SLOVENSKI STANDARD
SIST EN 16603-32-10:2014

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Vesoljska tehnika - Strukturni varnostni faktorji za strojne dele vesoljskih plovil

Space engineering - Structural factors of safety for spaceflight hardware

Raumfahrttechnik - Strukturelle Sicherheitsfaktoren für Raumflughardware

Ingénierie spatiale - Facteurs de sécurité pour les structure spatiales

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49.140	Vesoljski sistemi in operacije	Space systems and operations

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Space engineering - Structural factors of safety for spaceflight hardware

Ingénierie spatiale - Facteurs de sécurité pour les structure spatiales

Raumfahrttechnik - Strukturelle Sicherheitsfaktoren für Raumflughardware

This European Standard was approved by CEN on 10 February 2014.

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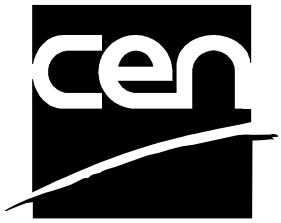

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Foreword

This document (EN 16603-32-10:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-32-10:2014) originates from ECSS-E-ST-32-10C Rev.1.

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of an identical text or by endorsement, at the latest by February 2015, and conflicting national standards shall be withdrawn at the latest by February 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1
Scope

The purpose of this Standard is to define the **F**actors **O**f **S**afety (FOS), Design Factor and additional factors to be used for the dimensioning and design verification of spaceflight hardware including qualification and acceptance tests.

This standard is not self standing and is used in conjunction with the ECSS-E-ST-32, ECSS-E-ST-32-02 and ECSS-E-ST-33-01 documents.

Following assumptions are made in the document:

- that recognized methodologies are used for the determination of the limit loads, including their scatter, that are applied to the hardware and for the stress analyses;
- that the structural and mechanical system design is amenable to engineering analyses by current state-of-the-art methods and is conforming to standard aerospace industry practices.

Factors of safety are defined to cover chosen load level probability, assumed uncertainty in mechanical properties and manufacturing but not a lack of engineering effort.

The choice of a factor of safety for a program is directly linked to the rationale retained for designing, dimensioning and testing within the program. Therefore, as the development logic and the associated reliability objectives are different for:

- unmanned scientific or commercial satellite,
- expendable launch vehicles,
- man-rated spacecraft, and
- any other unmanned space vehicle (e.g. transfer vehicle, planetary probe)

specific values are presented for each of them.

Factors of safety for re-usable launch vehicles and man-rated commercial spacecraft are not addressed in this document.

For all of these space products, factors of safety are defined hereafter in the document whatever the adopted qualification logic: proto-flight or prototype model.

For pressurized hardware, factors of safety for all loads except internal pressure loads are defined in this standard. Concerning the internal pressure, the factors

of safety for pressurised hardware can be found in ECSS-E-ST-32-02. For loads combination refer to ECSS-E-ST-32-02.

For mechanisms, specific factors of safety associated with yield and ultimate of metallic materials, cable rupture factors of safety, stops/shaft shoulders/recess yield factors of safety and limits for peak Hertzian contact stress are specified in ECSS-E-ST-33-01.

Alternate approach

The factors of safety specified hereafter are applied using a deterministic approach i.e. as generally applied in the Space Industry to achieve the structures standard reliability objectives. Structural safety based on a probabilistic analysis could be an alternate approach but it has to be demonstrated this process achieves the reliability objective specified to the structure. The procedure is approved by the customer.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications, do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16603-10-02	ECSS-E-ST-10-02	Space engineering – Verification
EN 16603-10-03	ECSS-E-ST-10-03	Space engineering – Testing
EN 16603-32	ECSS-E-ST-32	Space engineering – Structural general requirements
EN 16603-32-02	ECSS-E-ST-32-02	Space engineering – Structural design and verification of pressurized hardware

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01, ECSS-E-ST-10-02, ECSS-ST-E-10-03, and ECSS-E-ST-32 apply.

3.2 Terms specific to the present standard

3.2.1 local design factor (K_{LD})

factor used to take into account local discontinuities and applied in series with FOSU or FOSY

3.2.2 margin policy factor (K_{MP})

factor, specific to launch vehicles, which includes the margin policy defined by the project

3.2.3 model factor (K_M)

factor which takes into account the representativity of mathematical models

3.2.4 project factor (K_P)

factor which takes into account at the beginning of the project the maturity of the design and its possible evolution and programmatic margins which cover project uncertainties or some growth potential when required

3.2.5 prototype test

test performed on a separate flight-like structural test article

3.2.6 protoflight test

test performed on a flight hardware

3.2.7 test factors (KA and KQ)

factors used to define respectively the acceptance and the qualification test loads

3.2.8 ultimate design factor of safety (FOSU)

multiplying factor applied to the design limit load in order to calculate the design ultimate load

3.2.9 yield design factor of safety (FOSY)

multiplying factor applied to the design limit load in order to calculate the design yield load

3.3 Abbreviated terms

For the purpose of this standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply.

Abbreviation	Meaning
AL	acceptance test load
DLL	design limit load
DUL	design ultimate load
DYL	design yield load
FOS	factor of safety
FOSU	ultimate design factor of safety
FOSY	yield design factor of safety
FRP	fibre reinforced plastics
GSE	ground support equipment
KA	acceptance test factor
KQ	qualification test factor
LCDA	launch vehicle coupled dynamic analysis
LL	limit load
N/A	not applicable
QL	qualification test load
S/C	spacecraft