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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	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviated terms	4
5 Testing philosophy	5
5.1 Objectives, tasks and principles of development test for launch vehicle and its units.....	5
5.1.1 Development test.....	5
5.1.2 Objectives.....	5
5.1.3 Test planning.....	6
5.1.4 Organization and test sequence.....	6
5.1.5 Development test programme plan.....	6
5.1.6 Effects of implementation of principles.....	9
5.2 LV and rocket unit test types during their development.....	10
5.2.1 Tests in development phase.....	10
5.2.2 Test in routine production phase.....	11
5.2.3 Test for units.....	12
6 Test type and programme requirements	12
6.1 Test object and type requirements.....	12
6.1.1 Engineering and engineering technological breadboarding.....	12
6.1.2 Integration/check-out mock-up test.....	13
6.1.3 Electrical mock-up test.....	14
6.1.4 Fuelling mock-up test.....	14
6.1.5 Antenna mock-up test.....	15
6.1.6 Static load test.....	16
6.1.7 Vibration test.....	16
6.1.8 Acoustic test.....	16
6.1.9 Shock load test.....	17
6.1.10 Cold test of rocket units.....	17
6.1.11 Hot firing test.....	18
6.1.12 Electromagnetic compatibility (EMC) test.....	19
6.1.13 Climatic test.....	20
6.1.14 Fire and explosion safety test.....	20
6.1.15 Lightning and statics resistance test.....	20
6.1.16 Transportability test.....	21
6.1.17 Lifetime test.....	21
6.1.18 Test at integration site and launching site.....	22
6.1.19 Flight test.....	23
6.1.20 LV components disposal requirements.....	24
6.1.21 Batch production test.....	24
6.2 General requirements to development test programme and individual test programme.....	25
6.2.1 Contents of development test programme plan.....	25
6.2.2 Test programme plans for test models.....	27
6.2.3 Requirements for test methods established by test programme plans.....	27
6.2.4 Contents of test programme plans.....	27
6.2.5 Requirements for communications systems programme plan.....	27
6.3 General test object requirements.....	28
6.3.1 Test objects.....	28
6.3.2 Documentation for test objects.....	28
7 Criteria	28

8 Reporting	29
Annex A (informative) Manufacturing stage, item categories and test categories	30
Annex B (informative) Requirements applicability matrix	31
Annex C (informative) Typical test report contents	33
Annex D (informative) Typical test programme plan contents	34
Bibliography	37

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Foreword

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

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

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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.

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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 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.