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Space systems — General test requirements for launch vehicles

Systèmes spatiaux — Exigences générales d'essai pour véhicules lanceurs

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 24917:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

— correction of terms and definitions according to other existing standards;

— modification of the “Flight vehicle development test structure” (Figure 1);

— modification of the “Requirements applicability matrix” (Annex B).

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides space launch vehicle customers, contractors and manufacturers with general requirements for test types and programmes for space launch vehicles and rocket units (modules) for use in the documentation associated with their test activity.

This document is intended to help reduce the development time and cost of space launch vehicles and rocket units, and to enhance their quality and reliability through the use of common, optimized and approved requirements in the space launch vehicle test scope and organization.

Space systems — General test requirements for launch vehicles

1 Scope

This document establishes general test requirements for launch vehicles equipped with liquid-propellant engines, launched from stationary ground-, sea- and air-based launchers, in all phases of their development.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14302, *Space systems — Electromagnetic compatibility requirements*

ISO 14303, *Space systems — Launch-vehicle-to-spacecraft interfaces*

3 Terms and definitions

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

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

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

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

3.1
space-rocket complex
set of *flight vehicles* (3.2) with functionally relative technical facilities intended for transportation, storage, maintenance service, preparation, launching and flight control of flight vehicles with payload

3.2
flight vehicle
launch vehicle (3.3) including space *nose section* (3.6)

3.3
launch vehicle
vehicle designed to transport payloads to space

[SOURCE: ISO 10795:2019, 3.139, modified — The preferred term "launcher" has been removed.]

3.4
unit
lowest level of hardware assembly for which *acceptance* (3.26) and *qualification tests* (3.25) are required

[SOURCE: ISO 15864:2004, 3.1.13]

3.5
orbital stage
stage of *flight vehicle* (3.2) capable of injecting payloads into their planned orbit from the sub-orbital trajectory that resulted from operation of lower stages

3.6
nose section
set of a *fairing* (3.7) and fairing adapter

3.7
fairing
technical device intended to protect a spacecraft or a space *nose section* (3.6) from external influences during transportation on a launcher, and to keep it on trajectory when launching into orbit

3.8
integration site
equipment and facility designed for *launch vehicle* (3.3) storage, assembly, testing, preparation, maintenance, servicing and preparation for transportation to the *launch pad* (3.9)

[SOURCE: ISO/TR 17400:2003, 3.1]

3.9
launch pad
equipment and facility designed to provide for the pre-launch and launch operations of spacecraft

[SOURCE: ISO/TR 17400:2003, 3.3]

3.10
statement of work
contractual document prepared during project initiation and planning that describes what the project needs to deliver and outlines all work required to complete the project

[SOURCE: ISO 10795:2019, 3.229]

3.11
technical specification
specification expressing technical requirements for designing and developing the solution to be implemented

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

[SOURCE: ISO 10795:2019, 3.238]

3.12
test metrological support
establishment and application of scientific and organizational foundations, technical facilities, rules and standards necessary to achieve the measurement traceability, precision, completeness, operativeness and the reliability of parameters control and technical performance characteristics of items

3.13
development test programme plan
obligate organizational and methodological document which specifies the *test object* (3.23) and objectives, types, sequence and scope of experiments, order, conditions, place, time, support of test, test reporting and responsibilities for test support and performance

3.14
reliability assurance programme plan
document specifying a set of requirements and measures aimed at providing and controlling the satisfaction of requirements established in the *statement of work* (3.10) for a space *launch vehicle* (3.3) and its components' reliability during their development

3.15
development test
test to provide information that can be used to check the validity of analytic techniques and assumed design parameters, uncover unexpected system response characteristics, evaluate design changes, determine interface compatibility, prove qualification and acceptance procedures and techniques, check manufacturing technology, or establish accept/reject criteria

[SOURCE: ISO 10786:2011, 3.17]

3.16
safety assurance programme plan
document which establishes a set of requirements and measures aimed at assuring that all safety risks associated with the space *launch vehicle* (3.3) design, development, manufacture and use are accordingly identified, assessed, minimized, controlled and accepted

3.17
communications systems programme plan
document establishing the structure of communication systems (including telemetry measurement, command and tracking communication lines, etc.) hardware born set on *launch vehicle* (3.3), *launch pad* (3.9) and positioned along the flight route necessary for performance the measurement requirements, location and orientation of sensors and their characteristics, frequency bands, minimal frequency of sensor scanning

3.18
flight test
test in real conditions of the functioning and performance of target tasks

3.19
prototype model
item produced in the research and development process applying the newly developed working engineering and technological documentation for test verification of the conformity of its parameters and characteristics with the requirements specified in *statement of work* (3.10) to research and development and correctness of adopted technical solutions

3.20
model
test mock-up
structurally, or physically, or structurally and physically similar item presenting a simplified reproduction of a *test object* (3.23) or its part intended for testing

3.21
structural model
model (3.20) representing the structural flight characteristics

3.22
electrical model
model (3.20) representing the electrical flight characteristics

3.23
test object
item under test

3.24
test type
classified test grouping identified according to a certain attribute

3.25
qualification test
required formal contractual test used to demonstrate that the design, manufacturing, and assembly have resulted in hardware designs conforming to specification requirements

[SOURCE: ISO 14623:2003, 2.52, modified — The term has been changed to singular form.]

3.26
acceptance test
required formal test conducted on flight hardware to ascertain that the materials, manufacturing processes and workmanship meet specifications and that the hardware is acceptable for intended usage

[SOURCE: ISO 14623:2003, 2.2, modified — The term has been changed to singular form.]

3.27
operational test
test conducted at the *launch vehicle* (3.3) site in an operational environment, with the equipment in its operational configuration

3.28
critical unit
unit (3.4) whose failure can affect the system operation sufficiently to cause the failure of the stated vehicle objectives or a partial loss of the mission, or whose proper performance is essential from a safety standpoint

3.29
pyrotechnic device
device or assembly containing, or actuated by, propellants or explosives, with the exception of large rocket motors

EXAMPLE Initiators, ignitors, detonators, squibs, safe and arm devices, booster cartridges, pressure cartridges, separation bolts and nuts, pin pullers, linear separation systems, shaped charges, explosive guillotines, pyrovalves, detonation transfer assemblies (mild detonating fuse, confined detonating cord, confined detonating fuse, shielded mild detonating cord, etc.), through-bulkhead initiators, mortars, thrusters, explosive circuit interrupters, and other similar items.

[SOURCE: ISO 26871:2012, 3.1.31]

4 Abbreviated terms

CSP	communications systems programme plan
CTS	control and test station
DTP	development test programme plan
EMC	electromagnetic compatibility
FTP	flight test programme plan
FV	flight vehicle
IS	integration site
LPRE	liquid-propellant engine
LS	launching site
LV	launch vehicle

OCN	on-board cable network
OS	orbital stage
PHS	pneumatic/hydraulic system
RAP	reliability assurance programme plan
SAP	safety assurance programme plan
SC	spacecraft
SNS	space nose section
SOW	statement of work
SRC	space-rocket complex

5 Testing philosophy

5.1 Objectives, tasks and principles of development test for launch vehicle and its units

5.1.1 Development test

A development test is one of the methods of verification which guarantees that all characteristics of the FV meet the requirements of the SOW. The FV is tested in the SRC during the launch preparation for test flight.

The development test of an FV and units of an LV includes ground development test phases and a flight test. The complete test programme for launch vehicles, upper stage, encompasses development, qualification, acceptance, pre-launch validation and follow-on operational test and evaluations. The test programme encompasses the testing of progressively more complex assemblies of hardware and computer software. Generally, the FV development test structure may be represented as a scheme in compliance with ISO 14300-1 (see Figure 1).

5.1.2 Objectives

5.1.2.1 Objectives of ground development test

The main objective of a ground development test is to verify the FV preparation technology for launch and launch itself, preliminarily to verify and evaluate the implementation of the specified parameters and characteristics, operation and interaction of the FV and its components when the operation conditions are being simulated (or under effect of these conditions).

5.1.2.2 Objectives of flight test

The main objective of a flight test is to comprehensively check the FV serviceability and confirm the SOW-specified requirements for the space rocket complex under real operation conditions.

5.1.2.3 Objectives for reliability and safety programmes

One of the main objectives of the LV (OS) ground development test is to achieve the SOW-assigned levels of reliability and safety indexes before flight test commencement and confirm these during the flight test. The reliability and safety index levels are normalized in the RAP and SAP, the latter including an environmental safety guarantee.

5.1.2.4 Objectives of test for launch vehicle and its units

The main objectives of the development test of an FV, LV and its units are as follows:

a) verification of unit structure strength, rigidity, confirmation of rocket module parameters, verification of equipment mechanical loading regimes;

b) breadboarding;

c) test of technological cycle of preparing FV for launch and launch itself;

d) comprehensive verification of units functioning during launch and propulsion systems operation in the assigned regimes;

e) verification of the ground technical means/launch vehicle compatibility;

f) test of FV interfaces [LV, upper stage vehicle, spacecraft (SC)];

g) confirmation of the correctness of adopted engineering solutions;

h) verification of the sufficiency of measuring aids and telemetry data processing techniques;

i) individual tests of all FV components;

j) verification of operation convenience;

k) personnel training.

5.1.3 Test planning

The tasks to be solved during LVs testing are identified according to the design, assigned characteristics, LV test maturity, design (modernization) novelty, dedicated operation conditions change and are presented in the test programmes.

5.1.4 Organization and test sequence

The organization and order for conducting the development test are determined by the comprehensive development test programme plan.

5.1.5 Development test programme plan

5.1.5.1 Planning

In order to meet the assigned LV (OS) characteristics requirements, the supplier plans a development test.

5.1.5.2 Initiation of the programme

The comprehensive development test programme plan is developed in accordance with the LV (OS) hierarchical structure. The main starting documents for developing the FV development test programme are the statement of work, the preliminary project and the reliability assurance programme.

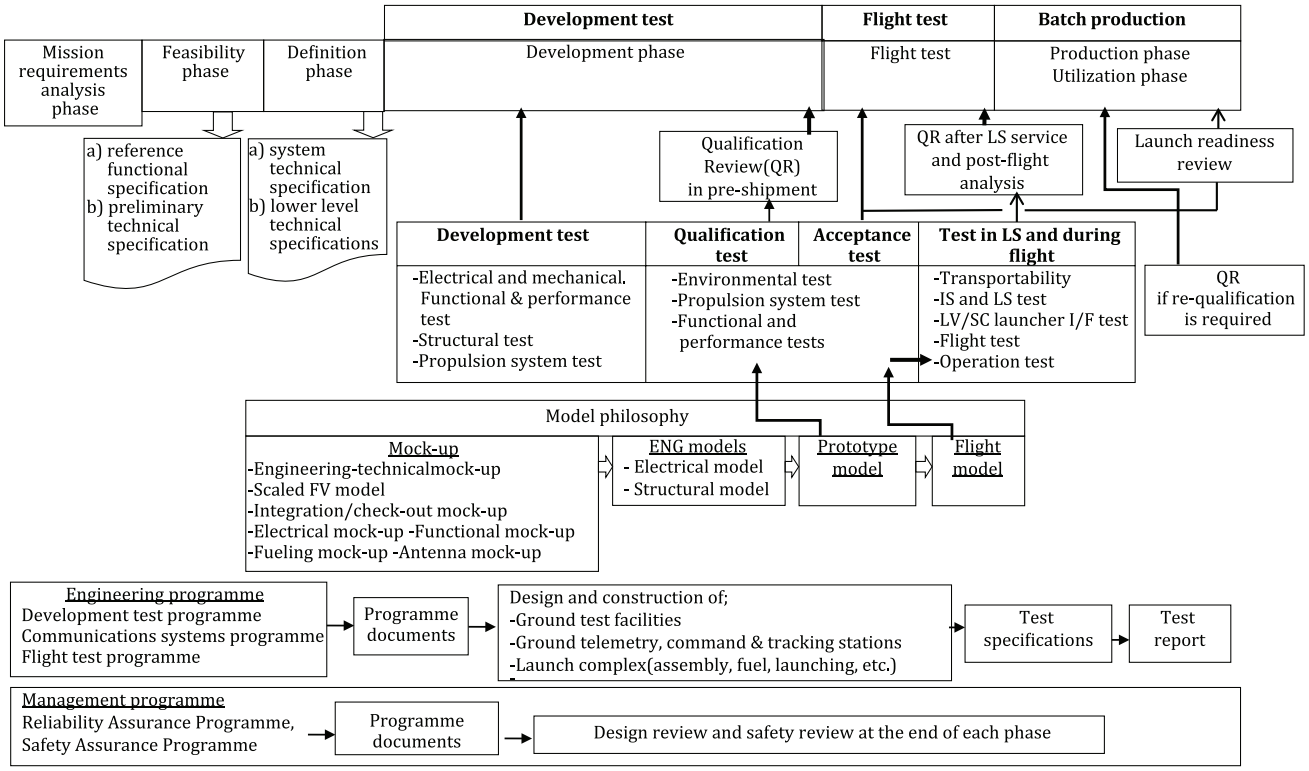

Figure 1 — Flight vehicle development test structure

5.1.5.3 Contents of development test programme plan

The FV comprehensive development test programme is a common system of independent, particular programme-technical documents, identifying the individual test objectives and scope, establishing the criteria of OS or LV completeness and readiness for transferring to higher test levels.

The test sequence, scope and object, controlled characteristics, types of test and test phasing in the course of LV (rocket unit) development are assigned by the LV (rocket unit) manufacturers-contractors in the comprehensive development test programme, other test programmes.

5.1.5.4 Principles of development test programme plan

The LV (OS) development test programme plan (DTP) is based on the following principles:

a) system approach to the test planning with a detailed coordination of all types and phases of test; absolute assurance and confirmation of the assigned characteristics of the SRC items during ground test; use of results of optimizing the complex systems functioning as a component of other complexes;

b) fulfilment of the main test work scope applying test facilities (stands, rigs, models, etc.) before starting ready-made (standard) LV (OS) test under real operation conditions (full-scale test);

c) confirmation of all-round interaction of all FV components and demonstration of their functioning reliability under full-scale conditions, as well as conduct of that part of test applying test means which cannot be technically performed or are economically inexpedient within the assigned time during the flight test, and on the basis of the following provisions:

   1) determination of nomenclature and characteristics of modified and newly developed test stands (rigs) on condition that they would assure fulfilment of the planned test types and scopes;

   2) use (if necessary with updating) of test facilities, stands and technological fittings developed for previous items;