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

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

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Contents

Page

Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

ISO/TR 17400 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This Technical Report establishes the general characteristics related to testing at launch pad and integration sites for launch vehicle and spacecraft.

The purpose of this Technical Report is to establish 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 Technical Report establishes recommended 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 Technical Report is applicable to new projects and programs and to redesigned and upgraded launch pad and integration sites. This Technical Report establishes 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 Technical Report may be applicable 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 may be applied.

2 Normative references

The following referenced documents are indispensable for the application 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 9000:2000, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000:2000 and the following apply.

3.1
integration site
equipment and facility designed for launch vehicle storage, assembly, testing, preparation, maintenance, servicing and preparation for transportation to the launch pad

3.2
international launch site
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
launch pad site end-to-end testing
integration site end-to-end testing
launch pad or integration site development phase including the testing and evaluation of its overall readiness to support a launch vehicle and a spacecraft

3.5
launch pad site support system
integration site support system
component launch pad or integration site, which enables the main system to operate

3.6
main system
launch pad or integration site or components primarily responsible for providing preparation and launch of a launch vehicle or spacecraft

3.7
main system factory testing
launch pad or integration site development phase that includes the testing of a completely assembled and checked out main system 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 or integration site development phase including the testing of an assembled, fully equipped, and checked out (or factory tested) main system; the testing is conducted at the operational launch pad or integration site to determine the system readiness for further testing or operation

3.9
test supervision
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 should be conducted in accordance with the regulatory and design documentation specifications.

4.2 The test supervision team should coordinate 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 should be the technical manager during the launch pad and integration site and system testing.

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

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

4.5 Customer representatives participating in the testing may work in a Joint Control and Acceptance Group (JCAG). JCAG functions should be determined in agreements developed by the customer.

4.6 The system testing and acceptance team should have the authority to convene representatives of design and unit manufacturing organizations. These representatives should be 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 should have 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.

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

4.9 The test supervision team should have 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 should report to the body that appointed the team indicating the reasons for such a termination (suspension) and provide the necessary documentation.

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

4.11 Personnel permitted to perform testing should have the skills required to operate the main systems within the range of their operational duties and should 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 should undergo a medical examination prior to commencement of duties and annually thereafter.

4.13 Launch pad and integration site safety precautions should be taken before the beginning of testing or experimental and research tasks.

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

4.15 During system testing and acceptance, interested organizations may 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 should be cleared with the space complex development organization.

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

4.18 When any test fails, the cause of the failure should be 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 should be 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 should process 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 should be made by the launch pad and integration site developers.

4.23 During the testing of main systems, a test log should be maintained. The following should be 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 may have been made;

— information about replaced components;

— main system nonconformity's 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 Implementation of the main system and the changes required for the elimination of failures should be implemented on the basis of the design documents authorizing the changes. If necessary, change the design documentation.

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

4.26 Companies should 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 should, 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 should be involved in the control.

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

5.1 Testing phases

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

— main system factory testing;

— main system field testing;

— launch pad and integration site end-to-end 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 should be 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 should be 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 should be 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 should be 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 other subsequent tests (if necessary). 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.

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

The end-to-end testing should be 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 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 should be identified in the individual contract document.

6.2 Test and acceptance procedure

The following procedure should be adopted for test and acceptance:

a) facility and support system test and acceptance should be 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 should be 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 should include representatives of the organizations in charge of the launch vehicle, spacecraft, and other main system development and grant the representatives the status of team members.

6.3.3 Ten working days before the test (or agreed specified date between the related organizations), the manufacturing organization should submit 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 electric equipment insulation resistance included in the main system or connected thereto and the electric equipment of the cable network connected thereto;

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, supervision team, and also the organizations participating in tests (the launch pad (integration site) developer, main system and unit developer and manufacturer, and customer) should 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 should be allowed to undergo factory testing.

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

6.3.7 Logistics support of the main system testing should be 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 should 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 should be performed:

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

— the test team should supply 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 send copies of these documents and documents listed in 6.3.4 to the manufacturer organization.

6.3.10 The main system should be 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 should forward 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 should send 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 should be 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 may not 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 should be tested at the main system manufacturing organization (or organizations) and the interaction among all the parties during the main system assembly and checkout should be defined in the decision.

6.3.15 Upon completion of the main system testing, the customer representative should provide 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 should be included in the field testing.

6.4 Main system field testing

6.4.1 The test team should be 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 should be involved in test team activities.

6.4.3 Ten 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) should submit 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 should participate in the field testing.

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

— the main system should be assembled at the operational launch pad or integration site, equipped and checked out, and should be accepted by the project management department of the assembly

organization and by the customer representative and should include in its data log the approval of the assembly organization and the customer representatives for field testing; or

— the main system should be fully equipped and factory tested, should be accepted by the project management body of the main system manufacturing organization and by the customer representative, and should include 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:

— should be prepared for testing in accordance with the operation's manual. If the main system was subjected to factory testing, the manual should have been updated to reflect factory test results;

— should pass the tests indicated in the operations documentation;

— should not include any equipment with expired technical certification.

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

6.4.8 The measurement system of the main system should pass 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 may 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 should 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 should develop a test schedule that should be approved by the main system manufacturer, the launch pad developer, and the customer representatives.

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

6.4.12 The space complex developer should provide 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 should 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 should deliver special items, auxiliary instruments and tools together with the main system before the testing starts.

6.4.15 The team that conducted the testing should provide 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 (include as an enclosure to the certificate).

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

6.4.17 Upon completion of the testing, the following should be accomplished:

— if the main systems are not assembled at the operations launch pad or integration site, the operations organization representative should approve 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 should complete the acceptance certificate and warranty obligations.

6.4.18 The test organization should send 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 systems and facility after field test

6.5.1 The operations organization should appoint 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 should be 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 should have 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 should have the following authority:

— to convene specialized subteam for verifying specific main system and facility readiness (The chairman of the acceptance team should determine the functions of the specialized subteam and approve 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 should accept 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 should submit 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 should submit 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 should be 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) should 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 should be contained in the acceptance data package.

6.5.10 The main systems and facility should be 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 should accept 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, should perform the end-to-end testing.

6.6.2 The end-to-end test team should have 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 should use 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 Ten calendar days prior to the beginning of test (or agreed specified date between the related organizations), the test organization should submit 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) should 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 and spacecraft mock-ups for the end-to-end testing (the launch vehicle and spacecraft development organizations provide to the space complex developer individual agreements on their readiness for the testing);

— 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, should be accepted for end-to-end testing.

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

6.6.7 The end-to-end testing should be 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 should ensure repeatable operations as required by the test program.

6.6.8 The space complex development organization should obtain the approval of the customer representative and the test organization for acceptance of the launch vehicle and spacecraft mock-ups to the joint effort between the launch pad and integration sites during testing.

6.6.9 The following should be 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 may 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 should be performed:

a) the test team should issue 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 should issue the final report on readiness for operation.

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

6.6.12 The test organization should send 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 ensure a copy of the report is sent to the organizations participating in the testing.

6.6.13 Thirty calendar days (or agreed specified date between the related organizations) after test completion, the test organization should send the test report to the launch pad developer and the customer for approval and ensure 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 should be 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 should send 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 should be issued before the beginning of space complex operation. By decision of the launch pad developer, the main system and facility development organizations should 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 should send 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 should perform the acceptance of the launch pad (integration site). The team should be appointed by the customer not later than 30 calendar days prior to the determined acceptance time.

6.7.2 The customer should appoint the chairman of the acceptance team.

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

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

6.7.5 The team should have 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 should provide the analysis of the respective recommendations;

— evaluation of the quality of the facility and assembly work and the launch pad and integration site itself (excellent, good, or satisfactory).

6.7.6 The team has the authority, when necessary, to organize the subtask to perform additional launch pad and integration site main system and facility testing.