ECSS-E-70 Part 2A
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Space engineering

Ground systems and operations — Part 2: Document requirements definitions (DRDs)

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Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of documents.

This Standard has been prepared by the ECSS Ground systems and operations Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board.

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Introduction

Ground systems and operations are key elements of a space system and as such play an essential role in achieving mission success. Mission success is defined here as the achievement of the target mission objectives as expressed in terms of the quantity, quality and availability of delivered mission products and services within a given cost envelope.

Mission success requires successful completion of a long and complex process covering the definition, design, implementation, validation, in flight operations and post operational activities, involving both the ground segment and also space segment elements. It involves technical activities, as well as human and financial resources, and encompasses the full range of space engineering disciplines. Moreover it necessitates a close link with the design of the space segment in order to ensure proper compatibility between both elements of the complete space system.

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Scope

Part 2 of ECSS-E-70 “Space engineering — Ground systems and operations” defines the content of the document requirements definitions (DRDs) which are called up by other ECSS Standards and specifically referenced in ECSS-E-70 Part 1: “Principles and requirements”.

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Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

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Terms, definitions and abbreviated terms

The terms, definitions and abbreviated terms of ECSS-P-001 and ECSS-E-70 Part 1 apply.

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Document requirements definitions (DRD) list

ECSS Standards specify the production and use of project documents. Document requirements definitions are defined to control the content of the project documents.

Document requirements definitions serve to ensure

a. completeness and consistency of information within documents,

b. that the information contained in a document conforms to its defined scope, and correctly implements its interfaces with other documents, and

c. that portions of a document can be generated or maintained by separate organizational groups and seamlessly integrated into a coherent whole.

Table 1 lists and gives a summary of the DRDs that are defined in the annexes of this Standard and called up in ECSS-E-70 Part 1A.

Table 1: ECSS-E-70 DRD list

DRD ID	DRD title	DRD summary content	Applicable to (phase)	Delivered (phase)	Remarks
ECSS-E-70 Part 2A, annex A	Customer requirements document (CRD)	Formally defines the requirements from the customer on the ground segment. Covers design, implementation and operations as well as cost and programmatic issues.	B	B	
ECSS-E-70 Part 2A, annex B	Ground segment baseline definition (GSBD)	Formal response to CRD. Constitutes the ground segment technical baseline for the its design, implementation of the ground segment and for the operations of the mission. It includes conformance to CRD requirements, identifies derived requirements and major constraints and assumptions.	C to F	B	
ECSS-E-70 Part 2A, annex C	Mission operations concept document (MOCD)	Defines the overall mission operations concept at the level of major ground segment entities.	A, B	A*/B	
ECSS-E-70 Part 2A, annex D	Space segment user manual (SSUM)	Provides all information required to implement the ground segment and to operate the space segment, i.e.: • space segment design characteristics of operational relevance (e.g. operational modes, constraints); • telemetry and telecommand lists (i.e. all information items required for ground processing of TM and TC); • nominal and contingency recovery procedures (only covering space segment aspect).	C to F	C*/D	Used in phases C/D for design of G/S and maintenance in phase F
ECSS-E-70 Part 2A, annex E	Operational validation plan (OVP)	Provides all information required to execute the operational validation of the ground segment, i.e.: • definition of simulations and rehearsal activities; • timeline of above activities; • related organizational aspects and required resources and participation.	D	D	

* Delivery phase marked with an asterisk indicates a preliminary (draft) delivery

Table 1: ECSS-E-70 DRD list *(continued)*

DRD ID	DRD title	DRD summary content	Applicable to (phase)	Delivered (phase)	Remarks
ECSS-E-70 Part 2A, annex F	Flight operations plan (FOP)	Defines information required to operate the space segment during all applicable in-orbit phases of the mission, i.e.: • general operation organization and decision making process and major mission rules; • detailed schedule of flight operations; • Flight control procedures (FCP see below) for both nominal operations and major contingencies.	D	E, F	To contain also space segment disposal procedures
ECSS-E-70 Part 2A, annex G	Ground operations plan (GOP)	Defines all information required to operate the corresponding ground facility and its constituent elements in order to support the mission, i.e.: • operations management and organizational aspects; • detailed schedule of activities for the entity in relation to mission events; • elementary entity operation procedures.	D	E, F	To contain also ground segment disposal procedures

* Delivery phase marked with an asterisk indicates a preliminary (draft) delivery

Table 1: ECSS-E-70 DRD list *(continued)*

DRD ID	DRD title	DRD summary content	Applicable to (phase)	Delivered (phase)	Remarks
ECSS-E-70 Part 2A, annex H	Operations anomaly report (OAR)	Documents a departure from the expected performance of an item during its operation. Includes: • date and time of anomaly occurrence and unique identifier for the anomaly; • summary description of the symptoms and impacts; • corrective actions and recommendations.	E	E	
ECSS-E-70 Part 2A, annex I	Flight control procedure (FCP)	Elementary constituent of the FOP. • Defines all actions to be performed to ensure adequate configuration of the space segment to achieve a given mission goal. • Addresses operational responsibilities, system prerequisites and post execution verification conditions. Two types of FCPs can be distinguished, for nominal and routine operations, and contingency operations respectively.	D	E, F	To contain also space segment disposal procedures

* Delivery phase marked with an asterisk indicates a preliminary (draft) delivery

Annex A (normative)

Customer requirements document (CRD) DRD

A.1 Introduction

The customer requirements document (CRD) defines the requirements from the space segment customer on the supplier of the ground segment and operations.

A.2 Scope and applicability

A.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the customer requirements document. This DRD does not define format, presentation or delivery requirements for the customer requirements document.

A.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

A.3 References

A.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

A.3.2 Source documents

This DRD defines the content and data requirements of a Customer Requirements Document as controlled by the following source document:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

A.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 shall apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
AOCS	attitude and orbit control system
CRD	customer requirements document
DRD	document requirements definition
GSBD	ground segment baseline definition
HCI	human-computer interaction
LEOP	launch and early orbit phase

A.5 Description and purpose

The CRD contains all the essential top-level assumptions, constraints and operational requirements for the [insert project name] mission to allow the supplier of the ground segment and operations to perform a design of the ground segment and to develop an operations concept

A.6 Application and interrelationship

The CRD shall be written by the space project customer and is the highest-level requirements document defining the requirements on the ground segment and operations. The supplier of the ground segment and operations shall formally respond to the CRD with the ground segment baseline definition document (GSBD) where all requirements in the CRD can be traced to a proposed implementation.

A.7 Customer requirements document preliminary elements

A.7.1 Title

The document to be created based on this DRD shall be titled "[insert project name] customer requirements document".

A.7.2 Title page

The title page shall identify the project document identification number, title of the document, date of release and release authority.

A.7.3 Contents list

The contents list shall identify the title and location of every clause and major subclause, figure, table and annex contained in the document.

A.7.4 Foreword

A foreword shall be included in the document which describes the following items:

a. identification of which organizational entities prepared the document;

b. information regarding the approval of the document;

c. identification of other organizations that contributed to the preparation of the document;

d. a statement of effectivity identifying which other documents are cancelled or replaced in whole or in part;

e. a statement of significant technical differences between this document and any previous document;

f. the relationship of the document to standards or other documents.

A.7.5 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the CRD and the reasons prompting its preparations. The introduction shall not contain requirements.

A.8 Customer requirements document content

A.8.1 Scope and applicability

This clause shall be numbered 1 and shall describe the scope and applicability of the customer requirements document.

A.8.1.1 Scope

This subclause shall be numbered 1.1 and shall contain the following statements:

> "The [insert project name] customer requirements document constitutes the highest level requirements document formally defining the requirements on [insert ground systems and operations supplier name] for the operation of the [insert project name] mission.
>
> The response to the [insert project name] customer requirements document shall be contained in the [insert project name] ground segment baseline definition, produced by the [insert ground systems and operations supplier name]. In case differences arise between the [insert project name] customer requirements document and the [insert project name] ground segment baseline definition, the [insert project name] customer requirements document shall have priority."

A.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the [insert project name] customer requirements document with respect to the design, implementation, verification and validation and operations of entities of the [insert project name] ground segment and of the operations of the [insert project name] mission.

A.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

A.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

> "The following normative documents contain provisions which, through reference in this text, constitute provisions of this customer requirement document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this customer requirement document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.
>
> [insert document identifier] [insert document title]."

A.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

> "The following documents, although not a part of this customer requirements document, amplify or clarify its contents:
>
> [insert document identifier] [insert document title]."

A.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

A.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this customer requirements document, with the definition for each term.

If a project dictionary or glossary is applicable the following sentence shall be inserted:

> "The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

> "The following terms and definitions are specific to this document:
>
> [insert term] [insert definition]."

A.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the customer requirements document with the full meaning or phrase for each abbreviation.

A.8.4 Mission overview

This clause shall be numbered 4 and shall contain the following subclauses.

A.8.4.1 Mission description

This subclause shall be numbered 4.1 and shall briefly describe the main objectives and characteristics of the space mission.

A.8.4.2 Spacecraft

This subclause shall be numbered 4.2 and shall briefly describe the spacecraft.

A.8.4.3 Instruments

This subclause shall be numbered 4.3 and shall briefly describe the instruments on-board the spacecraft.

A.8.4.4 Ground segment

This subclause shall be numbered 4.4 and shall briefly describe the ground segment that is foreseen for the control and operations of the spacecraft, the instruments and the ground segment itself.

A.8.4.5 Operations

This subclause shall be numbered 4.5 and shall briefly describe the operations that are foreseen to achieve the goal of the space project.

A.8.5 Project responsibilities

This clause shall be numbered 5 and shall briefly describe the distribution of responsibilities within the space project. This shall include the responsibilities of the space project customer and those of the ground systems and operations supplier.

A.8.6 Major project milestones

This clause shall be numbered 6 and shall contain the following subclauses.

A.8.6.1 Space segment milestones

This subclause shall be numbered 6.1 and shall summarize the major project milestones relating to the space segment.

A.8.6.2 Ground segment milestones

This subclause shall be numbered 6.2 and shall summarize the major project milestones relating to the ground segment.

A.8.7 Mission constraints

This clause shall be numbered 7 and shall contain the following subclauses describing any constraints or other essential mission information that impacts on the design of the ground systems or the mission operations.

A.8.7.1 Launch

This subclause shall be numbered 7.1 and shall identify the launch vehicle, the launch site location, the ascent trajectory and the injection characteristics.

A.8.7.2 Orbit

This subclause shall be numbered 7.2 and shall identify the main orbital parameters for each distinct orbital phase i.e. wherever the orbit changes significantly.

A.8.7.3 Operational period

This subclause shall be numbered 7.3 and shall identify the intended operational period(s).

A.8.7.4 Operational phases and facility utilization

This subclause shall be numbered 7.4 and shall identify each distinct operational phase and shall identify any constraints on the use of ground segment facilities for each phase. Typical mission phases shall include LEOP, in-orbit commissioning, routine operations, disposal (e.g. de-orbiting). For deep space missions this can include periods of hibernation.

Constraints on the use of ground segment facilities may identify, for example:

- experimenter-supplied or operated facilities to be used for payload monitoring and control or for payload data processing;
- satellite manufacturer's facilities to be used for the post-launch maintenance of on-board software.

A.8.7.5 Satellite

This subclause shall be numbered 7.5 and shall identify any constraints imposed on the ground segment by the satellite. For example, uplink and downlink RF frequencies, on-board antenna patterns.

A.8.7.6 Other constraints

This subclause shall be numbered 7.6 and shall identify any other constraints not covered by the above categories.

A.8.8 Mission operations requirements

This clause shall be numbered 8 and shall identify the high level requirements on the mission operations and, by derivation, on the ground segment.

The requirements shall be specified at a level appropriate to permit all significant aspects of the mission operations concept to be developed. This in turn shall allow all major decisions concerning the deployment of ground segment facilities and their major design drivers to be established.

Requirements shall be organized according to the operations functional breakdown given in the subclauses A.8.8.1 to A.8.8.8. Requirements of the following classes shall be included for each major functional heading, where applicable:

- functional;
- performance;

- availability;
- operational;
- interface;
- design (implementation);
- maintainability;
- safety;
- security;
- human-computer interface (HCI).

Often the requirements for a given function differs for different mission phases. In these instances, requirements shall first be defined for the routine mission phase and then those requirements that are different for other mission phases shall be specified.

A.8.8.1 Mission planning and scheduling

This subclause shall be numbered 8.1 and shall identify the requirements for the mission planning function. This includes all activities relating to the processing of planning inputs and planning requests, the resolution of planning conflicts and the planning of on-board and ground resources utilization. It also includes the preparation of plans, schedules or timelines of operations as a result of the planning exercise.

A.8.8.2 Mission implementation

This subclause shall be numbered 8.2 and shall identify the requirements for the implementation of mission operations i.e. requirements relating to the commanding of the satellite and the payload instruments, the real-time monitoring of these operations and the verification of commanding activities.

A.8.8.3 Health monitoring

This subclause shall be numbered 8.3 and shall identify the requirements for routine monitoring of the health of the platform subsystems and the payload elements.

A.8.8.4 Performance monitoring and evaluation

This subclause shall be numbered 8.4 and shall identify the requirements for off-line processing of satellite telemetry data for the purposes of tuning of telemetry calibration data, for evaluating long-term performance trends and for monitoring the utilization of on-board resources.

A.8.8.5 Flight dynamics

This subclause shall be numbered 8.5 and shall identify the requirements for orbit and attitude determination and control. This shall include (as applicable): tracking data scheduling, acquisition and processing, support for AOCS data uplinking, manoeuvre planning, execution and evaluation, thruster calibration and performance monitoring, fuel management (e.g. logging, budgeting and lifetime prediction), implementation of collision avoidance strategy.

A.8.8.6 Mission product management

This subclause shall be numbered 8.6 and shall identify the requirements relating to the management of mission products or services. This shall include (as applicable): scheduling of data collection, data reception, data processing including value-added processing (e.g. meteorological product extraction), data archiving and cataloguing, data distribution (including mechanisms and media) and on-line access to data.

A.8.8.7 On-board software maintenance

This subclause shall be numbered 8.7 and shall identify the requirements for post-launch maintenance of on-board software for each distinct on-board processor within the satellite subsystems and the payload elements.

A.8.8.8 Other mission-specific operations functions

This subclause shall be numbered 8.8 and shall identify the requirements for other mission-specific operations functions not covered by any of the above categories. For example, special requirements pertaining to in-orbit testing, in-orbit commissioning or end-of-life operations, such as technological experiments, de-orbiting or other disposal operations.

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Annex B (normative)

Ground segment baseline definition (GSBD) DRD

B.1 Introduction

The ground segment baseline definition document (GSBD) constitutes the formal response to the customer requirements document (CRD) and establishes the ground segment technical baseline for its design, implementation and operations. It includes the supplier's compliance with CRD requirements, identifies derived requirements, major constraints and assumptions.

B.2 Scope and applicability

B.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the ground segment baseline definition. This DRD does not define format, presentation or delivery requirements for the ground segment baseline definition.

B.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

B.3 References

B.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

B.3.2 Source documents

This DRD defines the data requirements of the ground segment baseline definition as controlled by the following source document:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

B.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
AOCS	attitude and orbit control system
CRD	customer requirements document
DDF	design definition file
DRD	document requirements definition
EGSE	electrical ground support equipment
GSBD	ground segment baseline definition
GSS	ground segment supplier
MEC	mission exploitation centre
OCS	operation control system
PCC	payload control centre
RF	radio frequency
SSC	space system customer
TT&C	telemetry, tracking and command

B.5 Description and purpose

The GSBD is the top-level design document produced by the ground segment and operations supplier (GSS) to define the support to be provided for the mission. The GSBD forms the basis for all other specification and design activities undertaken by the GSS, as well as constituting the baseline for generating cost and schedule information.

B.6 Application and interrelationship

The GSBD constitutes the formal response to the CRD. All requirements in the CRD shall be traced in the GSBD and appropriately apportioned into specific GSBD clauses (mainly in clause 7 and its subclauses). Furthermore, any additional requirements may be derived in the GSBD to ensure common understanding and unambiguous interpretation of the CRD requirements.

B.7 Ground segment baseline definition preliminary elements

B.7.1 Title

The document to be created based on this DRD shall be titled "[insert project name] ground segment baseline definition".

B.7.2 Title page

The title page for this document shall identify the project document identification number, title of the document, date of release and release authority.

B.7.3 Contents list

The contents list shall identify the title and location of every clause and major subclause, figure, table and annex contained in the document.

B.7.4 Foreword

A foreword shall be included in the document which describes the following items:

a. a statement of significant technical differences between this document and any previous release;

b. the distribution list for the project document indicating the name of the recipient and his organization;

c. the identification of which organization(s) have prepared or contributed to the preparation of the document;

d. information regarding the approval of the document;

e. an abstract.

B.7.5 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the GSBD and the reasons prompting its preparations. The introduction shall not trace CRD requirements nor contain requirements.

B.8 Ground segment baseline definition content

B.8.1 Scope and applicability

This clause shall be numbered 1 and shall contain the following subclauses.

B.8.1.1 Scope

This subclause shall be numbered 1.1 and shall contain the following statements:

> "The [insert project name] ground segment baseline definition constitutes the formal technical response of [insert ground segment supplier name] to the [insert project name] customer requirements document produced by [insert space system customer name]. It is an element of the [insert project name] design definition file (DDF) and is complemented by a management plan that includes work package definitions, planning and costs. When signed, the [insert project name] ground segment baseline definition constitutes the agreement between [insert ground segment supplier name] and [insert space system customer name] on the technical baseline for the implementation of the [insert project name] ground segment and mission operations.
>
> The [insert project name] ground segment baseline definition establishes the [insert project name] ground segment facilities and services that need to be provided in order to fulfil the requirements stated in the [insert project name] customer requirements document. It consists of the technical definition of the ground segment, including its architecture, mission analysis, operations and logistics concepts and logistics plan. All the assumptions made for this technical baseline, the interfaces required to major internal and external systems, as well as the foreseen quality of the facilities and services to be provided are also specified."

B.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the [insert project name] ground segment baseline definition with respect to the design, implementation, verification and validation and operations of entities of the [insert project name] ground segment and of the operations of the [insert project name] mission.

B.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

B.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

"The following normative documents contain provisions which, through reference in this text, constitute provisions of this ground segment baseline definition document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this ground segment baseline definition document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

[insert document identifier] [insert document title]."

The project-specific CRD shall be included in the list above.

B.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

"The following documents, although not a part of this ground segment baseline definition, amplify or clarify its contents:

[insert document identifier] [insert document title]."

B.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

B.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this ground segment baseline definition, with the definition for each term.

If a project dictionary or glossary is applicable the following sentence shall be inserted:

"The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

"The following terms and definitions are specific to this document:

[insert term] [insert definition]."

B.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the ground segment baseline definition with the full meaning or phrase for each abbreviation.

B.8.4 Mission description and ground segment overview

This clause shall be numbered 4 and shall contain the following subclauses.

B.8.4.1 Mission description

This subclause shall be numbered 4.1 and shall briefly describe the main objectives and characteristics of the space mission.

B.8.4.2 Mission operations concept overview

This subclause shall be numbered 4.2 and shall briefly describe the intended operational concept that would fulfil the mission objectives. Together with the mission description subclause above, it serves the purpose of putting the ground segment overview into context.

B.8.4.3 Ground segment overview

This subclause shall be numbered 4.3 and shall provide an overview of the full ground segment that would achieve the objectives of the space mission. In particu-

lar, it shall identify those ground segment entities that fall under the GSS technical responsibility and those that are considered external.

B.8.5 Mission constraints and implementation assumptions

This clause shall be numbered 5 and shall contain the following subclauses.

B.8.5.1 Mission constraints

This subclause shall be numbered 5.1 and shall identify all constraints coming from the launch and the space segments (e.g. space segment operability constraints, spacecraft visibility, eclipse handling, orbit determination and attitude reconstruction precision) and their impact on the mission operations concept and the ground segment architecture.

B.8.5.2 Ground segment implementation assumptions

This subclause shall be numbered 5.2 and shall list all the assumptions that have been made to produce the ground segment baseline definition.

B.8.6 Ground segment interfaces

This clause shall be numbered 6 and may contain the following subclauses depending on the GSS responsibility.

B.8.6.1 Interfaces to space segment

This subclause shall be numbered 6.1 and shall summarize the interfaces with the space segment including:

- the RF level interfaces,
- the TT&C transmission level protocols and their mission specific implementation,
- the TT&C application level interfaces (i.e. the operational services between on-board and associated ground data handling applications and their formats), and
- operability requirements.

B.8.6.2 Interfaces to launch segment

This subclause shall be numbered 6.2 and shall summarize the interfaces with the launch segment (e.g. launcher characteristics, communication with spacecraft once at the launch site, voice communications).

B.8.6.3 Interfaces to external entities

This subclause shall be numbered 6.3 and shall summarize the interfaces with external entities that constitute part of the ground segment, but whose implementation is not under the GSS responsibility.

B.8.7 Pre-launch support and implementation

This clause shall be numbered 7 and may contain the following subclauses depending on the GSS responsibility.

B.8.7.1 Mission analysis and system studies

This subclause shall be numbered 7.1 and shall define and justify all the mission analysis and system studies that are required to design a ground segment that meets the objectives of the space mission.

B.8.7.2 Ground systems design and implementation

This subclause shall be numbered 7.2 and shall define the technical approach to design and implementation of the individual ground system elements under the responsibility of the GSS (e.g. mission control system, EGSE system, ground

station system, ground communication subnet). A dedicated subclause shall be used to cover each ground system element under GSS responsibility.

B.8.7.3 Operations preparation

This subclause shall be numbered 7.3 and shall define the technical approach to the production and validation of mission operations data (procedures and databases) and the build-up and training of operations teams.

B.8.7.4 Ground segment integration and technical verification and validation

This subclause shall be numbered 7.4 and shall define the technical approach to integration and testing of the ground system elements up to the level of the individual ground systems, and the technical verification and validation of the ground systems as a whole.

B.8.7.5 Operational validation

This subclause shall be numbered 7.5 and shall define the technical approach to operational validation of the ground segment.

B.8.8 Mission operations

This clause shall be numbered 8 and may contain the following subclauses depending on the GSS responsibility.

B.8.8.1 Mission planning and scheduling

This subclause shall be numbered 8.1 and shall describe the technical approach for the mission planning function for each mission phase. This includes all activities relating to the processing of planning inputs and planning requests, the resolution of planning conflicts and the planning of on-board and ground resources utilization. It also includes the preparation of plans, schedules or timelines of operations as a result of the planning exercise.

B.8.8.2 Mission implementation

This subclause shall be numbered 8.2 and shall describe the technical approach for the implementation of mission operations, i.e. activities relating to the commanding of the satellite and the payload instruments (where applicable), the real-time monitoring of these operations and the verification of commanding activities.

B.8.8.3 Health monitoring

This subclause shall be numbered 8.3 and shall describe the technical approach for routine monitoring of the health of the platform subsystems and the payload elements.

B.8.8.4 Performance monitoring and evaluation

This subclause shall be numbered 8.4 and shall describe the technical approach for of-line processing of satellite telemetry data for the purposes of tuning of telemetry calibration data, for evaluating long-term performance trends and for monitoring the utilization of on-board resources.

B.8.8.5 Flight dynamics

This subclause shall be numbered 8.5 and shall identify describe the technical approach for orbit and attitude determination and control. This shall include (as applicable): tracking data scheduling, acquisition and processing, support for AOCS data uplinking, manoeuvre planning, execution and evaluation, thruster calibration and performance monitoring, fuel management (logging, budgeting and lifetime prediction), implementation of collision avoidance strategy.

B.8.8.6 Mission product management

This subclause shall be numbered 8.6 and shall describe the technical approach for the management of mission products or services. This shall include (as applicable): scheduling of data collection, data reception, data processing including value-added processing (e.g. meteorological product extraction), data archiving and cataloguing, data distribution (including mechanisms and media) and on-line access to data.

B.8.8.7 On-board software maintenance

This subclause shall be numbered 8.7 and shall identify describe the technical approach for post-launch maintenance of on-board software for each distinct on-processor within the satellite subsystems and the payload elements.

B.8.8.8 Other mission-specific operations functions

This subclause shall be numbered 8.8 and shall identify describe the technical approach for other mission-specific operations functions not covered by any of the above categories. For example, in-orbit testing, in-orbit commissioning, logistics associated with re-flights or end-of-life operations, such as technological experiments, de-orbiting or other disposal operations.

B.8.9 Ground segment systems and facilities

This clause shall be numbered 9 and contain the following subclauses that shall define the ground segment systems and facilities including their required supporting logistics infrastructure (e.g. geographical location, required rooms).

B.8.9.1 Ground station system

This subclause shall be numbered 9.1 and shall define the network of ground stations required to support the mission in all phases.

B.8.9.2 Ground communication subnet

This subclause shall be numbered 9.2 and shall define the communications network that is required to support the mission and to distribute the mission products in the different phases, including back-up.

B.8.9.3 Mission control centre

This subclause shall be numbered 9.3 and shall define the mission control centre in terms of required systems/elements, the corresponding operation team(s) and operations data. If several control centres exist (e.g. operations control centre, payload control centre, and mission exploitation centre), then a subclause shall be provided for each of them.

B.8.9.4 Special to project facilities

This subclause shall be numbered 9.4 and shall summarize (if any) special project facilities provided by GSS in support of the mission (e.g. software licences, consumables, building modifications) as identified in other parts of the GSBD.

B.8.10 Required input and output items and services

This clause shall be numbered 10 and shall contain the following subclauses.

B.8.10.1 [Insert name of GSS] provided

This subclause shall be numbered 10.1 and shall list all the deliverable items and services required from the GSS to support the mission.

B.8.10.2 [insert name of SSC]-provided

This subclause shall be numbered 10.2 and shall list all the deliverable items and services required from the SSC in order to support the GSS work. They may include

- space segment documents and information (e.g. space segment user manual, mission operations database),
- support to or supply of the space segment simulator and other test or training tools,
- provision of an RF suitcase,
- access to the space segment for testing purposes,
- provision of space segment engineering support for the ground segment design phases,
- provision of tools, document and engineering support required for the maintenance of the space segment software during operations execution, and
- provision of space segment engineering support for the in-orbit control of the mission during critical phases, and for in-orbit commissioning.

B.8.11 Ground segment quality

This clause shall be numbered 11 and, for the proposed ground segment (including human functions), shall define the achievable quality in terms of performances, availability and usefullness of the mission products.

B.8.12 Annexes

The following annexes shall be provided.

B.8.12.1 Annex A - CRD vs. GSBD traceability matrix

This annex shall be numbered Annex A and shall provide a CRD vs. GSBD traceability matrix. This matrix shall have 4 columns.

Starting from the left:

The first column contains a list of all requirements in the CRD.

The second column provides a cross-reference (e.g. one or more GSBD paragraphs) where the requirement is fulfilled.

The third column indicates the level of the supplier's compliance of the GSBD to the CRD; possible values are:

- COMPLIANT
- PARTIALLY COMPLIANT
- NON-COMPLIANT.

The fourth column shall provide a brief justification in those cases where column three indicates partial or non-compliance.

B.8.12.2 Annex B - To-be-resolved items

This annex shall be numbered Annex B and shall list all the items for which a clear resolution has not yet been found. It serves as a "shopping list" which summarizes the still open points.

B.8.12.3 Annex C - To-be-determined and to-be-confirmed items

This annex shall be numbered Annex C and shall list all the items for which further information is required before committing to a specific ground segment implementation. It serves as a "shopping list" which summarizes the still to-be-confirmed points.

Annex C (normative)

Mission operations concept document (MOCD) DRD

C.1 Introduction

The mission operations concept document (MOCD) defines the operations concepts for the various phases of the mission, covering both the space segment and the ground segment.

C.2 Scope and applicability

C.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the mission operations concept document. This DRD does not define format, presentation or delivery requirements for the mission operations concept document.

C.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

C.3 References

C.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

C.3.2 Source documents

This DRD defines the data requirements of the mission operations concept document as controlled by the following source documents:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

C.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
CFI	customer furnished items
DRD	document requirements definition
GSBD	ground segment baseline definition
LEOP	launch and early orbit phase
MOCD	mission operations concept document

C.5 Description and purpose

The mission operations concept document identifies the required operational processes for the mission and how they shall be achieved by the different ground segment elements (including operations personnel). It is a precursor document for the elaboration of detailed requirements for the ground segment and operations.

C.6 Application and interrelationship

The MOCD is a supporting document for the preparation of the ground segment baseline definition (GSBD), which is the formal response to the CRD. Relevant requirements in the CRD document shall be traced within the MOCD. Furthermore, additional operational details may be derived in the MOCD to ensure common understanding and unambiguous interpretation of the CRD requirements.

The mission analysis report produced during Phase A/0 constitutes a major input to the MOCD.

C.7 Mission operation concept document preliminary elements

C.7.1 Title

The document to be created based on this DRD shall be titled "[insert project name] mission operations concept document".

C.7.2 Title page

The title page for this document shall identify the project document identification number, title of the document, date of release and release authority.

C.7.3 Contents list

The contents list shall identify the title and location of every clause and major subclause, figure, table and annex contained in the document.

C.7.4 Foreword

A foreword shall be included in the document which describes the following items:

a. identification of which organizational entities prepared the document;

b. information regarding the approval of the document;

c. identification of other organizations that contributed to the preparation of the document;

d. a statement of effectivity identifying which other documents are cancelled or replaced in whole or in part;

e. a statement of significant technical differences between this document and any previous document;

f. the relationship of the document to standards or other documents.

C.7.5 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the MOCD and the reasons prompting its preparation.

C.8 Mission operations concept document content

C.8.1 Scope and applicability

This clause shall be numbered 1 and shall contain the following subclauses.

C.8.1.1 Scope

This subclause shall be numbered 1.1 and shall contain the following statements:

> The [insert project name] mission operations concept document constitutes part of the formal technical response of [insert ground segment supplier name] to the [insert project name] CRD produced by [insert space system customer name]. It is a complementary document to the [insert project name] ground segment baseline definition document.

C.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the [insert project name] mission operations concept document with respect to the operations of entities of the [insert project name] ground segment and of the [insert project name] mission.

C.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

C.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

> "The following normative documents contain provisions which, through reference in this text, constitute provisions of this mission operations concept document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this mission operations concept document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.
>
> [insert document identifier] [insert document title]."

C.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

> "The following documents, although not a part of this mission operations concept document, amplify or clarify its contents:
>
> [insert document identifier] [insert document title]."

C.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

C.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this mission operations concept document, with the definition for each term.

If a project dictionary or glossary is applicable, the following sentence shall be inserted:

> "The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

> "The following terms and definitions are specific to this document:
>
> [insert term] [insert definition]."

C.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the mission operations concept document with the full meaning or phrase for each abbreviation.

C.8.4 Mission operations requirements and constraints

This clause shall be numbered 4 and shall include all the essential input information that drives or constrains the operations concepts. It shall contain the following subclauses:

C.8.4.1 Mission description

This subclause shall be numbered 4.1 and shall briefly describe the mission's scope, objectives and the top-level requirements on its operations. This information shall be derived from the mission analysis report and the customer requirements document.

C.8.4.2 End-users

This subclause shall be numbered 4.2 and shall identify all distinct categories of mission end-user and describe the data products, services, associated availability and timeliness of delivery requirements.

C.8.4.3 Programmatic and operational constraints

This subclause shall be numbered 4.3 and shall identify any constraints relating to the design of the ground segment or its operation, for example:

- the re-use of existing ground segment elements or infrastructure;
- the use of remote facilities for operation or maintenance of part of the space or ground segments, such as experimenter-provided control facilities or industry-provided facilities for software maintenance;
- the use of customer furnished items (CFI) developed as part of the space segment programme and to be re-used for operations.

C.8.4.4 Relationships with other missions/programmes

This subclause shall be numbered 4.4 and shall describe the relationship of the mission with other missions or programmes, for example:

- membership of an on-going family of missions of the same or similar design;
- membership of a multi-national or coordinated multi-mission programme;
- agreements for the ground segment to support other concurrent missions or programmes or to process data from other missions.

C.8.4.5 External dependencies or interfaces with other organizations

This subclause shall be numbered 4.5 and shall describe the operational interfaces with other agencies, companies or other third parties.

C.8.5 Space segment characteristics

This clause shall be numbered 5 and shall describe the capabilities and characteristics of the space segment platform, payload(s) and the space link subnet. The objective shall be to capture all the salient operational characteristics that contribute to the analysis of the required operations processes. This shall include a description of:

- on-board autonomous functions;
- the mechanisms for on-board generation, storage and downlinking of mission data products
- the provision of end-user services.

C.8.6 Mission operations concepts

This clause shall be numbered 6 and shall contain separate subclauses (numbered 6.1, 6.2, ..., 6.n) describing the mission operations concepts for each distinct mission phase. The operations concepts shall be presented according to the same top-level breakdown of operations processes, as defined below. It is recognized that at a certain level of breakdown, some of these processes are not applicable for a given mission phase and the corresponding subclause shall therefore be omitted. For example, mission exploitation processes are not normally undertaken during the LEOP. In a similar way:

- there can be some additional mission-specific operations processes;
- the concept for accomplishing a given process can be the same for several mission phases, in which case it shall not be repeated, but instead a cross-reference shall be made to the relevant subclause where the concept is described.

The operations concept shall identify how the given operations process shall be accomplished by the use of facilities and operations personnel. It shall also identify:

- areas where existing operational capabilities and services are re-used. For example, there may be a mission constraint to re-use an existing infrastructure, perhaps modified or extended for the mission;
- areas where existing operational capabilities cannot satisfy the concept, i.e. new developments are required;
- areas where a trade-off is required, for example if it is not obvious whether a given operational process should be achieved by ground automation or whether it should be performed manually by an operator.

C.8.6.1 Planning processes

These subclauses shall be numbered 6.n.1 and shall describe the concept for the planning and scheduling of space and ground segment operations. This shall include:

a. user request management;

b. space segment routine operations;

c. ground segment maintenance requests;

d. constraints management;

e. resources management (space and ground);

f. conflict resolution;

g. space segment operations scheduling;

h. ground facilities operations scheduling.

C.8.6.2 Operations execution processes

These subclauses shall be numbered 6.n.2 and shall describe the concept for the implementation of scheduled operations for the space and ground segment. This shall include:

a. schedule execution;

b. procedure execution;

c. manual commanding;

d. command pre-transmission validation and uplink management;

e. command verification;

f. schedule and command history archiving;

g. space and ground segment health monitoring;

h. anomaly detection, isolation and recovery.

C.8.6.3 Evaluation processes

These subclauses shall be numbered 6.n.3 and shall describe the concept for evaluating the success of executed operations and for monitoring the performance of the space segment. This shall include:

a. data analysis processes (trend analysis, future predictions);

b. monitoring of resource availability and utilization with provision of feedback to the planning processes described earlier;

c. report production (automated report production, routine operations reporting, anomaly reporting).

C.8.6.4 Mission exploitation processes

These subclauses shall be numbered 6.n.4 and shall describe the concept for the processing, archiving and delivery of mission products to the end-users in a timely manner. This shall include:

a. data transmission between ground entities;

b. data processing on ground (e.g. products processing);

c. data delivery to the end-user;

d. data archiving, cataloguing and retrieval;

e. processed data feedback to mission planning.

C.8.6.5 Support processes

These subclauses shall be numbered 6.n.5 and shall describe the concepts for all other activities required in support of operations that are not covered by any of the above categories. This shall include:

a. orbit and attitude determination and maintenance;

b. orbital and geometric event prediction;

c. ground station coverage predictions;

d. operational database maintenance;

e. ground software maintenance;

f. on-board software maintenance.

C.8.6.6 Mission operations teams

These subclauses shall be numbered 6.n.6 and shall describe the mission operations teams' organizational structure and the allocation of responsibilities to individuals (roles). The reporting channels and mechanisms for operational support shall also be described (e.g. call-out procedures for first and second-line operations support staff). The philosophy for operations staff recruitment and training shall also be addressed.

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Annex D (normative)

Space segment user manual (SSUM) DRD

D.1 Introduction

The space segment user manual (SSUM) provides all the design and operational information for the space segment that is required by the ground segment and operations supplier (GSS) to prepare for and implement the mission operations.

D.2 Scope and applicability

D.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the space segment users manual. This DRD does not define format, presentation or delivery requirements for the space segment user manual.

D.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

D.3 References

D.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements
ECSS-E-70-41[1)]	Space engineering — Telemetry and telecommand packet utilization

D.3.2 Source documents

This DRD defines the data requirements of a Space Segment User Manual as controlled by the following source documents:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

1) To be published.

D.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD.

Abbreviation	Meaning
CRD	customer requirements document
DRD	document requirements definition
FMECA	failure modes, effects and criticality analysis
FTA	fault tree analysis
FOP	flight operations plan
SGICD	space-to-ground interface control document
SSUM	space segment user manual
TM/TC	telemetry/telecommand

D.5 Description and purpose

The SSUM shall contain the following information:

a. a complete description of the different mission phases and the associated activities (operations) to be performed;

b. a description of the satellite at system level;

c. a complete description of the space-to-ground interfaces;

d. operating modes at the system level;

e. a detailed design description of each on-board subsystem;

f. detailed requirements for ground mission-specific processes needed during operations;

g. telemetry and telecommand list and data base required for ground processing of TM/TC;

h. procedures for both nominal and contingency operations.

The SSUM is used by the GSS for the following purposes:

- the establishment of the operational databases which contain the characteristics and processing information for the telemetry and telecommands;
- the production of the flight operations plan (FOP) which includes timelines or schedules for the different mission phases and procedures for all nominal and contingency operations;
- the identification of requirements for mission specific software and hardware needed on ground, to support the mission.

D.6 Application and interrelationship

The SSUM complements the customer requirements document (CRD) by providing detailed information on the design and operation of the space segment.

D.7 Space segment user manual preliminary elements

D.7.1 General

Reflecting the complexity of satellite missions and their operation, the SSUM is usually a substantial document that runs to several volumes. The division of the document into volumes and the sub-division of volumes into “books” or “parts” is not prescribed by this DRD, but is left to the discretion of the authors. However, where the SSUM runs to more than one volume, the “Title”, “Title page”, “Amend-

ment control table" and "Contents list" defined below shall be repeated for each volume. The contents list for each volume shall indicate the location of the current volume within the overall document and shall identify the detailed contents of the current volume. The other preliminary elements defined below shall only appear in volume 1 of the SSUM.

It is anticipated that much of the information contained in the SSUM shall be derived from other documents. Nevertheless the SSUM shall be a self-contained document, i.e. all required material shall be included in the SSUM and not cross-referenced to other documents.

D.7.2 Title

The document to be created based on this DRD shall be titled "[insert project name] space segment user manual".

D.7.3 Title page

The title page for this document shall identify the project document identification number, title of the document, date of release and release authority.

D.7.4 Contents list

The contents list shall identify the title and location of every clause and major subclause, figure, table and annex contained in the document.

D.7.5 Foreword

A foreword shall be included in the document which describes the following items:

a. a statement of significant technical differences between this document and any previous release;

b. the distribution list for the project document indicating the name of the recipient and his organization;

c. the identification of which organization(s) have prepared or contributed to the preparation of the document;

d. information regarding the approval of the document;

e. an abstract.

D.7.6 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the SSUM and the reasons prompting its preparation.

D.8 Space segment user manual content

D.8.1 Scope and applicability

This clause shall be numbered 1 and shall contain the following subclauses.

D.8.1.1 Scope

This subclause shall be numbered 1.1 and shall provide a short definition of SSUM contents.

D.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the [insert project name] space segment user manual with respect to the design, implementation, verification and validation and operations of entities of the [insert project name] ground segment and of the operations of the (insert project name) mission.

D.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses

D.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

> "The following normative documents contain provisions which, through reference in this text, constitute provisions of this space segment user manual. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this space segment user manual document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.
>
> [insert document identifier] [insert document title]"

The project-specific CRD shall be included in the list above.

D.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

> "The following documents, although not a part of this space segment user manual, amplify or clarify its contents:
>
> [insert document identifier] [insert document title]".

D.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

D.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this space segment user manual, with the definition for each term.

If a project dictionary or glossary is applicable, the following sentence shall be inserted:

> "The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

> "The following terms and definitions are specific to this document:
>
> [insert term] [insert definition]."

D.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the SSUM, with the full meaning or phrase for each abbreviation.

D.8.4 Mission definition

This clause shall be numbered 4 and shall contain the following subclauses.

D.8.4.1 Mission description

This shall be a general description of the mission and identification of the content of different phases from launch to disposal phase.

D.8.4.2 Mission analysis constraints

This shall detail any space segment constraints to be taken into account in mission analysis.

D.8.4.3 Mission phases and purposes

This shall detail the results of analyses for positioning and for in-orbit operations, taking into account satellite constraints.

a. Results of analyses for positioning (or initial orbits):
   - pre-launch configuration;
   - launch window (variations over one year);
   - satellite or launch vehicle separation sequence;
   - positioning strategy;
   - required accuracy for attitude and orbit determination;
   - chronological order of nominal operational sequences;
   - visibility of the ground stations used;
   - detailed analysis of high-risk sequences;
   - fuel consumption;
   - risks of interference with satellites currently operating.

b. Results of analyses for in-orbit operations:
   - in-orbit flight control strategy (e.g. change of position, phasing, de-orbiting);
   - fuel consumption;
   - consequences that the environment can have on operational sequences (e.g. sensor blinding, eclipses);
   - risks of interference with satellites currently operating.

D.8.5 Satellite system description

This clause shall be numbered 5 and shall contain the following subclauses.

D.8.5.1 System design summary

This subclause shall be numbered 5.1 and shall include the following:

a. summary of the satellite system design, showing the definition of the platform subsystems, the distribution of functions and the major interfaces between them;

b. a block diagram of the space segment;

c. a top-level description of the on-board software architecture, for the platform subsystems and payload elements;

d. description of the objectives of the payload as a whole and (where applicable) of each individual experiment or instrument;

e. description of nominal payload operations scenarios and any constraints on payload operations, e.g. mutually exclusive modes of operation, power or resource sharing.

D.8.5.2 System-level autonomy

This subclause shall be numbered 5.2 and shall include the following:

a. description of system-level autonomy provisions in the areas of mission management and fault management;

b. definition, for each autonomous function, of the logic or rules used and the interfaces with the on-board subsystems or payload and the ground (e.g. inputs, reporting mechanism).

D.8.5.3 System-level configurations

This subclause shall be numbered 5.3 and shall include the following:

a. drawings of the overall satellite configuration in all mission phases (e.g. launch, separation, following deployments);

b. definition of the satellite reference axes system(s);

c. drawings of the platform and equipment layouts.

D.8.5.4 System-level budgets

This subclause shall be numbered 5.4 and shall include the distribution (or allocation) of the following budgets, per platform subsystem or payload, or per mission phase, as appropriate:

- satellite mass evolution;
- satellite mass properties evolution;
- power consumption for all operational modes;
- power available in different mission phases;
- thermal budget and constraints and predictions;
- RF links (down and up);
- telemetry and telecommand date rates (e.g. per virtual channel);
- memory;
- timing (including allocation between space and ground segments);
- propulsion system data;
- attitude measurement sensor data;
- pointing accuracy in routine phase;
- pointing accuracy in manoeuvre phase;
- alignment.

D.8.5.5 Satellite or ground station interface specifications

This subclause shall be numbered 5.5 and contain the following information needed to define the communications between the space segment and ground systems:

a. the RF interface specifications for satellite/ground stations:
   - frequency band for the radio link;
   - RF standards used;
   - specifications for satellite transmission and reception (power, rate);
   - retransmitting and receiving spectra;
   - nominal and worst case TM/TC antenna coverage;
   - nominal and worst case link budget;
   - transit time (or phase shift) for ranging measurement signals.

b. the encoding and description of data exchanged between the satellites and the satellite control centre:
   - standards used;
   - structure and description of telemetry and telecommands;
   - principle and description of ranging measurements.

D.8.6 System level operations

This clause shall be numbered 6 and shall contain the following subclauses.

D.8.6.1 Mission timelines

The baseline event timelines for each mission phase from separation from the launcher until the start of routine operations (i.e. LEOP, commissioning, payload calibration).

The baseline event timeline for daily activities during the routine phase (or any other appropriate repeat cycle of routine operations).

The baseline event timelines for any subsequent critical (or non-routine) phases during the mission (e.g. eclipse, phases, manoeuvres, planetary, encounters).

Each timeline shall contain a detailed description (i.e. at the level of each single operational action) of the complete sequence of operations to be carried out, including the rationale behind the chosen sequence of events, a definition of any constraints which exist (e.g. absolute timing, relative timing) and the logical interrelationships between operations in the sequence.

D.8.6.2 System-level modes

Identification and description of all nominal and back-up modes (at the system level). This shall include

- their purpose (i.e. circumstances under which they shall be used),
- operational constraints,
- resource utilization,
- the definition of the associated modes for each platform subsystem and payload, and
- ground monitoring requirements.

Identification of the allowable mode transitions and the operational procedure corresponding to each such transition.

This clause shall make appropriate reference to subsystem or payload modes and procedures contained in subclauses D.8.7 and D.8.8.

D.8.6.3 System-level failure analysis

The results of the system-level failure modes, effects and criticality analysis (FMECA) and the list of single point failures.

Potential system-level failures shall be identified by means of a fault tree analysis (FTA).

D.8.7 Platform subsystems description

This clause shall be numbered 7 and shall contain a separate subclause for each satellite platform subsystem with the following contents:

D.8.7.1 [Insert subsystem name] subsystem

D.8.7.1.1 Design summary

An overview of the subsystem at a level of detail such that the information presented in the subsequent sections can be understood in the overall context of the subsystem. This shall therefore include the following:

- the overall functions of the subsystem and the definition of its operational modes during the different mission phases;
- description of any subsystem-level management functions, fault management concept and redundancy provisions;
- a summary description of the component units/equipment and on-board software including the functions which each supports;
- subsystem functional block diagrams and a diagram showing the source of telemetry outputs and the sink of telecommand inputs;
- interface;
- budgets.

D.8.7.1.2 Unit or equipment design definition

A separate subclause shall be provided for each subsystem unit with the following contents:

a. a detailed design description, including block diagrams, functional diagrams, logic and circuit diagrams;

b. physical characteristics including location and connections to the satellite structure, axes definition and alignment where relevant, dimensions and mass properties;

c. principle of operation and operational constraints of the unit or equipment.

If a unit is composed of many complex elements or modules, it can be necessary to provide a lower level of breakdown; however, the structure shall be consistent with this sub-section.

D.8.7.1.3 Subsystem software (where applicable)

a. Description of software design

   Description of the organization of the subsystem software and the physical mapping of software into subsystem hardware.

b. Subsystem software

   Detailed description of each component of the subsystem software i.e. scheduler, interrupt handler, I/O system, telecommand packet handling system, telemetry packet handling system, etc. This shall include its functions, component routines, input/output interfaces, timing and performance characteristics, flowcharts and details of any operational constraints.

c. Application process service software

   A short description of the services implemented making cross-reference to ECSS E-70-41 “Telemetry and telecommand packet utilization”, as tailored for the mission.

   For each service, a summary of all telemetry and telecommand structures (e.g. packets) shall be provided together with the circumstances under which they are generated, the generation frequency, content and interpretation.

d. Memory map

   For each memory block, a map shall be provided showing RAM and ROM address areas, areas allocated for program code, buffer space and working parameters (e.g. content of protected memory).

D.8.7.1.4 Subsystem performance

Definition of all relevant subsystem performance characteristics (detailed performance data shall be placed in annexes).

Definition of the expected performance degradation as a function of mission lifetime and identification of the resultant impact in terms of modified operational requirements or constraints.

D.8.7.1.5 Subsystem TM/TC list

For each subsystem, the following lists shall be provided:

a. a list of the housekeeping telemetry parameters. For each parameter it shall include a function description with validity conditions, telecommand relationship and all technical information necessary for using it;

b. a list of the telecommands. For each telecommand it shall include a functional description with utilization conditions (e.g. pre-transmission validity, criticality level) and execution verification in telemetry.

This data may be provided within the Satellite Database, which shall formally constitute part of this SSUM.

D.8.7.1.6 Subsystem operations

a. Subsystem modes

Definition of all distinct nominal and back-up modes of the subsystem. This shall include:

- their purpose (i.e. circumstances under which they shall be used);
- operational constraints;
- resource utilization;
- the definition of the associated modes for each subsystem unit, equipment and software function;
- ground monitoring requirements.

Identification of the allowable mode transitions and any subsystem-level operational constraints.

b. Nominal operational procedures

Definition of an operational procedure for each nominal mode transition identified above. For each procedure, the following shall be provided:

- an introduction describing the purpose of the procedure and the mission phase(s) or circumstances when applicable;
- the body of the procedure, which shall be structured according to distinct operational steps. Each step may include:
  - pre-requisites for the start of the step. Define, where applicable:
    * satellite system-level or subsystem-level pre-requisites (e.g. configuration and resource requirements, such as power, fuel);
    * satellite attitude and orbit pre-requisites;
    * ground system pre-requisites;
  - telecommands to be sent;
  - telemetry to be monitored to verify correct execution of the step;
  - recovery actions;
  - interrelationships between steps (e.g. conditional branching within the procedure, timing requirements or constraints, hold and check points);
  - conditions for completion of the step.

Procedures should also be supplied as “executable” files in the satellite database.

c. Subsystem failure analysis

Identification of potential subsystem failures by means of a systematic failure analysis (including a subsystem FMECA and FTA).

Identification of the methods by which the ground segment can identify a failure condition from analysis of the telemetry data and isolate the source of the failure.

d. Contingency procedures

Definition of a recovery procedure for each failure case identified above. This may utilize a nominal operational procedure already identified above, but more likely it requires the definition of a new procedure. The same information shall be provided for recovery as for the nominal operational procedures above. For some failures, or groups of failures, the recovery method can be mode, mission, or phase dependent, in which case separate procedures shall be defined for each mode/mission phase.

D.8.8 Payload definition

This clause shall be numbered 8.

D.8.8.1 General

A separate subclause shall be provided for each payload element with the same contents as subclause D.8.7.

D.8.8.2 Payload data definition

In addition, the following subclause shall also be provided.

a. Definition of the sensor output data, circumstances of generation, content and data rate, for each operational mode of the payload.

b. Definition of the processing performed on the sensor data, the algorithms used, selection or rejection criteria.

c. Definition of the required ground processing of the payload data.

Annex E (normative)

Operational validation plan (OVP) DRD

E.1 Introduction

The operational validation plan (OVP) constitutes the formal definition, by the supplier of the ground segment and operations, of how the operational validation for the mission is achieved.

E.2 Scope and applicability

E.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the operational validation plan. This DRD does not define format, presentation or delivery requirements for the operational validation plan.

E.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

E.3 References

E.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

E.3.2 Source documents

This DRD defines the data requirements of an operational validation plan as controlled by the following source documents:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

E.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
CRD	customer requirements document
DFT	data flow tests
DRD	document requirements definition
MRT	mission readiness tests
ORR	operational readiness review
OVP	operational validation plan
OVRR	operational validation readiness review

E.5 Description and purpose

The operational validation plan shall contain the plan for all activities subsequent to the integration and technical validation of the ground systems.

The purpose of operational validation is to demonstrate for the entire ground segment the supplier's compliance with the CRD.

E.6 Application and interrelationship

The OVP shall be written by the supplier of the ground segment and operations. It defines how the ground segment shall be validated in order to satisfy the operational requirements contained in the customer requirements document (CRD).

E.7 Operational validation plan preliminary elements

E.7.1 Title

The document to be created based on this DRD shall be titled "[insert project name] operational validation plan".

E.7.2 Title page

The title page shall identify the project document identification number and the title of the document.

E.7.3 Approval page

The approval page shall identify the names, titles and affiliations of all parties who are to approve the operational validation plan. This shall include at least one representative from the supplier of the ground segment and operations and one representative from the space segment customer. Space shall be provided for the approval parties to affix and date their signatures.

E.7.4 Distribution list

The distribution list shall identify the names, titles, affiliations and locations of all parties who are to receive a copy of the operational validation plan.

E.7.5 Amendment control table

The amendment control table shall contain the following:

a. the change number;

b. the type of change;

c. the date of issue;

d. the effective date;

e. the parts of the OVP affected;

f. the signature of the party authorising the change.

E.7.6 Contents list

The contents list shall identify the title and location of every volume, part, clause and major subclause, figure, table and annex contained in the document.

E.7.7 Foreword

A foreword shall be included in the document which describes as many of the following items as are appropriate:

- identification of which organizational entities prepared the document;
- identification of other organizations that contributed to the preparation of the document;
- a statement of effectivity identifying which other documents are cancelled or replaced in whole or in part;
- a statement of significant technical differences between this document and any previous document;
- the relationship of the document to other standards or documents.

E.7.8 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the OVP and the reasons prompting its preparations.

E.8 Operational validation plan content

E.8.1 Scope and applicability

This clause shall be numbered 1 and shall describe the scope and applicability of the operational validation plan.

E.8.1.1 Scope

This subclause shall be numbered 1.1 and shall include the following statement:

> "The [insert project name] operational validation plan defines the objectives, schedules and rules for the performance of tests for the operational validation of the [insert project name] mission."

E.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the [insert project name] operational validation plan with respect to the operations of entities of the [insert project name] ground segment and of the operations of the [insert project name] mission.

E.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

E.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

> "The following normative documents contain provisions which, through reference in this text, constitute provisions of this operational validation plan. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this operational validation plan are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.
>
> [insert document identifier] [insert document title]."

E.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

"The following documents, although not a part of this operational validation plan, amplify or clarify its contents:

[insert document identifier] [insert document title]."

E.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

E.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this operational validation plan, with the definition for each term.

If a project dictionary or glossary is applicable the following sentence shall be inserted:

"The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

"The following terms and definitions are specific to this document:

[insert term] [insert definition]."

E.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the operational validation plan with the full spelled-out meaning or phrase for each abbreviation.

E.8.4 Overview

This clause shall be numbered 4 and shall include the following subclauses.

E.8.4.1 OVP objectives, schedule and success evaluation

This subclause shall be numbered 4.1 and shall include:

a. a statement of the OVP objectives;

b. a presentation of the overall structure and schedule for the OVP, including major milestones;

c. identification of any constraints or mission-specific considerations;

d. identification of the mechanisms and criteria to be used for measuring and evaluating the success of the OVP.

E.8.4.2 OVP management

This subclause shall be numbered 4.2 and define the management structure for the conduct of the OVP. In particular, the individual responsibilities of the following operations team shall be defined (as applicable):

- the flight operations team;
- the ground operations team;
- the flight dynamics team;
- the mission exploitation team.

as well as those of:

- the simulations officer(s);
- any independent QA group that is involved in the OVP.

E.8.4.3 Reviews

This subclause shall be numbered 4.3 and identify the procedures for conducting:

a. the operational validation readiness review (OVRR) which shall confirm that all the pre-requisites for the start of the OVP have been met;

b. the operational readiness review (ORR) which shall review the results of the operational validation testing and confirm the readiness of the ground segment to support in-orbit operations.

E.8.5 Simulations and rehearsals

This clause shall be numbered 5 and shall define the simulations and rehearsals plan. This shall comprise the overall timetable of simulations with an indication of any sequencing and logical inter-dependencies between simulation sessions.

This clause shall define the briefing and de-briefing procedures.

For each individual simulation or rehearsal, the following shall also be defined (this information may optionally be provided in an annex to the OVP or in a stand-alone simulation plan that is cross-referenced from this clause):

a. identification of the operational teams involved, the team members and their location;

b. the operational scenarios being simulated/rehearsed with explicit reference to the relevant FOP timelines or procedures that are to be used;

c. the ground segment elements (especially control room facilities) to be used and their configuration i.e. hardware, software and database version numbers;

d. the test tools (simulators) to be used and their configuration;

e. the time of the briefing, the expected duration of the simulation session and the expected time of the de-briefing.

E.8.6 Ground segment readiness tests

This clause shall be numbered 6 and shall define the ground segment readiness test plan, including mission readiness tests (MRTs) and data flow tests (DFTs). This shall include

a. an overall test plan, and

b. for each individual test

- the test timetable (start time, duration),
- the test configuration including, for instance, the identification of all ground segment entities to be used (e.g. hardware, software and database versions), initialization requirements,
- any applicable test constraints,
- manpower resources, and
- the test procedures to be used (cross-reference may be made to other documents where appropriate).

E.8.7 Records and reports

This clause shall be numbered 7 and shall define the contents of the following records and reports and shall identify the mechanisms and responsibilities for their production and subsequent maintenance and storage:

a. simulation logs;

b. simulation reports;

c. ground facilities readiness test reports;

d. operational validation anomaly records;

e. operational validation actions status records.

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Annex F (normative)

Flight operations plan (FOP) DRD

F.1 Introduction

The flight operations plan (FOP) constitutes the formal definition, by the supplier of the ground segment and operations, of how the mission shall be operated.

F.2 Scope and applicability

F.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the flight operations plan. This DRD does not define format, presentation or delivery requirements for the flight operations plan.

F.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

F.3 References

F.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001 Glossary of terms

ECSS-E-70 Part 1 Space engineering — Ground systems and operations — Part 1: Principles and requirements

F.3.2 Source documents

This DRD defines the data requirements of a flight operations plan as controlled by the following source documents:

ECSS-E-70 Part 1 Space engineering — Ground systems and operations — Part 1: Principles and requirements

F.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
DRD	document requirements definition
FCP	flight control procedure
FOP	flight operations plan
GOP	ground operations plan
MOCD	mission operations concept document
SSC	space system customer
SSUM	space segment user manual

F.5 Description and purpose

The FOP contains all the rules, procedures and timelines necessary to implement the in-orbit operations for the [insert project name] mission during all mission phases in accordance with the mission objectives and respecting any constraints imposed by the design of the space and ground segments. It also contains rules and procedures for the conduct of contingency operations.

F.6 Application and interrelationship

The FOP shall be written by the GSS to define how the mission is operated in order to satisfy the mission operations requirements defined in the customer requirements document (CRD) and the agreed operations concept as defined in the mission operations concept document (MOCD). The FOP shall be elaborated from the operational information for the space and ground segments contained in the space segment user manual (SSUM) provided by the SSC and the relevant user manuals for the ground systems.

F.7 Flight operations plan preliminary elements

F.7.1 General

Reflecting the complexity of satellite missions and their operation, the FOP is usually a substantial document that runs to several volumes. The division of the document into volumes and the sub-division of volumes into “books” or “parts” is not prescribed by this DRD, but is left to the discretion of the authors. However, where the FOP runs to more than one volume, the “Title”, “Title page”, “Amendment control table” and “Contents list” defined below shall be repeated for each volume. The contents list for each volume shall indicate the location of the current volume within the overall document and shall identify the detailed contents of the current volume. The other preliminary elements defined below shall only appear in volume 1 of the FOP.

F.7.2 Title

The document to be created based on this DRD shall be titled “[insert project name] flight operations plan”.

F.7.3 Title page

The title page shall identify the project document identification number and the title of the document.

F.7.4 Approval page

The approval page shall identify the names, titles and affiliations of all parties who shall approve the flight operations plan. This shall include at least one representative from the supplier of the ground segment and operations and one representative from the space segment customer. Space shall be provided for the approval parties to affix and date their signatures.

F.7.5 Distribution list

The distribution list shall identify the names, titles, affiliations and locations of all parties who shall receive a copy of the flight operations plan.

F.7.6 Amendment control table

The amendment control table shall contain:

a. the change number;

b. the type of change;

c. the date of issue;

d. the effective date;

e. the parts of the FOP affected.

F.7.7 Contents list

The contents list shall identify the title and location of every volume (see above), part, clause and major subclause, figure, table and annex contained in the document.

F.7.8 Foreword

A foreword shall be included in the document which describes the following items:

a. identification of which organizational entities prepared the document;

b. identification of other organizations that contributed to the preparation of the document;

c. a statement of effectivity identifying which other documents are cancelled or replaced in whole or in part;

d. a statement of significant technical differences between this document and any previous document;

e. the relationship of the document to other standards or documents.

F.7.9 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the FOP and the reasons prompting its preparations.

F.8 Flight operations plan content

F.8.1 Scope and applicability

This clause shall be numbered 1 and shall describe the scope and applicability of the flight operations plan.

F.8.1.1 Scope

This subclause shall be numbered 1.1 and shall include the following statement:

> "The [insert project name] flight operations plan defines the rules, procedures, timelines for the in-orbit operation of the [insert project name] mission."

F.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the flight operations plan with respect to the operations of entities of the ground segment and of the operations of the mission.

F.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

F.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

"The following normative documents contain provisions which, through reference in this text, constitute provisions of this flight operations plan. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this flight operations plan are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies."

[insert document identifier] [insert document title]."

F.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

"The following documents, although not a part of this flight operations plan, amplify or clarify its contents:

[insert document identifier] [insert document title]."

F.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

F.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this flight operations plan, with the definition for each term.

If a project dictionary or glossary is applicable the following sentence shall be inserted:

"The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required the following sentence shall be inserted:

"The following terms and definitions are specific to this document:

[insert term] [insert definition]."

F.8.3.2 Abbreviations

This clause shall be numbered 3.2 and shall list all abbreviations used in the flight operations plan with the full meaning or phrase for each abbreviation.

F.8.4 Mission management

This clause shall be numbered 4 and shall provide an introduction to the FOP and shall contain the mission rules, the definition of operational responsibilities, reporting channels and the ground segment configuration control rules. It shall contain the following subclauses.

F.8.4.1 Introduction

This subclause shall be numbered 4.1 and shall provide a summary of the mission, the ground segment and the overall operations concept. It shall present the overall FOP structure and rationale.

F.8.4.2 Mission rules

This subclause shall be numbered 4.2 and shall contain the rules and criteria governing how the mission operations shall be conducted. It shall include, in particular:

- launch hold criteria;

- the principles and mechanisms for the routine and foreseen contingency operations of the mission;
- rules and criteria for emergencies and anomalies not covered by existing contingency procedures. This relates to situations arising from multiple or unforeseen failures for which no pre-defined recovery action exists;
- rules and criteria for transferring operations between different authorities (where applicable);
- mission termination criteria.

F.8.4.3 Mission operations management

This subclause shall be numbered 4.3 and shall present the organization, responsibilities and location (e.g. control centres or control rooms) of the parties and teams involved in the mission operations during each mission phase. Organigrams shall be provided for each operational team, including the names and positions of each individual.

This subclause shall define the mechanisms for confirming the readiness to proceed with operations (briefing) and for reviewing the progress of execution of operations (de-briefing).

This subclause shall define the reporting channels for routine operations and the mechanisms to be deployed for anomaly reporting.

This subclause shall also identify the mechanisms for on-call support and the procedures for invoking it.

F.8.4.4 Configuration management and change control

This subclause shall be numbered 4.4 and shall define the procedures for instigation, approval, implementation and control of any modifications to the ground segment following the pre-launch configuration freeze.

F.8.5 [Insert mission phase name] operations

This clause shall be numbered 5 and shall contain separate subclauses for each mission phase containing:

a. a description of the operations phase including a list of major events and timings;

b. a description of the operations implementation strategy for the mission phase and the consequent structure and content of the remainder of this clause of the FOP;

c. timelines of operations relevant to this mission phase, containing:
   - a definition of each operational activity;
   - the planned start time (absolute or relative);
   - identification of the operational position that executes or monitors the activity;
   - an identification of the background activities to be conducted by each of the supporting operations teams (e.g. flight dynamics);
   - a cross-reference to the GOP and to flight control procedures (FCPs) contained elsewhere in the FOP;
   - briefing and de-briefing breakpoints.

F.8.6 Flight control procedures

This clause shall be numbered 6 and shall contain the procedures for the nominal and contingency operations of the space segment.

There shall be a matrix of utilization indicating for each FCP the mission phase(s) to which it is applicable, plus the authorization status of the FCP (validated or not validated).

FCPs shall be organized hierarchically with a structure that reflects the level of the operation (system-level, subsystem-level).

Although these FCPs relate to the operation of the space segment, they may include steps or sequences for associated ground segment activities and may call up other FCPs as necessary.

F.8.7 Hand-over procedures

This clause shall be numbered 7 and shall contain the procedures for hand-over of operations between different authorities (where applicable). The responsibilities of the different authorities involved shall be clearly defined.

Annex G (normative)

Ground operations plan (GOP) DRD

G.1 Introduction

A ground operations plan (GOP) shall be produced for each ground segment entity to define how that entity shall be operated in support of the mission.

G.2 Scope and applicability

G.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for the ground operations plan. This DRD does not define format, presentation or delivery requirements for the ground operations plan.

G.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

G.3 References

G.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

G.3.2 Source documents

This DRD defines the data requirements of a ground operations plan as controlled by the following source document:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

G.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
DRD	document requirements definition
FCP	flight control procedure
FOP	flight operations plan
GOP	ground operations plan

G.5 Description and purpose

The GOP shall contain all the rules, plans, timelines and procedures required to operate the given ground segment entity in support of the in-orbit operations for the [insert project name] mission. The GOP also contains rules and procedures for the conduct of contingency operations for the ground segment entity.

G.6 Application and interrelationship

The GOP shall be written by the organization responsible for the operation of the corresponding ground segment entity. Since the operation of all ground segment entities is driven by the top-level mission operations plan, the GOPs are sub-servient to the flight operations plan (FOP), which is the document that defines the overall mission operations plan and invokes, either directly or indirectly, support from the various ground segment entities.

G.7 Ground operations plan preliminary elements

G.7.1 Title

This document to be created based on this DRD shall be titled "[insert ground segment entity name] ground operations plan for the [insert mission name] mission".

G.7.2 Title page

The title page shall identify the project document identification number and the title of the document.

G.7.3 Approval page

The approval page shall identify the names, titles and affiliations of all parties who are to approve the ground operations plan. This shall include at least one representative from the supplier of the ground segment and operations and one representative from the space segment customer. Space shall be provided for the approval parties to affix and date their signatures.

G.7.4 Distribution list

The distribution list shall identify the names, titles, affiliations and locations of all parties who shall receive a copy of the ground operations plan.

G.7.5 Amendment control table

The amendment control table shall contain:

a. the change number;

b. the type of change;

c. the date of issue;

d. the effective date;

e. the parts of the GOP affected.

G.7.6 Contents list

The contents list shall identify the title and location of every volume, part, clause and major subclause, figure, table and annex contained in the document.

G.7.7 Foreword

A foreword shall be included in the document which describes the following items:

a. identification of which organizational entities prepared the document;

b. identification of other organizations that contributed to the preparation of the document;

c. a statement of effectivity identifying which other documents are cancelled or replaced in whole or in part;

d. a statement of significant technical differences between this document and any previous document;

e. the relationship of the document to other standards or documents.

G.7.8 Introduction

An introduction shall be included to provide specific information or commentary about the technical content of the GOP and the reasons prompting its preparation.

G.8 Ground operations plan content

G.8.1 Scope and applicability

This clause shall be numbered 1 and shall describe the scope and applicability of the ground operations plan.

G.8.1.1 Scope

This subclause shall be numbered 1.1 and shall include the following statement:

> "The [insert ground segment entity name] ground operations plan defines the rules, plans, timelines and procedures for the operation of the [insert ground segment entity name] in support of the in-orbit operations for the [insert mission name] mission."

G.8.1.2 Applicability

This subclause shall be numbered 1.2 and shall define the applicability of the ground operations plan with respect to the operations of the overall ground segment and of the operations of the mission.

G.8.2 References

This clause shall be numbered 2 and shall contain the following subclauses.

G.8.2.1 Normative references

This subclause shall be numbered 2.1 and shall contain the following statements:

> "The following normative documents contain provisions which, through reference in this text, constitute provisions of this ground operations plan. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this ground operations plan are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.
>
> [insert document identifier] [insert document title]."

G.8.2.2 Informative references

This subclause shall be numbered 2.2 and shall contain the following statement:

> "The following documents, although not a part of this GOP, amplify or clarify its contents:
>
> [insert document identifier] [insert document title]."

G.8.3 Definitions and abbreviations

This clause shall be numbered 3 and shall contain the following subclauses.

G.8.3.1 Definitions

This subclause shall be numbered 3.1 and shall list any applicable project dictionary or glossary, and all unusual terms or terms with a meaning specific to this ground operations plan, with the definition for each term.

If a project dictionary or glossary is applicable, insert the following sentence:

> "The definitions of [insert title and identifier of applicable dictionaries or glossaries] apply to this document."

If a list of definitions is required, insert the following sentence:

> "The following terms and definitions are specific to this document:
>
> [insert term] [insert definition]."

G.8.3.2 Abbreviations

This subclause shall be numbered 3.2 and shall list all abbreviations used in the ground operations plan, with the full meaning or phrase for each abbreviation.

G.8.4 [Insert ground segment entity name] management

This clause shall be numbered 4 and shall provide an introduction to the GOP including a description of the corresponding ground segment entity, its operational role and operation concept, the operational responsibilities and reporting channels and the configuration control rules for the entity. It shall contain the following subclauses.

G.8.4.1 Introduction

This subclause shall be numbered 4.1 and shall provide a description of the ground segment entity down to the level of individual subsystems and equipment and their configuration for the mission. This subclause shall also present the overall structure and rationale of the GOP.

G.8.4.2 Operational rules

This subclause shall be numbered 4.2 and shall contain the rules and criteria governing how the operations of the ground segment entity shall be conducted. It shall include, in particular:

- the principles and mechanisms for the routine and foreseen contingency operations of the entity;
- the modus operandi for emergencies and anomalies not covered by existing contingency procedures. This relates to situations arising from multiple or unforeseen failures for which no pre-defined recovery action exists;
- the mechanisms for planning and scheduling routine maintenance activities;
- rules and criteria for transferring operations to or from other ground segment entities (e.g. ground station handover).

G.8.4.3 [Insert ground segment entity name] operations management

This subclause shall be numbered 4.3 and shall present the organization and responsibilities of the parties and teams involved in the entity operations during the different mission phases. Organigrams shall be provided for each operational team, including the names and positions of each individual.

This subclause shall define the reporting channels for routine operations and the mechanisms to be deployed for anomaly reporting.

This subclause shall also identify the mechanisms for on-call support and the procedures for invoking it.

G.8.4.4 Configuration management and change control

This subclause shall be numbered 4.4 and shall define the procedures for instigation, approval, implementation and control of any modifications to the ground segment entity following the pre-launch configuration freeze.

G.8.5 [Insert mission phase name] operations

This clause shall be numbered 5 and shall contain separate subclauses for each mission phase containing:

a. an overview of the operations phase including a list of major events (relevant to this ground segment entity) and timings;

b. timelines of entity operations relevant to this mission phase, containing:
   - a definition of each operational activity;
   - the planned start time (absolute time or time relative to other activities);
   - identification of the operational position that executes or monitors the activity;
   - identification of any background activities to be conducted;
   - cross-references to the FOP and to operational procedures contained in later clauses and subclauses of this GOP.

G.8.6 Entity operational procedures

This clause shall be numbered 6 and shall contain the procedures for the nominal and contingency operations of the ground segment entity.

There shall be a matrix of utilization indicating for each procedure the mission phase(s) to which it is applicable, plus the authorization status of the FCP (validated or not validated).

Procedures shall be organized hierarchically with a structure that reflects the level of the operation (entity-level, subsystem-level).

G.8.7 Hand-over procedures

This clause shall be numbered 7 and shall contain the procedures for hand-over of operations to and from other ground segment entities (where applicable). The responsibility of the different entities involved shall be clearly defined.

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Annex H (normative)

Operations anomaly report (OAR) DRD

H.1 Introduction

An operations anomaly report (OAR) is generated to document a departure from expected performance during operation. This pertains to the operation of either the space or the ground segment.

H.2 Scope and applicability

H.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for an operations anomaly report. This DRD does not define format, presentation or delivery requirements for the OAR.

H.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

H.3 References

H.3.1 Glossary and dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

H.3.2 Source documents

This DRD defines the data requirements of an operations anomaly report as controlled by the following source documents:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

H.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
DRD	document requirements definition
LEOP	launch and early orbit phase
OAR	operations anomaly report
SVT	software validation test

H.5 Description and purpose

The purpose of an operations anomaly report is to provide all necessary evidence and supporting material concerning a detected anomaly (including recovery actions undertaken, where applicable) to allow the recipients to analyse the anomaly and, where requested, to propose a workaround solution or further recovery action.

H.6 Application and interrelationship

An operations anomaly report shall be produced by the supplier of the ground segment and operations for the information of the space segment customer and, potentially, to initiate support from the satellite or ground segment developer within the framework of a post-launch support contract.

H.7 Operations anomaly report preliminary elements

H.7.1 Identification number

Each OAR shall bear the name of the mission and shall have a unique (mission-level) identification number.

H.7.2 Operational context

This shall indicate the operational context in which the anomaly was detected (e.g. SVT, LEOP, commissioning phase).

H.7.3 Suspected problem source

This shall indicate the suspected source of the problem, e.g. ground subsystem, on-board subsystem or equipment or unit.

H.7.4 Title

Each OAR shall have a short descriptive title.

H.7.5 Date and time of occurrence

The date and time of occurrence of the anomaly shall be indicated. If this is not known precisely, the time of detection shall be indicated instead.

H.7.6 Severity

The severity of the anomaly shall be identified in terms of the level of operational impact on the ground or space segment. The severity shall be indicated as one of the following:

Table H-1: Severity classification

Severity	Impact
No impact	The anomaly has no impact on the primary mission objectives
Minor impact	The anomaly has no significant operational impact on the mission. For example, an operational error that caused a transient loss of data or service, which has since been restored, would fall into this category.
Major impact	The anomaly has a substantial impact on the mission objectives, or compromises the future safety of the mission or the available redundancies.

H.7.7 Originator

The names and designations (titles) of the originator(s) of the OAR shall be indicated.

H.7.8 Approval

The OAR shall bear the name, position and signature of the relevant manager authorising the report.

H.7.9 Distribution list

The distribution list shall identify the names, titles and locations of all parties who are designated to receive a copy of the OAR. This list shall include the mission director and a representative from the space segment customer.

H.7.10 Version control

The issue number (where applicable) and date of issue of the OAR shall be indicated.

H.7.11 Status

The status shall indicate whether action is required in response to this report, or whether the report is provided for information purposes only. If action is required, the name (designation) of the actionee shall be indicated.

H.8 Operations anomaly report content

H.8.1 Introduction

The introduction shall provide a description of the anomaly and the recovery actions taken to date. This introduction shall include the following information:

a. a summary of the operational impact;

b. a summary of recovery actions taken;

c. an indication of whether this is the first occurrence of the anomaly.

H.8.2 Details of the anomaly

This part of the report shall provide a detailed description of the anomaly, together with all supporting material required for a full understanding and further analysis by the report recipients, and shall include the following:

a. a cross-reference to any previous occasion(s) on which the same anomaly occurred (quoting OAR numbers);

b. details of the on-going and immediately preceding actions which can have contributed to the anomaly;

c. details of the prevailing ground segment and space segment configuration (as relevant) before, during and after the anomaly.

Supporting material may be provided in the form of:

- telemetry reports (display hardcopies, printouts, retrieval reports),
- telecommand history file reports (printouts, electronic reports),
- operational logs (e.g. console log),
- event logs, and
- mission-specific data, such as star-tracker maps, payload images.

Where appropriate, the supporting information may be placed in annexes to the report.

H.8.3 Actions taken

This part of the report shall provide a detailed chronicle of any actions taken to date as a direct reaction to the anomaly. Supporting material may be provided in the form of:

- telecommand history file reports (printouts, electronic reports),
- telemetry reports (display hardcopies, printouts, retrieval reports),
- operational logs (e.g. console log), and
- event logs.

H.8.4 Operational impact

This part of the report shall describe the impact (if any) of the anomaly on on-going or planned operations. This shall include:

a. details of outages of services or communications with the space segment;

b. the re-planning or re-scheduling undertaken to date;

c. the impact on available redundancies.

H.8.5 Recommendations

Where appropriate, this part of the report shall propose a course of action for further investigation and resolution of the anomaly:

a. either internally by the ground segment and operations supplier, or

b. by external parties.

A schedule for anomaly investigation or resolution shall be indicated.

Annex I (normative)

Flight control procedure (FCP) DRD

I.1 Introduction

A flight control procedure (FCP) is an elementary constituent of the flight operations plan (FOP) that defines all actions to be performed to ensure adequate configuration of the space segment to achieve a given mission goal.

I.2 Scope and applicability

I.2.1 Scope

This document requirements definition (DRD) establishes the data content requirements for an FCP. This DRD does not define format, presentation or delivery requirements for an FCP.

I.2.2 Applicability

This DRD is applicable to all projects using the ECSS Standards.

I.3 References

I.3.1 Glossary and Dictionary

This DRD uses terminology and definitions controlled by:

ECSS-P-001	Glossary of terms
ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

I.3.2 Source documents

This DRD defines the data requirements of a flight control procedure as controlled by the following source documents:

ECSS-E-70 Part 1	Space engineering — Ground systems and operations — Part 1: Principles and requirements

I.4 Definitions and abbreviations

For the purposes of this DRD the definitions and abbreviations given in ECSS-P-001 and in ECSS-E-70 Part 1 apply.

The following abbreviated terms are defined and used within this DRD:

Abbreviation	Meaning
DRD	document requirements definition
FCP	flight control procedure
FOP	flight operations plan
SOM	spacecraft operations manager
SPACON	spacecraft controller
SSUM	space segment user manual

I.5 Description and purpose

An FCP is a component of the flight operations plan that defines the actions to achieve a specific operational objective. Together, all FCPs cover all the planned operation procedures for the space segment. An FCP is a “building block” for the definition of the actual operations to be performed in a given mission phase. An FCP may be called up by a mission timeline, an automatically executing schedule, another FCP or it may be initiated manually.

I.6 Application and interrelationship

FCPs are written by the supplier of the ground segment and operations. They are elaborated from the operational procedures contained in the space segment user manual (SSUM) that is delivered by the satellite developer.

I.7 Flight control procedure preliminary elements

I.7.1 Identification number

Each FCP shall have a unique identification number.

I.7.2 Title

Each FCP shall have a descriptive title which, together with the identification number, uniquely identifies the platform subsystem or payload element to which the FCP pertains.

I.7.3 Version control

The version number and effective date of the FCP shall be indicated.

I.7.4 Author

The names of the author(s) of the FCP shall be indicated.

I.8 Flight control procedure content

A flight control procedure shall be composed of the following elements. Note that these requirements relate to any representation of the procedure that is presented to a human user, i.e. either in hardcopy form or on a visual display.

I.8.1 Introduction

The introduction shall describe the objective of the FCP in clear and concise wording. This shall include the context within which the procedure may be executed (or called up), a description of the goal of the procedure and all possible results. Where appropriate, figures or diagrams shall be included to facilitate the understanding of the procedure.

The introduction shall be provided for informative purposes only and shall not constitute part of the “executable” body of the procedure.

I.8.2 Required operational authority

This shall indicate any special operational authorization required for manual execution of the procedure. For example, the following may be specified:

"This procedure may be executed by the spacecraft controller (SPACON) only with the written authority of the spacecraft operations manager (SOM)."

I.8.3 Expected duration

The expected nominal duration of the procedure shall be indicated.

I.8.4 Pre-conditions

This part of the procedure shall define all conditions that shall be satisfied before the execution of the procedure can be started. It may also indicate conditions under which the procedure shall not be started.

These conditions shall refer to one or more of the following:

- mission phase;
- ground segment configuration;
- space segment configuration;
- orbit position or environmental conditions;
- status of other procedures.

I.8.5 Procedure body

I.8.5.1 General

The procedure body is the part of the procedure that contains the executable elements that achieve the goal of the procedure. The procedure body shall be composed of self-contained entities called "steps" . Steps can either be executed in sequence or in parallel. The structure of a step is similar to that of a procedure itself, i.e. it may have pre-conditions, an executable body and post conditions (see below). However, the statements allowed in the body are different. An activity can only be initiated in a step body (and not in a procedure) and a step cannot be included in another step.

NOTE If a procedure has no constituent steps, it is equivalent to having a single step that comprises the complete procedure body.

The procedure body may also contain a contingency element that manages contingency situations that are detected during the course of execution of the procedure. This contingency element is started at the same time as the body of procedure itself and stops when the procedure body stops.

I.8.5.2 Procedure step

Each step shall document the activities to be performed. For example:

- uplink telecommand;
- initiate command stack or pre-defined command sequence;
- execute ground segment command (for example: "select system display");
- verify telemetry;
- wait: either until (absolute time), for (delta time), whilst (condition true or not true);
- mission-specific statements.

I.8.5.3 Contingency element

At all points in its flow, the FCP shall contain sufficient contingency information

a. either to restore the system configuration (space segment and ground segment) such as to allow the procedure main body to continue its execution (i.e. by first suspending the procedure body, then executing the contingency action and then resuming the procedure body),

b. to achieve the goal of the procedure in a different manner to the one followed by the procedure body (i.e. by first suspending the procedure body, then executing the contingency action and then stopping the procedure), or

c. to abort the procedure if it is not possible to recover from the detected contingency (i.e. by first suspending the procedure body, then executing the contingency action and then aborting the procedure).

I.8.6 Post conditions

This part of the procedure shall perform the verification that the goal(s) of the procedure have been achieved or not, once the execution of the body of the procedure has been completed.

The possible status is:

- procedure terminated, success confirmed, or
- procedure terminated, procedure failed (reasons).

ECSS Document Improvement Proposal

1. Document I.D.	2. Document date	3. Document title
ECSS-E-70 Part 2A	2 April 2001	Ground systems and operations — Part 2: Document requirements definitions (DRDs)

4. Recommended improvement (identify clauses, subclauses and include modified text or graphic, attach pages as necessary)

5. Reason for recommendation

6. Originator of recommendation

Name:	Organization:	
Address:	Phone: Fax: e-mail:	**7. Date of submission:**

8. Send to ECSS Secretariat

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Note: The originator of the submission should complete items 4, 5, 6 and 7.

This form is available as a Word and Wordperfect-file on internet under
http://www.estec.esa.nl/ecss

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