INTERNATIONAL STANDARD

ISO 14621-1

Second edition
2019-05

Space systems — Electrical, electronic and electromechanical (EEE) parts —

Part 1:
Parts management

Systèmes spatiaux — Composants électriques, électroniques et électromécaniques (EEE) —

Partie 1: Gestion des composants

Reference number
ISO 14621-1:2019(E)

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

This edition cancels and replaces the first edition (ISO 14621-1:2003), which has been technically revised. The main changes compared to the previous edition are as follows:

— Introduction and definitions have been revised,

— consistency has been checked with ISO 14621-2, and

— the document has been aligned with the ISO/IEC Directives Part 2, 2018 edition.

A list of all parts in the ISO 14621 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 14621-1 and ISO 14621-2 are designed to jointly assist the user and supplier communities in developing and executing an effective process for the design, selection and application of electrical, electronic, and electromechanical (EEE) space parts throughout the life cycle of the programme.

NOTE In both ISO 14621-1 and ISO 14621-2, the family of EEE parts includes electro-optical parts.

The strategy represented in the ISO 14621 series is:

— for ISO 14621-1 a system approach to managing risk throughout the life cycle of the programme, by developing, selecting and properly applying the right EEE part for its intended application;

— for ISO 14621-2 a framework for developing and documenting an EEE parts control programme to assure that the parts used in space flight hardware have acceptable risk, i.e. possess adequate functional, radiation and reliability characteristics to meet the system requirements.

Both ISO 14621-1 and ISO 14621-2 should be tailored to meet the specific needs of each individual programme, i.e. to address the applicable system performance requirements, risk tolerance, budget, mission duration, operating environment, and schedule. Tailoring should result in a set of planned activities that are not only capable of achieving all contractual EEE parts related requirements, but also commensurate with the space system's unit-value/mission-criticality and life cycle technical data product requirements.

NOTE This type of planning is sometimes referred to as capability-based Safety, Dependability, and Quality Assurance (SD&QA) programme tailoring; and the guidance for performing it is provided in ISO/TS 18667.

ISO 14621-1 and ISO 14621-2 are relevant to all users and customers of space systems, and the suppliers and vendors that furnish space flight hardware. However, to utilize these documents to their fullest potential, it is necessary to understand the commercial space business environment which has unique cost and schedule constraint challenges.

This document discusses the following key elements that support an effective EEE parts management programme:

— Part obsolescence management — perform early assessment of part availability risk for the entire space system, develop and implement risk mitigation activities that will prevent or minimize programme disruption due to part shortages, and ensure long-term supportability throughout the programme life cycle.

— Supplier management — plan and execute techniques for verifying that the practices and products of suppliers and vendors comply with:

  — contractual requirements;

  — their documented internal business practices (also known as command media), which should be consistent with the commercial consensus on technical best practices.

— Cost management — minimize the costs, including verifying parts suppliers and vendors can provide the rationale why they set different costs for parts that are functionally identical, e.g. identify the cost of special processing applied to parts that are designed for a specific space environment or mission.

— Technology insertion — focus on creating a technology road map, which minimizes risk of obsolescence and develops a strategy for technology insertion during the entire system life cycle.

— Space parts community alert exchange — have a forum focused on managing peer to peer communication among space industry participants seeking to reduce or eliminate expenditures of resources on common problems, by sharing EEE parts related problem information collected during research, design, development, production, and operational phases of the programme.

— Process control — ensure the user's and supplier's approaches for controlling EEE parts risks, and risks of other critical items and processes, are documented, formally approved, and validated.

— Systems engineering — encourage parts engineering participation in all phases of the product life cycle.

— Training — provide effectively trained resources on the various processes required to develop, select, and properly apply the right EEE part for the its intended application, as well as to establish awareness of the parts management programme throughout all levels of the user and supplier communities.

Those specific elements or opportunities are presented in descriptive terms and illustrated in graphic flow charts. There is no intent to provide detailed descriptions of "how to" in this document. It may be cited as a basic guideline within a statement of work and/or for assessing proposals and contractor performance. All levels of contractual relationships (acquiring activities, primes, subcontractors and suppliers) may use this document. It is the responsibility of the user community to establish, define, and administer those tasks based on the programme goals and objectives and thus provide the "what" elements envisioned and establish their appropriate criteria for their programme.

Although this document was written with the intent of covering EEE parts, the concept established is a system approach for developing an EEE parts programme with reference to specific material and mechanical processes that make up EEE parts.

Space systems — Electrical, electronic and electromechanical (EEE) parts —

Part 1: Parts management

1 Scope

This document addresses the key elements for an EEE parts management programme for space systems and is written in general terms as a baseline for developing, implementing, validating, and evaluating a space parts management programme. The family of EEE parts includes electro-optical parts.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14621-2, *Space systems — Electrical, electronic and electromechanical (EEE) parts — Part 2: Control Programme Requirements*

ISO 17666, *Space systems — Risk management*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
best practice
documented process or product developed by the user community, consisting of suppliers and customers, teaming for the purpose of establishing industry guidelines

3.1.2
electronic, electrical, or electromechanical part
EEE part
device that performs an electronic, electrical, or electromechanical (EEE) function, including electro-optical devices, and consists of one or more elements so joined together that they cannot normally be disassembled without destroying the functionality of the device

3.1.3
integrated product team
IPT
integrated product team consisting of members selected from the appropriate disciplines

EXAMPLE Engineering, manufacturing, quality, suppliers or customers, as appropriate.

3.1.4
manufacturer
company or organization that transfers raw material into a product

3.1.5
performance specification
document that defines what the customer desires as a product, its operational environments and all required performance characteristics

3.1.6
product specification
document that defines the end item(s) the supplier intends to provide to satisfy all the *performance specification* (3.1.5) requirements

3.1.7
reliability engineering
integral part of the system engineering requirements definition and analysis function

Note 1 to entry: The tasks are to conduct cost/benefit trade-offs and to analyse and determine alternative design and procurement solutions.

3.1.8
systems engineering
interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution throughout its life

[SOURCE: ISO/IEC/IEEE 24748-1:2018, 3.57]

3.1.9
technology insertion strategy
decision making process to assess current and future part availability and trends, which leads to a decision regarding emerging or new technology insertion

Note 1 to entry: This process is used in the concept development phase, but also impacts the production and field support phases.

3.1.10
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.13, modified — Notes 1, 2, and 3 to entry have been deleted.]

3.1.11
vendor
seller of parts, products, or commodities

Note 1 to entry: This term can be interchangeable with *manufacturer* (3.1.4), depending on the application

3.1.12
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.12, modified — Notes 1, 2, and 3 to entry have been deleted.]

3.2 Abbreviated terms

ARN	anticipated reliability number
ASIC	application specific integrated circuit
BOM	bill of materials
CAM	computer-aided manufacturing
Cpk	process capability
DEMP	discharge electromagnetic pulse
DIC	digital integrated circuit
DM	design margin
DMSMS	diminishing manufacturing sources and material shortages
DoE	design of experiments
DPA	destructive physical analysis
EEE	electronic, electrical and electromechanical
EMC	electro-magnetic compatibility
EMP	electromagnetic pulse
EPI	epitaxial
ESD	electrostatic discharge
FMECA	failure modes and effects criticality analysis
F^3I	form, fit, function interfaces
FRACAS	failure reporting, analysis, and corrective action system
HAST	highly accelerated stress test
HEMP	high altitude electromagnetic pulse
IPD	integrated product design
MPU	micro processing unit
NDI	non-developmental item
OEM	original equipment manufacturer
PEM	plastic encapsulated microcircuit
PWB	printed wiring board
QML	qualified manufacturers list
QPL	qualified parts list
RH	relative humidity

SEB	single event burnout
SEE	single event effects
SEGR	single event gate rupture
SEL	single event latchup
SEU	single event upset
SGEMP	system-generated electromagnetic pulse
SPC	statistical process control

4 EEE parts management programme

4.1 EEE parts management process

4.1.1 General

The EEE parts management process defined in this document is designed to assist in dealing more proactively with critical parts management issues and to provide guidance for developing comprehensive strategies to manage EEE parts related performance, cost, and schedule risk via an integrated product team (IPT) process (Figure 1). The main aspects of the EEE parts management process are design process, supplier management, and shared data. The design process includes, but is not limited to, design margins, life cycle cost, technology insertion, technical support, system engineering support, parts selection, obsolescence management and validation/verification. The emphasis should be on concurrent rather than sequential consideration of these factors in design. Space systems users shall systematically select and proactively monitor their parts supplier base, while information collected from the EEE parts manufacturing and supplier communities shall be organized in a database and shared with IPT members.

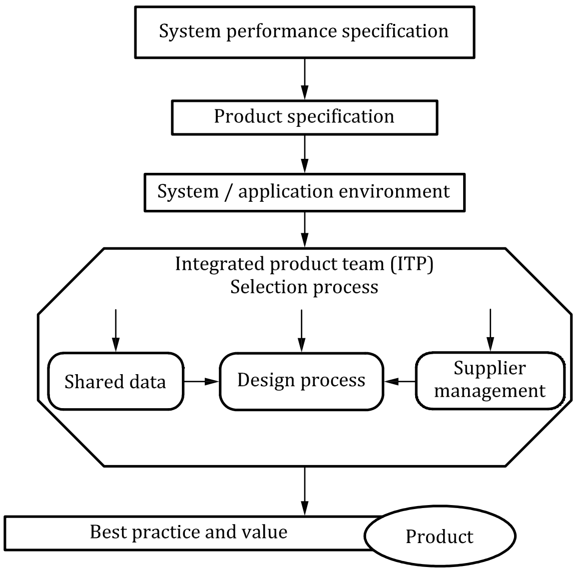


Figure 1 — Parts management IPT overview

4.1.2 Design process

The flow diagram (Figure 2) illustrates the interrelationships of the critical key elements that shall be addressed concurrently by engineering and supplier management (B) (see 4.2), to achieve the “best practice" selection of EEE parts and documentation required for the initial design. The results obtained from this analysis should be made available as shared data (A) (see 4.3). The following paragraphs describe the principles embodying the ten key elements. Refer to the Introduction.

4.1.3 Design margin

The objective of developing a design margin is to assist integrated product teams with critical analyses resulting in a robust design and minimized life cycle cost. The availability of computer-based analysis and simulation tools presents the opportunity to validate in detail those aspects of design prior to manufacturing/qualification commitment. Creating a design margin analysis based on actual conditions will provide a comprehensive description of EEE part characteristics with simulation results, thereby enhancing system performance. The design margin process (Figure 3) describes a minimum set of design analyses needed to maximize design robustness and identifies control limits and corrective action procedures. Metrics to validate the process include, but are not limited to, the following:

a) comparisons of actual design margins to established baselines;

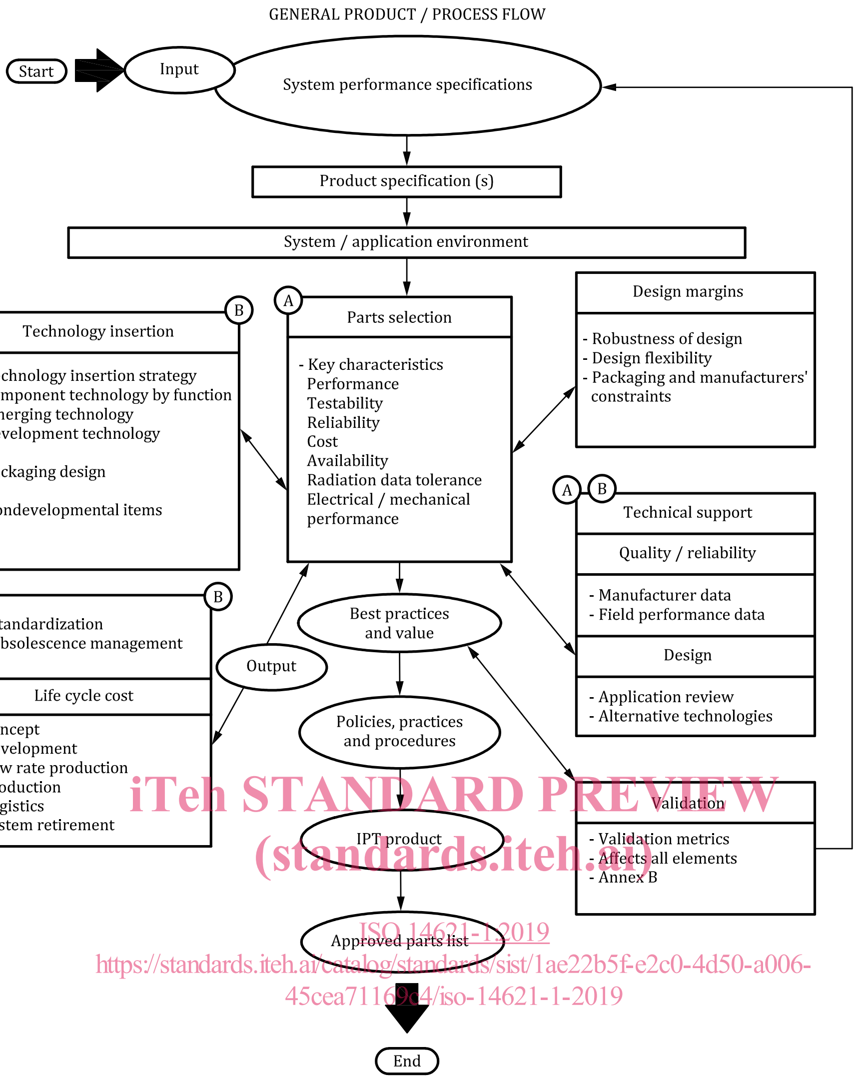
b) quality of engineering design changes;

c) qualification test performance (failures);

d) prediction analysis yield;

e) manufacturing/production yields.

Associated elements are parts selection (4.1.8) and technical support (4.1.6).



Key

Ⓐ linked to shared data (see 4.3)

Ⓑ linked to supplier management (see 4.2)

Figure 2 — Systems engineering IPT product

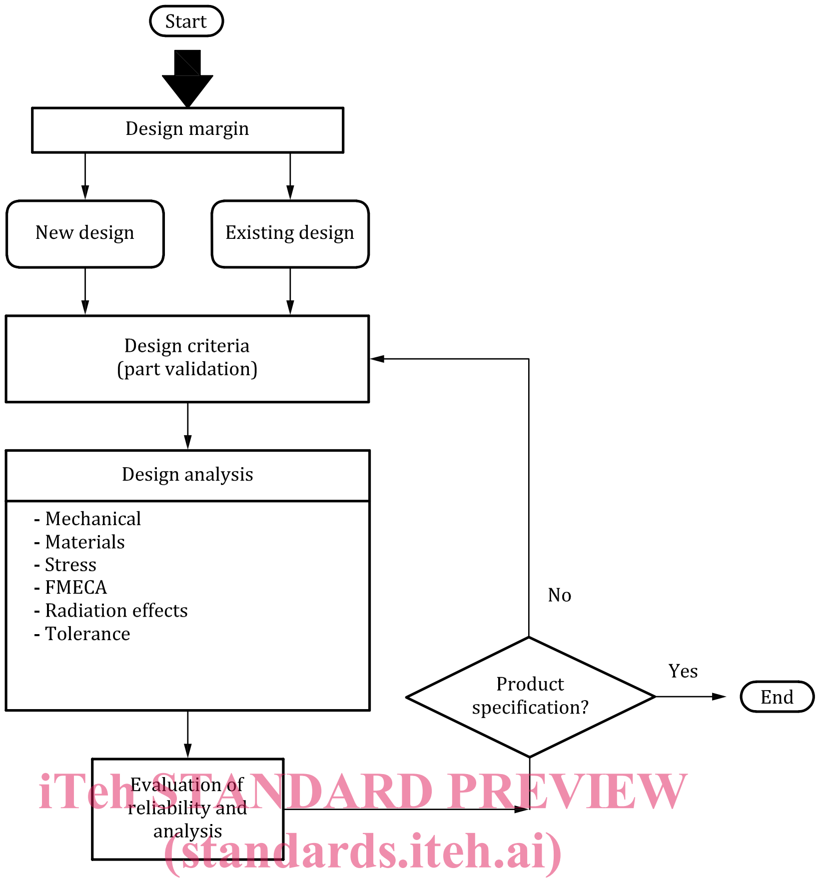


Figure 3 — Design margin process

4.1.4 Life cycle cost

In establishing life cycle cost for EEE parts, the following methods should be employed: identify technology assessment techniques and the mitigation of parts failure risk and utilize procedures that minimize programme disruptions due to parts obsolescence, unavailability, and other unwanted conditions. Life cycle cost analysis should include, as well as define, the EEE parts management programme's baseline and support a programmatic risk management methodology to control cost as well as reduce schedule disruptions throughout the life cycle of the programme (Figure 4).

Standardization techniques are becoming increasingly dependent on the available supplier base and market trends. A new and innovative process being implemented moves away from part number standardization to commodity/technology/family standardization. This concept should provide a lower cost/higher benefit approach as the demand for commercial EEE parts increases.

Factors to be considered include technology maturity, market base, material cost, ease of manufacture, performance management, logistics costs, standardization, and form, fit, function interfaces (F^3I). Initial nonrecurring costs should be de-emphasized and rationalized with long-term cost savings to provide the best value to the customer.

Through the implementation of technology assessments, strategic supplier relationships, technology leapfrogging, and creative risk mitigation techniques, programme continuity and integrity can be maintained, and life cycle costs can be minimized.

Validation of the life cycle cost objectives can be accomplished through the use of the following methods:

a) design-to-cost trade studies documenting parts selected during the design phase including all elements of cost;

b) periodic programme assessment of life cycle ratings, part technology, and part obsolescence;

