SLOVENSKI STANDARD
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Vesoljska tehnika - Kontrola razpok

Space engineering - Fracture control

Raumfahrttechnik - Überwachung des Rissfortschritts

Ingénierie spatiale - Maîtrise de la rupture

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49.140	Vesoljski sistemi in operacije	Space systems and operations

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English version

Space engineering - Fracture control

Ingénierie spatiale - Maîtrise de la rupture

Raumfahrttechnik - Überwachung des Rissfortschritts

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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European Foreword

This document (prEN 16603-32-01:2020) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN (Germany).

This document (prEN 16603-32-01:2020) originates from ECSS-E-ST-32-01C Rev.2 DIR1.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 16603-32-01:2014.

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

1
Scope

This ECSS Engineering Standard specifies the fracture control requirements to be imposed on space segments of space systems and their related GSE.

The fracture control programme is applicable for space systems and related GSE where structural failure can result in a catastrophic hazard in accordance with the definition of ECSS-Q-ST-40 or alternative applicable document specified by the customer like those applicable to the ISS or Exploration systems or payloads.

The requirements contained in this Standard, when implemented, also satisfy the fracture control requirements applicable to the NASA and ISS.

The NASA nomenclature differs in some cases from that used by ECSS. When ISS or Exploration-specific requirements and nomenclature are included, they are identified as such.

This standard may be tailored for the specific characteristic and constrains 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 16603-32	ECSS-E-ST-32	Space engineering – Structural
EN 16603-32-02	ECSS-E-ST-32-02	Space engineering – Structural design and verification of pressurized hardware
EN 16602-20	ECSS-Q-ST-20	Space product assurance – Quality assurance
EN 16602-40	ECSS-Q-ST-40	Space product assurance – Safety
EN 16602-70	ECSS-Q-ST-70	Space product assurance – Materials, mechanical parts and processes
EN 16602-70-15	ECSS-Q-ST-70-15	Space product assurance - Non-destructive inspection
EN 16602-70-36	ECSS-Q-ST-70-36	Space product assurance – Material selection for controlling stress-corrosion cracking
EN 16602-70-45	ECSS-Q-ST-70-45	Space product assurance – Mechanical testing of metallic materials
	DOT/FAA/AR-MMPDS	Metallic Materials Properties Development and Standardization (MMPDS) (former MIL-HDBK-5)
	EN ISO 6520-1	Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding

	ISO 17659	Welding – Multilingual terms for welded joints with illustrations

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

a. For the purpose of this Standard, the terms and definitions from ECSS-ST-00-01 apply, in particular for the following terms:

1. customer

NOTE In this standard, the customer is considered to represent the responsible fracture control or safety authority.

b. For the purpose of this Standard, the following terms and definitions from ECSS-E-ST-32 apply:

1. flaw

NOTE The term defect is used as a synonymous.

2. maximum design pressure (MDP)
3. service life
4. proof test
5. limit load
6. structure
7. safe life

c. For the purpose of this Standard, the following terms and definitions from ECSS-E-ST-32-02 apply:

1. burst pressure
2. hazardous fluid container
3. leak before burst, LBB
4. pressure component
5. pressure vessel
6. pressurized structure
7. sealed container
8. special pressurized equipment
9. visual damage threshold, VDT

NOTE 1 For typical implementation of thin-walled composite structure, the VDT is sometimes more specifically defined as the impact energy of an impactor with a hemi-spherical tip of 16 mm diameter resulting in 0,3 mm or more remaining surface deflection, after sufficiently long time to cover potential evolution of the indentation over time (due to e.g. wet ageing, fatigue loading, viscoelasticity of the resin) between impact and inspection.

NOTE 2 It can be time consuming to determine the VDT based on remaining surface deflection of 0,3 mm (see NOTE 1) after a sufficiently long time. Therefore, tests which cause mechanical damage corresponding to a deflection of at least 1 mm, immediately after impact, are sometimes used to determine the VDT.

10. non-hazardous LBB failure mode

d. For the purpose of this Standard, the following term and definition from ECSS-Q-ST-40 apply:

1. catastrophic hazard

NOTE alternative applicable documents specified by the customer, like those applicable to the ISS or Exploration systems or payloads, can make applicable a slightly different definition.

e. For the purpose of this Standard, the following terms and definitions from ECSS-Q-ST-70-15 apply:

1. special fracture control NDI

2. standard fracture control NDI

3.2 Terms specific to the present standard

3.2.1 aggressive environment

combination of liquid or gaseous media and temperature that alters static or fatigue crack-growth characteristics from normal behaviour associated with an ambient temperature and laboratory air environment

3.2.2 analytical life

life evaluated analytically by crack-growth analysis or fatigue analysis

3.2.3 catastrophic hazard

<other than NASA STS or ISS payloads> see ECSS-Q-ST-40B

3.2.4 close visual inspection

close proximity, intense visual examination of the internal and external surfaces of a structure, including structural details or locations, for indications of impact damage, flaws, and other surface defects

NOTE The inspection capability is evaluated by the surface deflection measurement (impact depth). The close visual inspection is considered to detect reliably a deflection larger than the visual damage threshold (VDT).

3.2.5 containment

damage tolerance design principle that, if a part fails, prevents the propagation of failure effects beyond the container boundaries

NOTE 1 A contained part is not considered PFCI, unless its release can cause a hazard inside the container. The container is a PFCI, and its structural integrity after impact is verified as part of fracture control activities.

NOTE 2 In this standard, the term containment in most cases also covers items which are e.g. restrained by a tether to prevent the occurrence of hazardous events due to failure of the item.

3.2.6 crack-like defect

defect that has the same mechanical behaviour as a crack

NOTE 1 "Crack" and "crack-like defect" are considered synonymous in this standard.

NOTE 2 Crack-like defects can, for example, be initiated during material production, fabrication or testing or developed during the service life of a component.

NOTE 3 The term "crack-like defect" can include:

- For metallic materials flaws, inclusions, pores and other similar defects.
- For non-metallic materials, debonding, broken fibres, delamination, impact damage and other specific defects depending on the material.

3.2.7 crack aspect ratio, a/c

<part-through surface crack> ratio of crack depth to half crack length

3.2.8 crack aspect ratio, a/c

<part-through corner crack> ratio of crack depth to crack length

3.2.9 crack growth rate

rate of change of crack dimension with respect to the number of load cycles or time

NOTE For example da/dN, dc/dN, da/dt and dc/dt.

3.2.10 crack growth retardation

reduction of crack-growth rate due to overloading of the cracked structural member

3.2.11 critical crack size

the crack size at which the structure fails under the maximum specified load

NOTE The maximum specified load is in many cases the limit load, but sometimes higher than the limit load (e.g. for detected defects, composites and glass items)

3.2.12 critical initial defect, CID

critical (i.e., maximum) initial crack size for which the structure can survive the specified number of lifetimes.

3.2.13 critical stress-intensity factor

value of the stress-intensity factor at the tip of a crack at which unstable propagation of the crack occurs

NOTE 1 This value is also called the fracture toughness. The parameter K_{Ic} is the fracture toughness for plane strain and is an inherent property of the material. For stress conditions other than plane strain, the fracture toughness is denoted K_c. In fracture mechanics analyses, failure is assumed to be imminent when the applied stress-intensity factor is equal to or exceeds its critical value, i.e. the fracture toughness. See 3.2.24.

NOTE 2 The term fracture toughness is used as a synonymous.

3.2.14 cyclic loading

fluctuating load (or pressure) characterized by relative degrees of loading and unloading of a structure

NOTE For example, loads due to transient responses, vibro-acoustic excitation, flutter, pressure cycling and oscillating or reciprocating mechanical equipment.

3.2.15 damage tolerance threshold strain

<composite structural items> maximum strain level below which damage compatible with the sizes established by non-destructive inspection (NDI), close visual inspection, the damage threat assessment, or the minimum sizes imposed does not grow in 10^6 cycles (10^8 cycles for rotating hardware) at a load ratio appropriate to the application

NOTE 1 Strain level is the maximum absolute value of strain in a load cycle.