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Entwurf**Raumfahrtproduktsicherung –
Zerstörungsfreie Prüfung oder zerstörungsfreie Inspektion;
Englische Fassung prEN 16602-70-15:2018**

Space product assurance –
Non-destructive testing or non-destructive inspection;
English version prEN 16602-70-15:2018

Assurance produit des projets spatiaux –
Inspection non destructifs;
Version anglaise prEN 16602-70-15:2018

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2018-04-27 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

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Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 102 Seiten

DIN-Normenausschuss Luft- und Raumfahrt (NL)

Nationales Vorwort

Dieses Dokument (prEN 16602-70-15:2018) wurde vom Technischen Komitee CEN/CLC/TC 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 (prEN 16602-70-15:2018) basiert auf ECSS-Q-ST-70-15C DIR1.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von prEN 16602-70-15:2018.

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

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.
- b) Für die Anwendung dieser Norm gilt der Begriff nach ECSS-E-ST-32-01:
 - 1) bruchanfälliges Bauteil mit sicherer Lebensdauer

ANMERKUNG Diese Definition entspricht der Definition von „schadenstolerante bruchanfällige Bauteile“ in den NASA-Normen, wie z. B. NASA-STD-5019.

3.2 Für diese Norm spezifische Begriffe

3.2.1

Schwarzlicht (UVA-Licht)

nahezu ultraviolette Strahlung zur Anregung der Fluoreszenz

3.2.2

NDI-Methode

Verfahren, bei dem ein physikalisches Prinzip für die zerstörungsfreie Prüfung und die zerstörungsfreie Inspektion eingesetzt wird

[QUELLE: EN 4179:2017]

3.2.3

NDI-Anweisung

schriftliche Beschreibung der genauen Schritte, die bei der Prüfung nach einer festgelegten Norm, Vorschrift, Spezifikation oder einem NDI-Verfahren einzuhalten sind

Anmerkung 1 zum Begriff: Diese Norm legt in allen Fällen ein NDI-Verfahren fest.

[QUELLE: EN 4179:2017]

3.2.4

NDI-Technik

spezifische Art und Weise der Anwendung einer NDI-Methode

Anmerkung 1 zum Begriff: Beispielsweise Ultraschalltauchtechnik.

[QUELLE: EN 4179:2017]

3.2.5

NDI-Verfahren

schriftliche Beschreibung aller wesentlichen Parameter und Vorkehrungen, die anzuwenden sind, wenn Produkte einer zerstörungsfreien Prüfung in Übereinstimmung mit (einer) Norm(en), Vorschrift(en) oder Spezifikation(en) unterzogen werden

Anmerkung 1 zum Begriff: Ein NDI-Verfahren kann die Anwendung von mehr als einer NDI-Methode oder NDI-Technik umfassen.

[QUELLE: EN 4179:2017]

3.2.6

verantwortliche Person der Stufe III

vom Arbeitgeber benannte Person der Stufe III mit der entsprechenden Verantwortung und Befugnis und die im Auftrag des Arbeitgebers die Qualifizierung und Zertifizierung des NDI-Personals durchführt

[QUELLE: übernommen nach EN 4179:2011-02]

3.2.7

besondere NDI-Methoden zur Überwachung des Rissfortschritts

NDI-Methoden, die im Rahmen der Rissfortschrittüberwachung an Teilen mit sicherer Lebensdauer angewendet werden, um Risse oder rissartige Fehler zu erkennen, die kleiner sind als die, von denen angenommen wird, dass sie mithilfe der Standard-NDI-Methoden zur Überwachung des Rissfortschritts erkennbar sind, oder die nicht den Anforderungen der Standard-NDI-Methoden zur Überwachung des Rissfortschritts entsprechen

Anmerkung 1 zum Begriff: Die besonderen NDI-Methoden beschränken sich nicht auf die fluoreszierende Eindringprüfung, die Durchstrahlungsprüfung, die Ultraschallprüfung, die Wirbelstromprüfung und die Magnetpulverprüfung.

[QUELLE: übernommen nach der Definition der „besonderen NDI-Methoden“ von ECSS-E-ST-32-01]

3.2.8

Standard-NDI-Methoden zur Überwachung des Rissfortschritts

NDI-Methoden für metallische Werkstoffe, für die das erforderliche, auf Statistiken basierende Vermögen zum Erkennen von Fehlern festgelegt wurde

Anmerkung 1 zum Begriff: Die in diesem Dokument behandelten Standard-NDI-Methoden beschränken sich auf die fluoreszierende Eindringprüfung, die Durchstrahlungsprüfung, die Ultraschallprüfung, die Wirbelstromprüfung und die Magnetpulverprüfung.

[QUELLE: übernommen nach der Definition der „besonderen NDI-Methoden“ von ECSS-E-ST-32-01]

3.2.9

Qualifikation des Personals

Fertigkeiten, Ausbildung, Kenntnisse, Prüfungen, Erfahrungen und visuelle Fähigkeiten, die Personal aufweisen muss, um die Anforderungen einer bestimmten Stufe fachgerecht zu erfüllen

[QUELLE: EN 4179:2009]

3.2.10

Zertifizierung des Personals

schriftliche Bestätigung eines Arbeitgebers, dass eine Person die zutreffenden Anforderungen erfüllt

Anmerkung 1 zum Begriff: In einigen Normen wird der Arbeitgeber als Zertifizierungsbehörde oder Zertifizierungsstelle bezeichnet.

[QUELLE: EN 4179:2009]

3.2.11

Produktfamilie

Kombination der folgenden Eindringprüfmittel: Eindringmittel, Zwischenreiniger und Entwickler

Anmerkung 1 zum Begriff: Der Zwischenreiniger fällt nicht unter Verfahren A nach EN ISO 3452-2:2013.

Anmerkung 2 zum Begriff: Bei der Prüfung nach EN ISO 3452-2:2013 stammen das Eindringmittel und der Zwischenreiniger vom selben Hersteller.

[QUELLE: übernommen nach EN ISO 3452-2:2013]

3.2.12

Verifizierung des Verfahrens

Prozess zur Zertifizierung der Wirksamkeit eines Inspektionsprozesses durch einen Nachweis, der auf einer repräsentativen Struktur in einer repräsentativen Umgebung und durch repräsentatives Inspektionspersonal erbracht wird

Anmerkung 1 zum Begriff: Ausrüstungen, in Bezug genommene Normen und schriftliche Verfahrensanweisungen sind Beispiele für den Inspektionsprozess.

Anmerkung 2 zum Begriff: Der Begriff „Qualifizierung“ nach ECSS-Q-ST-70-15 ist gleichbedeutend mit dem Begriff „Verifizierung“, der in der ECSS-Dokumentation verwendet wird.

[QUELLE: übernommen nach MIL-HDBK-6870B]

3.3 Abkürzungen und Symbole

Für die Anwendung dieser Norm gelten die Abkürzungen und Symbole nach ECSS-S-ST-00-01 und die folgenden Abkürzungen:

Abkürzung	Bedeutung	
AMS	Werkstoffspezifikation in der Luft- und Raumfahrt	(en: Aerospace Material Specification)
ASTM	Amerikanische Gesellschaft für Materialprüfung	(en: American Society for Testing and Materials)
CR	Computerradiographie	(en: Computed Radiography)
CT	Computertomographie	(en: Computed Tomography)
DDA	digitale Detektoranordnung	(en: Digital Detector Array)
DRD	Definition der Anforderungen an Dokumente	(en: Document Requirements Definition)
DR	digitale Radiographie	(en: Digital Radiography)
ET	Wirbelstromprüfung	(en: Eddy Current Testing)
EEE	elektrisch, elektronisch und elektromechanisch	(en: Electrical, Electronic and Electromechanical)

Abkürzung	Bedeutung	
EN	Europäische Norm	(en: European Norm)
FMECA	Fehlermöglichkeits-, Einfluss- und Kritikalitäts-Analyse	(en: Failure Modes, Effects and Criticality Analysis)
FSW	Rührreibschweißen	(en: Friction Stir Welding)
MMC	Metallmatrix-Verbundwerkstoffe	(en: Metal Matrix Composites)
MPI	Magnetpulverinspektion	(en: Magnetic Particle Inspection)
MPCB	Werkstoff- und Prozesskontrollausschuss	(en: Materials and Processes Control Board)
MT	Magnetpulverprüfung	(en: Magnetic Particle Testing)
NAS	Nationale Luft- und Raumfahrtspezifikation	(en: National Aerospace Specification)
NCR	Nichtkonformitäten/Fehler-Bericht	(en: Nonconformance Report)
NDI	zerstörungsfreie Untersuchung	(en: Non-Destructive Inspection)
NDT	zerstörungsfreie Prüfung	(en: Non-Destructive Testing)
NRB	Nichtkonformitäten-Prüfausschuss	(en: Nonconformance Review Board)
PFCI	möglicherweise rissgefährdetes Bauteil	(en: Potential Fracture Critical Item)
POD	Nachweiswahrscheinlichkeit	(en: Probability Of Detection)
PSM	Eindringsystemüberwachung	(en: Penetrant System Monitoring)
PT	Farbeindringprüfung	(en: dye Penetrant Testing)
RFD	Antrag auf Abweichung	(en: Request For Deviation)
RT	Durchstrahlungsprüfung	(en: Radiography Testing)
QQI	quantitativer Qualitätsindikator	(en: Quantitative Quality Indicator)
QMS	Qualitätsmanagementsystem	(en: Quality Management System)
TIG	Wolfram-Inertgas-Schweißen	(en: Tungsten Inert Gas welding)
TWI	The Welding Institute	
UT	Ultraschallprüfung	(en: Ultrasonic inspection Testing)
UTG	Ultraschall-Dickenmesung	(en: Ultrasonic Thickness Gauge)
UV	ultraviolett	(en: ultraviolet)
VDT	Schwellenwert für sichtbare Beschädigung	(en: Visual Damage Threshold)

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Space product assurance - Non-destructive inspection

Raumfahrtproduktsicherung - Zerstörungsfreie Inspektion

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European Foreword

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This document (prEN 16602-70-15) originates from ECSS-Q-ST-70-15C DIR1.

This document is currently submitted to the CEN ENQUIRY.

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

Introduction

Non-destructive Inspection (NDI) covers a wide range of processes used in quality control. The generic term NDI covers several sub processes such as Dye Penetrant Inspection, Radiography, Ultrasonic and Eddy Current. The processes are applied at the discretion of the design authority depending on the criticality of the part or component and inherent risk of the manufacturing process to create detrimental flaws. It is expected that every component used in spaceflight is subjected to some level of NDI in accordance with the present standard, which complements the ECSS-Q-ST-70-39C “Welding of metallic materials for flight hardware”.

The lack of NDI control throughout the supply chain has been evident in all space projects across the Europe. As no standard was in place at that time this has resulted in inconsistency in the rationale and application for NDI selection. NDI is generally applied for quality control to ensure that components are free of defects and discontinuities. For some components the NDI methods used form the basis of the fracture and fatigue verification and thus the assurance of design margins. The level of NDI is expected to be decided based on the manufacturing processes applied and the criticality of the part or component and the impact if that part fails in service.

1

Scope

This standard specifies NDI requirements for flight parts, components and structures used for space missions. It covers the NDI methods and stipulates the certification levels for personnel. The qualification of such processes are also specified for non-standard NDI techniques or where complex components are concerned. This standard also identifies the best practice across the large range of international and national standards.

Visual inspection included in this standard is not intended to include incoming inspection of, for example, raw materials, damage during transport, storage and handling and parts procurement verification.

The minimum requirements for NDI documentation are specified in the DRDs of the Annexes.

This standard does not cover the acceptance criteria of components, structures and parts submitted to this examination; it is expected that these criteria are identified on specific program application documentation.

This Standard does not apply to EEE components.

This standard may be tailored for the specific characteristic 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 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16601-40	ECSS-M-ST-40	Space management - Configuration and information management
EN 16602-10	ECSS-Q-ST-10	Space product assurance - Product assurance management
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
EN 16602-70-39	ECSS-Q-ST-70-39	Space product assurance -Welding of metallic materials for flight hardware
EN 16603-32	ECSS-E-ST-32	Space engineering – Structural general requirements
EN 16603-32-01	ECSS-E-ST-32-01	Space engineering – Fracture control
	EN 4179:2017	Aerospace series – Qualification and approval of personnel for non-destructive testing
	EN 12668-1:2010	Non-destructive testing. Characterization and verification of ultrasonic examination equipment. Instruments
	EN 13068-3:2001	Non-destructive testing - Radioscopic testing - Part 3: general principles or radioscopic testing of metallic materials by x- and gamma rays
	EN 1779:1999	Non-destructive testing - Leak testing - Criteria for method and technique selection
	EN ISO 3452-1:2013	Non-destructive testing — Penetrant testing — Part 1: General principles

EN reference	Reference in text	Title
	EN ISO 3452-2:2013	Non-destructive testing -- Penetrant testing -- Part 2: Testing of penetrant materials
	EN ISO 3452-3:2013	Non-destructive testing -- Penetrant testing -- Part 3: Reference test blocks
	EN ISO 5579:2013	Non-destructive testing -- Radiographic testing of metallic materials using film and X- or gamma rays -- Basic rules
	EN ISO 9712:2012	Non-destructive testing -- Qualification and certification of NDT personnel
	EN ISO 9934-1:2016	Non-destructive testing -- Magnetic particle testing -- Part 1: General principles
	EN ISO 9934-2:2015	Non-destructive testing -- Magnetic particle testing -- Part 2: Detection media
	EN ISO 9934-3:2014	Non-destructive testing -- Magnetic particle testing -- Part 3: Equipment
	EN ISO 15548-1:2013	Non-destructive testing -- Equipment for eddy current examination -- Part 1: Instrument characteristics and verification
	EN ISO 15548-2:2013	Non-destructive testing -- Equipment for eddy current examination -- Part 2: Probe characteristics and verification
	EN ISO 15548-3:2008	Non-destructive testing -- Equipment for eddy current examination -- Part 3: System characteristics and verification
	EN ISO 15549:2008	Non-destructive testing -- Eddy current testing -- General principles
	EN ISO 15708-2:2017	Non-destructive testing -- Radiation methods for computed tomography-Part2: Principles, equipment and samples
	EN ISO 16810:2012	Non-destructive testing -- Ultrasonic testing -- General principles
	EN ISO 17635:2016	Non-destructive testing of welds -- General rules for metallic materials
	EN ISO 17636-1:2013	Non-destructive testing of welds -- Radiographic testing -- Part 1: X- and gamma-ray techniques with film
	EN ISO 17636-2:2013	Non-destructive testing of welds -- Radiographic testing -- Part 2: X- and gamma-ray techniques with digital detectors
	EN ISO 17640:2017	Non-destructive testing of welds -- Ultrasonic testing -- Techniques, testing levels and assessment
	EN 13018:2016	Non-destructive testing - Visual testing - General principles
	AMS-STD-2154:2005	Process for Ultrasonic Inspection of Wrought Metals

EN reference	Reference in text	Title
	ASTM E 127:2015	Standard Practice for Fabrication and Control of Aluminium Alloy Ultrasonic Standard Reference Blocks
	ASTM E 137:2016	Standard practice for evaluation of mass spectrometers for quantitative analysis from a batch inlet
	ASTM E 164:2013	Standard Practice for Contact Ultrasonic Testing of Weldments
	ASTM E 426:2016	Standard Practice for Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys
	ASTM E 428-08(2013)	Standard Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing
	ASTM B 594:2013	Standard Practice for Ultrasonic Inspection of Aluminium-Alloy Wrought Products
	ASTM E 1254:2008	Standard guide for storage of radiographs and unexposed industrial radiographic films
	ASTM E 1417/1417M-11:2016	Standard Practice for Liquid Penetrant Testing
	ASTM E 1441:2011	Standard Guide for Computed Tomography (CT) Imaging
	ASTM E 1444/E1444M-:2011	Standard Practice for Magnetic Particle Testing
	ASTM E 1734:2016	Standard Practice for Radioscopic Examination of Castings
	ASTM E1742/E1742M:2012-	Standard Practice for Radiographic Examination
	ASTM E1814 - :2014	Standard Practice for Computed Tomographic (CT) Examination of Castings
	ASTM E 2375:2013	Standard Practice for Ultrasonic Testing of Wrought Products
	ASTM E 2445:2014	Standard Practice for Performance Evaluation and Long-Term Stability of Computed Radiography Systems
	ASTM E 2698:2010	Standard Practice for Radiological Examination Using Digital Detector Arrays
	IR99: 1999	Ionizing Radiation Regulations 1999
	NAS 410:2014	NAS Certification and Qualification of Non Destructive Test Personnel
	SAE-ARP-4402:2013	Eddy Current Inspection of Open Fastener Holes in Aluminium Aircraft Structure

EN reference	Reference in text	Title
	SAE-AS-4787:2013	Eddy Current Inspection of Circular Holes in Nonferrous Metallic Aircraft Engine Hardware
	SAE-AMS-2154C:2017	Inspection, ultrasonic, wrought metals, process for
	SAE-AMS-2644:2006	Inspection material penetrant
	QPL-AMS-2644:2016	Inspection material, penetrant

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-ST-00-01 apply.
- b. For the purposed of this Standards, the term and definition from ECSS-E-ST-32-01 apply:
 1. safe life potential fracture critical item

NOTE This definition is equivalent to the definition of "damage tolerant fracture critical items" in NASA standards like NASA-STD-5019.

3.2 Terms specific to the present standard

3.2.1 black light (UVA light)

near ultraviolet radiation used for exciting fluorescence

3.2.2 NDI method

discipline that applying a physical principle in non-destructive testing and non-destructive inspection

[EN 4179:2017]

3.2.3 NDI instruction

written description of the precise steps to be followed in testing to an established standard, code, specification or NDI procedure.

[EN 4179:2017]

NOTE This standard specifies in all cases an NDI procedure.

3.2.4 NDI technique

specific way of utilizing an NDI method

NOTE For example, ultrasonic immersion technique.

[EN 4179:2017]

3.2.5 NDI procedure

written description of all essential parameters and precautions to be applied when non-destructively testing products in accordance with standard(s), code(s) or specification(s)

NOTE An NDI procedure can involve the application of more than one NDI method or technique.

[EN 4179:2017]

3.2.6 responsible Level III

person Level III designated by the employer with the responsibility and authority and act on behalf of the employer for qualification and certification of NDI personnel

[adapted from EN 4179:2011-02]

3.2.7 special fracture control NDI

NDI methods applied in the context of fracture control implementation on safe life items that are capable of detecting cracks or crack-like flaws smaller than those assumed detectable by standard fracture control NDI or do not conform to the requirements for standard fracture control NDI.

[adapted from “Special NDI” definition of ECSS-E-ST-32-01]

NOTE Special NDI methods are not limited to fluorescent penetrant, radiography, ultrasonic, eddy current, and magnetic particle.

3.2.8 standard fracture control NDI

NDI methods of metallic materials for which the required statistically based flaw detection capability has been established.

[adapted from “Special NDI” definition of ECSS-E-ST-32-01]

NOTE Standard NDI methods addressed by this document are limited to fluorescent penetrant, radiography, ultrasonic, eddy current, and magnetic particle.

3.2.9 personnel qualification

skills, training, knowledge, examinations, experience and visual capability required for personnel to properly perform to a particular level

[EN 4179:2009]

3.2.10 personnel certification

written statement by an employer that an individual has met the applicable requirements

[EN 4179:2009]

NOTE In some standards employer is called certifying agency or body.

3.2.11 product family

combination of the following penetrant testing materials: penetrant, excess penetrant remover and developer.

[adapted from EN ISO 3452 Part 2:2013]

NOTE 1 Excess penetrant remover does not include method A from EN ISO 3452 Part 2:2013.

NOTE 2 During testing in compliance with EN ISO 3452 Part 2:2013 penetrant and excess remover are from the same manufacturer.

3.2.12 procedure verification

process of certifying the efficacy of an inspection process through a demonstration, on a representative structure, in a representative environment, and by representative inspection personnel.

[adapted from MIL-HDBK-6870B]

NOTE 1 Equipment, reference standards and written procedures are examples of inspection process include

NOTE 2 The term "qualification" from the ECSS-Q-ST-70-15 is synonymous with the term "verification" used in ECSS documentation.

3.3 Abbreviated terms and symbols

For the purpose of this Standard, the abbreviated terms and symbols from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AMS	Aerospace Material Specification
ASTM	American Society for Testing and Materials
CR	computed radiography
CT	computed tomography
DDA	digital detector array
DRD	document requirements definition
DR	digital radiography
ET	eddy current testing
EEE	electrical, electronic and electromechanical
EN	European Norm
FMECA	failure modes, effects and criticality analysis
FSW	friction stir welding
MMC	metal matrix composites
MPI	magnetic particle inspection
MPCB	materials and processes control board

MT	magnetic particle testing
NAS	National Aerospace Specification
NCR	nonconformance report
NDI	non-destructive inspection
NDT	non-destructive testing
NRB	nonconformance review board
PFCI	potential fracture control critical
POD	probability of detection
PSM	penetrant system monitoring
PT	dye penetrant testing
RFD	request for deviation
RT	radiography testing
QQI	quantitative quality indicator
QMS	quality management system
TIG	tungsten inert gas welding
TWI	The Welding Institute
UT	ultrasonic inspection testing
UTG	ultrasonic thickness gauge
UV	ultraviolet
VDT	visual damage threshold

3.4 Nomenclature

3.4.1 Formal verbs

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.

3.4.2 Conventions

The term “qualification” from the ECSS-Q-ST-70-15 is synonymous with the term “verification” used in ECSS documentation. This is not applicable to the qualification of personnel.

4 Principles

4.1 General

The NDI of materials is carried out in such a way that product integrity and surface texture remain unchanged. The NDI inspection of parts is particularly important for products or components where failure or malfunction can have serious implications.

These include loss of mission hardware and for flight hardware.

This standard specifies the necessary requirements to perform NDI for materials for space applications.

This is presented in the following Figure 4-1 which shows the steps taken and the choice of NDI method and technique.

NOTE Additional complementary material
information can be found in Annex F.

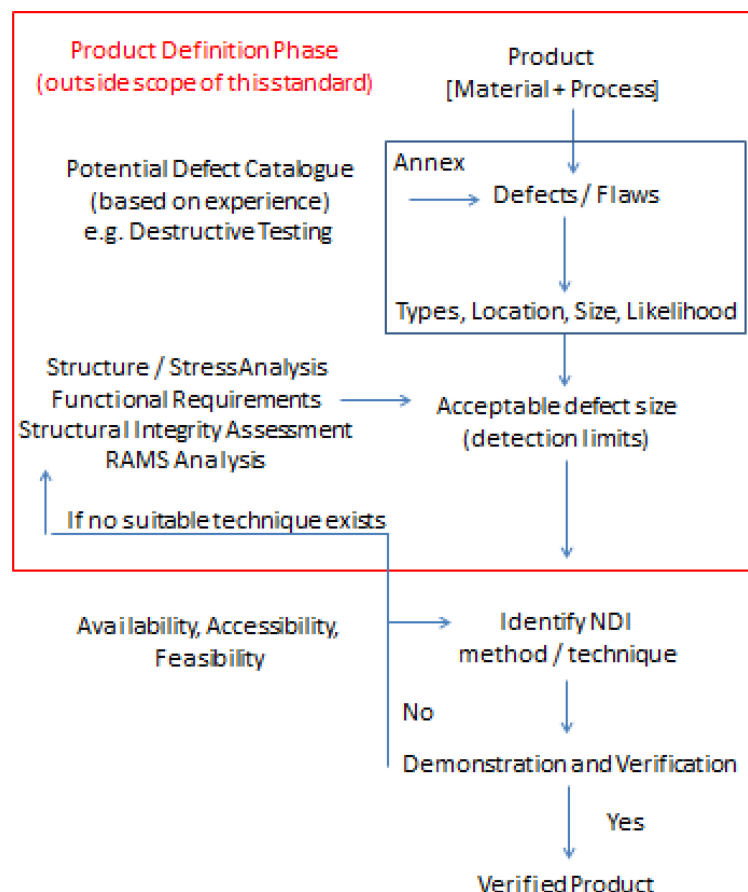


Figure 4-1: Flow chart showing steps to be taken for a part and choice of NDI method and technique.

Examples for potential defects are presented in Annex D.

Generic requirements

5.1 General

- a. The supplier shall establish and maintain documented NDI procedures for each part to be inspected.
- b. The supplier shall submit NDI procedure for customer approval.
- c. The design definition authority shall specify NDI acceptance criteria.

NOTE It is assumed that accept and reject criteria reflect the possible need to ensure that cracks smaller than the targeted crack size are reported as “detected cracks” in line with ECSS-E-ST-32-01 clause 10.7 (for example > 50 % of the targeted crack size).

- d. NDI procedure shall include NDI plan in conformance with DRD from Annex A for the chosen NDI method, report and number of samples tested.
- e. All NDI procedures shall be verified to assure repeatable defect sensitivity needed for classification of the part.
- f. The NDI plan shall be prepared prior to carrying out any NDI.
- g. The NDI plan shall be prepared by Level II and approved by Level III who is certified in the corresponding method in compliance with requirements from clause 5.7.
- h. The identified part areas shall be inspected.
- i. NDI shall be performed by certified NDI inspectors in accordance with requirements from clause 5.7 and requirements from clause 5.1.2 of ECSS-Q-ST-20.
- j. All written instructions shall be prepared by NDI Level II inspector as a minimum and approved by Level III responsible.
- k. The instructions specified in requirement 5.1j shall be uniquely identified.
- l. Application of new versions or issues of the instruction specified in the requirement 5.1j shall be submitted for customer approval.
- m. All parts subject to an NDI examination shall be recorded in the logbook.
- n. All NDI plans shall be subject to agreement between customer and supplier during MPCB in consultation with Level III responsible.

- o. Supplier shall raise NCRs about any flaws detected during NDI inspection not meeting the customer specifications.
- p. For any deviations from the customer requirements an RFD shall be raised in conformance with ECSS-M-ST-40.

5.2 Discontinuities and cracks

- a. Any unknown or critical discontinuities shall be recorded.
- b. For the discontinuities specified in the requirement 5.2a the Level III responsible for the specific method shall assess the need to raise an NCR in conformance with the DRD in Annex A from ECSS-Q-ST-10-09.
- c. The processing of the NCR shall be in compliance with requirements from ECSS-Q-ST-10-09.

NOTE This can lead to new inspection or to re-inspection of parts after identification of discontinuities to be performed by using the same NDI plan and procedure, and to the need of customer agreement.

- d. All detected cracks or crack-like flaws, regardless of size, shall be cause for rejection, unless approved by NRB and customer.

5.3 NDI drawing callouts

- a. NDI inspection specifications for all parts to be inspected shall be identified or referred to in all drawings.
- b. The drawings shall identify or refer to each inspection requirement by zone when different zones require different NDI inspection requirements and acceptance criteria.
- c. The drawings shall be updated when NDI inspection requirements are updated.

5.4 NDI process and configuration control

- a. A written NDI procedure, in conformance with DRD from Annex C, shall be developed for each part to be inspected, and approved by the responsible Level III of the appropriate NDI method.
- b. Configuration control shall be performed in compliance with ECSS-M-ST-40 for the following:
 - 1. Personnel qualification and certification
 - 2. NDI specification
 - 3. NDI standards
 - 4. NDI part-specific procedures

NOTE It is important that the meaning of NDI procedure, instruction, and specification is clarified between customer and supplier.

- c. All certification records, NDI reports, and associated paperwork shall be in accordance with requirements from ECSS-M-ST-40 clause 5.3.7 and ECSS-Q-ST-10 clause 5.2.6.

5.5 NDI procedure capability demonstration

- a. Supplier shall demonstrate NDI capability in accordance with clause 9.1.3.
- b. Capability demonstration test specimens not covered by clause 9.1.3 shall be agreed between customer and supplier.
- c. The test specimens shall be representative of the material, defect types and part geometry to be inspected.

NOTE 1 NDI procedures can be verified on parts or on test pieces simulating the actual part and which provide the essential features of the part with regard to the important application variables which can affect defect sensitivity and confidence level. These aspects can differ significantly between different NDI methods.

NOTE 2 Examples are similarity based on wetting behaviour for penetrant inspection and microstructure features for eddy current and ultrasonic inspection.

- d. POD demonstration by “hit and miss” method needs not be performed for:
 - 1. Guided manual inspection
 - 2. Local manual inspection of small area or volume with reference to the applied procedure and equipment, if coverage of the complete area or volume can be guaranteed.
- e. For detected defects the accuracy of the sizing method shall be demonstrated.

NOTE The concept of POD does not apply to already detected defects.

5.6 Organizational guidelines and documentation requirement

- a. The NDI organization shall be specified in the suppliers QMS.

NOTE Examples for the definition of this organization are provided in EN 4179:2017 and NAS 410:2014. Further guidelines are presented in NASA-STD-5009:2008 Appendix A.

5.7 NDI personnel qualification and certification

- a. For penetrant, magnetic, eddy current, ultrasonic, radiographic, thermographic and shearographic testing, personnel for non-destructive inspections, shall be certified, in accordance with EN 4179:2017 or NAS 410:2014.
- b. For NDI methods not explicitly covered by EN 4179:2017 or NAS 410:2014, personnel certification shall be specified and recorded in the written practice and referenced in NDI plan, in accordance with requirements of clause 6.4 of EN 4179:2017 or NAS 410:2014.

NOTE Clause 6.4 of EN 4179:2017 is called “Emerging NDI methods”.

- c. Other standards may be accepted on a case by case basis, if agreed between the customer and supplier.

NOTE Examples of commonly applied standards are:
EN ISO 9712:2012 that covers leak testing and
visual inspection not covered by EN 4179:2017
and NAS 410:2014.