DEFENSE LOGISTICS AGENCY
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IN REPLY
REFER TO

DLA LAND AND MARITIME-VAC 26 September 2011

MEMORANDUM FOR MILITARY/INDUSTRY DISTRIBUTION

SUBJECT: Initial Draft; Engineering Practice Study (EPS), MIL-STD-750, Test Method 1051 to determine ramp rate(s) which protect DUT(s) from an induced thermal shock. Project Number 5961-2011-091.

The initial draft for this subject document, dated 26 September 2011, is now available for viewing and downloading from the DLA Land and Maritime website:

http://www.landandmaritime.dla.mil/Programs/MilSpec/ListDocs.asp?BasicDoc=19500EPStudies

This EPS is intended to review and evaluate the requirements of MIL-STD-750, Test Method 1051 (Temperature Cycling) to determine ramp rate(s) which protect DUT(s) from an induced thermal shock. The results of this study will form the basis for the next revision.

Concurrence or comments are required at this Center within 45 days from the date of this letter. Late comments will be held for the next coordination of the document. Comments from Military departments must be identified as either "Essential" or "Suggested". Essential comments must be justified with supporting data. Military review activities should forward comments to their custodians of this office, as applicable, in sufficient time to allow for consolidating the department reply. Since Navy-EC is the custodian for this document, all Navy review activities should forward their comments directly to this Center.

The point of contact for this EPS is Mr. Kyle Carpenter, DLA Land and Maritime-VAC, Post Office Box 3990, Columbus, OH 43216-3990. Mr. Carpenter can also be reached at 614-692-7078/850-7078, or by facsimile 614-692-6939/850-6939, or by e-mail to: Kyle.Carpenter@dla.mil.

/signed/
Thomas M. Hess
Chief
Active Devices Team

ENGINEERING PRACTICES STUDY

TITLE: MIL-STD-750, TEST METHOD 1051 (TEMPERATURE CYCLING)

PROJECT NUMBER: 5961-2011-091

26 September 2011

Study Conducted by DLA LAND AND MARITIME

Prepared by:
Kyle Carpenter
DLA - VAC

ENGINEERING PRACTICE STUDY

MIL-STD-750,Test Method 1051 (Temperature Cycling).

I. OBJECTIVES: An engineering practice study is being conducted to review and evaluate the requirements of MIL-STD-750, Test Method 1051 (Temperature Cycling) to determine ramp rate(s) which protect DUT(s) from an induced thermal shock. This exercise will also aid the user in determining if performing equipment is acceptable for compliance to a surveillance audit. If consensus indicates that the current requirements are ineffective and/or unachievable, then recommend revising said requirements.

II. BACKGROUND: Recent comments received by DLA have suggested that the current ramp rate requirements of MIL-STD-750, Test Method 1051 are unachievable using currently available temperature chambers. DLA auditors have also recently reported that many currently qualified suppliers are unable to meet the requirements of MIL-STD-750, Test Method 1051. DLA is requesting that custodians, review activities, users, and manufacturers review the requirements of MIL-STD-750, Test Method 1051 to ensure that they are effective and achievable. See the following attachments for the current and historical requirements of both MIL-STD-750 and MIL-STD-883.

III. METHODOLOGY: This office will consider revising the requirements of MIL-STD-750, Test Method 1051 if consensus indicates that the current requirements are ineffective and/or unachievable.

IV. RESULTS: All comments shall be submitted to Kyle.Carpenter@dla.mil within 45 days from the date of this letter. The final results of this effort, including recommendations and conclusions, will be documented in the final EPS report.

ATTACHMENT 1

METHOD 1051.7

TEMPERATURE CYCLING (AIR TO AIR)

1. Purpose. This test is conducted to determine the resistance of a semiconductor device to extremes of high and low temperatures, and to the effect of alternate exposures to these extremes.

1.1 Terms and definitions.

1.1.1 Load. The specimens under test and the fixtures holding those specimens during the test. Maximum load shall be determined by using the worst case load temperature with specific specimen loading. Monolithic loads used to simulate loading may not be appropriate when air circulation is reduced by load configuration. The maximum loading must meet the specified conditions.

1.1.2 Monitoring sensor. The temperature sensor that is located and calibrated so as to indicate the same temperature as at the worst case indicator specimen location. The worst case indicator specimen location is identified during the periodic characterization of the worst case load temperature.

1.1.3 Worst case load temperature. The worst case load temperature is the temperature of a specific area in the chamber when measured by thermocouples located at the center and at each corner of the load. The worst case load temperature shall be determined at periodic intervals.

1.1.4 Working zone. The volume in the chamber(s) in which the temperature of the load is controlled within the limits specified in table 1051-I.

1.1.5 Specimen. The device or individual piece being tested.

1.1.6 Transfer time. The elapsed time between specimen removal from one temperature extreme and introduction into the other.

1.1.7 Maximum load. The largest load for which the worst case load temperature meets the timing requirements (see 3.1).

1.1.8 Soak time. The elapsed time that occurs after the load has reached the temperature specified in table1051- I. **Error! Reference source not found.**.

1.1.9 Dwell time. The time from introduction of the load to one extreme temperature (hot chamber or cold chamber) until the initiation of the transfer to the other extreme temperature (hot chamber or cold chamber). The total dwell time equals the ramp time plus the soak time.

NOTE: During chamber profiling and characterization, a device temperature sensitive parameter should be used to ensure that for various load conditions, the specified soak time shall be guaranteed.

1.1.10 Ramp time. The time allowed for reaching a given temperature. This timing starts when the load is introduced to the chamber and ends when the load reaches the temperature specified in table 1051-I.

CAUTION: Due to the ramp capability of test equipment available today, if care is not taken when profiling and characterizing various load conditions or setting up the equipment, thermal shock can be induced. The ramp rate should be controlled as defined in 3.1 or one can create a thermal shock instead of temperature cycling.

2. Apparatus. The chamber(s) used shall be capable of providing and controlling the specified temperatures in the working zone(s) when the chamber is loaded with a maximum load. The thermal capacity and air circulation shall enable the working zone and loads to meet the specified conditions and timing (see 3.1). Worst case load temperature shall be continually monitored during test by indicators or recorders reading the monitoring sensor. Direct heat conduction to specimens shall be minimized.

3. Procedure. Specimens shall be placed in such a position with respect to the air stream that there is substantially no obstruction to the flow of air across and around the specimen. When special mounting is required, it shall be specified. The specimen shall then be subjected to the specified condition for the specified number of cycles performed continuously. This test shall be conducted for a minimum of 20 cycles using test condition C. One cycle consists of steps 1 and 2 or the applicable test condition to be counted as a cycle. Completion of the total number of cycles specified for the test may be interrupted for the purpose of test chamber loading or unloading of device lots or as the result of power or equipment failure. However, if for any reason the number of incomplete cycles exceed 10 percent of the total number of cycles specified, one cycle must be added for each incomplete cycle. See figure 1051–1 herein.

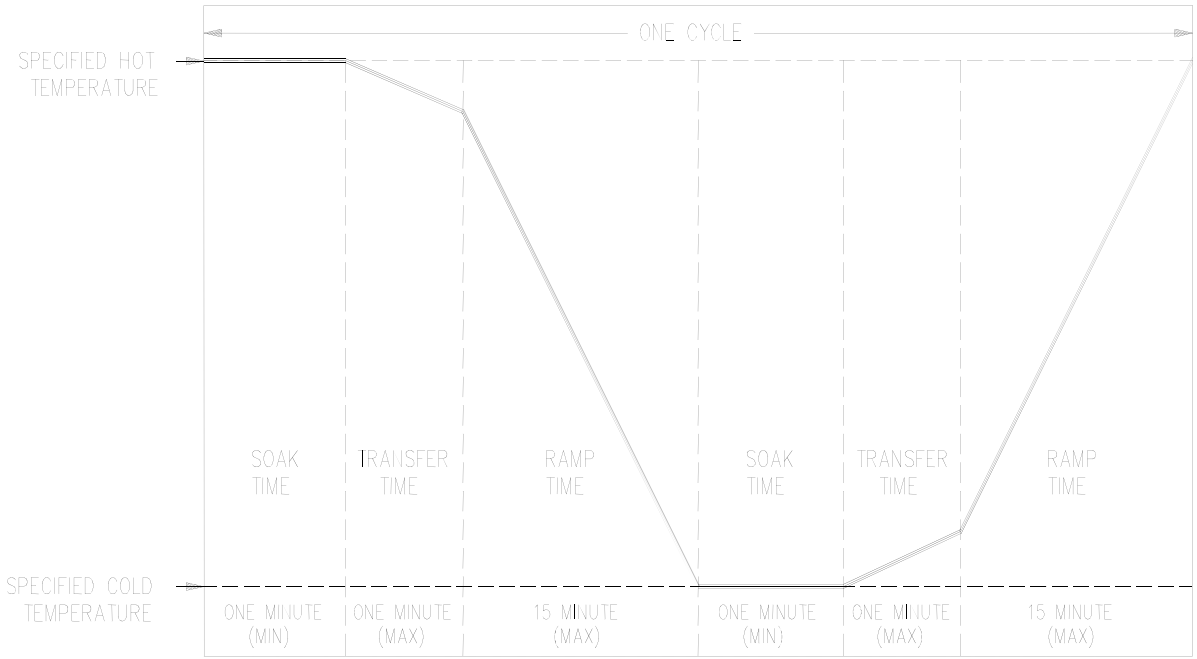


FIGURE 1051–1. Timing diagram showing one cycle.

3.1 Timing. The total transfer time from the hot chamber to the cold chamber or the cold chamber to the hot chamber shall not exceed 1 minute. The load may be transferred after a soak of 1 minute minimum. (The soak time shall begin once the worst case load (point which reaches temperature last) has reached the specified temperature. However, the dwell time shall not be less than 10 minutes. The ramp rate for DUT shall operate within the following temperature change rates: 15°C/minute minimum and 50°C/minute maximum independent of load size. However the total ramp time shall not exceed 15 minute. If necessary, the load size shall be increased or decreased to meet the specified temperature change rates.

TABLE 1051–I. Temperature–cycling test conditions.

Step	Dwell time (minutes)	Test condition, temperature, and tolerance (°C)						
		A	B	C	D	E	F	G
1 Cold	≥ 10	–55 +0 / –10	–55 +0 / –10	–55 +0 / –10	–65 +0 / –10	–65 +0 / –10	–65 +0 / –10	–55 +0 / –10
2 Hot	≥ 10	85 +10 / –0	125 +15 / –0	175 +15 / –0	200 +15 / –0	300 +15 / –0	150 +15 / –0	150 +15 / –0

NOTE: Steps 1 and 2 may be interchanged. The load temperature may exceed the + or – zero (0) tolerance during the recovery time. Other tolerances shall not be exceeded.

4. Summary. The following details shall be specified in the applicable performance specification sheet or acquisition document:

a. Special mounting, if applicable (see 3).

b. Test condition letter, if other than test condition C herein (see 3).

c. Number of test cycles, if other than 20 cycles (see 3).

d. End-point measurements and examinations, e.g., end-point electrical measurements, seal test method 1071**Error! Reference source not found.** of this test method standard), or other acceptance criteria.

ATTACHMENT 2

FIGURE 1010-1 (EXCERPT FROM MIL-STD-883, TEST METHOD 1010.8)

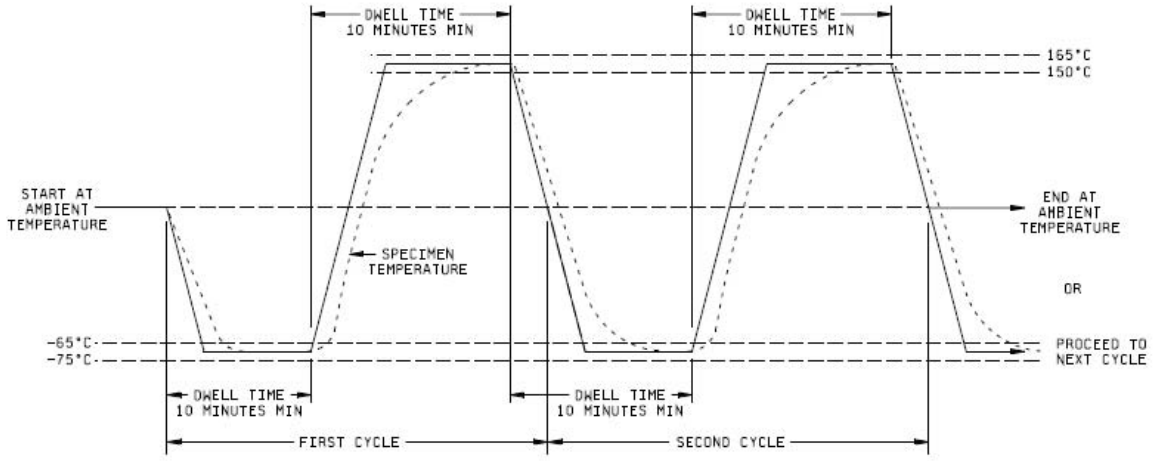
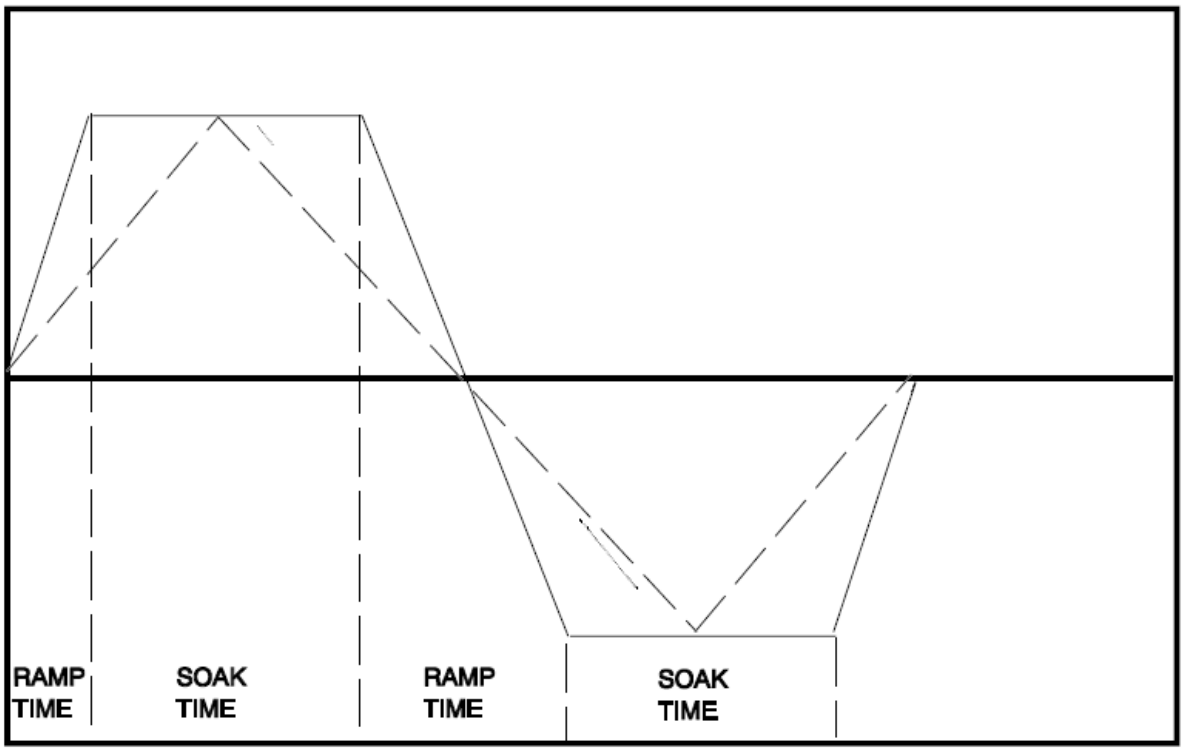


Figure 1010-1 An example of Temperature Cycling Test Condition C.

ATTACHMENT 3

FIGURE 1051-1 (EXCERPT FROM MIL-STD-750, TEST METHOD 1051.6)



Graph depicting two possible scenarios based on current interpretations of wording in specification.

——— Temperature profile with soak at temperature extremes

- - - - - - Temperature profile with no soak time

ATTACHMENT 4

PARAGRAPHS 3.1 AND TABLE 1056-II (EXCERPT FROM MIL-STD-750, TEST METHOD 1056.8)

3.1 Timing. The total transfer time from hot to cold or from cold to hot shall not exceed 10 seconds. The load may be transferred when the worst case load temperature is within the limits specified in table 1056-II**Error! Reference source not found.**. However, the dwell time shall not be less than 2 minutes and the load shall reach the specified temperature within 5 minutes.

TABLE 1056–II. Thermal shock temperature tolerances and suggested fluids. 1/

Test condition		A and B	C	D
		Temperature	Temperature	Temperature
Step 1	Temperature tolerance, °C	100 +10 / –2	125 +10 / –0	150 +10 / –0
	Recommended fluid	Water 2/ or Perfluorocarbon 3/	Perfluorocarbon 3/	Perfluorocarbon 3/
Step 2	Temperature tolerance, °C	–0 +2 / –10	–55 +0 / –10	–65 +0 / –10
	Recommended fluid	Water 2/ or Perfluorocarbon 3/	Perfluorocarbon 3/	Perfluorocarbon 3/

1/ Ethylene glycol shall not be used as a thermal shock test fluid.
2/ Water is indicated as an acceptable fluid for this temperature range. Its suitability chemically shall be established prior to use. When water is used as the fluid for condition A and the specified temperature tolerances are insufficient due to altitude considerations, the following alternate test conditions may be used:
   a. Temperature: +100°C –6°C, 0°C +6°C.
   b. Cycles shall be increased to 20.
3/ Perfluorocarbons contain no chlorine or hydrogen.

ATTACHMENT 5

PARAGRAPH 3.1 AND TABLE 1 (EXCERPT FROM MIL-STD-883, TEST METHOD 1011.9)

3.1 Timing. The total transfer time from hot to cold or from cold to hot shall not exceed 10 seconds. The load may be transferred when the worst case load temperature is within the limits specified in table I. However, the dwell time shall be not less than 2 minutes and the load shall reach the specified temperature within 5 minutes.

TABLE I. Thermal shock temperature tolerances and suggested fluids. 1/

Test conditions		A	B	C
		Temperature	Temperature	Temperature
Step 1	Temperature tolerance, °C	100 +10 -2	125 +10 -0	150 +10 -0
	Recommended fluid	Water 2/	Perfluorocarbon 3/	Perfluorocarbon 3/
Step 2	Temperature tolerance, °C	-0 +2 -10	-55 +0 -10	-65 +0 -10
	Recommended fluid	Water 2/	Perfluorocarbon 3/	Perfluorocarbon 3/

1/ Ethylene glycol shall- not be used as a thermal shock test fluid.

2/ Water is indicated as an acceptable fluid for this temperature range. Its suitability chemically shall be established prior to use. When water is used as the fluid for condition A and the specified temperature tolerances are insufficient due to altitude considerations, the following alternate test conditions may be used:

a. Temperature: 100°C -6°C, 0°C +6°C.

b. Cycles shall be increased to 20.

3/ Perfluorocarbons contain no chlorine or hydrogen.