SLOVENSKI STANDARD
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Space engineering - Testing

Space engineering - Testing

Raumfahrttechnik - Tests

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Space engineering - Testing

Raumfahrttechnik - Tests

This European Standard was approved by CEN on 1 October 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 14824:2003) has been prepared by CMC.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2004, and conflicting national standards shall be withdrawn at the latest by June 2004.

In this European Standard the annexes A and B are informative and the annex C is normative.

It is based on a previous version[1)] originally prepared by the ECSS Space engineering testing Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (ECSS) is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

This standard is one of the series of space standards intended to be applied together for the management, engineering and product assurance in space projects and applications.

Requirements in this standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

[1)] ECSS-E-10-03A

1 Scope

This European Standard;

a) specifies standard environmental and performance test requirements for a space system and its constituents;

b) specifies the test requirements for products and systems that are generally applicable to all projects;

c) specifies the documentation associated with testing activities;

d) is applicable to all types and combinations of project, organization and product;

e) is applicable to space systems and its constituents; and

f) covers each stage of verification by testing, for a space system from development to post-landing.

This European Standard does not specify acceptance criteria, specifications or procedures for any particular project or class of projects. In addition this standard does not apply to software testing, hardware below equipment levels, nor covers the following:

- sounding rockets;
- launch facilities;
- test facilities;
- training facilities and ground refurbishment;
- logistic facilities; and
- engine testing.

The requirements specified in this European Standard should be tailored to match the requirements of the particular profile and circumstances of a project.

NOTE Tailoring is a process by which individual requirements or specifications, standards and related documents are evaluated and made applicable to a specific project by selection, and in some exceptional cases, modification of existing or addition of new requirements.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13701:2001, *Space systems — Glossary of terms.*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13701:2001 and the following apply.

3.1.1
acceptance stage
verification stage with the objective of demonstrating that the product is free of workmanship defects and integration errors and ready for its intended use

3.1.2
airborne support equipment (ASE)
equipment installed in a recoverable launch vehicle to provide support functions and interfaces for the spacecraft during launch and orbital operations of the recoverable launch vehicle

NOTE ASE includes the hardware and software that provides the structural, electrical, electronic and mechanical interfaces with the launch vehicle. ASE is recovered with the launch vehicle.

3.1.3
burst pressure
maximum test pressure that pressurized equipment withstands without rupture to demonstrate the adequacy of the design in a qualification test

NOTE 1 Burst pressure is equal to the product of the maximum expected operating pressure, a burst pressure design factor, and a factor corresponding to the differences in material properties between test and design temperatures.

NOTE 2 An item subjected to a burst pressure test is not used for other purposes.

3.1.4
design environments
composite of the various environmental loads, to which the hardware is designed

NOTE Each of the design environments is based upon:

- maximum and minimum predicted environments during the operational life of the item;
- qualification margin that increases the environmental range to provide an acceptable level of confidence that a failure does not occur during the service life of the item;
- uncertainties and tolerances related to the analytical prediction.

3.1.5
environmental design margin
increase of the environmental extremes for the purpose of design and qualification above the levels expected during the life cycle

NOTE Environmental design margin includes levels such as mechanical, thermal, radiation as well as the time of exposure of them.

3.1.6
environmental test
simulation of the various constraints (together or separately) to which an item is subjected during its operational life cycle

NOTE Environmental tests cover natural and induced environments.

3.1.7
fundamental resonance (for structural modes)
first major significant resonance's as observed during one-axis vibration test for each of the three test axes

NOTE 1 The term fundamental resonance is used in conjunction with notching of sinusoidal vibration input spectrum for item qualification.

NOTE 2 Significant resonances are modes that have an effective mass greater than 10 % of the total mass of the item.

3.1.8
in-orbit stage
verification stage valid for projects whose characteristics (e.g. mission and in-orbit operations) require in-orbit verification

3.1.9
integrated system check
sub-set of the integrated system test, able to involve all major functions, at the maximum extent automatically performed and with the scope to provide the criteria for judging successful survival of the element in a given test environment, with a high degree of confidence, in a relatively short time

NOTE Integrated system check is also known as "abbreviated functional test".

3.1.10
integrated system test
test that has the scope to verify that the performance of the element meets the specification requirements, in terms of correct operation in all operational modes, including back-up modes and all foreseen transients

NOTE Integrated system test is also known as "system functional test".

3.1.11
limit load
maximum anticipated load, or combination of loads, which a structure is expected to experience during the performance of specified missions in specified environments

NOTE Since the actual loads that are experienced in service are in part random in nature, statistical methods for predicting limit loads are generally employed.

3.1.12
low level sinusoidal vibration
exposing an item to a frequency sweep of low level sinusoidal vibrations to show possible deficiencies in workmanship, as a consequence of another environment

NOTE Low level sinusoidal vibration test is also known as "signature test".

3.1.13
maximum and minimum predicted equipment temperatures
highest and lowest temperatures that are expected to occur in flight on each equipment of the spacecraft during all operational and non-operational modes which include uncertainties

3.1.14
maximum predicted acceleration
acceleration value determined from the combined effects of the quasi steady acceleration and the transient response of the vehicle to engine ignition, engine burnout and stage separation

NOTE Where the natural frequency of the equipment mount or mounting structure can couple with engine initiated transients, the maximum predicted acceleration level accounts for the possible dynamic amplification.

3.1.15
maximum predicted acoustic environment
maximum value of the time average root-mean-square (r.m.s.) SPL (sound pressure level) in each frequency band occurring below payload fairing or within STS (space transportation system) orbiter cargo bay, which occurs during lift-off, powered flight or re-entry

NOTE The maximum predicted acoustic environment test spectrum is specified in octave or 1/3 octave bands over a frequency range of 31,5 Hz to 10 000 Hz. The duration of the maximum environment is the total period when the overall amplitude is within 6 dB of the maximum overall amplitude.

3.1.16
maximum predicted operating pressure
working pressure applied to equipment by the pressurizing system with the pressure regulators and relief valves at their upper operating limit, including the effects of temperature, transient peaks and vehicle acceleration

3.1.17
maximum predicted pyro shock environment
maximum absolute shock response spectrum determined by the response of a number of single degree of freedom systems using an acceleration amplification factor at the resonant frequency of lightly damped system (Q = 10)

NOTE 1 The shock response spectrum is determined at frequency intervals of one-sixth octave or less over a frequency range of 100 Hz to 4 000 Hz or more.

NOTE 2 The pyro shock environment imposed on the spacecraft equipment is due to structural response when the space or launch vehicle electro-explosive devices are activated. Resultant structural response accelerations have the form of superimposed complex decaying sinusoids that decay to a few percent of their maximum acceleration in 5 m/s to 15 m/s.

3.1.18
maximum predicted random vibration environment
random vibration environment imposed on the spacecraft, subsystems and equipment due to the lift-off acoustic field, aerodynamic excitations, and transmitted structure-borne vibration

NOTE 1 A different spectrum can exist for different equipment zones or for different axis. The equipment vibration levels are based on vibration response measurements made at the equipment attachment points during ground acoustic tests or during flight. The duration of the maximum environment is the total period during flight when the overall level is within 6 dB of the maximum overall level.

NOTE 2 The power spectral density is based on a frequency resolution of 1/6 octave (or narrower) bandwidth analysis, over a frequency range of 20 Hz to 2 000 Hz.

3.1.19
maximum predicted sinusoidal vibration environment
predicted environment imposed on the spacecraft, subsystems and equipment due to sinusoidal and narrow band random forcing functions within the launch vehicle or spacecraft during flight or from ground transportation and handling

NOTE 1 In flight, sinusoidal excitations are caused by unstable combustion, by coupling of structural resonant frequencies (POGO), or by imbalances in rotating equipment in the launch vehicle or spacecraft. Sinusoidal excitations occur also during ground transportation and handling due to resonant responses of tires and suspension systems of the transporter.

NOTE 2 The maximum predicted sinusoidal vibration environment is specified over a frequency range of 5 Hz to 100 Hz for flight excitation.

3.1.20
model philosophy
definition of the optimum number and characteristics of physical models to achieve a high confidence in the product verification with the shortest planning and a suitable weighing of costs and risks

3.1.21
moving mechanical assemblies
mechanical or electromechanical devices that control the movement of one mechanical part of a spacecraft relative to another part

NOTE Moving mechanical assemblies include:
deployment mechanisms, pointing mechanisms, drive mechanisms, design mechanisms and the actuators, motors, linkages, latches, clutches, springs, cams, dampers, booms, gimbals, gears, bearings and instrumentation that are an integral part of these mechanical assemblies (e.g. recorders).

3.1.22
multipacting
resonant back and forth flow of secondary electrons in a vacuum between two surfaces separated by a distance such that the electron transit time is an odd integral multiple of one half the period of the alternating voltage impressed on the surface

NOTE 1 Multipacting does not occur unless an electron impacts one surface to initiate the action, and a secondary emission of one or more electrons at each surface to sustain the action takes place.

NOTE 2 Multipacting is an unstable self-extinguishing action which occurs at pressures less than $6,65 \times 10^{-2}$ hPa, however, it becomes stable at a pressure less than $1,33 \times 10^{-3}$ hPa.

NOTE 3 The pitting action resulting from the secondary emission of electrons degrades the impacted surfaces. The secondary electron emission can also increase the pressure in the vicinity of the surfaces causing ionization (corona) breakdown to occur.

NOTE 4 These effects can cause degradation of performance or permanent failure of the radio frequency cavities, wave guides or other devices involved.

3.1.23
notching of sinusoidal vibration input spectrum
notching of the shaker input spectrum to limit structural responses at resonant frequencies according to qualification or acceptance loads

NOTE Notching of sinusoidal vibration input spectrum is a general accepted practise in vibration testing.

3.1.24
operational modes
combination of operational configurations or conditions that can occur during the service life for equipment or spacecraft

EXAMPLE Power-on or power-off, command modes, readout modes, attitude control modes, antenna stowed or deployed, and spinning or de-spun.

3.1.25
post-landing stage
verification stage valid for projects where characteristics for post-landing verification is performed (e.g. multimission projects)

3.1.26
pre-launch stage
verification stage with the objective to verify that the flight article is properly configured for launch and capable to function as planned for launch

3.1.27
proof pressure
test pressure for pressurized equipment to sustain without detrimental deformation

NOTE 1 The proof pressure is used to give evidence of satisfactory workmanship and material quality, or to establish maximum possible flaw size.

NOTE 2 The proof pressure is equal to the product of maximum predicted operating pressure (see 3.1.16), proof pressure design factor, and a factor accounting for the difference in material properties between test and design temperature.

3.1.28
qualification stage
verification stage with the objective to demonstrate that the design conforms to the requirements including margins

3.1.29
service life
total life expectancy of an item, equipment or space vehicle

NOTE The service life starts at the completion of assembly of the item and continues through all acceptance testing, handling, storage, transportation, launch operations, orbital operations, refurbishment, retesting, re-entry or recovery from orbit, and reuse if applicable.

3.1.30
space element
product or set of products intended to be operated in outer space

NOTE 1 In order to avoid repetition in the level of decomposition of the space product, the term element is used to define "systems within the system". The term element is used to identify any system within the space system.

NOTE 2 Elements that operate entirely in space or on the ground are referred to as "Space segment" and "Ground Segment" respectively.

3.1.31
space vehicle
integrated set of subsystems and equipment capable of supporting an operational role in space

NOTE A space vehicle can be an orbiting vehicle, a major portion of an orbiting vehicle, or a payload that performs its mission while attached to a launch or upper-stage vehicle. The ground support equipment is considered to be a part of the space vehicle.

3.1.32
stabilized test temperature
specified temperature for equipment and subsystem tests that has been achieved and has not changed by more than 1 °C during the previous one-hour period

NOTE During system level tests, performance verification testing can be started when the rate of change is below 1 °C within a time period equal or near the time constant of the spacecraft.

3.1.33
temperature reference, reference point
physical point located on the equipment providing a simplified representation of the equipment thermal status

NOTE 1 Depending upon the equipment dimensions, more than one temperature reference can be defined.

NOTE 2 The temperature of the reference point is measured by temperature sensors during test. The temperature distribution within the equipment and hot spots on the external casing due to point heat sources are not used as reference points.

3.1.34
ultimate load
maximum static load to which a structure is designed

NOTE Ultimate load is obtained by multiplying the limit load by the ultimate factor of safety.

3.2 Abbreviated terms

For the purposes of this European Standard the following abbreviated terms apply.

Abbreviation	Meaning
ABCL	as-built configuration list
ABM	apogee boost motor
AFT	abbreviated functional test
AOCS	attitude and orbit control system

APTC	ambient pressure temperature cycling
ASE	airborne support equipment
ATC	accelerate thermal cycling
AVM	anti vibration mounts
AVT	acceptance vibration test
BAPTA	bearing and power transfer assembly
CCB	configuration control board
CIDL	configuration item data list
CoG	centre of gravity
DRD	document requirements definition
ECLS	environmental control and life support
EGSE	electrical ground support equipment
EMC	electromagnetic compatibility
EQM	engineering qualification model
ESD	electrostatic discharge
ESSEH	environmental stress screening of electronic hardware
FM	flight model
FOP	flight operations plan
GSE	ground support equipment
HFE	human factors engineering
hi-rel	high reliability
ISC	integrated system check
ISST	integrated subsystem test
IST	integrated system test
LCDA	launcher coupled dynamic analysis
LEO	low Earth orbit
LEOP	launch and early orbit phase
LV	launch vehicle
M	mass
MEC	microgravity environmental compatibility
MIL (spec)	specification of the US Department of Defence