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Vesoljska tehnika - Sistemskotehnične splošne zahteve

Space engineering - System engineering general requirements

Raumfahrttechnik - Grundsätze und Verfahrensweise

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English version

Space engineering - System engineering general requirements

Raumfahrttechnik - Grundsätze und Verfahrensweise

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Foreword

This document (FprEN 16603-10:2016) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN (Germany).

This document (FprEN 16603-10:2016) originates from ECSS-E-ST-10C Rev.1 DIR1.

This document is currently submitted to the UAP.

This document will supersede EN 13292:1999, EN 14514:2004 and EN 14607-7:2004.

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

1 Scope

This standard specifies the system engineering implementation requirements for space systems and space products development.

Specific objectives of this standard are:

- to implement the system engineering requirements to establish a firm technical basis and to minimize technical risk and cost for space systems and space products development;
- to specify the essential system engineering tasks, their objectives and outputs;
- to implement integration and control of engineering disciplines and lower level system engineering work;
- to implement the "customer-system-supplier model" through the development of systems and products for space applications.

Generally, System Engineering is a discipline that can find beneficial application to the development and production of a wide variety of systems and throughout the product decomposition hierarchy. However the requirements in this Standard were developed to be appropriate for application as they are to complex space systems and products only; for lower level elements tailoring is necessary. The pre-tailoring table in Section 7 contains the applicability of the requirements of this document and its annexes according to product type.Specific requirements related to system engineering, like technical specification, verification, and testing are specified in dedicated documents and standards within the set of ECSS system engineering standards ECSS-E-ST-10-XX.

Discipline or element specific engineering implementation requirements are covered in dedicated ECSS standards. These standards are based on the same principles, process and documentation model. The applicability of each these standards can therefore not be considered in isolation from the others.

NOTE 1 The term "Discipline" is defined in ECSS-M-ST-10, as "a specific area of expertise within a general subject". The name of the discipline normally indicates the type of expertise, e.g. in the ECSS system mechanical engineering, software and communications are disciplines within the engineering domain.

NOTE 2 The requirements on the system engineering process are gathered in this standard; specific aspects of the SE process are further elaborated in dedicated standards.

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

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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 16603-11	ECSS-E-AS-11	Adoption Notice of ISO 16290, Space systems - Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment
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 16603-10-09	ECSS-E-ST-10-09	Space engineering – Reference coordinate system
EN 16603-10-24	ECSS-E-ST-10-24	Space engineering – Interface control
EN 16601-10	ECSS-M-ST-10	Space project management – Project planning and implementation
EN 16601-40	ECSS-M-ST-40	Space project management – Configuration and information management
EN 16602-20-10	ECSS-Q-ST-20-10	Off-the-shelf items utilization in space systems

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-S-ST-00-01 apply, in particular for the following terms:

1. acceptance
2. approval
3. configuration baseline
4. critical
5. development
6. equipment
7. inspection
8. integration
9. product tree
10. requirement
11. specification
12. subsystem
13. system
14. test
15. verification

b. For the purpose of this Standard, the terms and definitions from ECSS-E-AS-11C apply, in particular for the following terms:

1. technology readiness level

3.2 Terms specific to the present standard

3.2.1 requirement traceability

requirement attribute that links each single requirement to its higher level requirements inside the requirement set

Note 1 to entry: This enables the derivation of a requirement tree, which demonstrates the coherent flow-down of the requirements.

3.2.2 recurring product

product which conforms to a qualified design and is produced according to the corresponding production master file

3.2.3 system engineering

interdisciplinary approach governing the total technical effort required to transform a requirement into a system solution

Note 1 to entry: From IEEE P1220.

3.2.4 verification matrix

initial issue of the VCD which contains for each requirement to be verified the methods, levels and stages of product verification

Note 1 to entry: See ECSS-E-ST-10-02 for a more detailed definition of the VCD.

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
AIT	assembly, integration and test
AIV plan	assembly, integration and verification plan
AOCS	attitude and orbit control sub-system
AR	acceptance review
CDR	critical design review
COTS	commercial off-the-shelf
CRR	commissioning results review NOTE For space vehicles (e.g. launcher, transfer vehicle, crew transport vehicle) the CRR can be replaced or complemented by a flight qualification review (FQR).
DDF	design definition file
DDP	design development plan
DJF	design justification file
DRD	document requirements definition
ECSS	European Cooperation for Space Standardization
ELR	end-of-life review

FDIR	failure, detection, isolation, recovery
FM	flight model
FMECA	failure modes, effects, and criticality analysis
FRR	flight readiness review
FTA	fault tree analysis
GSE	ground support equipment
ICD	interface control document
ILS	integrated logistic support
IRD	interface requirement document
LRR	launch readiness review
MCR	mission closed-out review
MDD	mission description document
MDR	mission definition review
MOP	mission operations plan
MS	mission statement
ORR	operational readiness review
PDR	preliminary design review
PMP	project management plan
PRR	preliminary requirement review
PUM	product user manual
QR	qualification review
RAMS	reliability, availability, maintainability, safety
RF	radio frequency
RJF	requirement justification file
ROD	review of design
ROM/RAM	read only memory / random access memory
RTM	requirement traceability matrix
R&D	research and development
SE	system engineering
SEP	system engineering plan
SFT	system functional test
SRR	system requirement review
SVT	system validation test
TP	technology plan
TRL	technology readiness level
TS	technical requirements specification
UM	user manual

VCD	verification control document
VP	verification plan
w.r.t.	with respect to

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Overview of system engineering

4.1 The system engineering discipline

System engineering is defined as an interdisciplinary approach governing the total technical effort to transform requirements into a system solution.

A system is defined as an integrated set of elements to accomplish a defined objective. These elements include hardware, software, firmware, human resources, information, techniques, facilities services, and other support elements.

In this standard the concept of "system" is used in a wide sense. The highest level, often called "mission level" or "space system", consists usually of one (or more) space segment(s), of a ground segment, and of a user segment. Elements of system decomposition are also considered a system. For the purpose of this standard the system can be any element at any level of decomposition as defined by the function tree (see Annex H) or the product tree (see ECSS-M-ST-10 Annex B). The scope of an element can include hardware, software, procedures, man-in-the-loop, facilities and services.

From the perspective of the considered system, requirements originate from the next upper level (the customer) and elements are procured from the next lower level (the suppliers).

NOTE 1 The customer-supplier model is described in ECSS-S-ST-00.

NOTE 2 Through this standard the notion of customer refers to several actors ,in relation to the project phase. In fact a customer can be e.g. a scientific community in phase 0, a commercial user in phase A or an Agency in phase B. A supplier can on the other hand be an Agency in both phase 0 and phase A.

Figure 4-1 shows the boundaries of system engineering, its relationship with production, operations, product assurance and management disciplines and its internal partition into the following system engineering sub-functions:

- requirement engineering, which consist on requirement analysis and validation, requirement allocation, and requirement maintenance;
- analysis, which is performed for the purpose of resolving requirements conflicts, decomposing and allocating requirements during functional analysis, assessing system effectiveness (including analysing risk factors);

and complementing testing evaluation and providing trade studies for assessing effectiveness, risk, cost and planning;

- design and configuration which results in a physical architecture, and its complete system functional, physical and software characteristics;
- verification, which objective is to demonstrate that the deliverables conform to the specified requirements, including qualification and acceptance;
- system engineering integration and control, coordinating the various engineering disciplines and participants throughout all the project phases.

Figure 4-2 shows system engineering sub-functions, their inter-relationships and their main activities during the system engineering process.

System engineering sub-functions are applied in an iterative mode during implementation of the system engineering process described in clause 4.2.

Within the frame of a project, the system engineering function is generally implemented by a system engineering organisation of the supplier which is in charge of transforming the requirements of the customer into a system solution delivered by the supplier. For the purpose of this standard, the '*system engineering function*' only is referred to in the normative statements, independent of whether the supplier has a formal 'system engineering organisation' or not.

NOTE With respect to the next lower level, the supplier plays the role of the customer.