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Space systems — Space launch complexes, integration sites and other facilities — General testing guidelines

Systèmes spatiaux — Complexes de lancement spatial, sites d'intégration et autres installations — Lignes directrices pour les essais

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

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

This second edition cancels and replaces the first edition (ISO/TR 17400:2003), which has been technically revised.

The main changes compared to the previous edition are as follows:

— in the document all recommendations (“should”) were replaced by other verbs (“is”, “are”), all permissions (“may”) were replaced by “can”;

— the term “main system” was updated;

— 3.1, 5.5, 6.3.3, 6.6.5, 6.6.8 were specified according to comments and proposals of the subcommittee experts.

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

The purpose of this document is describing the uniform practices for organizing the tests and promoting verification of all parameters and characteristics of various launch complexes. It is necessary to define the functions and to coordinate the activities of all the test participants, namely, the developers of complexes and systems, the manufacturers of systems and equipment, the organizers of tests, the customer, and others.

This document describes test activities and lists who will be responsible for the testing at launch pad and integration sites for launch vehicle and spacecraft.

Space systems — Space launch complexes, integration sites and other facilities — General testing guidelines

1 Scope

This document is applicable to new projects and programs and to redesigned and upgraded launch pad and integration sites. This document describes the testing phases, goals, and general aspects for launch space complexes and complexes for assembly and tests of a vehicle and spacecraft and the associated equipment that, after successful testing, will be ready for launch vehicle processing and launch. This document can be applied to the creation of international launch pad and integration sites. At creation of new launching space complexes and complexes for assembly and tests of a vehicle and spacecraft (or at their modernization) within the framework of one country, the rules established by that country can be applied.

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 9000, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000 and the following apply.

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

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

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

3.1
integration site
equipment and facility designed for launch vehicle storage, assembly and testing, and launch vehicle (space rocket) and spacecraft/payload(s) integration, post-integration testing, and launch preparation, maintenance, servicing and preparation for transportation to the *launch pad* (3.3)

3.2
international launch pad and integration sites
land, ground/airborne/marine facilities, equipment, utilities, and infrastructure, created with the cooperation of several countries or the entities that belong to more than one country, necessary for the launch operations of launch vehicle and payload and for in-flight operations during the launch phase

3.3
launch pad
equipment and facility designed to provide for the pre-launch and launch operations of spacecraft

3.4
end-to-end testing
launch pad (3.3) or *integration site* (3.1) development phase including the testing and evaluation of its overall readiness to support a launch vehicle and a spacecraft

3.5
support system
integral part of the launch complex or *integration site* (3.1), which ensures the functioning of technological units (systems) and the conditions of normal life of the operating personnel

3.6
main system
constituent part of *launch pad* (3.3) or constituent part of *integration site* (3.1) primarily responsible for providing preparation and launch of a launch vehicle or spacecraft

3.7
main system factory testing
launch pad (3.3) or *integration site* (3.1) development phase that includes the testing of a completely assembled and checked out *main system* (3.6) to determine its operational readiness to be shipped to the operational launch pad or integration site for further testing or operation

3.8
main system field testing
launch pad (3.3) or *integration site* (3.1) development phase including the testing of an assembled, fully equipped, and checked out (or factory tested) *main system* (3.6), which is conducted at the operational launch pad or integration site to determine the system readiness for further testing or operation

3.9
test supervision team
acceptance team
group of experts formed by the customer (organization, company, etc.) with the goal of coordinating work during specific testing or acceptance phases

4 General characteristics

4.1 Testing of launch pad and integration sites and the main systems is conducted in accordance with the regulatory and design documentation specifications.

4.2 The test supervision team coordinates use of the launch pad and integration site and the system testing process and work management.

4.3 The launch pad and integration site developer provides technical management during the launch pad and integration site and system testing.

4.4 Appointments to test supervision and acceptance team are determined according to company or agency recommendations before the beginning of a related testing phase.

Customer representatives participate in team activities and sign respective documents in the event the representatives are employees of the company or agency.

4.5 As an option, customer representatives, participating in the testing, work in a joint control and acceptance group (JCAG). JCAG functions are determined in agreements developed by the customer.

4.6 The system testing and acceptance team has the authority to convene representatives of design and unit manufacturing organizations. These representatives are involved in:

— factory testing (the system manufacturing organization);

— field testing (the test organization);

— end-to-end testing (the team chairman).

4.7 Depending on the results of the analysis of malfunctions or failures found in the course of testing, the team has the authority to:

— continue testing without repeating the operations completed earlier;

— repeat the testing starting with a specific phase;

— repeat the testing from the beginning;

— stop testing before finding out the cause of the failure.

4.8 If failures occurred in the testing or the system was subjected to changes, the test supervision team has the authority to increase the scope of testing as necessary.

4.9 The test supervision team has the authority to suspend or terminate testing in the event of the following situations:

— occurrence of an emergency posing a hazard to personnel safety;

— failures;

— systems revealed to be out of conformance with the design specifications or documentation.

In these cases, the team reports to the body that appointed the team indicating the reasons for such a termination (suspension) and provides the necessary documentation.

4.10 Testing suspended in accordance with 4.9 can be restarted only upon permission from the body that appointed the team.

4.11 Personnel permitted to perform testing have the skills required to operate the main systems within the range of their operational duties and have passed tests on the knowledge of the equipment, its operating instructions, safety regulations, and test programs and procedures.

4.12 Personnel working in hazardous conditions or with harmful substances undergo a medical examination prior to commencement of duties and annually thereafter.

4.13 Prior to the start of the tests or work at the site, measures are taken to ensure the safety of the operating personnel and the environment.

4.14 The organization ensures safety requirements are observed and appropriate safety documents are maintained.

4.15 During system testing and acceptance, interested organizations can conduct experimental and research projects under special programs.

4.16 In the event experimental and research activities require the use of mock-ups of launch vehicles, spacecraft, or testing equipment, the special programs and reports are cleared with the space complex development organization.

4.17 Those main system items that fail during the tests are replaced upon the team decision.

4.18 When any test fails, the cause of the failure is established and eliminated.

4.19 Verify that the cause of the failure has been eliminated and continue testing:

— in case of a first-time (including independent elimination) failure - test team chairman, the tests continue from the moment of the termination;

— in case of recurrence of the same failure - test team chairman, the amount of retest is determined by the test team chairman depending on character of failure;

— in case of occurrence of the same failure in a third time - enterprise-developer of the main system together with the enterprise-manufacturer and representative customer, the tests are completely repeated. The differences among the developer of the main system, manufacturer, and representative customer are resolved by the developer of the launch pad (integration site) and customer.

4.20 Malfunctions and failures identified in the course of testing are eliminated by the organizations responsible for the cause of these malfunctions and failures.

4.21 During test preparation, performance, and finalization and during the acceptance of the launch pad and integration sites, main systems, and facilities, the organization in charge of the related work processes reports under the procedure established in accordance with its respective national aerospace industry practices.

4.22 The final decision on the results of the main system test and acceptance for operation is made by the launch pad and integration site developers.

4.23 During the testing of main systems, a test log is maintained. The following is entered into the log:

— list of completed operations;

— test progress report;

— defects, malfunctions, failures, deviations or functioning irregularities of the main system found during testing;

— methods for correcting the defects, malfunctions and failures;

— information on fine tuning or adjustments that were made;

— information about replaced components;

— main system nonconformities with the design documentation specifications;

— main system operating times on a daily or per-operation basis;

— decisions regarding test programs and/or procedure updates;

— suggestions for main system design and schemes improvement.

4.24 The main system and the changes required for the elimination of failures are implemented on the basis of the design documents authorizing the changes. If necessary, the design documentation is changed.

4.25 The procedure and timing for the submission of claims for faulty or incomplete main systems or for poor quality are established in accordance with the regulations accepted in the respective national space industry.

4.26 Companies finalize (approve and adopt) test programs and procedures within 30 calendar days of receipt (or agreed specified date between related organizations).

4.27 In performing the facility and assembly work, the test organization and the chief engineering system and facilities development organization, on a regular basis, ensure job quality control, building code compliance control, technical specification conformance control, and design document requirement conformance control. Experts from the operations or test organizations and the customer are involved in the control.

5 Testing and acceptance phases and goals for launch pad and integration site

5.1 Testing phases

The following main system and launch pad and integration site testing phases are adopted:

— main system factory testing;

— main system field testing;

— launch pad and integration site end-to-end testing (including space complex flight testing).

If necessary or on demand of the customer, other extra phases of tests are possible also.

5.2 Acceptance phases

The following main system and launch pad and integration site acceptance phases are adopted:

— main system acceptance after factory testing;

— main system and facility acceptance after field testing;

— launch pad and integration site acceptance after end-to-end testing.

5.3 Facility testing and acceptance

Facility testing and acceptance are accomplished in conformance with the established respective national aviation and space industry practice and the facility specifications.

5.4 Main system factory testing

Main system factory testing is conducted to verify the main system conformance to the design specifications and documentation, the operational readiness requirements, the main system acceptance by the customer's representatives, and system readiness for shipping to the assembly launch pad or integration site for further testing. The goals of the main system factory testing are:

— verification of main system completeness;

— verification of main system operational readiness and functioning interfaces and conformance to the design specifications and documentation;

— verification of the correct interaction and functioning of the item;

— verification of system compatibility and operation with the components of the launch vehicles, spacecraft, and main systems of the launch pad, as necessary;

— verification of the accuracy of the adopted design approaches;

— verification of the feasibility of the assembly process;

— verification of the serviceability of the protective devices and electrical interlocks in emergency modes;

— verification of the main system operational readiness and strength at the extreme parameter values indicated in the design specifications;

— verification of the adequacy and completeness of operations documentation;

— verification of the adequacy and applicability of the tools, devices, and instruments required for the main system operation;

— verification of the adequacy of the operational safety provisions;

— verification of maintenance and repair accessibility;

— verification of the quality of manufacturing, assembly, and checkout;

— dating the scope of the main system field testing;

— verification of transportability;

— evaluation of the main system's reliability;

— verification of the availability of component reliability documents (for experimental items only);

— verification of test metrological support.

5.5 Main system field testing

The main system field testing is conducted for the purpose of verifying main system operational readiness and determining system readiness for end-to-end testing (in the event the main systems are designated to undergo the end-to-end testing) or commissioning, if main systems aren't designed to undergo the end-to-end testing. The main system field testing goals are:

— verification of main system completeness;

— verification of main system assembly and checkout quality;

— verification of main system operational readiness and functioning interfaces and conformance to the design specifications and documentation;

— verification of the main system compatibility and operation with the launch pad and integration site's other main systems and facilities, as necessary;

— verification of the adequacy of the main system operation safety instructions indicated in the operations documentation;

— verification of maintenance and repair accessibility;

— verification of the human habitability conditions (lighting, ventilation, heating, harmful gas content, etc.);

— verification of the adequacy of the operations personnel;

— verification of the efficiency of modifications made based on the factory test results;

— verification of the sufficiency and serviceability of the tools, devices, and instruments required for main system operation;

— evaluation of the main system's reliability;

— verification of test metrological support;

— systems readiness assessment for end-to-end testing or commissioning, if systems aren't designed to undergo the end-to-end testing.

5.6 Launch pad and integration site end-to-end testing

The end-to-end testing is conducted for the purpose of verifying the launch pad and integration site operational readiness and determining the launch pad and integration site readiness for launch or other subsequent tests (if necessary). The end-to-end launch pad and integration site testing goals are:

— verification of the launch pad and integration site operational readiness and its conformance to the design specifications and documentation during standard operations involving launch vehicles

and spacecraft under conditions closely approximating those conditions of actual operations but in which testing does not require the actual launching of a launch vehicle;

— verification that the launch pad and integration site is complete;

— verification and update of the operational sequences of the main items during launch vehicle preparation, launch, aborted launch, and preparation for a post-abort launch;

— verification and update of the time requirements for the main system operational procedures;

— verification of the accuracy of the adopted design approaches;

— verification of the compatibility of the main systems in the process sequences as well as with launch vehicles and spacecraft;

— verification and update of the requirements and skill level of the operations personnel;

— verification and update of the completeness and adequacy of the operations documentation;

— verification of the adequacy of the safety maintenance of the launch pad and integration site and main systems, including emergency situations;

— evaluation of the supply of spare parts and tools;

— update of the procedure for launch pad and integration site maintenance and post-launch refurbishment;

— verification of the adequacy of the measures taken to eliminate failures and malfunctions based on the results of previous and end-to-end testing;

— evaluation of launch pad and integration site reliability;

— verification of metrological support.

6 General characteristics for testing and acceptance

6.1 General considerations

Nature of the testing toward acceptance of the launch pad and integration launch pad and integration site and the duties of each participating organizations are described generally in this section. Exact definition of the acceptance condition, testing, and the duties of the participating organizations are identified in the individual contract document.

6.2 Test and acceptance procedure

The following procedure is adopted for test and acceptance:

a) facility and support system test and acceptance are conducted in accordance with the national aviation and space industry practice;

b) factory main system test;

c) main system acceptance after factory test;

d) main system field testing;

e) main system and facility acceptance after field test;

f) end-to-end testing;

g) launch pad and integration site acceptance for operation as part of the space complex.

6.3 Main system factory testing

6.3.1 The factory test team is formed by the manufacturing organization at least 30 calendar days prior to the beginning of testing (or agreed specified date between related organizations).

6.3.2 During the factory testing involving individual items of the launch vehicle, spacecraft, and other main systems, the factory test team includes representatives of the organizations in charge of the launch vehicle, spacecraft, and other main system development and grants the representatives the status of team members.

6.3.3 10 working days before the test (or agreed specified date between the related organizations), the manufacturing organization submits the following documentation to the team:

a) design specifications;

b) complete set of the design documentation updated as of the date the testing begins, including:

   1) test program and procedures;

   2) measurement procedures, as necessary.

c) documents for the test equipment (benches, devices, instruments, etc.) that verify readiness for testing;

d) test schedule;

e) list of deviations from the design documentation that occurred during the manufacturing of the main system at the manufacturing organization;

f) records and technical reports on the test results of specific items;

g) report on the verification of the electric insulation resistance of electronic components and network cabling included in the main system(s);

h) acceptance records for the assembly of grounding and static electricity protection devices;

i) list of design identified modifications during the testing process as well as the set of documents authorizing these modifications;

j) reports on the testing or work completed before the beginning of the factory testing;

k) submission note;

l) test log.

6.3.4 During the factory testing, the supervision team and the organizations participating in tests (the launch pad (integration site) developer, main system and unit developer and manufacturer, and customer) execute the following activities:

— submission of the documentation required for main system 2 months prior to the beginning of the testing (or specified date agreed between related organizations);

— test organization;

— assurance and control of the completeness and quality of the test in accordance with the test program and procedures;

— technical supervision of the testing and involvement of the organization representatives in the testing;

— elimination of faults and failures identified in the course of testing and adaptation of aggregates under the documentation authorizing this adaptation;

— development and approval of the documentation authorizing the changes resulting from the test;

— correction of design documentation as necessary;

— analysis and evaluation of test results;

— main system maintenance in accordance with the operations documentation;

— provisioning of required benches, devices, instruments, control means, measuring devices, etc;

— replenishment of used parts and consumed materials;

— submission of the main unit for acceptance by the customer representative at the main system manufacturing organization;

— main system acceptance;

— shipment of the main system accepted by the customer representative according to contracts and schedules;

— issuance of a system acceptance certificate to the main system manufacturing organization and approval of the certificate and data sheet;

— notification for the recipient of the shipment of the accepted main system in accordance with the contract and schedule.

6.3.5 A completely equipped and checked-out main system accepted by the technical supervision body of the main system manufacturing organization is allowed to undergo factory testing.

6.3.6 The main system manufacturer/developer develops a test schedule that is approved by the main system developer, launch pad developer, and the customer representatives.

6.3.7 Logistics support of the main system testing is supplied by the main system manufacturing organization.

6.3.8 If the testing is conducted with the use of a launch vehicle, spacecraft, or other main system devices and items, the respective manufacturing organizations provide the devices and items in accordance with the main system manufacturing organization requirements.

6.3.9 After the test program is completed, the following are performed:

— the manufacturing organization and the customer representative execute required entries in the main system data log;

— the test team supplies the test certificate, the factory test report, the list of malfunctions and failures identified during testing, and suggestions for main system improvements (as an enclosure to the certificate) and sends copies of these documents and documents listed in 6.3.3 to the manufacturer organization.

6.3.10 The main system is accepted if:

— the testing was successful;

— the system is complete with documentation, spare parts, and accessories;

— the system is approved by the customer representative at the main system manufacturing organization;

— the customer representative has executed an entry about the approval of the main system for the field testing into the main system data log.

6.3.11 The main system manufacturing organization forwards the test data package within 20 calendar days and the test report within 30 calendar days after the completion of the test (or agreed specified date between the related organizations) to the following parties:

— main system and launch pad (integration site) developer and the customer representatives;

— customer representative at the main system manufacturing organization;

— test organization.

6.3.12 Within 10 working days after issuance of the test data package (or agreed specified date between the related organizations), the main system manufacturing organization sends pertinent extracts from the package to interested organizations for making decisions and suggestions for correcting malfunctions and failures that occurred during testing.

6.3.13 Shipment of approved equipment and components is arranged by the manufacturer and customer in accordance with international and/or national regulations.

6.3.14 If the main system developer makes a recommendation and it is approved by the launch pad and integration site developer, the customer, the general supplier, and the main system manufacturing organization, the full scope of the main system factory testing cannot be performed in the following cases:

a) if the complete main system assembly is not possible because the required industrial space and/or equipment and auxiliaries are not available;

b) if it is not feasible to develop expensive testing equipment and auxiliaries;

c) if it is not possible to disassemble the main system without degrading its quality.

In these situations, the main system is tested at the main system manufacturing organization (or organizations) and the interaction among all the parties during the main system assembly and checkout is defined in the decision.

6.3.15 Upon completion of the main system testing, the customer representative provides an assessment of the main unit for approval of the assembly and field testing, including a comment on the main system data log.

6.3.16 Upon completion of the main system assembly and checkout as indicated in 6.3.14, the factory testing is included in the field testing.

6.4 Main system field testing

6.4.1 The test team is appointed by the test organization 20 calendar days prior to the start of testing (or agreed specified date between the related organizations).

6.4.2 If testing involves the team of the launch vehicle, spacecraft, or other main systems, the representatives of the launch vehicle, spacecraft, and other main system developers are involved in test team activities.

6.4.3 10 calendar days prior to the beginning of testing (or agreed specified date between the related organizations), the general supplier (if the main system is assembled at the operational launch pad or

integration site) or the main system manufacturing organization (if the main system is not assembled at the operational launch pad or integration site) submits to the team the following documentation:

a) technical specifications;

b) full set of the design documentation, corrected for the start of field test, including:

   1) test program and procedures;

   2) measurement procedures;

c) test equipment documentation (for benches, auxiliary instruments, etc.) verifying equipment applicability for the testing;

d) field test schedule;

e) list of deviations from the design documentation that occurred during the main system assembly;

f) records of the insulation resistance testing to higher voltage, if necessary;

g) records of electrical equipment insulation resistance testing included in the main system or switched to it as well as the cable network;

h) acceptance records of the protective grounding unit assemblies and the main system static electricity protection units;

i) list of documents authorizing the modifications and alterations to the design documentation, in accordance with an established list, and the documents relating to their implementation;

j) submission note;

k) data package and test report for factory testing and acceptance;

l) data package for main unit checkout (if the main system is assembled at the operational launch pad or integration site);

m) records showing the correction of the testing malfunctions and failures as well as for the implementation of recommended improvements that require implementation before the beginning of field testing;

n) testing log;

o) assembly documentation in accordance with design specifications (if the main system is assembled at the operational launch pad or integration site);

p) results of the metrology expert's evaluation at the factory testing phase;

q) records showing the implementation of the metrology expert's recommendation conducted during the factory testing phase.

6.4.4 The representatives of the launch pad and integration site and main system developer and the customer participate in the field testing.

6.4.5 One of the following conditions is met before field testing the main system:

— the main system is assembled at the operational launch pad or integration site, equipped and checked out, and is accepted by the project management department of the assembly organization and by the customer representative and includes in its data log the approval of the assembly organization and the customer representatives for field testing;

— the main system is fully equipped and factory tested, is accepted by the project management body of the main system manufacturing organization and by the customer representative, and includes in

the data log the approval of the main system manufacturing unit and the customer representatives for field testing.

6.4.6 Before field testing, the main system:

— is prepared for testing in accordance with the operation's manual; if the main system was subjected to factory testing, the manual has been updated to reflect factory test results;

— passes the tests indicated in the operations documentation;

— not includes any equipment with expired technical certification.

6.4.7 The facility and support systems are accepted for testing in the course of testing the respective main systems.

6.4.8 The measurement system of the main system passes its own field testing before performance of the main system field testing to provide required measurements.

6.4.9 During the field testing, the supervision team and the organizations participating in tests that can include the launch pad or integration site developer, the main system and unit developer and manufacturer, the customer, the general supplier, and the organization executing assembly, checkout, and tests execute the following activities:

— submission of the documentation required for main system 2 months prior to the beginning of the testing (or specified date agreed between related organizations);

— timely preparation of the main system for testing;

— test organization;

— assurance and control of the completeness and quality of the test in accordance with the test program and procedures;

— technical supervision of the testing and involvement of the organization representatives in the testing;

— elimination of faults and failures identified in the course of testing and adaptation of aggregates under the documentation authorizing this adaptation;

— development and approval of the documentation authorizing the changes resulting from the test;

— correction of design documentation as necessary;

— analysis and evaluation of test results;

— main system maintenance in accordance with the operations documentation;

— provisioning of required benches, devices, instruments, control means, measuring devices, etc;

— replenishment of used parts and consumed materials;

— submission of the main unit for acceptance by the customer;

— main system storage and the completion of maintenance operations documentation specifications from the time of receipt of the main assembly from the main assembly manufacturing organization (if the main assembly is not assembled at the operational launch pad or integration site) and from the time of submission of the main system for field testing by the general supplier (if the main system is assembled at the operational launch pad or integration site) and during testing.

6.4.10 The main system developer develops a test schedule that is approved by the main system manufacturer, the launch pad developer, and the customer representatives.

6.4.11 The main system manufacturer provides test logistics support. If, by mutual agreement between the main system developer and the customer, both the test organization and the general supplier are involved in the test logistics support, the test procedure and schedule are agreed to by the test organization and by the general supplier.

6.4.12 The space complex developer provides the testing and funding for the propulsion system propellants, gases, etc., in accordance with the direction of the launch pad or integration launch pad and integration site developer.

6.4.13 Respective manufacturers supply the standard test items and devices of the launch vehicle, spacecraft, and other main systems required for testing in accordance with the instructions agreed to previously and submitted by the main system developers.

6.4.14 The main system manufacturer delivers special items, auxiliary instruments and tools together with the main system before the testing starts.

6.4.15 The team that conducted the testing provides the following documents upon the completion of the test program and transmit these documents to the testing organization:

— test completion data package;

— test report;

— list of malfunctions and failures and recommendations for final improvements (included as an enclosure to the certificate).

6.4.16 After approval of the data package testing, the general supplier or the main system manufacturer submits the main system to the acceptance team of the operations organization.

6.4.17 Upon completion of the testing, the following are accomplished:

— if the main systems are not assembled at the operations launch pad or integration site, the operations organization representative approves the data log at the main system manufacturing organization authorizing main system operation;

— in addition, if the main systems are assembled at the operations launch pad and integration site, the main system manufacturing organization completes the acceptance certificate and warranty obligations.

6.4.18 The test organization sends the test data package within 10 calendar days and the test report within 30 calendar days (or agreed specified date between the related organizations) to the interested parties.

6.5 Acceptance of the main system and facility after field test

6.5.1 The operations organization appoints the main system and facility acceptance team within 5 working days (or agreed specified date between the related organizations) after the written notifications about the completion of the field testing and the main system and facility readiness for acceptance. The notifications are sent to the inspection team by the following organizations:

— general supplier, if the main system was assembled at the operational launch pad or integration site;

— field test team, if the main system was not assembled at the operational launch pad or integration site.

6.5.2 The acceptance team has the following duties:

— verification of the conformance of the facility and assembly to specifications in accordance with design and cost estimate documentation, standards, facility standards, and regulations;

— verification of the completeness of the main system testing based on field test certificates;

— quality evaluation of the completed facility and assembly work;

— verification of the completeness and adequacy of the operations documentation;

— verification of the availability of logistical support and operations personnel;

— acceptance of the main systems for storage, maintenance, and end-to-end testing.

6.5.3 The acceptance team has the following authority:

— to convene specialized subteam for verifying specific main system and facility readiness (the chairman of the acceptance team determines the functions of the specialized subteam and approves the documents produced by the subteam);

— to verify that the scope of the completed work conforms to the data and the quality requirements;

— to perform additional testing of the main systems in accordance with documents approving the final improvements and, in an established procedure, to involve experts of related organizations, as necessary, for this testing;

— to verify the conformance of the scope and quality of the work indicated in the main system and facility acceptance certificates to the actual results.

6.5.4 The acceptance team accepts the main systems and facility only if the support systems of the facility (water supply, sewage, heating, electric, etc.) have been connected to their interfaces.

6.5.5 If the main system is not assembled at the operations launch pad or integration site, the main system primary manufacturing organization submits the documentation listed in 6.4.3 to the inspection team for the main system acceptance, in addition to the following:

— main system field test data package;

— main system field test report;

— records showing the correction of malfunctions and failures identified during the testing and implementation of the change recommendations for improvement of the main system, if the terms of their execution have expired.

6.5.6 If the main system is assembled at the operational launch pad or integration site, the general supplier submits the documentation listed in 6.5.5 to the inspection team for main system and facility acceptance, in addition to the following:

— list of organizations participating in the facility and assembly work, including the work completed and the names of the experts directly in charge of the work;

— set of detailed drawings that are the working documents for the facility;

— records, technical data sheets, and other documents certifying the quality of the materials, structural components, and parts used for the facility and assembly work;

— quality inspection work and records;

— work and developer logs.

6.5.7 After the acceptance team completes its activity, all the documentation is submitted to the operations organization.

6.5.8 Organizations that participate in the acceptance process (e.g. the launch pad or integration site developer, the main system developer and their suppliers and manufacturers, customer, general supplier, and organization performing the assembly, checkout, operations, and tests) perform the following activities prior to or during the main system and facility acceptance process:

— submission of the documentation in accordance with 6.5.5 to the acceptance team;

— submission of main system and facility design documentation to the test organization 30 calendar days (or agreed specified date between the related organizations) prior to the beginning of acceptance;

— timely preparation of the main system for acceptance;

— acceptance organization;

— monitoring the conformance of main system and facility parameters to the design specifications;

— elimination of faults and failures identified during main system acceptance and implementation of the changes recommended for improvements to the main system;

— development and approval of the documentation authorizing modification of the assembly and facilities related to the problems that occurred during the main system and facility acceptance;

— correction of design documentation as necessary;

— submission of the main unit for acceptance by the customer;

— main system acceptance together with a set of updated documents;

— main system storage and the completion of maintenance operations documentation specifications from the time of receipt of the main assembly from the main assembly manufacturing organization (if the main assembly is not assembled at the operational launch pad or integration site) and from the time of submission of the main system for field testing by the general supplier (if the main system is assembled at the operational launch pad or integration site) and during testing.

6.5.9 The results obtained by the acceptance team are contained in the acceptance data package.

6.5.10 The main systems and facility are considered accepted by the operations organization for storage and maintenance in accordance with operations documentation after the approval of the acceptance data package by the acceptance team.

6.5.11 The acceptance team accepts the main systems interrelated with the field-tested main systems and located in a separate, attached, or built-in facility of production, support, or maintenance characterized before the end-to-end testing.

6.6 Launch pad and integration site end-to-end testing

6.6.1 A test team, appointed by the customer 3 months (or agreed specified date between the related organizations) in advance, performs the end-to-end testing.

6.6.2 The end-to-end test team has the authority to establish a subtask to perform additional testing and verification in accordance with special programs designed to determine main system and facility readiness for operation.

6.6.3 The team uses the launch pad and integration site design specifications, the test program and procedures, the launch pad and integration site and its main system design documentation, and the test schedule for guidance.

6.6.4 10 calendar days prior to the beginning of test (or agreed specified date between the related organizations), the test organization submits to the team the following documentation:

— end-to-end test program and procedures;

— launch pad and integration site design specifications;

— launch pad and integration site operations documentation;

— records for the field testing and acceptance of the main system and facility, including the main system and facility acceptance data package indicated in 6.5.9;

— main system and facility data log;

— records showing the correction of the malfunctions and failures identified during main system field testing and the recommended improvements to be accomplished before the end-to-end testing begins;

— main system design documentation;

— end-to-end test log;

— test equipment documentation certifying its applicability for testing;

— documents permitting the operation of the main systems and facility under the scope of the related supervisory bodies;

— agreement on the readiness of the launch pad and integration site for the end-to-end testing;

— agreement on the readiness of the launch vehicle and spacecraft mock-ups for launch pad and integration site testing;

— agreement on the findings in the metrology experts evaluation of the main system;

— list of the attending personnel composed of the industry representatives, customer, agreed-upon-testing and operations organizations, team vice chairman, technical supervisor and persons approved by the team chairman.

6.6.5 Organizations that participate in end-to-end testing (e.g. the launch pad or integration site developer, the space complex developer, the launch vehicle or spacecraft developer, the main system developer and manufacturer, customer, general supplier, operational and testing organization) perform the following activities prior to or during launch pad or integration site end-to-end testing:

— two months prior (or agreed specified date between the related organizations) to the beginning of the test, submission to the test organization of the launch pad and integration site and main system documentation required for the end-to-end testing and operations;

— timely preparation of the launch pad (integration site) for the end-to-end testing;

— testing organization;

— training of skilled personnel for the end-to-end testing and operations;

— submission of the resolution on the readiness of the launch pad and integration site for end-to-end testing;

— submission of the agreement on the readiness of the launch vehicle pre-flight testing model and spacecraft mock-up for the end-to-end testing (the launch vehicle and spacecraft development

organizations provide their readiness for the testing as required by the space complex regulating authority);

— elimination of faults and failures identified during testing and the implementation of launch pad, integration site, main system, launch vehicle and spacecraft recommended improvements;

— development and approval of the documentation authorizing modification required to correct the problems that occurred during end-to-end test preparation and end-to-end testing;

— correction of design documentation as necessary;

— maintenance of the launch pad and integration site, its main systems and facility;

— replenishment of spare parts and consumable materials used during testing;

— participation in maintenance and testing;

— analysis and evaluation of test results.

6.6.6 The main system and facility of the launch pad and integration site, which pass field testing and are accepted by the acceptance team and for which the launch pad and integration site developer issues the agreement for acceptance to the end-to-end testing agreed to by the customer representative and by the test organization, are accepted for end-to-end testing.

The main systems accepted for end-to-end testing are prepared for testing in accordance with the operations instructions, which have been updated based on field test results, and pass the verification and certification requirements in the operations documentation.

6.6.7 The end-to-end testing is performed with launch vehicle and spacecraft mock-ups that are equipped with single use devices and the standard flight devices that interface with the launch pad or integration site main systems. These devices ensure repeatable operations as required by the test program.

6.6.8 The space complex development organization ensures that they receive formal approval of the launch vehicle pre-flight testing model and spacecraft mock-up by the launch vehicle and spacecraft customer representatives and the launch test organization(s), before approving access to the launch pad and integration site for end-to-end testing by these customer and test organizations (joint effort between the launch pad and integration site).

6.6.9 The following are supplied for end-to-end tests.

— propellants, gases, and other consumables;

— launch vehicle and spacecraft mock-ups;

— standard specifications and delivery and storage systems for propellants, gases, and combustible and lubricant materials used during the test program;

— single use operation devices, special testing equipment, instrument tools, and materials not indicated in the operations documentation that can be used during the test program;

— security during transportation of propellants from the manufacturer to the test organization.

6.6.10 After the completion of the test program, the following are performed:

a) the test team issues the following documents:

1) launch pad and integration site readiness data package;

2) launch pad and integration site test report;

3) list of recommendations for launch pad and integration site improvements and for correction of the malfunctions and failures identified during the test;

b) the launch pad developer issues the final report on readiness for operation.

6.6.11 The launch pad and integration site data logs are approved after completion of the testing.

6.6.12 The test organization sends the test data package to the launch pad developer, space complex developer, and customer for approval within 15 calendar days (or agreed specified date between the related organizations) and ensures a copy of the report is sent to the organizations participating in the testing.

6.6.13 30 calendar days (or agreed specified date between the related organizations) after test completion, the test organization sends the test report to the launch pad developer and the customer for approval and ensures a copy of the report is sent to the organizations participating in the testing.

6.6.14 The test data package and the test report are reviewed and approved 1 month (or agreed specified date between the related organizations) after receipt by the respective organizations.

6.6.15 The launch pad developer sends the extracts from the test data package and the recommendations for launch pad and integration site improvements to the interested parties within 20 calendar days after receipt of the documents.

6.6.16 The final report on launch pad and integration site readiness for operation is issued before the beginning of space complex operation. By decision of the launch pad developer, the main system and facility development organizations issue the reports about main system and facility readiness, as necessary.

6.6.17 If, according to the test team, the launch pad and integration site cannot be recommended for operation, the team is required to present a well-founded rationale and recommendation to the customer and the space complex development organization. The team sends copies of these documents to the launch pad or integration launch pad and integration site developer and the general supplier.

6.7 Launch pad or integration site acceptance after end-to-end testing

6.7.1 The acceptance team performs the acceptance of the launch pad (integration site). The team is appointed by the customer not later than 30 calendar days prior to the determined acceptance time.

6.7.2 The customer appoints the chairman of the acceptance team.

6.7.3 Launch pad or integration site acceptance is performed after the end-to-end testing and is completed by the time determined by the customer.

6.7.4 The authority of the team expires after the approval of the launch pad and integration site acceptance certificate.

6.7.5 The team has the duty of verifying the following:

— launch pad and integration site readiness for the operation based on the results of factory, field, and end-to-end tests as well as on the results of the main system and facility acceptance by the inspection teams;

— compliance with the actual cost of the launch pad and integration site to its projected cost and, in the event of deviations, the team provides the analysis of the respective recommendations;