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Space systems — Unmanned spacecraft operational procedures — Documentation

Systèmes spatiaux — Procédures opérationnelles de véhicule spatial non habité — Documentation

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Foreword

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

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

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

For an explanation on 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 the following URL: 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 edition of ISO 23041:2018 cancels and replaces the first edition ISO 23041:2007, which has been technically revised and includes the following changes:

— debris mitigation requirements based on 24113 were added;

— mission execution procedures and post-mission procedures now include de-orbit and re-entry;

— addition of a sub clause on propulsion subsystem; and

— addition of a sub clause on control re-entry segment.

Introduction

This document prescribes a standard means to facilitate the sharing and exchange of beneficial information among organizations (the spacecraft manufacturer, the mission equipment supplier, the customer or the spacecraft operation centre) and their involvement with space operations and support. This document provides a common interface to simplify space operations planning and reduce the effort needed to learn and deal with new space programmes and support organizations.

Space systems — Unmanned spacecraft operational procedures — Documentation

1 Scope

This document establishes standards, current guidelines and uniform procedures to minimize duplication of effort between the customer, the agency, participating nations and the emerging commercial space community. This document provides recommended practices for the development of space operations and support documentation, which should facilitate the sharing and exchange of beneficial information between organizations involved with space operations. This document establishes a common interface to simplify space operations planning and reduce the effort needed to learn and work with new space programmes and support organizations.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

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

3.1
abbreviated checklist
comprehensive list of items and time schedule of tasks to be done that are needed to check each step-by-step task at the telemetry/command (TLM/CMD) console and at the network console

3.2
acquiring agency
organization that is planning and managing the development and acquisition contracts for the space system, understands the engineering and technical aspects of the system's operation and acts as a provider of particular equipment if necessary

3.3
developing agency
organization that develops the spacecraft and operation system under contract to the acquiring agency

Note 1 to entry: One organization may constitute more than one of these agencies.

3.4
mission segment
ground system that consists of the facilities of mission data acquisition and processing

3.5
operations agency
agency responsible for the operations and maintenance of the space systems and organization to which the operations crew members belong

3.6
operations crew members
personnel who will be using the operations handbook to support space systems

3.7
separate and distinctive checklist
list that contains information to compensate the part of the operation facilities peculiar to the operations agency

3.8
spacecraft operation handbook
handbook that includes information needed for normal and contingent TLM/CMD operations

3.9
tracking control segment
ground system consisting of the facilities of spacecraft tracking, ranging and telemetry (TLM) monitor and command (CMD) control

Note 1 to entry: The launch segment includes the pre-launch segment, the spacecraft segment includes the mission segment and the ground segment includes the facilities and operations handbook.

3.10
space system operation
operation that contains launch segment operation, spacecraft segment operation and tracking control segment operation

Note 1 to entry: The launch segment operation includes pre-launch segment operation and the spacecraft segment operation includes the mission phase segment and the post-mission phase segment.

4 Symbols and abbreviated terms

AOCS	attitude and orbit control subsystem
AOS	acquisition of signal
BB	base band
CMD	command
EL	elevation angle
FCP	flight control procedure
FDIR	fault detection, isolation and reconfiguration
GCP	ground segment control procedure
IOT	in-orbit test
LEOP	launch and early orbit phase
LOS	loss of signal
MCL	mission (operation) checklist
OBC	onboard computer
OBDH	onboard data handling unit
OBS	onboard computer software

PS	power subsystem
RF	radio frequency
SOE	sequence of events
SOOH	satellite on-orbit operational handbook
SOP	satellite operation procedure
STR	structure
TCS	thermal control subsystem
TLM	telemetry
TTC	tracking, telemetry and command subsystem

5 Documentation

5.1 General preparations

5.1.1 General

Unless otherwise specified, the operation handbook and checklists shall include a reproducible copy in a digital format specified by the acquiring agency. If the magnitude of the information to be included in the operation handbook is such that a single volume is not practical, then more than one volume may be used to provide the material. The operation handbook shall contain a revision record when the document is changed or revised.

5.1.2 Arrangement of material

The document shall contain a main table of contents. At the beginning of each clause, there shall be a subsidiary clause table of contents. The clause table of contents shall include the page number and title of each sub clause or major subject headings.

When classified or proprietary information (needed for operation handbook) is involved, the same principles established for the treatment of the main table of contents shall be followed. The main table of contents shall contain numbers and titles of clauses with their initial page numbers, but shall not contain any classified or proprietary information.

EXAMPLE Operation crew members sometimes need detailed classified or proprietary design information of spacecraft for troubleshooting.

Space operation handbooks are normally unclassified. If the space system classification guide identifies the subjects as classified by the space systems operation crew members requirements, in accordance with current classification standards and for these classified subjects, the operation agency shall prepare a separate classified handbook or a classified supplement of the basic handbook.

The heading of the first or introductory paragraph of each clause shall be general in nature to facilitate including information concerning the main subject. Subordinate headings shall be definitive and identify the principal item that needs to be covered.

Wherever practical, text shall be simplified and decreased in quantity by the use of complementary artwork. All technical matter shall be written so that it is understandable by all personnel who are expected to use the handbook.

5.1.3 Illustration

The operation handbook shall contain the following illustrations:

a) general illustrations depicting the space system configuration;

b) illustrations to show clearly the layout of the space operations centre, including separate emergency/contingency facilities where applicable;

c) sufficient other illustrations and diagrams to show the major panels, cabinets, consoles, related equipment, etc. that the space operations crew personnel will use for operations;

d) sufficient diagrams, charts, schematics, etc. to depict the function, control and interrelationship of significant space system equipment.

Abbreviations, symbols, reference designations and colour coding references used in the space operations handbook shall also be specified, where applicable.

5.2 Space operation handbook

5.2.1 General

The space operation handbook shall provide the following:

a) General description of the space system giving the purpose, main features and particulars of the space system and supporting facilities [satellite segment, structure (STR), attitude and orbit control subsystem (AOCS), thermal control subsystem (TCS), tracking, telemetry and command subsystem (TTC), power subsystem (PS), payload communications subsystem and payload subsystem]; and a ground segment description giving both general and detailed information, including electrical power subsystem, environmental control subsystem, auxiliary equipment, communications, pre-launch segment, launch segment and mission life segment.

b) Operating functions giving general information, including the process and functional explanations, operations centre security procedures, changeover procedures, status and fault monitoring, activity coordination procedures, safety procedures, operations centre inspections and system test procedures, communications equipment procedures, ground system procedures, mission planning procedures, mission execution procedures and post-mission procedures including de-orbit and re-entry.

c) Mission operating procedures giving detailed information and defining individual and crew responsibilities.

d) Segment contingency procedures giving troubleshooting guidelines and remedial actions.

e) Operating limitations giving a description of specific limitations.

f) Ground segment emergency procedures giving detailed emergency operations procedures and corrective action.

g) Crew duties and responsibilities giving the individual positions and duties required during nominal and off-nominal operations.

h) Vocabulary giving technical terms, definitions, acronyms and abbreviations.

5.2.2 Overview

5.2.2.1 Front material

Front material shall include the bulleted list items in Figure 1. The cover/title page, list of effective pages, verification status sheets, table of contents, list of illustrations and list of tables shall be similar to the format of this recommended practice with details for preparation at the discretion of the acquiring agency.

NOTE The list of effective pages contains the revision of each page and revised date; the verification status sheets contain the stage of the document (i.e. WD, CD, review) and approved date.

The foreword shall discuss the various aspects of the operation handbook. Such discussion shall include the scope of the operation handbook and indicate the technical proficiency expected of the various space operations crew personnel. The foreword shall also indicate special interest items, e.g. new development items and critical operation items.

5.2.2.2 Requirements for clauses

Each operation handbook shall include the clauses listed in Figure 1. Additional clauses may be added if required. If a clause is not applicable, the title of that clause shall appear on the last page of the previous clause along with a notation that the clause is not applicable or that information will appear when it becomes available. The title of the clause shall appear in the main table of contents with an appropriate notation.

As appropriate, each clause shall have separate sections for information pertaining to satellite support during:

a) pre-launch period;

b) launch early orbit;

c) operations in nominal mode;

d) operations in degraded mode (period when the satellite is no longer fully operational but is still on orbit); and

e) post-mission phase (satellite end-of-life process).

The format for the presentation of the text, the amplified procedures and the abbreviated checklists shall be at the discretion of the acquiring agency. The format shall present the crew procedures in a simple, concise and understandable layout, consistent with space system requirements. For systems using digitized technical data, the visual template and the text shall be formatted so the screen presentation will be identical to the printed data.

If the operations agency does not require a printed page of the visual display, the visual display format shall comply with the style and format of a printed page. Each page of the emergency procedures clause shall have dialogue box and icon markings on all pages. An example is shown in Figure 2.

Warning marks “1” and contingent check segments “2” shall be selected by the operation agency.

Where possible, amplified procedures and checklists developed for a particular space system shall be standardized.

Front material

- Cover/title page
- List of effective pages
- Verification status sheets
- Table of contents
- List of illustrations
- List of tables
- Foreword

Clause 1 Space system description

Clause 2 Space system operating functions

Clause 3 Mission operating procedures

Clause 4 Space segment contingency procedures

Clause 5 Operating limitations

Clause 6 Ground segment emergency procedures

Clause 7 Crew duties and responsibilities

Clause 8 Vocabulary

Figure 1 — Standard sequence for space operation handbook

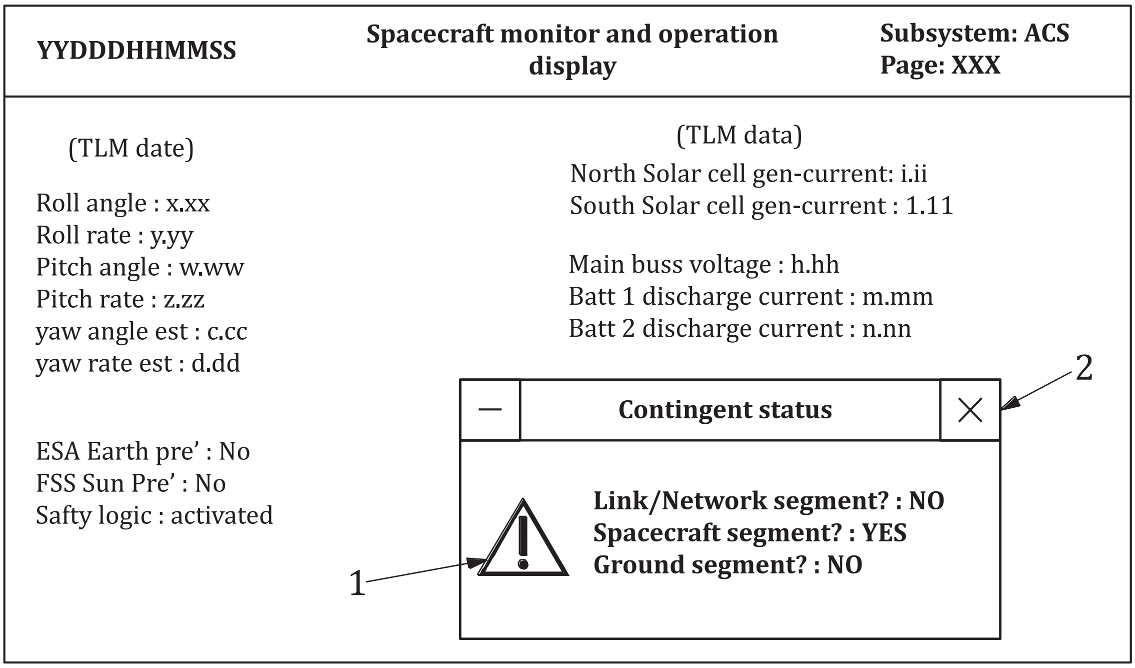
YYDDDHHMMSS
Spacecraft monitor and operation display
Subsystem: ACS
Page: XXX
(TLM date)
Roll angle : x.xx
Roll rate : y.yy
Pitch angle : w.ww
Pitch rate : z.zz
yaw angle est : c.cc
yaw rate est : d.dd
ESA Earth pre' : No
FSS Sun Pre' : No
Safty logic : activated
(TLM data)
North Solar cell gen-current: i.ii
South Solar cell gen-current : 1.11
Main buss voltage : h.hh
Batt 1 discharge current : m.mm
Batt 2 discharge current : n.nn
Contingent status
Link/Network segment? : NO
Spacecraft segment? : YES
Ground segment? : NO
1
2

Figure 2 — Visual display page of an emergency procedure