EUROPEAN COOPERATION

ECSS

FOR SPACE STANDARDIZATION

Space project management

Project planning and implementation

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.

This Standard has been prepared by the ECSS-M-ST-10 Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Change log

ECSS-M-10A 19 April 1996	First issue
ECSS-M-10B 13 June 2003	Second issue
ECSS-M-ST-10C 31 July 2008	Third issue This issue combines the contents of ECSS-M-10B, ECSS-M-20B and ECSS-M-30A. It supersedes these three standards. The descriptive text of the previous standards has been combined and rewritten to delete duplications and correct inconsistencies. The requirements of ECSS-M-10B have been maintained with following exceptions: • Requirements on function tree have been deleted and moved to ECSS-E-10. • Requirements on model matrix have been deleted. • Some requirements have been moved to newly established DRDs (e.g. WBS and WP DRD). • Some requirements have been edited to eliminate inconsistencies. The requirements of ECSS-M-20B have been maintained with following exceptions: • Some requirements have been deleted because they are obvious. • Requirements of clause 5.4 are covered by ECSS-M-ST-40. • Some requirements have been edited to eliminate inconsistencies. The content of ECSS-M-30A has been completely updated and rewritten.
ECSS-M-ST-10C Rev. 1 6 March 2009	Third issue revision 1 Changes with respect to version C (31 July 2008) are identified with revision tracking. The main changes are: • Changed term "technical specification" to "technical requirements specification". • Table F-1 updated to align it with ECSS-E-ST-10, and Table G-1 updated to identify DRD references. • Insertion of missing Header "4.4.3.2.1 Overview" (resp. "4.4.3.3.1 Overview") after clause number 4.4.3.2 (resp. 4.4.3.3) causing renumbering of subsequent clauses.

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Introduction

Project planning and implementation is the project function, encompassing a coherent set of processes for all aspects of project management and control.

This is done by:

* establishing the project requirements and constraints derived from the mission statement.

* defining phases and formal milestones enabling the progress of the project to be controlled with respect to cost, schedule and technical objectives (i.e. project control function).

* defining project breakdown structures, which constitute the common and unique reference system for the project management to:

    — identify the tasks and responsibilities of each actor;

    — facilitate the coherence between all activities of the whole project;

    — perform scheduling and costing activities.

* setting up a project organization to perform all necessary activities on the project.

1
Scope

The scope of this ECSS Standard is limited to describing the key elements of project planning and implementation and identifying the top level requirements and products that together provide a coherent and integrated project planning across the 3 ECSS branches.

Where other ECSS management, engineering, or product assurance standards contain more specific and detailed requirements related to project planning, references are provided to identify where these can be found within the ECSS system.

This standard may be tailored for the specific characteristic and constrains of a space project in conformance with ECSS-S-ST-00.

2
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 revision 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 more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

ECSS-S-ST-00-01	ECSS system – Glossary of terms
ECSS-M-ST-40	Space project management – Configuration and information management

3
Terms and definitions

3.1 Terms defined in other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.

3.2 Terms specific to the present standard

3.2.1 discipline

specific area of expertise within a general subject

> NOTE   The name of the discipline normally indicates the type of expertise (e.g. in the ECSS System, system engineering, mechanical engineering, software and communications are disciplines within the Engineering domain)

3.2.2 domain

general area of interest or influence covering a number of inter-related topics or sub-areas

> NOTE   The name of a domain normally indicates the area of interest (e.g. in the ECSS System, the Management, Engineering, and Product Assurance branches represent three different domains).

3.2.3 function

combination and interaction of a number of operations or processes, which together achieve a defined objective

3.3   Abbreviated terms

For the purposes of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply.

Abbreviation	Meaning
AR	acceptance review
B/L	baseline
CBCP	current baseline cost plan
CDR	critical design review
CRR	commissioning result review
DRL	document requirements list
EAC	estimate at completion
EGSE	electrical ground support equipment
ELR	end-of-life review
ETC	estimate to completion
FRR	flight readiness review
GSE	ground support equipment
ILS	integrated logistic support
ITT	invitation to tender
LRR	launch readiness review
MCR	mission close-out review
MDR	mission definition review
MGSE	mechanical ground support equipment
N/A	not applicable
OBCP	original baseline cost plan
OBS	organizational breakdown structure
ORR	operational readiness review
PDR	preliminary design review
PMP	project management plan
PRD	project requirements documents
PRR	preliminary requirements review
QR	qualification review
RFP	request for proposal
RFQ	request for quote
SRR	system requirements review
WBS	work breakdown structure
WP	work package

4
Principles

4.1 Project planning

4.1.1 Introduction

Project planning and implementation encompasses all of the processes carried out in order to plan and execute a space project from initiation to completion at all levels in the customer-supplier chain in a coordinated, efficient and structured manner. It is a project wide activity receiving inputs from all project disciplines and involving close co-operation across the project domains.

A space project typically comprises a space segment and a ground segment which are implemented in parallel (see ECSS-E-ST-70). They rely on, and have interfaces with the launch service segment. These three segments comprise a space system.

In principle, a proposal to initiate a space project can be raised by any party. However, the most common initiators are:

- individual governments, or co-operation between a number of governments;

- national, or international space agencies, either singly or collectively;

- national or international scientific communities;

- operators of commercial space systems.

In this ECSS standard, the top level customer is defined as the organization responsible for generating the top level space segment and ground segment business agreements and for interface arrangements with other external space system elements.

The following clauses 4.1.2 to 4.1.11 describe the key elements to be addressed, assessed, and balanced when planning a project.

4.1.2 Purpose and objectives of the project

The purpose and objectives of the project are defined by the project initiator in the mission statement which includes key performance parameters and technical and programmatic constraints to be applied to the project. They are normally coordinated with the top level customer, if one has been assigned.

4.1.3 Availability of and need to develop new technologies

This is an assessment carried out jointly by the customer and supplier to identify the availability of scientific and technological know-how and the technology needed to implement the project. The result of this assessment, which can be a significant cost and schedule driver, is a major input to the assessment of required resources and facilities and to the subsequent technical and programmatic risk assessment.

4.1.4 Availability of and need to reuse existing equipments/products

This is an assessment of the feasibility of reusing existing products and is typically carried out as a direct response to a customer requirement. The result of this assessment, which also can have a significant influence on cost and schedule is a major input to the assessment of required resources and facilities and to the subsequent technical and programmatic risk assessment.

4.1.5 Availability of and need for human resources, skills and technical facilities

This is an assessment carried out jointly by the customer and supplier of the resources, skills and facilities required to implement the project. The result of this assessment shows if required resources, skills and facilities are adequate, or if additional skills, resources, or facilities are needed to complete the project.

4.1.6 Risk assessment

The initial assessments of the technical and programmatic risks of a project are carried out by the customer, based on the project initiator's inputs with respect to the purpose and objectives of the project, together with the identified technical and programmatic constraints to be applied to the project. The initial assessment is subsequently regularly expanded to include other relevant parameters as they become available, and as the project matures. Comprehensive risk assessments are conducted at each major project review.

4.1.7 Development approach

The development approach for a project is jointly defined by the customer and supplier to comply with the project initiator's mission statement, requirements and constraints, and balancing these with the outcome of paragraphs 4.1.3 to 4.1.6 above.

4.1.8 Project deliverables

The customer has the responsibility for defining the deliverable products, needed to meet the project initiator's mission statement, taking into account the assessments noted in clauses 4.1.4 to 4.1.7 above.

4.1.9 Customer requirements and constraints

Customer requirements and constraints are prepared by the customer based on the outputs from 4.1.2 to 4.1.8 above and put into a format suitable for direct application in an invitation to tender (ITT). They address technical and programmatic requirements, as well as political, commercial, and industrial constraints to be applied to the project and collectively represent the project requirements documents (PRD).

4.1.10 Project requirements documents (PRD)

The project requirements documents are an integral part of an ITT, request for proposal (RFP), or request for quote (RFQ) prepared and released by a customer to potential suppliers.

The PRD typically comprise

- Statement of work

- Technical requirements documented in Technical <u>Requirements</u> Specification<u>, as defined in ECSS-E-ST-10-06</u>

- Management requirements

- Engineering requirements

- Product assurance requirements

- Programmatic requirements

- Other, project specific requirements (e.g. geographical distribution, model philosophy to be applied)

- Documents requirements list (DRL)

- Tender requirements

Under the ECSS system, management, engineering and product assurance requirements are contained in the M, E, and Q standards, progressively tailored by each customer in the customer-supplier chain to reflect the type and phase of the project covered by the business agreement, as well as the scope of the suppliers' tasks required by the PRD.

4.1.11 Project management plan

The top level project plan is the project management plan which defines the project management approach and methodology to be used throughout the life cycle of the project, together with an overview of all elements of project management disciplines. It includes the definition of the system engineering and product assurance management approach or provides references to separate system engineering and product assurance plans which together make up the total planning documentation used to implement a project.

4.2 Project organization

4.2.1 Introduction

The establishment of a well structured and coherent organizational structure for implementing a project at all levels in the customer-supplier chain is a key factor for ensuring an effective and efficient management approach. At each level in the customer-supplier chain a project organization can be built as a self-standing project team containing all necessary disciplines within the team structure or, more often, can be built around a core project team containing key project functions with other necessary functions being provided from outside the project team as external support.

Irrespective of the organizational approach followed for a project, the elements summarized below are relevant at all levels in the customer-supplier chain.

4.2.2 Organizational structure

It is essential that the project organizational structure is arranged to include all disciplines essential to implement the project with well defined functions as well as clear reporting lines, inter-relationships and interfaces. All project actors below the top level customer and above the lowest level supplier(s) have the roles of suppliers and customers, and their organizational structures are constructed to accommodate both roles.

The organizational structure provides a clear and unambiguous definition and allocation of individual roles and responsibilities together with the necessary authority to implement these within the internal project set–up as well as towards project external interfaces.

4.2.3 Communication and reporting

Effective means of communication are essential tools for ensuring clear and efficient inter-action between all project actors, as well as between the project team and its external interfaces. Information technology is the primary means for the exchange of information. Communication serves initially to provide clarity about the project's goals and objectives and subsequently, to support the day to day work of the project team. Regular reporting is an important tool for exchanging information concerning the progress of the project.

4.2.4 Audits

Audits are independent examinations to determine whether processes and procedures achieve the specified objective. They are an essential tool to identify problem areas.

4.3 Project breakdown structures

4.3.1 Introduction

Project breakdown structures provide the basis for creating a common understanding between all actors. They break the project down into manageable elements as described in the following clauses 4.3.2 to 4.3.7.

4.3.2 Function tree

The function tree is the breakdown of the system performances into functions. Each function is decomposed into sub–functions independent of the type of products involved. The "function" approach is applied during project start–up or during the system definition phase. More details about the function tree are given in ECSS-E-ST-10, function tree DRD.

4.3.3 Specification tree

The specification tree defines the hierarchical relationship of all technical requirements specifications for the different elements of a system or product. More details about the specification tree are given in ECSS-E-ST-10, specification tree DRD.

4.3.4 Product tree

The product tree is the breakdown of the project into successive levels of hardware and software products or elements, articulated to perform the functions identified in the function tree. However, the function and the product tree do not necessarily mirror each other. The product tree includes the development models, the GSE, the integration tools and test equipment, and external items necessary to validate the end product and ILS items. It includes items submitted to customer configuration control and items that are the subject of a technical requirements specification. The product tree forms the basis for the elaboration of the project work breakdown structure.

An example of a product tree is shown in Figure 4-1.
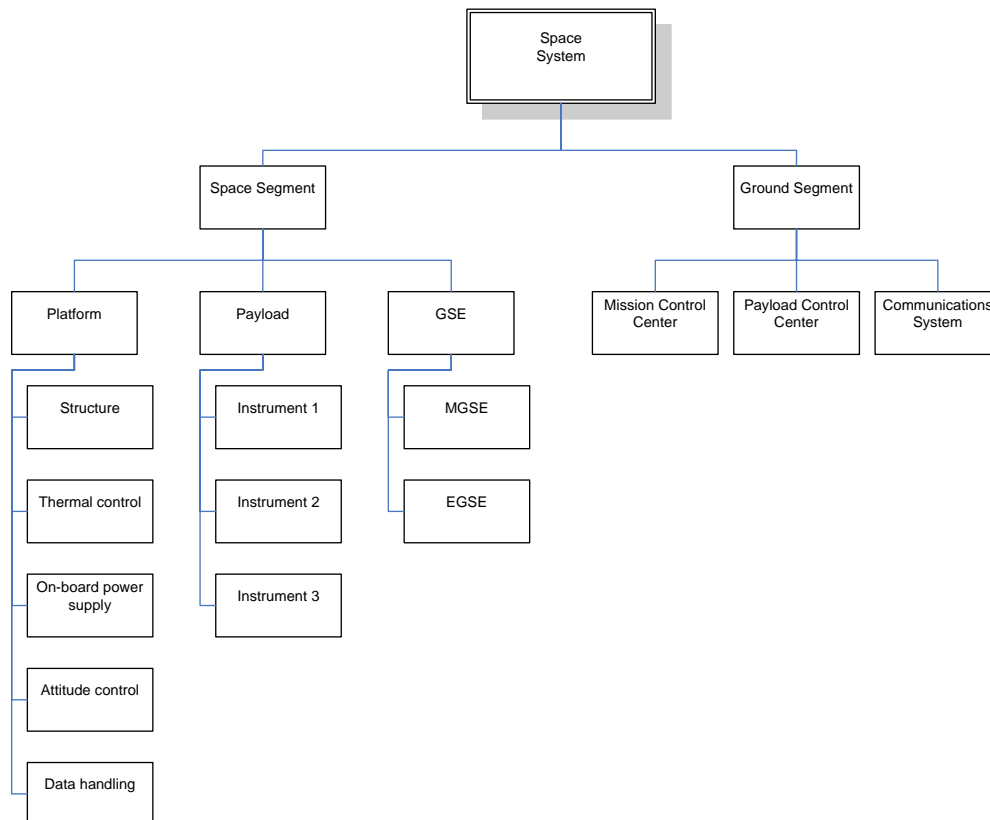
Figure 4-1: Product tree example

4.3.5 Work breakdown structure (WBS)

The WBS is the principal structure used in managing a project and provides a framework for managing cost, schedule and technical content. It divides the project into manageable work packages, organized according to the nature of the work by breaking down the total work to be performed into increasing levels of detail.

The WBS is derived from the product tree, selected elements of which are extended to include support functions (i.e. management, engineering, product assurance) and associated services (e.g. test facilities).

An example of a WBS is shown in Figure 4-2.
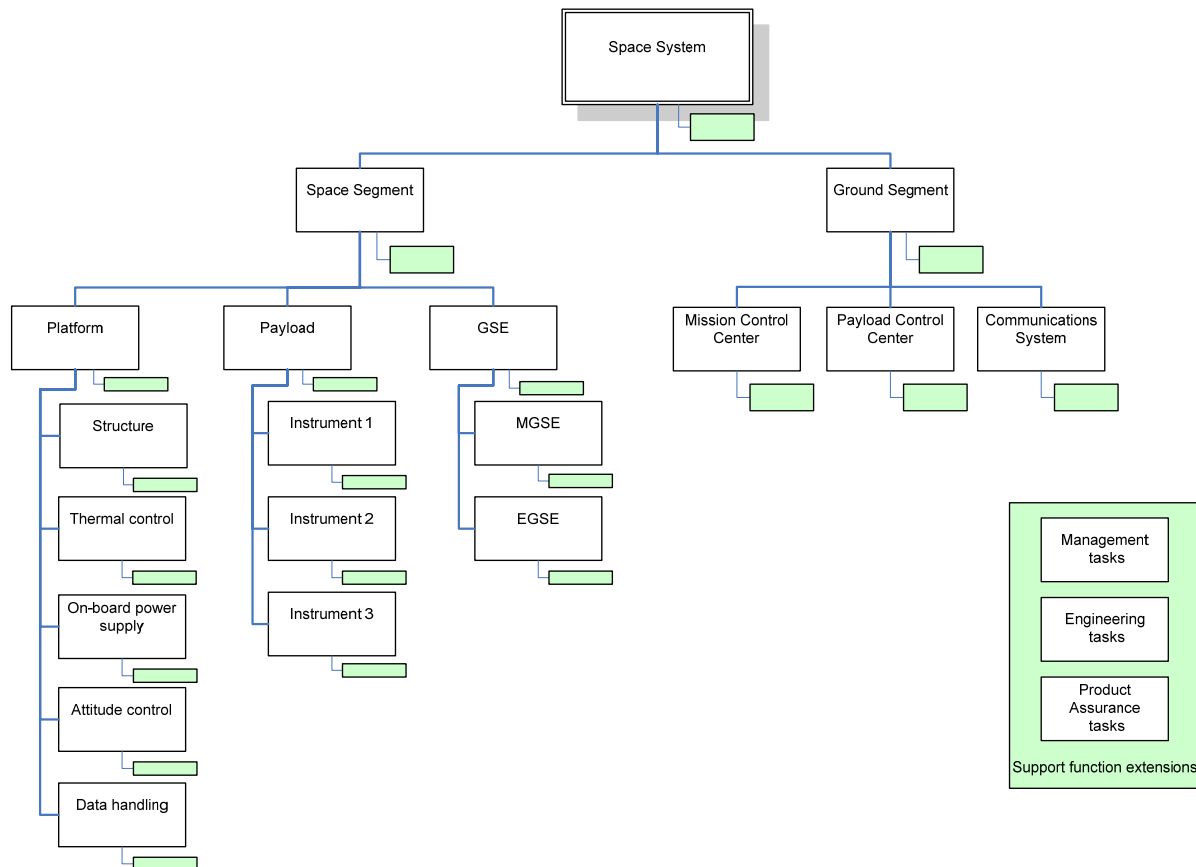
Figure 4-2: WBS example

4.3.6 Work package (WP)

A WP can be any element of the WBS down to the lowest level that can be measured and managed for planning, monitoring, and control.

Control work packages are identified by the supplier at the level in the WBS where visibility and control is required, and for which reporting is to be performed. The control work packages represent the total work-scope and are agreed by the customer.

The work of each supplier is explicitly identified in the work breakdown structure by at least one control work package.

4.3.7 Organization breakdown structure (OBS)

The OBS depicts the proposed project organization, including the interface and contractual responsibilities, as opposed to company organization breakdown structure, which depicts the functional aspects of the company. The project OBS shows the key personnel and the assigned responsible parties for each work package in the WBS.

4.4   Project phasing

4.4.1   Introduction

The life cycle of space projects is typically divided into 7 phases, as follows:

- Phase 0 - Mission analysis/needs identification

- Phase A - Feasibility

- Phase B - Preliminary Definition

- Phase C - Detailed Definition

- Phase D - Qualification and Production

- Phase E –Utilization

- Phase F – Disposal

A typical project life cycle is illustrated in Figure 4-3.

Project phases are closely linked to activities on system and product level. Depending on the specific circumstances of a project and the acceptance of involved risk, activities can overlap project phases.

At the conclusion of the major activities and the related project reviews configuration baselines are established (see ECSS-M-ST-40).

Activities	Phases						
	Phase 0	Phase A	Phase B	Phase C	Phase D	Phase E	Phase F
Mission/Function		MDR	PRR				
Requirements			SRR	PDR			
Definition					CDR		
Verification					QR		
Production					AR ORR		
Utilization					FRR	CRR ELR LRR	
Disposal							MCR

Figure 4-3: Typical project life cycle

Phases 0, A, and B are focused mainly on

- the elaboration of system functional and technical requirements and identification of system concepts to comply with the mission statement, taking into account the technical and programmatic constraints identified by the project initiator and top level customer.
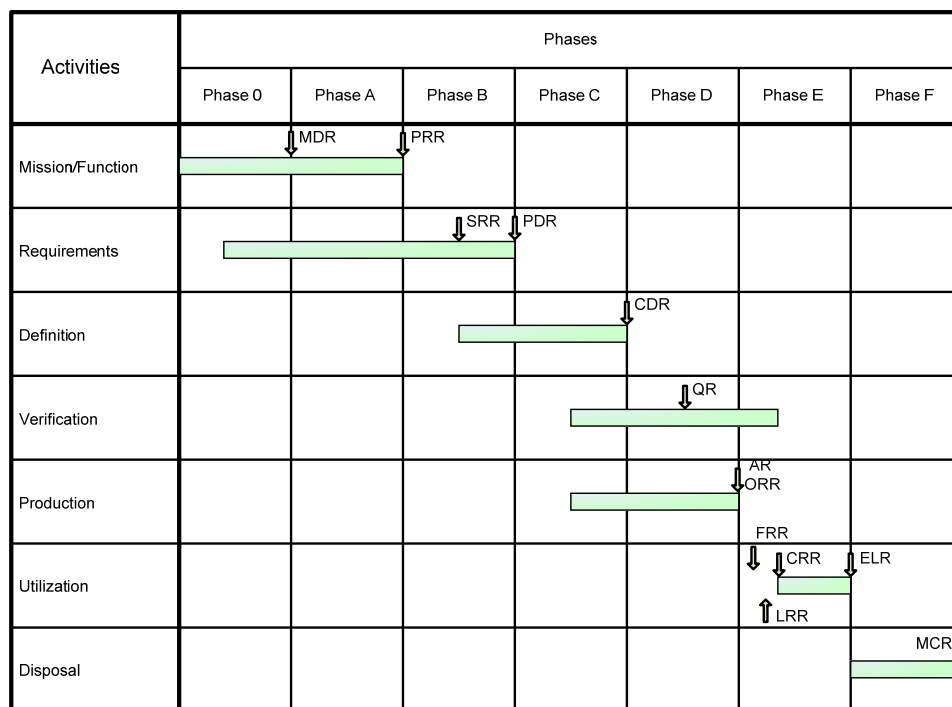
- the identification of all activities and resources to be used to develop the space and ground segments of the project,

- the initial assessments of technical and programmatic risk,

- initiation of pre-development activities.

Phases C and D comprise all activities to be performed in order to develop and qualify the space and ground segments and their products.

Phase E comprises all activities to be performed in order to launch, commission, utilize, and maintain the orbital elements of the space segment and utilize and maintain the associated ground segment.

Phase F comprises all activities to be performed in order to safely dispose all products launched into space as well as ground segment.

Each of the above project phases includes end milestones in the form of project review(s), the outcome of which determines readiness of the project to move forward to the next phase.

Requirements on organization and conduct of reviews are provided in ECSS-M-ST-10-01.

With the exception of the MDR which normally involves only the project initiator, and the top level customer, all other project reviews up to and including the AR are typically carried out by all project actors down to the lowest level supplier in the customer-supplier chain involved in the project phases containing these reviews.

From the PRR to the PDR, the sequence of the reviews is "top down", starting with the top level customer and his top level supplier, and continuing down the customer-supplier chain to the lowest level supplier. From the CDR to the AR, the sequence of reviews is reversed to "bottom up", starting with the lowest level supplier and its customer and continuing up through the customer-supplier chain to the 1st level supplier and the top level customer. This so called "V model" is illustrated in Figure 4-4.
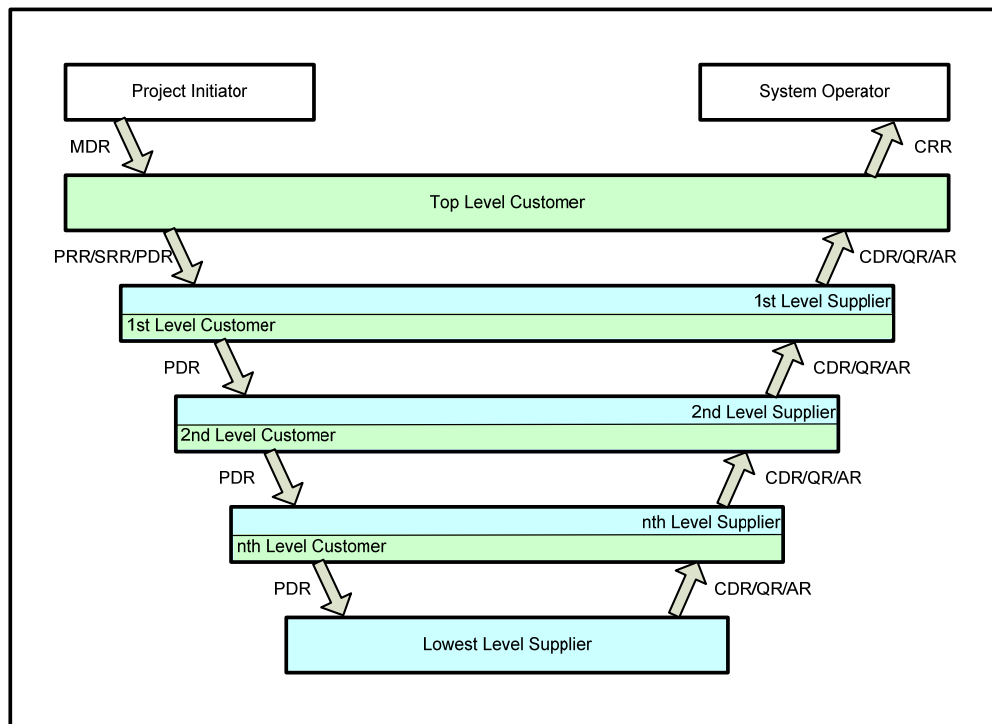
Figure 4-4: Review life cycle

4.4.2 Relationship between business agreements and project phases

A business agreement can cover a single project phase, a sequential grouping of project phases or sub-phases (e.g. phase B1/phase B2; phase B2/phase C1/phase C2), depending on such factors as funding availability, competitive tendering, schedule, perceived risk. Irrespective of the approach used for defining the scope of individual business agreements, all space projects essentially follow the classical project phases in sequence and include all of the major objectives and key milestones of each of these phases.

4.4.3 Project phases

4.4.3.1 General

The clause 4.4.3 provides an introduction and overview of the typical major tasks, associated review milestones, and review objectives for each of the phases in a project life cycle.

4.4.3.2 Phase 0 (Mission analysis/needs identification)

4.4.3.2.1 Overview

This is mainly an activity conducted by the project initiator, the top level customer and representatives of the end users.

4.4.3.2.2   Major tasks:

- Elaborate the mission statement in terms of identification and characterization of the mission needs, expected performance, dependability and safety goals and mission operating constraints with respect to the physical and operational environment.

- Develop the preliminary technical <u>requirements</u> specification.

- Identify possible mission concepts.

- Perform preliminary assessment of programmatic aspects supported by market and economic studies as appropriate.

- Perform preliminary risk assessment.

4.4.3.2.3   Associated review

The mission definition review (MDR) is held at the end of phase 0.

The outcome of this review is used to judge the readiness of the project to move into phase A.

4.4.3.2.4   Main review objective(s)

The primary objective of this review is to release the mission statement and assess the preliminary technical <u>requirements</u> specification and programmatic aspects.

4.4.3.3   Phase A (Feasibility)

4.4.3.3.1   <u>Overview</u>

This is mainly an activity conducted by the top level customer and one or several first level suppliers with the outcome being reported to the project initiator, and representatives of the end users for consideration.

4.4.3.3.2   Major tasks
- Establish the preliminary management plan, system engineering plan and product assurance plan for the project.
- Elaborate possible system and operations concepts and system architectures and compare these against the identified needs, to determine levels of uncertainty and risks.
- Establish the function tree.
- Assess the technical and programmatic feasibility of the possible concepts by identifying constraints relating to implementation, costs, schedules, organization, operations, maintenance, production and disposal.
- Identify critical technologies and propose pre-development activities.
- Quantify and characterize critical elements for technical and economic feasibility.
- Propose the system and operations concept(s) and technical solutions, including model philosophy and verification approach, to be further elaborated during Phase B.
- Elaborate the risk assessment.

4.4.3.3.3   Associated review

The preliminary requirements review (PRR) is held at the end of Phase A. The outcome of this review is used to judge the readiness of the project to move into Phase B.

4.4.3.3.4   Main review objective(s)

The primary objectives of this review are:

- Release of preliminary management, engineering and product assurance plans.

- Release of the technical <u>requirements</u> specification.

- Confirmation of the technical and programmatic feasibility of the system concept(s).

- Selection of system and operations concept(s) and technical solutions, including model philosophy and verification approach, to be carried forward into Phase B.

4.4.3.4   Phase B (Preliminary definition)

4.4.3.4.1   Major tasks

- Finalize the project management, engineering and product assurance plans.

- Establish the baseline master schedule.

- Elaborate the baseline cost at completion.

- Elaborate the preliminary organizational breakdown structure (OBS).

- Confirm technical solution(s) for the system and operations concept(s) and their feasibility with respect to programmatic constraints.

- Conduct "trade-off" studies and select the preferred system concept, together with the preferred technical solution(s) for this concept.

- Establish a preliminary design definition for the selected system concept and retained technical solution(s).

- Determine the verification program including model philosophy.

- Identify and define external interfaces.

- Prepare the next level specification and related business agreement documents.

- Initiate pre-development work on critical technologies or system design areas when it is necessary to reduce the development risks.

- Initiate any long-lead item procurement required to meet project schedule needs.

- Prepare the space debris mitigation plan and the disposal plan.

- Conduct reliability and safety assessment.

- Finalize the product tree, the work breakdown structure and the specification tree.

- Update the risk assessment.

4.4.3.4.2 Associated reviews

There are 2 project reviews associated with Phase B.

- The system requirements review (SRR) held during the course of Phase B.

- The preliminary design review (PDR) held at the end of Phase B. The outcome of this review is used to judge the readiness of the project to move into Phase C.

4.4.3.4.3 Main review objectives - System requirements review

The primary objectives of this review are:

- Release of updated technical requirements specifications.

- Assessment of the preliminary design definition.

- Assessment of the preliminary verification program.

4.4.3.4.4 Main review objectives – Preliminary design review

The primary objectives of this review are:

- Verification of the preliminary design of the selected concept and technical solutions against project and system requirements.

- Release of final management, engineering and product assurance plans.

- Release of product tree, work breakdown structure and specification tree.

- Release of the verification plan (including model philosophy).

4.4.3.5   Phase C (Detailed definition)

4.4.3.5.1 Major tasks

The scope and type of tasks undertaken during this phase are driven by the model philosophy selected for the project, as well as the verification approach adopted.

- Completion of the detailed design definition of the system at all levels in the customer-supplier chain.

- Production, development testing and pre-qualification of selected critical elements and components.

- Production and development testing of engineering models, as required by the selected model philosophy and verification approach.

- Completion of assembly, integration and test planning for the system and its constituent parts.

- Detailed definition of internal and external interfaces.

- Issue of preliminary user manual.

- Update of the risk assessment.

4.4.3.5.2 Associated review

The critical design review (CDR) is held at the end of phase C. The outcome of this review is used to judge the readiness of the project to move into phase D.

4.4.3.5.3   Main review objectives

- Assess the qualification and validation status of the critical processes and their readiness for deployment for phase D.

- Confirm compatibility with external interfaces.

- Release the final design.

- Release assembly, integration and test planning.

- Release flight hardware/software manufacturing, assembly and testing.

- Release of user manual.

4.4.3.6   **Phase D (Qualification and production)**

4.4.3.6.1   Major tasks

- Complete qualification testing and associated verification activities.

- Complete manufacturing, assembly and testing of flight hardware/software and associated ground support hardware/software.

- Complete the interoperability testing between the space and ground segment.

- Prepare acceptance data package.

4.4.3.6.2   Associated reviews

There are 3 project reviews associated with phase D

- The qualification review (QR) held during the course of the phase.

- The acceptance review (AR) held at the end of the phase. The outcome of this review is used to judge the readiness of the product for delivery.

- The operational readiness review (ORR), held at the end of the phase.

4.4.3.6.3   Main review objectives – Qualification review

The primary objectives of this review are:

- To confirm that the verification process has demonstrated that the design, including margins, meets the applicable requirements.

- To verify that the verification record is complete at this and all lower levels in the customer-supplier chain.

- To verify the acceptability of all waivers and deviations.

Where development encompasses the production of one or several recurring products, the QR is completed by a functional configuration verification during which:

- The first article configuration is analyzed 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.

4.4.3.6.4   Main review objectives – Acceptance review

The primary objectives of this review are:

- To confirm that the verification process has demonstrated that the product is free of workmanship errors and is ready for subsequent operational use.

- To verify that the acceptance verification record is complete at this and all lower levels in the customer-supplier chain.

- To verify that all deliverable products are available per the approved deliverable items list.

- To verify the "as-built" product and its constituent components against the required "as designed" product and its constituent components.

- To verify the acceptability of all waivers and deviations.

- To verify that the Acceptance Data Package is complete.

- To authorize delivery of the product.

- To release the certificate of acceptance.

4.4.3.6.5   Main review objectives - Operational readiness review (ORR)

The primary objectives of this review are:

- To verify readiness of the operational procedures and their compatibility with the flight system.

- To verify readiness of the operations teams.

- To accept and release the ground segment for operations.

4.4.3.7   Phase E (Operations/utilization)

4.4.3.7.1   Major tasks

The major tasks for this phase vary widely as a function of the type of project concerned. Therefore, only a general overview of activities during this phase is provided here.

- Perform all activities at space and ground segment level in order to prepare the launch.

- Conduct all launch and early orbital operations.

- Perform on-orbit verification (including commissioning) activities.

- Perform all on-orbit operations in order to achieve the mission objectives.

- Perform all ground segment activities in order to support the mission.

- Perform all other ground support activities in order to support the mission.

- Finalize the disposal plan.

4.4.3.7.2 Associated reviews

There are 4 project reviews associated with phase E.

- The flight readiness review (FRR) is held prior to launch.

- The launch readiness review (LRR), held immediately prior to launch.

- The commissioning result review (CRR), held after completion of the on-orbit commissioning activities.

- The end-of-life review (ELR) held at the completion of the mission.

4.4.3.7.3 Main review objectives - Flight readiness review (FRR)

The flight readiness review is conducted prior to launch. The objective of this review is to verify that the flight and ground segments including all supporting systems such as tracking systems, communication systems and safety systems are ready for launch.

4.4.3.7.4 Main review objectives - Launch readiness review (LRR)

The launch readiness review is conducted just prior to launch. The objective of this review is to declare readiness for launch of the launch vehicle, the space and ground segments including all supporting systems such as tracking systems, communication systems and safety systems and to provide the authorization to proceed for launch.

4.4.3.7.5 Main review objectives - Commissioning result review (CRR)

The commissioning result review is held at the end of the commissioning as part of the in-orbit stage verification. It allows declaring readiness for routine operations/utilization.

This Review is conducted following completion of a series of on-orbit tests designed to verify that all elements of the system are performing within the specified performance parameters. Successful completion of this review is typically used to mark the formal handover of the system to the project initiator or to the system operator.

4.4.3.7.6 Main review objectives – End of life review (ELR)

- To verify that the mission has completed its useful operation or service.

- To ensure that all on-orbit elements are configured to allow safe disposal.

4.4.3.8 Phase F (Disposal)

4.4.3.8.1 Major tasks

Implement the disposal plan.

4.4.3.8.2 Associated review

The mission close-out review (MCR) is held at the end of this phase.

4.4.3.8.3 Main review objectives

To ensure that all mission disposal activities are adequately completed.

4.4.4 Project specific reviews

In addition to the project reviews identified above, and depending on the type of project, the applicable business agreement and the overall implementation approach adopted, additional reviews can be inserted into the project planning against agreed sub-milestones/additional milestones to meet particular project needs.

Typical examples of such reviews are :

- Detailed design review (software specific review, addressed in ECSS-E-ST-40)

- In orbit operations review (addressed in ECSS-E-ST-70)

- First article configuration review (serial production specific review)

- System design review

- System qualification review at ground level (launcher specific review)

- System qualification review at flight level (launcher specific review)

These reviews are not further addressed in this standard.

5
Requirements

5.1 Project planning

5.1.1 Overview

Project planning requirements are applicable to all actors of a project from the top level customer down to the lowest level supplier. Project actors who have the role of a customer and a supplier carry the responsibilities associated with both roles. The scope and detail of requirements made applicable is a function of the level of each actor in the customer-supplier chain, with the full scope of all requirements applicable to the top level supplier. The overall scope made applicable reduces, down through the customer-supplier chain but becomes more specific as a function of the role played by each of these actors and the type of product(s) to be developed and delivered by them.

5.1.2 Requirements on customers

a. Each customer shall prepare business agreements (ITT's, RFP's, or RFQ's), including the project requirements documents (PRD) to be made applicable between him and his supplier(s).

b. Each customer shall use the ECSS standards to establish the project management, engineering and product assurance requirements applicable for the project.

c. Each customer shall make applicable to his supplier(s) only those ECSS standards relevant to the type and phase(s) of the project addressed by the business agreement.

d. Each customer shall specify by tailoring the minimum requirements within the applicable standards necessary for his supplier(s) to achieve the project objectives.

e. Each customer shall approve the project management plans and key personnel of his supplier(s).

f. Each customer shall verify compliance of his supplier(s) with all project requirements and constraints.

g. Each customer below the top level customer in the customer-supplier chain shall in addition ensure that planning for his suppliers is consistent with the planning requirements imposed on him by his customer.

5.1.3　Requirements on suppliers

a. Each supplier in the customer-supplier chain shall prepare a project management plan (PMP) in conformance with Annex A.

b. Each supplier in the customer-supplier chain shall submit the PMP to his customer for approval.

5.2　Project organization

5.2.1　Organizational structure

5.2.1.1　Requirements on customers and suppliers

a. Each customer and supplier shall define the authority for project management and business agreement signing.

b. If the project has links with other projects, each customer and supplier shall define the responsibilities relating to the definition and the management of interfaces.

c. Where a customer, or supplier, employs consultants or other specialists to assist him in performing his duties, then the roles, responsibilities and authority of these consultants and specialists shall be defined.

d. When a customer supplies a product to a supplier he shall have the responsibility of a supplier in respect of that product.

5.2.1.2　Requirements on suppliers

a. The supplier shall set up the project management organization in such a way that adequate resources are allocated to the project to ensure timely completion of the business agreement.

b. The supplier shall nominate a project manager with a project team under his authority and reporting directly to him.

c. The supplier shall ensure that the project manager has the authority to execute all tasks needed under the business agreement with direct access to his company management hierarchy to resolve conflicts at the appropriate level.

d. The supplier shall identify the key personnel to be deployed on the work, and include them in the project organization.

e. The supplier shall demonstrate that the key personnel have the necessary qualification, skills and experience to perform the task for which they are allocated.

f. The supplier's project management organization shall exercise an active monitoring and control over its own and lower tier supplier's activities and lead its lower tier supplier's in the execution of subcontracted activities to ensure that their services conform to the customer's requirements.

g.   If a supplier is responsible for more than one business agreement within a project, and the business agreements have different customers, then each business agreement shall be clearly identified and accomplished according to the appropriate relationships.

h.   The first level supplier shall establish, maintain and distribute a project directory including key personnel, as a minimum.

5.2.2   Communication and reporting

5.2.2.1   Requirements on customers and suppliers

a.   The top level customer shall:

1.   specify a reporting system for the project;

2.   specify an action monitoring system for the project.

b.   Each customer and supplier in the customer-supplier chain shall implement and maintain the project reporting an action monitoring systems.

c.   Formal meetings between the customer and his supplier(s) shall be held to review progress against approved project planning and address major deviations or changes proposed to the project requirements documents.

d.   The frequency, location and schedule of customer-supplier project meetings shall be agreed by all participating parties.

e.   Customer-supplier meetings shall be based on an agreed written agenda.

f.   A chairperson and secretary shall be designated at the beginning of the meeting.

g.   The results of the meeting shall be documented in the agreed minutes signed by all parties involved in the meeting.

h.   Agreed actions shall be documented in an action item list.

i.   Each action shall be allocated

1.   a unique identification,

2.   the identification of the origin (e.g. meeting),

3.   the initiator,

4.   the description of the action (clear and concise),

5.   the person responsible for the action,

6.   the close-out date,

7.   the current status, and

8.   the close-out reference (e.g. document, letter).

j.   Action items shall be reviewed at each meeting.

k.   Any matters documented in the minutes of meeting having impact on the business agreement shall be subject to the contract change procedure for implementation.

5.2.2.2   Requirements on suppliers

a.   The supplier shall prepare and submit progress reports to his customer in conformance with Annex E.

b.   The supplier shall prepare minutes of progress meetings for approval of the customer.

c.   The supplier shall notify the customer within an agreed period of time of any event that could significantly affect the achievement of the business agreement objectives in terms of cost, technical performance and schedule, and any situation resulting in a substantial schedule or planning change demanding immediate customer involvement.

5.2.3   Audits

5.2.3.1   General requirements

a.   Every audit performed shall be followed by a report prepared by the auditor and containing the views of both parties.

b.   The conclusions of the audit and the draft report shall be discussed with the supplier, before finalization and release.

c.   In the event of disagreement with any of the audit conclusions, the supplier may add his observations and comments.

d.   The final audit report shall not be divulged without the agreement of the audited supplier.

5.2.3.2   Requirements on customers

a.   The customer shall notify the supplier in due time of

    1.   his intention to perform an audit;

    2.   the objectives and the scope of the audit;

    3.   the designated auditor and his terms of reference;

    4.   the audit schedule.

5.2.3.3   Requirements on suppliers

a.   The supplier shall accept to be audited by the customer or by a third party agreed between the customer and the supplier in the framework of the business agreement.

b.   The supplier shall have the right to demand that the audit be performed by a third party, and that the third party obtain authorization each time the audit necessitates access to information concerning patent rights or confidentiality associated with defence secrecy.

c.   The supplier shall perform audits of his own project activities and of the project activities of his lower tier supplier(s) to verify conformance with project requirements.

d. The supplier shall provide right of access for participation by the customer in his own audits and in audits of his lower tier suppliers.

e. The supplier shall provide his customer access to his facilities and data which are relevant in the frame of the business agreement.

5.3   Project breakdown structures

a. The supplier shall develop the product tree for his products down to the deliverable end items, incorporating the product trees of each of his lower tier suppliers, in conformance with Annex B.

b. The product tree shall be established at start of phase B and finalized not later than PDR.

c. The rules for product item identification shall be uniform within the project.

d. A unique identification shall be assigned to each item within the product tree.

e. The identification shall remain unchanged during the product lifetime, unless a modification causes discontinuation of interchangeability.

f. The product tree shall be subject to customer approval.

g. The supplier shall maintain the product tree up-to-date under configuration control.

h. The supplier shall establish the work breakdown structure (WBS) for his work share, incorporating the WBS of each of his lower tier suppliers, in conformance with Annex C.

i. Work related to manufacturing, assembly, integration and test of all product models shall be shown in the WBS.

j. Support functions (management, engineering, product assurance) shall be identifiable in connection with its related product tree elements.

k. The WBS shall be subject to customer approval.

l. Each supplier shall maintain up-to-date the WBS for his work share in the project.

m. The supplier shall identify control work packages based on the approved WBS, and the level of visibility required by the customer.

n. The supplier shall establish work package (WP) descriptions for each work package shown in his WBS in conformance with Annex D.

o. Each WP shall have a single responsible WP manager.

p. The supplier shall establish a project organization breakdown structure (OBS), which includes.

1. the interface and contractual responsibilities amongst the involved parties

2. the key personnel and the assigned responsible parties for each work package in the WBS

q. The project OBS shall be submitted to the customer for approval.

r. The supplier shall maintain the approved OBS, keep it up-to-date, and issue it to the lower tier suppliers and the customer.

5.4 Project phasing

a. The customer shall organize the project into sequential phases which include all project specific reviews and decision milestones.

> NOTE   Phases and reviews are defined in clause 4.4.3.

b. The customer shall prepare project review procedures for all project reviews.

c. The customer shall ensure that the project reviews of his supplier(s) are in line with the top down / bottom up sequence of the overall project review planning.

d. The customer shall take the decision to move from one phase to the next on the basis of the outcome of the associated "end of phase" review.

> NOTE 1   Information concerning the expected delivery of ECSS management branch documents per review is provided in Annex F.
>
> NOTE 2   Information concerning additional documents which are defined as outputs of the management standards requirements and which are not part of review data packages is provided in Annex G.

Annex A (normative)
Project management plan (PMP) – DRD

A.1   DRD identification

A.1.1   Requirement identification and source document

This DRD is called from ECSS-M-ST-10, requirement 5.1.3a.

A.1.2   Purpose and objective

The PMP is prepared to state the purpose and provide a brief introduction to the project management system. It covers all aspects of the latter.

A.2   Expected response

A.2.1   Scope and content

<1>   Introduction

a.   The PMP shall contain a description of the purpose, objective and the reason prompting its preparation (e.g. program or project reference and phase).

<2>   Applicable and reference documents

a.   The PMP shall list the applicable and reference documents used in support of the generation of the document.

<3>   Objectives and constraints of the project

a.   The PMP shall briefly describe the objective and constraints of the project in conformance with the project requirements documents.

<4>   Project organization

a.   The PMP shall describe the project organization approach in conformance with the requirements as defined in clause 5.2.

<5>   Project breakdown structures

a.   The PMP shall describe the project breakdown structures approach in conformance with the project breakdown structure requirements as defined in clause 5.3 and identify the title of individual documents called up by these requirements.

<6>   Configuration, information and documentation management

a.   The PMP shall describe the configuration, information and documentation management approach, as defined in ECSS-M-ST-40, Annex A.

b.   If the configuration, information and documentation management approach is contained in a rolled-out configuration management plan, the PMP may include only a brief description together with a reference to the configuration, information and documentation management plan.

<7>   Cost and schedule management

a.   The PMP shall describe the cost and schedule management approach, as defined in ECSS-M-ST-60.

b.   If the cost and schedule management approach is described in a rolled-out cost and schedule management plan, the PMP may include only a brief description together with a reference to the cost and schedule management plan.

<8>   Integrated logistic support

a.   The PMP shall describe the integrated logistic support approach, as defined in ECSS-M-ST-70.

<9>   Risk management

a.   The PMP shall briefly describe the risk management approach which is described in more detail in a rolled-out risk management policy and plan, as defined in ECSS-M-ST-80, Annexes A and B.

<10>   Product assurance management

a.   The PMP shall describe the product assurance management approach, including the proposed breakdown into PA disciplines and the interfaces between these disciplines, as defined in ECSS-Q-ST-10, Annex A.

b.   If the product assurance management approach is described in a rolled-out PA plan, the PMP may include only a brief description together with a reference to the product assurance plan.

<11>   Engineering management

a.   The PMP shall describe the engineering management approach, including the proposed breakdown into engineering disciplines and the interfaces between these disciplines, as defined in ECSS-E-ST-10, Annex D.

b.   If the engineering management approach is described in a rolled-out system engineering plan, the PMP may include only a brief description together with a reference to the system engineering plan.

A.2.2   Special remarks

None.

Annex B (normative)
Product tree – DRD

B.1 DRD identification

B.1.1 Requirement identification and source document

This DRD is called from ECSS-M-ST-10, requirement 5.3a.

B.1.2 Purpose and objective

The objective of the product tree document is to describe, in a single document, the hierarchical partitioning of a deliverable product down to a level agreed between the customer and supplier.

The product tree is part of the design definition file. It is the starting point for selecting configuration items (as specified in ECSS-M-ST-40) and establishing the work breakdown structure. It is a basic structure to establish the specification tree (as defined in ECSS-E-ST-10).

B.2 Expected response

B.2.1 Scope and content

<1> Introduction

a. The product tree shall contain a description of the purpose, objective and the reason prompting its preparation (e.g. program or project reference and phase).

<2> Applicable and reference documents

a. The product tree shall list the applicable and reference documents used in support of the generation of the document.

<3> Tree structure

a. The product tree shall provide the breakdown of lower level products constituting the deliverable product.

b.   For each item identified in the product tree, the following information shall be provided:

1.   identification code;

2.   item name;

3.   item supplier;

4.   applicable specification.

c.   The product tree shall be presented either as a graphical diagram or an indentured structure where the product (i.e. at the top level of the tree) is decomposed into lower level products.

d.   Each product item selected as configuration item shall be identified in the product tree.

e.   When recurrent products from previous space projects are used, they shall be identified in the tree structure.

B.2.2   Special remarks

None.

Annex C (normative)
Work breakdown structure (WBS) – DRD

C.1 DRD identification

C.1.1 Requirement identification and source document

This DRD is called from ECSS-M-ST-10, requirement 5.3h.

C.1.2 Purpose and objective

The objective of the work breakdown structure (WBS) is to provide, in a single document, a framework for project in cost and schedule management activities (as defined in ECSS-M-ST-60) and for managing technical content. It assists project's actors in:

- conducting tender comparisons and business agreement negotiations;

- optimizing the distribution of work amongst the different suppliers;

- monitoring the schedule of the project.

The WBS divides the project into manageable work packages, organized by nature of work. It identifies the total work to be performed down to a level of detail agreed between the customer and supplier.

Information concerning the determination of the appropriate WBS level of detail is provided in ECSS-M-ST-10, Annex H.

C.2 Expected response

C.2.1 Scope and contents

<1> Introduction

a. The WBS shall contain a description of the purpose, objective and the reason prompting its preparation (e.g. program or project reference and phase).

<2> **Applicable and reference documents**

a. The WBS shall list the applicable and reference documents used in support of the generation of the document.

<3> **Tree structure**

a. The WBS shall provide a logical and exhaustive breakdown of the product tree elements, that includes the customer's defined support functions (e.g. project management, engineering, product assurance support) necessary to produce the end item deliverables (development and flight models) and the necessary services as appropriate for the project.

b. A coding scheme for WBS elements that represents the hierarchical structure when viewed in text format shall be used.

> NOTE 1 A common coding system facilitates communications among all project actors.
>
> NOTE 2 E.g.: to each WBS element is assigned a code used for its identification throughout the life of the project. It can be a simple decimal or alphanumeric coding system that logically indicates the level of an element and related lower-level subordinate elements.

c. The WBS shall identify all control work-packages.

d. The control work-packages may be further broken down by the supplier in several more detailed work-packages.

e. All defined work-packages together shall cover the total work scope.

f. The WBS shall be presented either as a graphical diagram or an indentured structure.

C.2.2   Special remarks

None.

Annex D (normative)
Work package (WP) description – DRD

D.1   DRD identification

D.1.1   Requirement identification and source document

This DRD is called from ECSS-M-ST-10, requirement 5.3n.

D.1.2   Purpose and objective

The objective of the work package description is to describe the detailed content of each element of the WBS as defined in ECSS-M-ST-10, Annex C.

D.2   Expected response

D.2.1   Scope and content

a.   The WP description shall contain the following elements:

  1.   project name and project phase;

  2.   WP title;

  3.   unique identification of each WP and issue number

  4.   supplier or entity in charge of the WP performance;

  5.   WP manager's name and organization;

  6.   supplier's country;

  7.   product to which the tasks of the WP are allocated (link to the product tree);

  8.   description of the objectives of the WP;

  9.   description of the tasks;

  10.   list of the inputs necessary to achieve the tasks;

  11.   interfaces or links with other tasks or WP's;

  12.   list of constraints, requirements, standards, and regulations;

  13.   list of the expected outputs;

14.   list of deliverables;

15.   location of delivery;

16.   start event identification including date;

17.   end event identification including date;

18.   excluded tasks.

D.2.2   Special remarks

None.

Annex E (normative)
Progress report – DRD

E.1 DRD identification

E.1.1 Requirement identification and source document

This DRD is called from ECSS-M-ST-10, requirement 5.2.2.2a.

E.1.2 Purpose and objective

The objective of the progress report is to provide all actors with actual information concerning the status of the project.

E.2 Expected response

E.2.1 Scope and content

a. The progress report shall contain the following information:

1. The project manager's assessment of the current situation in relation to the forecasts and risks, at a level of detail agreed between the relevant actors.

2. The status of the progress of work being performed by the supplier.

3. Status and trends of agreed key performance and engineering data parameters.

4. Adverse trends in technical and programmatic performance and proposals for remedial actions.

5. Planning for implementation of remedial actions.

6. A consolidated report derived from the lower tier suppliers status reports.

7. Progress on all actions since the previous report.

E.2.2 Special remarks

None.

Annex F (informative)
ECSS management branch documents delivery per review

Table F-1 provides the information concerning the expected delivery of ECSS management branch documents per review.

> NOTE This table constitutes a first indication for the data package content at various reviews. The full content of such data package is established as part of the business agreement, which also defines the delivery of the document between reviews.

The various crosses in a row indicate the increased levels of maturity progressively expected versus reviews. The last cross in a row indicates that at that review the document is expected to be completed and finalized.

Table F-1 :Management Documents Delivery per Review

Document Title	Phase													DRD ref.
	0	A	B		C	D		E					F	
	MDR	PRR	SRR	PDR	CDR	QR	AR	ORR	FRR	LRR	CRR	ELR	MCR	
Project management plan		X	X	X										ECSS-M-ST-10, Annex A
Product tree		X	X	X	X	X	X							ECSS-M-ST-10, Annex B
Work breakdown structure		X	X	X										ECSS-M-ST-10, Annex C
Work package description		X	X	X										ECSS-M-ST-10, Annex D
Schedule	X	X	X	X	X	X	X	X	X					ECSS-M-ST-60, Annex B
Cost estimate report		X	X	X										ECSS-M-ST-60, Annex G
Configuration management plan		X	X	X										ECSS-M-ST-40, Annex A
Configuration item list				X	X									ECSS-M-ST-40, Annex B
Configuration item data list				X	X	X	X							ECSS-M-ST-40, Annex C
As-built configuration list						X	X							ECSS-M-ST-40, Annex D
Software configuration file				X	X	X	X							ECSS-M-ST-40, Annex E
Configuration status accounting reports				X	X	X	X							ECSS-M-ST-40, Annex F
Risk management policy document	X	X	X	X										ECSS-M-ST-80, Annex A
Risk management plan	X	X	X	X										ECSS-M-ST-80, Annex B
Risk assessment report		X	X	X	X	X	X	X	X					ECSS-M-ST-80, Annex C

Annex G (informative)
Management documents delivery (periodic or incident triggered)

Table G-1 lists the documents which are defined as outputs of the management standards requirements and which are not part of review data packages.

Table G-1: Management documents delivery (periodic or incident triggered)

Document Title	DRD ref.
Cost breakdown structure	ECSS-M-ST-60, Annex A
Schedule progress report	ECSS-M-ST-60, Annex C
Company Price Breakdown Forms	ECSS-M-ST-60, Annex D
Geographical Distribution Report	ECSS-M-ST-60, Annex E
Cost Estimating Plan	ECSS-M-ST-60, Annex F
Milestone Payment Plan	ECSS-M-ST-60, Annex H
Inventory Record	ECSS-M-ST-60, Annex I
Cost and Manpower Report	ECSS-M-ST-60, Annex J
OBCP and CBCP for Cost Reimbursement	ECSS-M-ST-60, Annex K
OBCP and CBCP for Fixed Price	ECSS-M-ST-60, Annex L
EAC and ETC for Cost Reimbursement	ECSS-M-ST-60, Annex M
EAC for Fixed Price	ECSS-M-ST-60, Annex N
Contract Change Notice	ECSS-M-ST-60, Annex O
Change request	ECSS-M-ST-40, Annex G
Change proposal	ECSS-M-ST-40, Annex H
Request for deviation	ECSS-M-ST-40, Annex I
Request for waiver	ECSS-M-ST-40, Annex J

Annex H (informative) Determination of the appropriate WBS level of detail

The main challenge associated with developing the work breakdown structure (WBS) is to determine the balancing between the project definition aspects of the WBS and the requirements for data collecting and reporting. One has to keep in mind that the WBS is a tool designed to assist the project manager when decomposing the project only to the levels necessary to meet the needs of the project, the nature of the work, and the confidence of the team.

An excessive WBS levels can lead to unrealistic levels of maintenance and reporting, and consequently to an inefficient and over costly project. The theory that more management data equates to better management control has been proven false many times over in the last decades when assessing systems performance. On the other hand, if not detailed enough it makes the element difficult to manage or the risk unacceptable.

Among the different questions arising when developing a WBS, an important one is: should the WBS be decomposed further?

To help answering this question, we propose the following list of questions. If most of the questions can be answered YES, then the WBS element analyzed should be decomposed. On the contrary, if most of the questions can be answered NO, then this is not necessary. If the answers are approximately 50/50, then additional judgment is needed.

- Is there a need to improve the assessment of the cost estimates or progress measuring of the WBS element?

- Is there more than one individual responsible for the WBS element? Often a variety of resources are assigned to a WBS element, a unique individual is assigned the overall responsibility for the deliverable created during the completion of the WBS element.

- Does the WBS element content include more than one type of work process or produces more than one deliverable at completion?

- Is there a need to assess the timing of work processes that are internal to the WBS element?

- Is there a need to assess the cost of work processes or deliverables that are internal to the WBS element?

- Are there interactions between deliverables within a WBS element to another WBS element?

- Are there significant time gaps in the execution of the work processes that are internal to the WBS element?

- Do resource requirements change over time within a WBS element?

- Are there acceptance criteria, leading to intermediate deliverable(s), applicable before the completion of the entire WBS element?

- Are there identified risks that require specific attention to a subset of the WBS element?

- Can a subset of the work to be performed within the WBS element be organized as a separate unit?

Bibliography

ECSS-S-ST-00	ECSS system – Description, implementation and general requirements
ECSS-E-ST-10	Space engineering – System engineering general requirements
ECSS-E-ST-40	Space engineering – Software general requirements
ECSS-E-ST-70	Space engineering – Ground systems and operations
ECSS-M-ST-10-01	Space project management – Organization and conduct of reviews
ECSS-M-ST-60	Space project management – Cost and schedule management
ECSS-M-ST-70	Space project management – Integrated logistic support
ECSS-M-ST-80	Space project management – Risk management
ECSS-Q-ST-10	Space product assurance – Product assurance management