					
Acoustical Noise	62	b	b	b					

a. *Environmental requirement contained in MIL-E-5400 (or MIL-T-21200) and test contained herein is applicable when this specification is envoked unless specifically not required by the detail equipment specification or the procuring agency.*

b. *Environmental requirements contained in MIL-E-5400 (or MIL-T-21200) but test contained herein is not applicable when this specification is envoked unless specifically required by the detail equipment specification or the procuring agency.*

c. *Not standard environmental requirement of MIL-E-5400 (or MIL-T-21200). These tests are applicable only when specifically required by the detail equipment specification or the contract.*

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1. Equipments housed in combination cases.
2. Transit cases or equipment housed in combination cases.

6.4 Calculation of Explosive Mixture - For 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:

(1) Chamber air temperature during test: 80° F
(2) Fuel temperature: 75° F
(3) Specific gravity of fuel at 60° F: 0.704
(4) Test altitude: 20,000 feet (P = 6.75 pounds/inch^2)
(5) Air-vapor ratio (desired): 13 to 1

Step 1 - Employing the following equation, calculate the Apparent Air-Vapor Ratio:

$$AAV = \frac{AV(DESIRED)}{1.04\left[\frac{P}{14.696}\right]-0.04} = \frac{13}{1.04\left[\frac{6.75}{14.696}\right]-0.04} = 29.70$$

Where AF = Air-fuel ratio
AAV = Apparent air-vapor ratio
AV = Desired air-vapor ratio
P = Pressure equivalent of altitude, lb/in^2

Step 2 - Since AV = AF, (note (a)), use figure 17 to determine weight of air and divide by AAV to obtain uncorrected weight of fuel required. (See note (b)).

$$W_{FU} = \frac{Wa}{29.70} = \frac{3.455}{29.70} = 0.116 \text{ lb fuel weight}$$

(uncorrected)

Step 3 - Knowing fuel temperature and specific gravity at 60° F use figure 18 to determine specific gravity at given temperature.

Step 4 - Using figure 19, read from specific gravity determined under step 3 for the correction factor k. Apply factor.

$$W_{FC} = W_{FU} \times k = 0:116 \times 1.01 = 0.117 \text{ lb fuel weight}$$

(corrected)

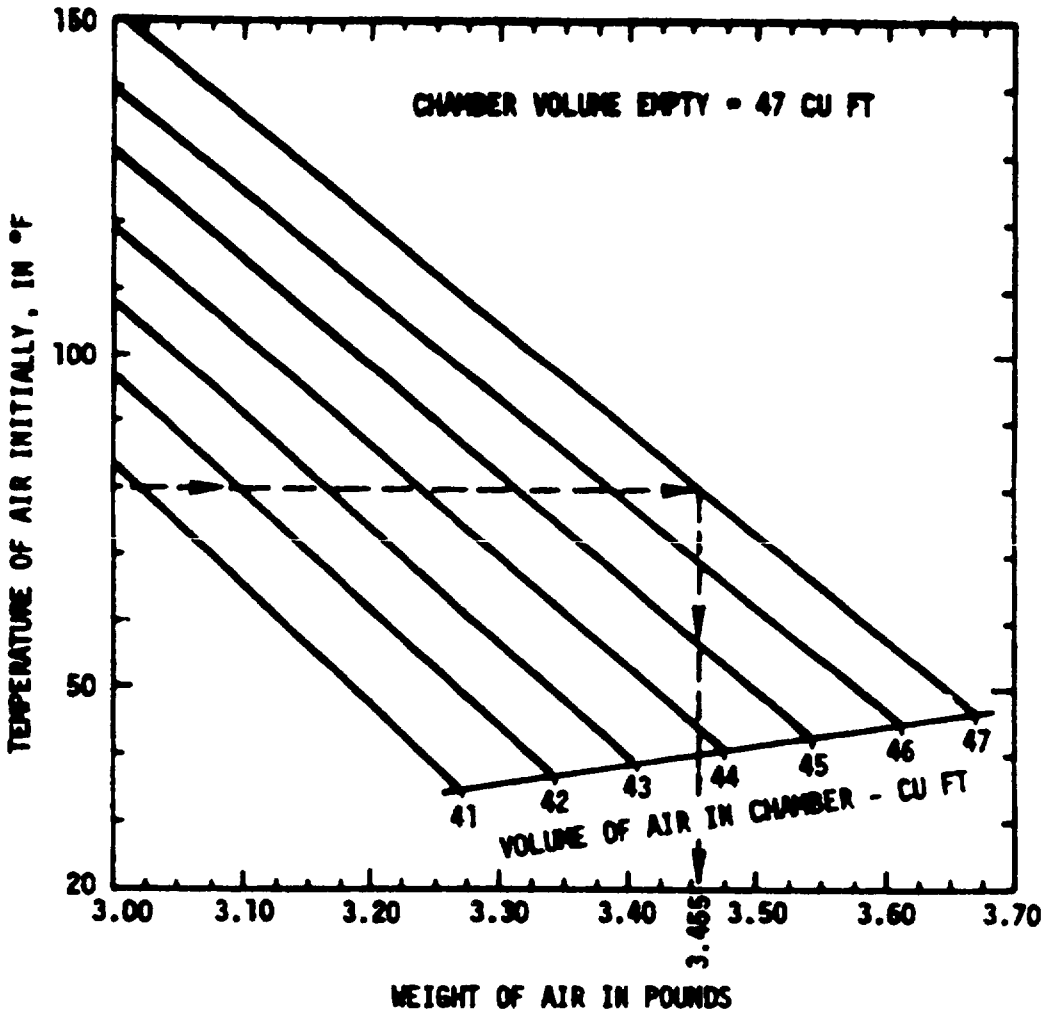

FIGURE 17 - *Weight of Air Charge Initially Placed in Chamber at 29.92 in H_G Based upon Air Temperature and Chamber Volume*

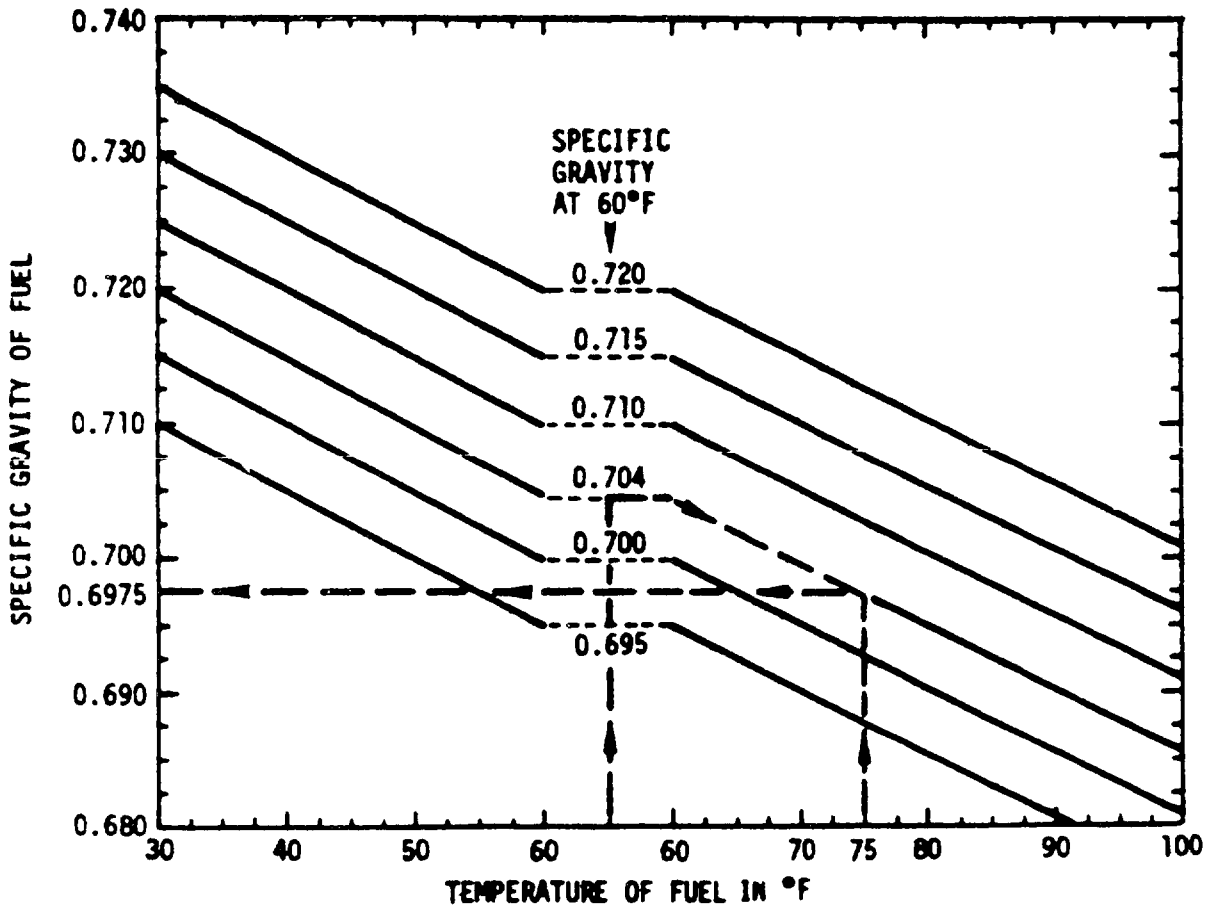

FIGURE 18 - Variation in Specific Gravity with Fuel Temperature for 100/130 Octane AV Gas

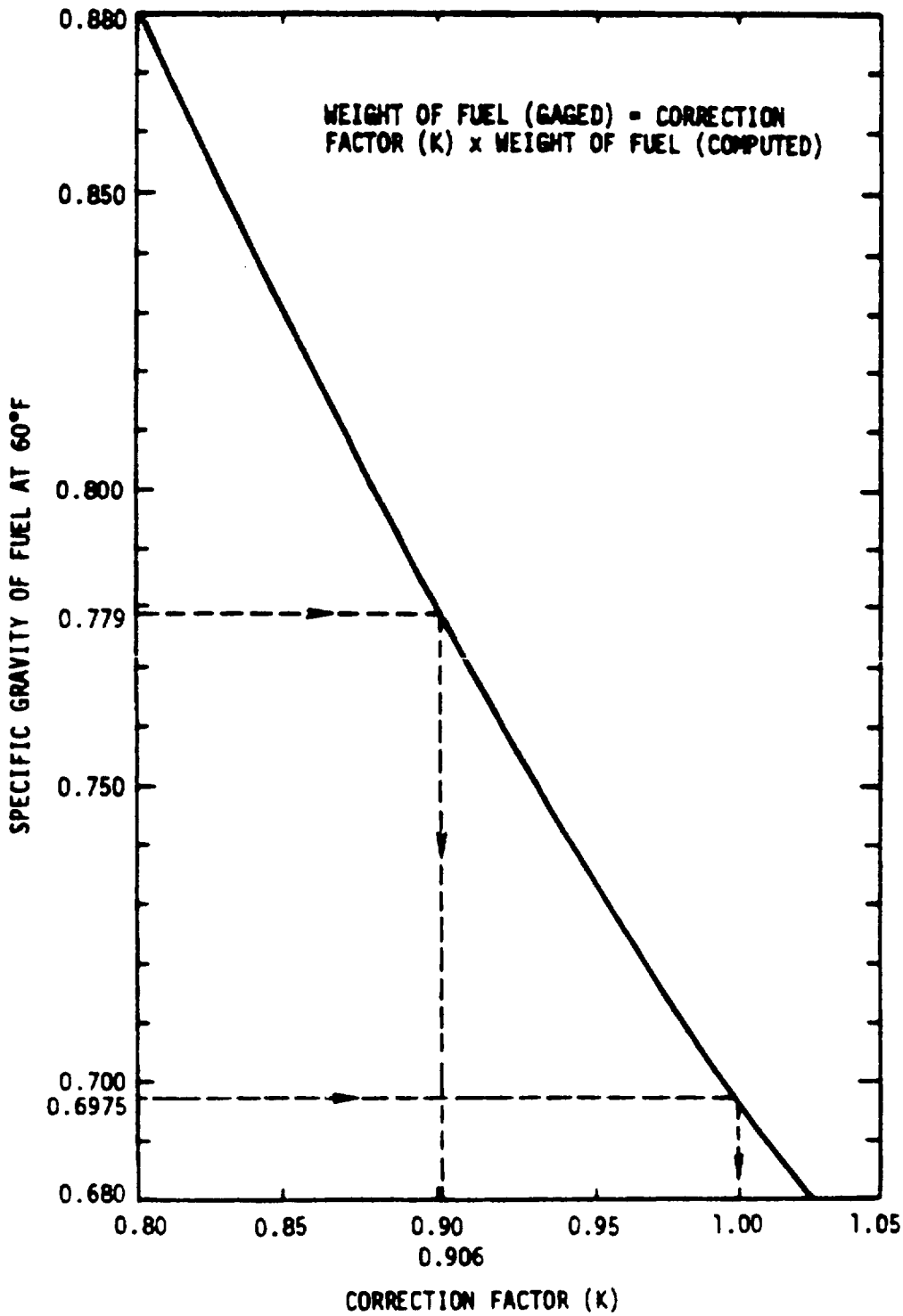

FIGURE 19 - *Correction of Computed Fuel Weight to Gauge Indicated Weight Based upon Specific Gravity of Fuel Used*

6.4.1 Additional information concerning the calculation of proper Fuel-Air-Ratio may be obtained from WADC report WADC-TR-57-387, ASTIA Document No. AD 130832.

NOTE: (a) At or above 10,000 feet altitude, with chamber air temperature above 60° F and an 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.

NOTE: (b) Figure 17 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.

6.5 Supersession Data - This issue of MIL-T-5422 supersedes all previous issues of MIL-T-5422 for new Navy designs. Previous issues of MIL-T-5422 remain in effect to cover procurement of previously designed equipment.

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