SLOVENSKI STANDARD
SIST EN 16603-35-10:2014

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Vesoljska tehnika - Preskušanje skladnosti komponent tekočih pogonskih goriv

Space engineering - Compatibility testing for liquid propulsion components, subsystems and systems

Raumfahrttechnik - Kompatibilitätstests für Flüssigkeitsantriebe

Ingénierie spatiale - Essais de compatibilité des composants, sous-systèmes et systèmes de propulsion liquide

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49.140	Vesoljski sistemi in operacije	Space systems and operations

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Space engineering - Compatibility testing for liquid propulsion components, subsystems and systems

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Raumfahrttechnik - Kompatibilitätstests für Flüssigkeitsantriebe

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Table of contents

Figures

Tables

Foreword

This document (EN 16603-35-10:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16603-35-10:2014) originates from ECSS-E-ST-35-10C.

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of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.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 prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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

ECSS-E-ST-35-10 belongs to the propulsion field of the mechanical discipline, as defined in ECSS-S-ST-00, and concerns itself with compatibility testing of propulsion components, sub-systems and systems.

Compatibility encompasses the interaction of two or more materials, solids (e.g. structural materials), liquids (e.g. propellants, simulation and cleaning liquids) or gases (e.g. air, pressurants). In case the interaction has the effect that the properties of the materials change, there is the possibility of a compatibility issue.

The standard:

- identifies materials used in propulsion for which incompatibility can create problems,
- identifies the time scale at which problems can occur. It makes a difference whether a system is only stored or operational for a short period and is to function only during launch (time scale measured in months) and systems that have a long life in orbit (time scale measured in years),
- identifies the liquid propulsion components, subsystems and systems to be subject to compatibility testing,
- identifies, specifies and defines the tests, test conditions and compatibility test procedures to ensure that representative compatibility testing can take place, and
- establishes the test requirements.

The standard is applicable to the design and the qualification of liquid propulsion components, sub-systems and systems and can be applied to their development; it also applies to COTS items procured for the propulsion system.

From the tests described in this standard the effects of interactions of space propulsion materials and fluids on the components, subsystems and systems can be established. In this way it can be assured that the component, subsystem or system satisfies the requirements.

This standard is limited to tests on component-, subsystem- and system-level. Only for those cases where new materials, substances or conditions are involved for which there is no experience or data available, the performance of screening tests is specified.

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 general requirements
EN 16603-32-10	ECSS-E-ST-32-10	Space engineering – Structural factors of safety for spaceflight hardware
EN 16603-35	ECSS-E-ST-35	Space engineering – Propulsion general requirements
EN 16603-35-06	ECSS-E-ST-35-06	Space engineering – Cleanliness requirements for spacecraft propulsion hardware
EN 16602-70-36	ECSS-Q-ST-70-36	Space product assurance – Material selection for controlling stress-corrosion cracking
EN 16602-70-37	ECSS-Q-ST-70-37	Space product assurance – Determination of the susceptibility of metals to stress-corrosion cracking
EN 16602-70-45	ECSS-Q-ST-70-45	Space product assurance – Mechanical testing of metallic materials
	ASTM C 1291-00a	Standard Test Method for Elevated Temperature Tensile Creep Strain, Creep Strain Rate, and Creep Time-to-Failure for Advanced Monolithic Ceramics
	ASTM C 1337-96	Standard Test Method for Creep and Creep Rupture of Continuous Fiber-Reinforced Ceramic Composites under Tensile Loading at Elevated Temperatures
	ASTM C 1368-06	Standard Test Method for Determination of Slow Crack Growth Parameters of Advanced Ceramics by Constant Stress-Rate Flexural Testing at Ambient Temperature
	ASTM C 1465-08	Standard Test Method for Determination of Slow Crack Growth Parameters of Advanced Ceramics by Constant Stress-Rate Flexural Testing at Elevated

		Temperatures
	ASTM C 1576-05	Standard Test Method for Determination of Slow Crack Growth Parameters of Advanced Ceramics by Constant Stress Flexural Testing (Stress Rupture) at Ambient Temperature
	ASTM D 395	Test Methods for Rubber Property—Compression Set
	ASTM D 570-98	Standard Test Method for Water Absorption of Plastics
	ASTM D 624-00	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
	ASTM D 638-03	Standard Test Method for Tensile Properties of Plastics
	ASTM D 1434-82 (Reapproved 2003)	Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
	ASTM D 2240-04	Standard Test Method for Rubber Property – Durometer Hardness
	ASTM G 4-95	Standard Guide for Conducting Corrosion Coupon Tests in Field Applications
	ASTM G 31-72 (Reapproved 1999)	Standard Practice for Laboratory Immersion Corrosion Testing of Materials
	ASTM G 71-81 (reapproved 1998)	Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes.
	ASTM G 72-01	Standard Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High-Pressure Oxygen-Enriched Environment
	ASTM G 86-98a	Standard test method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Ambient Liquid Oxygen and Pressurized Liquid and Gaseous Oxygen Environments
	ASTM G 111-97	Standard Guide for Corrosion Tests in High Temperature or High Pressure Environment, or Both
	ASTM G 142-98	Standard Test Method for Determination of Susceptibility of Metals to Embrittlement in Hydrogen Containing Environments at High Pressure, High Temperature, or Both
	ISO 175	Plastics; Methods of Tests for the Determination of the Effects of Immersion in Liquid Chemicals
	ISO 1817, 3rd edition 1999-03-01	Rubber, vulcanized – Determination of the effect of liquids
	ISO 10297	Transportable gas cylinders — Cylinder valves — Specification and type testing
	ISO 15859-1	Space systems – Fluid characteristics sampling and test methods - Oxygen

	ISO 15859-7	Space systems – Fluid characteristics sampling and test methods – Hydrazine
	ISO 21010	Cryogenic vessels — Gas/materials compatibility
	NACE TM0499-99 Item No. 21239	Standard Test Method Immersion Corrosion Testing of Ceramic Materials

3 Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-ST-00-01 and ECSS-E-ST-35 apply.

For the purpose of this Standard, the following term from ECSS-E-ST-32 applies:

maximum expected operating pressure (MEOP)

For the purpose of this Standard, the following term from ECSS-Q-ST-70-36 applies:

stress corrosion

3.2 Terms specific to the present standard

3.2.1 ageing

entirety of all changes in chemical and physical characteristics occurring in a material in the course of time

3.2.2 auto ignition temperature

lowest temperature at which a substance produces hot-flame ignition in the environment and at the pressure without the aid of an external energy source

3.2.3 compatibility

absence of unacceptable performance or reliability loss due to chemical reactions and physical changes in materials or substances during the compatibility life

NOTE 1 Compatibility always involves two or more materials in contact with each other.

NOTE 2 Compatibility is always related to the application and the requirements.

3.2.4 compatibility life

life cycle from the first exposure of two or more materials to each other until disposal

3.2.5 contaminant gas

undesired gas present in the propulsion system at any time in its life

3.2.6 corrosion

reaction of the engineering material with its environment with a consequent deterioration in properties of the material

3.2.7 dissimilar metals

metals with different electrochemical potentials

3.2.8 galvanic corrosion

corrosion as a result of an electrochemical potential difference between electrical conductors in an electrolyte

3.2.9 hydrogen embrittlement

condition of low ductility or reduced mechanical properties resulting from the absorption of hydrogen

NOTE stress intensity factor, K

factor describing the stress state near the tip of a crack caused by a remote load, residual stress or both.

NOTE The magnitude of K depends on sample geometry, the size and location of the crack, and the magnitude and the modal distribution of loads on the material. $K = \sigma \cdot Y \cdot \sqrt{\pi \cdot a}$

where:

a	half the crack length
K	stress intensity factor
Y	dimensionless geometrical function
σ	applied stress

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
CAAR	compatibility assessment and applicability report
COTS	commercial of-the-shelf
CPE	chlorinated poly ethylene
CTLP	compatibility testing for liquid propulsion
DSC	differential scanning calorimeter
EPDM	ethylene propylene diene monomer
EPR	ethylene propylene rubber

GOx	gaseous oxygen
LOx	liquid oxygen
MMH	mono methyl hydrazine
MON	mixed oxides of nitrogen (MON-X is X% NO and (100-X) % of N_2O_4
NVR	non-volatile residue
PVC	poly vinyl chloride
SEM	scanning electron microscope
SS	stainless steel
TGA	thermal gravimetric analysis

4 General requirements for compatibility tests

4.1 General

4.1.1 Compatibility test assessment

a. The supplier shall analyse and define the conditions for the compatibility tests with respect to the application and the requirements for the component, sub-system or system and define them in conformance with the DRD in Annex A.

4.1.2 Test conditions

a. Compatibility testing shall take place under conditions reproducing the actual use of the items.

NOTE For example: The test items treatments, processes and handling, to be the same as those for the actual flight hardware items.

b. The extent of compatibility testing shall comply with the reliability requirements for the component, subsystem or system.

4.1.3 Test duration

a. The duration of the compatibility test shall be established using the compatibility life and mission reliability requirements

NOTE 1 The type of information to be obtained for the component, subsystem or system is e.g. a quick first impression or an impression based on an exposure under well controlled conditions with detailed and precise measurements.

NOTE 2 For short compatibility lives (e.g. as for launchers), the duration of compatibility tests can be the same as the compatibility life or somewhat larger. For large compatibility lives (e.g. satellites in orbit) accelerated compatibility tests can be used.