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1 October 2014

Space product assurance

Quality and safety assurance for space test centres

ECSS Secretariat
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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

ECSS-Q-20-07A 31 July 2002	First issue
ECSS-Q-20-07B	Never issued
ECSS-Q-ST-20-07C 1 October 2014	Second issue The main changes between ECSS-Q-20-07A and the current version are the following: • Revision of the document according to ECSS drafting rules for ECSS "Issue C" Standards • Reorganization of the content of the document to separate descriptive text and requirements, including clarification and modification of requirements • Transformation of the informative Annex C "Questionnaire on the use of hazardous items and operations" of the previous version into a Normative DRD in Annex A • Implementation of Change Requests • Removal of all references to ISO 9001 paragraphs, replaced by requirement 5.1a, which makes applicable the complete EN 9100 standard • Increased focus on configuration control, traceability of the measurement chain, and dependability and safety of test facilities • Update reference to applicable standards

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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.

This Standard was originally prepared with focus on organisations capable of providing test services for space and launch segment elements and subsystems.

1
Scope

This Standard specifies quality assurance and safety assurance requirements for space test centres, applicable to the test process, test personnel (both, of the customer and the space test centre), 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-10-03	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-20-08	Space product assurance - Storage, handling and transportation of spacecraft hardware
ECSS-Q-ST-70	Space product assurance - Materials, mechanical parts and processes
ECSS-Q-ST-70-01	Space product assurance - Cleanliness and contamination control
ISO 9000:2005	Quality management systems - Fundamentals and Vocabulary
EN 9100:2009	Quality Management Systems - Requirements for Aviation, Space and Defense Organisations
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

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

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

1. approval
2. assurance
3. audit
4. availability
5. calibration
6. certification
7. cleanroom
8. corrective action
9. critical item
10. dependability
11. preventive action
12. procedure
13. process
14. product
15. quality assurance
16. reliability
17. risk
18. safety
19. test
20. traceability

b. For the purpose of this standard, the following terms and definitions from ECSS-Q-ST-70 apply:

1. critical process

c. For the purpose of this standard, the following terms and definitions from ISO 9000:2005 apply:

1. management system
2. quality management system
3. quality policy
4. top management

3.2 Terms specific to the present standard

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 modification

<<CONTEXT: test facility>> change in the configuration of an existing test facility

3.2.3 quality representative

<<CONTEXT: test centres>> representative from the space test centre management with designated responsibility for quality management

3.2.4 safety management system

<<CONTEXT: test centres>> management system to direct and control the space test centre organization with regard to safety

3.2.5 safety policy

<<CONTEXT: test centres>> overall intentions and directions of the space test centre with regards to safety as formally expressed by top management

3.2.6 safety representative

<<CONTEXT: test centres>> representative from the space test centre management with designated responsibility for safety

3.2.7 space test centre

complete entity including the organization that provides, maintains and operates test facilities for space projects and applications, including accompanied services

3.2.8 test campaign

<<CONTEXT: test centres>> 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

3.2.9 test facility

technical plant to provide specific simulated conditions for testing equipment for space projects and applications, including test connections and instrumentation attached as necessary to perform the test

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

3.2.10 test personnel

staff developing, maintaining or operating a test process

3.2.11 test process

set of 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, reporting, reviewing and recording.

3.2.12 test specimen

item or device under test

NOTE This term is synonym of test article and test item.

3.3 Abbreviated terms and symbols

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

Abbreviation	Meaning
FRR	facility readiness review

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 performed under the responsibility of the space test centre 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.

The basic principles of the space test centre quality and safety programme are 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.

The quality and safety programme needs to demonstrate the integration of activities from the following disciplines:

a. ECSS-Q-20 Quality assurance

b. ECSS-Q-30 Dependability

c. ECSS-Q-40 Safety

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

e. ECSS-E-10 System engineering

f. ECSS-M-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 For example, 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 quality and safety management system shall cover work carried out in the space test centre's permanent facilities, or in temporary or mobile facilities.

d. The space test centre shall specify the processes for the quality and safety management system and their application throughout the space test centre.

e. The space test centre shall specify the sequence and interaction of the quality and safety management processes.

f. The space test centre shall specify criteria and methods to demonstrate that both the operation and control of quality and safety management processes are effective.

g. The space test centre shall demonstrate the availability of resources and information to support the operation and monitoring of quality and safety management processes.

h. The space test centre shall monitor, measure, and analyse quality and safety management processes.

i. The space test centre shall implement actions to achieve planned results and continual improvement of quality and safety management processes.

j. 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.

k. 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.

l. The space test centre shall ensure 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.

m. 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.

NOTE The space test centre can make use of the parent organisation documentation to comply with this requirement.

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.

5.2.2 Facility description

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

1. functional performance,
2. general arrangement drawing,
3. interface definition.

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 define 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 development of their capability for any test requirements that exceed the current known state of the art,
5. the identification of standards for maintenance and calibration of items used by the space test centre,
6. the establishment and follow-up of rules to control conformity to requirements between design and acceptance of space test centre items,
7. the assessment of risks related to customer supplied products and the applicable processes.

NOTE The task of item 6 can be achieved by calculation, test analysis, or simulation.

5.3.3 Responsibility and authority

a. Top management shall ensure that management and technical responsibilities and authorities are defined and communicated within the organisation.

b. Management and technical responsibilities and authorities shall be delegated in case of personnel absence, and defined and communicated within the organisation.

c. Top management shall ensure that space test centre personnel are free from undue pressures, conflict of interest or influences that can affect the quality of their work.

5.3.4 Quality and safety representatives

a. Top management shall appoint a quality 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 personnel safety, test specimens or test facilities are at risk, the safety representative, or designated trained staff, shall have defined authority to stop the activity.

5.4 Personnel competence and training

5.4.1 General

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

b. The space test centre shall ensure that all personnel is trained to comply with the applicable safety requirements.

c. The space test centre shall ensure that personnel undergoing on-the-job training are subject to supervision by a person competent to perform such task.

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

e. All space test centre personnel conducting or supporting potentially hazardous operations in the space test centre shall receive specific safety training, including the preventive measures to be taken.

5.4.2 Competence, awareness and training

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

b. The space test centre shall identify the required competence and authorisation to perform test process and test facility related activities in the space test centre.

c. The space test centre shall identify the available competence and the training needs to reach the required competence and authorisation as specified in requirement 5.4.2b.

d. The space test centre shall establish and implement criteria for managing the competences and the authorisation to perform the test centre activities.

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

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

g. The space test centre shall evaluate the effectiveness of the training performed.

h. Space test centre and customer personnel performing lifting and hoisting operations shall be trained and certified by an authorized body.

NOTE An authorized body to train and certify lifting and hoisting operators can be accredited according to national legislation. In the absence of this, an authorized body can be the manufacturer of the lifting or hoisting equipment or its authorised representative.

i. The space test centre shall maintain a list of certified operators specified in requirement 5.4.2h.

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

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

l. Records specified in the requirement 5.4.2k 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 ensure that all processes are carried out under controlled conditions using test facilities, measuring equipment, servicing equipment and environmental conditions meeting all process 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 ensure 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 define 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 establish, document and implement an environmental control programme, as a minimum for temperature, relative humidity and differential pressure, to ensure conformance with the levels specified in clause 5.3.1 of ECSS-Q-ST-70-01.

b. In addition to environmental parameters specified in the requirement 5.5.2a, the space test centre shall assess the impacts of other parameters specified by the customer that affect the test specimen's environmental conditions or the test results.

NOTE These parameters can include among others 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 These supplies can include among others gases and liquids to support the test process.

d. The environmental control programme specified in the requirement 5.5.2a shall document how to achieve, measure and maintain the applicable environmental control parameters throughout the space test centre.

e. 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.

f. 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 clause 5 of 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.

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 identify restricted areas, and implement a system for their security and access control.

NOTE Example of restricted areas are cleanrooms, areas for storage of sensitive documentation, and 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 facilities

5.6.1 Design and development of test facilities

a. The space test centre shall establish and maintain documented procedures to:

1. control and verify the design and development of existing and new test facilities;
2. control and verify the modification of test facilities in compliance with requirements from the clause 5.6.2;
3. control and verify the software used in the test process;
4. verify the operation of the test facilities;
5. demonstrate that the test facilities meet the specified performance requirements.

b. The space test centre shall identify and plan all phases of the test facilities development and related processes.

NOTE Phases of test facility development include design, planning, reviews, installation, commissioning and acceptance.

c. The activities specified in the requirement 5.6.1b shall be performed in cooperation among engineering, quality and safety assurance staff.

d. The space test centre shall demonstrate that processes specified in the requirement 5.6.1b are carried out under controlled conditions, including

conformance to applicable standards specified in business agreements, codes, legislation, quality and safety plans or documented procedures.

e. The space test centre shall demonstrate that personnel are trained on the maintenance and operation of the new or modified test facility.

f. The space test centre shall specify the requirements for any verification and validation of test facilities or parts of them.

g. Records shall be maintained for verified and validated test facilities.

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 acceptance and revalidation after software updates.

i. 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.

5.6.2 Configuration control of test facilities

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 configuration item list for each test facility and associated equipment.

c. The configuration item list specified in the requirement 5.6.2b shall include as a minimum:

1. all software used,
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 establish and maintain a declared materials list for each thermal vacuum test facility.

NOTE The facility declared materials list applies only to materials exposed to vacuum.

g. Records shall be maintained for all items of test and measurement equipment, including at least:

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.

5.6.3 Calibration control of test facilities

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 the International System of Units.

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 standards used to perform the calibration.

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

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 5.6.3d 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. If the calibration activity is outsourced to a lower tier supplier, the space test centre shall specify the requirements to the 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. If the requirement 5.6.3h is not met, the space test centre shall justify the lower tier supplier selection.

j. The space test centre shall perform the acceptance 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 available.

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

5.6.4 Maintenance control of test facilities

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

d. The space test centre shall perform the acceptance 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 available.

g. The maintenance records specified in requirement 5.6.4f shall contain as a minimum:

1. the description of the work performed,
2. any relevant measurements, and
3. the date and the responsible space test centre personnel or lower tier supplier performing the maintenance activity.

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

i. The procedure specified in requirement 5.6.4h shall contain as a minimum the verification method, the pass or fail criteria and the periodicity.

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

5.6.5 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.

b. The risk assessment shall 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.

5.6.6 Dependability of test facilities

a. A dependability analysis shall be performed including all equipment and subassemblies of the test facility.

NOTE Example of a dependability analysis is a failure modes, effects and criticality analysis (FMECA). For the methodology to perform a FMECA, refer to ECSS-Q-ST-30-02.

b. Critical items shall be identified as a result of the analyses specified in requirement 5.6.6a and the requirements of clause 5.6.5.

c. For critical items specified in the requirement 5.6.6b a mitigation action plan to reduce the criticality shall be identified and implemented before its further use.

NOTE Refer to ECSS-Q-ST-10-04.

d. The analyses specified in requirement 5.6.6a and the requirements of clause 5.6.5 shall be performed for each new facility, reviewed after each facility upgrade or modification, and updated when effecting a change in the operation, functional performance or interfaces of the facility.

e. The space test centre shall monitor and record all test facility failures.

NOTE The following items need monitoring:

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

f. The space test centre shall perform a failure trend analysis according to a defined method and periodicity.

NOTE Trend analyses can include data coming from:

- the assessment of tests performed in a given period regarding test duration and test conditions,
- a review of the maintenance activities performed, and the root cause analyses of non-conformances.

5.7 Test process realization

5.7.1 Planning of the test process

a. The space test centre shall establish and maintain documented procedures to verify the test planning, test preparation, test execution and test related hardware and infrastructure so that the specified requirements of the customer are met.

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.

5.7.2 Evaluation of customer requirements

a. The space test centre shall define the procedure for the review of requirements of routine, repetitive and new or complex tasks.

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

c. The review specified in 5.7.2b shall cover any work that is outsourced by the space test centre.

5.7.3 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 5.7.3a 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 5.7.3a are carried out under controlled conditions, including 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 throughout each test campaign;
2. conformance to applicable standards specified in the business agreements, 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;
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.

d. The planning shall demonstrate the compatibility of the design of the test processes with the infrastructure, the test facilities, the test execution, and the applicable test procedures.

e. 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.

f. Records shall be maintained for verified and validated processes.

g. 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.

h. The space test centre shall assess the risks of the test process, performed with methodologies agreed by the quality and safety representative.

NOTE The risk assessment includes both technical and programmatic risks.

5.7.4 Test process and service provision

5.7.4.1 Facility test report

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

b. The facility test report shall 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 uncertainty, where relevant,
10. the agreed confidentiality level.

5.7.4.2 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.

b. The following shall be used as inputs by the test centre, for the identification of needs specified in 5.7.4.2a:

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.

c. Prior to the actual test run, the space test centre shall document the applicable inspections or tests and the records to be established.

5.7.4.3 Test specimen

a. The identification of the test specimen and associated test items shall be retained throughout all stages of work to ensure continued configuration control.

b. The space test centre shall ensure that all specified interfaces between the test facility and test specimen are available.

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 activity carried out by the space test centre on the test specimen shall be authorized by the customer.

f. 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.

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

5.7.4.4 Handling, storage, transportation and preservation

a. The space test centre shall implement handling, storage, transportation and preservation of the test specimen and associated test equipment in conformance with the requirements from clause 4 to clause 7 of ECSS-Q-ST-20-08, and in agreement with the customer.

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

c. Access control to the storage area shall be established to provide as a minimum the same security level as in working areas.

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 5.7.4.4e shall be available to the customer.

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

5.8 Monitoring and measurement

5.8.1 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 shall be performed by the space test centre before each test 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 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,
   (i) nonconformances, waiver and deviations that can affect the test,
3. personnel qualification and availability,
4. ground support equipment (GSE) dedicated to the test and infrastructure readiness,
5. test specimen (in case responsibility has been contractually transferred to the space test centre),
6. results from pre-tests (dry-runs, rehearsals), and
7. 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.

NOTE The declaration of facility readiness can also be called a facility readiness report.

g. The facility shall not be declared ready until so authorized 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 from clause 4 to clause 7 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 facility data to the PTR board including, as a minimum,

1. test facility data packages,
2. nonconformances and related dispositions,
3. declaration that test facility data meet customer requirements.

5.8.2 Control of nonconformances

a. The nonconformance control programme shall be performed in conformance with requirements from clause 5 and clause 6 of 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 5.8.2e 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.

5.8.3 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, defining:

1. use of lessons learned as input to its future activities,
2. use of the outcome from the lessons learned review to determine appropriate actions.

5.9 Safety

5.9.1 Safety programme

5.9.1.1 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.

5.9.1.2 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 or incident,
   3. The description of the responsibilities and authorities in all accident, incident and emergency procedures.

5.9.2 Safety policy and objectives

a. The space test centre management shall define the space test centre safety policy, including a commitment to safety in the space test centre.

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

c. The space test centre shall demonstrate that the safety policy is known and 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 5.9.2d are reviewed periodically.

5.9.3 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 specified in 5.9.2,
5. the responsibilities and authorities of all space test centre personnel with regards to safety,
6. applicable safety procedures and instructions,
7. applicable accident/incident and emergency procedures specified in 5.9.1.2.

5.9.4 Safety management of test campaigns

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, containing as minimum the information specified in the DRD from the Annex A.

c. 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.

d. The information from the questionnaire specified in the requirement 5.9.4b shall be recorded and processed as input data for the design and verification of the test process, in addition to the standard safety precautions.

e. 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.

f. The space test centre shall perform a safety risk assessment for each test campaign.

g. 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 dossier, including:

1. records of risk assessment for the test campaign, including the actions performed to eliminate or reduce the risks to an acceptable level,
2. the space test centre safety questionnaire,
3. all supporting safety documentation,
4. records of safety reviews,
5. records of safety briefings to the test personnel, including records of attendance,
6. records of dry runs, when these are identified as an action from the safety risk assessment for the test campaign,
7. test specific safety procedures,
8. test specific emergency procedures,
9. evidence that all safety actions are closed prior to the test execution,
10. identification and planning the need for specific medical, rescue or other specialized personnel on stand-by during the testing activities with known hazardous operations.

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

i. Prior to each test campaign, the space test centre shall provide a safety briefing to customers, including as a minimum:

1. safety and emergency procedures and instructions,
2. use of personal protective equipment,
3. contacts of space test centre personnel in case of emergency,
4. location of safety and emergency equipment,
5. evacuation procedure and assembly points.

NOTE The space test centre can organize additional safety briefings to customers to account for specific safety risks.

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 5.9.4b.

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.

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.

A.2.2 Special remarks

None.

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	5.7.1 Planning of the test process 5.7.2 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	5.6.5 Risk assessment of test facilities 5.6.6 Dependability of test facilities 5.7.1 Planning of the test process 5.7.3 Design and development of the test process
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	5.6.5 Risk assessment of test facilities 5.6.6 Dependability of test facilities 5.7.2 Evaluation of customer requirements

Project step	Task	EN 9100:2009 subclause	ECSS-Q-ST-20-07 clause (delta)
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 notes and documents, plans and procedures for realization, verification and validation, and safety plan.	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	5.6.2 Configuration control of test facilities 5.7.3 Design and development of the test process 5.7.4.2 Validation of the test process and service provision
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	5.7.2 Evaluation of customer requirements 5.6.5 Risk assessment of test facilities 5.6.6 Dependability of test facilities 5.7.4.2 Validation of the test process and service provision
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	5.6.3 Calibration control of test facilities 5.6.4 Maintenance control of test facilities
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	5.6.2 Configuration control of test facilities 5.7.4.2 Validation of the test process and service provision 5.7.4.3 Test specimen

Project step	Task	EN 9100:2009 subclause	ECSS-Q-ST-20-07 clause (delta)
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	5.7.4.2 Validation of the test process and service provision
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	5.7.4 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	5.6.5 Risk assessment of test facilities 5.6.6 Dependability of test facilities

Bibliography

ECSS-S-ST-00	ECSS system - Description, implementation and general requirements
ECSS-M-ST-80	Space project management - Risk management
ECSS-Q-ST-10-04	Space product assurance - Critical-item control
ECSS-Q-ST-30-02	Space product assurance - Failure modes, effects (and criticality) analysis (FMEA/FMECA)