
**Space systems — Space experiments
— General requirements**

Systèmes spatiaux — Expériences spatiales — Exigences générales

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 14619:2003), which has been technically revised.

The main changes are as follows:

- description of new terms and definitions;
- adjustment of organizational roles and responsibilities;
- definition and clarification of the content of documents;
- addition of information on ensuring the long-term sustainability of the space environment.

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

Introduction

This document establishes the requirements for conducting space experiments (SEs).

Space systems are used for solving various practical problems of humanity. The possibilities for expanding the use of these systems are far from being exhausted. The space environment provides ideal conditions for certain scientific studies, which are difficult or impossible to carry out in a terrestrial environment.

It often happens that an experiment is conducted on board a space system that is available and operational (i.e. the experiment becomes part of the operations of the space system itself). The SE is carried out using both hardware and software subsystems. This poses a problem of accomplishing two interrelated objectives:

- to ensure successful execution and performance of the experiment;
- to avoid interfering with an operational space system so as not to impair its functioning.

One method of solving this problem is to standardize the procedure for integrating (introducing) SEs into the operational processes of the space system. This document specifies the procedures for an experiment preparation on the ground and processing of the data, obtained when conducting SEs with the use of a space system that is already operational.

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Space systems — Space experiments — General requirements

1 Scope

This document addresses experimental add-on components to a space system under development and specifies the procedures for preparing and carrying out space experiments (SEs), and analysis and processing of the findings.

It is applicable to both manned and unmanned space systems. It can be tailored to the specific needs of different kinds of SEs.

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 14300-1, *Space systems — Programme management — Part 1: Structuring of a project*

ISO 14300-2, *Space systems — Programme management — Part 2: Product assurance*

ISO 14620-1, *Space systems — Safety requirements — Part 1: System safety*

ISO 14620-2, *Space systems — Safety requirements — Part 2: Launch site operations*

ISO 10795, *Space systems — Programme management and quality — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10795 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

space system

system that contains at least a space, a ground or a launch segment

3.2

space experiment

SE

system of operations, actions, and/or observations performed in space with the objective of obtaining information on the subject under investigation

3.3

space experiment project

SE project

developed plan for conducting a *space experiment* (3.2): from a proposal preparation up to analysis and processing of the results, and preparation of the final report

3.4

scientific equipment

set of equipment designed to perform a *space experiment* ([3.2](#)) and purposefully integrated into a *space system* ([3.1](#))

3.5

project manager

authorized person accountable for planning, execution and accomplishing the stated objectives of the project

3.6

principal investigator

authorized person accountable for a specific scientific project

3.7

collaborator

authorized person who participates in a *space experiment* ([3.2](#))

4 Space experiment organizational requirements

4.1 General

Execution of an SE using a space system shall be in accordance with the relevant programme management and safety International Standards, specifically ISO 14300-1, ISO 14300-2, ISO 14620-1 and ISO 14620-2.

4.2 Participants

The following participants shall be responsible for the management and execution of an SE:

- a) project manager;
- b) principal investigator;
- c) collaborator(s).

4.3 Phases

The phases include:

- a) SE planning (see [Clause 5](#));
- b) development (see [Clause 6](#));
- c) execution (see [Clause 7](#));
- d) analysis and processing of the results and preparation of the final report (see [Clause 8](#)).

5 Planning phase

5.1 General

The objective of operations at the planning phase of an SE is to assess the feasibility of conducting a particular SE in a particular space system. In addition, the effects of the experiment on the orbital environment shall be assessed for the long-term sustainability of the space activities. The organization of an SE shall be achieved through the following steps:

- a) preparation of a proposal (see [5.2](#));

- b) preparation of a project based on the proposal (see [5.3](#));
- c) scientific evaluation of the project (see [5.4](#));
- d) technical feasibility of the project (see [5.5](#));
- e) economic appraisal of the project (see [5.6](#));
- f) development and approval of statement of work (see [5.7](#)).

5.2 Proposal

5.2.1 General

The proposal reflects the intention of the principal investigator(s) to conduct an SE.

The proposal shall contain the following information to allow the project manager to assess the feasibility of conducting a specific SE using a specific space system, and to carry out its scientific, technical and economic assessment:

- a) terms and definitions (see [5.2.2](#));
- b) introduction (see [5.2.3](#));
- c) SE's objectives and tasks (see [5.2.4](#));
- d) SE participants' responsibilities (see [5.2.5](#));
- e) requirements for SE equipment (see [5.2.6](#));
- f) requirements for ground support for an SE (see [5.2.7](#));
- g) technical specification for a space system (see [5.2.8](#));
- h) project financing and source of funding (see [5.2.9](#));
- i) scientific and technical justification for the SE (as an annex to the proposal) (see [5.2.10](#)).

5.2.2 Terms and definitions

This section shall include terms and definitions, symbols and acronyms.

5.2.3 Introduction

This section shall include the name and background of the SE and applicable references.

5.2.4 SE's objectives and tasks

This section shall include the objective(s) of an SE and a list of task(s) designed to achieve the general objective(s) of the SE.

5.2.5 SE participants' responsibilities

This section shall list the SE participants, their main responsibilities at various phases of the SE and their general responsibilities for performance of the SE.

5.2.6 Requirements for SE equipment

This section shall include a description of the following:

- a) SE equipment and its application;

- b) SE equipment modules and their applications;
- c) requirements for the equipment parameters critical for accomplishing the SE's objectives, including the requirements for the detection, isolation and repair of malfunctions;
- d) mock-ups, instrumentation, design documents and operations manuals included in the deliverables.

5.2.7 Requirements for the ground-support for an SE

This section shall include the following items:

- a) the procedure and schedule for development, manufacturing, testing and delivery of equipment, equipment mock-ups and instrumentation, together with the relevant documents;
- b) a summary of the main operations and time constraints for the preparation of the ground support facilities to prepare for scientific observations, and a description of the equipment to perform analysis and processing the results;
- c) a description of the requirements and time constraints for the development of special mathematical support for scientific observations and for processing the results;
- d) a summary of potential emergencies and measures for handling emergencies.

5.2.8 Technical specification for a space system

This section shall include a description of the following:

- a) spacecraft capabilities required to ensure proper performance of the equipment (spacecraft design, power-supply system, data handling and transmission, conditions of functioning and maintenance on board the spacecraft, scope and accuracy of parameter measurements, the normal operating values of various factors for the equipment needed to carry out an experiment, and the main hazards and safety measures);
- b) requirements driven by integration of an SE into a space system;
- c) requirements for consumables (lists of consumables and refills and of materials to be returned to earth, including their mass and dimensions characteristics, and the condition of the recovered materials);
- d) spacecraft capabilities required to carry out scientific observations, including the following:
 - 1) radio ground-communication stations;
 - 2) maintenance of spacecraft orbit and attitude;
 - 3) orientation and stabilization of the equipment needed for the experiment;
 - 4) scheduling parameters for scientific observations;
 - 5) crew operations necessary, if applicable;
- e) requirements for the ground preparation complex (requirements for scientific observations, monitoring and data recording);
- f) requirements for a spacecraft crew (i.e. requirements for training for the activities needed during the performance of the SE and scientific observations).

5.2.9 Project financing and the source of funding

This section shall describe the project financing and the source of funding.

5.2.10 Scientific and technical justification for the SE (as an annex to the proposal)

The scientific and technical justification of the SE should include:

- a) SE's objective;
- b) SE's tasks;
- c) status of the problem under investigation;
- d) relevance of the SE;
- e) available scientific and technical preliminary work or practices;
- f) justification of the need to perform the SE in microgravity;
- g) description of the SE;
- h) main target parameters of scientific equipment;
- i) a potential developer of scientific equipment.

5.3 Project

The project shall contain the following information to make it possible for the project manager to conduct an SE from the moment of preparation of a proposal up to analysis and processing of the results and preparation of the final report:

- a) project objectives;
- b) project tasks;
- c) project participants' responsibilities;
- d) project requirements;
- e) project milestones.

5.4 Scientific evaluation of the project

Scientific evaluation of a project shall include information about relevance and effectiveness of the SE and the validity of the applied scientific methods.

5.5 Technical feasibility of the project

The technical feasibility of the project shall contain technical requirements on the possibility of conducting a particular SE using a particular space system.

5.6 Economic appraisal of the project

The economic appraisal of the project should include information about the project financing and projected economic benefits from the implementation of the project.

5.7 Statement of work

5.7.1 General

The statement of work for the SE defines the technical capabilities for conducting the SE and should include data for the SE feasibility.

The SE statement of work shall be prepared jointly by the SE project manager and the SE participants, and shall include the following sections:

- a) terms and definitions (see [5.7.2](#));
- b) introduction (see [5.7.3](#));
- c) SE's objectives and tasks (see [5.7.4](#));
- d) SE participants' responsibilities (see [5.7.5](#));
- e) scientific equipment (see [5.7.6](#));
- f) requirements for ground support for an SE (see [5.7.7](#));
- g) technical specification for the space system (see [5.7.8](#));
- h) SE implementation procedure (see [5.7.9](#));
- i) SE output data: analysis and processing of the experiment results (see [5.7.10](#));
- j) list of documents (see [5.7.11](#)).

5.7.2 Terms and definitions

This section shall include terms and definitions, symbols and acronyms.

5.7.3 Introduction

This section shall include the name and background of the SE, and applicable references.

5.7.4 SE's objectives and tasks

This section shall include the objective(s) of the SE and a list of task(s) designed to achieve the general objective(s) of the SE.

5.7.5 SE participants' responsibilities

This section shall list the SE participants, their main responsibilities at various phases of the SE and their general responsibilities for performance of the SE.

5.7.6 Scientific equipment

This section shall include a description of the following:

- a) equipment and supporting facilities (space, airborne, maritime, etc.) used to prepare and carry out the experiment;
- b) scientific equipment and components, both on board the spacecraft and as part of the support facilities;
- c) equipment used to record the data obtained during the SE.
- d) requirements for consumables (lists of consumables and refills and of materials to be returned to earth, including their mass and dimensions characteristics, and the condition of the recovered materials).

5.7.7 Requirements for ground support for an SE

This section shall include a description of the following:

- a) types and applications of ground test operations, and control and measurement operations with the equipment integrated into the spacecraft and its mock-ups;
- b) requirements for such operations;
- c) a procedure for the exchange of data obtained during the ground preparation of the equipment;
- d) a crew training programme.

5.7.8 Technical specification for the space system

This section shall include a description of the following:

- a) spacecraft capabilities required to ensure proper performance of the equipment (spacecraft design, power-supply system, data handling and transmission, conditions of functioning and maintenance on board the spacecraft, scope and accuracy of parameter measurements, the normal operating values of various factors for the equipment needed to carry out an experiment, and the main hazards and safety measures);
- b) requirements driven by integration of the SE into a space system;
- c) spacecraft capabilities required to carry out scientific observations, including the following:
 - 1) radio ground-communication stations;
 - 2) maintenance of spacecraft orbit and attitude;
 - 3) orientation and stabilization of the equipment needed for the experiment;
 - 4) scheduling parameters for scientific observations;
- d) requirements for the ground preparation complex (problem to be solved by the SE; requirements for scientific observations, monitoring and data recording);
- e) requirements defining the conditions necessary for the execution of the scientific observations, including the position of the spacecraft relative to that of the support facilities, the sequence of the basic operations to be performed during the preparation for and performance of the scientific observations, and the required attitude of the spacecraft;
- f) requirements to avoid excessive deterioration of the orbital environment, caused by mission objectives and hardware, released into outer space.

5.7.9 SE implementation procedure

This section shall include the following:

- a) SE approach and methodology;
- b) SE flow;
- c) SE samples;
- d) SE set-up;
- e) specialized SE tools;
- f) supporting analyses;
- g) SE input data;

- h) SE output data.

5.7.10 SE output data — Analysis and processing of the experiment results

This section shall include a description of the following:

- a) the data or materials to be obtained during the SE;
- b) the data format to be used and the procedure to be used to transfer materials to the SE operator;
- c) the nature of and processing procedure for the data or materials obtained;
- d) a procedure and deadline for the preparation of the reports containing the results of the SE.

5.7.11 List of documents

This section shall contain a list of the documents and the procedures for processing the statement of work and of the technical and performance documents to be prepared by the SE participants for execution and support of the SE.

6 Development phase

6.1 General

In addition to all performance and interface requirements contained in this document, it is presupposed that the system complies with all applicable regulations.

The objectives during the development phase of the SE shall be as follows:

- a) development and approval of a programme plan (see [6.2](#));
- b) design and engineering of the equipment (see [6.3](#));
- c) preparation of the hardware for the ground support of the scientific observations and for the results processing (see [6.4](#));
- d) integration of the SE into the flight programme (see [6.5](#)).

6.2 SE programme plan

6.2.1 General

The programme plan for the SE shall include procedures and instructions for the performance of certain work activities during the SE preparation and implementation, and when processing the findings.

The SE programme plan shall be prepared jointly by the SE project manager and the SE participants, and shall include the following sections:

- a) introduction (see [6.2.2](#));
- b) SE's objectives and tasks (see [6.2.3](#));
- c) SE participants' responsibilities (see [6.2.4](#));
- d) scientific equipment (see [6.2.5](#));
- e) preparation on the ground (see [6.2.6](#));
- f) SE implementation procedure (see [6.2.7](#));
- g) SE sessions management and performance (see [6.2.8](#));

- h) Scientific observations management and support (see [6.2.9](#));
- i) Analysis and processing of the experiment results (see [6.2.10](#)).

6.2.2 Introduction

This section shall include the name and background of the SE.

6.2.3 SE's objectives and tasks

This section shall include the objective(s) of an SE and a list of task(s) designed to achieve the general objective(s) of the SE.

6.2.4 SE participants' responsibilities

This section shall list the SE participants, their basic responsibilities at various phases of the SE and their general responsibilities for performance of the SE.

6.2.5 Scientific equipment

This section shall include a description of the following:

- a) the equipment and supporting facilities (space, airborne, maritime, etc.) used to prepare and carry out the experiment;
- b) scientific equipment and components, both on board the spacecraft and as part of the support facilities;
- c) the equipment used to record the data obtained during the SE;
- d) requirements for consumables (lists of consumables and refills and of materials to be returned to earth, including their mass and dimensions characteristics, and the condition of the recovered materials).

6.2.6 Preparation on the ground

This section shall include a description of the following:

- a) types and application of ground test operations, and control and measurement operations with the equipment integrated into the spacecraft and its mock-ups;
- b) requirements for such operations;
- c) procedure for the exchange of data obtained during the ground preparation of the equipment;
- d) crew training programme.

6.2.7 SM implementation procedure

This section shall include the following:

- a) the procedure for delivery of the equipment and consumables to the spacecraft;
- b) a description of the main operations for installation, preparation and maintenance of the equipment on board the spacecraft and the requirements for these operations;
- c) the scheduling requirements for the scientific observations and for maintenance of the equipment;
- d) the scope of the research and the procedure for the transfer of the SE results to earth;
- e) details of potential emergencies and measures to handle them.

6.2.8 SE sessions management and performance

This section shall include a description of the following:

- a) duration of the session;
- b) list of operations.

6.2.9 Scientific observations management and support

This section shall include a description of the following:

- a) list of operational groups formed from representatives of the SE participants, and the composition, location and objectives of these groups, as well as procedures for their co-operation;
- b) types of operations to be performed on the ground when preparing for the scientific observations, the nature of these operations and the procedures for carrying them out;
- c) procedure and schedule for data transfer during the preparations and during the scientific observations;
- d) requirements for the organization of communications.

6.2.10 Analysis and processing of the experiment results

This section shall include a description of the following:

- a) the data or materials to be obtained during the SE;
- b) the data format to be used and the procedure to be used to transfer materials to the SE operator;
- c) the nature of and processing procedure for the data or materials obtained;
- d) procedure and deadline for the preparation of the reports containing the results of the SE.

6.3 Design and engineering of the equipment

The technical specification for the equipment shall include the unit composition of the equipment, detailing technical characteristics.

The technical specification for scientific equipment shall be prepared jointly by the project manager, SE participants and the developer of equipment.

6.4 Preparation of the hardware for the ground support of the scientific observations and for the results processing

This section shall include a list of the hardware.

6.5 Integration of the SE into the flight programme

This section shall include a description of the following:

- a) objectives of the experimental studies;
- b) nature of the SE and the equipment required;
- c) scope of the studies and the schedules for the scientific observations;
- d) procedure for the transfer of the SE results.