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Space product assurance

Quality and safety assurance for space test centres

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Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards. Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

This Standard has been prepared by the ECSS-Q-ST-20-07C Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Change log

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Introduction

This ECSS Standard was developed to ensure that space test centres working for European space projects operate a quality and safety assurance system in line with ECSS requirements, internationally recognised standards and best working practices.

This Standard makes applicable the requirements of EN 9100:2009 and provides additional requirements specific to space test centres. The quality management system of the space test centre, or that of the organization of which it is part, is to be in conformance with these requirements.

This Standard also incorporates requirements from ISO/IEC 17025:2005 that are considered applicable for space test centres working for space projects.

This Standard does not make compulsory Certification of the space test centre against the requirements of the aforementioned Standards by a recognised certification authority.

1
Scope

This Standard specifies quality assurance and safety assurance requirements for space test centres, applicable to the test process, test personnel (customer and own), test facilities, test environment and any operations related to the test specimen under responsibility of the space test centre as requested by the customer.

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

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

ECSS-S-ST-00-01	ECSS – Glossary of terms
ECSS-E-ST-10-02	Space engineering – Verification
ECSS-E-ST-10-03	Space engineering - Testing
ECSS-Q-ST-10-09	Space product assurance – Nonconformance control system
ECSS-Q-ST-20	Space product assurance – Quality assurance
ECSS-Q-ST-70-01	Space product assurance – Cleanliness and contamination control
EN 9100:2009	Quality Management Systems – Requirements for Aviation, Space and Defense Organisations

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:

approval

assurance

audit

availability

calibration

certification

cleanroom

corrective action

critical item

dependability

preventive action

procedure

process

product

quality assurance

reliability

risk

safety

test

traceability

3.2 Terms specific to the present standard

The following terms and definitions are specific to this Standard in the sense that they are complementary or additional to those contained in ECSS-S-ST-00-01.

3.2.1. critical operation

operation that can result in injury to persons, significant material damage or other unacceptable consequences if not properly performed

3.2.2. management system

system to establish policy and objectives and to achieve those objectives

3.2.3. modification

change in the configuration of an existing test facility

3.2.4. QA representative

representative from the space test centre management with designated responsibility for quality assurance

3.2.5. quality policy

overall intentions and directions of the space test centre with regard to quality as formally expressed by top management

3.2.6. quality management system

management system to direct and control the space test centre organization with regards to quality

3.2.7. safety policy

overall intentions and directions of the space test centre with regards to safety as formally expressed by top management

3.2.8. safety management system

management system to direct and control the space test centre organization with regard to safety

3.2.9. safety representative

representative from the space test centre management with designated responsibility for safety

3.2.10. test campaign

series of test processes starting with the arrival of the test specimen in the space test centre and ending with its departure from the space test centre

3.2.11. space test centre

complete entity including the organization that provides, maintains and operates test facilities for space projects and applications, including accompanied services, and that is capable of performing test campaigns for the verification and validation of space elements

3.2.12. test facility

technical plant to provide specific simulated conditions for testing equipment for space projects and applications

NOTE Test facility includes test equipment and associated infrastructure, including supplies.

3.2.13. test personnel

staff having the applicable competence and qualification to develop, maintain and operate the designated processes

3.2.14. test process

all activities necessary to perform a test, or a series of tests, to comply with the requirements specified in the business agreement

NOTE This includes, but is not limited to, test design, planning, preparation, acceptance, performance, reports, reviews and records.

3.2.15. top management

person or group of people who direct and control the space test centre at the highest level.

3.3 Abbreviated terms and symbols

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

Abbreviation	Meaning
FRR	facility readiness review
IEC	International Electrical Committee
ITAR	International Traffic in Arms Regulations
NCR	nonconformance report
QA	quality assurance

3.4 Nomenclature

3.4.1 Formal verbs

The following nomenclature apply throughout this document:

- The word “shall” is used in this document to express requirements. All the requirements are expressed with the word “shall”.
- The word “should” is used in this document to express recommendations. All the recommendations are expressed with the word “should”.

NOTE It is expected that, during tailoring, all the recommendations in this standard are either converted into requirements or tailored out.

- The words “may” and “need not” are used in this document 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”.
- The word “can” is used in this document 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.

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

4
Space test centre quality and safety management principles

4.1 Objective

The objective of quality and safety assurance for space test centres is to ensure that all technical and programmatic risks associated with the testing of space products are adequately managed through the implementation of an effective quality and safety assurance programme.

4.2 General principles

The space test centre is responsible to demonstrate that a quality and safety assurance programme covering the definition, design, development, implementation and continuous improvement of:

a. competences,

b. processes, and

c. facilities,

is established, implemented and maintained throughout the test service provision to a customer and at all levels of the supply chain.

The early identification of aspects potentially detrimental for the quality of the test service, the safety of persons and products, and the cost-effective prevention of any adverse consequence of such aspects, are the basic principles of the space test centre quality and safety programme.

The quality and safety programme needs to demonstrate the integration of activities from disciplines specified in other ECSS standards:

a. ECSS-Q-ST-20 Quality assurance

b. ECSS-Q-ST-30 Dependability

c. ECSS-Q-ST-40 Safety

d. ECSS-Q-ST-70 Materials, mechanical parts and processes

e. ECSS-E-ST-10 System engineering

f. ECSS-M-ST-80 Risk management

5
Quality and safety management system requirements

5.1 General requirements

a. The space test centre shall operate a quality management system in compliance with requirements from the EN 9100:2009.

b. The space test centre shall establish, document, implement and maintain a quality and safety management system and continually improve its effectiveness.

NOTE The effectiveness of the continual improvement of the quality and safety management system can be demonstrated through a reduction of customer complaints and nonconformances, increased customer satisfaction, proactive identification of risks affecting the quality and safety of space test centre operations.

c. The space test centre shall carry out its testing activities in compliance with the requirements of this Standard

NOTE The space test centre satisfy the needs of the customer and the regulatory authorities.

d. The quality and safety management system shall cover work carried out in the space test centre's permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

e. The space test centre shall:

1. specify the processes for the quality and safety management system and their application throughout the space test centre,

2. specify the sequence and interaction of the quality and safety management processes,

3. specify criteria and methods to demonstrate that both the operation and control of quality and safety management processes are effective,

4. demonstrate the availability of resources and information to support the operation and monitoring of quality and safety management processes,

5. monitor, measure, and analyse quality and safety management processes, and

6. implement actions to achieve planned results and continual improvement of quality and safety management processes.

f. The quality and safety management system of the space test centre, or its parent organization, shall be implemented and maintained to allow external and internal revisions or audits by customer or external authorities.

g. If the space test centre is part of an organization performing activities other than testing, the responsibilities of key personnel in the organization that have an involvement on the testing activities of the space test centre shall be specified to identify potential conflicts of interest.

h. The space test centre shall demonstrate that non-space related activities have no detrimental effect over the activities carried out in the space test centre.

NOTE For example non-space related activities include infrastructure works or testing performed for other industrial sector.

i. The space test centre quality and safety management system shall be supported by lower level documentation as follows:

1. quality and safety manual(s);

2. quality and safety procedures;

3. standard operating procedures, work instructions and project plans;

4. quality and safety records.

5.2 Documentation, records and data control

5.2.1 General

a. The space test centre shall establish and maintain a documentation and records control system in conformance with the requirements from the EN 9100:2009.

b. The space test centre shall establish and maintain a system for the identification, storage, protection, retrieval, retention and disposition of test data in conformance with the customer requirements.

5.2.2 Facility description

a. The space test centre shall establish and maintain a documented description of the test facilities, and associated infrastructure, including as a minimum:

1. functional performance,

2. general arrangement drawing,
3. interface definition,
4. material list of a test facilities ,

b. The facility description shall be provided to the customer upon request.

5.3 Management responsibility

5.3.1 Organization

a. The space test centre shall specify its organization and management structure, its place in the parent organization, and the relationships among management, technical operations, support services and the quality and safety management system.

5.3.2 Planning

a. The space test centre shall plan the following tasks:

1. the preparation of project and quality plans for critical processes,
2. the identification of controls, processes, equipment, fixtures, resources and skills,
3. the update of quality control, inspection and verification techniques, including the development of new instrumentation or complex facilities,
4. the identification to develop the capability of the space test centre for any measurement requirements that exceed the current known state of the art,
5. the identification of standards for maintenance and calibration of systems, sub-systems, measuring equipment and items,
6. the establishment and follow-up of clear rules to control conformity to requirements between design and acceptance by various means.
7. the assessment of risks related to customer supplied products and the applicable processes.

NOTE The means specified in the requirement 5.3.2a.6 include calculation, test analysis, and simulation.

5.3.3 Responsibility and authority

a. Top management shall demonstrate that management and technical responsibilities and authorities are specified and communicated within the organization.

b. Deputies shall be appointed for the key space test centre personnel in their absence.

c. Top management shall demonstrate that space test centre personnel are free from undue pressures and influences that can affect the quality of their work.

5.3.4 Quality and safety representatives

a. Top management shall appoint a QA representative with defined authority:

   1. to ensure that the quality management system is established, implemented and maintained,

   2. to report its performance to the space test centre management and any needs for improvement, and

   3. to ensure quality assurance awareness throughout the space test centre.

b. Top management shall appoint a safety representative with defined authority:

   1. to ensure that safety processes for the space test centre are established, implemented and maintained,

   2. to report to top management on the performance of safety in the space test centre and any need for improvement, and

   3. to ensure safety assurance awareness throughout the space test centre.

c. In case when personnel safety, test specimens or test facilities are at risk, the safety representative, or designated trained staff, shall have defined authority, to stop the test or to request the responsible manager to stop the test.

5.4 Personnel competence and training

5.4.1 General

a. The space test centre shall demonstrate that all personnel are competent and qualified to perform their assigned tasks.

b. The space test centre shall demonstrate that all personnel comply with all safety regulations.

c. The space test centre shall demonstrate that personnel undergoing on-the-job training are subject to supervision.

d. Where contracted and additional technical and key personnel are used, the space test centre shall demonstrate that such personnel are supervised and competent and that they work in compliance with the space test centre's quality and safety management system.

e. All space test centre personnel and customers, conducting or supporting potentially hazardous operations in the space test centre, shall receive the safety training.

f. For each test, in addition to other training, briefings shall be performed for operators on potential risks.

g. Briefings specified in the requirement 5.4.1f shall include the technical preventive measures to be observed and the precautions to be taken.

h. Briefing of operators should include dry runs of the tasks to be performed and associated emergency actions.

5.4.2 Competence, awareness and training

a. The identification of the education, training and competence objectives for the space test centre personnel shall be carried out on a periodic basis, as a minimum once a year.

b. The identification of training needs shall include training for personnel being reassigned to jobs other than those for which they were originally trained.

c. Evaluation of the effectiveness of the training shall be performed.

d. The space test centre shall specify and maintain job descriptions for managerial and technical personnel involved in the operations of the space test centre.

e. A skills and competences matrix, or an equivalent method, shall be used to identify the applicable competence profiles and the training requirements.

f. Space test centre personnel performing selected handling operations shall be trained and certified by an authorized body.

NOTE Handling operations include for example lifting and hoisting operations.

g. A list of certified operators shall be maintained.

h. The space test centre shall demonstrate that customer personnel performing selected handling operations, are trained and certified by an authorized body.

i. The space test centre shall maintain records of the relevant authorization(s) to perform the work, competence, educational and professional qualifications, training, skills and experience of all technical personnel, including contracted personnel.

j. Records specified in the requirement 5.4.2h shall be available and shall include the date on which authorization or competence is confirmed.

5.5 Infrastructure and work environment

5.5.1 General

a. The space test centre shall demonstrate that all processes are carried out under controlled conditions using test facilities, test and measuring equipment, servicing equipment and environmental conditions meeting the customer requirements.

NOTE 1 The use of unsuitable test facilities, equipment and environmental conditions can for example lead to invalid test results.

NOTE 2 Measuring equipment includes hardware and software.

b. The space test centre shall take provisions to demonstrate that the specified environmental and cleanliness conditions are achieved and maintained throughout the test process in order to preserve the test specimen and the test equipment.

c. Activities listed in the requirements 5.5.1a and 5.5.1b shall be planned and documented, prior to their beginning, and recorded during their execution.

d. The space test centre shall specify and implement a housekeeping programme applicable to all test areas, including transport bays, airlocks, test floor environment, control rooms and associated infrastructure.

5.5.2 Environmental control

a. The space test centre shall control, as a minimum, temperature, relative humidity and differential pressure in conformance with the levels specified in the requirements of the ECSS-Q-ST-70-01.

b. In addition to environmental parameters specified in the requirement 5.5.2a, the space test centre shall assess all parameters that can affect the test specimen's environmental conditions or the test results.

NOTE These parameters can include, but not be limited to, the following: light level, electromagnetic radiation, magnetic cleanliness, vibration, ionising radiation, and acoustic environment.

c. The cleanliness level of supplies shall be controlled when required by a test process.

NOTE Supplies can include gases and liquids to support the test process.

d. The space test centre shall implement and document an environmental control programme.

e. The environmental control programme specified in the requirement 5.5.2d shall document how to achieve, measure and maintain the

applicable environmental control parameters throughout the space test centre.

f. In case a generic environmental control programme exists at parent organization level, any deviation and addition with respect to the generic programme, shall be documented in a dedicated document.

g. The results of all environmental control parameters are quality records and shall be controlled in conformance with the requirement 5.2.1a.

5.5.3 Cleanliness and contamination control

a. The space test centre shall establish, document and implement a cleanliness and contamination control programme, in conformance with the requirements of the ECSS-Q-ST-70-01.

b. The space test centre cleanliness and contamination control programme shall document how to achieve, measure and maintain the applicable cleanliness levels throughout the space test centre.

c. The space test centre cleanliness and contamination control programme shall include:

1. the indication of a minimum set of cleanliness levels for the facility when no specific requirements are set by the customers;
2. the specific cleanliness levels to be verified;
3. the methods and frequencies of checking the cleanliness levels;
4. the procedures for the applicable competence and training of personnel;
5. the cleaning procedures;
6. the working procedures for achieving and maintaining the applicable cleanliness levels.

d. In case a generic cleanliness and contamination control programme exists at parent organization level, any deviation and addition with respect to the generic programme, shall be documented in a space test centre dedicated document.

e. The cleanliness levels shall be specified for molecular contamination in terms of surface contamination.

f. The cleanliness levels shall be specified for particulate contamination in terms of both, surface and airborne contamination.

g. For a space test centre where flight hardware is exposed, the minimum cleanliness level of the environment for airborne particles shall be ISO class 8 in compliance with the requirement 5.3.1.4.a of the ECSS-Q-ST-70-01.

h. In absence of specific frequency requirements, the space test centre shall determine and justify the frequency at which surface cleanliness levels are measured.

i. The frequency for the measurement of particulate fall-out and cumulative molecular witnesses should not be less than once per year.

j. The results of all cleanliness and contamination control parameters are quality records and shall be controlled in conformance with the requirement 5.2.1a.

5.5.4 Site security and access control

a. The space test centre shall specify and implement a system for security and access control to restricted areas.

NOTE Restricted areas include clean rooms and all areas where test specimens or hazardous items are stored, handled or tested.

b. The space test centre shall maintain a list of authorized persons who have access to restricted areas.

NOTE 1 The space test centre can agree with the customer on special provisions for the security and access control of the test specimen

NOTE 2 Access control to the test facilities and cleanrooms can be implemented by:

- guard(s) posted at the entrance(s);
- a magnetic card lock system;
- an electrical door lock system;
- a camera monitoring system;
- a mechanical (normal) key system.

5.6 Test process realization

5.6.1 Overview

If the space test centre is involved in the design and development of a test facility (or its modification) as the owner or as a supplier, the term “test process” used in this clause is replaced by “test facility”.

5.6.2 Planning of the test process

a. To demonstrate that the specified requirements of the customer are met, the space test centre shall establish and maintain documented procedures to:

1. control and verify the design of existing and new test facilities;
2. control and verify the modification of test facilities in compliance with requirements from the clause 5.6.5.3;.
3. control and verify the software used in the test process;
4. verify the operation of the test facilities;

5. verify the test planning, test preparation, test execution and test related hardware and infrastructure.

NOTE 1 Hardware for example includes jigs and tools.

NOTE 2 Annex B gives an example of the design and development sequences of a generic test process.

5.6.3 Evaluation of customer requirements

a. The space test centre shall maintain knowledge of the technology that is provided to the customer within the contractual agreements.

b. The space test centre shall agree with the customer on:

1. the support of test evaluation processes,

2. the provision of an impartial consultancy service to gain test efficiency.

c. The space test centre shall specify the procedure for the review of requirements of routine, repetitive and new or complex tasks, including the follow up of contractual events.

d. The space test centre shall maintain records of all requirements review.

e. The review shall cover any work that is outsourced by the space test centre.

5.6.4 Design and development of the test process

a. The space test centre shall identify and plan all phases of the testing process development and related servicing processes.

NOTE Phases of testing include design, planning, preparation, acceptance, execution, report and reviews.

b. The activities specified in the requirement 5.6.4a shall be performed in cooperation among engineering, quality and safety assurance staff.

c. The space test centre shall demonstrate that processes specified in the requirement 5.6.4a are carried out under controlled conditions.

d. Controlled conditions specified in the requirement 5.6.4c shall include the following:

1. documented procedures specifying test design, test planning, test preparation, test execution and management, test data acquisition and storage, format and contents of test reports, test reviews and inspections, tracking of the test specimen from reception to storage or departure and test-related services;

2. conformance to applicable standards specified in the business agreement, codes, legislation, quality and safety plans or documented procedures;

3. monitoring and control of test (process) parameters and test facility characteristics;
4. the approval of test processes, procedures, facilities and equipment as appropriate or applicable by the customer;
5. inspection and maintenance of test facilities, infrastructure, and software to demonstrate continuing test process capability;
6. applicable competence, training and certification of test personnel and lower tier suppliers in conformance with the requirements of clause 5.4.

e. The design and development activities shall be assigned to qualified personnel supported by resources.

f. The planning shall be updated as the design of the test process evolves.

g. The planning shall demonstrate the compatibility of the design of the test processes with the installation, the execution, the servicing, the inspection, the acceptance, the validation and the applicable test procedures.

h. The space test centre shall specify the requirements for any verification and validation of test processes or parts of them, including associated facilities, equipment and personnel.

i. Records shall be maintained for verified and validated processes, facilities and the qualification of personnel.

j. The space test centre shall apply process control to outsourced services for test processes or parts of them as well as for maintenance services.

k. The space test centre shall specify organizational and technical interfaces between different groups which provide input to the design process

NOTE Example of the inputs for the design process is engineering support

l. The information on design and development of a test process shall be documented and maintained.

m. The space test centre shall assess the risks of the design and development process, executed with methodologies agreed by the QA and safety representative.

NOTE The risk assessment includes both technical and programmatic risks.

5.6.5 Test process and service provision

5.6.5.1 Test report

a. The space test centre shall ensure that all tests are documented in test reports.

b. The test report shall be prepared, controlled and distributed in conformance with the requirements from the clause 5.2.

c. The test report shall be in conformance with the DRD in Annex C of ECSS-E-ST-10-02 and include as a minimum:

1. name and address of the space test centre and location where the test was carried out;
2. names of key space test centre personnel involved in the test;
3. name and address of the customer;
4. description and identification of the test set up and test specimen;
5. date of receipt of the test specimen and date(s) of execution of the test;
6. identification of the test specification or description of the method or procedure;
7. description of the sampling procedure, where relevant;
8. measurements, examinations, derived results and measurement units, supported by tables, graphs, sketches and photographs as appropriate;
9. a statement on measurement accuracy, where relevant;
10. the agreed confidentiality level.

5.6.5.2 Validation of the test process and service provision

a. The space test centre shall identify the need for dry-runs, rehearsals, simulations as well as the level of simulation, based on:

1. complexity and specificity of the test process;
2. evaluation of the risks for the test specimen and the facility in case of test interruption or failure;
3. adequacy of qualifications of personnel employed on the test;
4. comprehensiveness and effectiveness of the end-to-end verification performed on the test set-up and facility subsystems.

b. The space test centre shall follow a quality plan or documented procedure to state the applicable inspections or tests and the records are established prior to the actual test run.

5.6.5.3 Configuration control

a. The space test centre shall establish and maintain a documented procedure for:

1. configuration identification,
2. configuration change control, and
3. configuration status accounting of its test facilities.

b. The space test centre shall specify a product tree for each system used in the test process.

c. The product tree specified in the requirement 5.6.5.3b shall include as a minimum:

1. all software used in the test process,
2. all critical items, and
3. all facility items that are under maintenance control and whose replacement by a different part number changes the facility configuration.

d. The configured items of the facilities shall be described by the applicable documents and drawings.

e. The space test centre shall establish and maintain a technical file for each test facility describing the as-built configuration status of the facility.

f. The space test centre shall assess on a regular basis the status of infrastructure, facilities, software and the qualifications of responsible personnel.

NOTE Means of assessment for example are inspections, continuous monitoring of critical parameters.

g. Records of the activities specified in the requirement 5.6.5.3f and any related certification shall be maintained.

h. The space test centre shall identify the development of the status of a test set-up and related documentation for the different phases of the test process, and maintain records of this status.

i. If applicable by the customer, the space test centre shall identify the status of the test specimen and related documentation from receipt to departure, and maintain records of the status, type and number of inspections that are executed by the space test centre.

j. The identification of test items shall be made at the earliest possible stage of the test process.

k. The identification of test items shall be retained throughout all stages of work to ensure continued configuration control.

NOTE The identification can be achieved by a permanent method of marking or engraving on the item or packaging.

l. The identification of customer-supplied items shall be agreed with the customer.

m. Records shall be maintained for all items of test and measurement equipment.

n. Each record shall include:

1. the name of the item or equipment,
2. the manufacturer's name and type identification and unique identifier,
3. date received and date placed in service, and
4. current location.

5.6.5.4 Control of test specimen

a. The test specimen shall be specified in its configuration on the test facility.

b. All interfaces between the test facility and test specimen shall be specified.

c. In case of a transfer of responsibility for the test specimen from the customer to the space test centre, this transfer shall be contractually specified.

d. The incoming inspection, the handling, the transport and the integration of the test set-up shall be performed in agreement with the customer.

e. Any intervention carried out by the space test centre on the test specimen shall be authorized by the customer.

f. All operations performed on flight or similarly critical development items shall be documented.

g. During the period that the space test centre has responsibility for the test specimen, the management of the test-specimen-related documents shall be specified and agreed by the customer.

h. For critical applications, regular interventions on the test specimen shall be performed by using step-by-step procedures.

5.6.5.5 Handling, storage, transportation and preservation

a. The space test centre shall implement and maintain documented procedures, in agreement with the customer, engineering, quality and safety assurance staff, which cover the safe handling, storage, transportation and preservation of the test specimen and associated test equipment from the arrival at the test centre up to the departure.

b. The documented procedures shall cover as a minimum:

1. methods for safe handling, storage and transportation of the test specimen and associated test equipment to prevent damage or deterioration;

2. preservation of the applicable environmental conditions as well as safety and security aspects;

3. definition of responsibilities between the customer and the space test centre;

4. programme of inspections;

5. conditions for the arrival and departure;

NOTE 1 Examples for inspections specified in the requirement 5.6.5.5b.4 are: incoming and final inspections.

NOTE 2 Examples for conditions for the arrival and departure referred in the requirement 5.6.5.5b.5 are: related to customs, and ITAR regulations.

c. The space test centre shall apply methods for preservation of the test specimen and associated test equipment when they are under the space test centre's control.

d. Prior to critical operations affecting the test specimen, the handling sequences shall be approved by the customer.

e. All lifting and hoisting equipment, including slings and accessories, shall be certified by an authorized body and covered by a valid certificate.

f. The certificates and their validity periods for all lifting and hoisting equipment specified in the requirement 5.6.5.5e shall be available to the customer.

g. Designated personnel shall brief customer personnel involved in lifting and hoisting operations inside the space test centre.

h. The storage area for the test specimen and equipment shall be a designated area, separated from the working area.

i. Access control to the storage area shall be established to provide the same security level, as in working areas.

j. Transportation operations outside the space test centre premises, and which are under space test centre control, shall be planned and documented, and submitted for the customer approval.

k. The space test centre shall control packing, packaging and marking processes to demonstrate conformance to specified requirements.

5.6.5.6 Calibration control

a. The space test centre shall implement a metrology and calibration programme in conformance with the requirements of clause 5.2.6 of the ECSS-Q-ST-20.

b. The space test centre shall demonstrate that all measurement equipment affecting test results are calibrated and traceable to international or national standards.

c. The space test centre shall demonstrate the traceability of calibration by documenting the unbroken chain of activities performed to link the measurement results to the relevant standards.

NOTE 1 Traceability to a standard can be demonstrated by a dedicated calibration or a comparison to a calibrated reference standard or described and agreed methods.

NOTE 2 ECSS-E-ST-10-03 provides the applicable test accuracies.

d. The space test centre shall establish a Calibration Plan per facility to cover all measurement and acquisition equipment used in the test process.

e. The Calibration Plan specified in the requirement 5.6.5.6d shall include:

1. a unique identification of the equipment to be calibrated,

2. the calibration activities with their periodicity,
3. the applicable specification,
4. the identified resources.

f. The space test centre shall establish and maintain a calibration schedule to demonstrate that the calibration tasks are allocated, coordinated and synchronized in time and location.

g. When the calibration activity is outsourced to a lower tier supplier, the space test centre shall specify the requirements to a lower tier supplier.

h. A lower tier supplier complying with the requirements of ISO/IEC 17025:2005 or ISO 10012:2003 shall be selected.

i. When the requirement 5.6.5.6h is not met, the space test centre shall justify the lower tier supplier selection.

j. The space test centre shall demonstrate the validity of the calibration data coming from lower tier supplier work.

k. The space test centre shall establish a system to identify and label the calibration status of measurement and acquisition equipment.

l. Measurement and acquisition equipment that is not subject to calibration or not in calibrated state shall be identified and labelled as such.

m. Records of the performance of the calibration activities shall be easily retrievable.

n. The calibration records shall contain as a minimum the measurement results, the measurement uncertainty or a statement of compliance with an identified specification.

5.6.5.7 Maintenance control

a. The space test centre shall establish a Maintenance Plan for infrastructure, test facilities, environmental monitoring, and software used in the test process.

b. The maintenance plan shall include for each facility item:

1. a unique identification,
2. the maintenance activities with their periodicity,
3. the applicable procedures,
4. the identified resources.

c. When the maintenance activity is outsourced to a lower tier supplier, the space test centre shall specify the requirements to a lower tier supplier.

d. The space test centre shall demonstrate the validity of the maintenance data coming from outsourced work.

e. The space test centre shall establish and maintain a maintenance schedule to demonstrate that the maintenance tasks are allocated, coordinated and synchronized in time and location.

f. Records of the performance of the maintenance activities shall be easily retrievable.

g. The maintenance records specified in the requirements 5.6.5.7f shall contain as a minimum the description of the work performed, any relevant measurements, the date and the responsible space test centre personnel or lower tier supplier performing the maintenance activity.

h. The space test centre shall demonstrate that computer software used for the operation of test facilities or for the acquisition of test results suits the intended application.

NOTE This includes revalidation after software updates.

i. The space test centre shall establish a procedure for periodical verification of test facility performance.

j. The procedure specified in the requirement 5.6.5.7i shall contain as a minimum the verification method, the pass/fail criteria and the periodicity.

NOTE Example of facility validations includes shaker footprint, sun simulator mapping and dummy tests in general.

5.6.6 Dependability and risk assessment of test facilities

a. For each facility, new or existing, a risk assessment covering all operational and non-operational aspects as well as health and safety risks shall be conducted and documented in compliance with the requirements from the clause 5.8.4.

NOTE For the performance of a risk assessment, refer to ECSS-M-ST-80.

b. A functional failure modes, effects and criticality analysis (FMECA) or equivalent recognised dependability analysis shall be performed for each new facility design and before each facility configuration change implementation, including all equipment and subassemblies of the test facility.

NOTE For the performance of a failure modes, effects, and criticality analysis, refer to ECSS-Q-ST-30

c. Critical items shall be identified as a result of the analyses specified in the requirements 5.6.6a and 5.6.6b.

d. For critical item specified in the requirement 5.6.6c a mitigation action shall be identified and implemented before its further use.

NOTE For establishing a critical items programme refer to ECSS-Q-ST-10-04.

e. The analyses specified in the requirements 5.6.6a, 5.6.6b and 5.6.6c shall be reviewed for updating after a major facility upgrade or modification.

f. The space test centre shall monitor periodically dependability performance and trends of the test facilities for improving the technical performance, safety, availability and operational costs of test facilities.

g. The space test centre shall monitor as a minimum:

1. items with significant accumulated operational time compared to their expected (residual) life,
2. items with a known history of problems,
3. items performing functions which are critical to the test conduct,
4. items for which spare availability is scarce or missing.

h. The space test centre shall specify and justify the methodology and the periodicity of the dependability performance and trends monitoring.

i. The dependability performance and trend analyses should include as a minimum data coming from:

1. the assessment of tests performed in the given period regarding test duration and test conditions,
2. a review of the maintenance activities performed, and
3. the root cause analyses of anomalies and nonconformances.

5.7 Monitoring and measurement

5.7.1 Monitoring and measurement of test activities

a. The space test centre shall establish and maintain documented procedures for the assessment of readiness of the test facility and the test set-up to verify that the applicable requirements are met.

b. A FRR meeting shall be held by the space test centre to verify the readiness of the test facility, with participation of test personnel with designated responsibility in engineering, quality and safety.

c. Records of the FRR meeting shall be kept by the space test centre.

d. The FRR shall address, as a minimum, the following topics:

1. test documentation, including test methods and procedures and acceptance criteria;
2. test facility status, including:
   (a) facility configuration for the test,
   (b) test facility data handling,
   (c) test facility measurement equipment,
   (d) equipment calibration,
   (e) environmental conditions,
   (f) cleanliness status,
   (g) maintenance status,
   (h) safety status.
3. status of nonconformances that may affect the test or test facility;

4. status of waivers and deviations that may affect the test or test facility;
5. personnel qualification and availability,
6. ground support equipment (GSE) and infrastructure readiness,
7. test specimen (in case responsibility has been contractually transferred to the space test centre),
8. results from pre-tests (dry-runs, rehearsals), and
9. final test preparation actions status.

e. All open actions coming from the FRR shall be identified and closed before the test execution.

f. The space test centre shall present a declaration of facility readiness to the TRR board convened to release the test activity.

g. The declaration of facility readiness shall be authorised by the quality representative.

h. Space test centre representatives shall participate in test readiness review (TRR) and post test review (PTR) in conformance with the requirements of the ECSS-E-ST-10-03.

NOTE Records of TRR and PTR are normally provided to the space test centre by the customer.

i. The space test centre shall establish and maintain documented procedures for the inspection of the test facility and the test set-up during the test execution to verify that the applicable requirements are met.

j. The space test centre shall present the preliminary test data to the PTR board including, as a minimum,

1. test facility data packages and logbooks,
2. nonconformances and related dispositions,
3. certification that test facility data meet requirements and clearance to end-of-test phase or further testing.

5.7.2 Control of nonconformances

a. The nonconformance control programme shall be performed in conformance with requirements from the ECSS-Q-ST-10-09.

b. The nonconformance control programme shall be documented and supported by procedures and instructions.

c. The space test centre shall specify the responsibilities and the authorities for the treatment of nonconformances relevant to the space test centre.

d. All test personnel shall be able to identify a nonconformance and issue a NCR.

e. Space test centre NCRs affecting the test specimen and any other customer property or the test programme shall be notified to the customer.

f. The classification of NCRs specified in the requirement 5.7.2e shall then be agreed with the customer.

g. The analysis of the nonconformances for test facilities or test service shall provide for lessons learned from the NCRs and their dissemination.

5.7.3 Lessons learned review

a. The space test centre shall review the lessons learned coming from its activities.

b. The space test centre shall establish and maintain a documented procedure for the management of lessons learned, including the frequency of lessons learned reviews.

c. The space test centre shall demonstrate the use of lessons learned as input to its future activities.

d. The outcome from the lessons learned review shall be used to determine appropriate actions.

5.8 Safety

5.8.1 Safety programme

5.8.1.1 General

a. The space test centre, in cooperation with the designated safety representative, shall establish a safety programme to assure the safety of all space test centre personnel, including the customer and visitors, the test specimen, the test facilities and its associated infrastructure.

b. The space test centre safety programme shall include, as a minimum:

1. systematic hazard identification, elimination or reduction;
2. safety risk assessment according to national legislation, including an approved action plan to implement the prevention measures associated to safety;
3. systematic identification, control and maintenance of safety critical items in conformance with national legislation;
4. systematic identification, control and maintenance of all applicable safety equipment in conformance with national legislation;
5. documented space test centre safety and emergency procedures and instructions;
6. applicable safety training of space test centre personnel
7. applicable safety briefings of customers and visitors;
8. systematic verification of safety requirements implementation by means of safety inspections and audits;

9. identified resources to meet national requirements, space test centre requirements or customer requirements for medical, safety and emergency services.

NOTE These requirements can be developed in-house or provided by supplier organizations or local services.

c. The safety programme shall be in conformance with the applicable laws and regulations.

5.8.1.2 Accidents, incidents and emergencies

a. The space test centre safety programme shall include, as a minimum the following accident / incident and emergency procedures:

1. The general emergency procedure for the space test centre
2. The procedures to be followed in case of accident / incident
3. The clear description of the responsibilities and authorities in all accident, incident and emergency procedures.

b. The emergency procedures shall be part of the safety briefing of space test centre staff and customers.

5.8.2 Safety policy and objectives

a. The space test centre management shall be responsible for:

1. the space test centre safety policy and its objectives,
2. commitment to safety, and
3. ensuring that safety is an essential part of all space test centre related activities.

b. The space test centre management shall periodically review its safety policy.

c. The space test centre shall demonstrate that the safety policy is supported by all space test centre personnel.

d. The space test centre management shall identify safety objectives.

e. The space test centre shall demonstrate that the safety objectives specified in the requirement 5.8.2d are reviewed systematically.

5.8.3 Safety manual of the space test centre

a. The space test centre, in cooperation with safety assurance, shall establish and maintain a Safety Manual that shall include the following information:

1. applicable international and national standards on which it is based
2. applicable health and safety legislation in the space test centre

3. national environmental legislation that has safety requirements which impact the space test centre.
4. the space test centre safety policy and objectives
5. the responsibilities and authorities of all space test centre personnel with regards to safety
6. applicable safety procedures and instructions
7. applicable emergency procedures.

5.8.4 Test facilities

a. The space test centre, in preparing the risk assessment for test facilities, shall identify the critical operations expected during the facility life cycle.

b. The risk assessment shall be documented and cover the following:
   1. a summary and description of each hazardous activity,
   2. an assessment of the risks associated with the hazard, its likelihood and severity,
   3. an identification of all risk reduction measures and the verification of their effectiveness after implementation,
   4. a clear indication of the remaining and acceptable risks to operate the facility,
   5. the methodology used for the risk assessment.

      NOTE For a risk assessment methodology, refer to ECSS-M-ST-80.

c. The risk assessment shall include the following:
   1. the identification of safety critical items, equipment or systems,
   2. the review of maintenance and inspection instructions, with respect to the safety critical items of the test facilities,
   3. the review of procedures for operation of safety critical items, equipment or systems,
   4. the review of facility emergency procedures,
   5. the review of facility recovery procedures.

5.8.5 Test campaign safety file

a. The space test centre shall identify all hazardous items and operations specific to the test campaign.

b. Information on hazardous items and operations specific to the test campaign shall include a safety questionnaire completed by the customer or by the space test centre in cooperation with the customer.

c. The safety questionnaire specified in the requirement 5.8.5b shall contain as minimum the information specified in the DRD from the Annex A.

d. The space test centre shall agree with the customer the delivery conditions of the safety questionnaire filled in by the customer.

NOTE Delivery conditions are for example the format of the questionnaire, the time of delivery.

e. The information from the questionnaire specified in the requirement 5.8.5b shall be recorded and processed as input data for the design and verification of the testing process, in addition to the standard safety precautions.

f. On request from the space test centre, the customer shall provide any product certification and personnel training records that are applicable by law.

NOTE 1 Products and personnel belonging to the customer usually operate in the space test centre.

NOTE 2 Product certification can be for example applicable for pressure vessels, pyrotechnics, lifting devices, radiation sources.

NOTE 3 Personnel training records can be for example applicable to the handling of lifting devices.

g. The space test centre shall perform a safety risk assessment for each test campaign, indicating the actions to eliminate or reduce the significant risks to an acceptable level.

h. For test campaigns that require safety precautions other than those already implemented in the space test centre, the space test centre shall prepare a specific safety file.

i. The safety file specified in the requirement 5.8.5h shall include:

1. records of risk assessment for the test campaign,
2. the space test centre safety questionnaire
3. all supporting safety documentation
4. records of safety reviews
5. records of safety briefings, including records of attendance
6. test specific safety procedures
7. test specific emergency procedures
8. evidence that all safety actions are closed prior to the test execution
9. identification and planning the need for specific medical, rescue or other specialized personnel on stand-by during the testing activities with known hazardous operations.

j. Critical operations shall be performed under the surveillance of designated qualified staff.

Annex A (normative) Questionnaire on the use of hazardous items and operations – DRD

A.1 DRD identification

A.1.1 Requirement identification and source document

This DRD is called from ECSS-Q-ST-20-07, requirement 5.8.5c

A.1.2 Purpose and objective

This DRD aims to identify and describe possible hazardous items and operations originating from the test specimen and specific to the test campaign. It consists from three parts.

A.2 Expected response

A.2.1 Scope and content

<1> Questionnaire Part 1: knowledge on safety hazards coming from the test specimen

a. To understand if any of safety hazards are coming from the test specimen, the customer shall provide answers Yes or No for the presence of the following:

1. radioactive sources and generators,
2. explosive or pyrotechnic devices, jettisonable devices,
3. mechanical energy,
4. mechanical properties of materials
5. Physical properties,
6. pressurized vessels including vacuum vessels,
7. high voltages,
8. high intensity light sources and lasers,

9. radio-frequency sources,
10. flammable, toxic or aggressive chemicals,
11. outgassing products and components,
12. biological hazards,
13. low- or high-temperature devices,
14. noises, and
15. other safety hazards not mentioned above

NOTE 1 Examples of mechanical properties for 4. are: sharp, rough, and slippery

NOTE 2 Examples of physical properties for 5. are: confined space, or working at height.

<2> Questionnaire Part 2: sensitivity of test specimen

a. To understand if a test specimen sensitive to any of the following factors listed below the customer shall provide answer Yes or No:

1. Vacuum including range of authorized pressures,
2. contamination including particles and organic ,
3. light levels with spectral distribution and geometry,
4. sound levels with spectral distribution,
5. temperature ranges,
6. mechanical sensitivity
7. humidity,
8. chemicals,
9. biological contamination,
10. electric, magnetic and electromagnetic fields, and
11. other factors not listed above.

NOTE Examples of mechanical sensitivity for 6 are: vibration, shocks, and gravity-sensitive devices

<3> Questionnaire Part 3: detailed description

a. In case of the answer Yes in Questionnaire Part 1 and Part 2 the customer shall provide the following:

1. Brief description of each task or operation with identification of hazardous operations.
2. Identification of the operating location for the hazardous operations within the testing area or departing and arriving areas.
3. Specific hazards to which personnel are exposed during the operation.

4. Configuration of the test specimen prior to, during, and at completion of each hazardous operation, including all the GSE.

5. Identification of the failure tolerances and the means for verifying that the failure tolerances are in place and operational.

6. Identification of any conditions that cause the operation to be considered hazardous.

7. Identification, of the safety precautions to be taken for each activity, hazardous or not, where specific guidelines are observed or actions are taken to prevent or limit hazards.

8. Identification, of procedures involving manually controlled pressurization of systems where the maximum operating pressure is reached.

9. Identification of organizational elements and facilities applicable to support the operations.

10. Identification of tools, equipment, and clothing for the safe performance of a hazardous operation or for emergency procedures associated with the operation.

11. Initial identification of the emergency or contingency actions for each hazardous operation.

12. Initial identification of the emergency or contingency actions specified in the requirement A.2.1<3>a.11 contains the following information:

    (a) specific actions to cope with emergency or contingency conditions and identification of the individuals directing the actions;

    (b) hazards unique to the operation and steps for rendering safe to protect personnel and equipment.

13. Evidence of customer's past experience in the handling of hazardous items.

14. Reference to previous safety procedures and hazard analyses carried out for other projects.

15. Recommendation of special provisions to be furnished the space test centre or possible test facility upgrading to minimize risk.

NOTE 1 Examples of specific hazards for 3 are: pyrotechnics, and propellants.

NOTE 2 Examples of failure tolerances for 5 are: redundancies, safety devices, inhibits.

NOTE 3 Examples of support to operations for 9 are: safety officer, security, and medical.

NOTE 4 Examples of hazards for 12 are: pressure relief, and operation abort

Annex B (informative)
Typical test process sequence

Project Step	Task	EN 9100:2009 subclause	ECSS-Q-ST-20-07 clause (delta)
Kick-off	Initiating of project; agreement and commitment with customer and project team.	7.1 Planning of product realization 7.2.1 Determination of requirements related to the product	5.6.2 Planning of the test process 5.6.3 Evaluation of customer requirements
Planning	Preparation of a plan for the design and development activities. Typical contents: Schedule, milestones, work packages description, cost planning, and quality and safety assurance planning.	7.1 Planning of product realization 7.3.1 Design and development planning	5.6.2 Planning of the test process 5.6.4 Design and development of the test process 5.6.6 Dependability and risk assessment of test facilities
Review	Performance of documented reviews to demonstrate that the design concept meets the requirements. Typical review: Pre-design facility review meeting.	7.2.1 Determination of requirements related to the product 7.3.4 Design and development review	5.6.3 Evaluation of customer requirements 5.6.6 Dependability and risk assessment of test facilities
Development	Identification and description of the requirements for the process to be developed, including applicable laws, safety regulations and technical standards. Typical output: Definition, description of the process provided by e.g. drawings, technical	7.3.2 Design and development inputs 7.3.3 Design and development outputs 7.3.5 Design and development verification 7.3.6 Design and development validation 7.3.7 Control of design and development changes	5.6.4 Design and development of the test process 5.6.5.2 Validation of the test process and service provision 5.6.5.3 Configuration control

Project Step	Task	EN 9100:2009 subclause	ECSS-Q-ST-20-07 clause (delta)
	notes and documents, plans and procedures for realization, verification and validation, and safety plan.		
Review	Performance of documented reviews to demonstrate that the design output and the planned realization meet the requirements. Typical reviews: Pre-test design review, and test readiness review (TRR).	7.2.1 Determination of requirements related to the product 7.3.2 Design and development inputs 7.2.2 Review of requirements related to the product	5.6.3 Evaluation of customer requirements 5.6.5.2 Validation of the test process and service provision 5.6.6 Dependability and risk assessment of test facilities
Purchasing	Purchasing of items or provisions to be supplied for the designated process in conformance with the planning under consideration of terms of verification and validation.	7.4 Purchasing	5.6.5.6 Calibration control 5.6.5.7 Maintenance control
Integration	Where necessary, realized software and hardware shall be integrated into the specified requested system. Typical output: Test set-up, system, programme, operation manual, and safety procedures.	7.3.7 Control of design and development changes 7.5.1 Control of production and service provision 7.5.2 Validation of processes for production and service provision 7.5.3 Identification and traceability 7.5.4 Customer property 7.6 Control of monitoring and measuring equipment	5.6.5.2 Validation of the test process and service provision 5.6.5.3 Configuration control 5.6.5.4 Control of test specimen
Implementation	Implementation of the realized system, hardware or software. Typical output: Pre-tests, test readiness, acceptance reports, and inspection records.	7.3.5 Design and development verification 7.3.6 Design and development validation 7.5.1 Control of production and service provision 7.5.2 Validation of processes for production and service provision	5.6.5.2 Validation of the test process and service provision

Project Step	Task	EN 9100:2009 subclause	ECSS-Q-ST-20-07 clause (delta)
Realization	Realization, manufacturing or test execution to meet and fulfil the given tasks and requirements in conformance with the planning. Typical output: Test reports, inspection records, and operation.	7.5 Production and service provision 7.2.3 Customer communication	5.6.5 Test process and service provision
Review	Performance of documented reviews to demonstrate that the realized product (e.g. test, hardware, or software) is in conformity with the requirements. Typical review: Acceptance review (AR), and post-test review (PTR).	7.2.1 Determination of requirements related to the product 7.3.4 Design and development review	5.6.6 Dependability and risk assessment of test facilities

Bibliography

ECSS-S-ST-00	ECSS system – Description, implementation and general requirements
ECSS-M-ST-40	Space project management – Configuration and information management
ECSS-M-ST-80	Space project management – Risk management
ECSS-Q-ST-10-04	Space product assurance – Critical-item control
ECSS-Q-ST-30	Space product assurance – Dependability
ECSS-Q-ST-40	Space product assurance – Safety
ISO IEC 17025:2005	General requirements for the competence of testing and calibration laboratories
ISO 10012:2003	Measurement management systems – Requirements for measurement processes and measuring equipment