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Space Project Management

Project Phasing and Planning

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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 must be accomplished, rather than in terms of how to organise and perform the necessary work. This allows existing organisational 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 Management Standards Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board.

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Introduction

The objective of project phasing and planning is to define what shall be done and by when it shall be done.

Project phasing and planning shall minimise, during the life cycle of the project, the technical, scheduling and economic risks.

The activities required to make the system are defined and grouped into 'phases'. This is called 'project phasing'.

Each phase has characteristic activities and results in successive baselines of the system or the products. The duration and resources of each activity are estimated and their dependencies are scheduled using this information. This is called 'project planning'.

The customer decides on the authorisation of the next phase by formal review and hence controls the progress of the project.

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Scope

The present document, 'Project Phasing and Planning', is part of a collection of ECSS standards belonging to the management branch.

Its purpose is to define the principles and requirements to be observed during the management of the project phasing and planning.

Each requirement and its purpose is described together with the expected output.

The requirements specified herein apply to and affect the customer and supplier at all levels, when the capability to design and supply conforming product needs to be demonstrated. These requirements are tailored in related Project Requirements Documents, and are applicable to any actor of a space project.

This project phasing and planning document covers all the phases of the project.

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References

2.1 Normative References

This ECSS standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these apply to this ECSS standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

This ECSS standard belongs to the Space Project Management series called up by the 'Policy and Principles' standard ECSS-M-00. The standards listed below shall be considered in association with this document.

ECSS-M-10	Project Breakdown Structures.
ECSS-M-20	Project Organisation.
ECSS-M-40	Configuration Management.
ECSS-M-50	Information/Documentation Management.
ECSS-M-60	Cost and Schedule Management.
ECSS-M-70	Integrated Logistic Support.
ECSS-Q-00	Product Assurance.

The applicable revision index shall be that valid at the time the Project Requirements Documents are created.

2.2 Informative References

RG Aéro 00040	General Recommendations for the Project Management Specification.
CNES IM-30-00	Logique de déroulement de programme.
MR-P/01	Management Requirements on Industrial Contracts. (supersedes ESA PC/941904/TD/510)
IEC 1160	Formal Design Review.
MPM 30-00-02	Organisation et Conduite des revues.

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Definitions and Abbreviations

3.1 Definitions

For the purposes of this standard, the definitions given in ECSS-P-001 Issue 1 apply. In particular, it should be noted that the following terms have a specific definition for use in ECSS standards.

As-built Configuration
Business Agreement
Configuration
Configuration Baseline
Contract
Contractor
Cost
Customer
Data
Development
Document
Documentation
Evolution
Functional Specification
Implementation Document
Industrial Organisation
Information
Life Cycle Cost
Milestone
Model
Phase (Project Phase)
Process
Product Tree

Project
Project Requirements Document
Purchaser
Resource
Review
Space Element
Space System
Specification
Supplier
System
Tailoring
Task
Technical Specification

The following terms and definitions are specific to this standard and shall be applied.

Document release

Refer to ECSS-M-50

3.2 Abbreviations

The following abbreviations are defined and used within this standard.

Abbreviation	Meaning
AR:	Acceptance Review
CDR:	Critical Design Review
DJF:	Design Justification File
ECSS:	European Cooperation for Space Standardization
EIDP:	End Item Data Package
FRR:	Flight Readiness Review
ICD:	Interface Control Document
ILS:	Integrated Logistic Support
LRR:	Launch Readiness Review
PDR:	Preliminary Design Review
PRR:	Preliminary Requirements Review
QR:	Qualification Review
TS:	Technical Specification
SRR:	System Requirements Review

Fundamentals of Project Phasing and Planning

4.1 Basic Principles

In general terms, all projects can be broken down into phases.

Each phase is designed to advance the system or product from one baseline to another after successful completion of its characteristic activities.

During these phases, mostly at the end of them, Project Reviews are planned as milestones in the project phasing.

Each review is a critical examination performed by a team not directly responsible for the activities covered by the review.

Reviews aim at helping to:

- assess the validity of output elements in relation with the requirements and/or the predictions,
- decide to start the next phase.

The sequence of activities on a system or a product, and their links, form a typical life cycle (figure 1). The sequence of reviews shall start at the highest level for requirements and definition (PRR, SRR, PDR) and at the lowest levels for justification and verification (CDR, QR, AR).

Partitioning the project into phases is a major contribution to the overall risk management.

4.2 Sequence of Activities on a System (or a Product)

A system or product originates during a sequence of activities which is determined by the project phasing.

Generally, the following successive activities appear in a project:

- **The 'mission/function activities'** which correspond with the specification of the required mission and functions. These activities are formally closed by the Preliminary Requirements Review (PRR), which identifies the feasibility status and leads to the Functional Configuration Baseline. This state is called functional state.
- **The 'requirements activities'** during which the requirements for the system, its elements and the interfaces of the project are identified and evaluated.

These activities are formally closed by a Preliminary Design Review (PDR), which leads to the Development Configuration Baseline of the system or product, with establishment of verifiable requirements. This state is called 'specified state'.

- **The 'definition and justification activities'** starting after the System Requirements Review (SRR) at which the system specification has been approved. These activities are determined by a set of data enabling identification of the system or product, to allow it to be developed, produced, employed and maintained.

The justification of this state of design, in the form of analyses, trade-offs or design reports, constitutes an important element of the documented project progress.

These activities are closed by the Critical Design Review (CDR), which leads to the detailed definition of the products and their interfaces. The output of the CDR consists in the Production Configuration Baseline of the product ready for production. This state is called 'defined state'.

- **The 'verification activities'** including qualification: These activities, beginning after the Development Configuration Baseline, involve the definition of the set-up, test and qualification conditions and initialising the methods and means of production and verification.

Verification is not limited to qualification only but it can also involve development model testing at all the levels and includes analyses.

The qualification process involves all the tasks contributing to prove, through theoretical and experimental justifications, that the as defined product meets the specified requirement and is producible.

The qualification process shall also qualify the production methods and means.

These activities are closed by a Qualification Review (QR), which leads to the 'qualified state' of the system or product.

- **The 'production activities'**

The production begins after the Critical Design Review (CDR) which has reviewed the Production Master File, in compliance with the controlled baseline. Production includes all the tasks enabling manufacturing and verification of the products intended for delivery to users.

The as-built status and test results are documented for each specimen and in an Acceptance Review (AR), the customer recognises that the specimen of the completed product conforms to its configuration baseline. This state is called 'accepted state'.

- **The 'utilisation activities'**

These activities correspond to each of the different specimens of the system or product in service, operated and maintained by the user, who manages the Log Books of the different specimens.

During these utilisation activities, the product can evolve under different living state configurations.

For launchers and complex satellite projects, Flight Readiness Reviews (FRR) and Operational Readiness Reviews take place before launch and at the beginning of these utilisation activities. Also, for long production programmes, in-flight qualification is often decided.

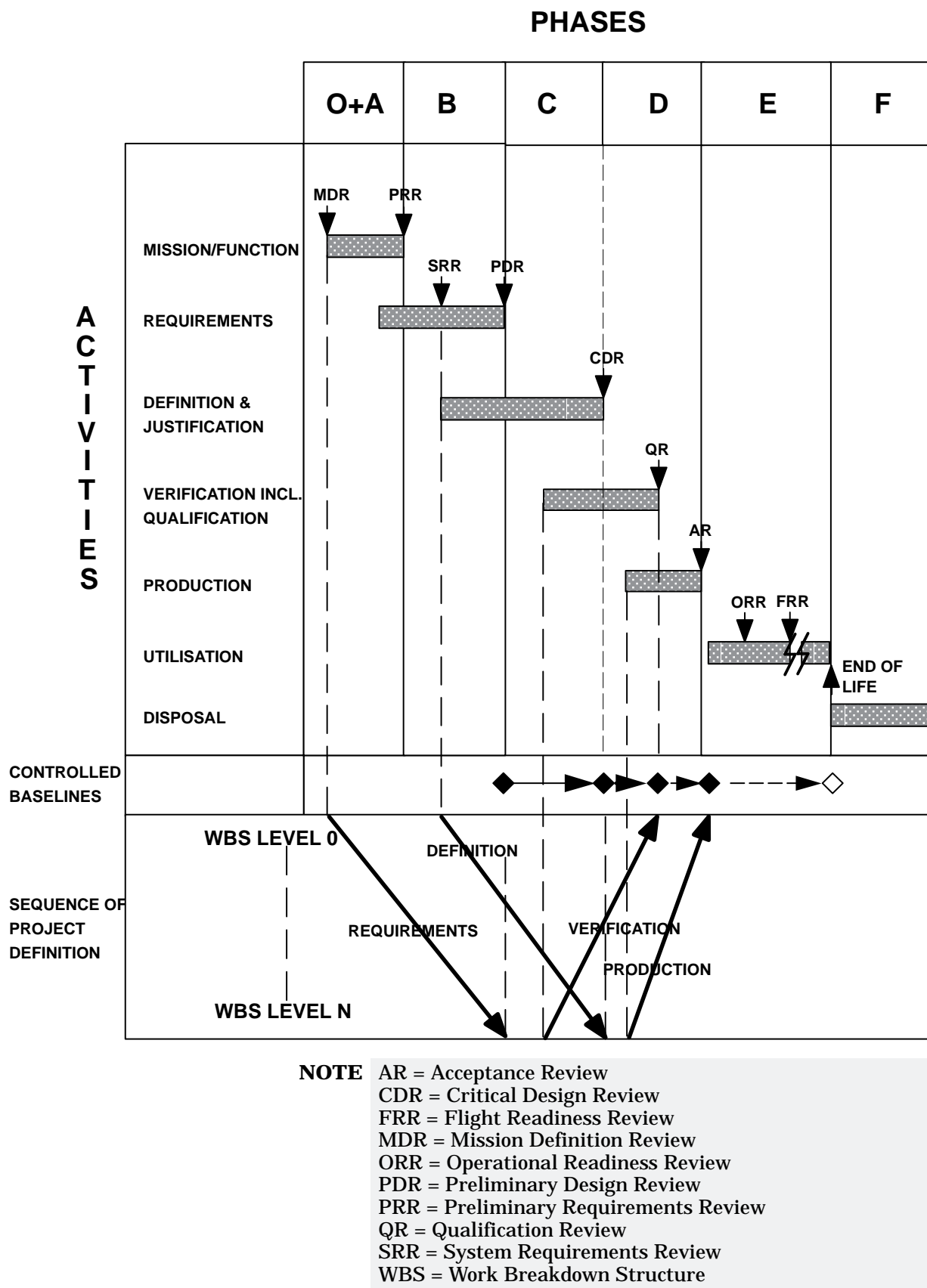


Figure 1: Typical project life cycle

- **‘The disposal activities’**

These activities cover all the elements from the end of life until final disposal of the product.

4.3 Project Phases

The planning of a project is structured into sequential phases. The start of a phase is generally subject to the passing of a milestone, usually occurring after a specific review.

Although each phase is a part of a sequential logic, the start of the next phase can be decided before all the tasks of the current phase are fully completed. In this case, induced risks have to be clearly identified.

The overlapping of the activities of different phases does not prevent responsibility for the phases from being assigned to different lead actors.

The model philosophy shall be defined as early as possible with respect to project phasing and planning, taking into account available resources and technological risks.

Usually a project is broken down into seven major phases:

4.3.1 Phase 0: Mission Analysis/Needs Identification

This phase concerns the needs identification and the mission analysis and allows:

- identification and characterisation of the intended mission,
- its expression in terms of needs, expected performance and dependability and safety goals,
- assessment of operating constraints, in particular as regards the physical and operational environment,
- identification of possible system concepts, with emphasis on the degree of innovation and any critical aspect. The data obtained from currently active programmes shall be used as a source of feedback,
- preliminary assessment of project management data (organisation, costs, schedules).

The above analysis results in the phase 0 documentation (e.g. mission specification).

At the end of the phase 0, a Mission Definition Review can take place.

4.3.2 Phase A: Feasibility

The feasibility phase (phase A) should result in finalising the expression of needs expressed in phase 0 and proposing solutions meeting the perceived needs.

This phase enables the refinement of the needs expressed in phase 0, and to start the process of responding to the needs:

- by quantifying and characterising their critical elements (for technical and economic suitability),
- by establishing the Function Tree,
- by exploring the various possible system concepts, by modelling in order to determine possibilities, characteristics or the criticality of certain elements,
- by comparing these concepts against the needs, to determine levels of uncertainty and risks,
- by estimating the technical and industrial feasibility,
- by identifying, for each possible system concept, the constraints relating to costs, schedules, organisation, utilisation (operations, implementation, maintenance), production and disposal, as well as the estimated margins in relation to the targets.

For that, the following shall be performed:

- analysis at system level of new products and critical elements,
- use of feedback data from previous projects,
- assessment of patents either existing or pending during this phase,

The phase A can be performed either by the consumer; first level customer or by first level supplier.

Phase A documentation includes all the project management data. It can be an updating of the phase 0 documentation and results.

The above activities are iterative. They connect with those in phase 0 and may lead to modifying the definition of the intended mission.

At the end of the phase A, the Preliminary Requirements Review (PRR) is conducted, which leads to a system concept selection and the establishment of the controlled baseline of the Functional Specification associated to it.

4.3.3 Phase B: Preliminary Definition (Project and Product)

This phase allows:

- the selecting of technical solutions for the system concept selected in phase A,
- acquiring a precise and coherent definition (performance levels, costs, schedules) at every level, and preparing elements of decision for progressing to the following phase, by refining the understanding of the technical feasibility factors evaluated during the previous phase,
- at system level, during the phase B, the System Requirements Review (SRR) to be conducted,
- Initial identification of 'Make or buy' alternatives after the SRR, at a time when the customer is elaborating the Product Tree and writing the products specifications,
- confirming the feasibility of the recommended solution, as well as defining the operating conditions (technical and economic).

This confirmation is backed up by:

- the assessment of techniques, technologies and means to implement (logistics and maintenance), including pre-development work on critical technologies or system design areas when it is necessary to reduce the development risks,
- the assessment of manufacturing, production and operating costs,
- consultations between the actors, including proposals and undertakings on their part,
- reliability and safety assessment,
- assessment of environmental impacts,
- ensuring coherence between the specified requirements of higher level components and those of lower levels, by establishing the specifications tree, the project breakdown structures and the internal and external interfaces, and by ensuring harmony between the various management plans submitted by the actors participating in the programme,
- starting the analysis of the logistics necessary for fulfilling the mission. The elements acquired at the end of this phase shall be sufficient to allow the consideration of logistics requirements and Life Cycle Cost in the subsequent project phases. Corresponding specifications are established,
- elaborating the Design Justification File (DJF).

Procurement of long-lead items may need to be started during phase B, in order to meet project schedule objectives.

Phase B documentation contains elements to support decision-making permitting confirmation of the project, including in particular, the exhaustive expression of the need by means of Technical Specifications (TS). At the end of the phase B, the Preliminary Design Review is conducted, which delivers the Development Configuration Baseline described in the Technical Specifications (TS) and Design Justification File (DJF) and which leads to a preliminary definition of interfaces (preliminary Interface Control Documents). Implementation Documents (including the Development Plan) provided by suppliers will be agreed at this point in time.

The Preliminary Definition phase should result in selection, justification and confirmation of the solution retained for the development.

4.3.4 Phase C: Detailed Definition (Product)

This phase:

- allows detailed study of the solution retained during the previous phase, as well as the production of representative elements of this solution, leading to a detailed definition of the system and its components,
- allows a definitive 'make or buy' decision for the products, if necessary,
- allows confirmation of the set-up, test and qualification conditions, and initialising the methods and means of production and verification,
- sees start-up of technology assessments or qualification (or continuation, if these steps were started in the previous phase), as well as the starting of procurement,
- allows updating of the Production Master File, to the definitive standard enabling production of the first models of the system,
- enables the establishment of the interfaces within the development configuration baseline and to put the corresponding Interface Control Documents (ICD's) under configuration control,
- allows preparation of phase E activities.

This phase results in the acceptance of the Production Master File.

At the end of this phase, the Critical Design Review (CDR) is conducted.

4.3.5 Phase D: Production/Ground Qualification Testing

The phase D is the end of the system development.

Production Master File and operational documentation are released in phase D.

The phase D:

- permits a qualified definition of the products, components and the system itself, by completing the ground qualification process, and in particular by the provision of experimental results completing the theoretical elements acquired previously and also during this phase,
- allows production of material, software and components necessary for obtaining these experimental results (qualification models and the associated means),
- enables the confirmation and qualification of methods, procedures, and the production and verification means allowing manufacture, assembly, integration and verification tasks, and to conduct the Qualification Reviews.

Ground qualification testing provides a means of verifying the technical conformity of the components against the requirements (**design qualification**), as well as their aptitude to be used operationally (**operational qualification**), with identification of the functional and operational margins.

This phase, ending with the Acceptance Review (AR), which comprises all the elements described above, allows the preparation of the utilisation phase and the series production (if any).

The acceptance process shall include an agreed technical process complete with checks and tests, during which the customer acknowledges the conformity of the delivered product with the current configuration baseline of the product ordered. At the end of this process, the customer shall decide whether to accept the supply.

The phases C and D are generally inseparable, owing to the integrated nature of the activities.

4.3.6 Phase E: Utilisation

This phase comprises the launch campaign, launch and in-flight acceptance of space elements if needed, and it corresponds to operation and maintenance of the system, as well as the acquisition of feedback.

This phase is often divided into two sub-phases:

- a sub-phase E1, which is an overall test and commissioning phase of the system, at the end of which the first In-Space Test Review is conducted. It generally comprises launch activities, in-flight qualification and acceptance testing of the system, which allows assessment and measurement of performance levels as well as level of service attained and in-flight qualification and acceptance of the system.
- a sub-phase E2, which is the utilisation phase itself. This phase shall take into account the technical events of operation and requests for improvements. The major parameters regarding the state of the system in operation are periodically presented in 'operations reviews', which contribute to improvements in operation, while generating feedback for future projects. It can also show the need for redevelopment of certain products (such as ground support equipment or software, for example).

This phase also covers the series production of recurring products.

4.3.7 Phase F: Disposal

The disposal phase covers all events from the end-of-life till final disposal of the product.

This phase is generally prepared during the utilisation phase of the system. It is specific to the product in question.

It is initiated by the consumer.

Withdrawal from service may give rise to an end-of-life assessment.

The complete project inventory is reviewed with respect to its future use or disposition – disposition may give rise to an environmental impact assessment.

4.4 Relationships between Phases and States

It is possible to identify relationships between the planning phases of a project and the states adopted by the system during development.

These relationships equate to the creation of controlled baselines which record the state of the system after each phase.

These baselines are verified in formal reviews at the end of each phase ; their acceptance allows starting of the following phase(s).

Figure 1 shows the principle covering the relationships between the phases of a project and the states of the corresponding system.

4.5 Relationships between Phases and Reviews

The project is structured in phases. The starting of a phase is conditioned by passing a milestone and is supported by a decision.

A review is generally conducted at the end of a phase. The aim of the review is to verify that:

- the objectives of the phase are met,
- the outputs of the phase have been produced in conformance to the specifications established in previous phases.

During the review held at the conclusion of a phase, it shall be verified that all information necessary to commence the next phase is available. The information includes the possible best technical definitions, as appropriate for the product current status of evolution, as well as sufficiently detailed planning data for the

schedule aspects (and if appropriate, cost) of related activities. This will enable all the actors to commit to the next phase in the project life cycle with confidence.

In addition to ensuring completeness of the data passed from one phase to the next, documentation shall be updated to include refinements to all the specifications, process definitions, designs, operations manuals, etc. as necessary, and as determined by the maturity of the product, thus providing current overall reference data for the remaining phases of the project.

Reviews are organised most often at milestones in the project schedule and allow critical and independent assessment of potential problems, and the proposal of solutions.

They allow the customer to assess the progress of the project in relation to the technical, financial and scheduling goals.

Two major types of reviews can be identified:

- reviews associated with the completion of a phase: these characterise the definition state of the system and its components and products at a given moment in time,
- reviews conducted according to the type of system being produced, its complexity, interfaces with other projects and the critical stages.

Reviews follow the life cycle of the project phasing, succeeding one another from top to bottom of the Product Tree from the system level down to the item level for the feasibility and preliminary definition phases. Thereafter they go upwards, from the item level to the system level, from the detailed definition phase up to the utilisation phase.

Guidelines for review organisation are given by document ECSS-M-30-01 (Organisation and Conduct of Reviews).

4.6 Relationships between Phases and Interfaces

4.6.1 Internal Interfaces

The internal interfaces are defined in ECSS-M-10 and their management is addressed in ECSS-M-40.

4.6.2 External Interfaces

External interfaces are defined in ECSS-M-10 and include interfaces with external systems and customer-furnished equipment and services.

During phase 0, the assessment of the utilisation constraints and the identification of potential solutions shall point out the possible needs of the external interfaces and the relevant aspects.

During phase A, the external interfaces need to be defined and their implications shall be analysed, in particular in terms of investment, development, production and operating constraints.

During phase B, the external project interfaces shall be subject to a detailed definition and their coherence with the system (or product) and its components shall be estimated.

The external interfaces are validated at the end of phase C, in order to permit commitment to the system production and qualification phase (phase D).

In this ECSS standard, in order to facilitate reading and traceability, the requirements are listed according to numbered topics. Each numbered requirement is composed of a general wording (**bold text**), and often by an explanatory text attached to the general requirement and an expected output (text in *italics*).

Requirements Relative to Project Phasing and Planning

5.1

During phase A, all the actors shall establish their project phasing and planning in accordance with the overall system phasing and planning.

AIM: Demonstrate how the goals are to be achieved, by considering all the constraints of the project.

The project phasing and planning shall highlight the successive states of the system to be produced, and identify the products it contains. The milestones outlining the phases, and the associated goals used for determining the successive states of the system and its products shall be specified.

The activities, means and resources necessary for the performance of the business agreements are identified.

Requirements in terms of management, verification etc. are defined and put in place (preparation of Project Requirements Documents).

The project phasing and planning shall be globally stable during the course of the project and shall be established on the basis of a development-risk analysis.

EXPECTED OUTPUT: *Coherent project phasing and planning during the life cycle of the project.*

5.2

During phase B, the project phasing and planning shall be detailed and consolidated on the basis of actual and validated planning data from all the concerned actors.

AIM: Ensure the reflection of actual confirmed planning data from all the actors in the project phasing and planning.

EXPECTED OUTPUT: *Consolidated project phasing and planning taking into account validated data from all the actors.*

5.3

The project phasing and planning shall be made applicable, at all levels of the industrial organisation, with respect of Project Requirements Documents.

AIM: Ensure coherence between all the levels of activities.

Each level shall ensure setting up of the means necessary for controlling the progress of the project by its suppliers.

EXPECTED OUTPUT: *Coherent Project Requirements Documents at all the levels.*

5.4

The responsibility for external interfaces shall be clearly identified and included in the project phasing and planning.

AIM: Ensure consideration of the external interfaces in the project.

EXPECTED OUTPUT: *Clear identification of external interfaces responsibilities in the Implementation Documents.*

Requirements Relative to Phases and their Contents

The phasing of a project is based on a step-by-step approach ensuring the achievement of technical, scheduling and financial goals. This approach takes the form of a sequence of phases, separated by milestones.

Reviews associated with these milestones allow assessment of the technical definition as well as task progress, and also serve as an opportunity to examine any difficulty encountered, and the residual risks. They also make it possible to modify the provisional data for the following phases.

The decision to start a phase is taken by the customer (or his managing authority).

The customer can decide to start part of a phase before the work and of a previous phase has been fully completed or the conclusions reached. This decision shall be submitted to a risk assessment process. At the minimum, all open issues are to be identified and documented.

Project phasing can be simplified in relation to the defined state of the system and its components; in particular certain phases or processes may be tailored. This tailoring shall be previously defined in the preceding phase documentation by each customer to his suppliers.

Every supplier shall submit any simplification (tailoring) of the phasing for approval to his customer.

6.1 Phase 0 – Mission Analysis/Needs Identification

6.1.1

The consumer or first level customer shall evaluate the nominal limit and external environmental conditions in which the system (end-product) shall accomplish its mission, both in nominal mode and degraded mode.

The consumer or first level customer shall establish, in terms of requirements, the expected performance levels as well as the dependability and safety goals, taking into account the environmental conditions.

EXPECTED OUTPUT: *Definition of consumer/first level customer's imposed requirements and constraints.*

6.1.2

The consumer or first level customer shall define and characterise the functions of the system.

EXPECTED OUTPUT: *Preliminary Functional Specification*

6.1.3

The consumer or first level customer shall identify and evaluate different possible system concepts, identifying critical and innovative aspects.

EXPECTED OUTPUT: *Identification of the possible system concepts.*

6.1.4

The consumer or first level customer shall identify and evaluate needs, overall environment and framework of project management and develop all the necessary data for starting the next phase.

Phase 0 should result in identification and characterisation of the intended mission, determining the associated needs and generate a phase 0 documentation.

For that, based on agreement between the consumer/first level customer and industrial communities, shall be used:

- feedback data from previous projects,
- documentary and patents research,
- applicable standards and codes of practice.

EXPECTED OUTPUT: *The framework of the project: initial project planning (tasks, partners, scope of work of each actor operations framework, production framework, industrial organisation, external interfaces needs, target budget, etc.).*

6.2 Phase A – Feasibility

6.2.1

Each actor shall

- **detail the possible system concepts, and determine solutions for further analysis,**
- **determine the critical elements, and estimate performances and risks,**
- **establish a Function Tree (if required),**
- **recommend one or several system concept solution(s) identifying the elements and their justification,**
- **identify one or more supplier(s) to perform the phase B.**

EXPECTED OUTPUT: *System concept options, which include:*

- *the technical elements and in particular the feasibility of the solutions responding to the needs,*
- *the principal characteristics of each solution in terms of performance and risks, costs, schedules,*
- *evaluation of external interfaces and investments,*
- *the solution selected by the customer and the justification of the choice.*

6.2.2

Each actor shall

- **specify the external interfaces (i.e. ground multimission means, Support System, networks, launch means, external entities and/or passengers...),**
- **explore different concepts meeting dependability and safety needs, including at the functional interface level,**
- **study the response to any need concerning ergonomics,**
- **give a preliminary definition of any need concerning integrated logistic support.**

EXPECTED OUTPUT: *Preliminary TS for project including the interfaces.*

6.2.3

Each supplier shall prepare a preliminary Development Plan and associated data enabling decisions to be taken as trade-offs between performance levels and cost and schedule targets.

EXPECTED OUTPUT: *the preliminary Development Plan and associated data, which expresses the general approach of the project; it identifies:*

- *the $n + 1$ level of the Product Tree, for a customer at level n ,*
- *the major development risks, and the mitigating precautions required,*
- *the characteristics of the model philosophy,*
- *the means and resources necessary,*
- *the estimation of cost and schedule targets,*
- *the general organisation of the project.*

6.2.4

The first level customer shall decide the category of the project (see ECSS-M-00) and each customer shall prepare Project Requirements Documents for his suppliers.

EXPECTED OUTPUT: *Project Requirements Documents.*

6.2.5

The consumer or first level customer shall release the Functional Specification at the end of phase A.

EXPECTED OUTPUT: *An approved Functional Specification.*

6.3 Phase B – Preliminary Definition

If several suppliers are requested to perform the phase B, the customer shall provide them with the same basic information (competitive phase B).

6.3.1

The supplier shall further define the technical solution retained from phase A in terms of comparisons of performance levels and analysis of risks on technical, costing and scheduling aspects and trade-off technical solutions associated with the different design options.

EXPECTED OUTPUT: *design justification documentation, specifying how each of the solutions offered for the expressed requirements shall be justified.*

fied (i.e. type of works to be made and corresponding resources), taking into account the potential environmental impact of the project.

- *Preliminary Design Justification File (DJF) including:*
 - * *the technical description for the solutions appraised and their associated costs*
 - * *the solution retained and its associated cost.*

6.3.2

The Project Requirements Documents issued by the first level customer shall address preparation for phases E and F.

- EXPECTED OUTPUT:
- *Preliminary issue of mission analysis,*
 - *Preliminary issue of system operational handbook,*
 - *Simulation facilities specification,*
 - *Inputs to Disposal Plan.*

6.3.3

Customer and supplier shall acquire a precise, complete and coherent definition for the system architecture and its breakdown into major functions.

- EXPECTED OUTPUT:
- *final version of the Technical Specification for the system, including interfaces,*
 - *Technical Specifications for the next level elements in the Product Tree, including interfaces,*
 - *Preliminary issue of ICD's,*
 - *the reliability, availability, maintainability and safety (dependability and safety) file containing the dependability and safety allocations for the defined elements of the Product Tree.*

6.3.4

First level supplier shall issue Project Requirements Documents for his subordinate suppliers

- EXPECTED OUTPUT: *Project Requirements Documents covering dimensions, design and environment,...*

6.3.5

Customer and supplier shall finalise the project phasing and planning for the future phases.

- EXPECTED OUTPUT: *Finalised project phasing and planning with phases, review plan, supplies, model philosophy and required dates, showing interrelations with external interfaces in terms of deliveries to/from the project, common reviews, etc.*

6.3.6

At each level, customer and supplier shall establish the Business Agreement Structure to carry out the related work.

- EXPECTED OUTPUT: *Defined Business Agreement Structure down to a level consistent with the industrial organisation envisaged.*

6.3.7

Each customer shall provide his suppliers with the Project Requirements Documents valid for phases C/D at the beginning of phase B.

AIM: Provide unique common basis for requirements for the suppliers for phase C/D preparation.

EXPECTED OUTPUT: *A unique set of Project Requirements Documents for phases C/D preparation.*

6.3.8

Each supplier shall provide all the documents required for preparation of phase C/D documentation and the engagement of early procurement and technology work as required.

EXPECTED OUTPUT: *Documents enabling the customer to engage in early procurement and technology work and to establish the requirements baseline for the phases C/D.*

6.3.9

Each customer shall prepare the necessary data for initiation of the development business agreement (phases C/D) and, if required, recurring production.

EXPECTED OUTPUT: *Technical Specifications for lower level components, (including interfaces),*

- *Documentation for phases C/D go-ahead, including elements related to the means and resources necessary; the costs and schedule targets; information relating to the set up and management of the industrial organisation; model philosophy and supplies. These elements shall be drawn from industrial proposals covering the development (phases C/D) and, if required, recurring production,*
- *Development Plan updated.*

6.3.10

Each customer shall, when necessary, engage in assessment work or technology qualification, as well as starting long-lead procurements and Support System development.

EXPECTED OUTPUT: *Business agreements for validation of new technology qualification and for supplying the long lead items.*

6.3.11

Each supplier shall prepare Implementation Documents demonstrating the compliance with the management standards and the requirements of the Project Requirements Documents.

EXPECTED OUTPUT: *Agreed Implementation Documents.*

6.4 Phase C – Detailed Definition

6.4.1

Customer and supplier shall finalise the detailed definition of the solution retained during the preliminary definition phase.

EXPECTED OUTPUT: *Definition documentation for the system.*

6.4.2

Customer and supplier shall verify that the detailed definition of the system will satisfy all the Technical Specifications, including interfaces, at all levels of the Product Tree.

EXPECTED OUTPUT: *Interface Control Documents,
Final lower level TS.*

6.4.3

Customer and supplier shall confirm the verification requirements, including qualification and acceptance requirements, and define the methods and means for production, verification and tests.

EXPECTED OUTPUT: *Verification requirements,
Production Master File,
User's documentation (preliminary).*

6.4.4

Customer and supplier shall produce a complete dependability and safety analysis indicating in-service dependability including interfaces, taking worst case operating conditions into account.

EXPECTED OUTPUT: *Dependability and safety analysis documentation including environmental impact.*

6.4.5

Customer and supplier shall consolidate the design and verification including qualification and acceptance plans at all levels and verify coherence between individual test plans and the functional test plan of the system.

EXPECTED OUTPUT: *Verification Plans,
Design Justification File.*

6.4.6

Supplier shall start the procurements, on the basis of the declared lists and completion of the technologies assessment and qualification.

EXPECTED OUTPUT: *Procurements and facilities management policy,
Production of models for characterisation of the technologies and validation of the design,
Technology assessment and qualification documentation.*

6.4.7

At first level, the customer and supplier shall finalise mission analysis for the operations to be performed and shall confirm the conditions and cost of operations.

EXPECTED OUTPUT: *System operation qualification plan,
Updated issue of system operational handbook (in-orbit procedures, telemetry and telecommand list, system database, ...)
Request for use of station network and of multimission facilities.*

6.5 Phase D – Production/Ground Qualification Testing

6.5.1

The supplier shall produce the first models implementing the defined state which are submitted to qualification.

EXPECTED OUTPUT: *Production of models needed for qualification.*

6.5.2

The system, including interfaces, shall be ground qualified.

EXPECTED OUTPUT: *Qualification test reports.*

6.5.3

As part of the acceptance, the operational readiness of the system and its components shall be verified.

EXPECTED OUTPUT: *System Operation Plan,
System database validated,
End Item Data Package and Log Book,
Flight control procedures validated,
Ground Facilities Operation procedures validated.*

6.5.4

Integrated Logistic Support (ILS) documentation and data shall be established.

EXPECTED OUTPUT: *ILS documentation and database.*

6.6 Phase E – Utilisation

6.6.1

Launch, and in-flight acceptance testing of the needed number of space elements shall be included in phase E for the mission qualification.

EXPECTED OUTPUT: *In-flight qualification of the system.*

6.6.2

The first level customer shall organise an operations review, giving baselines to the technical and management goals of the entry into service documentation.

EXPECTED OUTPUT: *Baselines to the operational documentation and ILS (including the final issue of system operational handbook).*

6.6.3

During the utilisation phase, the operation and maintenance plans shall be implemented, observed and updated with data obtained from operational use.

EXPECTED OUTPUT: *Operation and Maintenance Plan,
Integrated Logistic Support system and database.*

6.6.4

During this phase, the conformity of operations versus the operations plan shall be guaranteed and the operational quality of the system maintained.

EXPECTED OUTPUT: *Updated operations plan and procedures, and ILS system.*

6.6.5

The feedback procedures shall be implemented to ensure consideration of lessons learned concerning evolution in requirements for developments in the future.

EXPECTED OUTPUT: *Updated operations plan and procedures, and ILS system.*

6.6.6

The consumer shall prepare the disposal plan for the system, identifying the planning of the withdrawal from operations and the final disposal of the system.

Technical and legal requirements with respect to disposal shall be defined as early as possible (phase A or B) in order to allow assessment of corresponding constraints and implementation of design solutions. The resulting activities to be executed during the operational and disposal phase will be described in the disposal plan.

EXPECTED OUTPUT: *Disposal plan.*

6.6.7

Series production shall be performed in conformity with the state defined in the applicable Production Master Files as established during phases C/D and Project Requirements Documents for phase E.

The series production performed within phase E is based on the configuration baseline available at the end of phase D.

EXPECTED OUTPUT: *Recurring products in compliance with the production configuration baselines.*

6.6.8

Any evolution shall follow configuration management rules, (including requalification if necessary) so that the already-manufactured product stays in conformity with the product defined in the current configuration baseline.

EXPECTED OUTPUT: *Maintained qualified and accepted states for all the recurring products.*

6.6.9

Throughout this phase, the production entity shall establish and maintain the capability necessary for guaranteeing the required level of production capacity and quality.

EXPECTED OUTPUT: *Supplier's production documentation.*

6.6.10

Each recurring product shall, when delivered, be accompanied by an End Item Data Package (EIDP) defining its accepted state, and an Equipment Log Book which serves for recording in-service evolution (living state).

EXPECTED OUTPUT: *EIDP and Log Book for each recurring product.*

6.6.11

The transfer of ownership of recurring products shall be subject to an acceptance process, ending in an Acceptance Review (AR).

EXPECTED OUTPUT: *Acceptance Review documentation for recurring products.*

6.7 Phase F – Disposal Phase

These requirements apply also to the disposal of inventory items after phases C/D.

6.7.1

The disposal phase (phase F) shall only start after a decision by the consumer on the basis of a Disposal Plan, and with the collaboration of all the concerned actors.

EXPECTED OUTPUT: *Updating of Disposal Plan and decisions for withdrawal from service.*

6.7.2

The Disposal phase shall result in the co-ordinated and controlled performance of the operations necessary for total or partial cessation of use of the system and its constituent products and their final disposal. This phase shall be executed in conformity with the Disposal Plan.

The disposal shall be executed in conformity with the decision of the consumer and in accordance with the legal and administrative dispositions.

The withdrawal can be partial or total and can be started partially during the utilisation phase.

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Requirements Relative to Relationships between Phases & Reviews

7.1

The consumer shall hold a Mission Definition Review at the end of phase 0.

AIM: Evaluate the results of the mission analysis works performed in phase 0, with a view to deciding the direction of the project.

On the basis of the results of Mission Definition Review, the consumer can decide the direction to be given to the project during the following feasibility phase (Phase A).

EXPECTED OUTPUT: *Confirmation of the mission needs.*

7.2

The consumer or the first level customer shall require that a Preliminary Requirements Review (PRR) be held at the end of phase A.

- AIM: – Evaluate the results of the work performed during this phase, to show the feasibility of the project with the intention of obtaining a decision by the consumer.
- Examine the validity of the system architecture and the solutions proposed in response to the requirements of the preliminary Functional Specification ; verifying downward consistency of the system/products requirements.
 - Release the Functional Specification.

On the basis of the results of the Preliminary Requirements Review, project decision shall be taken to start the following phase, known as the Preliminary Definition Phase (or phase B). The PRR being aimed at verifying that the consumer expectations have been correctly translated into requirements by the first level customer, the latter should take the initiative in requiring that the review be held.

EXPECTED OUTPUT: *Phase A documentation reviewed and related recommendations issued:*

- *the preliminary development plan and the estimated budget including development works,*
- *the finalised Functional Specification,*
- *the preliminary system TS (including the preliminary interface specifications),*
- *the Project Requirements Documents.*

7.3

The consumer or the first level customer shall require that a System Requirements Review (SRR) be held during the phase B.

- AIM: – Examine the compatibility of the system architecture and the allocation of performance-level requirements to products and sub-assemblies, in relation to the mission requirements,
- Examine the compatibility of the system interface specifications between the components of the system,
 - Evaluate the acceptance criteria,
 - Release the System TS and the external interface specifications and component interfaces.

The review is an integral part of the approval procedure for the system architecture and the associated specifications.

On the basis of the results of the System Requirements Review (SRR), final confirmation of the programme, and decision to start development can be taken. Consequently, the initiative of this review should be taken by the consumer.

The system TS shall be approved and then follow the configuration management rules.

EXPECTED OUTPUT: *Following documentation reviewed and related recommendations issued:*

- *the system TS including interfaces,*
- *the preliminary definition documentation for the system containing all the elements necessary for starting the project development activities and defining the architecture of the main components,*
- *the design justification documentation,*
- *the system phase B documentation, containing elements relating to means, necessary resources, cost and schedule targets, industrial organisation, management processes and supplies.*

7.4

At the end of phase B and start of phase C, each customer down to lower levels of the Product Tree shall hold a Preliminary Design Review (PDR) on the components and lower level products.

- AIM: – Check for compatibility between the product definition and the system TS, and verify that the performance-level requirements are met,
- Evaluate the acceptance criteria,
 - Release components and product TS.

Every PDR should be chaired by the customer and conducted at the respective supplier's premises.

On the basis of the PDR, the customer can approve the product TS (the TS then follows the configuration management rules) and authorise the go-ahead of phases C/D.

EXPECTED OUTPUT: – *the TS for the component or product concerned,*
 – *the preliminary definition documentation for the products,*
 – *the Design Justification File,*
 – *documentation to start phases C/D,*
 – *draft ICD's.*

7.5

At each level of the Product Tree, after completion of all the related PDR's, the customer shall confirm that the preliminary design is capable of meeting his requirements.

AIM: – Check for compatibility between the design and the customer requirements,
 – Examine definition of the operational aspects (sizing of operational teams, training teams, preparation of the flight plan, operational qualification, man/machine interfaces, ergonomic aspects).

EXPECTED OUTPUT: *Formal confirmation of the go-ahead by the customer before the CDR.*

7.6

The customer and each supplier down to lower levels of the Product Tree shall hold Critical Design Reviews (CDR) at the end of phase C, on the products and the system components.

AIM: – Finalise the detailed definition of the products, their interfaces and the qualification conditions, as well as those of the system components,
 – Decide on the completeness of the detailed definition process as well as on the qualification process and industrial manufacturing planning.

The production of the qualification models is authorised, on the basis of the Production Master Files prepared during phase C. The Production Master Files and ICD's shall follow the configuration management rules.

EXPECTED OUTPUT: *Reviewed:*
 – *definition documentation,*
 – *Design Justification File,*
 – *verification plans,*
 – *Production Master Files and the final ICD's,*
 – *User's Documentation (preliminary version).*

7.7

During phase D, each supplier down to the agreed level of the Product Tree shall hold a Qualification Review on ground (QR), chaired by the customer.

AIM: – Achieve ground qualification of the products as well as associated production means,
 – Authorise the production of the recurring products.

The Qualification Review shall be conducted by the customer, on the basis of the qualification reports, the complete Design Justification Files, and the finalised User's Documentation.

NOTE Where development encompasses the production of one or several recurring products, the Qualification Review is completed by a First Article Configuration Review during which:

- the first article configuration is analysed from the viewpoint of reproducibility,
- the Production Master Files for the series productions are released,
- the series production go-ahead file is accepted by the customer.

EXPECTED OUTPUT: *Ground qualification of the system by the customer.*

7.8

For the ground elements, the first level customer shall hold a Qualification Review after on-site installation.

AIM: Achieve technical qualification of the ground elements (control centre, user's ground element...).

This QR shall be organised under the responsibility of the first level customer, on the basis of the following documents:

- complete Design Justification File for the system including ground element,
- qualification reports,
- User's Documentation, including Installation, Utilisation, Operations and Maintenance Manuals.

EXPECTED OUTPUT: *Qualification of the ground element of the system.*

7.9

The first level customer shall hold an Acceptance Review on the system after the end of the qualification and acceptance programme.

AIM: Confirm the completion of the phases C/D objectives,
Declaration of readiness for shipment to launch site.

EXPECTED OUTPUT: *Certificate of acceptance.*

7.10

The first level customer shall hold a Flight Readiness Review (FRR) before each launch and for each flight model of the space element; this review shall be conducted before the space element leaves for the launch campaign.

AIM: Verify the readiness of the space element for the flight.

The Flight Readiness Review is organised under the responsibility of the first level supplier, who will demonstrate :

- conformity of the space element characteristics (definition, performance levels) in relation to the mission goals,
- the as-built configuration of the space component, any difference in relation to the current configuration baseline, and the state of the corresponding waivers,
- the state of elements still considered as 'critical', particularly those able to have an impact on the mission,
- the state of the interfaces with the other system components,

- the launch campaign plan,
- the completion of the safety reviews and all the safety related issues.

EXPECTED OUTPUT: *Declaration of readiness for the flight.*

7.11

The consumer shall hold an Operational Readiness Review before each launch and for each flight model of the space element.

- AIM: – Decide on the results of operational qualification, which enables the verification of the operational compatibility of the system and its elements in relation to the ground support system, and to decide on the suitability of the system, its components and the ground support system to be used in operational conditions,
- Ensure that the operational teams are correctly trained and are the right size.

This review shall be conducted after the vehicle/ground compatibility tests and the operational qualification tests, during which the operational procedures (both in nominal mode and degraded modes) will have been implemented.

The Operational Readiness Review is conducted by the consumer.

EXPECTED OUTPUT: *Declaration of operational readiness.*

7.12

The consumer shall participate in the Launch Readiness Review (LRR), conducted by the launcher organisation, on the site and before each launch.

- AIM: – Verify the completion of actions decided at the Flight Readiness Review (FRR),
- Verify the operational state and the availability of the launcher, the launch base, the stations, network and all other means required for launch.

Launch Readiness Review (LRR) gives the authorisation for launch.

EXPECTED OUTPUT: *Declaration of readiness for launch.*

7.13

For projects with repetitive launches the consumer shall hold a flight qualification review based on in-flight tests after the first launch.

- AIM: – Measure the capability of the system to fulfil the intended mission,
- Achieve operational qualification of the system.

This review is conducted after the in-flight qualification process. This process comprises the qualification of all the products, testing of the ground system, performance and utilisation of in-flight operation tests.

The consumer will authorise the operational use of the system. The series production will be formally authorised.

7.14

An in-flight acceptance shall be performed at the beginning of the in-flight operation (end of sub-phase E1). The consumer shall review in-orbit performance as necessary.

- AIM: – Pronounce in-flight acceptance of the system, while deciding on its capability to fulfil the intended mission,
- Authorise entry into service,
 - Ensure feedback to the actors in the project (lessons learned).

The first In-Space Test Review will be conducted at the end of the system in-flight acceptance tests, in order to draw lessons concerning operational entry into service of the system, thus verifying its aptitude to fulfil the intended mission.

- EXPECTED OUTPUT: – *Pronouncing of in-flight acceptance of the system,*
- *Completion and issue of the acceptance certificate,*
 - *Continuous usage of the system.*