SLOVENSKI STANDARD
SIST EN 16603-35-01:2014

01-november-2014

Nadomešča:
SIST EN 14607-5-1:2005

Vesoljska tehnika - Pogon za vesoljska plovila

Space engineering - Liquid and electric propulsion for spacecraft

Raumfahrttechnik - Flüssige und elektrische Antriebe von Raumfahrzeugen

Ingénierie spatiale - Propulsion liquide et électrique pour satellites

Ta slovenski standard je istoveten z: **EN 16603-35-01:2014**

ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

SIST EN 16603-35-01:2014 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16603-35-01

September 2014

ICS 49.140

Supersedes EN 14607-5-1:2004

English version

Space engineering - Liquid and electric propulsion for spacecraft

Ingénierie spatiale - Propulsion liquide et électrique pour satellites

Raumfahrttechnik - Flüssige und elektrische Antriebe von Raumfahrzeugen

This European Standard was approved by CEN on 23 February 2014.

CEN and CENELEC 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 CEN-CENELEC Management Centre or to any CEN and CENELEC 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 and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of 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 United Kingdom.

CEN-CENELEC Management Centre:
Avenue Marnix 17, B-1000 Brussels

Table of contents

Foreword

This document (EN 16603-35-01:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-35-01:2014) originates from ECSS-E-ST-35-01C.

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 supersedes EN 14607-5-1:2004.

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.

Introduction

The ECSS Propulsion standards structure is as follows.

ECSS-E-ST-35 Propulsion general requirements

- Standards, covering particular type of propulsion
  - ECSS-E-ST-35-01 Liquid and electric propulsion for spacecrafts
  - ECSS-E-ST-35-02 Solid propulsion for spacecrafts and launchers
  - ECSS-E-ST-35-03 Liquid propulsion for launchers
- Standard covering particular propulsion aspects
  - ECSS-E-ST-35-06 Cleanliness requirements for spacecraft propulsion hardware
  - ECSS-E-ST-35-10 Compatibility testing for liquid propulsion systems

1
Scope

This Standard defines the regulatory aspects applicable to elements and processes for liquid, including cold gas, and electrical propulsion for spacecraft. It specifies the activities to be performed in the engineering of such propulsion systems, their applicability, and defines the requirements for the engineering aspects: functional, interfaces, environmental, design, quality factors, operational and verification.

General requirements applying to all type of Propulsion Systems Engineering are defined in ECSS-E-ST-35.

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 16601-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16603-10	ECSS-E-ST-10	Space engineering – System engineering general requirements
EN 16603-20	ECSS-E-ST-20	Space engineering – Electrical and electronic
EN 16603-20-06	ECSS-E-ST-20-06	Space engineering – Spacecraft charging
EN 16603-20-07	ECSS-E-ST-20-07	Space engineering – Electromagnetic compatibility
EN 16603-31	ECSS-E-ST-31	Space engineering – Thermal control general requirements
EN 16603-32	ECSS-E-ST-32	Space engineering – Structural general requirements
EN 16603-35	ECSS-E-ST-35	Space engineering – Propulsion general requirements
EN 16602-30	ECSS-Q-ST-30	Space product assurance – Dependability

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

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

3.2 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-ST-00-01 apply.

4
Liquid propulsion systems for spacecraft

4.1 Overview

Liquid propulsion systems for spacecraft provide the forces and torques for orbit transfer, orbit maintenance and attitude control. For manoeuvrable spacecraft, capsules and transport vehicles, they provide in addition the forces and torques for rendez-vous and docking.

Apart from what is specific for propellant combustion, liquid propulsion criteria are also applicable to cold gas propulsion systems.

The present clause 4 covers also the design and use of propulsion ground support equipment (GSE), defined in ECSS-E-ST-70.

4.2 Functional

4.2.1 Mission

a. The propulsion system shall conform to the spacecraft mission requirements including:

1. Ground operations

NOTE For example: functional control, testing, propellant, simulant loading and spacecraft transportation.

2. Pre-launch and launch activities

NOTE For example: integration, storage, ageing and transport.

3. In-orbit operations.

NOTE For example: orbit transfer, orbit maintenance and attitude control) and the complete in-orbit life.

4.2.2 Functions

a. The propulsion system shall provide the total impulse, minimum impulse bit, thrust levels and torques required by the AOCS.

b. The following aspects shall be defined:

1. Thruster firing modes

NOTE For example: steady state, off-modulation, pulse mode.

2. Thrust level and orientation
3. Thrust-vector control
4. Thrust centroid time
5. Minimum impulse bit
6. Impulse reproducibility
7. Total impulse
8. Cycle life
9. Mission life
10. Reliability level
11. Thrust noise
12. Propellant gauging.

c. The propulsion system shall fulfil its functions while subjected to the specified external loads during its mission, including:

1. mechanical loads;

NOTE For example: quasi-static loads, vibrations, transportation.

2. thermal loads;
3. electrical loads.

4.3 Constraints

4.3.1 Accelerations

a. Limits on acceleration levels, induced or experienced by the propulsion system, shall be specified at spacecraft level.

NOTE This is in order to:

- avoid perturbations, e.g. during possible observations or experiments;
- protect sensitive equipments;
- design adequate tank PMD.

4.3.2 Pressure vessels and pressurized components

a. Support structures of pressure vessels and pressurized components shall allow deformations of the vessels due to pressure or temperature changes and cycles to occur without causing stresses that exceed acceptable limits.

4.3.3 Induced and environmental temperatures

a. The non-operating and operating temperature limitations of the propulsion system shall be specified.

4.3.4 Thermal fluxes

a. Thruster surroundings shall conform to the radiative and conductive heat fluxes rejected by the thrusters.

4.3.5 Thruster plume effects

a. Elements of the spacecraft sensitive to plume effects shall be identified.

b. The allowed plume effects on elements identified in clause 4.3.5a shall be specified at spacecraft level.

c. The generation of perturbing torques, forces, thermal gradients, contamination and erosion of surfaces, due to plume effects, shall be defined and documented accordingly.

d. The plume analysis specified in 4.3.5c shall be reported in conformance with the Plume analysis report DRD in ECSS-E-ST-35.

4.4 Interfaces

a. The liquid propulsion system shall conform to its specified spacecraft interfaces, including:

1. Structure

   NOTE For example: inserts, tank support structure and vibration levels.

2. Thermal

   NOTE For example: conduction, radiation levels, tank, thruster and line thermal control.

3. Power

   NOTE For example: valve drivers, pressure transducers, thermistors, heaters and thermocouples.

4. Electromagnetic compatibility

5. Pyrotechnics

   NOTE For example: pyrotechnic valves.

6. Mechanisms

NOTE For example: valves, regulators, actuators and actuation system.

7. AOCS, OBDH and TM/TC.

NOTE For example: commanding, handling of data for status and health monitoring and failure detection.

b. Interfaces shall be defined:

1. For ground tests and loading activities, with the propulsion GSE.

2. For safety and prelaunch operation with the launcher authorities.

4.5 Design

4.5.1 General

4.5.1.1 Architecture

a. The propulsion system architecture shall apply the requirements in ECSS-Q-ST-30.

b. The propulsion system architecture shall provide evidence that fail safe, redundancy, reliability and safety requirements are met.

4.5.1.2 Replacement of parts

a. For replacement of parts during development, testing and mission life pre-launch activities ECSS-E-ST-35, requirements 4.5.1c, d and e. shall be applied.

4.5.1.3 Water-hammer effect

a. A water-hammer effects analysis shall be performed to support the propulsion system design and ensure proper functioning.

b. The analysis specified in 4.5.1.3a shall be reported in conformance with the Propulsion transient analysis report DRD in ECSS-E-ST-35.

4.5.1.4 Piping

a. A pipework design analysis shall be performed including non-consumables, cross-coupling, leakage, pressure, eigenfrequencies, water-hammer.

b. The consequences in terms of operational restrictions shall be identified.

4.5.1.5 Closed volumes

a. The design of the propulsion system shall prevent hazardous pressure increase in closed volumes.

b. The need for any pressure relief capability shall be identified and analysed.