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Ersatz für
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Space engineering – Verification; English version EN 16603-10-02:2018

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Nationales Vorwort

Dieses Dokument (EN 16603-10-02:2018) wurde vom Technischen Komitee CEN/CLC/JTC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat von DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-06-02 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Dieses Dokument (EN 16603-10-02:2018) basiert auf ECSS-E-ST-10-02C Rev.1.

Dieses Dokument ersetzt EN 14725:2003.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von EN 16603-10-02:2018.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischen Norm, die denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

Änderungen

Gegenüber DIN EN 14725:2005-01 wurden folgende Änderungen vorgenommen:

a) Neustrukturierung des Dokuments, insbesondere wie folgt: Verschieben der Leitlinien im dazugehörigen Handbuch, Aufnahme eines einleitenden Abschnitts zu den Verifizierungsgrundsätzen, Strukturierung der Anforderungsabschnitte entsprechend dem Ablauf des Verifizierungsprozesses, wie in den Grundsätzen zusammengefasst;

b) Klärung der Anwendbarkeit von Normen für unterschiedliche Produkttypen (z. B. Träger, Transportsystem, Bodensegment, GSE);

c) Klärung der Verifizierungsdokumentation im Vergleich zur Validierungsdokumentation;

d) Verschieben von ausführlichen Testanforderungen nach EN 16603-10-03 (basiert auf ECSS-E-ST-10-03C) „Tests“, einschließlich der DRDs der AITP, der Prüfspezifikation und der Prüfdurchführung;

e) Einführung eines Plans zur Risikobeurteilung und Risikominderung hinsichtlich solcher Anforderungen, die nicht durch Tests verifiziert wurden;

f) Klärung der Durchführbarkeit der Verifizierung nach dem Grundsatz der Ähnlichkeit als Analyseverfahren in Zusammenhang mit verschiedenen Produkttypen (Anforderung 5.2.2.3c);

g) Klärung hinsichtlich Produktkategorien in Abhängigkeit von Gemeinsamkeiten und einschlägigen Qualifikationsanforderungen (5.2.4.2);

h) Klärung der Verifizierungstätigkeiten in der Stufe „im Orbit“, insbesondere in Zusammenhang mit der Inbetriebnahme (5.2.4.5);

i) Aufnahme einer Anforderung hinsichtlich der Ausgabe der Datenbank in elektronischer Form (5.4.1c);

j) Einführung des „Stands der Übereinstimmung“ in den VCD-Daten (VCD DRD);

k) Vereinfachung der Nummer und des Inhalts der DRD.

Frühere Ausgaben

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Nationaler Anhang NA
(informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3.1 Begriffe aus anderen Normen

a) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-S-ST-00-01, besonders die folgenden Begriffe:

1) Abnahme

2) Analyse

3) Inbetriebnahme

4) Prüfung

5) Qualifizierung

6) Test

7) Validierung

8) Verifizierung

3.2 Für diese Norm spezifische Begriffe

3.2.1
Modellphilosophie
Festlegung der optimalen Anzahl und der Eigenschaften physischer, virtueller und hybrider Modelle, um bei kürzester Planungszeit unter angemessener Kosten- und Risikoabwägung Vertrauen in die Produktverifizierung zu erzielen

3.2.2
Design-Review
Verifizierungsverfahren unter Verwendung anerkannter Berichte oder Belege, die eindeutig aufzeigen, dass die Anforderung erfüllt wurde

Anmerkung 1 zum Begriff: Konstruktionsunterlagen, Entwurfsberichte, technische Beschreibungen, Konstruktionszeichnungen

3.2.3
Verifizierungskontrollausschuss
VCB
(en: Verification Control Board)
Ausschuss, der sich aus Kunden- und Lieferantenvertretern zusammensetzt und den Verifizierungsprozess überwacht sowie die Anforderungen am Ende der Verifizierung beurteilt

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3.2.4
Verifizierungsebene
Ebene in der Produktarchitektur, in der die Verifizierung durchgeführt wird

3.3 Abkürzungen

Für die Anwendung dieser Norm gelten die Abkürzungen nach ECSS-S-ST-00-01.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16603-10-02

November 2018

ICS 49.140

Supersedes EN 14725:2003

English version

Space engineering - Verification

Ingénierie spatiale - Vérification

Raumfahrttechnik - Verifikation

This European Standard was approved by CEN on 28 September 2018.

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.

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Rue de la Science 23, B-1040 Brussels

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European Foreword

This document (EN 16603-10-02:2018) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN (Germany).

This document (EN 16603-10-02:2018) originates from ECSS-E-ST-10-02C Rev.1.

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 May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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 14725:2003.

The main differences between EN 14725:2003 (that was based on ECSS-E-10-02A) and this standard are:

- Restructuring of the document following, in particular: moving of the guidelines in the associated Handbook, inclusion of an introductive clause on the Verification principles, structuring of the requirement clauses in line with the verification process flow as summarized in the principles.
- Clarification on standard applicability to different types of products (e.g. launcher, transportation system, ground segment, GSE).
- Clarification of the verification vs. validation coverage.
- Moving of detailed test requirements to EN 16603-1003 (based on ECSS-E-ST-10-03C) “Testing” including AIT Plan, Test Specification and Test Procedure DRDs.
- Introduction of risk assessment and mitigation plan concerning those requirements not verified by test.
- Clarification on the applicability of verification by similarity as analysis method in relationship to different types of products (requirement 5.2.2.3c)
- Clarification on product categories vs. heritage and relevant qualification requirements (clause 5.2.4.2)
- Clarification on in-orbit stage verification activities, in particular the relationship with the commissioning (clause 5.2.4.5)
- Inclusion of a requirement concerning the verification database delivery in electronic form (requirement 5.4.1c)
- Introduction of “status of compliance” in the VCD data (VCD DRD)

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- Simplification of DRD's number and content

This document has been prepared under a standardization request 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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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1 Scope

This Standard establishes the requirements for the verification of a space system product.

It defines the fundamental concepts of the verification process, the criteria for defining the verification strategy and specifies the requirements for the implementation of the verification programme. It includes also the list of the expected documentation (i.e. Document requirements definitions, DRDs).

This Standard is intended to apply to different products at different levels from a single equipment to the overall system.

Discipline related verification aspects are complemented in Standards specific to those disciplines.

For verification process for SW the following standards are considered fully sufficient for development of these items:

- ECSS-E-ST-40 Space engineering – Software
- ECSS-Q-ST-80 Space product assurance - Software product assurance

Detailed requirements for Testing are covered in the ECSS E-ST-10-03.

This standard does not specifically address Validation of space products as a separate process, since product Verification is performed against requirements that also address the suitability of the product to fulfil the needs of its intended use. As such, Validation is achieved through the Verification process provided adequate requirements are placed on the product.

It is recognised that testing and analysis also occur during the product development process, but they are not addressed by this standard as they are not formal requirement verification activities in the sense of the customer-supplier relationship.

The guidelines on verification are provided in the associated handbook ECSS-E-HB-10-02A.

The requirements on the systems engineering process are gathered in ECSS-E-ST-10 “System Engineering”; specific aspects of the SE process are further elaborated in dedicated standards, in particular: ECSS-E-ST-10-06 “Technical Specification”, ECSS-E-ST-10-02 “Verification” (the present standard), and ECSS-E-ST-10-03 “Testing”. 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

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

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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 16603-10-03	ECSS-E-ST-10-03	Space engineering — Testing
EN 16601-10	ECSS-M-ST-10	Space project management — Project planning and implementation
EN 16602-10-09	ECSS-Q-ST-10-09	Space product assurance — Nonconformance control system
EN 16602-20	ECSS-Q-ST-20	Space product assurance — Quality assurance.

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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. analysis
3. commissioning
4. inspection
5. qualification
6. test
7. validation
8. verification

3.2 Terms specific to the present standard

3.2.1 model philosophy

definition of the optimum number and the characteristics of physical, virtual, and hybrid models required to achieve confidence in the product verification with the shortest planning and a suitable weighting of costs and risks

3.2.2 review-of-design

verification method using approved records or evidence that unambiguously show that the requirement is met

NOTE design documents, design reports, technical descriptions, engineering drawings

3.2.3 Verification Control Board (VCB)

board composed of customer and supplier representatives that monitors the verification process and assesses the requirements verification close-out.

3.2.4 verification level

product architectural level at which the relevant verification is performed

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3.3 Abbreviated terms

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

3.4 Nomenclature

The following nomenclature applies throughout this document:

a. The word “shall” is used in this Standard to express requirements. All the requirements are expressed with the word “shall”.

b. The word “should” is used in this Standard to express recommendations. All the recommendations are expressed with the word “should”.

NOTE It is expected that, during tailoring, recommendations in this document are either converted into requirements or tailored out.

c. The words “may” and “need not” are used in this Standard to express positive and negative permissions, respectively. All the positive permissions are expressed with the word “may”. All the negative permissions are expressed with the words “need not”.

d. The word “can” is used in this Standard to express capabilities or possibilities, and therefore, if not accompanied by one of the previous words, it implies descriptive text.

NOTE In ECSS “may” and “can” have completely different meanings: “may” is normative (permission), and “can” is descriptive.

e. The present and past tenses are used in this Standard to express statements of fact, and therefore they imply descriptive text.

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4
Verification principles

4.1 Verification process

4.1.1 Verification objectives

The overall objective of verification is to demonstrate, through a dedicated process, that the deliverable product meets the specified requirements.

A satisfactory completion of the verification process is the basis for a contractual acceptance (as defined in ECSS-S-ST-00-01) of the product by the Customer.

The objectives of the Verification process are as follows:

- to demonstrate the qualification of design and performance, as meeting the specified requirements at the specified levels;
- to ensure that the product is in agreement with the qualified design, is free from workmanship defects and acceptable for use;
- to confirm product integrity and performance at particular steps of the project life cycle (e.g. launch, commissioning, mission events and landing).
- to confirm that the overall system (including tools, procedures and resources) is able to fulfil mission requirements;

4.1.2 Verification activities

The verification process activities consist of planning, execution, reporting, control and closeout as summarized in Figure 4-1.

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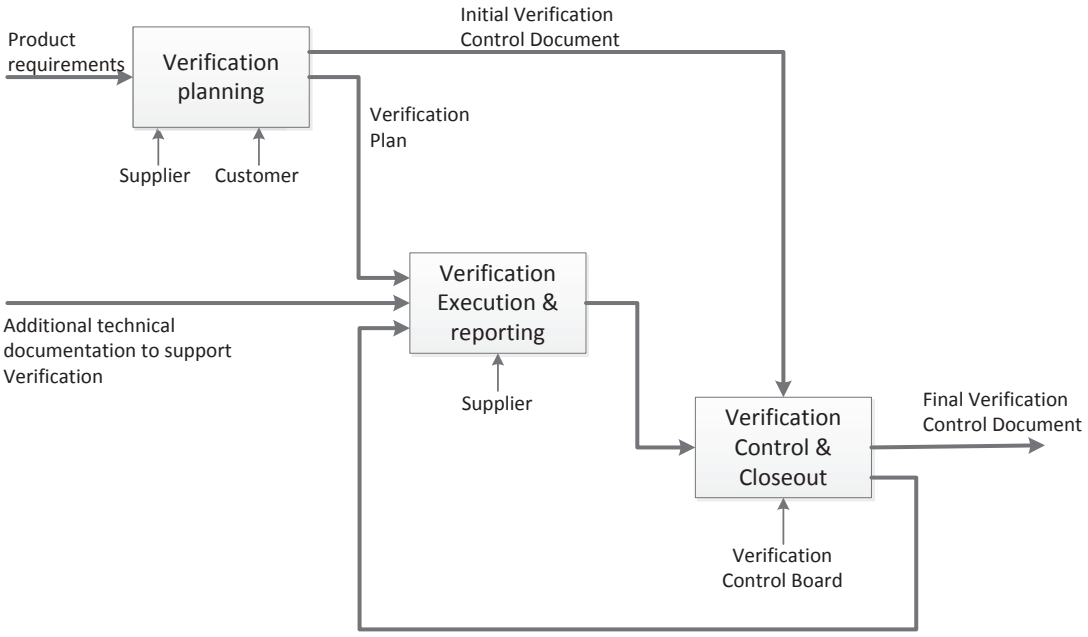

Figure 4-1: Verification process and activities

4.1.3 Verification documentation

The verification process and its implementation activities are documented by means of a specific set of verification documents.

- Verification plan (VP), see clause 5.2.8.1.
- Assembly, integration and test (AIT) plan, see ECSS-E-ST-10-03.

  NOTE The Verification Plan and the AIT Plan can be combined in one single AIV Plan (i.e. in this case VP and AIT plans do not exist anymore as single entities).

- Verification control document (VCD), see clauses 5.2.8.2 and 5.4.4.1.
- Test specification, see ECSS-E-ST-10-03.
- Test procedure, see ECSS-E-ST-10-03.
- Test report, see ECSS-E-ST-10-03, and clause 5.3.2.1 of the present standard.
- Analysis report, see ECSS-E-ST-10, and clause 5.3.2.2 of the present standard.
- Review of design report, see clause 5.3.2.3.
- Inspection report, see clause 5.3.2.4.
- Verification report, see clause 5.3.2.5.

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4.2 Verification planning

4.2.1 Verification approach

To reach the verification objectives the verification approach is established in early phases of a project by analyzing the requirements to be verified, taking into account:

- design peculiarities and constraints,
- qualification status of candidate solutions (product category),
- availability and maturity of verification tools,
- verification (including test) methodologies,
- ground segment and in orbit constraints for the in-orbit stage (including commissioning),
- programmatic constraints, and
- cost and schedule.

In generating the verification approach, the supplier conducts the following steps:

— Identify *"what"* are the products and requirements subject of the verification process;

— Identify *"How"* to verify them by considering the methods stated in the technical specification

— Identify *"When"* to implement by applying the chosen verification strategy.

These steps are generally conducted in an iterative process based on technical, cost and schedule considerations, ensuring that the approach is agreed by both the supplier and the customer.

4.2.2 Verification methods

The verification is executed by one or more of the following verification methods: test, analysis, review of design and inspection. This list shows the order of precedence that, in general, provides more confidence in the results.

4.2.3 Verification levels

The verification is performed incrementally at different product decomposition levels. The number and type of verification levels depends upon the complexity of the project and on its characteristics.

The usual verification levels for a space product are equipment, subsystem, element, segment and overall system.

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4.2.4 Verification stages

The verification process is implemented in subsequent verification stages along the project life cycle.

The stages depend upon project characteristics and identify a type of verification. The verification stages are qualification, acceptance, pre-launch, in-orbit (including commissioning) and post-landing.

4.2.5 Model philosophy

The verification by test is implemented on the selected models chosen for the project.

Model philosophy is defined by means of an iterative process which combines programmatic constraints, verification strategies and the integration and test programme, taking into account the development status of the candidate design solution.

4.2.6 Verification tools

The verification tools to be used to perform verification activities are identified and their procurement and utilisation planned. The extent to which the tools are themselves subjected to formal verification depends upon their role.

4.3 Verification execution and reporting

The verification process activities are incrementally performed at different product decomposition levels and in different stages, applying a coherent bottom-up strategy and utilizing a suitable combination of different verification methods.

In particular the verification by test is carried-out on different physical models in agreement with the selected model philosophy.

4.4 Verification control and closeout

The verification process is monitored in its execution by the Verification Control Board (see 5.4.2) and confirmed completed when, based on objective evidence, the VCD deems the product as verified against the identified requirements and the associated verification objectives. This has to be finally confirmed by the customer.

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