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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.

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).

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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 second edition cancels and replaces the first edition (ISO 15865:2005), which has been technically revised.

The main changes are as follows:

— alignment of terms and definitions with ISO 10795;

— introduction of space system's components;

— completion of criteria to be verified during qualification assessment;

— additional information on the recognized applicable methods;

— update of bibliography.

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.

Space systems — Qualification assessment

1 Scope

This document establishes general rules for qualification assessment of space systems and products used in space systems against their functional and technical specifications. It establishes general requirements 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 document 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) general requirements for qualification assessment of item readiness;

b) approaches to qualification.

This document 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.

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)

ISO 10795, *Space systems — Programme management and quality — Vocabulary*

ISO 14300-1, *Space systems — Programme management — Part 1: Structuring of a project*

ISO 21349, *Space systems — Project reviews*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10795 and the following apply.

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

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

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

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 to entry: Additional activities performed during the review include:

— analysis of the reasons of nonconformities;

— elaboration of recommendations on improving.

3.1.3
technical specification
TS
specification expressing technical requirements for designing and developing the solution to be implemented

Note 1 to entry: The technical specification evolves from the functional specification and defines the technical requirements for the selected solution as part of a business agreement.

[SOURCE: ISO 21351:2005, 3.1.11, modified — The abbreviated term "TS" has been added.]

3.2 Abbreviated terms

DJDF	design justification data file
DJP	design justification plan
EEE	electrical, electronic, and electromechanical
GTP	ground test plan
TS	technical specification

4 Objectives and principles

4.1 Objectives

The qualification process should ensure that the following goal is achieved: confirmation of suitability of the space system and the space system's components.

Simultaneously the following objectives should be achieved:

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 the space system's products in accordance with ISO 14620-1;

e) ensuring that the quality level required by the space system's customers is reached;

f) assisting customers in the selection of proper products and services of the space system on a competitive basis;

g) providing objective evidences of the quality of the space system to make a positive decision on the insurance of the space system;

h) ensuring that the product meets the disposal requirements;

i) ensuring that each component is operated in accordance with the requirements of the operational documentation.

4.2 Principles

The space system's qualification assessment should be based on the following principles:

a) consistency of qualification assessment for different levels of the space systems and the structural scheme of the space systems;

b) proper definition of the requirements to be verified by qualification;

c) use of only approved items for qualification assessment with deviations justified and agreed upon by the customer and the supplier;

d) use of all appropriate information obtained in all phases of the programme;

e) 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;

f) 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;

g) proper planning of the qualification assessment;

h) 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 actions with customer approval;

i) tailoring of the execution of the qualification assessment and its precision during the item life cycle.

4.3 General requirements and recommendations

A supplier can develop a space system's component 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 document is used as a part of a contractual agreement between a customer and a 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). The following considerations should be included in the agreement:

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 document is used 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 document 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.

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 is in accordance with contract provisions.

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 are 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 (e.g. 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 aims 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 is based on the obligatory or voluntary principle - in terms of legislation - of the space system's qualification assessment in accordance with the normative documents.

Qualification assessment of a space system's elements 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 shall be a reasonable compromise between cost, schedule, risk, and effectiveness.

5.1.2 Specific features

5.1.2.1 Qualification assessment for space systems 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 space system;

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 space system's 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 space systems or the space system's elements.

a) The space systems or the space system's elements are completed and their documentation is approved.

b) Requirements traceability is established.

c) All specified operational constraints (i.e. mechanical, thermal, electrical mechanical compatibility/ EMC, radiations 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 coordinates the plan submitted by the supplier and accepts the reports.

A typical example of DJP is given in Annex C.

The space system's qualification assessment matrix may include the space system's quality assessment for the development and production phases and space system item inspection during the production and operation phases.

Implementation of the DJP shall be aligned with the program 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 be administratively or materially independent 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 space system's item program 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 the space system's 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 programs;

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 the space system's qualification:

— implementing preliminary (local) qualification reviews performed by the organizations taking part in space system's development, production, or operation;

— accounting for all of the factors impacting the space system's item quality, reliability, and safety in the process of the space system's development, design, testing, manufacturing, and operation;

— ensuring that the test equipment (test control equipment) and measuring equipment meet the necessary technical levels;

— ensuring the competence of the laboratories (centres) by periodic verifications.

5.2.3 Applicable methods

Table 1 lists the recognized applicable methods.

Selection of the applicable methods and their level of detail is determined by a number of factors including the qualification tasks to be accomplished, available prior information, project innovation, risk, product tree level, life cycle phase, item reliability, lot size, and supplier's experience. Methods resulting in quantitative estimates (e.g. statistical methods) are preferable for analysis, when appropriate.

Table 1 — Descriptions of applied methods

ID	Name of method	Description
1	Analysis	Determination of essential qualities, performance, and limitations of an item by cognitive or computational methods.
2	Acceptance tests	Tests and verifications performed during product acceptance, including waiver and input control.
3	Estimation tests	Tests for detailed estimation of item capabilities.
4	Qualification tests	Tests for confirmation of meeting TS requirements, including safety factors.
5	Delta-qualification method	Specific tests of a part of an item in a limited area in which the loads and environment have changed (due to modification, use, etc.).
6	Qualification by similarity	Method of qualification of a new item based on the qualification of similar items in the past.
7	Quality system certification	Confirmation that the supplier has procedures to ensure the manufacture of products meet customer requirements.

Table 1 *(continued)*

ID	Name of method	Description
8	Inspection	Customer's planned or unplanned verification of the work performed by the supplier.
9	Review	Systematic examination of items for the purpose of assessing the results obtained at a given time in the project; conducted by persons who are not responsible for the project.

5.3 Qualification assessment process

5.3.1 Qualification assessment process input

Input data for activities initiated at any life cycle phase or product tree level include the following:

a) list of requirements to be confirmed at the given phase or level, applicable methods, assessment accuracy, and the qualification assessments specified by DJP;

b) list of work performed during the previous phase;

c) list of non-conformances obtained during the previous phase or level (if any) and corrective actions implemented for their elimination;

d) revised DJP in accordance with 5.1.1;

e) actions on detailed qualification assessment performed at different phases of the product life cycle:

   1) alternative calculations;

   2) comparison of a new design with a similar and already accepted design, if available;

   3) tests and demonstrations;

f) reviews.

5.3.2 Activities on product definition during phases O to C

During these phases the following actions shall be performed:

a) analysis of:

   1) TS for a product and its components (including analysis of their conformance to the advanced requirements);

   2) justification of redundancy and reserves;

   3) contingency plans intended to overcome hazardous situations;

   4) single points-of-failure;

   5) critical items and their reliability;

   6) primary reliability problems requiring special attention during subsequent development and test;

b) assessment of:

   1) technical decisions and their rationale from the viewpoint of the specified reliability and safety requirements of the product and its components;

   2) feasibility of advanced requirements for items, systems, and components;

3) proper selection of components, including EEE;

4) experience obtained during the development of similar products and prototypes (including foreign items);

5) application of qualification by similarity;

6) compliance with reliability and safety requirements;

7) implementation of the recommendations that resulted from reliability analysis (summary data on failures and associated corrective actions);

8) manner in which quality assurance requirements are satisfied during the manufacturing process (including problems of run time, increased loads and severe conditions of routine hot tests, and other tests requiring additional resources);

9) completeness and adequacy of assurance plans for reliability, safety, ground testing, and qualification assessment.

5.3.3 Design review

As specified in ISO 14300-1 and ISO 21349, design reviews shall be held at various life cycle stages. At each of these life cycle stages, a group of experts representing all of the relevant disciplines should be formed to participate in the review.

NOTE Each review is a critical verification with the participation of competent specialists in the appropriate disciplines and under the leadership of a person whose activity is not directly connected with the organization responsible for the project or the programme. Information and justification on the activities completed are reviewed by the experts in such activities.

The experts' aim should be to facilitate:

a) making a decision on whether the technical elements meet the contractual requirements and the aims of the phase under review;

b) taking corrective and preventive actions, or both, in case of non-conformances or insufficiency;

c) making a decision on transition to the next phase.

5.3.4 Design verification

Design verification shall be performed to make sure that the output of a phase complies with the specified requirements. Design verification actions shall be documented.

5.3.5 Qualification assessment during updating of production technologies

At this phase of qualification assessment, the following issues should be addressed:

a) general design and technological assessment of component characteristics (i.e. feasibility, conceptual technological solutions);

b) applied materials assessment (list of structural materials, including new materials and their basic physical, mechanical, chemical and technological properties);

c) problems of supplying advanced materials to production enterprises;

d) decisions on occupational safety and health, fire-and-explosion safety, toxicity, environmental safety, and industrial sanitation in the processing of selected materials and their wastes under industrial conditions;

e) analysis of recommendations on utilization of worn or failed items; industrial waste utilization or elimination considering requirements for personnel health and environment protection;

f) new technological processes, including analysis of material sciences problems and solutions (i.e. list of problems of the new processes that require solution and verification);

g) technological, material sciences, and metrology problems (i.e. list of scientific, experimental, and technological work to be performed in the next phases of the item's manufacture);

h) analysis of product assembly and integration plan and interface diagrams;

i) assessment of available and required capacity of experimental, industrial, and test base as well as required list of equipment, stands, and structures, including newly created, updated, procured, or leased;

j) technical documentation analysis;

k) analysis of production preparation actions;

l) analysis of tests, verifications, and other actions related to the processes including:

   1) critical processes;

   2) processes using equipment, which have extremely complicated, large-sized, labour-consuming, or unique characteristics;

   3) arrangement or layout of production facilities;

   4) construction or modification of production and test facilities;

   5) training of personnel for new kinds of activities.

5.3.6 Qualification assessment during ground tests

5.3.6.1 Anticipated activities

Required input data for initiation of activities are described in 5.3.1.

During ground testing the following actions shall be anticipated:

a) analysis of:

   1) extent to which GTP requirements were met in item and component testing (or analogue and prototype testing in the case of qualification by similarity);

   2) status of GTP implementation for space system's product and its elements;

   3) status of reliability program implementation for space system's elements and components;

   4) final test reports for space system's items and components (submitted by developing suppliers who conducted the tests);

   5) independent assessments conducted by expert commissions at the customer's request;

   6) results of flight item acceptance tests conducted at the production facility;

   7) developer's reports on elimination of failures and non-conformances detected during tests;

b) assessment of:

   1) ground test results;

   2) implementation of the expert commission's recommendations;

   3) conformance of technical characteristics to the TS requirements based on test results;

4) acceptance inspection, run time, and modes of test items and their components designated for flight tests.

5.3.6.2 Development of ground test plan (GTP) for the space system's items and their elements

Input data include non-conformances detected during GTP implementation, in addition to those specified in 5.3.1.

The following actions shall be performed in each phase:

a) assessment of:

1) compliance with the requirements provided by standards and functional and technical specifications on development for space system's items and its components at each phase;

2) completeness of the verification of technical characteristics as specified in the TS for the item and its components;

3) appropriateness of the GTP to the item (and its component);

4) adequacy of mock-ups for different kinds of ground tests;

5) adequacy of ground tests in duplicating actual operational conditions;

6) completeness of interface tests of integrated systems;

b) analysis of:

1) distribution of qualification assessment in the different phases;

2) production readiness;

3) emergency test plans in case of accident and hazardous situations;

4) flight dynamics testing and dynamic characteristic correction programs;

5) extent to which flight test problems might be solved in ground tests;

6) plans for testing of safety margins (for reserve assessment) and tests of resources;

7) verification of implementation of recommendations set forth in review reports;

8) verification of qualification by similarity and the data obtained from analogue and prototype testing.

5.3.6.3 Test assessment

5.3.6.3.1 All necessary and sufficient tests shall be performed at each phase for the purpose of:

a) verification of specified technical characteristics of a product;

b) verification of a product's functional characteristics;

c) obtaining data for the DJDF.

5.3.6.3.2 During preparation and performance of tests and processing test results, the following documents should be prepared:

a) plans or technical task descriptions for separate types of tests or verifications, which contain:

1) requirements to be verified;

2) goals of test or verification;

3) registered parameters;

4) acceptance criteria;

b) processing procedures, which should contain:

1) equipment to be used;

2) tests and verifications;

3) measurements;

4) measurement registration and processing methods;

c) reports on the progress and results of tests;

d) reports, combining the results of individual tests, for transfer to the next phase.

5.3.6.3.3 Test verifications shall be performed:

a) prior to tests to ensure that adequate resources, procedures and materials are available;

b) after tests to determine test conformance (non-conformance) to test procedures;

5.3.6.3.4 A review of the results obtained shall be documented.

5.3.7 Flight tests

5.3.7.1 The following analyses and assessments should be performed:

a) analysis of:

1) reports of developing organizations on final elimination of non-conformances detected during past flight tests, as appropriate;

2) reports of the developers on product and component modifications;

3) developers' reports on the effectiveness of corrective actions;

4) any changes in items and components;

5) modified item ground testing;

6) additional documents on readiness of the next item for flight tests including results and recommendations from previous ground and flight tests, as appropriate;

7) readiness of the next item for flight test, including its acceptance test results and the elimination of detected non-conformances;

8) expert commission and developing organization review reports authorizing the next item for flight test or re-flight;

b) assessment of:

1) implementation of recommendations of expert commissions for correction of failures detected during previous ground and flight tests;

2) TS requirements implementation.

5.3.7.2 The flight test results qualification process is completed by:

a) a report issued by the organization or commission responsible for flight tests after the tests are completed; and

b) a decision that a complex accomplishes the objectives

5.3.7.3 Simultaneously, preparations are made to enter full-scale production of the item, as appropriate.

5.3.8 Full-scale production

5.3.8.1 At the start of this phase (phase D), the following tasks should be performed:

a) establishment of parameters to control the stability of technological processes;

b) establishment of a process to maintain traceability of product technical characteristics during acceptance inspection, acceptance tests, and operation;

c) analysis of detected failures and non-conformances and effectiveness of actions to eliminate them;

d) analysis of product modifications, including assessment of their impact on:

   1) cost, schedule, and risk;

   2) need for new qualification assessment;

e) analysis of the adequacy and effectiveness of modifications intended to increase reliability;

f) analysis of the supplier's documentation on the elimination of any non-conformance;

g) analysis of adequacy of the inspection process for critical items.

5.3.8.2 Performing the tasks in 5.3.8.1 utilizes:

a) technical review;

b) qualification assessments of specified technical characteristics;

c) sampling to assess the current technical characteristics;

d) analysis of the causes of failures and non-conformances;

e) analysis of the effectiveness of actions taken to eliminate the non-conformances.

5.3.9 Software qualification assessment

In the process of software qualification assessment, analysis of the following shall be performed:

a) optimization of algorithms, data formats, and the command system configuration;

b) software algorithms;

c) description of the mathematical model of the system and modelling results;

d) list of software algorithm modules;

e) memory, processor, and data transfer requirements for execution of algorithms;

f) input language;

g) software operational documentation;

h) list of functional and service modules;

i) dialogue tables and languages (for interactive systems);

j) input and output data array structure;

k) data support algorithms;

l) software development process;

m) storage of test algorithms;

n) functional block diagrams and timing diagrams of software operation in all operational modes.

5.3.10 Configuration aspects

All design changes and modifications shall be identified, documented, verified, and approved by an authorized person before their implementation in accordance with ISO 14300-1.

The supplementary provisions in this subclause relate to configuration management and any additional requirements for qualification of modified components. In implementing these, the applicability of analysis by similarity should be considered.

Measures should be taken by the supplier to guarantee that:

a) up-to-date definitions of the product and any modifications introduced are continuously available;

b) modifications are subject to thorough and detailed study by all concerned in order to:

   1) verify that all aspects of the modifications are identified and analysed (i.e. aspects relating to definition, design, production, inspection, testing, qualification, implementation and logistic support);

   2) ensure that any necessary qualification reassessment is performed;

c) all interested parties are informed of the approved modifications;

d) Only the modifications approved by the organization responsible for that product (project) may be incorporated into the product and the documents.

5.3.11 Disposal phase

As a part of the process of qualification assessment, the supplier should study problems associated with end-of-life, such as:

a) recovery and processing of space system's fragments (launch vehicle stages, landed worn-out spacecraft, etc.);

b) elimination of space system's products when their operation is completed (e.g. de-orbiting for sinking in special areas of the ocean, boosting to higher orbits, or recovery for reuse or disassembly).

5.4 Documents

The following documents should be prepared and made available to appropriate recipients in accordance with programme plans (such as supplier, customer, and sub suppliers):

a) matrix relating the space system, subsystem, and component qualification to the specified requirements and containing documentation for the acceptance of each assessed parameter;

b) project schedule and DJP and DJDF by life cycle phases and product tree levels.

5.5 Requirements

5.5.1 The documents confirming the space system's product qualification with respect to the specified requirements shall be subject to the qualification review. At the completion of this review, the project decision authority issues a conclusion on the space system's product qualification with respect to the requirements provided by normative documents. If the qualification assessment has detected any non-conformance of the product to the requirements, in a contractual situation, the decision on further actions is made in accordance with provisions of the contractual agreement, if any.

The results of implementation of each phase of qualification assessment shall be documented in the DJDF containing an assessment of results obtained during that phase and a comparison of these results with the results predicted for that phase.

5.5.2 In case of contractual agreement, the report is presented to the customer, in accordance with provisions of the agreement defined in 4.2.

5.5.3 The customer should use the report as the basis for a decision, taking into account other conditions of the contractual agreement, either to continue the work or to take other actions as provided in the customer-supplier agreement. The decision is distributed in accordance with any contractual conditions.

Annex A
(informative)

Use of DJDF

A.1 Justification of design

On completion of development, the theoretical and experimental justifications (study files, calculations, test reports) support a conclusion on whether or not the design of the product meets the requirements of the TS.

A.2 DJDF

A.2.1 General

The DJDF is incrementally generated during the detailed design process in conformity with the design justification plan (DJP). The DJDF:

a) facilitates access to required justification information;

b) provides a list of the required justifications;

c) represents an important element in making a decision on the product design qualification.

A.2.2 Content and completion of the DJDF

The supplier incrementally puts together the DJDF concurrently and in parallel with the design and development of the product and of its design data file. The DJDF thus provides, at all times, the status of the justification with respect to the requirements of the TS.

In the course of product development, studies and computations, as well as tests and simulations of any sort, contribute to the collection of justification information identified in the DJP.

A.2.3 Sequential status of the DJDF

The following observations characterize the sequential and incremental development of the DJDF.

a) The DJDF changes and is improved steadily in parallel with the generation of the product design.

b) The DJDF may have several pre-defined milestones, depending on the complexity of the product.

c) The first milestone applicable to the DJDF is the preliminary design review (PDR). At this point it contains the initial data elements and is essentially a preliminary DJDF.

d) The design and justification already contained in the DJDF are used by the supplier as a basis for the decision to begin production of articles for qualification tests (or coding in the case of computer programmes). This decision is made when the supplier judges that the design is sufficiently advanced. This is done within the framework of a design review (usually a critical design review).

e) When submitting the design for qualification, if this step is planned for in the DJP, the DJDF ties together the justifications already obtained and those that remain to be obtained. The DJDF ensures a reduction in the risk of failure during qualification testing, particularly when failure has a high potential to affect programme progress (increased cost, schedule delays, etc.).