METHOD 501.7

HIGH TEMPERATURE

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TABLES

METHOD 501.7

HIGH TEMPERATURE

NOTE: Tailoring is essential. Select methods, procedures, and parameter levels based on the tailoring process described in Part One, paragraph 4.2.2, and Annex C. Apply the general guidelines for laboratory test methods described in Part One, paragraph 5 of this Standard.

1. SCOPE.

1.1 Purpose.

Use high temperature tests to obtain data to help evaluate effects of high temperature conditions on materiel safety, integrity, and performance.

1.2 Application.

Use this method to evaluate materiel likely to be deployed in areas where temperatures (ambient or induced) are higher than standard ambient.

1.3 Limitations.

Limit use of this Method to evaluating the effects of relatively short-term (months, as opposed to years), even, distributions of heat throughout the test item. This Method is not generally practical for:

a. Evaluating time-dependent performance degradation (aging) effects that occur during continuous long-term exposure to high temperatures (under storage or operational modes) where synergetic effects may be involved. For such high temperature aging effects, test in the natural environment.

b. Evaluating materiel in a high temperature environment where solar radiation produces significant thermal gradients in the materiel. For simulating direct solar impingement, use Method 505.7, Procedure I.

c. Evaluating actinic (photochemical) effects (use Method 505.7, Procedure II).

d. Evaluating the effects of aerodynamic heating without considerable tailoring.

2. TAILORING GUIDANCE.

2.1 Selecting This Method.

After examining requirements documents and applying the tailoring process in Part One of this standard to determine where high temperatures are foreseen in the life cycle of the materiel, use the following to confirm the need for this Method, and to place it in sequence with other Methods. It is preferable to conduct Method 505.6, Procedure I prior to Method 501.7, in order to obtain maximum response and stabilization temperatures for items exposed to direct solar radiation.

2.1.1 Effects of High Temperature Environments.

High temperatures may temporarily or permanently impair performance of materiel by changing physical properties or dimensions of the material(s) of which it is composed. The following are examples of problems that could result from high temperature exposure that may relate to the materiel being tested. Consider the following typical problems to help determine if this Method is appropriate for the materiel being tested. This list is not intended to be all-inclusive.

a. Parts bind from differential expansion of dissimilar materials.

b. Lubricants become less viscous; joints lose lubrication by outward flow of lubricants.

c. Materials change in dimension, either totally or selectively.

d. Packing, gaskets, seals, bearings and shafts become distorted, bind, and fail causing mechanical or integrity failures.

e. Gaskets display permanent set.

f. Closure and sealing strips deteriorate.

g. Fixed-resistance resistors change in values.

h. Electronic circuit stability varies with differences in temperature gradients and differential expansion of dissimilar materials.

i. Transformers and electromechanical components overheat.

j. Operating/release margins of relays and magnetic or thermally activated devices alter.

k. Shortened operating lifetime.

l. Solid pellets or grains separate.

m. High pressures created within sealed cases (projectiles, bombs, etc.).

n. Accelerated burning of explosives or propellants.

o. Expansion of cast explosives within their cases.

p. Explosives melt and exude.

q. Discoloration, cracking, or crazing of organic materials.

r. Out-gassing of composite materials or coatings (i.e. VOCs, CO, and Phthalates).

s. Failure of adhesives.

2.1.2 Sequence Among Other Methods.

a. General. Use the anticipated life cycle sequence of events as a general sequence guide (see Part One, paragraph 5.5).

b. Unique to this Method. There are at least two philosophies related to test sequence. One approach is to conserve test item life by applying what are perceived to be the least damaging environments first. For this approach, generally apply the high temperature test early in the test sequence. Another approach is to apply environments to maximize the likelihood of disclosing synergetic effects. This test may be used in combination with shock and vibration tests to evaluate the effect of dynamic events (i.e., shipping, handling, and shock) on hot materials. Also, this test may contribute significantly to the results of low pressure testing of seals, e.g., see paragraphs 2.1.1d, e, and f.

2.2 Selecting Procedures.

This Method includes three test procedures, Procedure I (Storage), Procedure II (Operation), and Procedure III (Tactical-Standby to Operational). Determine the procedure(s) to be used.

> **NOTE:** The materiel's anticipated Life Cycle Environmental Profile (LCEP) may reveal other high temperature scenarios that are not specifically addressed in the procedures. Tailor the procedures as necessary to capture the LCEP variations, but do not reduce the basic test requirements reflected in the below procedures. (See paragraph 2.3 below.) **NOTE: Consider the potential synergistic effects of temperature, humidity and altitude, and the use of Method 520.5 in addition to this method. However, Method 520 is NOT a substitute for Method 501.**

2.2.1 Procedure Selection Considerations.

When selecting procedures, consider:

a. The operational purpose of the materiel.

b. The natural exposure circumstances (ambient or induced).

c. The test data required to determine whether the operational purpose of the materiel has been met.

d. Procedure sequence. If both the storage and operation procedures are to be applied, perform Procedure I before Procedure II. Consider using Procedure III in lieu of Procedure II for unique cases in which materiel in its operational configuration is non-operational (awaiting use) and is exposed to solar heating, e.g., aircraft cockpits, ground vehicle passenger compartments, etc.

e. Other significant adjacent heat sources that could affect the materiel such as motors, engines, power supplies, other electronics, or exhaust air.

f. Combining of Procedures I and II when using constant temperature. When attempting to combine procedures it is preferable to conduct Procedure II followed by Procedure I and then a repeat of Procedure II. Testing should be conducted in series with no return to ambient conditions until test completion.

2.2.2 Difference Among Procedures.

While all three procedures involve temperature conditioning and performance testing, they differ on the basis of the temperature load prior to and during performance tests. The storage procedure assesses the effects of high temperature storage on subsequent materiel performance. The operation procedure assesses the effects of high temperatures during performance. The tactical-standby to operational procedure evaluates the ability of materiel (usually enclosed by transparent or translucent material) that has soaked in the sun in a high temperature environment to become operational in a relatively short period of time.

a. Procedure I - Storage. Use Procedure I to investigate how high temperatures during storage affect the materiel (integrity of materials, and safety/performance of the materiel). This test procedure includes exposing the test item to high temperatures (and low humidity where applicable) that may be encountered in the materiel's storage situation, followed by an operational test at ambient conditions. For materiel inside an enclosure that is, in turn, exposed to solar heating, consider using Method 505.7, Procedure I to determine the actual level of heating of the test materiel caused by solar loading.

b. Procedure II - Operation. Use Procedure II to investigate how high ambient temperatures may affect materiel performance while it is operating. There are two ways to perform Procedure II:

(1) Expose the test item to cyclic chamber conditions with the test item operating either continuously or during the period of maximum response (highest item temperature).

(2) Expose the test item to a constant temperature and operate the test item when its temperature stabilizes. (To be used only for items situated in close proximity to heat-producing equipment or when it is necessary to verify operation of an item at a specified constant temperature.)

c. Procedure III - Tactical-Standby to Operational. This procedure is not a substitute for solar radiation (Method 505.7). This procedure evaluates the materiel's performance at the operating temperatures after being presoaked at non-operational temperatures. Since actinic effects and directional heating are not applicable in this method, consider applying this procedure when materiel is in an enclosed environment, (e.g., aircraft and ground vehicles with closed transparent or translucent areas can develop high internal temperatures prior to equipment operation due to solar heating; enclosures such as communications shelters may require immediate operation after being exposed to solar heating). These are not items in storage or transit situation, but rather items in the operational configuration (ready-to-go as needed) that must be operational in a relatively short period of time. Usually, the "cooling" option refers to merely opening the enclosed areas and allowing the ambient air to begin cooling the interior areas so normal operation can begin.

The term "tactical" is used here to identify materiel that is not in storage, but is in a standby operational configuration, and as such is subjected to extended non-operational conditions immediately prior to operation.

2.3 Determine Test Levels and Conditions.

Having selected this method and relevant procedures (based on the test item's requirements documents and the tailoring process), complete the tailoring process by identifying appropriate parameter levels and applicable test conditions and techniques for these procedures. Base these selections on the requirements documents and the Life Cycle Environmental Profile, and information provided with this procedure. Consider the following when selecting test levels.

2.3.1 Climatic Conditions.

Identify the appropriate climatic conditions for the geographic areas in which the materiel will be operated and stored. There are two climatic categories where high temperatures are typically encountered: Hot Dry and Basic Hot (Part One, Annex C, Figure C-1). Data for these areas are shown in Tables 501.7-I, -II, and -III. Determine high temperature levels with respect to:

a. Climatic area of concern.

b. Exposure to solar radiation: Is this exposure directly on the materiel, shipping container, protective package shelter, etc.?

c. Analysis of the path of heat transfer from the ambient air and solar radiation to the materiel.

Table 501.7-I. Summary of high temperature diurnal cycle ranges.[1/]

Design Type	Location	Ambient Air °C (°F)	Induced [2/] °C (°F)
Basic Hot (A2)	Many parts of the world, extending outward from the hot dry category of the southwestern United States, northwestern Mexico, central and western Australia, Saharan Africa, South America, southern Spain, and southwest and south central Asia.	30 - 43 (86 - 110)	30 - 63 (86 - 145)
Hot Dry (A1)	Southwest and south central Asia, southwestern United States, Saharan Africa, central and western Australia, and northwestern Mexico.	32 - 49 (90 - 120)	33 - 71 (91 - 160)

[1/] The diurnal cycles for temperature and humidity are given in tables 501.7-II and -III.

[2/] Induced conditions are air temperature levels to which materiel may be exposed during extreme storage or transit situations, or non-operational but in the operational configuration without containerization.

Table 501.7-II. High temperature cycles, climatic category A2 - Basic Hot.[1/]

Time of Day	Ambient Air Conditions		Induced (Storage and Transit) Conditions	
	Temperature[3/] °C (°F)	Humidity[2/] % RH	Temperature[3/] °C (°F)	Humidity[2/] % RH
0100	33 (91)	36	33 (91)	36
0200	32 (90)	38	32 (90)	38
0300	32 (90)	41	32 (90)	41
0400	31 (88)	44	31 (88)	44
0500	30 (86)	44	30 (86)	44
0600	30 (86)	44	31 (88)	43
0700	31 (88)	41	34 (93)	32
0800	34 (93)	34	38 (101)	30
0900	37 (99)	29	42 (107)	23
1000	39 (102)	24	45 (113)	17
1100	41 (106)	21	51 (124)	14
1200	42 (107)	18	57 (134)	8
1300	43 (109)	16	61 (142)	6
1400	43 (110)	15	63 (145)	6
1500	43 (110)	14	63 (145)	5
1600	43 (110)	14	62 (144)	6
1700	43 (109)	14	60 (140)	6
1800	42 (107)	15	57 (134)	6
1900	40 (104)	17	50 (122)	10
2000	38 (100)	20	44 (111)	14
2100	36 (97)	22	38 (101)	19
2200	35 (95)	25	35 (95)	25
2300	34 (93)	28	34 (93)	28
2400	33 (91)	33	33 (91)	33

[1/] These cycles were obtained from AR 70-38, 1 August 1979 (see paragraph 6.1, reference c), and essentially conform to those in MIL-HDBK-310 and NATO STANAG 4370, AECTP 230 (paragraph 6.1, references a and b). These values represent typical conditions throughout a typical day in this climatic category. "Induced Conditions" are air temperature levels to which materiel may be exposed during storage or transit situations that are aggravated by solar loading, or during non-operating situations but in an operational configuration and not containerized.

[2/] Humidity control during high temperature testing is generally not necessary. Use these values only in special cases where, for instance, it is known that high levels of temperature and low humidity may adversely affect your items.

[3/] Data were originally recorded in °F and converted to °C. Hence, table data conversion may not be consistent.

Table 501.7-III. High temperature cycles, climatic category A1 – Hot Dry.[1/]

Time of Day	Ambient Air Conditions		Induced (Storage and Transit) Conditions	
	Temperature[3/] °C (°F)	Humidity[2/] % RH	Temperature[3/] °C (°F)	Humidity[2/] % RH
0100	35 (95)	6	35 (95)	6
0200	34 (94)	7	34 (94)	7
0300	34 (93)	7	34 (94)	7
0400	33 (92)	8	33 (92)	7
0500	33 (91)	8	33 (92)	7
0600	32 (90)	8	33 (91)	7
0700	33 (91)	8	36 (97)	5
0800	35 (95)	6	40 (104)	4
0900	38 (101)	6	44 (111)	4
1000	41 (106)	5	51 (124)	3
1100	43 (110)	4	56 (133)	2
1200	44 (112)	4	63 (145)	2
1300	47 (116)	3	69 (156)	1
1400	48 (118)	3	70 (158)	1
1500	48 (119)	3	71 (160)	1
1600	49 (120)	3	70 (158)	1
1700	48 (119)	3	67 (153)	1
1800	48 (118)	3	63 (145)	2
1900	46 (114)	3	55 (131)	2
2000	42 (108)	4	48 (118)	3
2100	41 (105)	5	41 (105)	5
2200	39 (102)	6	39 (103)	6
2300	38 (100)	6	37 (99)	6
2400	37 (98)	6	35 (95)	6

[1/] These cycles were obtained from AR 70-38, 1 August 1979 (see paragraph 6.1, reference c), and essentially conform to those in MIL-HDBK-310 and NATO STANAG 4370, AECTP 230 (paragraph 6.1, references a and b). These values represent typical conditions throughout a typical day in this climatic category. "Induced Conditions" are air temperature levels to which materiel may be exposed during storage or transit situations that are aggravated by solar loading, or during non-operating situations but in an operational configuration and not containerized.

[2/] Humidity control during high temperature testing is generally not necessary. Use these values only in special cases where, for instance, it is known that high levels of temperature and low humidity may adversely affect your item.

[3/] Data were originally recorded in °F and converted to °C. Hence, table data conversion may not be consistent.

2.3.2 Exposure Conditions.

Before determining the levels at which to set test temperatures, determine the way in which the materiel is exposed to heat in normal storage and operational circumstances. Review the Life Cycle Environmental Profile (LCEP) to help make this determination (see Part Three for additional guidance). Consider at least the following exposure conditions, and the possible alternative of using Method 505.7, Procedure I:

a. Deployment configuration.

(1) Exposed. Of interest are the most severe conditions that materiel would experience when deployed in any climatic area of the world without the benefit of a protective cover or sheltering enclosure.

(2) Sheltered. Of interest are the most severe conditions that materiel would experience when deployed in any climatic area of the world when under cover or inside a sheltering enclosure. The amount of ventilation available and the presence of adjacent shade can significantly affect the temperature of the air surrounding sheltered materiel. Examples of these situations are provided below. (Note: If field data are not available, the conditions for this exposure may be approximated using Part Three of this document, MIL-HDBK-310 and/or NATO STANAG 4370, AECTP 230 (paragraph 6.1, references a and b)). The outdoor ambient air temperature and humidity conditions described in these references are those measured in standard meteorological shelters at a height of 1.2 to 1.8 m (4 to 6 ft) above the ground.

(a) Inside unventilated enclosures.

(b) Within enclosed vehicle bodies.

(c) Within aircraft sections having surfaces exposed to solar heating.

(d) Inside of tents.

(e) Under closed tarpaulins.

(f) Located above, on, or below the surface of the Earth.

b. Special conditions. Although high temperature testing is generally based on the average temperature of the air envelope surrounding the materiel, significant localized heating can occur because of special heating conditions. This localized heating can be well above the average surrounding air and therefore can significantly affect the evaluation of the materiel's thermal behavior and performance. When these conditions exist (as described below), include or simulate them in the high temperature test setup to the extent practical. These extreme conditions would be applied by extending the levels of the temperatures given in Tables 501.7-I and 501.7-II based on actual field measurements.

(1) Aggravated solar. These conditions are induced but involve temperatures as high as 71 to 85 ºC (160 to 185 ºF), making greater allowance for the effects of solar radiation. Applicable conditions for such testing include materiel that is employed in enclosed compartments having glazed or transparent panels (aircraft cockpits, vehicle compartments, etc.); consider applying Method 505.7.

(2) Man-made sources. Man-made heat-producing devices (motors, engines, power supplies, high-density electronic packages, etc.) may significantly raise the local air temperature near the materiel, either by radiation, convection, or impingement of exhaust air. This near constant temperature environment may negate the effects of the diurnal cycle.

2.3.3 Exposure Duration.

Determine the duration of exposure that the materiel will experience for each of the exposure conditions identified. Exposure may be constant or cyclic, in which case, also identify the number of times that the exposure occurs.

Caution: When temperature conditioning, ensure the total test time at the most severe temperature does not exceed the life expectancy of any material (see Part One, paragraph 5.19).

2.3.3.1 Constant Temperature Exposure.

For constant temperature exposure (used only for items situated in close proximity to heat-producing equipment or when it is necessary to verify operation of an item at a specified constant temperature), soak the test item until its temperature has stabilized, and maintain the test temperature at least two hours following test item stabilization.

NOTE: This is not a substitute for situations in which diurnal cycling is typical.

2.3.3.2 Cyclic Temperature Exposure.

For cyclic exposure, determine the test duration based on an estimate of the number of cycles required to satisfy the design requirements and the guidance below. The duration of high temperature exposure may be as significant as the temperature itself. Because Procedures I and II could expose the test items to cyclic temperatures, the number of cycles is critical. (Cycles are 24-hour periods unless otherwise specified.)

a. Procedure I - Storage. The number of cycles for the storage test is set at a minimum of seven to coincide with the one percent frequency of occurrence of the hours of extreme temperatures during the most severe month in an average year at the most severe location. (The maximum temperature occurs for approximately one hour in each cycle.) When considering extended storage, critical materials, or materials determined to be very sensitive to high temperature, increase the number of cycles to assure the design requirements are met.

b. Procedure II - Operation. The minimum number of cycles for the operational exposure test is three. This number is normally sufficient for the test item to reach its maximum response temperature. A maximum of seven cycles is suggested when repeated temperature response is difficult to obtain.

2.3.4 Test Item Configuration.

Determine the test item configuration based on realistic configuration(s) of the materiel anticipated for storage and operation. As a minimum, consider the following configurations:

a. In a shipping/storage container or transit case.

b. Protected or unprotected (under canopy, enclosed, etc.).

c. In its normal operating configuration (realistic or with restraints, such as with openings that are normally covered).

d. Modified with kits for special applications.

e. Stacked or palletized configurations.

2.3.5 Humidity.

Generally, relative humidity (RH) control during high temperature tests is not necessary. In special cases, extremely low RH may have a significant effect on some materiel during high temperature testing. If the materiel has special characteristics that could be affected by extremely low RH, use the values for RH shown in Tables 501.7-II and -III.

2.4 Test Item Operation.

When it is necessary to operate the test item, use the following guidelines for establishing test operating procedures.

CAUTION: If the sheltered environment is intended to be occupied during exposure to high temperature, it is recommended that sensors are installed to detect VOCs, CO, and Phthalates due to potential out-gassing.

a. General. See Part One, paragraph 5.8.2.

b. Unique to this method.

(1) Include operating modes that consume the most power (generate the most heat).

(2) Include the required range of input voltage conditions if changes in voltage could affect the test item thermal dissipation or response (e.g., power generation or fan speed).

(3) Introduce the cooling media that normally would be applied during service use (e.g., forced air or liquid coolant). Consider using cooling medium inlet temperatures and flow rates that represent both typical and worst-case degraded temperature and flow conditions.

(4) For steady-state temperature testing, consider thermal stabilization to be achieved when the temperatures of critical internal operating components are relatively constant (as described in Part One, paragraph 5.4.1). (Because of test item duty cycling or the operating characteristics, a constant operating temperature may never be achieved.)

(5) For cyclic temperature testing, and depending on the cycle and test item characteristics, the thermal responses of the test item will also be cyclic.

(6) Consider non-operational conditions similar to those of storage & transit, and the need for immediate operation without cooling - other than that of the surrounding ambient air.

2.5 Additional Guidelines.

Review the materiel specifications and requirements documents. Apply any additional guidelines necessary. Part Three of this document includes further information on the high temperature environment (e.g., paragraphs 2.1 and 4.1).

3. INFORMATION REQUIRED.

3.1 Pretest.

The following information is required to conduct high temperature tests adequately.

a. General. Information listed in Part One, paragraphs 5.7 and 5.9; and Annex A, Task 405 of this Standard.

b. Specific to this Method.

(1) Relative humidity control requirements (if necessary). (See paragraph 2.3.5 of this Method.)

(2) Thermocouple locations. The component/assembly/structure to be used for thermal response and temperature stabilization purposes. (See Part One, paragraph 5.4.)

(3) For Procedure III, based on the LCEP, identify the anticipated maximum non-operational temperature (exposure to high temperatures and solar loading) for the materiel, as well as the accompanying high ambient temperature. The LCEP should define whether or not the item will be operated at the maximum operational temperature immediately following the storage environment.

c. Tailoring. Necessary variations in the basic test procedures to accommodate environments identified in the LCEP.

3.2 During Test.

Collect the following information during conduct of the test:

a. General. Information listed in Part One, paragraph 5.10; and in Annex A, Tasks 405 and 406 of this Standard.

b. Specific to this Method.

(1) Record of chamber temperature-versus-time data (and humidity, if controlled) for the duration of the test.

(2) Record of the test item temperature-versus-time data for the duration of the test.

3.3 Post-Test.

The following post test data shall be included in the test report.

a. General. Information listed in Part One, paragraph 5.13; and in Annex A, Task 406 of this Standard.

b. Specific to this Method.

(1) Length of time required for each performance check.

(2) Temperature versus time data (test item and chamber).

(3) Any deviations from the original test plan.

4. TEST PROCESS.

4.1 Test Facility.

a. The required apparatus consists of a chamber or cabinet together with auxiliary instrumentation capable of maintaining and monitoring the required conditions of high temperature (and humidity, where required) throughout an envelope of air surrounding the test item(s) (see Part One, paragraph 5.18).

b. Unless justified by the materiel platform environment and to prevent unrealistic heat transfer in the materiel, maintain the air velocity in the vicinity of the test item so as to not exceed 1.7 m/s (335 ft/min).

c. Continuously record chamber conditions and, if required, test item temperatures.

4.2 Controls.

a. Temperature. Unless otherwise specified in the test plan, if any action other than test item operation (such as opening the chamber door) results in a significant change of the test item temperature (more than 2 °C (3.6 °F)) or chamber air temperature, re-stabilize the test item at the required temperature before continuing the test. For Procedure II, if the operational check is not completed within 15 minutes, reestablish test item temperature/RH conditions before continuing.

b. Rate of temperature change. Unless otherwise specified or documented in the LCEP, use a rate of temperature change not exceeding 3 °C (5 °F) per minute to prevent thermal shock.

c. Temperature measurement. Install temperature sensor instrumentation on or in the test item to measure temperature stabilization data (see Part One, paragraph 5.4).

d. Data recording. Record chamber temperature (and humidity if controlled) in accordance with Part One, paragraphs 5.2 and 5.18, and at a sufficient rate to satisfy the post-test analysis (see Part One, paragraph 5.18)

4.3 Test Interruption.

Test interruptions can result from two or more situations, one being from failure or malfunction of test chambers or associated test laboratory equipment. The second type of test interruption results from failure or malfunction of the test item itself during required or optional performance checks.

4.3.1 Interruption Due to Chamber Malfunction.

a. General. See Part One, paragraph 5.11, of this Standard.

b. Specific to this Method.

(1) Undertest interruption.

(a) Cycling. If a cyclic high temperature test is being conducted and an unscheduled interruption occurs that causes the test conditions to fall out of allowable tolerances toward standard ambient temperatures, continue the test from the end of the last successfully-completed cycle.

(b) Steady state. If a steady state (non-cyclic) test is being conducted (only for items near constant-heat-producing sources), and an unscheduled interruption occurs that causes the test conditions to fall out of allowable tolerances toward standard ambient conditions, re-stabilize the test item at the required test temperature and continue the test from the point where test conditions were interrupted.

(2) Overtest interruption (e.g., loss of chamber control).

(a) Inspection and performance check. If an interruption in a cyclic or steady state test results in more extreme exposure of the test item than required by the materiel specifications, follow the interruption by a complete physical inspection and an operational check (where possible) before continuing the test.

(b) Safety, performance, materials problems. When these types of problems are discovered after an overtest, the preferable course of action is to terminate the test and re-initiate testing with a new test item. If this is not done and a test item failure occurs during the remainder of the test, the test results could be considered invalid because of the overtest conditions. If no problem has been encountered, reestablish pre-interruption conditions and continue from the point where the test tolerances were exceeded.

4.3.2 Interruption Due to Test Item Operation Failure.

Failure of the test item(s) to function as required during mandatory or optional performance checks during testing presents a situation with several possible options.

a. The preferable option is to replace the test item with a “new” one and restart from Step 1.

b. A second option is to replace / repair the failed or non-functioning component or assembly with one that functions as intended, and restart the entire test from Step 1.

> **NOTE**: When evaluating failure interruption, consider prior testing on the same test item and consequences of such.

4.4 Test Setup.

a. General. See Part One, paragraph 5.8.

b. Unique to this Method. Include in the test setup any additional heat sources or an appropriate simulation (see paragraph 2.3.2b).

4.5 Test Execution.

The following steps, alone or in combination, provide the basis for collecting necessary information concerning the materiel in a high temperature environment.

4.5.1 Preparation for Test.

4.5.1.1 Preliminary Steps.

Before starting the test, review pretest information in the test plan to determine test details (e.g., procedures, test item configuration, cycles, durations, parameter levels for storage/operation, etc.). (See paragraph 3.1, above.)

4.5.1.2 Pretest Standard Ambient Checkout.

All test items require a pretest standard ambient checkout to provide baseline data. Conduct the checkout as follows:

Step 1 Conduct a visual examination of the test item with special attention to stress areas, such as corners of molded cases, and document the results.

Step 2 In order to determine thermal response (paragraph 3.1c), install temperature sensors in, on, or around the test item as described in the test plan.

Step 3 Conduct an operational checkout (Part One, paragraph 5.8.2) at standard ambient conditions (Part One, paragraph 5.1) as described in the plan and record the results.

Step 4 If the test item operates satisfactorily, proceed to paragraph 4.5.2, 4.5.3, or 4.5.4 as appropriate. If not, resolve the problems and repeat Step 3 above. If resolution requires replacement of the item or removal of sensors in order to repair, then repeat Steps 1 through 3 above.

4.5.2 Procedure I - Storage.

> **NOTE**: If the LCEP has defined the need to operate the test item at the high operational temperature immediately following storage, consider using Procedure III.

Step 1 Place the test item in its storage configuration and install it in the chamber.

Step 2 Adjust the chamber environment to the required test conditions, either cyclic exposure (Tables 501.7-II or 501.7-III) or constant exposure (see paragraph 2.3.3.1), for the start of the test period at a rate not to exceed 3 °C/min (5 °F/min). Maintain for the specified time following temperature stabilization of the test item.

Step 3 a. For cyclic storage, expose the test item to the temperature (and humidity, if applicable) conditions of the storage cycle for a minimum of seven continuous 24-hour cycles, or as specified in the LCEP and the test plan. Record the thermal response of the test item.

b. For constant temperature storage (to be used only for items situated in close proximity to equipment producing constant high temperatures; see paragraph 2.3.2b(2)), maintain the test temperature at least two hours following test item temperature stabilization (see Part One, paragraph 5.4). The additional two hours will help ensure unmeasured internal components actually reach stabilization. If not possible to instrument internal components, base any additional soak time on thermal analysis to ensure temperature stabilization throughout the test item.

Step 4 At the completion of the constant temperature soak or the last cycle, adjust the chamber air temperature to standard ambient conditions and maintain until the test item temperature is stabilized.

Step 5 Conduct a visual examination and operational checkout of the test item, and record the results for comparison with pretest data. See paragraph 5 for analysis of results.

4.5.3 Procedure II - Operation.

Step 1 With the test item in the chamber in its operational configuration, install any additional temperature sensors necessary to measure the maximum temperature response of the test item, ensuring the functioning components are included.

Step 2 If performing the constant temperature exposure, go to Step 3. For cycling temperature exposure, go to Step 8.

Step 3 <u>Constant temperature exposure</u>. Adjust the chamber air conditions to the required temperature (and humidity, if applicable) at which the materiel must operate at rate not to exceed 3 °C/min (5 °F/min).

Step 4 Maintain the chamber conditions at least two hours following test item temperature stabilization (see Part One, paragraph 5.4). If not possible to instrument internal components, base the additional soak time on thermal analysis or previously measured data to ensure temperature stabilization throughout the test item.

Step 5 Conduct as thorough a visual examination of the test item as possible considering chamber access limitations, and document the results for comparison with pretest data.

Step 6 Operate the test item and allow its temperature to re-stabilize. Conduct an operational checkout of the test item in accordance with the test plan and document the results for comparison with pretest data. If the test item fails to operate as intended, follow the guidance in paragraph 4.3.2 for test item failure.

Step 7 Skip Steps 8 through 10 and proceed directly to Step 11.

Step 8 <u>Cycling temperature exposure</u>. Adjust the chamber air temperature (and humidity, if applicable) to the initial conditions, of the operational cycle appropriate for materiel deployment, at a rate not to exceed 3 °C/min (5 °F/min). Maintain until the test item's temperature has stabilized.

Step 9 Expose the test item to at least three cycles or the number of cycles necessary to assure repeated test item response. Document the maximum test item response temperature. Conduct as complete a visual examination of the test item as possible considering chamber access limitations. Document the results.

Step 10 Operate the test item during the maximum test item temperature response period of the exposure cycle. If the test item fails to operate as intended, follow the guidance in paragraph 4.3.2 for test item failure. The maximum test item temperature response period may not coincide with the maximum temperature cycle conditions because of the thermal lag of the test item. Repeat until a successful operational checkout of the test item has been accomplished in accordance with the approved test plan, and the results have been documented.

Step 11 With the test item not operating, adjust the chamber air temperature to standard ambient conditions and maintain until the test item temperature has stabilized.

Step 12 Conduct a complete visual examination and operational checkout in accordance with the approved test plan and document the results for comparison with pretest data. See paragraph 5 for analysis of results.

4.5.4 Procedure III - Tactical-Standby to Operational.

Step 1 With the test item in the chamber and in its tactical configuration, install any additional temperature sensors necessary to measure the temperature response of the test item, ensuring the functioning components are included.

Step 2 Adjust the chamber air temperature to the anticipated maximum non-operating temperature, and maintain this temperature until the test item temperature has stabilized, plus a minimum of two additional hours to ensure complete stabilization.

Step 3 Adjust the chamber air temperature to the high operational temperature identified in the LCEP as quickly as possible (at a rate no less than 2 ºC (3.6 ºF) per-minute). As soon as the chamber instrumentation indicates this temperature has been reached, operate the test item in accordance with the approved test plan and document the results for comparison with pretest data. If the test item fails to operate as intended, follow the guidance in paragraph 4.3.2 for test item failure. If identified in the LCEP that the item will be subjected to multiple exposures of this environment, repeat Steps 2 and 3 as required by the test plan.

Step 4 With the test item not operating, adjust the chamber air temperature to standard ambient conditions and maintain until the test item temperature has stabilized.

Step 5 Conduct a complete visual examination and operational checkout in accordance with the approved test plan, and document the results for comparison with pretest data. See paragraph 5 for analysis of results.

5. ANALYSIS OF RESULTS.

In addition to the guidance provided in Part One, paragraphs 5.14 and 5.17, the following information is provided to assist in the evaluation of the test results. Apply any data relative to failure of a test item to meet the requirements of the materiel specifications to the test analysis, and consider related information such as:

a. Results of nondestructive examinations (if any) of materiel at the temperature extreme.

b. Degradation or changes in operating characteristics allowed at the high extreme temperatures.

c. Necessity for special kits or special operating procedures for high temperature exposure.

d. Evidence of improper lubrication and assurance that the lubricants specified for the environmental condition were used.

e. For Procedure III, the amount of time required for the test item to become operational.

6. REFERENCE/RELATED DOCUMENTS.

6.1 Referenced Documents.

a. MIL-HDBK-310, Global Climatic Data for Developing Military Products.

b. NATO STANAG 4370, Allied Environmental Conditions and Test Publication (AECTP) 230; Climatic Conditions.

c. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.

d. MIL-STD-2105C, Test Method Standard – Hazard Assessment Tests for Non-Nuclear Munitions.

6.2 Related Documents.

a. Synopsis of Background Material for MIL-STD-210B, Climatic Extremes for Military Equipment. Bedford, MA: Air Force Cambridge Research Laboratories, 24 January 1974. DTIC number AD-780-508.

b. NATO STANAG 4370, Environmental Testing.

c. Allied Environmental Conditions and Test Publication (AECTP) 300, Climatic Environmental Tests (under STANAG 4370), Method 302.

d. Egbert, Herbert W. "The History and Rationale of MIL-STD-810 (Edition 2)" January 2010," Institute of Environmental Sciences and Technology, Arlington Place One, 2340 S. Arlington Heights Road, Suite 100, Arlington Heights, IL 60005-4516.

(Copies of Department of Defense Specifications, Standards, and Handbooks, and International Standardization Agreements are available online at https://assist.dla.mil.

Requests for other defense-related technical publications may be directed to the Defense Technical Information Center (DTIC), ATTN: DTIC-BR, Suite 0944, 8725 John J. Kingman Road, Fort Belvoir VA 22060-6218, 1-800-225-3842 (Assistance--selection 3, option 2), http://www.dtic mil/dtic/ and the National Technical Information Service (NTIS), Springfield VA 22161, 1-800-553-NTIS (6847), http://www ntis.gov/.