

FUNDAMENTALS OF CLIMATICS TESTING

by

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Types of Environmental Tests

Type of Process/Test	Purpose	Performed on	Attempts to simulate service environment
Element Development	Early verification that components, materials and concepts will meet specification.	Samples and prototypes	Yes
Design Verification	Verify that systems will meet design specifications	As close to production configuration as possible	Yes
Reliability Development	Find and eliminate design and process items that reduce reliability	As close to production configuration as possible	No (But sometimes misguidedly tries)
Environmental Stress Screening	Transform latent failures into patent failures before delivery to the end user.	Production hardware.	No

Climatics is the science of measuring, analyzing, controlling and testing with climatic, weather, or meteorological conditions.

Although they are usually thought of as being natural environments, they are often created or modified by man.

Climatics deals with variables of temperature, pressure, moisture, corrosive environments, sand & dust, icing, solar radiation, and combinations.

What does an Environmental Test Engineer do?

Translates system operational requirements into environmental design and testing requirements for systems, sub-systems, and components, to ensure life-cycle durability.

Functions include participation in the design, testing, and manufacturing procedures described (but not limited to) in the following tasks:

Determine life-cycle requirements for systems, sub-systems, and components. Request detailed analysis from others (FEA, thermal analysis) when required.

Supply environmental design and test requirements with proper margins for types of hardware and phase development. Tailor standard requirements for application (IEC, ISTA, UL, 810F).

Conduct design trade-off analyses for environmental control, mitigation, or protection and input results to design, reliability and others.

Prepare environmental test requirements for in-house laboratory tests; input specification requirements for supplier tests.

Monitor or participate in environmental tests (supplier, in-house, customer) and review, report and use results for possible design corrective action.

Collect and maintain environmental data bank (and FRACAS).

List of Units

- 1 - Operating – High Temperature
- 2 - Operating – Low Temperature
- 3 - Storage and Transportation – High and Low Temperature
- 4 - Temperature Shock
- 5 - Humidity – Condensing and non-condensing
- 6 - Altitude
Operational/Storage transportation
Temp/Altitude
- 7 - Rapid Decompression/Explosive Decomp
- 8 - Combined Environments
- 9 - Solar Radiation – actinic and thermal effects

10 - Salt Fog

11 - Sand & Dust

12 – Rain

13 - Immersion

14 - Explosive Atmosphere

15 - Icing

16 - Fungus

17 - Acceleration

18 - Space Simulation

19 - Test Documentation

Unit Outline (except for the last three)

Definition of the Climatic Environment

Discussion of the source of the requirement

What the test can reveal

Appropriate Functional testing

Chambers/Equipment - simulating the environment

- Structure

- Controllers

- Instrumentation

 - Sensors

 - Recorders

- Fixturing

Performing the test

Test Acceleration

What can go wrong?

Where does Laboratory Testing Fit in?

Analysis

Simulation

Laboratory Testing

Field trials or deployment

History:

The military was the first organization to “formalize” environmental testing. (During and after WWII)

Both design and testing standards were introduced, although they often conflicted. (MIL 5400, MIL 5422, MIL-STD-810C.

Test standards at first were “cook books” with every parameter defined. MIL-STD-810, A, B, C.

From 810C

3.1 Procedure I

- Step 1 - Prepare the test item in accordance with General Requirements 3.2 and raise the internal chamber temperature to 71°C (160°F). Maintain for a period of not less than 4 hours or until the test item stabilizes.
- Step 2 - At the conclusion of this time period, the test item shall be transferred, within 5 minutes, to a cold chamber with an internal chamber temperature of -57°C (-70°F).
- Step 3 - The test item shall be exposed to this temperature for a period of not less than 4 hours or until the test item stabilizes.
- Step 4 - At the conclusion of this time period, the test item shall, within 5 minutes be returned to the high temperature chamber maintained at 71°C (160°F).
- Step 5 - The test item shall be exposed to this temperature for a period of not less than 4 hours or until the test item stabilizes.
- 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 stabilize.

From 810F

Procedure I - Shock from constant extreme temperatures. (Figure 503.4-1.)

- Step 1. With the test item in the chamber, adjust the chamber air temperature to the low temperature extreme specified in the test plan (a). Maintain this temperature for a period as determined in the test plan (a-b).
- Step 2. Transfer the test item in no more than one minute (b-c) to an atmosphere at temperature T2 that will produce the thermal shock specified in the test plan, and maintain this temperature as specified in the test plan (c-e).
- Step 3. If required in the test plan, evaluate the effects of the thermal shock on the test item to the extent practicable.
- Step 4. If other cycles in reversed directions are required, transfer the test item to the T1 environment in less than one minute (e-f) and stabilize as required in the test plan (f-b), evaluate the thermal shock effects (if required), and continue as in steps 2 and 3 above. If other one way shocks are required, return the test item to the T1 environment at a rate of not more than 3_C/minute and repeat Steps 1-3. If no other shocks are required, go to Step 5.
- Step 5. Return the test item to standard ambient conditions.
- Step 6. Examine the test item and, if appropriate, operate. Record the results for comparison with pretest data.

Failure Definition - Sample

A failure is defined as a test rejection based on inability of the UUT to satisfy the performance or test requirements under the applicable test conditions.

Failure Observation Examples

Failure of Functional Test

Error message

Indicator Lights on Test Equipment

Indicators on UUT

Moving parts not moving

Visual Observation

Cracks

Separation of components

Fogging of optical elements

Loose parts, degraded coatings

Failures by Type of Test:

Operational Testing - must meet all functional criteria during exposure to environment.

Storage and Transportation - Does NOT need to work during exposure, but must meet all operational criteria "X" minutes after exposure.

Crash Safety, Explosive Decompression etc. - Does not need to operate during or after exposure, but must not come apart or come loose, in such a manner to cause a safety hazard.

Failure Reporting

“Should a unit under test (UUT) fail as a result of testing performed in accordance with this procedure, testing shall be stopped. Upon detection of any failure, a TFR shall be generated. Full particulars concerning the failure shall be immediately documented in the test log with probable cause and proposed corrective action added to the TFR as soon as available.”

Functional Testing - General

Three levels -

Level One - (i.e. Acceptance test procedure, Factory Test procedure) - Should test EVERY function of the UUT.

Usually requires a lot of time and extensive test equipment not available at the test site.

Ideally performed before and after each test. Each time it is skipped, it's a gamble.

Level Two - (Functional Test, FT) - Tests as much of the UUT's function as reasonable in no more than 20 or 30 minutes.

Utilizes test equipment which is available at the test site.

Test is performed before and after each test, and between test phases.

The UUT is available for observation and for manipulating controls. (Door open, centrifuge at rest, etc.)

Level Three - (Brief Operational Test, BOT) - tests as much of the UUT's function as reasonable in no more than 2 - 5 minutes.

Objectives:

Requires no contact with the UUT to perform or initiate. (doors closed, centrifuge turning, etc.)

UUT can be left operating, tested in a continuous loop.

Special Functional tests:

Optical Devices may need TV monitoring.

Mechanical devices may need simulated loads.

Try to simulate service usage.

Special for temperature tests - highest and lowest heat dissipation modes, warm up time.

Special Test equipment and cables:

STE should be rugged enough to survive the trip to the lab.

Cables: Make sure they are long enough, you may need special length cables just for Environmental Tests. You will certainly need special cables for acceleration testing.

Cable/Connector Design: **REMEMBER - THE CABLE AND THE CONNECTOR MUST SURVIVE THE SAME ENVIRONMENT AS THE UUT!!!!**

TEST DOCUMENTATION

REQUIREMENTS FLOW DOWN

Requirements must start somewhere

Examples:

Equipment Specification

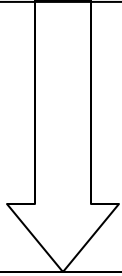
Marketing requirements document

Customer Spec

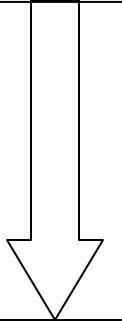
SOMETHING

Whatever it is “should” include environmental design requirements.

Specification



Test Plan



Test Procedure

Describes the usage, transportation and storage environments.

May also include test standards/methods

Describes the test standards and methods

Lists all planned tests, may include reference to specification requirements

Includes all test parameters i.e. temperatures, times, levels, concentrations, operational requirements and Pass/Fail Criteria

Includes schedules (with or without dates) and resource requirements (equipment and people)

Includes description of functional tests and equipment required.

Step by step instructions for each test.

Includes Functional test, data sheets, data taking requirements

Test Documentation:

Before you start

Record:

Manufacturer, Model Number, serial number,
calibration data.

Environmental Test Equipment

Special test equipment AND SOFTWARE

Test Specimen

During the test:

Photographs: You can't take too many pictures.

Test Log: You can't write too much.

Periodically verify that automatically recorded data actually is being recorded.

Failure Reports (TFR etc) - Create before tests if your company doesn't have them.

Test Reports -

Detailed references to test requirements.

Chronology

Failures

Corrective action and retest?

Photographs, data sheets, TFR's and test logs

Conclusions

Certifications

FRACAS

Failure Reporting and Corrective Action System

Database holding all failures and corrective actions,
integrated with TFR form.

Can be referenced by project, environment, part type
and part number

Difficult to enforce:

Entering data

Maintaining

Using

NEXT STEPS

1. Review where your requirements come from?
from Customer?
from Marketing?
from Competition?
 2. Pick an applicable standard
 3. Develop a customized test plan using the standard as a guide.
- ...and of course, we can help with all of these!

ANNUAL RELIABILITY SYMPOSIUM

May 7-11, 2007

Santa Clara, CA

- 1) **Design for Reliability (DfR)** - Learn the building block tools for reliability during the concept and design phase. *May 7-8*
- 2) **Design for Manufacturability (DfM)** - Learn what tools are needed to produce great products with high quality. *May 9*
- 3) **Design for Warranty Cost Reduction (DfW)** - Introduces a proven warranty event cost model that helps identify warranty cost red. Solutions. *May 10*
- 4) **Design of Experiments (DoE)** - Includes basic statistics behind a DOE as well as a workshop in which we perform a DOE on a specific product. *May 9-10*
- 5) **Best Accelerated Reliability Test Methods: HALT, ALT, and RDT** – This course will review each of the best Accelerated Test Methods and show when to use each. Great for those already familiar with the concepts of HALT as well as those that are newcomers to the field. *May 7-8*
- 6) **Fundamentals of Climatic Testing** - Review the different types of climatic tests—temperature, humidity, altitude, rain, solar, salt/fog, & more. *May 9-10*
- 7) **Software Reliability** - Highlights “best practices” in S/W Reliability and explains their application & positive impact to each of the development life cycle phases: Concept, Design, Implementation, & Testing. *May 11*

Ops A La Carte LLC is proud to announce that we now own and operate 

HIGHLIGHTS ABOUT 

- Tested over 500 products in over 50 different industries
- Second oldest HALT facility in the world, established in 1995 (originally owned by QualMark)
- Most experienced staff with over 50 years of combined experience in HALT and HASS
- We only use degreed engineers to run all our HALT.
- HALT equipment has all latest technology – only lab in region
- Our HALT/HASS services are fully integrated with our other consulting services.
- We provide HALT/HASS services on a world-wide basis, using partner labs for tests outside California.



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TEST LAB CAPABILITIES

HALT & HASS Labs adds two more pieces of Reliability Test equipment.

In addition to our two HALT chambers, we now have an electro-dynamic shaker capable of doing two axis sine and random, and we also have a Combined Temperature/Humidity chamber. Both chambers add versatility to the types of reliability tests we can perform.

HERE IS A LIST OF SOME OF THE SPECS WE CAN TEST TO:

- DO160
- IEC
- IEEE
- ISTA/ASTM
- JEDEC
- MIL-STD-810
- SAE
- SEMI
- Telcordia
- and more