
**Space systems — Qualification
assessment**

Systèmes spatiaux — Évaluation de la qualification

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15865 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

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Space systems — Qualification assessment

1 Scope

This International Standard establishes common rules for assessing the qualification of space systems and products used in space systems against their functional and technical specifications. It establishes a basis for determining system or product readiness for any stage of the life cycle. This includes, for example, readiness for development, manufacture, test, operation, modification, or disposal.

This International Standard is applicable to systems and products used in flight or ground support and to products at all levels in a product tree. It applies to systems and products consisting of hardware, software, facilities, materials, methods, processes, procedures or any combination of these.

It establishes common:

- a) rules for assessment of item readiness;
- b) approaches to qualification.

This International Standard is intended for use as the basis for a design justification plan. It is intended to be used either in establishing an agreement for such a plan between a customer and a supplier or as the basis for a supplier's internal qualification practices.

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2 Normative references

The following referenced documents are indispensable for the application 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 14300-1:2001, *Space systems — Programme management — Part 1: Structuring of a programme*

ISO 14620-1:2002, *Space systems — Safety requirements — Part 1: System safety*

ISO 21349:—¹⁾, *Space systems — Project reviews*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

1) To be published.

**3.1.1
qualification process**

process that covers all the verification activities including all the items of the product (component, equipment, subsystem and system)

**3.1.2
review**

documented process of the requirement conformity or nonconformity objective evaluation against the requirements specified by standards or specifications and their incomes on reaching any milestone

NOTE 1 Additional activities performed during the review include:

- analysis of the reasons of nonconformities;
- elaboration of recommendations on improving.

NOTE 2 This definition accords with that given in ISO 21349.

**3.1.3
technical specification
TS**

specification that establishes the exact required values for performance, operating environments, and other features (including non-functional features) for a product

NOTE This definition accords with that given in ISO 21351.

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3.2 Abbreviated terms

| | |
|------|---|
| DJDF | Design justification data file |
| DJP | Design justification plan |
| QS | Quality system |
| EEE | Electrical, electronic, and electromechanical |
| GTP | Ground test plan |
| PDR | Preliminary design review |
| RAP | Reliability assurance program |
| RMP | Reliability and maintainability plan |
| SAP | Safety assurance program |
| SS | Space system |
| ST | Space technology |
| TS | Technical specification |

4 Objectives and principles

4.1 Objectives

The qualification process should ensure achieving the following objectives:

- a) ensuring that the product meets specified requirements;
- b) ensuring that the product matches production drawings;
- c) confirming product operability after tests, verifications, flight tests and landing;
- d) ensuring the safety of SS products in accordance with ISO 14620-1;
- e) ensuring the required quality level to SS customers;
- f) assisting customers in selection of proper SS products and services on a competitive basis;
- g) creating terms and conditions favourable for SS insurance;
- h) assuring that the product is able to comply with the disposal requirements.

4.2 Principles

SS qualification assessment should be based on the following principles:

- a) proper definition of the requirements to be verified by qualification;
- b) use of only approved items for qualification assessment with deviations justified and agreed upon by the customer and the supplier in accordance with contractual provisions;
- c) use of all appropriate information obtained in all phases of the programme;
- d) sequential analysis of the results obtained during all phases and levels of the programme, taking into account the results obtained in the previous phase and other levels as appropriate;
- e) lowering the uncertainty of the assessment as the additional information becomes available, particularly when the development transitions from one phase to the next or when it proceeds to the next level;
- f) proper planning of the qualification assessment;
- g) early detection of problems potentially capable of impacting cost, schedule, safety or quality of the programme (or any combination of these) and implementation of corrective action with customer approval;
- h) tailoring of the execution of the qualification assessment and its precision during the item life cycle.

The customer should analyse the past performance of his/her own potential suppliers and use this performance as an element of supplier selection criteria and he/she should issue the TS to these suppliers.

4.3 General requirements and recommendations

A supplier can develop a space system item either in compliance with a customer–supplier contract, or without a contract when there is an expected market for the item after the development is complete. In either case, a supplier acts as a customer towards its own suppliers.

When this International Standard is made part of a contractual agreement between a customer and supplier, the agreement shall establish the customer and supplier responsibilities and authorities, as appropriate,

concerning the qualification processes and item acceptance. This agreement shall define the qualification logic (stages, list of results and justifications required for customer acceptance at each stage). Other considerations that should be considered for inclusion in the agreement are:

- a) specific development items that are subject to the qualification process;
- b) designation of responsibility and the processes to be used for approval of items for qualification assessment,
- c) customer approvals required for supplier implementation of the DJP;
- d) content and scheduling of status, progress, or completion reports from the supplier to the customer;
- e) participation of the customer in reviews.

To achieve the qualification goals, the supplier shall be responsible for qualification of its product, whether the development is done in fulfilment of a customer–supplier contract or as an independent development.

When this International Standard is applied in a contractual situation, the supplier shall ensure that the supplier's product definition is valid with respect to the customer's TS.

When this International Standard is used as a basis for qualification of a product that is developed independently by a supplier (outside of a customer–supplier contract), the supplier shall perform an internal qualification to ensure that the product meets the design input data requirements. At each order, the supplier should justify the ability of the product to satisfy the requirements expressed in the customer's supply specification.

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The supplier shall determine when the item is qualified, based on the theoretical and experimental justification established by the supplier and the results of qualification testing. In a contractual situation, this determination shall be in accordance with contract provisions.

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In a contractual situation, the customer shall have final responsibility for endorsing the qualification and declaring that the product meets its design requirements and can be manufactured. This endorsement and declaration shall be based on the contractually agreed upon conditions.

A preparatory process of internal qualification may be carried out by the supplier for his own purposes in advance of the contractually agreed upon qualification process.

The results of the qualification activity (verification process) shall be compiled in the DJDF by the supplier.

4.4 Levels

Qualification assessment should be implemented sequentially according to the different levels of the product tree as defined in ISO 14300-1. Typical qualification levels are the following:

- a) part (for example, an EEE part);
- b) component;
- c) subsystem;
- d) system.

Items to be qualified at any level can include hardware, software, facility, material, processes, methods, and procedures.

4.5 Design justification data file (DJDF)

The DJDF is aimed at integration of all information confirming the design item compliance to specified requirements. It provides a record of the values of specified technical characteristics that are subject to qualification. The DJDF includes data from all qualification assessments obtained during all phases of the project. It is developed under the supplier's responsibility and authority during design, production, qualification, operation, and disposal. The DJDF integrates information from qualification process documents and is based on functional and technical characteristics that are subject to qualification.

Each characteristic recorded in the DJDF is periodically assessed to detect trends. All measurement results are maintained in the DJDF. For characteristics displaying uncertainties or deviations, their values are entered into the DJDF prior to and after corrective measures are taken.

The use and contents of a DJDF are described in Annexes A and B, respectively.

NOTE The purpose of trend detection is to enable early application of corrective actions that are necessary to control a characteristic and maintain its value within a specified range.

5 Qualification assessment approach

5.1 General

5.1.1 General features

Qualification assessment of a SS item depends on first achieving a specified level of precision in the estimated or measured values of the specified technical characteristics. The qualification decision is based on comparing these values with the specified values for these characteristics.

Qualification assessment is based on the DJP. Before each new phase, the results of the previous phase should be used to prepare revisions to the DJP.

The qualification strategy should be a reasonable compromise between cost, schedule, risk, and effectiveness.

5.1.2 Specific features

5.1.2.1 Qualification assessment for SS is characterized by unique features (i.e. features not present in the qualification assessment of other products), such as:

- a) sparseness of data and (generally) an insufficient quantity of data for the use of statistical methods;
- b) limited access to the product during space operation;
- c) limited number of like products available for assessment;
- d) requirements for high reliability and safety;
- e) significant number of new technical problems due to lack of similarity to previous items;
- f) insufficient knowledge of environmental conditions and their impact on SS;
- g) inability to reproduce some space environmental conditions on the ground;
- h) necessity to solve complex scientific and technical problems in a short, fixed time due to external factors (e.g. meteorological factors).

5.1.2.2 The SS qualification process utilizes documentation and other results of activities performed during phases 0, A, B, C, D, E, and F specified in ISO 14300-1. In the general case, these results include:

- issue and co-ordination of the TS;
- design;
- working documentation;
- production set-up and prototype manufacturing results;
- ground test results;
- flight-test results;
- results of full-scale production and operation.

5.1.3 Criteria

The following criteria shall be verified during qualification assessment of the SS or SS item.

- a) The SS or SS item is completed and its documentation is approved.
- b) Requirements traceability is established.
- c) All specified operational constraints and environment load limitations are taken into account.
- d) All the assumptions inherent in the design of the system are defined and justified.
- e) The range of all technical characteristics (parameters) subject to qualification assessment is defined.
- f) Assessment tolerances are established to allow for uncertainties of the applied qualification assessment method.
- g) The applied method provides both nominal values and worst-case values of technical characteristics.

5.1.4 Design justification plan (DJP)

The supplier develops the DJP. Depending on contractual arrangements, the customer reviews and co-ordinates the plan submitted by the supplier and accepts the reports.

A typical example of DJP is given in Annex C.

The SS qualification assessment matrix may include SS quality assessment for the development and production phases and SS item inspection during the production and operation phases.

Implementation of the DJP should be aligned with the programme implementation schedule.

5.2 Arrangement of work

5.2.1 Principles for selection of an organization or a group of specialists for qualification reviews

5.2.1.1 Selection principles

The following principles should be followed when selecting any organization or group of specialists for qualification assessment review (see ISO 21349).

- a) The candidates should not be administratively or materially dependent on the assessment results;
- b) The candidates should be competent, which can be estimated by the frequency of expert assessments accomplished, practical confirmation of their assessments, and the extent to which their assessment recommendations were followed.

5.2.1.2 Examples of suitable personnel

The following are examples of sources of suitable personnel for performing qualification assessment review (in order of increasing level of independence):

- a) for an internal review, any part of the supplier's organization;
- b) any part of the customer organization;
- c) specially established commissions composed of skilled experts from the customer's organization, who are not responsible for the SS item programme or project;
- d) other industrial organizations (research and development institutes or laboratories are advisable).

5.2.2 Objectivity and adequacy of results

5.2.2.1 The unbiased confirmation of SS qualification with respect to the specified requirements is supported by the following factors:

- a) traceability of DJP implementation;
- b) completeness and adequacy of procedures for qualification assessment;
- c) completeness and adequacy of test and control programmes;
- d) capability of the applied methods used (as defined in 5.2.3).

5.2.2.2 The following actions also support the unbiased confirmation of SS qualification:

- implementing preliminary (local) qualification reviews performed by the organizations taking part in SS development, production, or operation;
- accounting for all of the factors impacting SS item quality, reliability, and safety in the process of SS development, design, testing, manufacturing, and operation;
- ensuring that test equipment (test control equipment) and measuring equipment meet the necessary technical levels;
- ensuring the competence of the laboratories (centres) by periodic verifications.