



BSI Standards Publication

Space product assurance — Quality assurance

National foreword

This British Standard is the UK implementation of EN 16602-20:2020. It supersedes BS EN 16602-20:2014, which is withdrawn.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

Space product assurance - Quality assurance

Assurance produit des projets spatiaux - Assurance
qualité

Raumfahrtproduktsicherung - Qualitätssicherung

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European Foreword

This document (EN 16602-20:2020) has been prepared by Technical Committee CEN-CENELEC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16602-20:2020) originates from ECSS-Q-ST-20C Rev.2.

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of an identical text or by endorsement, at the latest by September 2020, and conflicting national standards shall be withdrawn at the latest by September 2020.

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 will supersede EN 16602-20:2014.

The main changes with respect to EN 16602-20:2014 are listed below:

- Clause 3: Title of clause corrected. Term "acceptance authority media" added. References to ECSS-S-ST-00-01 made for terms "ground segment sub-system", "ground support equipment" and "repeatability"
- Term "stamp control" replaced by "acceptance authority media control"
- Titles of clauses 5.2.7 and 5.2.7.1, 5.8.3.2, A2.1<3>, Annex I modified
- Pre-Tailoring matrix updated using the TA agreed symbols as stated in Table 6 1 "Definitions of the columns of Table 6 2"
- Informative Annex I "Deliverable QA documents per review" updated
- Informative Annex J "ECSS-Q-ST-20 applicability according to programme phases" deleted
- Update of issue of EN 9100 standard in Bibliography

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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Scope

This Standard defines the quality assurance (QA) requirements for the establishment and implementation of a Quality Assurance programme for products of space projects.

Discipline related qualification activities are complemented in standards specific to those disciplines (e.g. ECSS-E-ST-32-01 for fracture control).

For software quality assurance, the software product assurance standard, ECSS-Q-ST-80 is applicable.

This Standard is applicable to all space projects.

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

For the tailoring of this standard the following information is provided:

- A table providing the pre-tailoring per “Product types” in clause 6
- A table providing the pre-tailoring per “Project phase” in Annex J

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 16602-10	ECSS-Q-ST-10	Space product assurance - Product assurance management
EN 16602-10-04	ECSS-Q-ST-10-04	Space product assurance - Critical-item control
EN 16602-10-09	ECSS-Q-ST-10-09	Space product assurance - Nonconformance control system
	EN 61340-5-1 (2007)	Electrostatics - Part 5-1: Protection of electronic devices from electrostatic phenomena - General requirements
	ANSI-ESD S20.20-2007	Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment

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, in particular for the following terms:
1. nonconformance
 2. process
 3. product assurance
 4. quality assurance
 5. space system
 6. space segment element
 7. space segment sub-system
 8. launch segment element
 9. launch segment sub-system
 10. ground segment element
 11. ground segment sub-system
 12. ground segment sub-system
 13. ground support equipment
 14. space segment equipment
 15. launch segment equipment
 16. ground segment equipment
 17. repeatability

3.2 Terms specific to the present standard

3.2.1 acceptance authority media

devices or media to confirm and document acceptance

NOTE 1 Examples of acceptance authority media are stamps, electronic signatures, passwords

NOTE 2 Wording adopted from EN 9100.

3.2.2 inspectability

ability of an item of being inspected

NOTE Inspectability includes provisions for the followings aspects:

- Definition of inspection including acceptance or rejection criteria, expressed in an unambiguous and quantified manner.
- Part and component accessibility for inspection
- Definition of tolerance methods for dimensional inspection performance (e.g. functional tolerances).

3.2.3 producibility

ability of an item of being producible

NOTE Producibility includes provisions for the following aspects:

- Design simplification and standardization, reduction in part types and part number.
- Guidelines for selection of preferred parts, materials and processes.
- Unambiguous definitions of the requirements and limits to be used.
- Definition of tolerance build-up methods, in order to simplify manufacturing, assembly, inspection.
- Standardization of interfaces.
- Part accessibility for assembly and inspection.
- Definition of design criteria consistent with the capability of manufacturing processes.
- Definition of design methods to ensure that the cleanliness requirements are compatible with the capability of related cleanliness procedures and facilities.

3.2.4 testability

ability of an item of being tested

NOTE Testability includes provisions for the followings aspects:

- Definition of test requirements, including acceptance or rejection criteria, expressed in an unambiguous and quantified manner.
- Part and component accessibility for test.

- Definition of recommended design techniques to facilitate fault detection, identification and location (e.g. test points, modularity, built-in test software, and feedback loops).

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
AIV	assembly, integration, verification
BB	breadboard
CI	configuration item
CoC	certificate of conformity
DRB	delivery review board
	NOTE: DRB is synonymous to “Acceptance Review Board” (ARB) in ECSS-M-ST-10
DRD	document requirements definition
EEE	electrical, electronic, electromechanical
EGSE	electrical ground support equipment
EIDP	end item data package
FGSE	fluidic ground support equipment
FM	flight model
GSE	ground support equipment
MGSE	mechanical ground support equipment
MIP	mandatory inspection point
NCR	nonconformance report
NRB	nonconformance review board
OGSE	optical ground support equipment
PA	product assurance
PM	project manager
QA	quality assurance
QM	qualification model
RFD	request for deviation
RFW	request for waiver
TRB	test review board
TRR	test readiness review
VCB	verification control board
VCD	verification control document

3.4 Nomenclature

The following nomenclature apply 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, all the 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 a complete different meaning: “may” is normative (permission) and “can” is descriptive.

- e. The present and past tense are used in this standard to express statement of fact, and therefore they imply descriptive text.

Quality assurance principles

4.1 QA management principles

The prime objective of Quality Assurance (QA) management is to ensure that a QA programme for projects covering mission definition, design, development and production of space systems is established, maintained and implemented.

All QA requirements are specified through definition and implementation of adequate methods and procedures.

Personnel whose performance determines or affects product quality are trained and certified in accordance with project needs.

4.2 General principles

The implementation of the following phase-independent activities is ensured by the QA function throughout the lead-time of projects:

- critical-items control
- nonconformance control
- alert management
- acceptance authority media control
- traceability
- metrology and calibration
- handling, storage and preservation
- statistical quality control (if required by the business agreement).

4.3 Design and verification principles

The objective of the QA function is to ensure that:

- a. a set of design rules and methods has been set up and is consistent with the project techniques and technologies;
- b. methods, procedures and tools have been defined and are implemented in order to prove that each applicable requirement is verified
- c. the design is producible and repeatable and that the resulting product can be verified and operated within the required operating limits;

- d. design and verification activities are planned in a consistent and logical way;
- e. the verification process is complete and includes clear test, test model and verification logic;
- f. a defined qualification approach is implemented to demonstrate that the item performs satisfactorily in the intended environment.

4.4 Procurement principles

All procurement activities including selection of procurement sources, procurement documents, procurement source surveillance and receiving inspection are controlled to ensure that all procured items and services conform to requirements.

4.5 Manufacturing, assembly and integration principles

All manufacturing, assembly and integration operations are planned and performed in coordination with inspections and tests to ensure that the deliverables are built, assembled and integrated to the approved configuration baseline.

Special processes and new technologies are identified in a timely manner and adequate evaluation or qualification activities should be implemented in line with the overall schedule.

4.6 Testing principles

Test facilities and test equipment are validated prior to their use to ensure conformance to project requirements.

All tests are performed in accordance with documented and released procedures and results are comprehensively recorded.

4.7 Acceptance and delivery principles

The objective is to ensure that an acceptance and delivery process is implemented which allows demonstrating and documenting the conformance of the delivered item.

4.8 GSE principles

Design, production, delivery and maintenance requirements for GSE are defined and implemented allowing for testability, availability, safety, life duration, operability and ability to interface as necessary with space segment in a safe way.

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Quality assurance requirements

5.1 QA management requirements

5.1.1 Quality assurance plan

- a. The supplier shall prepare, maintain and implement a QA plan in conformance with the DRD in Annex A.
- b. The QA plan shall be submitted to the customer for approval.

NOTE Information on the schedule for delivery of the QA plan is given in Annex I.

5.1.2 Personnel training and certification

- a. The supplier shall establish a documented training programme for the personnel whose performance determines or affects product quality.
- b. Personnel performing or evaluating special processes shall be trained and certified according to standards accepted by the customer.

NOTE The term “special process” is defined in ECSS-S-ST-00-01.

- c. Personnel performing non-destructive testing and evaluation shall be trained and certified according to standards accepted by the customer.
- d. The supplier shall maintain records of the training.

5.2 QA general requirements

5.2.1 Critical-items control

- a. The supplier shall implement Critical-items control in conformance with ECSS-Q-ST-10-04.

5.2.2 Nonconformance control system

- a. The supplier shall implement a nonconformance control system in conformance with ECSS-Q-ST-10-09.

5.2.3 Management of alerts

- a. The supplier shall manage alerts in conformance with ECSS-Q-ST-10, clause 5.2.9.

5.2.4 Acceptance authority media

- a. The supplier shall establish and maintain a documented acceptance authority media control system to ensure the correct and legitimate use of all fabrication and inspection authority media.
- b. Acceptance authority media shall be used to:
 - 1. signify the completion of operations and processes, and
 - 2. indicate inspection performance at source and incoming inspection, in process inspection and tests, final inspection, end point testing, storage and shipment.
- c. The use of acceptance authority media shall be restricted to authorized personnel as identified in the acceptance authority media control system.
- d. Acceptance authority media shall be traceable to individuals responsible for their use.
- e. Acceptance authority media shall be applied directly to parts and materials, when specified by engineering drawings and specifications, and associated documents, records, labels.
- f. Acceptance authority media materials and methods shall be compatible with the articles and their use.
- g. <<deleted>>

5.2.5 Traceability

- a. The supplier shall ensure that a bidirectional and unequivocal relationship between parts, materials or products and associated documentation or records is established and maintained.
- b. The supplier shall be capable to trace data, personnel and equipment related to procurement, manufacturing, inspection, test, assembly, integration and operations activities.
- c. The supplier shall be capable to trace backward the locations of materials, parts, sub-assemblies.
- d. The supplier shall be capable to trace forward the locations of materials from raw stock.
- e. The supplier shall establish controls to ensure that:
 - 1. identification numbers are assigned in a systematic manner,
 - 2. identification numbers of scrapped or destroyed items are not used again,
 - 3. identification numbers, once allocated, are not changed, unless the change is authorized by the customer.

NOTE Requirements for identification are addressed in ECSS-M-ST-40.

5.2.6 Metrology and calibration

- a. The supplier shall control, calibrate and maintain inspection, measuring and test equipment, whether owned by the supplier, on loan, or provided by the customer to demonstrate the conformance of product to the specified requirements.
- b. The supplier shall use equipment in a manner which ensures that measurement uncertainty is known and is consistent with the specified measurement capability.
- c. The supplier shall include in the calculations of all measurements the total error in the measurement process attributable to the cumulative error from the calibration chain, measuring equipment and those contributed by personnel, procedures and the environment.
- d. The supplier shall record the basis for the calculation of the cumulative errors as specified in requirement 5.2.6c.
- e. The supplier shall select inspection, measuring and test equipment in conformance with the required measurement accuracy and precision.
- f. The supplier shall identify, calibrate and adjust all inspection, measuring and test equipment and devices that can affect product quality at prescribed intervals, or prior to use, against certified equipment.
- g. The supplier shall establish, document and maintain calibration procedures, including details of equipment type, identification number, location, frequency of checks, check method, acceptance criteria and the action to be taken when results exceed the specified accuracy.
- h. The supplier shall ensure that the inspection, measuring and test equipment is capable of the specified accuracy and precision.
- i. The supplier shall identify inspection, measuring and test equipment with a suitable indicator or approved identification record to show the calibration status.
- j. The supplier shall maintain calibration records for inspection, measuring and test equipment.
- k. The supplier shall assess and document the validity of previous inspection and test results when inspection, measuring or test equipment is found to be out of calibration.
- l. The supplier shall ensure that the environmental conditions are suitable for the calibrations, inspections, measurements and tests being carried out.
- m. The supplier shall ensure that inspection, measuring and test facilities, including both test hardware and test software are protected against adjustments, which can invalidate the calibration setting.
- n. The supplier shall ensure that the inspection, measuring and test equipment is handled, preserved and stored such that the accuracy and fitness for use is maintained.
- o. The supplier shall check the test hardware or test software used for inspection to prove that it is capable of verifying the acceptability of the

product prior to release for use during production and installation, and recheck it at specified intervals.

NOTE 1 Examples of test hardware are: jigs, fixtures, templates and patterns.

NOTE 2 Test aids such as test leads, break-out boxes, mains leads and similar items are not subject to the entire set of requirements defined in this clause, but are validated in a way appropriate to their usage.

- p. The supplier shall establish the extent and frequency of such checks and maintain records as evidence of control.
- q. The supplier shall make the measurement design data available to the customer upon request.

5.2.7 Handling, storage, transportation and preservation

5.2.7.1 Handling, storage and transportation

- a. For handling, storage and transportation the requirements of ECSS-Q-ST-20-08 shall apply.

5.2.7.2 <<deleted>>

- a. <<deleted, requirement covered by 5.2.7.1a>>
- b. <<deleted, requirement covered by 5.2.7.1a>>
- c. <<deleted, requirement covered by 5.2.7.1a>>
- d. <<deleted, requirement covered by 5.2.7.1a>>
- e. <<deleted, requirement covered by 5.2.7.1a>>
- f. <<deleted, requirement covered by 5.2.7.1a>>

5.2.7.3 Preservation

- a. The supplier shall ensure that items subject to deterioration, corrosion or contamination through exposure to any environmental elements are preserved by methods that ensure maximum protection consistent with life and usage.

NOTE Examples of such environmental elements are: air and moisture.

5.2.8 Statistical quality control and analysis

5.2.8.1 General

- a. Statistical quality control and analysis methods shall be used to maintain or improve the specified control of quality, when statistically significant with respect to the product characteristics and to quantities produced.

NOTE Examples of statistical quality control and analysis methods are sample inspection plans, determination of quality levels, statistical process control and process capabilities studies.

- b. When employing statistical quality control and analysis methods, the supplier shall ensure that all the conditions for use are enforced.

NOTE Example of such conditions are sample significance, recording and elaboration of data, and formulation of clear decision rules.

- c. Statistical quality control applications, when used by the supplier for acceptance of materials, parts, processes and products, shall be submitted to the customer for approval.
- d. Trend analysis shall be performed on key characteristics and key parameters.
- e. The supplier shall verify that any abnormal change from the nominal tendency even within the specified limits are identified and analyzed.
- f. The supplier shall agree content, format of trend analysis and exportable data selection with the customer.

5.2.8.2 Sampling plans

- a. When sampling plans are used the supplier shall define and justify the following:
 - 1. sample size, sample selection methods and criteria for inspection severity,
 - 2. acceptance / rejection criteria, and
 - 3. screening of rejected lots.
- b. The supplier shall maintain records of the sampling tests, together with the identification of the characteristics to which sampling is applied.

5.3 QA requirements for design and verification

5.3.1 Design rules

5.3.1.1 Producibility

- a. The supplier shall ensure that the product is designed such that it can be produced with the specified level of quality.

5.3.1.2 Repeatability

- a. The supplier shall ensure that the product is designed such that its performances and characteristics can be reproduced consistently over different models and serial production.

5.3.1.3 Inspectability and testability

- a. The supplier shall ensure that the product is designed such that it can be inspected and tested under representative conditions, for production, AIV and operational environment.

5.3.1.4 Operability

- a. The supplier shall ensure that the product is designed such that it can be operated in accordance with programme constraints and requirements, throughout its whole life cycle including handling, storage, transportation, integration and operations.

5.3.2 Verification

5.3.2.1 General

- a. The supplier shall ensure that requirement verification is performed progressively, as each stage of the project is completed, and provides the organized base of data upon which qualification and acceptance is incrementally declared.
- b. The supplier shall ensure that top-down requirement allocations and bottom-up requirement verifications are complete and consistent.
- c. The supplier shall ensure that a process for tracking requirements and verification of results is established and maintained during the whole project life cycle.
- d. The supplier shall ensure that verification methods are adequate and consistent with the type and criticality of the requirements.
- e. The supplier shall ensure that appropriate reference to the verification documentation is recorded and status updated at project reviews up to final acceptance.

5.3.2.2 Design verification analysis

- a. The supplier shall ensure that the objectives of the analysis are defined in relation with the development logic defined in the verification plan.
- b. The following items shall be identified:
 1. reference of the configuration item definition under analysis;
 2. environmental constraints considered in the analysis;
 3. basic assumptions, analysis methods, mathematical models.

5.3.2.3 Design reviews

- a. The supplier shall ensure that design reviews are conducted in accordance with project requirements and written procedures.

NOTE Design reviews address the following items:

- Quality requirements and criteria for design, producibility, repeatability, testability and operability are adequately considered in design documentation.
- Methods and data required for procurement, manufacturing, inspection and test are available and validated.
- Risks of not achieving requirements are highlighted and adequately controlled.

5.3.2.4 Qualification process

5.3.2.4.1 Qualification

- a. The supplier shall ensure that all configuration items and their constituent items, either off-the-shelf or specifically designed, are properly qualified with margins commensurate with the application and use environment.

- b. The supplier QA shall review and approve the qualification plan.

NOTE The qualification plan is a subset of the Verification Control Document (VCD) as defined in ECSS-E-ST-10-02.

- c. The supplier QA shall review and approve the qualification results.

NOTE Qualification results are a subset of Verification Control Document (VCD) as defined in ECSS-E-ST-10-02.

- d. The supplier QA manager shall ensure that a Verification Control Board (VCB) is established to monitor the qualification process.

NOTE Verification Control Board (VCB) is defined in ECSS-E-ST-10-02.