

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Methods for product accelerated testing

Méthodes d'essais accélérés de produits

Document Preview

[IEC 62506:2023](#)

<https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Methods for product accelerated testing

Méthodes d'essais accélérés de produits

Document Preview

[IEC 62506:2023](https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023)

<https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 03.120.01, 21.020

ISBN 978-2-8322-7727-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms, definitions, symbols and abbreviated terms.....	9
3.1 Terms and definitions.....	9
3.2 Symbols and abbreviated terms	11
4 General description of the accelerated test methods.....	12
4.1 Cumulative damage model.....	12
4.2 Classification, methods and types of test acceleration	14
4.2.1 General	14
4.2.2 Type A: qualitative accelerated tests	15
4.2.3 Type B: quantitative accelerated tests	15
4.2.4 Type C: quantitative time and event compressed tests.....	16
5 Accelerated test models	17
5.1 Type A, qualitative accelerated tests.....	17
5.1.1 Highly accelerated limit tests (HALT)	17
5.1.2 Highly accelerated stress test (HAST)	21
5.1.3 Highly accelerated stress screening or audit (HASS or HASA).....	22
5.1.4 Engineering aspects of HALT and HASS	23
5.2 Types B and C – Quantitative accelerated test methods.....	23
5.2.1 Purpose of quantitative accelerated testing.....	23
5.2.2 Physical basis for the quantitative accelerated Type B test methods.....	23
5.2.3 Type C tests, time (C_1) and event (C_2) compression	25
5.3 Failure mechanisms and test design	27
5.4 Determination of stress levels, profiles and combinations in use and test – Stress modelling	27
5.4.1 General	27
5.4.2 Step-by-step procedure	28
5.5 Multiple stress acceleration methodology – Type B tests.....	28
5.6 Single and multiple stress acceleration for Type B tests.....	31
5.6.1 Single stress acceleration methodology	31
5.6.2 Stress models with stress varying as a function of time – Type B tests	38
5.6.3 Stress models that depend on repetition of stress applications – Fatigue models.....	40
5.6.4 Other acceleration models	41
5.7 Acceleration of quantitative reliability tests.....	42
5.7.1 Reliability requirements, goals, and use profile	42
5.7.2 Accelerated testing for reliability demonstration or life tests.....	44
5.7.3 Testing of components for a reliability measure	55
5.7.4 Reliability measures for components and systems	56
5.8 Accelerated reliability compliance or evaluation tests.....	57
5.9 Accelerated reliability growth testing	58
5.10 Guidelines for accelerated testing	59
5.10.1 Accelerated testing for multiple stresses and the known use profile	59
5.10.2 Level of accelerated stresses	59
5.10.3 Accelerated reliability and verification tests	59

6	Accelerated testing strategy in product development	60
6.1	Accelerated testing sampling plan.....	60
6.2	General discussion about test stresses and durations	60
6.3	Testing components for multiple stresses.....	61
6.4	Accelerated testing of assemblies	61
6.5	Accelerated testing of systems.....	61
6.6	Analysis of test results	62
7	Limitations of accelerated testing methodology.....	62
Annex A	(informative) Highly accelerated limit test (HALT)	63
A.1	HALT procedure.....	63
A.2	HALT step-by-step procedure	63
A.3	Example 1 – HALT test results for a DC/DC converter.....	65
A.4	Example 2 – HALT test results for a medical item	65
A.5	HALT test results for a Hi-Fi equipment	67
Annex B	(informative) Accelerated reliability compliance and growth test design	68
B.1	Use environment and test acceleration	68
B.2	Determination of stresses and stress duration.....	68
B.3	Overall acceleration of a reliability test.....	69
B.4	Example of reliability compliance test design assuming constant failure rate or failure intensity	70
B.4.1	General	70
B.4.2	Thermal cycling	71
B.4.3	Thermal exposure, thermal dwell	72
B.4.4	Humidity	72
B.4.5	Vibration test	73
B.4.6	Accelerations summary and overall acceleration.....	73
B.5	Example of reliability compliance test design assuming non-constant failure rate or failure intensity (wear-out)	75
Annex C	(informative) Estimating the activation energy, E_a	76
Annex D	(informative) Calibrated accelerated life testing (CALT)	78
D.1	Purpose of test	78
D.2	Test execution	78
Annex E	(informative) Example of how to estimate empirical factors	80
Annex F	(informative) Determination of acceleration factors by testing to failure	83
F.1	Failure modes and acceleration factors	83
F.2	Example of determination of acceleration factor	83
Annex G	(informative) Median rank tables 95 % rank.....	87
	Bibliography.....	89
	Figure 1 – Probability density functions (PDF) for cumulative damage, degradation, and test types	13
	Figure 2 – Relationship of PDFs of the item strength versus load in use	18
	Figure 3 – How HALT tests detect the design margin	19
	Figure 4 – PDFs of operating and destruct limits as a function of applied stress	20
	Figure 5 – Line plot for Arrhenius reaction model	35
	Figure 6 – Plot for determination of the activation energy.....	36
	Figure 7 – Bathtub curve.....	47

Figure 8 – Test planning with a Weibull distribution..... 50

Figure 9 – Example of a test based on the Weibull distribution..... 51

Figure 10 – Life time and "tail" of the failure rate or failure intensity..... 52

Figure 11 – Reliability as a function of life time ratio L_V and number of test items 53

Figure 12 – Nomogram for test planning 54

Figure A.1 – How FMEA and HALT supplement each other..... 63

Figure C.1 – Plotting failures to estimate the activation energy E_a 77

Figure E.1 – Weibull graphical data analysis..... 81

Figure F.1 – Weibull plot of the three data sets 84

Table 1 – Test types mapped to the item development cycle..... 14

Table A.1 – Comparison between classical accelerated tests and HALT tests..... 63

Table A.2 – Summary of HALT results for a DC/DC converter 65

Table A.3 – Summary of HALT results for a medical system 66


Table A.4 – Summary of HALT results for a Hi-Fi equipment..... 67

Table B.1 – Environmental stress conditions of an automotive electronic device 70

Table E.1 – Probability of failure of test samples A and B 81

Table F.1 – Voltage test failure data for Weibull distribution..... 83

Table G.1 – Median rank tables 95 % rank..... 87


 (https://standards.iteh.ai)
 Document Preview

[IEC 62506:2023](https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023)

<https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

METHODS FOR PRODUCT ACCELERATED TESTING

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62506 has been prepared by IEC technical committee 56: Dependability. It is an International Standard.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) references have been updated;
- b) symbols have been revised;
- c) errors in 5.7.2.3 and Annex B, mainly, have been corrected;
- d) calculation errors in the examples of Annex B and Annex F have been corrected.

The text of this International Standard is based on the following documents:

Draft	Report on voting
56/2000/FDIS	56/2016/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

iTeh Standards

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

[IEC 62506:2023](https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023)

<https://standards.iteh.ai/catalog/standards/sist/22d810c5-0dd8-4cb9-b4da-f4c424649ca1/iec-62506-2023>

INTRODUCTION

Many reliability or failure investigation test methods have been developed and most of them are currently in use. These methods are used to either determine product reliability or to identify potential product failure modes, and have been considered effective as demonstrations of reliability:

- fixed duration,
- sequential probability ratio,
- reliability growth tests,
- tests to failure, etc.

Such tests, although very useful, are usually lengthy, especially when the product reliability that has to be demonstrated is high. The reduction in time-to-market periods as well as competitive product cost, increase the need for efficient and effective accelerated testing. Here, the tests are shortened through the application of increased stress levels or by increasing the speed of application of repetitive stresses, thus facilitating a quicker assessment and growth of product reliability through failure mode discovery and mitigation.

There are two distinctly different approaches to reliability activities:

- the first approach verifies, through analysis and testing, that there are no potential failure modes in the product that are likely to be activated during the expected life time of the product under the expected operating conditions and usage profile;
- the second approach estimates how many failures can be expected after a given time under the expected operating conditions and usage profile.

Accelerated testing is a method appropriate for both cases, but used quite differently. The first approach is associated with qualitative accelerated testing, where the goal is identification of potential faults that eventually can result in product field failures. The second approach is associated with quantitative accelerated testing where the product reliability may be estimated based on the results of accelerated simulation testing that can be related back to the use of the environment and usage profile.

Accelerated testing can be applied to multiple levels of items containing hardware and software. Different types of reliability testing, such as fixed duration, sequential test-to-failure, success test, reliability demonstration, or reliability growth or improvement tests can be candidates for accelerated methods. This document provides guidance on selected, commonly used accelerated test types. This document should be used in conjunction with statistical test plan standards such as IEC 61123, IEC 61124, IEC 61649 and IEC 61710.

The relative merits of various methods and their individual or combined applicability in evaluating a given system or item, should be reviewed by the product design team (including reliability engineering) prior to selection of a specific test method or a combination of methods. For each method, consideration should also be given to the test time, results produced, credibility of the results, data required to perform meaningful analysis, life cycle cost impact, complexity of analysis and other identified factors.

In this document the term "item" is used as defined in IEC 60050-192 covering physical products as well as software. Services and people are however not covered by this document.

METHODS FOR PRODUCT ACCELERATED TESTING

1 Scope

This document provides guidance on the application of various accelerated test techniques for measurement or improvement of item reliability. Identification of potential failure modes that can be experienced in the use of an item and their mitigation is instrumental to ensure dependability of an item.

The object of the methods is to either identify potential design weakness or provide information on item reliability, or to achieve necessary reliability and availability improvement, all within a compressed or accelerated period of time. This document addresses accelerated testing of non-repairable and repairable systems. It can be used for probability ratio sequential tests, fixed duration tests and reliability improvement/growth tests, where the measure of reliability can differ from the standard probability of failure occurrence.

This document also extends to present accelerated testing or production screening methods that would identify weakness introduced into the item by manufacturing error, which can compromise item reliability. Services and people are however not covered by this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-192 – *International Electrotechnical Vocabulary (IEV) – Part 192: Dependability*, available at <http://www.electropedia.org/>

IEC 60300-3-5, *Dependability management – Part 3-5: Application guide – Reliability test conditions and statistical test principles*

IEC 60605-2, *Equipment reliability testing – Part 2: Design of test cycles*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 61123:2019, *Reliability testing – Compliance test plans for success ratio*

IEC 61124:2023, *Reliability testing – Compliance tests for constant failure rate and constant failure intensity*

IEC 61649:2008, *Weibull analysis*

IEC 61709, *Electric components – Reliability – Reference conditions for failure rates and stress models for conversion*

IEC 61710, *Power law model – Goodness-of-fit tests and estimation methods*

IEC 62429, *Reliability growth – Stress testing for early failures in unique complex systems*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-192 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

NOTE Symbols for reliability, availability and maintainability measures follow those of IEC 60050-192, where available.

3.1.1

activation energy

E_a

empirical factor for estimating the acceleration caused by a change in absolute temperature

Note 1 to entry: Activation energy is usually measured in electron volts per degree Kelvin.

3.1.2

detection screen

low stress level exposure to detect intermittent faults

3.1.3

event compression

increasing stress repetition frequency to be at considerably higher levels than it is in the field

3.1.4

highly accelerated limit test

HALT

test or sequence of tests intended to identify the most likely failure modes of the product in a defined stress environment

Note 1 to entry: HALT is sometimes spelt out as the highly accelerated life test (as it was originally named in error). However, as a non-measurable accelerated test, it does not provide information on life duration, but on the magnitude of stress which represents the limit of the design.

3.1.5

highly accelerated stress audit

HASA

process monitoring tool where a sample from a production lot is tested to detect potential weaknesses in a product caused by manufacturing

3.1.6

highly accelerated stress screening

HASS

screening intended to identify latent defects in a product caused by manufacturing process or control errors

3.1.7

item

subject being considered

Note 1 to entry: The item may be an individual part, component, device, functional unit, equipment, subsystem, or system.

Note 2 to entry: The item may consist of hardware, software, people or any combination thereof.

Note 3 to entry: The item is often comprised of elements that may each be individually considered. See "sub-item" (IEV 192-01-02) and "indenture level" (IEV 192-01-05).

Note 4 to entry: IEC 60050-191:1990 (now withdrawn; replaced by IEC 60050-192:2015) identified the term "entity" as an English synonym, which is not true for all applications.

Note 5 to entry: The definition for "item" in IEC 60050-191:1990 (now withdrawn; replaced by IEC 60050-192:2015) is a description rather than a definition. This new definition provides meaningful substitution throughout this document. The words of the former definition form the new Note 1 to entry.

Note 6 to entry: In this document people and services are excluded.

[SOURCE: IEC 60050-192:2015, 192-01-01, modified – Note 6 to entry has been added.]

3.1.8

life time

<of a non-repairable item> time interval from first use until user requirements are no longer met

Note 1 to entry: The end of life time is usually called failure of the component.

Note 2 to entry: The end of life is often defined as the time where a specified percentage of the components have failed, for example stated as a B_{10} or L_{10} value for 10 % accumulated failures.

3.1.9

precipitation screen

screening profile to precipitate, through failure, conversion of latent faults into revealed faults

3.1.10

step-stress test

test in which the applied stress is increased, after each specified interval, until failure occurs or a predetermined stress level is reached

Note 1 to entry: The 'interval' could be specified in terms of number of stress applications, durations, or test sequences.

Note 2 to entry: The test should not alter the basic failure modes, failure mechanisms, or their relative prevalence.

[SOURCE: IEC 60050-192:2015, 192-09-10]

3.1.11

test acceleration factor

ratio of the stress response rate of the test specimen under the accelerated conditions, to the stress response rate under specified operational conditions

Note 1 to entry: Both stress response rates refer to the same time interval in the life of the tested items.

Note 2 to entry: Measures of stress response rate are, for example, operating time to failure, failure intensity, and rate of wear.

[SOURCE: IEC 60050-192:2015, 192-09-09]

3.1.12

time compression

removal of exposure time at low or deemed non damaging stress levels from a test for the purpose of acceleration

3.2 Symbols and abbreviated terms

ADT	accelerated degradation test(ing)
AF	acceleration, acceleration factor
AF_{Test}	overall acceleration in a test
CALT	calibrated accelerated life testing
B_{10}	life time, the time where 10 % of the items have failed
C	confidence
CD	compact disc player in a HiFi equipment
DL	destruct limit
DSL	design specification limit
FIT	failure in time (failure per 10^9 hours)
HALT	highly accelerated limit test
HASA	highly accelerated stress audit
HASS	highly accelerated stress screening test
HAST	highly accelerated stress test
L	load
L_v	life time ratio
LDL	lower destruct limit
LDT	lower destruct temperature
LOL	lower operating limit
LOT	lower operating temperature
LRTL	lower reliability test limit
MTBF	mean operating time between failures
MTTF	mean operating time to failure
OL	operating limit
OVL	operation vibration limit
P_A	acceptance probability
PDF	probability density functions
PWB	printed wiring board
$R(t)$	reliability as a function of time; probability of survival to the time t
RTL	reliability test level
S	strength
SL	specification limit
SPRT	sequential probability ratio test
t_0	time denoted time 0
t_L	a specified time, e.g. life
THB	temperature humidity bias test
TTF	time to failure
UDL	upper destruct limit
UDT	upper destruct temperature
UOL	upper operating limit
UOT	upper operating temperature

URTL	upper reliability test limit
UUT	unit under test
VDL	vibration destruct limit
$\lambda(S)$	failure rate as a function of a stress
$\lambda(t)$	failure rate as a function of time

4 General description of the accelerated test methods

4.1 Cumulative damage model

Accelerated testing of any type is based on the cumulative damage principle. The stresses of the item in its life cause progressive damage that accumulates throughout the item life. This damage can, or not, result in an item's failure in the field.

The strategy of any type of accelerated testing is to produce, by increasing stress levels during testing, cumulative damage equivalent to that expected in the item's life for the type of expected stress. The determination of item destruct limits, without reliability estimation, provides information on whether there exists a sufficient margin between those destruct limits and item specification limits, thus providing assurance that the item will survive its predetermined life period without failure related to that specific stress type. This technique can, but not necessarily, quantify a probability of item survival for its life, and just provides assurance that the necessary adjustments in item strength would help eliminate such failure in item use. Where sufficient margins are determined unrelated to the probability of survival, the type of test is qualitative. In tests where this probability of survival is determined, the magnitude of the stress is correlated to the probability that the item would survive that stress type beyond the predetermined life, and this test type is quantitative.

Figure 1 depicts the principle of cumulative damage in both qualitative and quantitative accelerated tests.

In Figure 1, for simplicity, all stresses, operating limits, destruct limits, etc. are shown as absolute values. The specification values for an item are usually given in both extremes, upper and lower, thus the upper and lower (or low) specification limit, USL and LSL with the corresponding design limits (DSL), UDL and LDL, the upper and lower operating limits, UOL and LOL, and also the reliability test limits, URTL and LRTL. The rationale is that the opposite (negative stresses), can also cause cumulative damage probably with a different failure mechanism, thus the relationship between the expected and specified limits can be illustrated in the same manner as for the high or positive stress. As an example, cold temperature extremes can produce the same or different failure modes in an item. To avoid clutter, the positive and the negative thermal or any other stresses are not separately shown in Figure 1, thus the magnitudes of stresses are either positive or negative, and thus represented as absolute values only as upper or lower limits.