

SLOVENSKI STANDARD SIST EN 14607-2:2005

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Vesoljska tehnika - Mehanika - 2. del: Konstrukcija

Space engineering - Mechanical - Part 2: Structural

Raumfahrttechnik - Mechanik - Teil 2: Strukturen

Ingénierie spatiale - Mécanique - Partie 2: Structure PREVIEW

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Space engineering - Mechanical - Part 2: Structural

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Raumfahrttechnik - Mechanik - Teil 2: Strukturen

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 14607-2:2004) 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of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

It is based on a previous version ¹⁾ originally prepared by the European Cooperation for Space Standardization (ECSS) Mechanical Engineering Standard Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization 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 document 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 document 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.

EN 14607 Space engineering - Mechanical is published in 8 Parts: EVIEW

Part 1: Thermal control

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Part 2: Structural

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• Part 3: Mechanisms ee55cd0d2247/sist-en-14607-2-2005

- Part 4: ECLS
- Part 5: Propulsion
 - Part 5.1: Liquid and electric propulsion for spacecraft
 - Part 5.2: Solid propulsion for spacecraft, solid and liquid propulsion for launchers
- Part 6: Pyrotechnics
- Part 7: Mechanical parts
- Part 8: Materials

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia,

¹⁾ ECSS-E-30 Part 2A

Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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1 Scope

Part 2 of Space engineering - Mechanical defines the mechanical engineering requirements for structural engineering.

This document specifies the requirements to consider in all engineering aspects of structures: requirement definition and specification, design, development, verification, production, in-service and eventual disposal.

The document applies to all general structural subsystem aspects of space including: launch vehicles, transfer vehicles, re-entry vehicles, spacecraft, landing probes and rovers, sounding rockets, payloads and instruments, and structural parts of all subsystems.

When viewed from the perspective of a specific project context, the requirements defined in this document should be tailored to match the genuine requirements of a particular profile and circumstances of a project.

NOTE Tailoring is a process by which individual requirements of 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

The following referenced documents are indispensable for the application 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.

EN 13701:2001, Space systems — Glossary of terms. (S.iteh.ai)

ECSS-E-10, Space engineering — System engineering SIS1 EN 14607-2:2005

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3 Terms, definitions, abbreviated terms and units

3.1 Terms and definitions

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

3.1.1

A-value

mechanical property value above which at least 99 % of the population of values is expected to fall, with a confidence level of 95 %

NOTE A-value is also called A-allowable.

3.1.2

allowable stress (load)

maximum stress (load) in a structural part for a given operating environment to prevent rupture, collapse, detrimental deformation or unacceptable crack growth

3.1.3

B-value

mechanical property value above which at least 90 % of the population of values is expected to fall, with a confidence level of 95 %

NOTE B-value is also called B-allowable.

3.1.4

composite material

material that is made of two or more constituent materials

3.1.5

composite structure

structure composed of fibre-reinforced material, such as carbon, aramid or glass continuous aligned fibres in a resin, metallic or ceramic matrix

Fibre-reinforced plastic face sheeted sandwich panels containing light alloy or composite material cores are also defined as composite structures.

3.1.6

design load

limit load multiplied by a design factor

3.1.7

design parameters

physical features which influence the design performances

According to the nature of the design variables, different design problems can be identified such as: NOTE

- structural sizing for the dimensioning of beams, shells;
- · shape optimization;
- material selection;
- structural topology.

3.1.8

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dvnamic load

time varying load with deterministic or stochastic distributions.iteh.ai)

3.1.9

factor of safety (FOS)

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coefficient by which the design loads are multiplied in order to account for uncertainties in the statistical distribution of loads, uncertainties in structural analysis, manufacturing process, material properties and failure criteria

3.1.10

fail-safe

structure which is designed with sufficient redundancy to ensure that the failure of one structural element does not cause general failure of the entire structure with catastrophic consequences (e.g. loss of launcher and endangerment of human life)

Failure can be considered as rupture, collapse, seizure, excessive wear or any other phenomenon resulting in an inability to sustain limit loads, pressures or environments.

3.1.11

generalized mass

mass transformed by the mode shapes into the modal space (i.e. modal coordinates)

3.1.12

limit load

maximum load to be encountered in service with a given probability for a given design condition

3.1.13

margin of safety (MOS)

margin of the applied load multiplied by a factor of safety against the allowed load

3.1.14

maximum design pressure (MDP)

maximum pressure for which the system or component is designed

The MDP is always equal or larger than the MEOP. NOTE

3.1.15

maximum expected operating pressure (MEOP)

maximum pressure at which the system or component is expected to operate in a particular application

NOTE

MEOP includes the effects of temperature, transient pressure peaks, vehicle acceleration and relief valve tolerance.

3.1.16

POGO

propulsion generated oscillations

3.1.17

primary structure

part of the structure that carries the main flight loads and defines the fundamental resonance frequencies

3.1.18

proof load

load applied during a proof test

3.1.19

random load

vibration load whose instantaneous magnitudes are specified only by probability distribution functions giving the probable fraction of the total time that the instantaneous magnitude lies within a specified range

NOTE

Random load contains no periodic or quasi-periodic constituents.

3.1.20

safe life structure

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structure which has no failure when subject to the cyclic and sustained loads and environments encountered in the Stanuarus.iten.aij service life

3.1.21

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scatter factor

scatter factor https://standards.iteh.ai/catalog/standards/sist/ac5b1213-4ad8-4116-8d17-coefficient by which number of cycles or life time is multiplied in order to account for uncertainties in the statistical distribution of loads and cycles as well as uncertainties in fatigue analysis, manufacturing processes and material properties

3.1.22

secondary structure

structure attached to the primary structure with negligible participation in the main load transfer and the stiffness of which does not significantly influence the fundamental resonance frequencies

3.1.23

shock load

special type of transient load, where the load shows significant peaks and the duration of the load is well below the typical response time of the structure

3.1.24

(quasi) static loads

loads independent of time or which vary slowly, so that the dynamic response of the structure is not significant

(Quasi) static loads comprise both static and dynamic loads and are applied at a frequency sufficiently below the natural frequency of the considered part thus being equivalent to static loads for the structure.

3.1.25

stiffness

ratio between an applied force and the resulting displacement

3.1.26

structure

physical part carrying loads or supporting or protecting other components

The structure is usually split into primary and secondary structures. NOTE

3.1.27

transient load

deterministic load whose magnitude or direction varies with time and for which the dynamic response of the structure is significant

3.1.28

ultimate load

design load multiplied by the ultimate safety factor

3.1.29

ultimate strength

strength of a material in tension, compression, or shear, respectively, which is the maximum tensile, compressive, or shear stress that the material can sustain

NOTE

It is implied that the condition of stress represents uniaxial tension, uniaxial compression, or pure shear.

3.1.30

ultimate stress

engineering stress caused by the ultimate load

NOTE

With this definition no relation exists with ultimate strength.

3.1.31

vield load

design load multiplied by the yield safety factor

3.1.32

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yield strength

stress at which a material exhibits a specified permanent deformation or set

The permanent deformation is usually determined by measuring the departure of the actual stress-strain diagram from an extension of the initial straight proportion. The specified value is often taken as a unit strain of 0,002.

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3.1.33

yield stress

stress caused by the yield load

3.2 Abbreviated terms

The following abbreviated terms are defined and used within this document.

Abbreviation Meaning

AIT assembly, integration and tests

BIT built-in testing

computer aided design CAD

computer aided engineering CAE

computer aided manufacturing CAM

COG centre of gravity

COV coefficient of variation

degree of freedom DoF

environment control and life support **ECLS**

electromagnetic compatibility **EMC**

10

FCI fracture critical item

FEA finite element analysis

FE finite element

FM flight model

FMECA failure mode, effects and criticality analysis

FOS factor of safety

FSI fluid structure interaction

LCDA launcher coupled dynamic analysis

MDP maximum design pressure

MOI moment of inertia

MOS margin of safety

NDT non-destructive test

NDI non-destructive inspection

PFCI potential fracture critical item

(standards.iteh.ai)

PFO particle fall out

r.m.s. root-mean-square SIST EN 14607-2:2005

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SM structural model ee55cd0d2247/sist-en-14607-2-2005

4 Requirements

4.1 General

Structural design shall:

- a) aim for simple load paths;
- b) maximize the use of conventional materials;
- c) simplify interfaces;
- d) provide easy integration.

4.2 Mission

4.2.1 Lifetime

- a) All structural assemblies and components shall be designed to withstand applied loads due to the natural and induced environments to which they are exposed during the service-life and shall be able, in operation, to fulfil the mission objectives for the specified duration.
- b) The service-life shall be defined taking into account all ground operations, such as transportation, handling, testing and storage as well as all phases of pre-launch, launch, operation and descent.

- c) The phases, applicable loads and duration shall be determined based on:
 - 1) the requirements of the structure (i.e. single mission, expendable, re-usable or long-term deployment),
 - 2) the effect of all degradation mechanisms upon materials used in the construction (i.e. both terrestrial and space environments and all expected loading regimes), and
 - 3) experience with similar structures (e.g. qualification and problems identified in-service).
- d) Service-life evaluations shall be applied to determine:
 - 1) the inspection and maintenance requirements,
 - 2) when an item should be replaced (preventive maintenance), and
 - 3) the inspection and repair procedures and intervals (corrective maintenance).
- e) An envelope-lifetime, consisting of the most unfavourable sequence of events (loading cycles and thermal cycles) to which the structure can be subjected during its defined service-life, shall be defined as follows:
 - 1) It shall commence at the start of manufacturing and shall end with the completion of the mission;
 - 2) The envelope-lifetime shall be an envelope of all real lifetimes. If there are several variants in the real lifetime, the most severe shall be retained;
 - 3) The envelope-lifetime shall define all lifetime phases and their chronology;
 - 4) For each lifetime phase, the envelope shall take into account the maximum duration and the maximum number of cycles.

4.2.2 Natural and induced environment SIST EN 14607-2:2005 Natural and induced environment SIST EN 14607-2:2005 SIST EN 14607-2:2005 SIST EN 14607-2:2005

- a) Components and assemblies for space applications shall be compatible with:
 - 1) the operational environment conditions, and
 - 2) with the atmospheric conditions on earth in which they are manufactured and tested;
- b) Consideration shall be given to effects of gravitation and exposure of sensitive materials to manufacturing and atmospheric environments;
- c) Provisions (e.g. gravitational compensation and purging) shall be made for the protection of sensitive equipment or components.
- NOTE 1 The sensitivity of materials to the environment on earth can determine the requirements for quality control procedures.
- NOTE 2 The natural environment generally covers the climatic, thermal, chemical and vacuum conditions, cleanliness, levels of radiation and the meteoroid and space debris environment.
- NOTE 3 The induced environments cover the mechanical loads induced by ground handling and pre-launch operations, launch, manoeuvres and disturbances, re-entry, descent and landing. Additional induced environments include static pressure within the payload volume, temperature and thermal flux variations and the electromagnetic and humidity environments.

4.2.3 Mechanical environment

- a) The mechanical environment shall be defined by static and dynamic environment loads.
- b) The static and dynamic environment loads shall be defined in terms of constant acceleration, transient, sinusoidal and random vibration, acoustic noise and shock loads.
- c) All loads shall be considered in the worst combinations in which they occur.

NOTE The severest loads are experienced during launch, ascent and separation, and, where relevant during re-entry, descent and landing.

d) Consideration shall be given to the other loads which can effect the performance in an operational mode.

4.2.4 Microgravity, audible noise and human vibration

Structural requirements dictated by microgravity, audible noise and human vibration system level requirements shall be taken into account.

4.2.5 Corrosion effects

a) The selection of a material for corrosion resistance shall take into account the specific environment, the design and fabrication of individual and assembled components, compatibility of dissimilar materials, susceptibility to fretting and crack initiation.

NOTE Corrosion can be regarded as any deterioration in the physical and chemical properties of a material due to the chemical environment.

b) In cases where the behaviour of a material in a specific environment is not known, corrosion tests of representative materials (composition and condition) shall be performed, either under appropriate service conditions, or in more severe conditions (accelerated testing).

4.2.6 Ablation and pyrolysis

- a) The structural design shall take into account the material changes due to ablation and pyrolysis.
- b) In cases where an exact prediction of the behaviour of a material in a specific environment is not known, ablation and pyrolysis tests of representative materials (composition and condition) shall be performed, either under appropriate service conditions, or in more severe conditions (accelerated testing).

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4.2.7 Micrometeoroid and debris collision 0d2247/sist-en-14607-2-2005

- a) Pressurized structures, tanks, battery cells, pipes, electronic boxes and other specified equipment shall be protected from micrometeoroid and debris impact in order to prevent the risk of catastrophic failures.
- b) The selection and design of material and debris protection systems shall be based on a specified probability of survival.

NOTE The probability of survival is influenced by the probability of impact, critical debris size, material response to hypervelocity impacts, impact face; back face (spalling), mission duration, spacecraft orientation and multiple impacts.

4.2.8 Venting and purging

- a) Provision shall be made in the design of the structure for venting in order to avoid a build-up of excess pressure and to reduce the time to evacuate the structure.
- b) In cases where venting is not provided, the structure shall withstand build-up pressure without violating other requirements such as strength or stability.
- c) The openings for venting (e.g. to prevent contamination or risk of explosion) shall be compatible with the purging system gas supply pressure and flow rate.

4.2.9 Mass and inertia properties

Mass and inertia properties of the structure shall be determined during all phases of the design applying estimation, calculation or measurement techniques.

NOTE The mass and inertia properties of a structure comprise its mass, the location of its centre of gravity, its moments and products of inertia, and its balancing masses.