SLOVENSKI STANDARD
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Vesoljska tehnika - Tekoča pogonska goriva za lansirnike

Space engineering - Liquid propulsion for launchers

Raumfahrttechnik - Flüssigantriebe für Trägerraketen

Ingénierie spatiale - Propulsion liquide pour lanceurs

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Space engineering - Liquid propulsion for launchers

Ingénierie spatiale - Propulsion liquide pour lanceurs

Raumfahrttechnik - Flüssigantriebe für Trägerraketen

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

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Foreword

This document (EN 16603-35-03:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-35-03:2014) originates from ECSS-E-ST-35-03C.

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of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.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

Introduction

The requirements in this Standard ECSS-E-ST-35-03 (and in the 3 other space propulsion standards ECSS-E-ST-35, ECSS-E-ST-35-01 and ECSS-E-ST-35-02) are organized with a typical structure as follows:

- functional;
- constraints;
- development;
- interfaces;
- design;
- GSE;
- materials;
- verification;
- production and manufacturing;
- in-service (operation and disposal);
- deliverables.

This standard forms parts of ECSS-E-ST-35 series which has the following structure;

- ECSS-E-ST-35 Propulsion general requirements
- 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
- ECSS-E-ST-35-06 Cleanliness requirements for spacecraft propulsion components, subsystems, and systems
- ECSS-E-ST-35-10 Compatibility testing for liquid propulsion components, subsystems, and systems

ECSS-E-ST-35 contains all the normative references, terms, definitions, abbreviated terms, symbols and DRD that are applicable for ECSS-E-ST-35, ECSS-E-ST-35-01, ECSS-E-ST-35-02 and ECSS-E-ST-35-03.

In the use of this standard, the term ‘propulsion system’ is intended to be read and interpreted only and specifically for ‘liquid prolusion system’.

1 Scope

General requirements applying to all type of Propulsion Systems Engineering are defined in ECSS-E-ST-35. For Liquid propulsion for launchers activities within a space project the standards ECSS-E-ST-35 and ECSS-E-ST-35-03 are applied together.

This Standard defines the specific regulatory aspects that apply to the elements and processes of liquid propulsion for launch vehicles. It specifies the activities to be performed in the engineering of these propulsion systems and their applicability. It defines the requirements for the engineering aspects such as functional, physical, environmental, quality factors, operational and verification.

Other forms of propulsion (e.g. nuclear, nuclear-electric, solar-thermal and hybrid propulsion) are not presently covered in this issue of the Standard.

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 16603-10	ECSS-E-ST-10	Space engineering - System engineering general requirements
EN 16603-10-02	ECSS-E-ST-10-02	Space engineering - Verification
EN 16603-10-06	ECSS-E-ST-10-06	Space engineering - Technical requirements specification
EN 16603-32	ECSS-E-ST-32	Space engineering - Structural general requirements
EN 16603-32-02	ECSS-E-ST-32-01	Space engineering - Fracture control
EN 16603-32-02	ECSS-E-ST-32-02	Space engineering - Structural design and verification of pressurized hardware
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 16602-70	ECSS-Q-ST-70	Space product assurance - Materials, mechanical parts and processes
	ISO 15389:2001	Space systems - Flight-to-ground umbilicals

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-S-ST-00-01, ECSS-E-ST-35 and the following apply:

Abbreviation	Meaning
LPS	liquid propulsion system

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Overview of a liquid propulsion system

- Main functions of a liquid propulsion system are:
  - To provide thrust
  - To provide thrust vector control
  - To provide multiple burn capability if necessary
  - To supply pressurized gas for auxiliary functions (e.g. roll control, stage orientation)
  - To supply fluid for pneumatic control (e.g. Helium)
  - To provide thrust for propellant settling
  - To provide information concerning its status (e.g. measurement)

- The liquid propulsion system generally consists in:
  - the engine

  - the tank
  - the feed system
  - the pressurisation system
  - the command system
  - the TVC
  - auxiliary systems such as the anti-POGO device, roll control system

- The typical life of a liquid propulsion system is the following:
  - Manufacturing and assembly
  - Acceptance test (if any)
  - Storage and transport
  - Launcher integration
  - Pre-launch activities (e.g. flushing, leak tightness checks)
  - Tanks filling
  - Main stage Chill down (for cryogenic liquid propulsion system)
  - Launch chronology (including launch-abort activities)

— Lift-off
— Chill-down (for cryogenic liquid propulsion upper stages)
— Boost phases
— Stage separation
— Ballistic phase
— Passivation
— De-orbiting, reaching a graveyard orbit, or both

NOTE The way how to write the technical specification is given in ECSS-E-ST-10-06.

5
Functional

5.1 Overview

The general functional specification coming from mission optimisation at system level provides values for:

- Thrust
- Isp
- Burning time

The additional functional requirements are:

- thrust level versus time (throttling)
- propellant budget management (e.g. mixture ratio variation)
- TVC (e.g. maximum angle, acceleration, response time)
- start-up and shutdown transient requirements (e.g. duration, impulse scatter)
- auxiliary power to be delivered to the launcher (e.g. electrical and fluids)
- re-startability
- propellant depletion

5.2 Mission

a. ECSS-E-ST-35 clause 4.2 shall apply.

5.3 Functions

a. The technical specification shall provide the values of thrust, Isp and burning time with their deviations.

6
Constraints

6.1 Acceleration

a. Accelerations in the axial and lateral directions, assessed at launch vehicle level, shall be specified as an input for the propulsion system.

NOTE The acceleration has an impact on the:

- functioning of the vortex suppression devices in the tank outlets;
- pressure at the pump inlets;
- flow pattern in the tank;
- mechanical loads.

6.2 Geometrical constraints

a. The dimensioning of the liquid propulsion system and its components shall conform to the overall launch vehicle dimensions, interfaces between stages, ground infrastructure and requirements for transportation.

6.3 Electrical constraints

a. The design of the prop system shall be such that the electrical continuity is ensured.

6.4 Safety

a. The design of the liquid propulsion system shall conform to the safety requirements of the launch system.

NOTE For Example, ground safety requirements, flight safety requirements.

7
Development

7.1 Overview

The phases of development for a liquid propulsion system are as follows:

- definition of system and subsystem requirements conforming to mission requirements
- establishment of the general concepts
- trade-off of various concepts
- preliminary design
- risk analysis of the preliminary design and trade-off of various options
- detailed design and definition
- manufacturing and assembly of
  - components,
  - subsystems.
- integration of subsystem and system
- testing of:
  - components,
  - subsystems,
  - engines, and
  - system (functional stage).
- selection of the design to be qualified
- qualification process
- review of first article

7.2 Development logic

a. The development logic shall include a requirement verification plan in conformance with ECSS-E-ST-10-02 ‘verification plan’.

NOTE Example of verification methods are analyses, tests.