EUROPEAN COOPERATION

ECSS

FOR SPACE STANDARDIZATION

Space Project Management

Policy and Principles

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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Contents List

Figures

Tables

Introduction

The production of complex products requires the co–operation of several organisations which share a common goal : to provide a product which satisfies the consumer's needs (technical performance) under cost and schedule constraints.

To reach this goal, corresponding technical activities, and human and financial resources, shall be organised and co–ordinated in a structured manner in order to obtain the end product a.k.a. system. This structure, together with related processes, constitutes a project. It implies a target (system), a time frame, and actions to be performed under resource constraints.

Project management consists of the definition, implementation and execution of such actions including the verification that results obtained match with the expected ones.

Project management requires careful thinking about what shall be accomplished, laying out all the steps needed to build that future, and obtaining the resources required to carry out those steps. But most important, it requires dealing with reality, problems, delays, changes, obstacles and, sometimes, opportunities that arise as a project takes place.

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1

Scope

This standard is designed to facilitate the elaboration of a management system which is cost effective, appropriate to the project in which it is implemented, compatible with the actors' existing structures and which has the flexibility to adapt to changing needs throughout all the phases of an evolving project, and to new projects.

It contains the basic requirements and overall principles to be applied for the management of space projects, from definition of mission objectives to final disposal. It defines the scope and interfaces of this discipline with the activities relative to the domains of Engineering and Product Assurance which are addressed in the Engineering (–E) and Product Assurance (–Q) branches of the ECSS system, and explains how they are to be interrelated to ensure customer satisfaction. The set of related standards apply to all the actors for the execution of a space project.

This standard:

- presents and describes the documents generated by ECSS for conducting the managerial and technical activities associated with the deployment and execution of space projects,

- defines the basic management rules for the execution of space projects,

- defines the applicability of these rules to all the actors in these projects, including Space Agencies, Industry, Scientific Laboratories, etc.,

- identifies project requirements without imposing a particular organisational structure on the actors.

- proposes how these requirements can be tailored to specific project needs.

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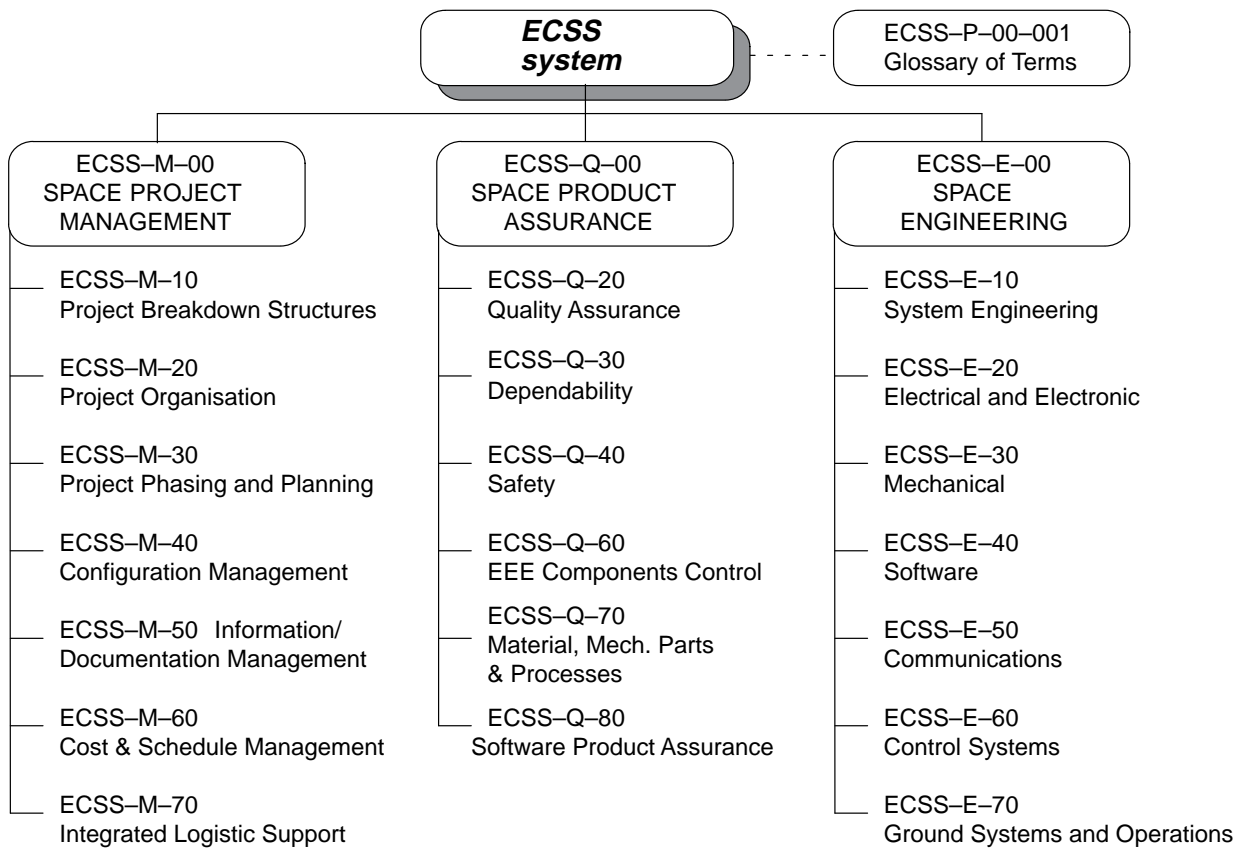
2

ECSS Standards Architecture and Domains

The ECSS standards system has three branches, designated as Management, Engineering, and Product Assurance (see figure 1). These branches are introduced by a so-called 'level 1' document respectively numbered ECSS–M–00, ECSS–E–00 and ECSS–Q–00. These top-level documents are both of normative and informative nature. The basic principles described therein are presented in detail in 'level 2' documents.

ECSS–M–00, the top-level document in the Management branch, serves to introduce the domain, content and architecture of the Management standards. It also covers common topics such as tailoring, risk management and overall project management.

The following points explain the role of the ECSS–M standards, together with their interfaces with the ECSS–E Engineering standards and the ECSS–Q Space Product Assurance standards:

- The ECSS–M Management standards define the process requirements to be applied to the overall project activities during the life cycle. They describe what needs to be achieved to establish project breakdown structures (e.g. Product Tree, Work Breakdown Structure), the project organisation and cost and schedule management, and cover also the management of configuration, documentation, and integrated logistic support.

- The ECSS–Q Space Product Assurance standards define the requirements for the management and performance of product assurance activities during a space project (quality assurance, dependability, safety, EEE components control, materials, mechanical parts and processes control, software product assurance).

- The ECSS–E Engineering standards are devoted to the products themselves. They cover:
  - the engineering process as applied to space systems and their elements or functions,
  - technical aspects of parts, assemblies, equipments, subsystems and systems used to accomplish, or associated with, space missions.

They include specifications, guidelines, manuals, handbooks and procedures, all identified as ECSS standards. Their objective is to enable engineers to work as efficiently as possible and to achieve the most appropriate product for the project application.

	ECSS system	ECSS–P–00–001 Glossary of Terms

ECSS–M–00 SPACE PROJECT MANAGEMENT	ECSS–Q–00 SPACE PRODUCT ASSURANCE	ECSS–E–00 SPACE ENGINEERING
ECSS–M–10 Project Breakdown Structures	ECSS–Q–20 Quality Assurance	ECSS–E–10 System Engineering
ECSS–M–20 Project Organisation	ECSS–Q–30 Dependability	ECSS–E–20 Electrical and Electronic
ECSS–M–30 Project Phasing and Planning	ECSS–Q–40 Safety	ECSS–E–30 Mechanical
ECSS–M–40 Configuration Management	ECSS–Q–60 EEE Components Control	ECSS–E–40 Software
ECSS–M–50 Information/ Documentation Management	ECSS–Q–70 Material, Mech. Parts & Processes	ECSS–E–50 Communications
ECSS–M–60 Cost & Schedule Management	ECSS–Q–80 Software Product Assurance	ECSS–E–60 Control Systems
ECSS–M–70 Integrated Logistic Support		ECSS–E–70 Ground Systems and Operations

Figure 1: Structure of the ECSS standards system.

3

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 'Policy and Principles' standard ECSS–M–00 calls up the standards in the Space Project Management series. 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–30	Project Phasing and Planning.
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–P–001	Glossary of Terms.
ISO 8402:1994	Quality management and quality assurance – Vocabulary.
ISO 9001:1994	Quality systems – Model for quality assurance in design/development, production, installation and servicing.
IEC(50):1991	International Electrotechnical Vocabulary.

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4

Definitions and Abbreviations

4.1 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.

Business Agreement

Configuration

Contract

Contractor

Cost

Critical Item

Customer

Data

Detectability

Document

Documentation

Implementation Document

Industrial Organisation

Phase (Project Phase)

Process

Product Tree

Project

Project Requirements Document

Purchaser

Resource

Space Element

Space System

Specification

Supplier

System

Task

Work Breakdown Structure

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

"Support System

The hardware and software products, together with the necessary human resources, which are essential to enable the Supported System to achieve its system functional performance from delivery to the end of the life cycle of the Supported System, at minimum total life cycle (discounted cash flow) cost."

"Supported System

The hardware and software products, together with the necessary human resources, which are essential to the system functional performance as expected by the consumer."

4.2   Abbreviations

The following abbreviations are defined and used within this standard.

Abbreviation	Meaning
ECSS:	European Cooperation for Space Standardization
WBS:	Work Breakdown Structure

5

Use of ECSS Standards to Define Project Requirements

5.1 Policy and Principles

It is a policy that ECSS level 1 and level 2 documents should, as far as is practicable, define requirements in terms of what is to be achieved, interface requirements to be satisfied, and constraints which shall not be breached. It is a cardinal principle that no particular methodologies, implementation techniques, or organisational arrangements shall be imposed. In addition, aimed at becoming European standards, the ECSS level 1 and level 2 documents are nonmandatory documents in the legal sense.

Consequently, these documents shall be made applicable on a project by the customer invoking them in the binding documentation in accordance with the relevant Business Agreement.

It is a policy that the supplier shall have the freedom to choose the methodology by which he intends to fulfil the project requirements, which reference the level 1 and level 2 standards, except where methodology guidelines and constraints, which are selectively provided in level 3 documents of the ECSS system of standards, are made applicable for the project.

In order to fulfil the objectives of ECSS , the level 1&2 standards allow for the following functions:

a. to enable optimisation of aspects of the 'customer/supplier' relationship that is established among all the actors of a space project. Consequently, they have been drafted so as to facilitate:

- the critical stages of the elaboration process of the Business Agreements and contracts clauses binding the various participants. They cover the preparation of an Invitation To Tender (ITT), by the purchaser, the elaboration of the industry proposal and the final negotiation preceding the contract award. During these three stages, the ECSS standards will enable the different actors (customer & supplier) to select the requirements set (and the replies to these requirements...) tailored to the nature of the particular project.

- the project execution.

b. to ensure the harmonisation in Europe of the requirements of various space projects. The availability of the ECSS system as a common source of require-

ments (applicable to all the actors of a space project, in every stage of the elaboration process of the customer/supplier relations) is the only way to reduce the proliferation of similar requirements, differently expressed from one project to another.

The ambitious aim to increase the competitiveness of space products can only be achieved if one maintains strict discipline for the cascade of requirements from the first level customer to the lower levels of the project's industrial organisation. At each level the customer shall apply to his suppliers only those requirements strictly necessary at the level of the relevant supplies.

5.2 Customer/Supplier Network

Exchanges of products within a project are governed by Business Agreements, which shall be understood in the wide sense. A Business Agreement is defined as any agreement between two or more parties for the supply of goods or services.

The term contract will be used in the narrow sense as any legally enforceable Business Agreement for the supply of goods or services. A contract is a special case of a Business Agreement.

Business Agreements can be made up of general terms and conditions, financial dispositions, deliverables and Project Requirements Documents.

As a consequence, the terms 'customer' and 'supplier' will be used generally in all the ECSS standards. 'Purchaser' and 'contractor' will only be used when the associated requirement applies only to a contract in the narrow sense as defined above.

In order to control the activities distributed by the Business Agreements among the various companies and agencies (the project actors), the roles of each participant shall be defined relative to the customer/supplier network.

Irrespective of the project phase, the concept of the 'customer/supplier' network (acquisition network) remains unchanged. Implementation of this concept, including deployment of project requirements, is described below and illustrated in figure 2 and table 1.

The following types of participant can be identified:

The **Consumer** is situated at level 0 of the organisation. The consumer is responsible for expressing its needs and expectations. He is responsible for identifying/approving the financing of the project and identifying politico/economic and major project constraints.

The **First Level Customer** is also situated at level 0 of the organisation. He can be the Consumer or the Consumer's agent.

From needs and expectations expressed by the consumer, the first level customer defines the project objectives (such as system technical performance, needed availability, delivery time, duration of operational life...) and constraints (environment of product utilisation, budget available, environment impact...), step ①. In collaboration with the Consumer, he is responsible for defining the functional (what the product shall do) and performance (how well it shall perform) requirements at system level. He is also in charge of planning project financing and organisation. After consultation with the first level Supplier at bid or Business Agreement negotiation stage, he monitors project execution by the first level Supplier (e.g. Prime Contractor) in order to ensure compliance with the performance and schedule objectives, cost and other constraints agreed with the Consumer. He prepares a set of Project Requirements Documents, step ②, which defines all the project requirements, either explicitly (in the case of product requirements) or by reference to selected ECSS standards or tailored variants of them. The selection and tailoring process, step ③, is addressed in sub-clause 5.3.

The **First Level Supplier** is situated at level 1 of the organisation. The first level supplier is responsible to the First level Customer for:

- responding, step ④, and demonstrating compliance, through the elaboration of Implementation Documents, to the project requirements (system concepts, related activities, proposed organisation), and to the politico/economic and project constraints,

- supplying a compliant system.

The first level Supplier also acts as the **Customer** for the next level and, as with the first level Customer, is responsible for defining the next level project constraints, output performance and needed availability, step ⑤.

The **next level Suppliers** (e.g. subcontractors, equipment manufacturers, etc.) are situated at the lower levels of the organisation, identified by higher numbers: 2, 3 etc. Each Supplier is responsible to the Customer at the level above for:

- responding, step ⑥, and demonstrating compliance, through the elaboration of Implementation Documents, to the project requirements and to the politico/ economic and project constraints,

- the supply of one or more constituents of the system.

As with the first level Supplier (see above), each lower level Supplier acts as Customer for the next level below.

Depending upon the project, Space Agencies can play different roles. They can be Consumer when they will benefit from the services of the system, they can be First Level Customer under a mandate given by a consumer, but they can be also supplier when they provide products at a given level in the customer-supplier network (i.e. Space Agency Furnished Equipment or Services). In any case, ECSS standards requirements are applicable.

Table 1: Participants' roles in customer/supplier network.

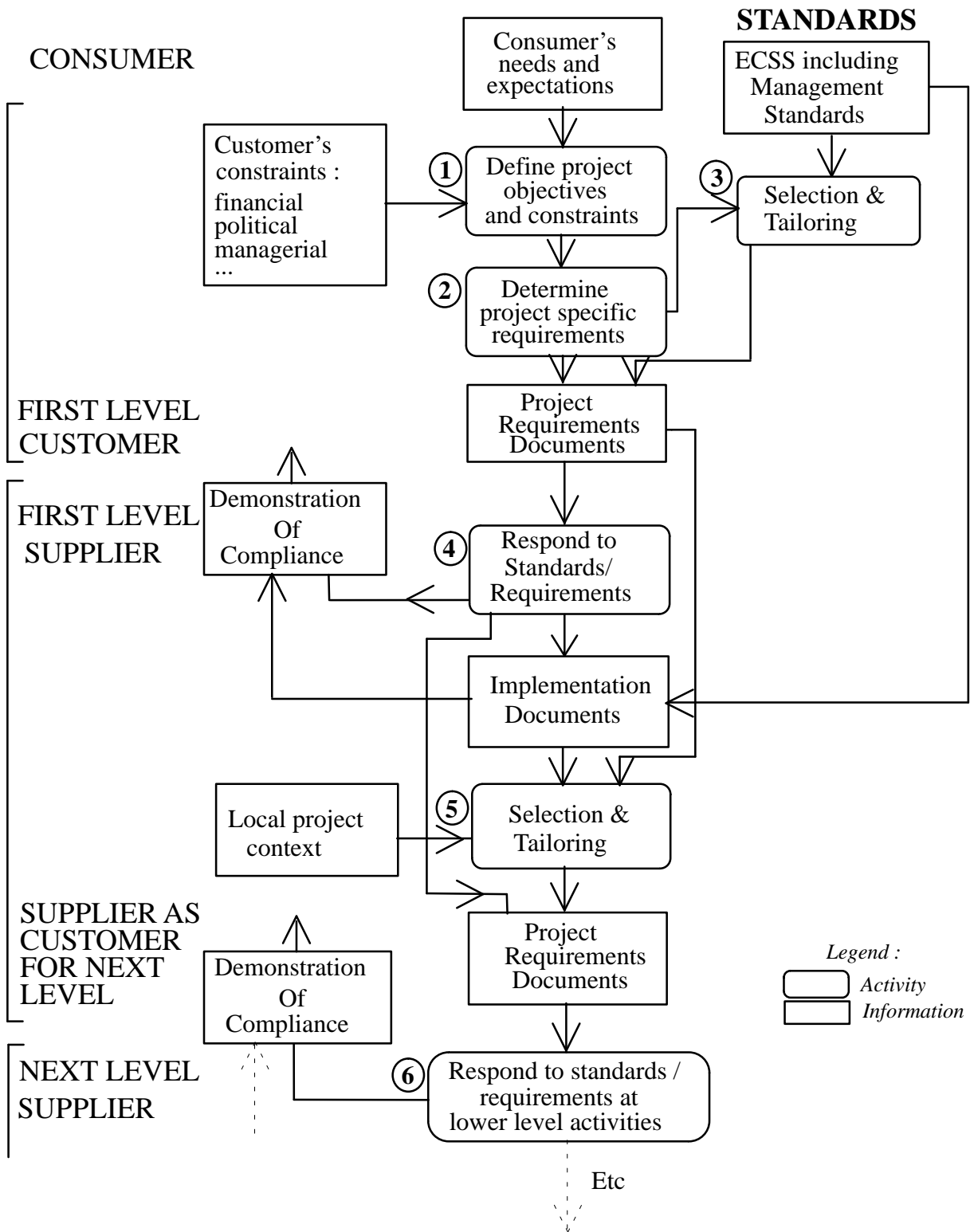| Participants' Roles in Customer/ Supplier Network		Outputs ⇒				
Level	Participant ⇓	Needs and Expectations	Project Constraints: – financial, – political, – managerial, ...	Project Requirements Documents	Demonstration of Compliance for the Outputs to be Supplied	Supply of Outputs
0	**Consumer**[1]	R	A			
0	**First Level Customer** (Can be Consumer or Consumer's Agent)[2]	AR	R	R	A	
1	**First Level Supplier** [3] (who is also	C	C	A	R	R
1	**Customer** from next level Supplier)	AR for next level	R for next level	R for next level	A for next level	
2	Next level **Supplier**[4] (who is also	C	C	A	R	R
2	**Customer** from next level Supplier, etc)	etc	etc	etc	etc	

Legend: R=Responsible for doing the activity; A=Agreement with activity output; C=Consulted.

[1] → e.g. End User: Commercial Organisation, Space Agency; Armed Forces; Coordinated Inter-governmental Organisation; Experimenter; etc.

[2] → e.g. Space Agency; Governmental Project Management Office.

[3] → e.g. Prime Contractor.

[4] → i.e. Level 2, 3, 4, etc., repeated as necessary.

STANDARDS

CONSUMER

Consumer's needs and expectations

ECSS including Management Standards

Customer's constraints : financial political managerial ...

① Define project objectives and constraints

③ Selection & Tailoring

② Determine project specific requirements

FIRST LEVEL CUSTOMER

Project Requirements Documents

FIRST LEVEL SUPPLIER

Demonstration Of Compliance

④ Respond to Standards/ Requirements

Implementation Documents

SUPPLIER AS CUSTOMER FOR NEXT LEVEL

Local project context

⑤ Selection & Tailoring

Demonstration Of Compliance

Project Requirements Documents

NEXT LEVEL SUPPLIER

⑥ Respond to standards / requirements at lower level activities

Etc

Legend :

Activity

Information

Figure 2: Principles governing the implementation of the customer–supplier network concept.

5.3   Selection and Tailoring of Standards

ECSS standards draw together a large body of space standards applicable to all the products and projects. However, selection and tailoring of ECSS standards are needed, at customer level, in order to meet the expectations of the consumer in

the most cost effective way. For that, adaptation of ECSS standards shall be based on identified specific project objectives and constraints.

Placing at the actors' disposal pre-established requirements in a form suitable for reference or quotation in binding documents is a way to facilitate this process.

The tailoring of the ECSS standards to the specific project requirements shall be done according to a number of criteria such as:

- the overall project risks, their criticality and their consequences with regard to technical performance, cost and schedule (refer to sub-clause 6.3),
- the class of products (refer to ECSS–E–00),
- the project category,
- industrial policy,

Selection can concern the choice of requirements to be taken into account, possible tailoring for some of them, and the practical modalities (processes, tooling, described in level 3 documents), whether imposed or not, for some or all of the actors.

The principle for drawing up the requirements specific to a project (Project Requirements Documents) and the responses from the different industrial organisation levels to these requirements in the form of 'Implementation Documents' is illustrated in figure 2.

The application principle for the Project Requirements Documents is as follows: they are drawn up by the first level customer and are to be followed by all the levels of the industrial organisation, with tailoring specified by each customer to the corresponding supplier, depending on the context.

The response from the different levels regarding the Project Requirements Documents can take the form of an individual Implementation Document for each Project Requirements Document or a single Implementation Document with a separate chapter for each Project Requirements Document.

Tailoring of the ECSS–M set to project specific management requirements can be based on a project ranking according to the pre-defined categories given below. Each space project shall be placed in one of the categories defined below, at the latest by the end of project phase A (definition according to ECSS–M–30) by the first level customer, and the lower levels shall be informed of the applicable project category.

The following project categories should be considered:

Category 1:

A project where loss of the mission would be unacceptable. The allocated budgets and development schedules shall be sufficient to obviate major technical deadlocks. All the risks shall be examined and reduced. Confidence levels shall be maximal, management services complete, and full in-depth knowledge of the product shall be acquired.

Category 2:

A project aimed at achieving overall control of project risks. Project risk/total cost compromises which minimise risk are sought after. Management services are lightened very slightly.

Category 3:

A project aimed at achieving overall containment of cost.

Project risk/total cost compromises which minimise cost are sought after. The level of accepted risk is higher. Management services are lightened.

Category 4:

A minimum cost project. The mission is only worth while if its cost is kept down. The management activities are reduced to a minimum.

On that basis, the customer can select a framework that meets the requirements of the consumer and that is appropriate for the project objectives and constraints. Details of the tailoring process are described in document ECSS–M–00–02.

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).

5.4 Requirements

5.4.1

The Customers at every level shall specify the minimum requirements necessary for their suppliers to achieve the project objectives.

AIM: Minimising requirements is a key factor in minimising supplier costs and maximising supplier responsiveness.

With the aim of reducing supplier costs, unnecessary non-value adding requirements shall be avoided, by using standard terms and conditions wherever practicable.

EXPECTED OUTPUT: *Business Agreements using standard terms and conditions with no overlap with the Project Requirements Documents. Both shall only specify what* is *to be achieved, not how it shall be done.*

5.4.2

In response to the customer's requirements, the supplier shall, in a set of documents submitted to the customer, demonstrate his compliance. Both customer's documents and supplier's documents shall be amended to reflect the requirements that the supplier shall satisfy, as agreed by negotiation.

AIM: Ensure that the requirements are adequately defined and documented, and that any difference between the contract and those of the proposal are resolved.

The supplier's documents will comprise the response to the Project Requirements Documents, i.e. Implementation Documents, and statements of compliance.

The supplier shall not submit a response in conflict with the national and international laws applicable to the project (Refer to ECSS–M–20–01, Guidelines for Drafting of Business Agreements).

Once agreed, the customer's Business Agreement documents shall take precedence over the supplier's documents.

EXPECTED OUTPUT: *Documented statement of compliance (or otherwise) with the customer's requirements.*

5.4.3

The contractor shall establish and maintain documented procedures for contract review and for the co-ordination of these activities, in accordance with sub-clause 4.3 of ISO 9001.

AIM: Allow the contractor to check he has the capability to meet the contract requirements.

The contractor shall perform contract reviews at planned events during project execution, and in particular in connection with contract changes and amendments.

EXPECTED OUTPUT: *Documented contract review and coordination procedures.*

6

Project Management

6.1   Objective

Project management is a process, which is aimed at the successful completion of a project. Successful completion is recognised when the project objectives are met with regards to technical, cost and schedule performance. It requires the implementation of management processes by applying suitable methods and techniques to support the people managing the projects. Project management is performed following a structured approach to manage the scope, quality, time, cost, organisation and logistics of the project, throughout all stages of its life cycle and at all levels of its hierarchy.

Project management provides the framework for the definition and implementation of the project through planning, organisation, performance monitoring, assessment of the results, introducing recovery actions or changes, if necessary, in order to meet overall project objectives.

Project management integrates the other core functions related to the execution of a project, which are grouped into engineering and product assurance disciplines within the ECSS standards.

6.2   Policy and Principles

The following principles shall be observed when project management processes are implemented:

- Project objectives are clearly defined, understood, and known to all participants at the outset of the project, and objectives are maintained during the life cycle of the project. This enables and motivates all participants to work towards a common goal.

- The project is managed with a structured approach, by breaking down the project into manageable elements. This allows scope definition, responsibility assignment, planning, monitoring and reporting at the levels of detail chosen for visibility and control.

- Project management includes measurement of achievements by the identification and tracking of deliverables during the evolution of the project. The totality of all deliverables, compliant with the requirements, contributes to the successful completion of the project.

- Formal relationships are established between project participants to allocate responsibility boundaries, and to govern interfaces between them. The formalised relations provide the means to establish an infrastructure, for conducting business consistently and efficiently.

- The incorporation of Quality into the product shall be the responsibility of everyone in the customer/supplier network.

- The responsibility for monitoring, assessing and certifying that Quality has been incorporated shall be clearly allocated at each level in the network.

- Project management includes risk management as inherent to all aspects of project work.

- Project management includes the management of human resources, which is fundamental to the success of the project.

Major elements of project management to serve these principles are: project breakdown structures, project organisation, project phasing and planning, configuration management, information/documentation management, cost and schedule management and integrated logistic support.

The objectives, policies and principles, and fundamental requirements for each element are outlined in clause 7.

6.3   Management of Risks

Risks are integral elements of any project. In space projects, there are specific risk aspects:

- the specific environmental conditions of space,

- a need for high level of performance,

- low production number,

- the related high costs involved,

- high development effort with limited opportunity for amortisation over production,

- inability to fully operate the space element under realistic conditions on ground,

- the limited access to the product during operation.

The ECSS standards result from the lessons learned from past projects, during which many problems have been experienced, their consequences measured, and different strategies for solving them tested.

6.3.1   Objective

The consequences of the risks are of very broad range, from performance reduction, cost increase and schedule delays, to mission failure, damage to property and consequential loss, environmental impact, loss of life or illness or injury.

The objective of the management of risks is to keep all these risks within defined and accepted boundaries, which constitute the risk policy for the concerned project.

All areas of the programme shall be covered including performance (technical and quality), programmatic (funding, consumer and user concerns, political, etc.), cost (contract performance and project cost), schedule and operation (logistic support, dependability and safety).

6.3.2   Policy and Principles

Risk management is an integral part of the project's management. Management of risk should be central to the project manager's understanding of the project. Management of risks is an important part of the overall project management with respect to the process of project decisions. Risk data are one element in the multi–attribute decision making process.

Any difficulty in attaining the project objectives needs to be exposed to the concerned parties, including the consumer when applicable, at the earliest opportunity.

The management of risk includes:

- the systematic identification and evaluation of all risk causes and consequences prior to definition and implementation of a decision to accept, to monitor or to take action. The risk assessment will support the decision making process, including consideration of uncertainties of the risk involved.

- the systematic definition, implementation, control and verification of actions appropriate for elimination and reduction of risk to an acceptable level.

A project risk management policy shall be defined, which complies with the above principles and takes into account project specific constraints. It shall allow the magnitude of consequences to be categorised into defined severities, and provide means for trade-offs between different types of consequences. It shall further define levels of decision making in the project organisation.
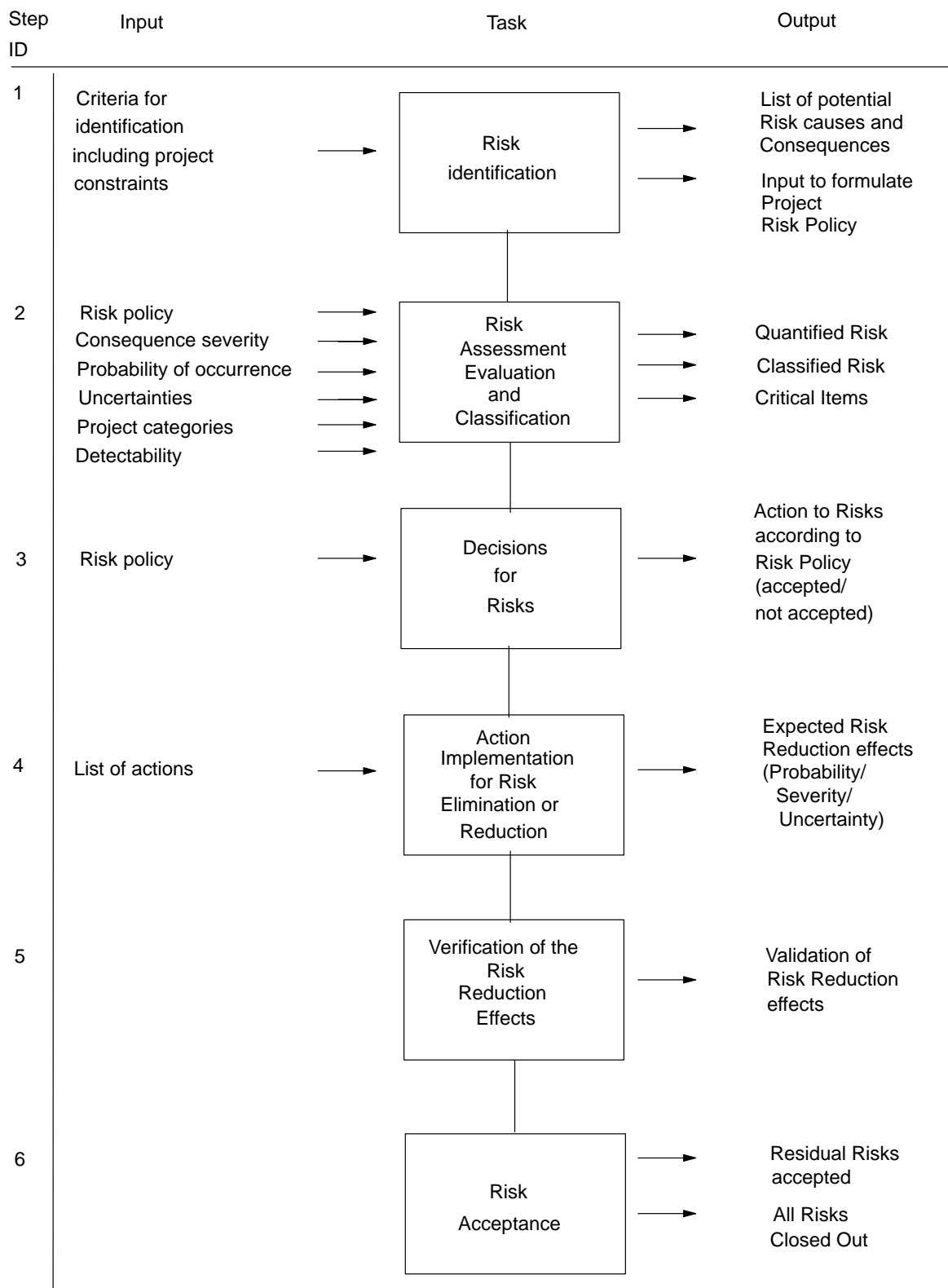
6.3.3 Risk Management Process

The overall Risk Management process can be summarised as shown in figure 3. The purpose of each individual step of the risk management process is described in Table 2.

This shall be a continuous and iterative process throughout the project's life cycle.

Table 2: Purpose of the individual steps of the risk management process.

Step ID	Question	Subject
1	What can go wrong?	For the subject of concern, based on the project baseline, the undesirable scenarios and their consequences have to be identified.
2	How severe are consequences?	Categorisation of scenarios according to severity of consequences.
	How likely are scenarios?	Identification of likelihoods and their uncertainties of events in scenarios.
	How large are risks?	Identification of magnitudes and uncertainties of risks, and risk contribution of individual scenarios.
	Can the risk be continuously monitored and assessed?	Evaluation of risk detectability and establishing of risk classification, taking into account the project category.
3	What is the decision about the risk?	Implementation of policy for risk decision making: accept/reject criteria such as safety & mission success target, risk reduction strategies such as hazard & failure reduction for technical risk (including failure tolerance), etc.
4	How can the risks be eliminated or reduced to acceptable level?	Implementation of action for elimination of risks or iterative application of risk reduction strategy by concentrating on main risk contributors.
5	How can reduction be assured and verified?	Tracking, monitoring and control of implementation and verification of risk reduction action in design, on project.
6	Is the residual risk acceptable?	Final evaluation of risk reduction and acceptance of residual risk.

Step ID	Input	Task	Output
1	Criteria for identification including project constraints	Risk identification	List of potential Risk causes and Consequences / Input to formulate Project Risk Policy
2	Risk policy / Consequence severity / Probability of occurrence / Uncertainties / Project categories / Detectability	Risk Assessment Evaluation and Classification	Quantified Risk / Classified Risk / Critical Items
3	Risk policy	Decisions for Risks	Action to Risks according to Risk Policy (accepted/ not accepted)
4	List of actions	Action Implementation for Risk Elimination or Reduction	Expected Risk Reduction effects (Probability/ Severity/ Uncertainty)
5		Verification of the Risk Reduction Effects	Validation of Risk Reduction effects
6		Risk Acceptance	Residual Risks accepted / All Risks Closed Out

Figure 3: Risk Management Process

6.3.4 Contribution of ECSS-Standards to Risk Management Process

The requirements included in ECSS standards define the inputs for the implementation of the overall risk management process, described in sub–clause 6.3.3.

a. ECSS–M–Standards

- partitioning the project into manageable elements (see ECSS–M–10) enables the detection of all the tasks to be performed, the links between them and the interfaces. The Product Tree allows the implementation of a process for an exhaustive interface identification. Interfaces as contributors to risk are then identified.

- the requirements on the organisation of the project (see ECSS–M–20), combined with the structure required in ECSS–M–10, result in the allocation of tasks and interfaces, which contributes to a reduction of the corresponding risks.

- the partitioning of the project into phases with reviews in between (see ECSS–M–30), allows a step-by-step development process with different solutions studied in parallel and decisions made on the basis of a structured rationale, with identification of the different technical risks, their assessment and a strategy for their management according to the risk policy defined for the project.

- the configuration and information/documentation management (ECSS–M–40 and ECSS–M–50) ensure the consistency of the system design and the information relevant to the project, between all actions and during the life cycle of the product.

- the requirements concerning cost and schedule controls (ECSS–M–60) ensure the detection of deviations, their reporting and the assessment of their consequences. The project organisation and planning allows the management and the monitoring of the corresponding recovery actions.

- the Logistic Support Analysis and the process for implementation of the support ensure the consistency of the system with its operation, maintenance and disposal processes. The requirements defined in ECSS–M–70 enables the detection and assessment of risks, and to define, implement and monitor the relevant countermeasures in the project.

b. ECSS–Q–Standards

- The contribution of the technical risk assessment and control process to the overall project risk management is defined in ECSS–Q–00. The detailed contributions are provided by ECSS–Q–40 for cases where risk consequences affect safety and by ECSS–Q–30 for cases where risk consequences affect dependability. Product quality is dealt with in ECSS–Q–20.

c. ECSS–E–Standards

- Engineering activities, necessary to define the system and to verify that the customer's requirements are achieved, are defined in ECSS–E–00 and ECSS–E–10. This breakdown of engineering activities includes also the contribution to the overall risk management in order to minimise technical risk.

6.3.5 Classification of the Risk

A risk can be characterised by its **consequences** on all the aspects of the project. The consequences can be classified into the following categories:

- loss of life, or injury to personnel
- loss of mission
- pollution of the environment
- degradation of mission objectives or performances
- cost increase
- schedule delay
- user dissatisfaction

6.3.5.1 Consequence Severity

The consequences shall be quantified by their **severity**, which is a measure of the magnitude of the consequence. The severity of a consequence shall be graded according to the following scale:

- catastrophic
- critical
- major
- significant
- negligible

The severity scale shall be defined by each project in its risk policy. However, the consequence severities affecting safety shall be defined as:

- catastrophic:
  - Loss of life, life threatening or permanently disabling injury or occupational illness.
  - Loss of an element of an interfacing manned system.
  - Loss of launch site facilities.
  - Long term detrimental environmental effects.
- critical:
  - Temporarily disabling but not life threatening injury or temporary occupational illness.
  - Loss of, or major damage to flight system, major flight system elements, or ground facilities.
  - Loss of, or major damage to public or private property.
  - Short term detrimental environmental effects.

6.3.5.2 Probability of Occurrence

A risk will also be quantified by the probability of occurrence of its consequences taking also into account the uncertainty of this probability. A relative scale can be used for the probability of occurrence.

6.3.5.3 Risk Acceptability

The criteria for risk **acceptability** shall be defined for each project according to the project category and as a function of the consequence severity and their probability of occurrence.

6.3.6 Requirements

a. A risk policy shall be defined for each project according to sub-clause 6.3.2.

b. Each actor shall conduct, throughout the project, the risk management process described in sub-clause 6.3.3 concerning the products and services under his responsibility leading to the acceptance of the residual risks.

AIM: Support decision making under uncertainties.

EXPECTED OUTPUT: *Risk management plan and objective evidence of proper implementation. The plan shall describe the process that will be used to identify, assess and reduce unacceptable risks and to monitor/report the status of the various risk management action plans.*

c. All implemented actions shall be verified with respect to their effectiveness.

d. Classification of risks shall be performed according to sub-clause 6.3.5.

7

Elements of Project Management

7.1 Project Breakdown Structures

7.1.1 Objective

The project breakdown structures, which constitute the common and unique reference system for the project management have the following objectives:

- ensure the coherence between technical, documentary, administrative and financial activities of the whole project,
- identify the responsibilities of each actor,
- provide a frame for planning, scheduling, costing and means of control.

The policy and principles to be observed when establishing, modifying and using the project breakdown structures are specified hereafter.

7.1.2 Policy and Principles

These structures provide a breakdown of the project objectives and content into different project structures serving different purposes, but coherent and consistent between themselves, in a systematic top-down approach.

The creation of the project breakdown structures will be derived from the first level customer's requirements, starting from the functional requirements to be built into the system. These can be presented in the form of a Function Tree. Then the process will go through Product Tree elaboration, which is the exhaustive definition of the system elements. Delineating the necessary tasks to develop and produce an element will lead to the Work Breakdown Structure. The identification of cost categories enables the establishment of the Cost Breakdown Structure. The allocation of the WBS to the Industrial Organisation will result in the Business Agreement Structure and Interfaces Allocation. The Configuration Item Tree, related to the Product Tree, is defined and used in conjunction with Configuration Management.

7.1.3   Requirements

a. The customers at all levels shall specify the requirements for Project Breakdown Structures. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Project Breakdown Structures.

AIM: A coherent and consistent approach to Project Breakdown Structures within each project. Refer to ECSS–M–10 (Project Breakdown Structures).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with project breakdown structures.*
Element of Implementation Documents saying how related requirements will be met.

7.2   Project Organisation

7.2.1   Objective

The project organisation objective is to conciliate the actors' existing structures with the needs and constraints of the project concerned.

7.2.2   Policy and Principles

This objective will be reached by elaboration of project management schemes applicable to all the actors in a space project, addressing in particular:

- responsibility and authority of the participants,
- resource requirements,
- personnel qualification and training,
- interrelation between the participants,
- Business Agreements related aspects between the participants,
- facilities and logistics (offices, clean rooms etc.),
- information technology and systems,
- project documentation.

7.2.3   Requirements

a. The customers at all levels shall specify the requirements for Project Organisation. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Project Organisation.

AIM: A coherent and consistent approach to Project Organisation within each project. Refer to ECSS–M–20 (Project Organisation).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with project organisation.*
Element of Implementation Documents saying how related requirements will be met.

7.3   Project Phasing and Planning

7.3.1   Objective

The objective of project phasing and planning is to minimise the technical, scheduling and economical risk of the project by introducing phases and formal milestones enabling the progress of the project to be controlled with respect to cost, schedule and technical objectives.

7.3.2 Policy and Principles

This objective is achieved by breaking the product life cycle into distinct phases, the objectives and work content of which shall be clearly defined, and tied to each other by milestones enabling the progress of the project to be controlled with respect to technical objectives, cost and schedule. Each milestone consists of a formal review process interrelated with technical baselines subject to configuration management, the results of which are formalised by appropriate documentation.

The number of phases and their objectives should be defined at the beginning of the project. The number of phases and their objectives should be tailored according to the risk that cost, schedule and technical problems compromise the successful completion of the project.

7.3.3 Requirements

a. The customers at all levels shall specify the requirements for Project Phasing and Planning. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Development Plan.

AIM: A coherent and consistent approach to Project Phasing and Planning within each project. Refer to ECSS–M–30 (Project Phasing and Planning).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with project phasing and planning.*
Element of Implementation Documents saying how related requirements will be met.

7.4 Configuration Management

7.4.1 Objective

The objectives of configuration management are to identify, describe and control the technical description of the system in a traceable way and throughout the complete life cycle of the product.

7.4.2 Policy and Principles

These objectives are achieved by the drawing up and validation of configuration baselines at predefined stages and by controlling their evolution.

Configuration management addresses in particular:

- the identification and description of each entity in the system subject to configuration control,
- the establishment of configuration baselines,
- the control of the evolution of the configurations from established baselines,
- the control of interfaces,
- the establishment of a documented configuration status at any time of the project life cycle, including all the agreed changes,
- the verification of completeness of the configuration identification,
- the identification of discrepancies related to the configuration of the system.

7.4.3 Requirements

a. The customers at all levels shall specify the requirements for Configuration Management. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Configuration Management.

AIM: A coherent and consistent approach to Configuration Management within each project. Refer to ECSS–M–40 (Configuration Management).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with configuration management.*
Element of Implementation Documents saying how related requirements will be met.

7.5 Information/Documentation Management

7.5.1 Objective

The objective of information/documentation management in the context of project management is to ensure that the information necessary for effective execution of all the other management processes can be recorded, retrieved and modified in a traceable, effective manner.

7.5.2 Policy and Principles

Information/documentation management and the systems which support it shall facilitate the execution of the project. The requirements placed upon the information system shall enable unnecessary changes to suppliers established in-house systems to be avoided.

Except where national or commercial security demand otherwise, information/documentation management systems shall be 'open' to all the project users, who will determine and define their own access needs.

Authority and responsibility for information content, input and retrieval shall be placed uniquely and at the lowest possible level in the project organisation to avoid non-value-adding interventions by intermediate layers.

The information management system shall allow the measurement of performance so that its activity can be continually improved.

7.5.3 Requirements

a. The customers at all levels shall specify the requirements for Information/Documentation Management. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Information/Documentation Management.

AIM: A coherent and consistent approach to Information/Documentation Management within each project. Refer to ECSS–M–50 (Information/Documentation Management).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with information/documentation management.*
Element of Implementation Documents saying how related requirements will be met.

7.6 Cost and Schedule Management

7.6.1 Objective

The objective of cost and schedule management is to provide a collective system of organised processes and actions in support of project management aimed at establishing the optimum use of human resources, facilities materials and funds in order to achieve the successful completion of the space project within its established goals:

- cost targets,
- timely completion,
- technical performance.

To this end, costs and tasks shall be planned and actively controlled, identifying those critical situations that could lead to adverse impacts on the project cost and schedule, together with the proposed recovery actions.

7.6.2 Policy and Principles

The work to be performed for every space project, shall be planned and controlled on the basis of the Work Breakdown Structure, to a level of detail commensurable with the achieved design maturity and adequate to the project phase for which cost and tasks are planned.

Cost shall be estimated and planned by cost categories, on the basis of defined economic conditions.

Cost data specified in the contract shall serve as a reference for cost control and reporting, at the actual level of control, agreed between the contractor and the purchaser.

Schedule planning and control is implemented by establishing and maintaining a schedule of project activities in which external inputs and task outputs are linked and project milestones are identified.

Reference schedule data specified in the Business Agreement shall be maintained throughout the project duration and periodically reported to the customer at the required level of visibility. Payment milestones shall be identified and traced.

Schedule criticality requiring special attention shall be highlighted for special reviews.

In case schedule deviation will affect an event selected as a project milestone for schedule/performances control purposes, a modified planning shall be established upon customer approval.

7.6.3 Requirements

a. The customers at all levels shall specify the requirements for Cost and Schedule Management. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Cost and Schedule Management.

AIM: A coherent and consistent approach to Cost and Schedule Management within each project. Refer to ECSS–M–60 (Cost and Schedule Management).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with cost and schedule management.*
Element of Implementation Documents saying how related requirements will be met.

b. A common project calendar shall be defined for the whole project.

AIM: Provide an agreed and consistent basis for the identification, analysis, reporting and time phasing of activities, cost and manpower data.

The common project calendar is a calendar for all the project activities to be used by all project actors.

EXPECTED OUTPUT: *Common project calendar.*

7.7 Integrated Logistic Support

7.7.1 Objective

The objective of integrated logistic support is to ensure the satisfaction of needs in terms of logistic support throughout the system life cycle.

7.7.2 Policy and Principles

The integrated logistic support will cover:

- the definition of the support system, which aims at maintaining the technical and availability performance of the system and which includes all the support resources being delivered as well as implemented,
- the integration of the logistic support activities into the project activities,
- the deployment of such activities throughout the system life cycle.

7.7.3 Requirements

a. The customers at all levels shall specify the requirements for Integrated Logistic Support. The suppliers at all levels shall respond to the ECSS standards (to the extent to which they are invoked by Project Requirements Documents) with appropriate Implementation Documents for Integrated Logistic Support.

AIM: A coherent and consistent approach to Integrated Logistic Support within each project. Refer to ECSS–M–70 (Integrated Logistic Support).

EXPECTED OUTPUT: *Appropriate element of the Project Requirements Documents dealing with integrated logistic support.*
Element of Implementation Documents saying how related requirements will be met.

8

Project Management Human Resources Aspects

Projects are managed through the people involved in them. It is of paramount importance to properly staff the project, to communicate the project objectives to the team, to allocate and to develop the members' skills effectively.

Project management will have also to embrace the diversity of the project members, to maintain a positive attitude toward every actor's ideas, to communicate openly and to resolve conflicts.

8.1   Staffing the Project

8.1.1

Each actor shall staff the project according to the personnel skills needed.

AIM: Ensure that role, responsibility and authority are appropriately assigned.

EXPECTED OUTPUT: *Effective project team.*

8.2   Training and Development

8.2.1

Each actor shall develop the team members' skills by appropriate training programme.

AIM: Ensure up-to-date members' skills.

EXPECTED OUTPUT: *Training programme.*

8.3   Team Performance Continuous Improvement

8.3.1

Each actor shall foster continuous improvement.

AIM: Increase on a permanent basis effectiveness and performance.

EXPECTED OUTPUT: *Continuous improvement programme.*