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EUROPEAN COOPERATION

ECSS

FOR SPACE STANDARDIZATION

Space engineering

Software

This ECSS document is a draft standard circulated for review and comment. It is therefore subject to change and may not be referred to as an ECSS Standard until published as such.

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Foreword

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

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

The formulation of this Standard takes into account the existing ISO 9000 family of documents, and the ISO/IEC 12207 standard.

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

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1 Scope

This software engineering Standard concerns the "product software", i.e. software that is part of a space system product tree and developed as part of a space project.

This Standard is applicable to all the elements of a space system, including the space segment, the launch service segment and the ground segment.

This Standard covers all aspects of space software engineering including requirements definition, design, production, verification and validation, and transfer, operations and maintenance.

It defines the scope of the space software engineering process and its interfaces with management and product assurance, which are addressed in the Management (-M) and Product assurance (-Q) branches of the ECSS System, and explains how they apply in the software engineering process.

This Standard reflects the specific methods used in space system developments, and the requirements for the software engineering process in this context. Together with the requirements found in the other branches of the ECSS Standards, this Standard provides a coherent and complete framework for software engineering in a space project.

This Standard is intended to help the customers to formulate their requirements and suppliers to prepare their response and to implement the work.

This Standard is not intended to replace textbook material on computer science or technology, and such material is avoided in this Standard. The readers and users of this Standard are assumed to possess general knowledge of computer science.

The scope of this Standard is the software developed as part of a space project, i.e. "Space system product software". It is not intended to cover software developments out of scope with the ECSS System of Standards. An example is the development of commercial software packages, where software is developed for a (large) volume market and not just for a single customer, and the main requirement analysis consists of market analysis, combined with a marketing strategy.

This Standard also applies to the development of non-deliverable software which affects the quality of the deliverable product.

Other classes of software products not covered are: management information systems (e.g. finance, planning), technical information systems (e.g. CAD/CAM, analysis packages) and supporting software products for documentation systems, database systems, spread-sheets. These usually result from the procurement or adaptation of existing commercial products, and are not part of the space system development. Such software products are however, often be part of a supporting infrastructure for space systems.

When viewed from the perspective of a specific project context, the requirements defined in this Standard should be tailored to match the genuine requirements of a particular profile and circumstances of a project (see annex C).

NOTE Tailoring is a process by which individual requirements or specifications, standards and related documents are evaluated and made applicable to a specific project, by selection and in some exceptional cases, modification of existing or addition of new requirements.

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 revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-P-001	Glossary of terms
ECSS-E-10	Space engineering — System engineering
ECSS-M-00	Space project management — Policy and principles
ECSS-M-10	Space project management - Project breakdown structures
ECSS-M-20	Space project management Project organization
ECSS-M-30	Space project management — Project phasing and planning
ECSS-M-40	Space project management — Configuration management
ECSS-Q-20	Space product assurance — Quality assurance
ECSS-Q-80	Space product assurance — Software product assurance

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3

Terms, definitions and abbreviated terms

3.1 Terms and definitions

The following terms and definitions are specific to this Standard in the sense that they are complementary or additional with respect to those contained in ECSS-P-001.

3.1.1
acceptance testing

the test of a system or functional unit usually performed by the customer on his premises after installation with the participation of the supplier to ensure that the contractual requirements are met

[ISO 2382]

3.1.2
configurable code

source or executable code that can be tailored by setting values of parameters

3.1.3
critical software

software supporting a safety or dependability critical function that if incorrect or inadvertently executed can result in catastrophic or critical consequences

NOTE For the definition of catastrophic and critical see ECSS-Q-30 and ECSS-Q-40.

3.1.4
deactivated code

code that, although incorporated through correct design and coding is not intended to execute in any software product configuration

3.1.5
integration test

a. the progressive linking and testing of programs or modules in order to ensure their proper functioning in the complete system

[ISO 2382]

b. testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them

[IEEE 610.12]

3.1.6
margin philosophy

rationale for margins allocated to the performance parameters and computer resources of a development, and how these margins shall be managed during the execution of the project

3.1.7
metric

the defined measurement method and the measurement scale

[ISO 9126]

3.1.8
migration

porting of a software product to a new environment

3.1.9
portability (a quality characteristic)

the capability of software to be transferred from one environment to another

[ISO 9126]

3.1.10
quality characteristics (software)

the set of attributes of a software product by which its quality is described and evaluated. A software quality characteristic may be refined into multiple levels of subcharacteristics

[ISO 9126]

3.1.11
quality model (software)

the set of characteristics and the relationships between them which provides the basis for specifying quality requirements and evaluating quality

[ISO 9126]

3.1.12
regression testing (software)

selective retesting to detect faults introduced during modification of a system or system component, to verify that the modifications have not caused unintended adverse effects, or to verify that a modified system or system component still meets its specified requirements

[IEEE 610.12]

3.1.13
reusability

the degree to which a software module or other work product can be used in more than one computer program or software system

[IEEE 610.12]

3.1.14
singular input

individual parameter stress testing

3.1.15
software

see 3.1.20 software product

3.1.16
software component
part of a software system

NOTE 1 Software component is used as a general term

NOTE 2 Components can be assembled and decomposed to form new components. In the production phase, components are implemented as modules, tasks or programs, any of which can be configuration items. This usage of the term is more general than in ANSI/IEEE parlance, which defines a component as a ”basic part of a system or program”; in this Standard, components are not always -”basic” as they can be decomposed.

3.1.17
software item
see 3.1.20 software product

3.1.18
software intensive system
space system where the dominant part of the constituents are software elements

NOTE In such systems, subsystems consist mainly of software. For this type of system, the majority of interfaces are software-software interfaces.

3.1.19
software observability
property of a system for which the-values of status variables can be determined throughout observations of the output variables

3.1.20
software product
set of computer programs, procedures and documentation and data associated with them

3.1.21
software product assurance
totality of activities, standards, controls and procedures in the lifetime of a software product which establishes confidence that the delivered software product, or software affecting the quality of the delivered product, conforms to customer requirements

3.1.22
software unit
separately compilable piece of source code

NOTE In this Standard no distinction is made between a software unit and a database; both are covered by the same requirements.

3.1.23
stress test
test that evaluates a system or software component at or beyond the limits of its specified requirements

3.1.24
unit test
test of software unit to ensure that there are no programming errors

3.1.25
unreachable code

code that cannot be executed due to design or coding error

3.1.26
usability (a quality characteristic)

the capacity of the software to be understood, learned, used and liked by the user, when used under specified conditions

[ISO 9126]

3.1.27
validation

confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[ISO 9000]

NOTE The validation process (for software): confirmation that the requirements baseline functions and performances are correctly and completely implemented in the final product.

3.1.28
verification

confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[ISO 9000]

NOTE The verification process (for software):confirmation that adequate specifications and inputs exist for any activity, and that the outputs of the activities are correct and consistent with the specifications and input.

3.2 Abbreviated terms

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

Abbreviation	**Meaning**
AOCS	attitude and orbit control system
AR	acceptance review

NOTE The term SW-AR may be used for clarity to denote ARs that solely involve software products.

CAD	computer aided design
CAM	computer aided manufacturing
CDR	critical design review

NOTE The term SW-CDR may be used for clarity to denote CDRs that solely involve software products.

COTS	commercial off-the-shelf software
CPU	central processing unit
DDF	design definition file
DDR	detailed design review
DJF	design justification file
ECSS	European Cooperation for Space Standardization
FMECA	failure mode effect and criticality analysis

HOOD	hierarchical object oriented design
HOORA	hierarchical object oriented requirements analysis
HRT	hard real time
HSIA	hardware software interaction analysis
HW	hardware
ICD	interface control document
IRD	interface requirements document
ISO	International Organization for Standardization
ISV	independent software validation
ISVV	independent software verification and validation
MGT	management file
MF	maintenance file
MMI	man machine interface
MOTS	modified off-the-shelf
OP	operational plan
ORR	operational readiness review
PDR	preliminary design review
	NOTE The term SW-PDR may be used for clarity to denote PDRs that solely involve software products.
QR	qualification review
	NOTE The term SW-QR may be used for clarity to denote QRs that solely involve software products.
RB	requirements baseline
RT	real time
SA	structured analysis
SD	structured design
SADT	structured analysis and design technique
SDE	software development environment.
SDL	synchronous design language.
SPA	software product assurance
SPR	software problem report
SRR	system requirements review
	NOTE The term SW-SRR may be used for clarity to denote SRRs that solely involve software products.
SW	software
SWE	software engineering
TS	technical specification
UML	unified modelling language
V&V	verification & validation

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4

Space system software engineering

4.1 Introduction

This clause 4 introduces the structure of this Standard and the framework of the space software engineering process that form its basis.

The context of space software engineering is the overall space system engineering process. This clause 4 defines the general relationships between the software engineering processes and the general engineering processes of space systems.

The software engineering activity differs from the other engineering disciplines covered by ECSS in one important aspect: software does not in itself produce heat, have mass or any other physical characteristics. The software engineering activity is a purely intellectual activity and a principle output of the activity is documentation. If the software code itself is considered as a specialized form of electronic documents, all visible outputs are in fact documentation.

It follows that this Standard focuses on requirements for the structure and content of the documentation produced.

Software is used for the implementation of highly complex functions. The ability to deal with a high level of complexity in a flexible way makes software an essential and increasing part of space segment and ground segment products. In space systems, software engineering is found at all levels ranging from system level functions down to the firmware of a space system part.

Therefore the requirements engineering process, in which the software requirements and specifications are defined, has a special emphasis in this Standard. The software requirements engineering process consumes a large and often underestimated amount of effort in the development of software for space systems.

As a result of the complexity of the functional and performance requirements, it also follows that special measures and emphasis apply for software verification and validation, especially for space segment software. The functions assigned to software can be critical to the space mission.

The maintenance of software for space systems also poses special problems, because they imply operational lifetimes that far exceed what is expected of general computer software products. For the space segment, this is further complicated by the fact that software in general is the only part of the space segment that undergoes major maintenance and repair, sometimes even redesign, after launch. In extreme cases, the space system mission itself is redesigned, implementing new space segment software after launch. Ground segment software is similarly characterized.

This Standard is complemented by ECSS-Q-80 Space product assurance — Software product assurance, with product assurance aspects. Together the two standards either define or refer to the definition of all software relevant processes for space projects.

The coverage of all software life cycle processes by the different ECSS Standards is illustrated in Figure 1.

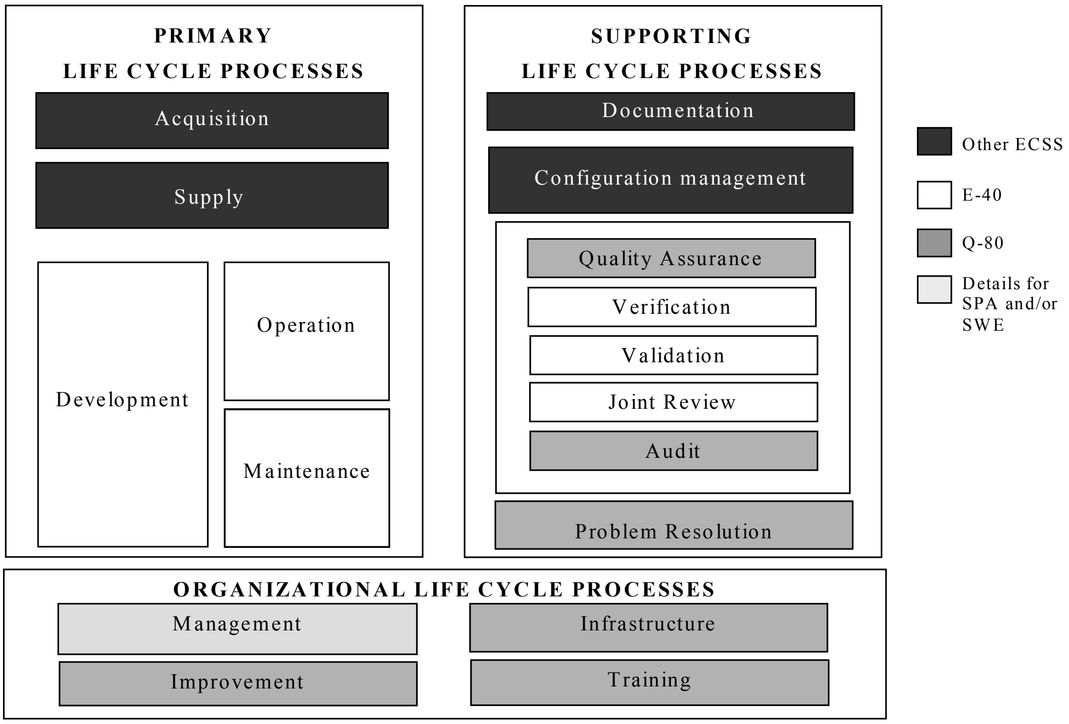


Figure 1: Software life cycle processes in ECSS Standards

4.2 Space system software engineering processes

4.2.1 General

The software engineering processes regulated by this Standard are based on the definitions and requirements given in the ECSS-M series (in particular M-20, M-30, M-40 and M-50), and the general engineering process requirements of ECSS-E-00. These requirements have been used to define the top level software engineering processes. This general framework defines the processes (that are later treated in detail in the following subclauses) and the top level interface between the software engineering processes and other space development processes.

The fundamental principle of this Standard is the ‘customer-supplier’ relationship, assumed for all software developments. The organizational aspects of this are defined in ECSS-M-20. The customer is, in the general case, the procurer of two strongly associated products: the hardware and the software for a system, subsystem, set, equipment or assembly (see ECSS-E-00). The concept of the ‘customer-supplier’ relationship is applied recursively i.e. the customer may himself be a supplier to a higher level in the space system as shown in Figure 2. The software customer therefore has two important interfaces. The first interface is to his software and hardware suppliers and this includes the functional analysis allocating adequately functional and performance requirements to his suppliers. The other where he is in his role as supplier at a higher level, ensuring that higher level system requirements are adequately taken into account.

The customer derives the functional and performance requirements for the hardware and software, based on system engineering principles and methods. The customer also controls the interface between the software and hardware. Software items are defined in the system breakdown at different levels. Nevertheless, it is important to manage the software-software interfaces irrespective of the level at which they occur. The customer's requirements are defined by this initializing process, and provide the starting point for the software engineering.

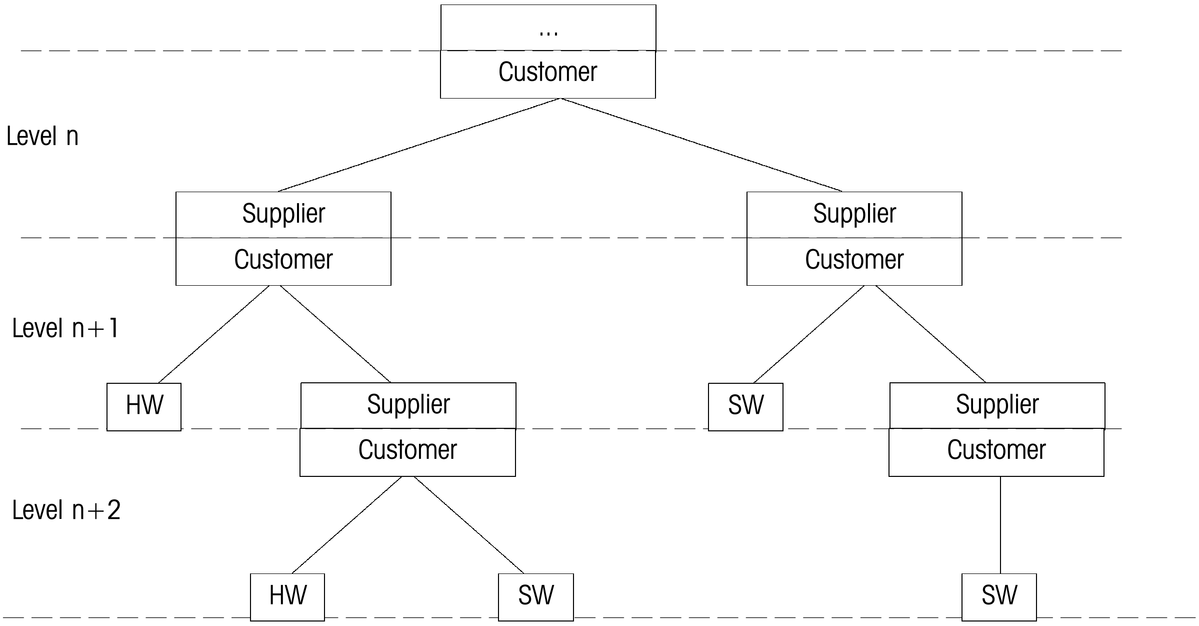


Figure 2: The recursive customer - supplier model

Reviews are the main interaction points between the customer and supplier. The reviews relevant to the software engineering process are the SRR, PDR, CDR, QR and AR, as defined by ECSS-M-30. All reviews are applicable to software. The reviews occur at different levels in the customer-supplier hierarchy and are sequenced according to the overall system level planning. This Standard is designed to be applied at any level, without explicit assumptions of how these reviews are integrated with other reviews in the development of a space system. The term system in this Standard is meant as system or subsystem at any decomposition level. An overview is shown in Figure 3. The commonly designated mission phases (e.g. 0, A, B) are used for the overall mission phases, and play no direct role in the software engineering activities as such. This means that the software engineering processes, together with their reviews and attached milestones as defined in this Standard, are not scheduled as the higher-level system mission phases. They are planned in relation to the immediate higher level development processes.

The notion of engineering processes is fundamental to this Standard, as the processes provide the means to describe the overall constraints and interfaces to the software engineering process at system level, and at the same time, provide the necessary freedom to the supplier to implement the individual activities and tasks implied by the processes. The freedom given to the supplier to implement the engineering processes is especially important for software engineering, because of the requirement to organize the work in accordance with a well defined software life cycle. There is a requirement to accommodate different types of software life cycles, both for reasons of efficient organisation of the work and also for reasons related to competitiveness and choice of software engineering technology. Different software life cycle types can be accommodated within the requirements in this Standard. Figure 4 illustrates the constraints. Figure 5 shows examples of variations within these constraints.

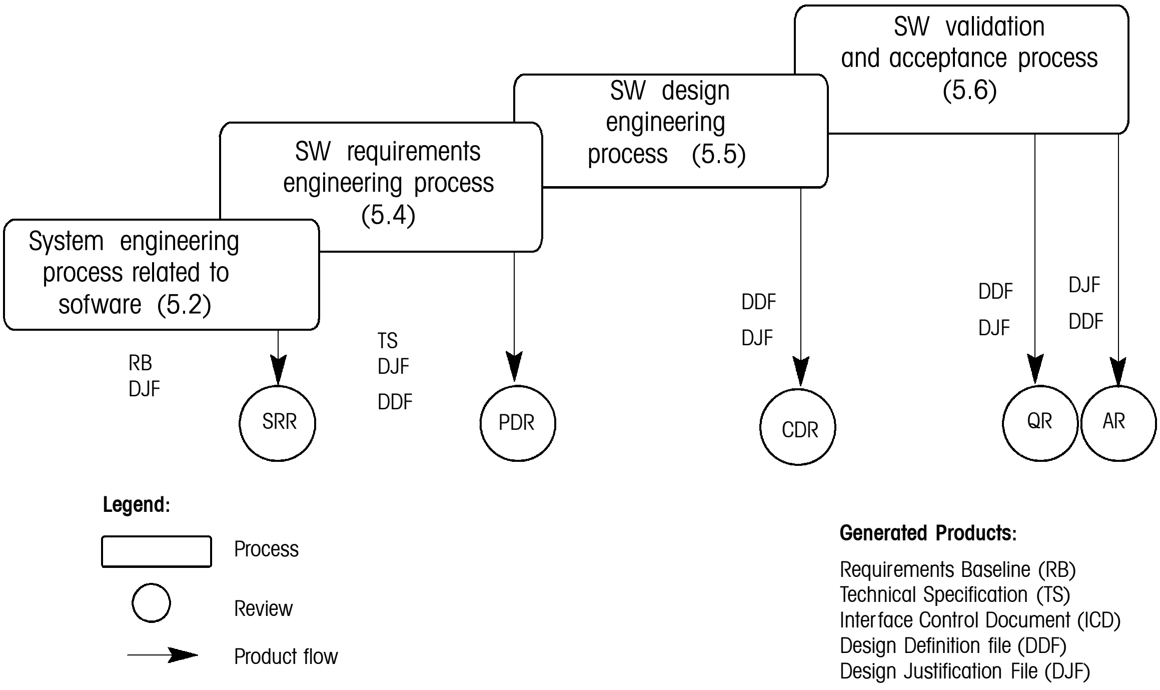

SW validation and acceptance process (5.6)
SW design engineering process (5.5)
SW requirements engineering process (5.4)
System engineering process related to sofware (5.2)
RB
DJF
SRR
TS
DJF
DDF
PDR
DDF
DJF
CDR
DDF
DJF
QR
DJF
DDF
AR
Legend:
Process
Review
Product flow
Generated Products:
Requirements Baseline (RB)
Technical Specification (TS)
Interface Control Document (ICD)
Design Definition file (DDF)
Design Justification File (DJF)

Figure 3: Overview of the software development processes

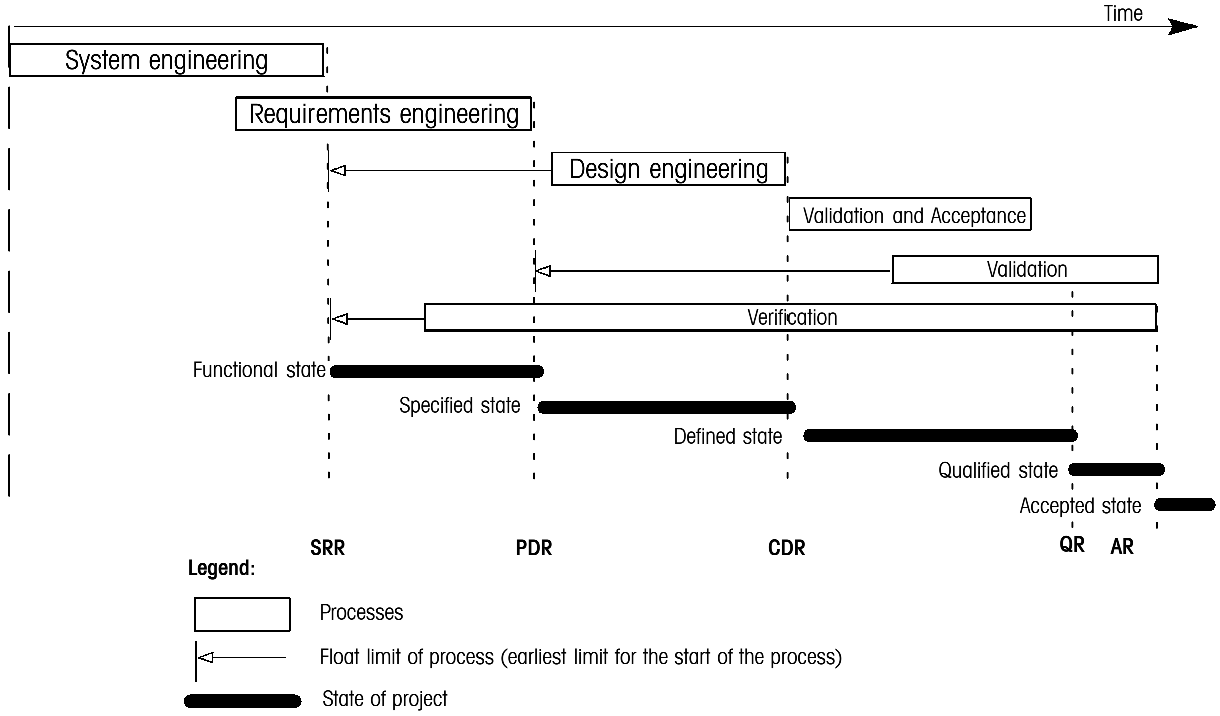


Figure 4: Process constraints

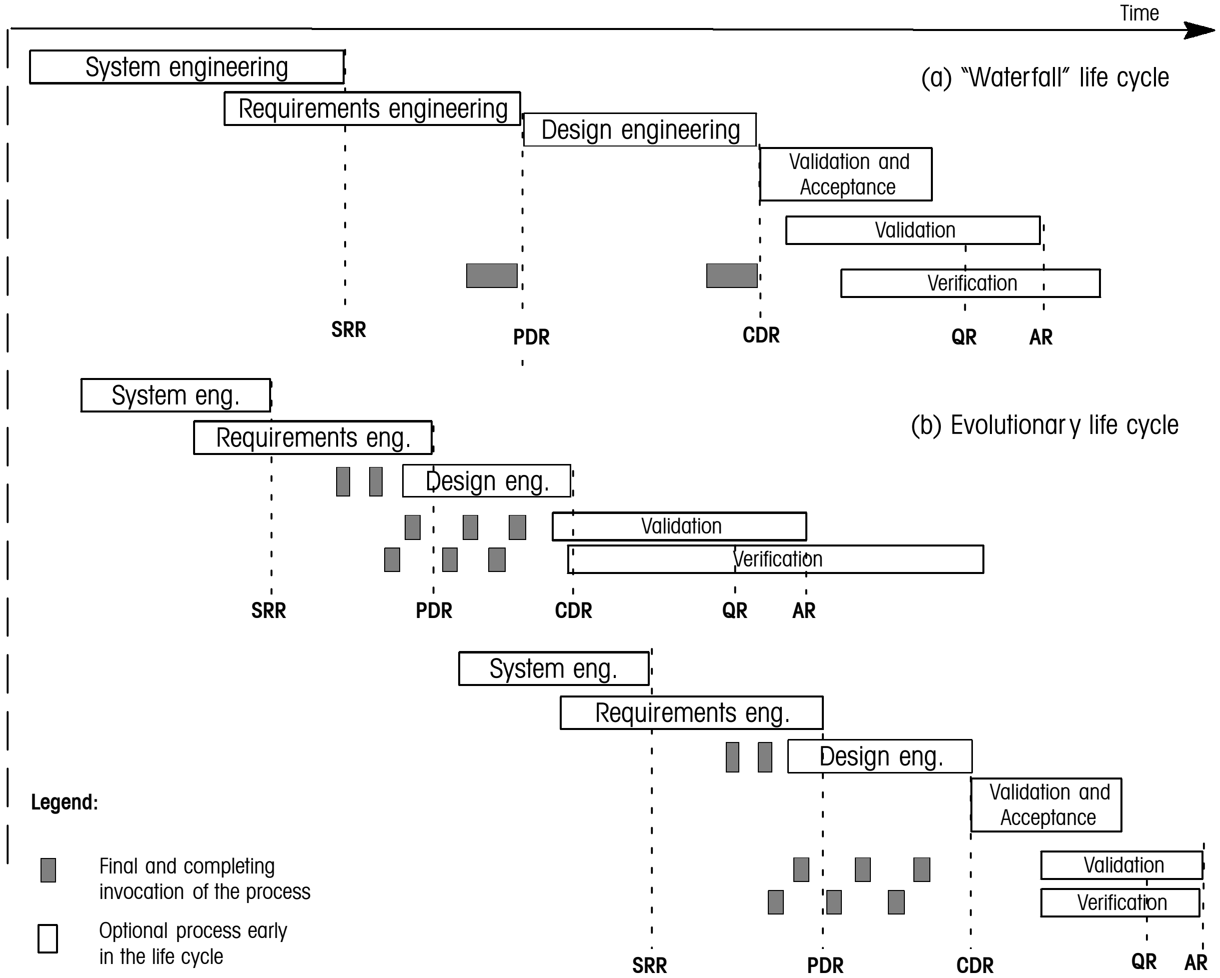


Figure 5: Accommodation of different software life cycles

4.2.2 Software requirements engineering process

The system engineering processes produce the information for input to system requirements review (SRR). This establishes the functional and performance requirements baseline (RB) of the software development, and the preliminary interface requirements.

A second part of the software requirements engineering process is the elaboration of the technical specification (TS), which is the supplier's response to the requirements baseline. This process may start in parallel or after the elaboration of the requirements baseline. The software product tree is defined by this process. The technical specification contains a precise and coherent definition of functions, performances, cost, schedule and implementation plans for all levels of the software to be developed. The preliminary interface control document (ICD) is generated by this process.

During the software requirements engineering activity, the result of all significant trade-offs, feasibility analyses, make-or-buy decisions and supporting technical assessments are documented in a design justification file (DJF).

The software requirements engineering process is completed by the preliminary design review (PDR). The input to the PDR is the technical specification, preliminary ICD and the DJF. The software architectural design is reviewed at the PDR. Additional reviews of the software architecture under the customer initiative, can be specifically included in the organization of the project.

The state of the software development after PDR is called "specified state".

4.2.3 Software design engineering process

The "design and configuration engineering process" mentioned in ECSS-E-10 is in software developments referred to as the "design engineering process".

This process does not start before SRR. It can start before the PDR, but it is after the PDR when the results of the requirements engineering process are reviewed and baselined that are used as inputs to the design engineering process.

The process produces the design of each element of the software product tree, in response to the requirements contained in the technical specification, ICD and DJF. All elements of the software design are documented in the design definition file (DDF). The DDF contains all the levels of design engineering results, including software code listings.

The rationale for important design choices, and analysis and test data that shows the design meets all requirements, is added to the DJF by this process. The results of this process are the input to the critical design review(CDR). The CDR signals the end of the design phase. For large software projects, all software sub-systems will undergo a CDR before they are integrated with the next highest level in the system hierarchy. Large software developments are partitioned in smaller manageable projects that are managed like any other subsystem development in space projects.

Finally this process produces also the coding, unit testing, integration testing and validation of the software product with respect to the technical specification. All elements of the testing activities are documented in the design justification file (DJF).

The integration activities include preparation and execution of the validation testing of the integrated product. At system level, which is the next higher level in the product tree, the system level integration takes place. The system level integration nominally takes place after completion of the CDR for the software product to be integrated with the system. However, depending on the system level life cycle and risk sharing approach, the system integration process can be specified invoked earlier, but not earlier than the software CDR.

4.2.4 Validation and acceptance process

The validation and acceptance process can start after the CDR and when the validation with respect to TS is complete.

The state of the software project after CDR is called “defined state”.

This process includes a qualification review (QR), with the DJF as input. The state of the software project after QR is called the “qualified state”.

4.2.5 Software operations engineering process

The operations process can start after completion of the acceptance review of the software. Since software products form an integrated part of a space system, the phasing and management of operations are determined by the overall system requirements and applied to the software products. The operations engineering processes are not directly connected to the overall mission phase E, but are, instead, determined by the requirement at system level to operate the software product at a given time.

General requirements for operations are found in ECSS-E-70 .

4.2.6 Software maintenance process

This separate process is started after the completion of the AR.

This process is activated when the software product undergoes any modification to code or associated documentation as a result of correcting an error, a problem or implementing an improvement or adaptation. The process ends with the retirement of the software product.

NOTE The software analysis process (as a general engineering process defined in the ECSS-E standards) is invoked by the requirements and design engineering processes. No separate output is produced by this process. The results produced by the analysis process are integrated with the requirements and design engineering outputs.

4.2.7 Software verification and validation (supporting) process

The software verification and validation process can start any time after the SRR.

This process is intended to confirm that the customer’s requirements have been properly addressed, that all requirements have been met and that all design constraints are respected.

The result of this process is included in the DJF.

A sub-process of this process is the transfer and acceptance of the software to the customer. This latter sub-process is completed by an acceptance review (AR), that takes place after QR. The acceptance review is a formal event in which the software product is evaluated in its operational environment. It is carried out after the software product is installed and transferred to the customer and installed on an operational basis. Software validation activities terminate with the acceptance review.

This state of the software after AR is called the “accepted state”.

NOTE The term “qualification engineering” is often used synonymously with the term “verification engineering” in projects delivering hardware. For the sake of clarity, “qualification engineering” is used in this Standard to denote “the total set of verification and validation activities”. This is consistent with other ECSS Standards outside the software engineering discipline, and to avoid confusion with the general verification engineering activities that are invoked in many places in software projects.

4.3 Organization of this Standard

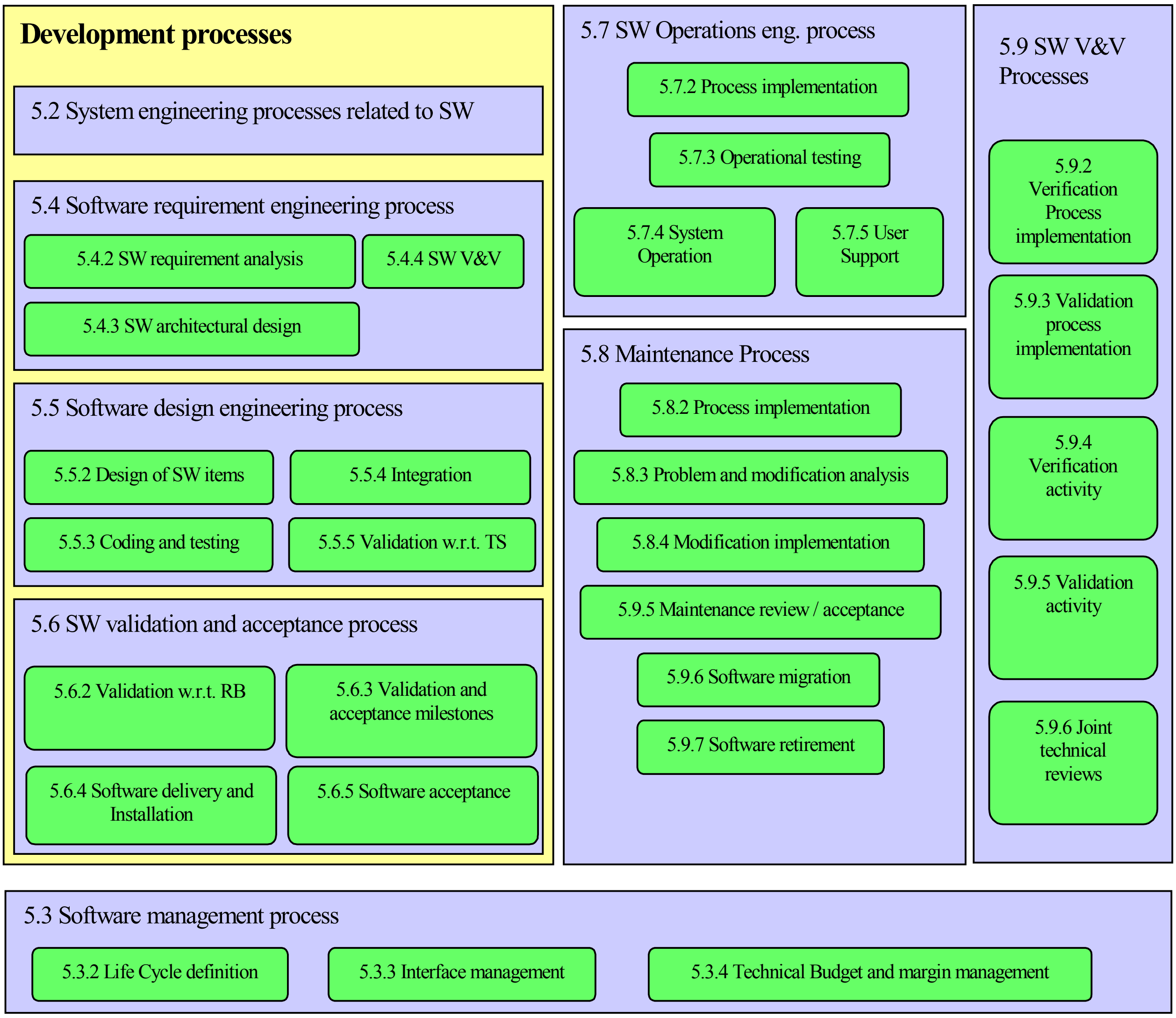
This Standard is organized in two main parts:

- **General requirements**. These are the core requirements for any space system software engineering activity.
- **Special requirements**. These are additional requirements for specific application areas. These requirements are always applicable, but are only active in developments where the addressed disciplines or application areas occur. This separation serves to make the general requirements core compact and clear.

Software documentation summaries are included in annex A.

In the preparation of this Standard the ISO/IEC 12207 Standard has been used extensively, providing a common internationally recognized framework for the terminology and engineering process description.

The organization of the general requirements of this Standard is reflected in detail in Figure 6.



Development processes
5.2 System engineering processes related to SW
5.4 Software requirement engineering process
5.4.2 SW requirement analysis
5.4.4 SW V&V
5.4.3 SW architectural design
5.5 Software design engineering process
5.5.2 Design of SW items
5.5.4 Integration
5.5.3 Coding and testing
5.5.5 Validation w.r.t. TS
5.6 SW validation and acceptance process
5.6.2 Validation w.r.t. RB
5.6.3 Validation and acceptance milestones
5.6.4 Software delivery and Installation
5.6.5 Software acceptance
5.7 SW Operations eng. process
5.7.2 Process implementation
5.7.3 Operational testing
5.7.4 System Operation
5.7.5 User Support
5.8 Maintenance Process
5.8.2 Process implementation
5.8.3 Problem and modification analysis
5.8.4 Modification implementation
5.9.5 Maintenance review / acceptance
5.9.6 Software migration
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5.9 SW V&V Processes
5.9.2 Verification Process implementation
5.9.3 Validation process implementation
5.9.4 Verification activity
5.9.5 Validation activity
5.9.6 Joint technical reviews
5.3 Software management process
5.3.2 Life Cycle definition
5.3.3 Interface management
5.3.4 Technical Budget and margin management

Figure 6: Structure of this Standard

4.4 Relation to other ECSS Standards

4.4.1 General

This subclause 4.4 discusses how this Standard interfaces with other ECSS series, namely the ECSS-Q series of standards (product assurance) and the ECSS-M series of standards (project management).

4.4.2 Software product assurance

Requirements on software product assurance are defined in ECSS-Q-80, which is the entry level document of the ECSS-Q series (product assurance) for software projects.

The ECSS-Q-80 Standard covers all aspects of space software product assurance including the implementation aspects of the software product assurance process, and both software process and product-related assurance activities.

It defines the scope of the space software product assurance process and its interfaces with management, engineering and other system-level product assurance activities, which are addressed in the management (-M), engineering (-E) and product assurance (-Q) branches of the ECSS System, and explains how they apply in the software product assurance process.

4.4.3 Software project management

4.4.3.1 Introduction

ECSS-M Standards define the requirements applicable to the management of space projects. The following subclauses describe how the ECSS-M Standards apply to the management of software projects.

In addition, requirements which cannot be found in M-series, because they are specific to software project management, are provided in subclause 5.3.

4.4.3.2 ECSS-M-00: Policy and principles

ECSS-M-00 is a top-level document which defines project management principles and general requirements applicable to all aspects of a space project including software.

Risk management is covered by ECSS-M-00-03. Some risk factors, such as exceeding the assigned memory budget or CPU load, are specific to software.

The terms “customer” and “supplier” used in this Standard are defined in ECSS-M-00A subclause 5.2.

4.4.3.3 ECSS-M-10: Project breakdown structures

The provisions of ECSS-M-10 apply to software, taking account of the specific features of the software.

The products of a software project are usually documents (including code) but may also include computer devices in the case of software intensive systems.

“Model matrix” in ECSS-M-10A, subclause 5.2, is concerned with material models and therefore is not relevant to software.

4.4.3.4 ECSS-M-20: Project organization

ECSS-M-20 provides a clear definition of the role and responsibility of each party to the project. ECSS-M-20 covers the requirements for software projects.

4.4.3.5 ECSS-M-30: Project phasing and planning

ECSS-M-30 defines the phasing and planning requirements for an entire space project, but some requirements also affect software development, because they are specified in ECSS-M-30 as applicable at any level of the project organization.

Project phases as defined in ECSS-M-30 are top-level (mission) phases, used to structure the whole space project. They do not apply recursively to software development. They are not the phases which are defined to give structure to software development life cycles, and for which no specific definition is requested in this Standard.

Similarly, the reviews as defined in ECSS-M-30 do not apply directly to software even though the concept of review applies recursively to all levels of a space project.

The terms “SRR”, “PDR”, “CDR”, “QR” and “AR” are defined in ECSS-M-30 , and these are reused to define joint technical reviews for a software development as described in subclause 4.2 of this Standard.

These reviews are synchronized with higher level reviews in a way which is project dependant. In clause 6, interface requirements are given for particular types of software. Requirements concerning phasing and reviews, and which are specific to software are given in subclause 5.3.

4.4.3.6 ECSS-M-40: Configuration management

The requirements, also for software developments, are contained in ECSS-M-40.

One facet of software configuration management is that all configuration items may be regarded as documents (even code). Therefore, the software configuration management can easily be automated.

4.4.3.7 ECSS-M-50: Information/documentation management

Information and documentation management are particularly performed to ensure the accessibility of information to all parties of the project and to ensure the coherence of this information. This also applies to software projects. The relevant requirements are not those in ECSS-M-50.

4.4.3.8 ECSS-M-60: Cost and schedule management

ECSS-M-60 contains requirements on software projects, although requirements on schedule management are more directly applicable to software, than costing requirements.

4.4.3.9 ECSS-M-70: Integrated logistic support

ECSS-M-70 is mainly of concern to large or software-intensive systems.

4.4.4 Engineering

4.4.4.1 ECSS-E-00: Policy and principles

ECSS-E-00 contains the basic rules and overall principles to be applied to all engineering activities during performance of a space project. It addresses the establishment, based on customer needs, of mission objectives, requirements, and specifications for space systems, and the design, definition, production, verification, operation, and eventual disposal of the systems themselves. It defines the scope and interfaces of these activities relative to the domains of management and product assurance which are addressed in the management (- M) and product assurance (- Q) branches of the ECSS system, and explains how they may apply in different ways depending on the type of space system concerned.

4.4.4.2 ECSS-E-10: System engineering

ECSS-E-10 is intended to guide the development of systems (including hardware, software, man-in-the-loop, facilities and services) for space applications. It specifies implementation requirements for the responsible system engineering organization consistent with the assumption that the system engineering process defined in standard ECSS-E-10-01 is applied.

4.4.4.3 ECSS-E-70: Ground systems and operations

ECSS-E-70 provides a high level description of all ground segment elements, the domain specific aspects of the associated engineering processes and defines related guidelines and requirements.

4.5 Tailoring of this Standard

The general requirements for selection and tailoring of applicable standards are defined in ECSS-M-00-02.

There are several drivers for tailoring, such as dependability and safety aspects, product quality objectives, software development constraints and commercial considerations.

Tailoring for software development constraints takes into account technical, operational and management factors, see annex C for details.

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5

General requirements

5.1 Introduction

This clause 5 defines the requirements for engineering software for space systems, applicable to any space projects producing computer software.

Each requirement can be identified by a hierarchical number. The text of the requirement is followed, where necessary, by further explanation of the aim. For each requirement, the associated output is given in the output section. With each output (e.g. “a.”, “b.”), the destination (document) of the output is indicated in brackets together with the corresponding review. For example: “[DDF, DJF; QR]” denotes an output to the design definition file and the design justification file. The output in this example is requested for the qualification review.

5.2 System engineering processes related to software

5.2.1 Introduction

This subclause 5.2 describes activities which are under the customer responsibility. The customer is responsible for the delivery of a system in which the developed software is integrated (refer to the recursive customer-supplier model described in 4.2).

The customer activities described here are only those that introduce additional requirements particular for software development:

- system requirement analysis,
- system partitioning,
- system level requirements for software verification and validation,
- system level integration of software,
- software operations, and
- software maintenance.

System level documentation is a prerequisite to the requirements engineering of the software. The requirements given in this subclause ensure the completeness and correctness of the customer’s system level documentation and establish a complete and verified requirements baseline for the software project.

5.2.2 System requirements analysis

5.2.2.1 System requirements specification

System requirements shall be derived from an analysis of the specific intended use of the system to be developed and documented.

EXPECTED OUTPUT:
a. *Functions and performance requirements of the system [RB; SRR];*
b. *Interface requirements [IRD(RB); SRR];*
c. *Design constraints and verification and validation requirements [RB; SRR];*
d. *Identification of lower level software engineering standards [RB;SRR] (see ECSS-Q-80B subclauses 6.3.2 and 6.3.3).*

5.2.2.2 System and functional criticality analysis

System and software criticality analysis shall be performed in accordance with ECSS-Q-80B subclauses 6.2.2 and 6.2.3

EXPECTED OUTPUT: *Overall safety and reliability requirements of the software to be produced [RB; SRR].*

5.2.3 System partitioning

5.2.3.1 Introduction

a. As a part of the system design process, a physical architecture and design (including HW, SW and human operations) of the system shall be derived.

NOTE 1 This is called top level partitioning of the system.

NOTE 2 This system design is derived from an analysis of the requirements on the system and its functions.

EXPECTED OUTPUT: *System design [DDF-system level; SRR].*

b. Conformance to the system design with all system requirements shall be verified.

EXPECTED OUTPUT: *System design to system requirements conformance [DJF-system level; SRR].*

c. All system requirements shall be allocated and traceable to the different system design partitions.

EXPECTED OUTPUT: *System requirements to system design traceability [DJF-system level; SRR].*

5.2.3.2 System partitioning

a. A top- level partitioning of the system shall be established.

EXPECTED OUTPUT: *Software-hardware interface requirements [IRD(RB); SRR].*

b. The system partitioning shall identify items of hardware, software and human operations, ensuring that all the system requirements are allocated to items.

EXPECTED OUTPUT: *Traceability to system partitioning [DJF; SRR].*

c. Hardware configuration items, software configuration items, and human operations shall be subsequently identified from these items.

EXPECTED OUTPUT: *System partition with definition of items [RB; SRR].*

d. The system partitioning and the system requirements allocated to the individual items shall be documented.

EXPECTED OUTPUT: *System configuration items list [RB; SRR].*

5.2.4 System level requirements for software verification and validation

5.2.4.1 Introduction

The general ECSS approach to the verification process is described in ECSS-E-10A clauses 4 and 5, covering both verification and validation activities.

5.2.4.2 Qualification engineering requirements

The customer shall adapt the requirements for qualification engineering given in subclause 5.6 to system level requirements.

AIM: To identify the customer's verification and validation process requirements at system level, and to prepare for software acceptance and software integration by introducing the corresponding verification and validation process requirements in the requirements baseline.

EXPECTED OUTPUT: *Verification and validation process requirements [RB; SRR].*

5.2.4.3 Software validation requirements at system level

The customer shall include requirements for validation of all elements of the software at system level, including validation at mission level.

AIM: To ensure that the software is validated at system level with realistic mission data and operational environments, and to minimize the functions that can only be validated by actual flight. This is because in general no prototype flights are possible, then the mission success imposes the software to be operational at the first flight

EXPECTED OUTPUT: a. *Functional requirements for support to system and mission level validation [RB; SRR];*

b. *Installation and acceptance requirements of the delivered software product at the operational and maintenance sites [RB; SRR].*

5.2.4.4 Requirements baseline verification

The customer shall verify the requirements baseline, considering the following:

- In cases where the customer's product is an integrated hardware and software product, this shall be performed in conformance with the ECSS system engineering standards.
- In cases where the customer's product is a software product, the customer shall apply this Standard in his role as "supplier" at a higher level in the product tree.

EXPECTED OUTPUT: *Requirements justifications [DJF-system level; SRR].*

NOTE The output is not part of the customer-supplier interface for the software engineering processes, and is therefore not part of any milestone inputs. Instead the output is part of the customer's own system DJF, and used only by the customer in his role as supplier at the next higher level in the product tree. The output is mentioned here for completeness only.

5.2.4.5 System requirements review

The customer shall conduct a system requirements review (SRR) in accordance with subclause 5.3.2.6.

EXPECTED OUTPUT: *SRR milestone report [RB;SRR].*

5.2.5 System level integration of software

5.2.5.1 Identification of software observability requirements

If a software product is integrated into a system, all software observability requirements to facilitate the software integration, shall be specified by the customer.

EXPECTED OUTPUT: *Software observability requirements [RB; SRR].*

5.2.5.2 Control and data interfaces for system level integration

If the software is integrated into a system, all the interfaces between the software and the system shall be specified by the customer, including the static and dynamic aspects, for nominal and degraded modes (e.g. behaviour in case of failure).

NOTE 1 The external interfaces, specific to software integrated in a system, can be:
- software interface with other software on the system (operating system, files, database management system or other applications software);
- hardware interfaces to the specific hardware configuration; and
- communication interfaces (particular network protocol for example).

NOTE 2 Space segment software is in general integrated with highly specialised processors and electrical equipment. The IRD and ICD therefore have a special importance and are controlled separately to ensure consistent design throughout the hardware and software life cycle.

EXPECTED OUTPUT: *System level interface requirements [IRD(RB); SRR].*

5.2.5.3 Data medium requirements for integration

The customer shall identify the interface data medium and prepare the requirements accordingly.

EXAMPLE The interface data can be defined and structured in such a way it can be automatically acquired by the SDE supplier. Trade-offs can be performed, taking into account the number of software packages in the system, the evolution of interface data, and the number of interface data sets.

EXPECTED OUTPUT: *System level data interfaces [IRD(RB); SRR].*

5.2.5.4 Identification of development constraints

The customer shall define specific development constraints on the supplier required to support the integration of the software into the system.

NOTE When the software is integrated into a system, the customer can check for applicability of some harmonization constraints such as: specification of the operating system to be used, specification of COTS to be used (e.g. database and MMI generator), and specification of the SDE to be used.

EXPECTED OUTPUT: *Development constraints [RB; SRR].*

5.2.5.5 Identification of customer's input for software integration into the system

The customer shall identify and plan the specific inputs to be provided by him to the supplier to support the integration of the software into the system, in accordance with the overall projects constraints with appropriate documentation in the requirements baseline.

NOTE When the software is integrated into a system, the customer can provide the supplier with specific inputs for validating the software in a representative environment. These inputs can be: breadboard or computer model, and a simulator of the hardware and software environment.

EXPECTED OUTPUT: *System level integration support products [IRD(RB); SRR].*

5.2.5.6 Identification of supplier's outputs for software integration into the system

The customer shall identify and plan the specific outputs to be delivered by the supplier to support the integration of the software into the system, and he shall prepare the requirements baseline accordingly.

NOTE When software is integrated into a system, some prototype versions or intermediate versions can be requested by the customer to prepare the integration, the functionalities and delivery dates for each of these versions are defined by the customer.

EXPECTED OUTPUT: *System level integration preparation requirements [IRD(RB); SRR].*

5.2.5.7 Planning of supplier support to system integration

The customer shall plan the support from the software supplier in order to integrate the software at system level.

NOTE This can include activities such as: training, maintenance, configuration and test support.

EXPECTED OUTPUT: *System level integration support requirements [MGT; SRR].*

5.2.6 Software operations

5.2.6.1 Phasing and management

Since software products are an integrated part of the space system, the phasing and management of operations shall be determined by the overall system requirements and shall be applied to the operations of software products.

EXPECTED OUTPUT: *Operational plan [OP; ORR].*

5.2.6.2 System requirements definition for software operations

a. The customer shall establish system requirements for the operation of software products.

EXPECTED OUTPUT: *Software operations requirements [RB; SRR].*

b. The supplier's response shall be agreed with the customer in the system requirements review (SRR), intended to release the operational plan for execution as established in subclause 5.7.

EXPECTED OUTPUT: *Operational plan [OP; ORR].*

5.2.7 Software maintenance

The customer shall establish system requirements for the maintenance of software products. The supplier's response shall be agreed with the customer in the system requirements review (SRR), intended to release the maintenance plan for execution as established in subclause 5.8.

EXPECTED OUTPUT: *Software maintenance requirements [RB; SRR].*

5.3 Software management process

5.3.1 Introduction

Most of the specific requirements for the management and control of space systems software projects exist in the ECSS-M series of documents. They are not repeated here. In addition, the software product assurance requirements described in ECSS-Q-80 are also used for the control of space systems software projects. Management plans are produced in relation with the following activities:

- development;
- configuration and documentation management;
- verification and validation;
- maintenance;
- quality assurance on process and product.

The requirements described in this subclause 5.3 define the engineering and control of software development in a space systems project, and they bridge the gap between the other ECSS Standards mentioned above and the software engineering activities in space projects.

The management and control tasks described in this subclause are:

- software life cycle,
- interface management, and
- technical budget and margin management.

The requirements in this subclause 5.3 apply to any type of software in a space project.

As defined in more detail in following subclauses, the software undergoes the overall software milestone reviews SRR, PDR, CDR, QR and AR as a minimum. A DDR is also requested for flight software in accordance with subclause 6.2.4. The customer can request further reviews (e.g. review of project plans, before the PDR) following requirements mentioned in subclause 5.9.6.

5.3.2 Software life cycle

5.3.2.1 Definition of software life cycle phases

To assure effective phasing and planning, the software development life cycle shall be broken into phases, each having its with associated milestones.

NOTE Detailed guidelines on software life cycle are found in the level 3 Standard ECSS-E-40-04.

EXPECTED OUTPUT: *Definition of the software life cycle phases included in the software development plan [MGT; SRR, PDR].*

5.3.2.2 Software life cycle identification

a. The software supplier shall define and follow a software development life cycle in accordance with subclause 4.2, and covering all activities from the statement of requirement to the entry of the software into service.

EXPECTED OUTPUT: *Project software development life cycle definition, included in the software development plan [MGT; SRR,PDR].*

b. The definition of the life cycle shall be associated with choices of techniques used during the development, operations and maintenance processes (e.g. data base management system, and extensive product reuse), with the risks inherent to the project (e.g. highly changeable specification, and stringent schedule constraints) and with synchronization points with the upper level.

EXPECTED OUTPUT: *Definition of software development, operations and maintenance techniques and identification of project risks, included in the software development plan [MGT; SRR, PDR].*

c. The choice of software life cycle shall be in accordance with the overall project requirements, and the process model of subclause 4.2 and ECSS-M-30 shall be used.

EXPECTED OUTPUT: *Definition of software life cycle in line with the software and system level processes included in the software development plan [MGT; SRR, PDR].*

5.3.2.3 Identification of inputs and outputs associated to each phase

The development life cycle shall define the input and output for each phase and its associated milestones.

EXPECTED OUTPUT: *Review plan-milestones (included in the software development plan) [MGT; SRR, PDR].*

5.3.2.4 Identification of documentation relevant to each milestone

The output for each phase shall consist of documents in complete or outline versions, including the results of verification of the technical outputs of the phase.

NOTE Milestones are the joint technical reviews at the customer -supplier level (SRR, PDR, CDR, QR and AR) and internal reviews at the supplier level. The outputs for each milestone are documents submitted for examination and are explicitly listed in the software life cycle definition.

EXPECTED OUTPUT: *Identification of outputs at each milestone (included in the software development plan) [MGT; SRR, PDR].*

5.3.2.5 Identification of interface between the development and maintenance processes

The interface between development and maintenance (e.g. documents to be produced, tools to be kept for maintenance) shall be identified for the software life cycle.

AIM: Define and prepare during development input for maintenance process of the software product. See subclause 5.8.

EXPECTED OUTPUT: *Elements of the software maintenance plan [MF; PDR].*

5.3.2.6 Software requirements baseline at the SRR

The customer's release of the software requirements baseline shall be included in the material submitted to the SRR.

NOTE The software requirements baseline results from a system requirements analysis and a system partitioning conducted by the customer. It represents the customer's requirements towards the software to be developed. These are constituted by the customer's requirements and the external interfaces of the software.

EXPECTED OUTPUT: *Customer approval of requirements baseline [RB; SRR]*

5.3.2.7 Software technical specification phase

A software technical specification phase shall be included at the beginning of the development life cycle.

AIM: To establish the technical specification for the project. This is the software suppliers response to the requirements baseline. The technical specification captures all technical requirements for the software product, and it is aimed to establish the technical specification early in the project.

EXPECTED OUTPUT: *a. Technical specification of the software [TS; PDR];*

b. Software architectural design [DDF; PDR];

c. Interface control document [ICD(TS); PDR];

d. Software architectural design trade-offs [DJF; PDR].

5.3.2.8 Preliminary design review

On completion of the technical specification phase, the software supplier shall hold a preliminary design review (PDR) with the customer.

AIM: — Agree with the customer or their representatives that all requirements with respect to the requirements baseline are captured in the technical specification.

— Review the software architecture.

EXPECTED OUTPUT: *Customer approval of technical specification and software architecture [TS, DDF, ICD(TS), DJF; PDR].*

5.3.2.9 Critical design review

a. At the end of the design, the software supplier shall hold a critical design review (CDR) with the customer.

AIM: During the CDR, the design definition file, operations software user manual and the associated design justification file are reviewed.

EXPECTED OUTPUT: *CDR milestone report [DJF; CDR].*

b. The completeness of the software validation activities with respect to the technical specification and their relevant products (e.g. test case specification and simulators) shall be reviewed.

EXPECTED OUTPUT: *a. Customer approval of the design definition file (e.g. software architectural design, detailed design and code) [DDF; CDR];*

b. Customer approval of the design justification file (e.g. results of unit and integration tests and results of validation with respect to the technical specifications) [DJF; CDR];

c. Customer approval of the design of system level interfaces and the system level integration plan [DDF, DJF; CDR];

d. Customer approval of the software user manual [DDF; CDR];

e. Customer approval of the validation with respect to TS report [DJF; CDR].

5.3.2.10 Software verification and validation process

Verification and validation shall be carried out at the end of the development life cycle.

AIM: To ensure, by means of verification and validation processes in a representative environment, that the software product conforms to its technical specification before integration in the system.

EXPECTED OUTPUT: *Software verification and validation activities phasing in the software development plan [MGT; SRR, PDR].*

5.3.2.11 Qualification review

a. The software supplier shall hold a qualification review (QR) to verify that the software product meets all of its specified requirements in the requirements baseline.

AIM: To verify that the software meets all of its specified requirements, and in particular that verification and validation process outputs enable transition to "qualified state" for the software products.

EXPECTED OUTPUT: *QR milestone report [DJF; QR].*

b. During QR, a summary of tests reports and software user manual are reviewed. The consistency of all software documentation (RB, TS, DDF, DJF) shall be verified.

EXPECTED OUTPUT: *Customer's approval of qualified state [DJF; QR].*

5.3.2.12 Acceptance review

After the qualification review, the customer shall hold an acceptance review (AR).

AIM: Acceptance of the software with respect to the intended operational environment.

EXPECTED OUTPUT: *Customer's approval of accepted state [DJF; AR].*

5.3.3 Interface management

5.3.3.1 Interface definition

Interfaces shall be defined in the requirements baseline in an interface requirements document, which defines the requirements applicable to various elements of the system product tree.

EXPECTED OUTPUT: *Interface requirement document [IRD(RB); SRR].*

5.3.3.2 Interface management procedures

Interface management procedures shall be defined in accordance with ECSS-M-40 requirements.

AIM: Define procedures which guarantee the consistency of the system interfaces.

EXPECTED OUTPUT: *a. Interface management procedures [RB; SRR];*

b. Part of configuration management requirements [RB; SRR].

5.3.4 Technical budget and margin management

5.3.4.1 Software technical budget and margin philosophy definition

Technical budget targets and margin philosophy dedicated to the software shall be specified by the customer in the requirements baseline.

AIM: To define the limits of software budgets associated with computer resources (such as: CPU load and maximum memory size) and performance requirements to be considered by the supplier.

EXPECTED OUTPUT: *Technical budgets and margin philosophy for the project [RB; SRR].*

5.3.4.2 Software technical budget management

The supplier shall manage margins regarding the technical budgets and present their status at each milestone, describing the utilized analytical hypothesis.

AIM: To establish the margins by analysis in the early phases of development and to consolidate them by performance measurements commensurate with the software implementation.

EXPECTED OUTPUT: *Margins and technical budgets status [DJF; PDR, CDR, QR, AR].*

5.4 Software requirements engineering process

5.4.1 Introduction

The software requirements engineering process consists of the following activities:

- software requirements analysis;
- software-architectural design;
- software verification and validation.

5.4.2 Software requirements analysis

5.4.2.1 Establishment and documentation of software requirements

The supplier shall establish and document software requirements, including the software quality requirements, as part of the technical specification

EXPECTED OUTPUT: *Software requirements specification [TS; PDR]*

a. Functional and performance specifications, including hardware characteristics, and environmental conditions under which the software item executes, including budgets requirements [TS; PDR];

b. Software product quality requirements (see ECSS-Q-80B subclause 7.2 [TS; PDR];

c. Security specifications, including those related to factors which can compromise sensitive information [TS; PDR];

d. Human factors engineering (ergonomics) specifications, including those related to manual operations, human-equipment interactions, constraints on personnel, and areas requiring concentrated human attention, that are sensitive to human errors and training [TS; PDR];

e. Data definition and database requirements [TS; PDR];

EXPECTED OUTPUT: *Interface control document [TS; PDR]*

f. Interfaces external to the software item [ICD(TS); PDR].

5.4.2.2 Software logical model definition

The supplier shall build an implementation-independent model of software items in order to analyse and document software requirements.

EXPECTED OUTPUT: *Software logical model [TS; PDR].*

5.4.2.3 Identification of requirement unique identifier

Each requirement shall be separately identified in order to allow for traceability.

EXPECTED OUTPUT: *Requirements unique identifier [TS; PDR].*

5.4.2.4 Software requirements evaluation

The supplier shall evaluate the software requirements invoking subclause 5.9.4.1.

EXPECTED OUTPUT: *a. Requirement traceability matrices [DJF; PDR];*

b. Requirements verification report [DJF; PDR].

5.4.3 Software architectural design

5.4.3.1 Transformation of software requirements into a software architecture

The supplier shall transform the requirements for the software item into an architecture that describes its top-level structure and identifies the software components, ensuring that all the requirements for the software item are allocated to its software components and later refined to facilitate detailed design.

EXPECTED OUTPUT: *Software architectural design [DDF; PDR].*

5.4.3.2 Software design description

The design description shall as a minimum cover hierarchy, dependency, interfaces and operational usage for the software components.

EXPECTED OUTPUT: *Hierarchy, dependency and interfaces of software components in the software architectural design [DDF; PDR].*

5.4.3.3 Software design documentation

The design description shall document the process, data and control aspects of the product.

EXPECTED OUTPUT: *Process, data and control aspects of software components in the software architectural design [DDF; PDR].*

5.4.3.4 Development and documentation of the software interfaces

The supplier shall develop and document a software architectural design for the interfaces external to the software item and between the software components of the software item.

EXPECTED OUTPUT: *a. Preliminary external interfaces design [ICD(TS); PDR];*

b. Preliminary internal interfaces design [DDF; PDR].

5.4.3.5 Evaluation of reuse of predeveloped software

The supplier shall consider the “reuse” of already developed, commercial off-the-shelf, modifiable off-the-shelf software, free software and open source (see also subclause 6.2.7 in ECSS-Q-80B).

EXPECTED OUTPUT: *Specification of reuse of predeveloped software [TS; PDR].*

5.4.3.6 Definition and documentation of the software integration requirements and plan

The supplier shall define and document preliminary test requirements and the plan for software integration.

EXPECTED OUTPUT: *Software integration test plan (preliminary) [DJF; PDR].*

5.4.3.7 Evaluation of the software architecture and the interface design

The supplier shall evaluate the architecture of the software item and the interface design invoking subclause 5.9.4.2.

EXPECTED OUTPUT: *a. Software architectural design and interface verification report [DJF; PDR];*

b. Software architectural design to requirements traceability matrices [DJF; PDR].

5.4.3.8 Conducting a preliminary design review

The supplier shall conduct a preliminary design review (PDR) in accordance with subclause 5.3.2.8.

NOTE The successful completion of the review establishes a baseline for the development of the software item.

EXPECTED OUTPUT: *PDR milestone report [DJF; PDR].*

5.4.4 Software verification and validation

The technical specification shall be accompanied by the specification of verification and validation of the software product. These specifications are determined by the customer's requirements baseline (subclause 5.2.4.2) and by invoking the relevant verification and validation processes.

The processes invoked are:

a. verification process implementation (subclause 5.9.2);

b. validation process implementation (subclause 5.9.3).

EXPECTED OUTPUT: *a. Software verification plan - independence, criticality and effort [DJF; PDR];*

b. Software verification plan - methods and tools [DJF; PDR];

c. Software verification plan - organization [DJF; PDR];

d. Software validation plan - independence, criticality and effort [DJF; PDR];

e. Software validation plan - methods and tools [DJF; PDR];

f. Software validation plan - organization [DJF; PDR].

5.5 Software design engineering process

5.5.1 Introduction

The software design engineering process consists of the following activities:

- design of software items;
- coding and testing;
- integration;
- validation with respect to the technical specification.

5.5.2 Design of software items

5.5.2.1 Detailed design of each software component

a. The supplier shall develop a detailed design for each component of the software and document it.

EXPECTED OUTPUT: *Software components design documents [DDF; CDR].*

b. Each software component shall be refined into lower levels containing software units that can be coded, compiled, and tested.

EXPECTED OUTPUT: *Software components design documents [DDF; CDR].*

c. It shall be ensured that all the software requirements are allocated from the software components to software units.

EXPECTED OUTPUT: *Software components design documents [DDF; CDR].*

5.5.2.2 Development and documentation of the software interfaces detailed design

The supplier shall develop and document a detailed design for the interfaces external to the software item, between the software components, and between the software units,in order to allow coding without requiring further information.

EXPECTED OUTPUT: *a. External interfaces design (update) [ICD(TS); CDR];*

b. Internal interfaces design (update) [DDF; CDR].

5.5.2.3 Development and documentation of the software user manual

The supplier shall develop and document the software user manual.

EXPECTED OUTPUT: *Software user manual [DDF; CDR].*

5.5.2.4 Definition and documentation of the software unit test requirements and plan

The supplier shall define and document test requirements and plan for testing software units, including stressing the software at the limits of its requirements.

EXPECTED OUTPUT: *Software unit test plan [DJF; CDR].*

5.5.2.5 Updating of the software integration test requirements and plan

The supplier shall update the test requirements and the plan for software integration.

EXPECTED OUTPUT: *Software integration test plan (update) [DJF; CDR].*

5.5.2.6 Evaluation of the software detailed design and test requirements

The supplier shall evaluate the software design and test requirements invoking subclause 5.9.4.3.

EXPECTED OUTPUT: *a. Design verification report [DJF; CDR];*
b. Design traceability matrices [DJF; CDR].

5.5.3 Coding and testing

5.5.3.1 Development and documentation of the software units, test procedures and test data

The supplier shall develop and document the following:

- the coding of each software unit;
- test procedures and data for testing each software unit.

EXPECTED OUTPUT: *a. Software component design documents and code (update) [DDF; CDR];*
b. Software unit test plan (update) [DJF; CDR].

5.5.3.2 Software unit testing

The supplier shall test each software unit ensuring that it satisfies its requirements and document the test results

EXPECTED OUTPUT: *a. Software component design document and code (update) [DDF; CDR];*
b. Software unit test reports [DJF; CDR].

5.5.3.3 Software user manual updating

The supplier shall update the software user manual.

EXPECTED OUTPUT: *Software user manual (update) [DDF; CDR].*

5.5.3.4 Updating of the software integration test requirements and plan

The supplier shall update the test requirements and the plan for software integration.

AIM: To make the test requirements and integration plan consistent with the results of the code design process.

EXPECTED OUTPUT: *Software integration test plan (update) [DJF; CDR].*

5.5.3.5 Code and unit test results evaluation

The supplier shall evaluate software code and test results, invoking subclause 5.9.4.4.

EXPECTED OUTPUT: *a. Software code verification report [DJF; CDR];*
b. Software code traceability matrices [DJF; CDR].

5.5.4 Integration

5.5.4.1 Software integration test plan development

The supplier shall develop and document an integration plan to integrate the software units and software components into the software item, providing with the following data:

- test requirements;
- test procedures;
- test data;
- responsibilities allocation;
- schedule information.

EXPECTED OUTPUT: *Software integration test plan [DJF; CDR].*

5.5.4.2 Software units and software component integration and testing

The supplier shall integrate the software units and software components, and test them, as the aggregates are developed, in accordance with the integration plan, ensuring that each aggregate satisfies the requirements of the software item and that the software item is integrated at the conclusion of the integration activity.

EXPECTED OUTPUT: *Software integration test report [DJF; CDR].*

5.5.4.3 Software user manual updating

The supplier shall update the software user manual.

EXPECTED OUTPUT: *Software user manual (update) [DDF; CDR].*

5.5.4.4 Software integration activities results evaluation

The supplier shall evaluate the software integration activities results invoking subclauses 5.9.4.5 and 5.9.4.6.

EXPECTED OUTPUT: *a. Software integration verification report [DJF; CDR];*
b. Software documentation verification report [DJF; CDR].

5.5.5 Validation with respect to the technical specification

5.5.5.1 Software validation with respect to the technical specification

a. The supplier shall evaluate the software with respect to the technical specification, conducting the validation tests against the technical specification, invoking the validation process (see subclause 5.9.5).

EXPECTED OUTPUT: *a. Validation with respect to the technical specification testing report [DJF; CDR];*
b. Validation with respect to the technical specification testing specification [DJF; CDR];
c. Software design and test evaluation report [DJF; CDR].

b. Every problem detected during the validation activities shall be subject of a problem resolution process (invoking subclause 5.9.5.5).

EXPECTED OUTPUT: *Problem and nonconformance reports [DJF; CDR].*

5.5.5.2 Conducting a critical design review

a. The supplier shall conduct a critical design review (CDR) in accordance with subclause 5.3.2.9.

EXPECTED OUTPUT: *CDR milestone report [DJF; CDR].*

b. All outputs for CDR shall be prepared and verified by the process “verification of software documentation” (subclause 5.9.4.6) in preparation of the CDR.

AIM: That the supplier baselines his design documentation for the project to transit from “specified state” to the “defined state”, thereby achieving the milestone of a completed design.

EXPECTED OUTPUT: *Software documentation verification report [DJF; CDR].*

c. Every problem detected during the review shall be subject of a problem resolution process (invoking subclause 5.9.5.5).

EXPECTED OUTPUT: *CDR milestone report [DJF;CDR].*

5.6 Software validation and acceptance process

5.6.1 Introduction

This process consists of the following activities:

- validation with respect to the requirements baseline;
- validation and acceptance milestones;
- software delivery and installation;
- software acceptance.

5.6.2 Validation with respect to the requirements baseline

a. The customer shall evaluate the software with respect to the requirements baseline, invoking the validation process (see subclause 5.9.5).

EXPECTED OUTPUT: *a. Validation with respect to the requirements baseline testing specification[DJF; QR, AR];*

b. Validation with respect to requirements baseline testing report [DJF; QR, AR].

b. This validation shall be performed not later than the acceptance review.

EXPECTED OUTPUT: *Phasing of activities of the software validation with respect to the requirements baseline in the software development plan [MGT; SRR, PDR].*

5.6.3 Validation and acceptance milestones

5.6.3.1 Conducting a qualification review

The qualification review (QR) shall be conducted in accordance with subclause 5.3.2.11.

AIM: To verify that the software meets all the requirements, and in particular that verification and validation process outputs enable transition to “qualified state” for the software products.

EXPECTED OUTPUT: *a. Preliminary software acceptance data package [DJF; QR];*

b. Software release document [DDF; QR];

c. Software delivery [DDF; QR];

d. Software design and test evaluation report [DJF; QR];

e. Validation testing report [DJF; QR];

f. Test specification evaluation [DJF; QR];

g. QR milestone report [DJF; QR].

5.6.3.2 Conducting an acceptance review

a. The acceptance review (AR) shall be conducted in accordance with subclause 5.3.2.12.

EXPECTED OUTPUT: *AR milestone report [DJF; AR].*

b. The software supplier's acceptance support task (see subclause 5.6.5.4) shall support the customer's acceptance activities in preparation of the AR.

AIM: To ensure that the customer receives adequate supplier support to perform his acceptance and integration activities in preparation of the AR, invoking subclause 5.6.5.4.

EXPECTED OUTPUT: *a. Final software acceptance data package [DJF; AR];*

b. Acceptance testing documentation [DJF; AR];

c. Software release document [DDF; AR];

d. Software delivery [DDF; AR].

5.6.4 Software delivery and installation

5.6.4.1 Preparation and updating of the software product

The supplier shall:

a. Prepare and update the deliverable software product as established in the requirements baseline for system integration, system validation testing, software installation, or software acceptance support.

EXPECTED OUTPUT: *a. Software delivery [DDF; QR];*

b. Software release document [DDF; QR].

b. Update the established baseline for the design and code of the software item.

EXPECTED OUTPUT: *Software acceptance data package [DJF; QR].*

5.6.4.2 Supplier's provision of training and support

The supplier shall provide initial and continuing training and support to the customer as specified in the requirement baseline.

EXPECTED OUTPUT: *Training material [DDF; QR].*

5.6.4.3 Installation planning

The supplier shall develop a plan to install the software product in the target environment.

EXPECTED OUTPUT: *Installation plan [DJF; AR].*

5.6.4.4 Installation activities reporting

a. The resources and information to install the software product shall be determined and be available.

b. The supplier shall assist the customer with the set-up activities.

c. It shall be ensured that the software code and databases initialize, execute and terminate as specified in the installation plan.

d. The installation events and results shall be documented.

EXPECTED OUTPUT: *Installation report [DJF; AR].*

5.6.5 Software acceptance

5.6.5.1 Acceptance test planning

The customer shall establish an acceptance test plan specifying the intended acceptance tests with tests suited to the target environment.

EXPECTED OUTPUT: *Acceptance test plan [DJF; AR]*

5.6.5.2 Acceptance test execution

The customer shall execute the acceptance testing.

EXPECTED OUTPUT: *Acceptance test report [DJF; AR].*

5.6.5.3 Executable code generation and installation

The acceptance shall include generation of the executable code from configuration managed source code components and its installation on the target environment.

EXPECTED OUTPUT: *Executable code generation test in the acceptance test plan [DJF; AR].*

5.6.5.4 Supplier's support to customer's acceptance

a. The supplier shall support the customer's acceptance reviews and testing of the software product.

EXPECTED OUTPUT: *AR milestone report [DJF; AR].*

b. Acceptance reviews and testing shall consider the results of the joint reviews (ECSS-Q-20A subclause 4.6.4.4 and 8.3), audits (ECSS-Q-20A subclause 2.6), software validation testing (ECSS-Q-80B subclause 6.3.4), and system validation testing (if performed).

EXPECTED OUTPUT: *AR milestone report [DJF; AR].*

c. The results of the acceptance reviews and testing shall be documented.

EXPECTED OUTPUT: *Acceptance testing documentation [DJF; AR].*

5.6.5.5 Evaluation of acceptance testing

The acceptance tests shall be evaluated with respect to the requirements baseline.

EXPECTED OUTPUT: *Traceability of acceptance tests to the requirements baseline [DJF; AR].*

5.7 Software operations engineering process

5.7.1 Introduction

The operation process may start after completion of software acceptance. Since software products are an integrated part of the space system, the phasing and management of operation is determined by the overall system requirements and applied to the software products. The operation engineering processes are therefore not directly connected to the overall mission phase E, but are determined by the system level requirement to operate the software product at a given time. Ground segment software products are for example in extensive operational use to qualify the ground segment, well before the actual mission operation occur. Similarly, for flight segment software, extensive ground operations are, in general, performed for testing flight equipment long before space system flight operations begin.

Both the documents and the reviews identified as outputs by the subclauses of 5.7 are therefore part of the operations activities for the space systems, and the requirements for these reviews and their documentation forms part of the space system operations engineering requirements covered in other ECSS standards. The provisions of this subclause 5.7 are intended to produce the required software engineering inputs for the system level activities.

The operation process comprises the activities and tasks of the operator. The process covers the operation of the software product and operational support to users. Because operation of a software product is integrated into the operation of the system, the activities and tasks of this process refer to the system.

The operator manages the operation process at the project level following the management process (ECSS-M-30). This process consists of the following activities:

- process implementation;
- operational testing;
- software operation;
- user support.

5.7.2 Process implementation

5.7.2.1 Operational plans and standards development

The operator shall develop, document and execute a plan and set operational standards for performing the activities and tasks of this process.

EXPECTED OUTPUT: *Operational plan - plan and standards [OP; ORR].*

5.7.2.2 Problem handling procedures definition

a. The operator shall establish procedures for receiving, recording, resolving, tracking problems, and providing feedback.

EXPECTED OUTPUT: *Operational plan - procedures for problem handling [OP; ORR].*

b. Whenever problems are encountered, they shall be recorded in accordance with the change control established and maintained in conformance with ECSS-M-40.

EXPECTED OUTPUT: *Problem and nonconformance report [OP]*

5.7.2.3 Operational testing definition

The operator shall establish procedures for:

- testing the software product in its operation environment,
- entering problem reports and modification requests to the maintenance process (see subclause 5.8), and
- releasing the software product for operational use in accordance with the change control established and maintained in conformance with ECSS-M-40.

EXPECTED OUTPUT: *Operational plan - operational testing specifications [OP; ORR].*

5.7.3 Operational testing

5.7.3.1 Operational testing execution

a. For each release of the software product, the operator shall perform operational testing in accordance with the change control established and maintained in conformance with ECSS-M-40.

EXPECTED OUTPUT: *Operational testing results [OP; ORR].*

b. On satisfying the specified criteria, the software product shall be released for operational use.

EXPECTED OUTPUT: *Software delivery [OP; ORR].*

5.7.3.2 Software operational requirements demonstration

a. The customer shall ensure that prior to the operations phase, the software has been demonstrated capable of implementing the operational requirements.

NOTE This demonstration can be part of the acceptance tests of the system.

EXPECTED OUTPUT: *Validation of operational requirements [OP; ORR].*

b. This demonstration shall be representative in terms of:

- hardware operating environment,
- situations to which the software is designed to be fault tolerant,
- system configuration,
- sequence of operations and phases, and
- operator interventions.

EXPECTED OUTPUT: *Demonstration criteria [OP; ORR].*

5.7.4 Software operation

The software shall be operated in its intended environment according to the software user manual.

5.7.5 User support

5.7.5.1 User's assistance

a. The operator shall provide assistance and consultation to the users.

b. User's requests and subsequent actions shall be recorded and monitored.

5.7.5.2 Handling of user's requests

a. The operator shall forward user requests to the maintenance process for resolution.

b. User's requests shall be addressed and the actions that are planned and taken shall be reported to the originators of the requests.

5.7.5.3 Provisions of work-around solutions

a. If a reported problem has a temporary work-around solution before a permanent solution can be released, the originator of the problem report shall be given the option to use it.

b. Permanent corrections, releases that include previously omitted functions or features, and system improvements shall be applied to the operational software product using the maintenance process (subclause 5.8).

5.8 Software maintenance process

5.8.1 Introduction

The maintenance process contains the activities and tasks of the maintainer. This process is activated just before QR . The objective is to modify an existing software product while preserving its integrity. This process includes the migration and retirement of the software product. The process ends with the retirement of the software product.

The activities provided in this subclause 5.8 are specific to the maintenance process; however, the process can utilize other processes in this Standard. If the software engineering process (subclause 4.2) is utilized, the term supplier there is interpreted as maintainer.

The maintainer manages the maintenance process at the project level following the management process (ECSS-M-10), which is instantiated for software in this process.

Both the documents and the reviews identified by the subclauses in this subclause 5.8 are part of the general maintenance activities for the space systems, and the requirements for these reviews and documentation are part of the space system maintenance engineering requirements, covered in other ECSS Standards. The provisions of this subclause 5.8 produce the required software engineering inputs for this system level activities.

This process consists of the following activities:

- process implementation;

- problem and modification analysis;
- modification implementation;
- in flight modification;
- maintenance review and acceptance;
- software migration;
- software retirement.

5.8.2 Process implementation

5.8.2.1 Software maintenance process planning

The maintainer shall develop, document, and execute plans and procedures for conducting the activities and tasks of the maintenance process.

EXPECTED OUTPUT: *Maintenance plan - plans and procedures [MF; QR].*

5.8.2.2 Software maintenance process procedures, methods and standards

Software maintenance shall be performed using the same procedures, methods, tools and standards as used for the development.

EXPECTED OUTPUT: *Maintenance plan - applicability of development process procedures, methods, tools and standards [MF; QR].*

5.8.2.3 Problem reporting and handling

a. The maintainer shall establish procedures for receiving, recording and tracking problem reports and modification requests, providing feedback to the requester.

EXPECTED OUTPUT: *Maintenance plan - problem reporting and handling [MF; QR].*

b. Whenever problems are encountered, they shall be recorded and entered in accordance with the change control established and maintained in conformance with ECSS-M-40.

EXPECTED OUTPUT: *Problem and nonconformance report [MF].*

5.8.2.4 Implementation of configuration management process

The maintainer shall implement (or establish the organizational interface with) the configuration management process (ECSS-M-40) for managing modifications.

EXPECTED OUTPUT: *Maintenance plan - configuration management process [MF; QR].*

5.8.3 Problem and modification analysis

5.8.3.1 Problem analysis

The maintainer shall analyse the problem report or modification requests for its impact on the organization, the existing system, and the interfacing systems for the following:

- type (e.g. corrective, improvement, preventive, or adaptive to new environment);
- scope (e.g. size of modification, cost involved, and time to modify);
- criticality (e.g. impact on performance, safety, or security).

EXPECTED OUTPUT: *Modification analysis report and problem analysis report [MF].*

5.8.3.2 Problem verification

The maintainer shall reproduce or verify the problem.

EXPECTED OUTPUT: *Modification analysis report and problem analysis report [MF].*

5.8.3.3 Development of options for modifications

Based upon the analysis, the maintainer shall develop options for implementing the modification.

EXPECTED OUTPUT: *Modification analysis report and problem analysis report [MF].*

5.8.3.4 Documentation of problem, analysis and implementation

The maintainer shall document the problem or the modification request, the analysis results and implementation options in the problem analysis report or in the modification analysis report respectively..

EXPECTED OUTPUT: *Modification analysis report and problem analysis report [MF].*

5.8.3.5 Customer approval of selected modification options

The maintainer shall obtain approval for the selected modification option in accordance with procedures agreed with the customer.

5.8.4 Modification implementation

5.8.4.1 Analysis and documentation of product modification

The maintainer shall conduct and document an analysis to determine which documentation, software units, and their versions shall be modified.

EXPECTED OUTPUT: *Modification identification [MF].*

5.8.4.2 Documentation of software product changes

All changes to the software product shall be documented in accordance with the procedures for document control and configuration management.

5.8.4.3 Invoking of software engineering process for modification implementation

The maintainer shall enter the software engineering process (subclause 4.2) to implement the modifications and consider the following:

- Test and evaluation criteria for testing and evaluating the modified and the unmodified parts (software units, components, and configuration items) of the system shall be defined and documented.
- The complete and correct implementation of the new and modified requirements shall be ensured.
- It also shall be ensured that the original, unmodified requirements were not affected.
- The test results shall be documented.

5.8.5 Inflight modification

5.8.5.1 Definition of inflight modification capability for flight software

The customer shall specify the requirements to perform software modifications inflight, when this capability is identified for space segment software.

NOTE Due to the long lifetime often encountered with space segment software, special requirements also exist to ensure that the supporting tools (e.g. compilers, engineering tools and inflight modification tools) can support the in-orbit reprogramming during the specified lifetime.

EXPECTED OUTPUT: *Requirements for inflight modification capabilities [RB; SRR].*

5.8.5.2 Definition of functional and performance requirements for inflight modification

When inflight modification is specified for space segment software , the supplier shall perform analysis of the specific implications for the software design and validation processes and include the necessary functional and performance requirements in the technical specification and the corresponding design in the software architectural design.

EXPECTED OUTPUT: a. *Specifications for inflight software modifications [TS; PDR];*

b. *Design for inflight modification [DDF; PDR].*

5.8.6 Maintenance review and acceptance

a. The maintainer shall conduct joint reviews with the organization authorizing the modification to determine the integrity of the modified system.

EXPECTED OUTPUT: *Baseline for changes [MF].*

b. Upon successful completion of the reviews, a baseline for the change shall be established.

EXPECTED OUTPUT: *Baseline for changes [MF].*

5.8.7 Software migration

5.8.7.1 Applicability of this Standard to software migration

If a system or software product (including data) is migrated from an old to a new operational environment, it shall be ensured that any software product or data produced or modified during migration conform to this Standard.

5.8.7.2 Migration planning and execution

A migration plan shall be developed, documented, and executed, including the following items:

- requirements analysis and definition of migration;
- development of migration tools;
- conversion of software product and data;
- migration execution;
- migration verification;
- support for the old environment in the future;
- operator involvement in the activities.

EXPECTED OUTPUT: *Migration plan [MF].*

5.8.7.3 Contribution to the migration plan

The maintainer shall contribute to the migration plan and justification including the following items:

- statement of why the old environment is no longer to be supported;
- description of the new environment with its date of availability;
- description of other support options available, once support for the old environment has been removed;
- the date as of which the transition takes place.

EXPECTED OUTPUT: *Migration plan [MF].*

5.8.7.4 Preparation for migration

Parallel operations of the old and new environments can be conducted for smooth transition to the new environment. During this period, training shall be provided and specified in the operational plan.

5.8.7.5 Notification of transition to migrated system

a. When the scheduled migration takes place, notification shall be sent to all concerned.

b. All associated old environment's documentation, logs, and code shall be placed in archives.

5.8.7.6 Post-operation review

a. A post-operation review shall be performed to assess the impact of changing to the new environment.

b. The results of the review shall be sent to the appropriate authorities for information, guidance, and action.

5.8.7.7 Maintenance and accessibility of data of former system

Data used by or associated with the old environment shall be accessible in accordance with the requirements for data protection and audit applicable to the data.

5.8.8 Software retirement

5.8.8.1 Retirement planning

Upon customer's request to retire a software product, a retirement plan to remove active support by the operator and maintainer shall be developed, documented and executed, considering the following items:

- cessation of full or partial support after a certain period of time;
- archiving of the software product and its associated documentation;
- responsibility for any future residual support issues;
- transition to the new software product;
- accessibility of archive copies of data.

EXPECTED OUTPUT: *Retirement plan [MF].*

5.8.8.2 Notification to the operator of retirement plan

Notifications of the retirement plan and activities shall be provided to the operator, including the following items:

- description of the replacement or upgrade with its date of availability;
- statement of why the software product is no longer to be supported;
- description of other support options available, once support is removed.

EXPECTED OUTPUT: *Retirement notification to operator [MF].*

5.8.8.3 Identification of requirements for software retirement

Parallel operations of the retiring and the new software product can be conducted for smooth transition to the new system. During this period, user training shall be provided as specified in the contract.

5.8.8.4 Maintenance and accessibility to data of the retired product

Data used by or associated with the retired software product shall be accessible in accordance with the contract requirements for data protection and audit applicable to the data.

5.9 Software verification and validation (supporting) processes

5.9.1 Introduction

These verification and validation processes may be executed with varying degrees of independence. The degree of independence may range from the same person, or different person in the same organization, to a person in a different organization, with varying degrees of separation. In the case where the processes are executed by an organization independent of the supplier, it is called Independent Software Verification and Validation (ISVV); or Independent Software Validation (ISV), if only the Validation Process is independent.

The following subclauses are intended to be invoked by other parts of this Standard. For this reason the output destination is not noted explicitly.

NOTE The supplier process verification evaluation is handled as part of the ECSS management and is therefore not covered as part of the software activities (tailoring of ISO/IEC 12207:1995 subclause 6.4.2.2).
In addition, ECSS-Q standards provide requirements related to the supplier process assessment which are not repeated in this Standard.

The software verification and validation engineering processes consist of:

- verification process implementation,
- validation process implementation,
- verification activity,
- validation activity, and
- joint technical reviews process.

5.9.2 Verification process implementation

5.9.2.1 Determination of the verification effort for the project

a. A determination shall be made concerning the verification effort and the degree of organizational independence.

EXPECTED OUTPUT: *Software verification plan - organizational independence and effort identification.*

b. Applicability of ECSS-M-00A clause 6.3 (management of risks), and ECSS-Q-80B subclauses 6.2.2 (software dependability and safety) and 6.2.6.14 (independent software verification and validation) shall be checked.

EXPECTED OUTPUT: *Software verification plan - identification of risks and level of independence.*

c. The project requirements shall be analysed for criticality. Criticality shall be gauged in terms of:

- the potential of an undetected error in a system or software requirement for causing death or personal injury, mission failure, or financial or catastrophic equipment loss or damage;
- the maturity of and risks associated with the software technology to be used;
- availability of funds and resources.

EXPECTED OUTPUT: *Software verification plan - criticality and resources identification.*

5.9.2.2 Establishment of the verification process, methods and tools

a. A verification process shall be established to verify the software products.

EXPECTED OUTPUT: *Software verification plan - verification process identification.*

b. Target life cycle activities and software products needing verification shall be determined based upon the scope, magnitude, complexity, and criticality analysis mentioned in 5.9.2.1 c.

EXPECTED OUTPUT: *Software verification plan - software products identification.*

c. Verification activities and tasks defined in subclause 5.9.4, including associated methods, techniques, and tools for performing the tasks, shall be selected for the target life cycle activities and software products.

EXPECTED OUTPUT: *Software verification plan - methods and tool.*

5.9.2.3 Selection of the organization responsible for conducting the verification

a. If the project warrants an independent verification effort, a qualified organization responsible for conducting the verification shall be selected.

EXPECTED OUTPUT: *Independent verification organization selection*

b. This organization shall be assured of the independence and authority to perform the verification activities.

> NOTE ECSS-Q-80B subclause 6.2.6.14 (independent software verification and validation), ECSS-M-00A subclause 7.2.3 and ECSS-M-20 (project organization) contain further requirements relevant for this subclause.

AIM: A coherent and consistent approach to project organization within each project.

EXPECTED OUTPUT: *Appropriate element of project requirements documents dealing with project organization.*

5.9.2.4 Development and documentation of a verification plan covering the software verification activities

Based upon the verification tasks as determined, a verification plan shall be developed and documented, addressing the following items:

- the life cycle activities and software products subject to verification;
- the required verification tasks for each life cycle activity, software product, related resources, responsibilities, and schedule;
- the procedures for forwarding verification reports to the customer and other involved organizations.

EXPECTED OUTPUT: *Software verification plan - organization and activities.*

5.9.3 Validation process implementation

5.9.3.1 Determination of the validation effort for the project

The validation effort and the degree of organizational independence of that effort shall be determined, coherent with ECSS-Q-80B subclause 6.3.4.2.

EXPECTED OUTPUT: *Software validation plan - effort and independence.*

5.9.3.2 Establishment of a validation process

a. The validation process shall be established to validate the software product,

EXPECTED OUTPUT: *Software validation plan - validation process identification.*

b. Validation tasks defined in subclause 5.9.5, including associated methods, techniques, and tools for performing the tasks, shall be selected.

EXPECTED OUTPUT: *Software validation plan - methods and tools.*

5.9.3.3 Selection of a validation organization

a. If the project warrants an independent validation effort, a qualified organization responsible for conducting the effort shall be selected.

EXPECTED OUTPUT: *Independent software validation plan-organization selection.*

b. The conductor shall be assured of the independence and authority to perform the validation tasks.

EXPECTED OUTPUT: *Independent software validation plan-level of independence.*

c. This subclause shall be applied with ECSS-M-00A subclause 7.2.3 and ECSS-Q-80B, subclause 6.3.4.21.

EXPECTED OUTPUT: *Appropriate element of project requirements documents dealing with project organization.*

5.9.3.4 Development and documentation of a validation plan

A validation plan shall be developed and documented, including, as a minimum the following:

- items subject to validation;
- validation tasks to be performed;
- resources, responsibilities, and schedule for validation;
- procedures for forwarding validation reports to the customer and other parties.

EXPECTED OUTPUT: *Software validation plan - organization and activities.*

5.9.4 Verification activity

5.9.4.1 Verification of software requirements

The software requirements shall be verified considering the criteria listed below:

- software requirements are traceable to system partitioning and system requirements;
- software requirements are externally and internally consistent (not implying formal proof consistency);
- software requirements are verifiable;
- feasibility of software design;
- feasibility of operations and maintenance;
- the software requirements related to safety, security, and criticality are correct as shown by suitably rigorous methods.

EXPECTED OUTPUT: *a. Requirements traceability matrices;*

b. Requirements verification report.

5.9.4.2 Verification of the software architectural design

The software architectural design shall be verified considering the criteria listed below:

- external consistency with the requirements of the software item;
- internal consistency between the software components;
- traceability from the requirements to the software item;
- feasibility of producing a detailed design;
- feasibility of operations and maintenance;
- the design is correct with respect to the requirements and the interfaces;
- the design implements proper sequence of events, inputs, outputs, interfaces, logic flow, allocation of timing and sizing budgets, and error definition, isolation and recovery;
- the chosen design can be derived from requirements;
- the design implements safety, security and other critical requirements correctly as shown by suitable rigorous methods.

EXPECTED OUTPUT: *a. Software architectural design to requirements traceability matrices;*

b. Software architectural design and interface verification report.

5.9.4.3 Verification of the software detailed design

The software detailed design shall be evaluated in accordance with the criteria listed below:

- traceability to the architectural design of the software item;
- external consistency with architectural design;
- internal consistency between software components and software units;
- feasibility of testing;
- feasibility of operation and maintenance;
- the design is correct with respect to requirements and interfaces;
- the design implements proper sequence of events, inputs, outputs, interfaces, logic flow, allocation of timing and sizing budgets, and error definition, isolation, and recovery;
- the chosen design can be derived from requirements;
- the design implements safety, security, and other critical requirements correctly as shown by suitable rigorous methods.

EXPECTED OUTPUT: a. *Detailed design traceability matrices;*

b. *Detailed design verification report.*

5.9.4.4 Verification of code

The code shall be verified considering the criteria listed below:

- the code is traceable to design and requirements, testable, correct, and in conformity to software requirements and coding standards;
- the code implements proper event sequence, consistent interfaces, correct data and control flow, completeness, appropriate allocation timing and sizing budgets, and error definition, isolation, and recovery;
- the chosen code can be derived from design or software requirements;
- the code implements safety, security, and other critical requirements correctly as shown by suitable rigorous methods;
- external consistency with the requirements and design of the software item;
- internal consistency between software units;
- test coverage of units;
- feasibility of software integration and testing;
- feasibility of operation and maintenance.

EXPECTED OUTPUT: a. *Software code traceability matrices;*

b. *Software code verification report.*

5.9.4.5 Verification of software integration

a. The software integration shall be verified considering that the software components and units of each software item are completely and correctly integrated into the software item.

EXPECTED OUTPUT: *Software integration verification report.*

b. In addition, the supplier shall evaluate software integration test plan, design, code, tests, test results and software user manual, considering the criteria specified below:

  - external consistency with system requirements;
  - traceability to software architectural design;
  - internal consistency;
  - interface testing coverage;
  - requirements test coverage;

- conformance to expected results;
- feasibility of software validation testing;
- feasibility of operation and maintenance.

EXPECTED OUTPUT: *Software integration verification report.*

5.9.4.6 Verification of software documentation

The documentation shall be verified considering the criteria listed below:

- the documentation is adequate, complete, and consistent;
- documentation preparation is timely;
- configuration management of documents follows specified procedures.

EXPECTED OUTPUT: *Software documentation verification report.*

5.9.4.7 Evaluation of test specifications

Test requirements, test cases, and test specifications shall demonstrate the coverage of all software requirements of the technical specification or the requirements baseline.

EXPECTED OUTPUT: *a. Traceability of the requirements baseline to the validation tests;*

b. Traceability of the technical specifications to the validation tests.

5.9.4.8 Verification of software validation with respect to the technical specifications and the requirements baseline

The validation tests shall be verified considering the criteria listed below:

- test coverage of the requirements of the software item;
- conformance to expected results;
- feasibility of system integration and testing, if conducted;
- feasibility of operation and maintenance.

EXPECTED OUTPUT: *Test results evaluation.*

5.9.4.9 Problem and nonconformance handling

a. Problems and nonconformances detected by the software verification effort shall be entered into the problem resolution process (ECSS-Q-80B subclauses 5.3.5 and 5.3.6).

EXPECTED OUTPUT: *Problem and nonconformance reports.*

b. All problems and nonconformances shall be resolved.

EXPECTED OUTPUT: *Problem and nonconformance report.*

c. Results of the verification activities shall be made available to the customer and other involved organizations.

EXPECTED OUTPUT: *Problem and nonconformance report.*

5.9.5 Validation activity

5.9.5.1 Development and documentation of a software validation testing specification

a. The supplier shall develop and document, for each validation requirement of the software item, a set of tests, test cases (inputs, outputs, test criteria), and test procedures for conducting software validation testing, ensuring that the integrated software item is ready for software validation testing.

EXPECTED OUTPUT: *Software validation testing specification.*

b. The supplier shall evaluate the test specifications in accordance with subclause 5.9.4.6.

EXPECTED OUTPUT: *Software documentation verification report.*

5.9.5.2 Conducting the validation tests

The validation tests shall be conducted as specified in the output of subclause 5.9.5.1 above, including:

- testing with stress, boundary, and singular inputs;
- testing the software product for its ability to isolate and minimize the effect of errors; that is graceful degradation upon failure, request for operator assistance upon stress, boundary and singular conditions;
- testing that the software product can perform successfully in a representative operational environment.

EXPECTED OUTPUT: *Validation testing report.*

5.9.5.3 Evaluation of the design, code, tests, test results, and software user manual

The supplier shall evaluate the design, code, tests, test results, and software user manual in accordance with the criteria listed below:

- test coverage of the requirements of the software item;
- conformance to expected results;
- feasibility of system integration and testing, if conducted;
- feasibility of operation and maintenance.

EXPECTED OUTPUT: *Software design and test evaluation report.*

5.9.5.4 Updating the software user manual

The supplier shall update the software user manual.

EXPECTED OUTPUT: *Software user manual (update).*

5.9.5.5 Problem and nonconformance handling

a. Problems and nonconformances detected during the validation shall be the subject of a problem resolution process (ECSS-Q-80B subclauses 5.3.5 and 5.3.6).

EXPECTED OUTPUT: *Problem and nonconformance report.*

b. All problems and nonconformances shall be resolved.

EXPECTED OUTPUT: *Problem and nonconformance report.*

c. Results of the validation activities shall be made available to the customer and other involved organizations.

EXPECTED OUTPUT: *Problem and nonconformance report.*

5.9.5.6 Test readiness review

Test readiness reviews, as established in subclause 5.9.6, joint technical review process, shall be held before the commencement of key test activities.

EXPECTED OUTPUT: *Technical review report.*

5.9.6 Joint technical review process

5.9.6.1 Introduction

The joint review process is a process for evaluating the status and products of an activity of a project as appropriate. Joint reviews shall be held throughout the life cycle of the software. This process may be employed by both parties, where one party (reviewing party) reviews another party (reviewed party).

5.9.6.2 Support to software reviews

The software support of to joint technical reviews shall be related to project phasing and planning (refer to ECSS-M-30). Therefore software shall undergo the overall software milestone reviews SRR, PDR, CDR, QR and AR as a minimum. The supplier shall support any further reviews requested by the customer.

NOTE Internal reviews can be replaced by inspections.

EXPECTED OUTPUT: *Milestone review reports.*

5.9.6.3 Technical reviews

a. Technical reviews (including milestone reviews) shall be held to evaluate the software products or services under consideration and provide evidence that:

- they are complete;
- they conform to applicable standards and specifications;
- changes are properly implemented and affect only those areas identified by the configuration management process;
- they adhere to applicable schedules;
- they are ready for the next activity;
- the development, operation, or maintenance is being conducted according to the plans, schedules, standards, and guidelines laid down for the project.

EXPECTED OUTPUT: *Technical review reports.*

b. Reviews shall be planned of each identified software product within its defined software life cycle according to the criteria above.

EXPECTED OUTPUT: *Technical review reports.*

6

Special requirements

6.1 Introduction

This clause 6 defines the specific requirements for engineering of computer software for space systems. They are special in the sense that they apply only where the software engineering disciplines or technologies identified in this clause are exploited in the project.

6.2 Space segment software

6.2.1 Introduction

The space segment software calls for special engineering requirements, due to the highly specialized environment and because the software implements functions that directly relate to space system dependability.

The requirements are presented specifying which is the general activity that contains them.Detailed software engineering guidelines for space segment software are found in ECSS-E-40-01

6.2.2 System level integration of software: system observability

6.2.2.1 System observability requirements definition

Observability data shall include the data for the system observability and shall take into account the constraints imposed by the computer such as the bandwidth allocation and the overloading of the processor.

NOTE 1 The general requirement for software observability data intends to facilitate the software integration or the software trouble shooting. Purpose of space on-board software is generally to access or control (in a reactive or interactive way) some hardware, whose visibility is also important.

NOTE 2 Observability requirements can impair the performance requirements (e.g. computer throughput, bandwidth, and ground exploitation rate of telecommands). This has an impact when specifying the observability requirements (e.g. considering the need of oversampling).

EXPECTED OUTPUT: *System observability requirements [RB; SRR].*

6.2.2.2 Software observability data definition

The customer shall specify the system observability data individually to be completed by the supplier later in the technical specification

EXPECTED OUTPUT: *System observability requirements [RB; SRR].*

6.2.2.3 Criteria to define observability requirements

When specifying the observability requirements, the customer shall trade off the software visibility with the risk of activating undesirable code on-board.

NOTE The software observability requirements, considered only during the integration, and not during flight, can result into some deactivated code.

EXPECTED OUTPUT: *System observability requirements [RB; SRR].*

6.2.3 System level integration of software: system database

The customer shall specify a system database to ensure the consistency of common data, considering the following additional aspects:

- Specification of the system database use for the supplier. For instance, the database may be used to produce automatically configured software (e.g. generation of tables, constant data, initial values).
- Specification of the system database size, the possible modification that can be foreseen after the acceptance review, and the accepted impact in terms of software maintenance.

EXPECTED OUTPUT: *System database specification (content and use) [RB; SRR].*

6.2.4 Software lifecycle: detailed design review

6.2.4.1 Detailed design review planning

At the end of the detailed design, the software supplier shall hold a detailed design review (DDR) with the customer.

AIM: — Review the detailed design.

— Review the software technical budget status (e.g. CPU and memory).

— Review the completeness and stability of the technical specification requirements. This DDR objective can be implemented in case of evolution of technical specification requirements after the PDR.

EXPECTED OUTPUT:

a. Customer approval of the design definition file (software architectural design, detailed design) [DDF; DDR];

b. Customer approval of the design of software interface and the software integration test plan [DJF; DDR];

c. Customer approval of the margins and technical budget status [DJF; DDR];

d. Customer approval of the updated technical specifications [TS; DDR].

6.2.4.2 CDR plan for flight software

In order to avoid that software items are subject to several reviews, the software elements defined in the general requirements for review at CDR, but actually reviewed at DDR, shall be removed from the CDR list.

EXPECTED OUTPUT: *Revised CDR outputs in the software development plan [MGT; SRR, PDR].*

6.2.5 Software requirements analysis: logical model

6.2.5.1 Definition of a software logical model

The supplier shall construct a logical model of the functional requirements of the software product.

NOTE 1 The logical model can be the result of an iterative verification process with the customer.It also supports the requirements capture, documents and formalizes the software requirements.

NOTE 2 A logical model is a representation of the technical specification, independent from the implementation, written with a formalized language and it can be possibly executable. Formal methods can be used to prove properties of the logical model itself and therefore of the technical specification. The logical model allows in particular to verify a technical specification is complete (i.e. by checking a software requirement exists for each logical model element), and consistent (because of the model checking).
The logical model can be completed by specific feasibility analyses such as benchmarks, in order to check the technical budgets (e.g. memory size and computer throughput). In case the modelling technique allows for it, preliminary automatic code generation can be used to define the contents of the software validation test specification.

EXPECTED OUTPUT: *Software logical model [TS; PDR].*

6.2.5.2 Definition of behavioural view for space reactive software

For space reactive software, the logical model shall include a behavioural view.

NOTE Space reactive software is defined as a software that fulfils the following characteristics:
- it is real-time software;
- it runs remotely;
- it manages closely a specific limited target computer;
- it controls a potentially long living system with visibility limitation into an hostile environment;
- it drives its own availability and reliability.

EXPECTED OUTPUT: *Behavioural view in software logical model for space reactive software [TS; PDR].*

6.2.5.3 Man-machine interface (MMI) prototype for interactive software

For interactive software, the logical model shall be associated with a prototype of the man-machine interface (see 6.5.4)

NOTE Space interactive software is defined as a software that fulfils the following characteristics:
- generally it is not real-time, although there can be some real-time connection from the laptop to the environment;
- it is loaded into the processor from a external device (e.g. a disk, a floppy);
- It does not manage the hardware. It uses a general-purpose platform with extendable resources as a mean to execute;
- It is generally intended to control experiments whose lifetime is in the range from hours to one year;
- It has a graphical user interface;
- As space software, space interactive software runs into a hostile environment (radiation).

EXPECTED OUTPUT: *MMI prototype [TS; PDR].*

6.2.6 Verification of software requirements: feasibility of design and operation

6.2.6.1 Schedulability analysis

The supplier shall use an analytical model to perform a schedulability analysis and prove that the design is feasible.

NOTE The schedulability analysis proves that the real-time behaviour is predictable, i.e. that all the tasks complete before their deadline in the worst case condition.

EXPECTED OUTPUT: *Schedulability analysis [DJF; PDR].*

6.2.6.2 Technical budgets management

The technical budget (memory size, and CPU utilization) shall be monitored:

a. The memory size shall be estimated for static code size, static data size and stack size.

EXPECTED OUTPUT: *Technical budgets -Memory estimation [DJF; PDR].*

b. The CPU utilization shall be estimated.

EXPECTED OUTPUT: *Technical budgets -CPU estimation [DJF; PDR].*

6.2.6.3 Software behaviour modelling and verification techniques

The software behaviour shall be verified using the behavioural view of the logical model produced in subclause 6.2.5.2.

EXPECTED OUTPUT: *Software behaviour verification [DJF; PDR].*

6.2.6.4 Design feasibility demonstration

Modelling or simulation shall be used to prove the feasibility of the design, if no analytical model exists.

EXPECTED OUTPUT: *Design feasibility verification with models or simulation [DJF; PDR].*

6.2.7 Software architectural design: static and dynamic architecture

6.2.7.1 Software architectural design contents

The software architectural design shall describe:

- the static architecture (i.e. decomposition into software elements such as packages and classes or modules),
- the dynamic architecture, which involves active objects such as threads, tasks and processes,
- the mapping between the static and the dynamic architecture, and
- the software behaviour.

EXPECTED OUTPUT: *a. Software static architecture [DDF; PDR];*

b. Selected analysable computational model [DDF; PDR];

c. Software dynamic architecture [DDF; PDR];

d. Software behaviour [DDF; PDR].

6.2.7.2 Software design method

A method (e.g. object oriented or functional) shall be used to produce the static architecture including:

- software elements, and their interfaces, and

- software elements relationships,

6.2.7.3 Selection of a computational model

a. The dynamic architecture design shall select an analysable computational model and shall be described accordingly.

EXPECTED OUTPUT: *Computational model [DDF; PDR].*

b. Scheduling simulations shall be performed.

EXPECTED OUTPUT: *Scheduling simulation report [DJF; PDR].*

6.2.7.4 Description of software dynamic behaviour

The software architecture design shall also describe the dynamic behaviour of the software, for instance by means of description techniques based on automata and scenario or techniques used for the behavioural view of the logical model (see subclause 6.2.5.2).

EXPECTED OUTPUT: *Software dynamic behaviour[DDF; PDR].*

6.2.8 Design of software items: physical model

6.2.8.1 Production of software items physical model

The software design shall produce the physical model of the software items described during the software architectural design.

NOTE The physical model includes the static design, the dynamic design, the mapping between the static and the dynamic views, and the behaviour of the software elements.

EXPECTED OUTPUT: *a. Software static design [DDF; DDR, CDR];*

b. Software dynamic design [DDF; DDR, CDR];

c. Software elements behaviour [DDF; DDR, CDR];

d. Compatibility of design methods with the computational model [DDF; DDR,CDR].

6.2.8.2 Utilization of methods for software static design

A design method (e.g. object oriented or functional method) shall be used to produce the static design including:

- software elements and their interfaces, and
- software elements relationships.

6.2.8.3 Description of the dynamic aspects of physical model

a. The dynamic design shall be based on the computational model selected during the software architectural design and shall describe the dynamic aspect of the physical model accordingly.

EXPECTED OUTPUT: *Software dynamic design [DDF; DDR, CDR].*

b. Scheduling simulations shall be performed.

EXPECTED OUTPUT: *Scheduling simulation report [DJF; DDR, CDR].*

6.2.8.4 Utilization of description techniques for the software behaviour

The software design shall also describe the dynamic behaviour of the software elements, for instance by means of description techniques based on automata and scenario or techniques used for the behavioural view of the logical model (see subclause 6.2.5.2)

EXPECTED OUTPUT: *Dynamic behaviour [DDF; DDR, CDR].*

6.2.8.5 Determination of design methods consistency

In some cases, several design methods can be used for different items of the same software. In this case, special care shall be dedicated to check that all the utilized methods are, from a dynamic stand-point, consistent between themselves and consistent with the selected computational model.

EXPECTED OUTPUT: *Compatibility of design methods with the computational model [DDF; DDR, CDR].*

6.2.9 Verification of design: feasibility of operation

6.2.9.1 Schedulability analysis refinement

The schedulability analysis performed during the software architectural design shall be refined on the basis of the detailed design documentation.

EXPECTED OUTPUT: *Schedulability analysis (update) [DJF; CDR].*

6.2.9.2 Technical budgets management

The technical budget (e.g., memory size, and CPU utilization) shall be monitored:

a. The memory size shall be refined for static code size, static data size and stack size expressed on a thread basis, measuring them per terminal design objects.

EXPECTED OUTPUT: *Technical budgets (update) - Memory size [DJF; CDR].*

b. The CPU utilization shall be refined considering the worst case execution time of each terminal active object (therefore including the call to the protected objects).

> NOTE The worst case execution time of each terminal active object is multiplied by the number of times the object is executed per second. The resulting quantity is summed over all non-terminal objects. The result is the estimated percentage processor utilization.

EXPECTED OUTPUT: *Technical budgets (update) - CPU utilization [DJF; CDR].*

6.2.9.3 Behavioural model verification

Software behaviour shall be modelled and verified by means of the techniques used in subclause 6.2.8.4.

EXPECTED OUTPUT: *Software behaviour verification [DJF; CDR].*

6.2.10 Verification of design: feasibility of testing

The evaluation of testing feasibility shall check the following aspects:

- Appropriate verification points are identified and included in the detailed design in order to prepare the effective testing of the performance requirements.
- Assertions defining computational invariant properties, or temporal properties (possibly derived from the behavioural model) are added within the design.
- Capability of fault injection.

EXPECTED OUTPUT: *Testing feasibility report [DJF; CDR].*

6.2.11 Verification of coding and testing: feasibility of operation

6.2.11.1 Schedulability analysis refinement

The schedulability analysis performed during detailed design shall be refined with the actual information extracted from the code.

EXPECTED OUTPUT: *Schedulability analysis (update) [DJF; CDR].*

6.2.11.2 Technical budget update

The technical budget shall be updated with the measured values and shall be compared to the margins.

EXPECTED OUTPUT: *Technical budgets (update) [DJF; CDR].*

6.2.12 Evaluation of validation: complementary system level validation

The supplier shall identify the requirements of the technical specification and the requirements baseline that cannot be tested on its own environment, and shall forward to the customer a request to validate them on the real system.

NOTE Some of the requirements cannot be verified because the test environment used for the validation does not allow it. These requirements can be only tested when the software is integrated within the system (e.g. satellite, launcher).

EXPECTED OUTPUT: *Complement of validation at system level [DJF; AR].*

6.2.13 Maintenance: long term maintenance

a. The maintenance plan shall take into account the spacecraft lifetime.

EXPECTED OUTPUT: *Maintenance plan [MF].*

b. If this lifetime goes after the expected obsolescence date of the software engineering environment, then the maintainer shall propose solutions to be able to produce and upload modifications to the spacecraft up to its end of life.

EXPECTED OUTPUT: *Long term maintenance solutions [MF].*

6.3 Ground segment software

No special requirements concerning the software engineering processes are identified at this level. Detailed software engineering guidelines for ground segments are found in ECSS-E-40-03.

6.4 Software reuse

6.4.1 Introduction

The following subclauses are applicable in the software engineering process for projects where:

- it is intended to reuse the software products being developed for other space projects;
- it is intended to reuse software products from other space projects and third-party "commercial off-the-shelf" are intended to be part of the software product.

6.4.2 Developing software for intended reuse

6.4.2.1 Definition of constraints for software to be reused

The customer shall specify the special constraints that apply for the development, to enable future reuse of the software.

NOTE When the customer requires reuse of developed software components, he specifies the generic application domain of these components. This can for example include requirements on software architecture for given target computers and operating systems, the interfaces required for reuse and the level where reuse is required (e.g. function, sub-system, and code modules).

EXPECTED OUTPUT: *Requirements for 'design for reuse' [RB; SRR].*

6.4.2.2 Definition of methods and tools for software to be reused

The supplier shall define procedures, methods and tools for reuse, and apply these to the software engineering processes to comply with the reusability requirements for the software development.

EXPECTED OUTPUT: *Software for intended reuse - justification of methods and tools [DJF; PDR].*

6.4.2.3 Evaluation of potential reuse of software

An evaluation of the reuse potential of the software shall be performed at PDR and CDR.

EXPECTED OUTPUT: *Software for intended reuse - evaluation of reuse potential [DJF; PDR, CDR].*

6.4.3 Reuse of pre-developed software

6.4.3.1 Analysis of potential reusability

The analysis of the potential reusability of existing software components shall be performed through:

- identification of the re-use components with respect to the functional requirements baseline, and
- a quality evaluation of these components, invoking ECSS-Q-80B subclause 6.2.6.

  NOTE There are no special requirements concerning the verification and validation requirements for reused software. The requirements are the same as for software developed without reuse. The difference is that some already existing verification and validation plans and results can be available with the reused products. However, the full verification validation and validation verification requirement apply to reused software as for any other part of the software development.

EXPECTED OUTPUT: *Justification of reuse with respect to requirements baseline in the software reuse file [DJF; PDR].*

6.4.3.2 Software acquisition process implementation

The supplier shall implement the software acquisition process for reused software, and document the process in the software development plan, as described in the ECSS-Q-80B subclause 6.2.7.

EXPECTED OUTPUT: *Software acquisition process implementation in the software development plan [MGT; SRR, PDR].*

6.5 Man-machine interfaces

6.5.1 Introduction

Software projects which include the development of a significant interactive direct interface to a human user or operator, lead to the involvement of the specialized software engineering and human factors disciplines covering this field and the requirements of this subclause 6.5 are applicable.

The reason for the special subclauses is that modern MMI technology (e.g. graphical user interfaces, and multi-layered choice menus), is not feasible to specify or design using conventional software engineering documentation methods. The non-linear and multi-dimensional nature of modern MMI cannot be described adequately only using two-dimensional documents that by nature are linear in structure. This is very similar to other systems with significant human factors requirements, such as cars, airplanes, and buildings. In those cases a mock-up or model is implemented during the requirements engineering. An analogous approach in software engineering applies for software with extensive human interaction requirements.

For any MMI development a scenario driven requirements analysis can be performed. The term MMI used in the following subclauses also includes customization of COTS supplied MMI.

6.5.2 Establishment of the need for a MMI mock-up

For software with interface to human operators, the customer shall, based on the complexity and requirements of the MMI, determine if a software mock-up of the MMI is requested to support the requirements engineering processes.

EXPECTED OUTPUT: *MMI software mock-up requirements [RB; SRR].*

6.5.3 MMI standards and guidelines definition

The customer shall determine if general MMI standards or guidelines shall be applicable to the software project and include these requirements in the requirements baseline.

AIM: To ensure that appropriate guidelines, and style-guides are selected for projects in cases where, for example, a common MMI style and functionality applies for several suppliers' products.

EXPECTED OUTPUT: *MMI general requirements and guidelines [RB; SRR].*

6.5.4 MMI software mock-up development

a. The supplier shall develop a software mock-up to support the requirements engineering process, in accordance with customer's requirements.

EXPECTED OUTPUT: *MMI specifications for software [TS; PDR].*

b. The supplier shall use the mock-up to prototype the specifications of man-machine interfaces for the software, such that MMI specifications are consolidated and evaluated with respect to human factors and use.

AIM: The aim of this subclause includes:

— proper considerations of human factors,

— that the man-machine interface reach an acceptable state of definition during requirements engineering activities, and

— that the technical performance of the man-machine interface is verified.

NOTE Depending on the nature of the project, the supplier can opt to later upgrade the software mock-up of the MMI to become part of the final software product. However, unless the mock-up is later upgraded to become part of the final product tree, the mock-up needs not to be a formal delivery to the customer.

EXPECTED OUTPUT: *Report on evaluation of MMI specifications using a software mock-up [DJF; PDR].*

c. The customer shall ensure that end-users, or their representatives, participate in the MMI mock-up evaluation.

6.6 Critical software

For critical software ECSS-Q-80 applies.

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Annex A (normative)

Software documentation

A.1 Introduction

This annex defines the contents of the software documents to be produced. The contents are defined by the outputs of the clauses in this standard, and the list of the outputs for each milestone of the project is provided below. The detailed structure of the software documents (e.g. table of contents, number of volumes) are not defined here, but left open to be determined by the size and nature of the individual software projects. The overall structure is given in Figure A-1.

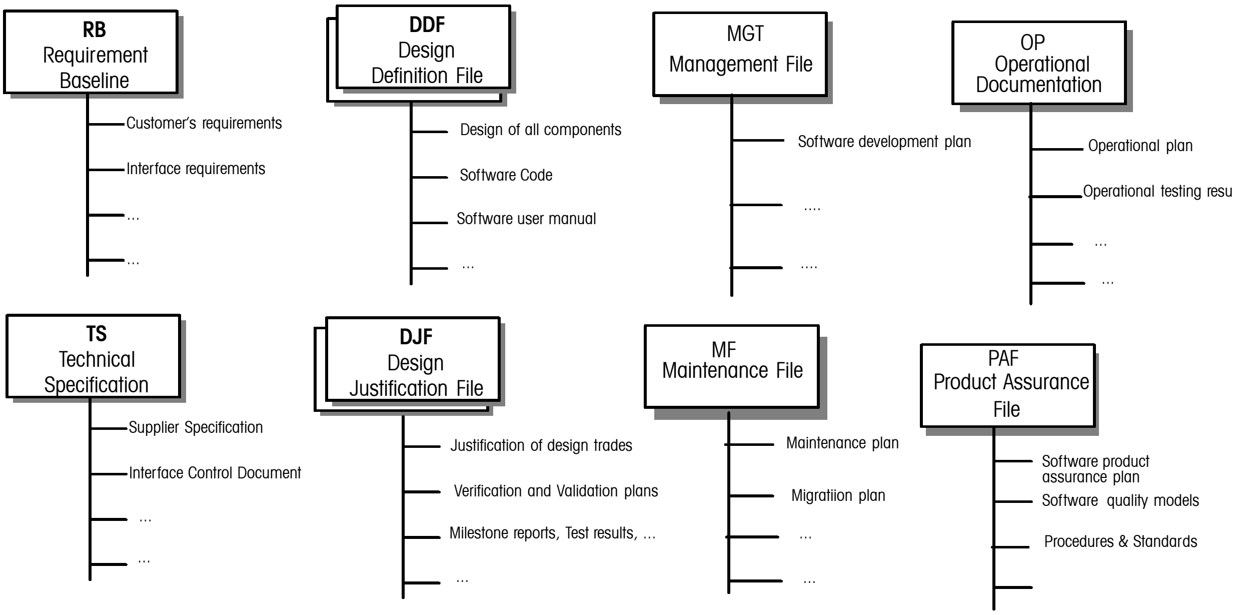

Figure A-1: Overview of software documents

The following convention is used in this annex to, uniquely, identify the expected outputs referenced in Clauses 5 & 6 of this Standard: w.x.y.zindex1-index2 where w.x.y.z is the subclause reference identifier(e.g. 5.4.4.1, 6.2.4.1, or 5.5.1), index1 is used to distinguish an identified separated requirement in a subclause (reulting e.g. from a split of a subclause into several requirements), index2 is used to identify its associated outputs (in case where there is several outputs for a w.x.y.zindex1 subclause)

For example :

- E40-5.2.2.1-a denotes the expected output 'a' associated to subclause E40-5.2.2.1,
- E40-5.2.3.2c denotes the expected output associated to subclause 5.2.3.2c, and
- E40-5.2.3.9b-a denotes the expected output 'a' associated to subclause 5.3.2.9b

A.2 Requirements Baseline (RB)

A.2.1 General

The RB expresses the customer's requirements. It is generated by the requirements engineering processes, and it is the primary input to the SRR review process.

The IRD expresses the customer's interface requirements for the software to be produced by the supplier. It shall be produced in all cases where the software product is intended for integration with the customer's hardware or software products. This document is part of the requirements baseline. Depending on the size and nature of the project, the IRD may form separate clauses or separate volumes of the RB.

A.2.2 RB contents at SRR

E40-5.2.2.1-a	Functions and performance requirements of the system [RB; SRR]
E40-5.2.2.1-c	Design constraints and verification and validation requirements [RB; SRR]
E40-5.2.2.1-d	Identification of lower level software engineering standards [RB; SRR]
E40-5.2.2.2	Overall safety and reliability requirements of the software to be produced [RB; SRR]
E40-5.2.3.2c	System partition with definition of items [RB; SRR]
E40-5.2.3.2d	System configuration items list [RB; SRR]
E40-5.2.4.2	Verification and validation process requirements [RB; SRR]
E40-5.2.4.3-a	Functional requirements for support to system and mission level validation [RB; SRR]
E40-5.2.4.3-b	Installation and acceptance requirements of the delivered software product at the operational and maintenance site [RB; SRR]
E40-5.2.4.5	SRR milestone report [RB; SRR]
E40-5.2.5.1	Software observability requirements [RB; SRR]
E40-5.2.5.4	Development constraints [RB; SRR]
E40-5.2.6.2a	Software operations requirements [RB; SRR]
E40-5.2.7	Software maintenance requirements [RB; SRR]
E40-5.3.2.6	Customer approval of requirements baseline [RB; SRR]

E40-5.3.3.2-a	Interface management procedures [RB; SRR]
E40-5.3.3.2-b	Part of configuration management requirements [RB; SRR]
E40-5.3.4.1	Technical budgets and margin philosophy for the project [RB; SRR]
E40-5.8.5.1	Requirements for inflight modification capabilities [RB;SRR]
E40-6.2.2.1	System observability requirements [RB;SRR]
E40-6.2.2.2	System observability requirements [RB; SRR]
E40-6.2.2.3	System observability requirements [RB; SRR]
E40-6.2.3	System database specification (content and use) [RB; SRR]
E40-6.4.2.1	Requirements for "design for reuse" [RB; SRR]
E40-6.5.2	MMI software mock-up requirements [RB; SRR]
E40-6.5.3	MMI general requirements and guidelines [RB; SRR]
Q80-5.6.1	Software acquisition process for COTS, OTS or MOTS [RB; SRR]
Q80-6.2.2.1	Critical function identification and analysis [RB; SRR]

A.2.3 RB contents at PDR

Q80-6.2.2.4	Critical function identification and analysis [RB; PDR, CDR, QR, AR, ORR]

A.2.4 RB contents at CDR

Q80-6.2.2.4	Critical function identification and analysis [RB; PDR, CDR, QR, AR, ORR]

A.2.5 RB contents at QR

Q80-6.2.2.4	Critical function identification and analysis [RB; PDR, CDR, QR, AR, ORR]

A.2.6 RB contents at AR

Q80-6.2.2.4	Critical function identification and analysis [RB; PDR, CDR, QR, AR, ORR]

A.2.7 RB contents at ORR

Q80-6.2.2.4	Critical function identification and analysis [RB; PDR, CDR, QR, AR, ORR]

A.2.8 IRD contents at SRR

E40-5.2.2.1-b.	Interface requirements [IRD(RB); SRR]
E40-5.2.3.2a	Software-hardware interface requirements [IRD(RB); SRR]
E40-5.2.5.2	System level interface requirements [IRD(RB); SRR]
E40-5.2.5.3	System level data interfaces [IRD(RB); SRR]
E40-5.2.5.5	System level integration support products [IRD(RB); SRR]
E40-5.2.5.6	System level integration preparation requirements [IRD(RB); SRR]
E40-5.3.3.1	Interface requirement document [IRD(RB); SRR]

A.3 Technical Specification (TS)

A.3.1 General

The TS contains the supplier's response to the requirements baseline, and is the primary input to the PDR review process.

Depending on the size and nature of the project, the following sub-documents can be separate clauses or separate volumes of the TS.

The ICD is the supplier's response to the IRD, and is part of the TS.

A.3.2 TS contents at PDR

E40-5.3.2.7-a	Technical specification of the software [TS; PDR]
E40-5.3.2.8	Customer approval of technical specification and software architecture [TS, DDF, ICD(TS), DJF; PDR]
E40-5.4.2.1-a	Software requirements specification [TS; PDR] - Functional and performance specifications, including hardware characteristics, and environmental conditions under which the software item executes, including budgets requirements [TS; PDR]
E40-5.4.2.1-b	Software requirements specification [TS; PDR] - Software product quality requirements (see ECSS-Q-80B subclause 7.2) [TS; PDR]
E40-5.4.2.1-c	Software requirements specification [TS; PDR] - Security specifications, including those related to factors which can compromise sensitive information [TS; PDR]
E40-5.4.2.1-d	Software requirements specification [TS; PDR] - Human-factors engineering (ergonomics) specifications, including those related to manual operations, human-equipment interactions, constraints on personnel, and areas requiring concentrated human attention, that are sensitive to human errors and training [TS; PDR]
E40-5.4.2.1-e	Software requirements specification [TS; PDR] - Data definition and database requirements [TS; PDR]
E40-5.4.2.2	Software logical model [TS; PDR]
E40-5.4.2.3	Requirements unique identifier [TS; PDR]
E40-5.4.3.5	Specification of reuse of predeveloped software [TS; PDR]
E40-5.8.5.2-a	Specifications for inflight software modifications [TS; PDR]
E40-6.2.5.1	Software logical model [TS; PDR]
E40-6.2.5.2	Behavioural view in software logical model for space reactive software [TS; PDR]
E40-6.2.5.3	MMI prototype [TS; PDR]
E40-6.5.4a	MMI specifications for software [TS; PDR]
Q80-7.1.1, Q80-7.1.2, Q80-7.1.3.3, Q80-7.2.1.1	Software quality requirements [TS; PDR]

A.3.3 TS contents at DDR

E40‑6.2.4.1‑d	Customer approval of the updated technical specifications [TS; DDR]

A.3.4 ICD contents at PDR

E40‑5.3.2.7‑c	Interface Control Document [ICD(TS); PDR]
E40‑5.3.2.8	Customer approval of technical specification and software architecture [TS, DDF, ICD(TS), DJF; PDR]
E40‑5.4.2.1‑f	Interfaces external to the software item [ICD(TS); PDR]
E40‑5.4.3.4‑a	Preliminary external interfaces design [ICD(TS); PDR]

A.3.5 ICD contents at CDR

E40‑5.5.2.2‑a	External interfaces design (update) [ICD(TS); CDR]

A.4 Design Definition File (DDF)

A.4.1 General

The DDF is a supplier‑generated file that documents the result of the design engineering processes. The DDF is the primary input to the CDR review process and it contains all the documents called for by the design engineering requirements.

A.4.2 DDF contents at SRR

E40‑5.2.3.1a	System design [DDF‑system level; SRR]
Q80‑6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80‑6.2.4.5	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80‑6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR; PDR, CDR, QR, AR, ORR]

A.4.3 DDF contents at PDR

E40‑5.3.2.7‑b	Software architectural design [DDF; PDR]
E40‑5.3.2.8	Customer approval of technical specification and software architecture [TS, DDF, ICD(TS), DJF; PDR]
E40‑5.4.3.1	Software architectural design [DDF; PDR]
E40‑5.4.3.2	Hierarchy, dependency and interfaces of software components in the software architectural design [DDF; PDR]
E40‑5.4.3.3	Process, data and control aspects of software components in the software architectural design [DDF; PDR]
E40‑5.4.3.4‑b	Preliminary internal interfaces design [DDF; PDR]
E40‑5.8.5.2‑b	Design for in–flight modification [DDF; PDR]
E40‑6.2.7.1‑a	Software static architecture [DDF; PDR]
E40‑6.2.7.1‑b	Selected analysable computational model [DDF; PDR]
E40‑6.2.7.1‑c	Software dynamic architecture [DDF; PDR]
E40‑6.2.7.1‑d	Software behaviour [DDF; PDR]
E40‑6.2.7.3a	Computational model [DDF; PDR]

E40-6.2.7.4	Software dynamic behaviour [DDF; PDR]
Q80-6.2.3.5-a	Measures in the design [DDF; PDR, CDR]
Q80-6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.4.6	Authorized changes-Software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.8	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.9,	
Q80-6.2.4.10	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

A.4.4 DDF contents at DDR

E40-6.2.4.1-a	Customer approval of the design definition file (software architectural design, detailed design) [DDF; DDR]
E40-6.2.8.1-a	Software static design [DDF; DDR, CDR]
E40-6.2.8.1-b	Software dynamic design [DDF; DDR, CDR]
E40-6.2.8.1-c	Software elements behaviour [DDF; DDR, CDR]
E40-6.2.8.1-d	Compatibility of design methods with the computational model [DDF; DDR, CDR]
E40-6.2.8.3a	Software dynamic design [DDF; DDR, CDR]
E40-6.2.8.4	Dynamic behaviour [DDF; DDR, CDR]
E40-6.2.8.5	Compatibility of design methods with the computational model [DDF; DDR, CDR]

A.4.5 DDF contents at CDR

E40-5.3.2.9b-a	Customer approval of the design definition file (e.g. software architectural design, detailed design and code) [DDF; CDR]
E40-5.3.2.9b-c	Customer approval of the design of system level interfaces and the system level integration plan [DJF,DDF; CDR]
E40-5.3.2.9b-d	Customer approval of the software user manual [DDF; CDR]
E40-5.5.2.1a	Software components design documents [DDF; CDR]
E40-5.5.2.1b	Software components design documents [DDF; CDR]
E40-5.5.2.1c	Software components design documents [DDF; CDR]
E40-5.5.2.2–b	Internal interfaces design (update) [DDF; CDR]
E40-5.5.2.3	Software user manual [DDF; CDR]
E40-5.5.3.1-a	Software component design documents and code (update) [DDF; CDR]
E40-5.5.3.2-a	Software component design document and code (update) [DDF; CDR]
E40-5.5.3.3	Software user manual (update) [DDF; CDR]
E40-5.5.4.3	Software user manual (update) [DDF; CDR]
E40-6.2.8.1-a	Software static design [DDF; DDR, CDR]

E40-6.2.8.1-b.	Software dynamic design [DDF; DDR, CDR]
E40-6.2.8.1-c	Software elements behaviour [DDF; DDR, CDR]
E40-6.2.8.1-d	Compatibility of design methods with the computational model[DDF; DDR, CDR]
E40-6.2.8.3a	Software dynamic design [DDF; DDR, CDR]
E40-6.2.8.4	Dynamic behaviour [DDF; DDR, CDR]
E40-6.2.8.5	Compatibility of design methods with the computational model [DDF; DDR, CDR]
Q80-6.2.3.5-a	Measures in the design [DDF; PDR, CDR]
Q80-6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.4.5	Software configuration file [DDF; CDR, QR, AR, ORR]
Q80-6.2.4.6	Authorized changes -Software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.8	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.9,	
Q80-6.2.4.10	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

A.4.6 DDF contents at QR

E40-5.6.3.1-b	Software release document [DDF; QR]
E40-5.6.3.1-c	Software delivery [DDF; QR]
E40-5.6.4.1a-a	Software delivery [DDF; QR]
E40-5.6.4.1a-b	Software release document [DDF; QR]
E40-5.6.4.2	Training material [DDF; QR]
Q80-6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.4.5	Software configuration file [DDF; CDR, QR, AR, ORR]
Q80-6.2.4.6	Authorized changes-Software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.8	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.9,	
Q80-6.2.4.10	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

A.4.7 DDF contents at AR

E40-5.6.3.2b-c	Software release document [DDF; AR]
E40-5.6.3.2b-d	Software delivery [DDF; AR]
Q80-6.2.4.3	Software configuration file [DDF; AR, ORR]
Q80-6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

Q80-6.2.4.5	Software configuration file [DDF; CDR, QR, AR, ORR]
Q80-6.2.4.6	Authorized changes -Software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.8	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.9,	
Q80-6.2.4.10	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

A.4.8 DDF contents at ORR

Q80-6.2.4.4	Software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.4.5	Software configuration file [DDF; CDR, QR, AR, ORR]
Q80-6.2.4.6	Authorized changes -Software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.8	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.9,	
Q80-6.2.4.10	Identification and protection method or tool in the software configuration file [DDF; PDR, CDR, QR, AR, ORR]
Q80-6.2.4.11	Identification and protection method or tool in the software configuration file [DDF; SRR, PDR, CDR, QR, AR, ORR]

A.5 Design Justification File (DJF)

A.5.1 General

The DJF is generated and reviewed at all stages of the development and review processes. It contains the documents that describe the trade-offs, design choice justifications, verification plan, validation plan, validation testing specification, test procedures, test results, evaluations and any other documentation called for to justify the design of the supplier's product. The DJF is a primary input to the CDR, QR and AR milestones, and supporting input for the other milestones.

A.5.2 DJF contents at ANY milestone

Q80-5.3.5.1-b	Nonconformance [DJF]
Q80-5.3.5.1-c	Nonconformance record [DJF]

A.5.3 DJF contents at SRR

E40-5.2.4.4	Requirements justification [DJF-system level; SRR]
E40-5.2.3.1b	System design to system requirements conformance [DJF-system level; SRR]
E40-5.2.3.1c	System requirements to system design traceability [DJF-system level; SRR]
E40-5.2.3.2b	Traceability to system partitioning [DJF; SRR]
Q80-5.6.3.1	Software component list [DJF; SRR,PDR]
Q80-5.7.3.3	Evidence of suitability of the software development environment [DJF; SRR, PDR]
Q80-6.2.4.12	Labelling of media [DJF; SRR, PDR; CDR, QR, AR, ORR]

Q80-6.2.6.14	ISVV plan [DJF; SRR, PDR]
Q80-6.2.7.1,	
Q80-6.2.7.2,	
Q80-6.2.7.3,	
Q80-6.2.7.4,	
Q80-6.2.7.7	Justification of selection of reused software in the software reuse file [DJF, SRR, PDR]
Q80-6.2.7.5,	
Q80-6.2.7.6,	
Q80-6.2.7.8	Software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.10	Quality report of proposed product in the software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.11	Action plan in the software reuse file [DJF; SRR, PDR, CDR]
Q80-7.2.4.4	Technical specification for reusable components in the software reuse file [DJF; SRR, PDR]
Q80-7.2.4.7	Test reports for the software reuse file [DJF; SRR, PDR]
Q80-7.4.1-a,	
Q80-7.4.2,	
Q80-7.4.3,	
Q80-7.4.5	Justification of selection of ground equipment [DJF; SRR, PDR]
Q80-7.4.1-b	Receiving inspection report [DJF; SRR, PDR]

A.5.4 DJF contents at PDR

E40-5.3.2.7-d	Software architectural design trade-offs [DJF; PDR]
E40-5.3.2.8	Customer approval of technical specification and software architecture [TS, DDF, ICD(TS), DJF; PDR]
E40-5.3.4.2	Margins and technical budgets status [DJF; PDR, CDR, QR, AR]
E40-5.4.2.4-a	Requirement traceability matrices [DJF; PDR]
E40-5.4.2.4-b	Requirements verification report [DJF; PDR]
E40-5.4.3.6	Software integration test plan (preliminary) [DJF; PDR]
E40-5.4.3.7-a	Software architectural design and interface verification report [DJF; PDR]
E40-5.4.3.7-b	Software architectural design to requirements traceability matrices [DJF; PDR]
E40-5.4.3.8	PDR milestone report [DJF; PDR]
E40-5.4.4-a	Software verification plan - independence, criticality and effort [DJF; PDR]
E40-5.4.4-b.	Software verification plan - methods and tools [DJF; PDR]
E40-5.4.4-c	Software verification plan - organization [DJF; PDR]
E40-5.4.4-d	Software validation plan - independence, criticality and effort [DJF; PDR]
E40-5.4.4-e.	Software validation plan - methods and tools [DJF; PDR]
E40-5.4.4-f	Software validation plan - organization [DJF; PDR]

E40-6.2.6.1	Schedulability analysis [DJF; PDR]
E40-6.2.6.2a	Technical budgets - Memory estimation [DJF; PDR]
E40-6.2.6.2b	Technical budgets - CPU estimation [DJF; PDR]
E40-6.2.6.3	Software behaviour verification [DJF; PDR]
E40-6.2.6.4	Design feasibility verification with models or simulation [DJF; PDR]
E40-6.2.7.3b	Scheduling simulation report [DJF; PDR]
E40-6.4.2.2	Software for intended reuse - justification of methods and tools [DJF; PDR]
E40-6.4.2.3	Software for intended reuse - evaluation of reuse potential [DJF; PDR, CDR]
E40-6.4.3.1	Justification of reuse with respect to requirements baseline in the software reuse file [DJF; PDR]
E40-6.5.4–b	Report on evaluation of MMI specifications using a software mock-up [DJF; PDR]
Q80-5.6.3.1	Software component list [DJF; SRR, PDR]
Q80-5.7.3.3	Evidence of suitability of the software development environment [DJF; SRR, PDR]
Q80-6.2.3.5-b	Verification activities [DJF; SRR, PDR]
Q80-6.2.4.12	Labeling of media [DJF; SRR, PDR; CDR, QR, AR, ORR]
Q80-6.2.6.14	ISVV plan [DJF; SRR, PDR] and ISVV report [DJF; PDR, CDR, QR, AR, ORR]
Q80-6.2.7.1:	
Q80-6.2.7.2,	
Q80-6.2.7.3,	
Q80-6.2.7.4,	
Q80-6.2.7.7	Justification of selection of reused software in the software reuse file [DJF; SRR, PDR]
Q80-6.2.7.5,	
Q80-6.2.7.6,	
Q80-6.2.7.8	Software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.10	Quality report of proposed product in the software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.11	Action plan in the software reuse file [DJF; SRR, PDR, CDR]
Q80-6.3.3.5	Document justifying suitability of language [DJF; PDR]
Q80-7.1.11	Result of studies on mumerical errors presented at each milestone of the software development [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.2.1.4	Verification and validation method for each requirement [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.2.4.4	Technical specification for reusable components in the software reuse file [DJF; SRR, PDR]
Q80-7.2.4.7	Test reports for the software reuse file [DJF; SRR, PDR]
Q80-7.3.1.1	
Q80-7.3.1.2,	

Q80-7.3.1.3,	
Q80-7.3.1.4,	
Q80-7.3.1.5	Detailed test planning documentation [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.3.1.6	Verification reports [DJF, PDR, CDR, QR, AR]
Q80-7.4.1-a,	
Q80-7.4.2,	
Q80-7.4.3,	
Q80-.4.5	Justification of selection of ground equipment [DJF; SRR, PDR]
Q80-7.4.1-b	Receiving inspection report [DJF; SRR, PDR]

A.5.5 DJF contents at DDR

E40-6.2.4.1-b	Customer approval of the design of software interface and the software integration test plan[DJF; DDR]
E40-6.2.4.1-c	Customer approval of the margins and technical budget status [DJF; DDR]
E40-6.2.8.3b	Scheduling simulation report [DJF; DDR, CDR]

A.5.6 DJF contents at CDR

E40-5.3.2.9a	CDR milestone ~~R~~report [DJF; CDR]
E40-5.3.2.9b-b	Customer approval of the design justification file (e.g. results of unit and integration tests and results of validation with respect to the technical specifications) [DJF; CDR]
E40-5.3.2.9b-c	Customer approval of the design of system level interfaces and the system level integration plan [DDF, DJF; CDR]
E40-5.3.2.9b-e	Customer approval of the validation with respect to TS report [DJF; CDR]
E40-5.3.4.2	Margins and technical budgets status [DJF; PDR, CDR, QR, AR]
E40-5.5.2.4	Software unit test plan [DJF; CDR]
E40-5.5.2.5	Software integration test plan (update) [DJF; CDR]
E40-5.5.2.6-a	Design verification report [DJF; CDR]
E40-5.5.2.6-b	Design traceability matrices [DJF; CDR]
E40-5.5.3.1-b	Software unit test plan (update) [DJF; CDR]
E40-5.5.3.2-b	Software unit test reports [DJF; CDR]
E40-5.5.3.4	Software integration test plan (update) [DJF; CDR]
E40-5.5.3.5-a	Software code verification report [DJF; CDR]
E40-5.5.3.5-b	Software code traceability matrices [DJF; CDR]
E40-5.5.4.1	Software integration test plan [DJF; CDR]
E40-5.5.4.2	Software integration test report [DJF; CDR]
E40-5.5.4.4-a	Software integration verification report [DJF; CDR]
E40-5.5.4.4-b	Software documentation verification report [DJF; CDR]
E40-5.5.5.1a-a	Validation with respect to the technical specification testing report [DJF; CDR]

E40-5.5.5.1a-b	Software validation with respect to the technical specification testing specification [DJF; CDR]
E40-5.5.5.1a-c	Software design and test evaluation report [DJF; CDR]
E40-5.5.5.1b	Problem and nonconformance reports [DJF; CDR]
E40-5.5.5.2a	CDR milestone report [DJF; CDR]
E40-5.5.5.2b	Software documentation verification report [DJF; CDR]
E40-5.5.5.2c	CDR milestone report [DJF; CDR]
E40-6.2.8.3b	Scheduling simulation report [DJF; DDR, CDR ~~PDR]~~
E40-6.2.9.1	Schedulability analysis (update) [DJF; CDR]
E40-6.2.9.2a	Technical budgets (update) – Memory size [DJF; CDR]
E40-6.2.9.2b	Technical budgets (update) – CPU utilization [DJF; CDR]
E40-6.2.9.3	Software behaviour verification [DJF; CDR]
E40-6.2.10	Testing feasibility report [DJF; CDR]
E40-6.2.11.1	Schedulability analysis (update) [DJF; CDR]
E40-6.2.11.2	Technical budgets (update) [DJF; CDR]
E40-6.4.2.3	Software for intended reuse – evaluation of reuse potential [DJF; PDR, CDR]
Q80-6.2.3.5-b	Verification activities [DJF; SRR, PDR]
Q80-6.2.4.12	Labeling of media [DJF; SRR, PDR; CDR, QR, AR, ORR]
Q80-6.2.6.14	ISVV report [DJF; PDR, CDR, QR, AR, ORR]
Q80-6.2.7.5,	
Q80-6.2.7.6,	
Q80-6.2.7.8	Software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.10	Quality report of proposed product in the software reuse file [DJF; SRR, PDR, CDR]
Q80-6.2.7.11	Action plan in the software reuse file [DJF; SRR, PDR, CDR]
Q80-6.3.4.9	Nonconformance report and SPR [DJF; CDR, QR, AR, ORR]
Q80-6.3.4.19,	
Q80-6.3.4.20,	
Q80-6.3.4.21	Updated test documentation [DJF; CDR, QR, AR, ORR]
Q80-7.2.1.4	Verification and validation method for each requirement [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.1.11	Result of studies on mumerical errors presented at each milestone of the software development [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.2.2.3-b	Justification of design choices [DJF; CDR]
Q80-7.2.4.6	Test reports for the software reuse file [DJF; CDR]
Q80-7.3.1.1,	
Q80-7.3.1.2,	
Q80-7.3.1.3,	
Q80-7.3.1.4,	
Q80-7.3.1.5	Detailed test planning documentation [DJF; PDR, CDR, QR, AR, ORR]

Q80-7.3.1.6	Verification reports [DJF, PDR, CDR, QR, AR]

A.5.7 DJF contents at QR

E40-5.3.2.11a	QR milestone report [DJF; QR]
E40-5.3.2.11b	Customer's approval of qualified state [DJF; QR]
E40-5.3.4.2	Margins and technical budgets status [DJF; PDR, CDR, QR, AR]
E40-5.6.2a-a	Validation with respect to the requirements baseline testing specification [DJF; QR, AR]
E40-5.6.2a-b	Validation with respect to requirements baseline testing report [DJF; QR, AR]
E40-5.6.3.1-a	Preliminary software acceptance data package [DJF; QR]
E40-5.6.3.1-d	Software design and test evaluation report [DJF; QR]
E40-5.6.3.1-e	Validation testing report [DJF; QR]
E40-5.6.3.1-f	Test specification evaluation [DJF; QR]
E40-5.6.3.1-g	QR milestone report [DJF; QR]
E40-5.6.4.1b	Software acceptance data package [DJF; QR]
Q80-6.2.4.12	Labeling of media [DJF; SRR, PDR; CDR, QR, AR, ORR]
Q80-6.2.6.14	ISVV report [DJF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.9	Nonconformance report and SPR [DJF; CDR, QR, AR, ORR]
Q80-6.3.4.19,	
Q80-6.3.4.20,	
Q80-6.3.4.21	Updated test documentation [DJF; CDR, QR, AR, ORR]
Q80-7.1.11	Result of studies on mumerical errors presented at each milestone of the software development [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.2.1.4	Verification and validation method for each requirement [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.3.1.1,	
Q80-7.3.1.2,	
Q80-7.3.1.3,	
Q80-7.3.1.4,	
Q80-7.3.1.5	Detailed test planning documentation [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.3.1.6	Verification reports [DJF; PDR, CDR, QR, AR]

A.5.8 DJF contents at AR

E40-5.3.2.12	Customer's approval of accepted state [DJF; AR].
E40-5.3.4.2	Margins and technical budgets status [DJF; PDR, CDR, QR, AR]
E40-5.6.2a-a	Validation with respect to the requirements baseline testing specification [DJF; QR, AR]
E40-5.6.2a-b	Validation with respect to requirements baseline testing report [DJF; QR, AR]
E40-5.6.3.2a	AR milestone report [DJF; AR]

E40-5.6.3.2b-a	Final software acceptance data package [DJF; AR]
E40-5.6.3.2b-b	Acceptance testing documentation [DJF; AR]
E40-5.6.4.3	Installation plan [DJF; AR]
E40-5.6.4.4	Installation report [DJF; AR]
E40-5.6.5.1	Acceptance test plan [DJF; AR]
E40-5.6.5.2	Acceptance test report [DJF; AR]
E40-5.6.5.3	Executable code generation test in the acceptance test plan [DJF; AR]
E40-5.6.5.4a	AR milestone report [DJF; AR]
E40-5.6.5.4b	AR milestone report [DJF; AR]
E40-5.6.5.4c	Acceptance testing documentation [DJF; AR]
E40-5.6.5.5	Traceability of acceptance tests to requirements baseline [DJF; AR]
E40-6.2.12~~.~~	Complement of validation at system level [DJF; AR]
Q80-6.2.4.12	Labeling of media [DJF; SRR, PDR; CDR, QR, AR, ORR]
Q80-6.2.6.14	ISVV report [DJF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.9	Nonconformance report and SPR [DJF; CDR, QR, AR, ORR]
Q80-6.3.4.19,	
Q80-6.3.4.20,	
Q80-6.3.4.21	Updated test documentation [DJF; CDR, QR, AR, ORR]
Q80-6.3.5.3,	
Q80-6.3.5.5	Acceptance test plan [DJF; AR]
Q80-6.3.5.7	Nonconformance report and SPR [DJF; AR]
Q80-6.3.5.8,	
Q80-6.3.5.9	Acceptance test report [DJF; AR]
Q80-7.1.11	Result of studies on mumerical errors presented at each milestone of the software development [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.2.1.4	Verification and validation method for each requirement [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.3.1.1,	
Q80-7.3.1.2,	
Q80-7.3.1.3,	
Q80-7.3.1.4,	
Q80-7.3.1.5	Detailed test planning documentation [DJF; PDR, CDR, QR, AR, ORR]
Q80-7.3.1.6	Verification reports [DJF, PDR, CDR, QR, AR]

A.5.9 DJF contents at ORR

Q80-6.2.4.12	Labeling of media [DJF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.14	ISVV report [DJF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.9	Nonconformance report and SPR [DJF; CDR, QR, AR, ORR]
Q80-6.3.4.19,	

Q80‑6.3.4.20,	
Q80‑6.3.4.21	Updated test documentation [DJF; CDR, QR, AR, ORR]
Q80‑7.1.11	Result of studies on mumerical errors presented at each milestone of the software development [DJF; PDR, CDR, QR, AR, ORR]
Q80‑7.2.1.4	Verification and validation method for each requirement [DJF; PDR, CDR, QR, AR, ORR]
Q80‑7.3.1.1,	
Q80‑7.3.1.2,	
Q80‑7.3.1.3,	
Q80‑7.3.1.4,	
Q80‑7.3.1.5	Detailed test planning documentation [DJF; PDR, CDR, QR, AR, ORR]

A.6 Management File (MGT)

A.6.1 General

The MGT is a supplier generated file that describes the management features of the software project (organizational breakdown and responsibilities, work activities breakdown, selected life cycle, deliveries, milestones. risks...)

A.6.2 MGT contents at SRR

E40‑5.2.5.7	System level integration support requirements [MGT; SRR]
E40‑5.3.2.1	Definition of the software life cycle phases included in the software development plan [MGT; SRR, PDR]
E40‑5.3.2.2a	Project software development life cycle definition, included in the software development plan [MGT; SRR, PDR]
E40‑5.3.2.2b	Definition of software development, operations and maintenance techniques and identification of project risks, included in the software development plan [MGT; SRR, PDR]
E40‑5.3.2.2c	Definition of software life cycle in line with the software and system level processes included in the software development plan [MGT; SRR, PDR]
E40‑5.3.2.3	Review plan – milestones (included in the software development plan) [MGT; SRR, PDR]
E40‑5.3.2.4	Identification of outputs at each milestone (included in the software development plan) [MGT; SRR, PDR]
E40‑5.3.2.10	Software verification and validation activities phasing in the software development plan [MGT; SRR, PDR]
E40‑5.6.2b	Phasing of activities of the software validation with respect to the requirements baseline in the software development plan [MGT; SRR, PDR]
E40‑6.2.4.2	Revised CDR outputs in the software development plan [MGT; SRR, PDR]
E40‑6.4.3.2	Software acquisition process implementation in the software development plan [MGT; SRR, PDR]
Q80‑5.1.5.1	Training plan [MGT; SRR]

Q80-5.6.3.2	Purchasing data [MGT; SRR, PDR]
Q80-5.7.2	Descriptions of choices of development equipment in the software development plan [MGT; SRR, PDR]
Q80-6.2.1.1,	
Q80-6.2.1.2,	
Q80-6.2.1.3	Software development plan [MGT; SRR, PDR]
Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.1	Definition of methodology and tools in the software development plan [MGT; SRR, PDR]
Q80-7.2.4.5	Configuration management for software reuse file [MGT; SRR, PDR]

A.6.3 MGT contents at PDR

E40-5.3.2.1	Definition of the software life cycle phases included in the software development plan [MGT; SRR, PDR]
E40-5.3.2.2a	Project software development life cycle definition, included in the software project development plan [MGT; SRR, PDR]
E40-5.3.2.2b	Definition of software development, operations and maintenance techniques and identification of project risks, included in the software development plan [MGT; SRR, PDR]
E40-5.3.2.2c	Definition of software life cycle in line with the software and system level processes included in the software development plan [MGT; SRR, PDR]
E40-5.3.2.3	Review plan – milestones (included in the software development plan [MGT; SRR, PDR]
E40-5.3.2.4	Identification of outputs at each milestone (included in the software development plan) [MGT; SRR, PDR]
E40-5.3.2.10	Software verification and validation activities phasing in the software development plan [MGT; SRR, PDR]
E40-5.6.2b	Phasing of activities of the software validation with respect to the requirements baseline in the software development plan [MGT; SRR, PDR]
E40-6.2.4.2	Revised CDR ouputs in the software development plan [MGT; SRR, PDR]
E40-6.4.3.2	Software acquisition process implementation in the software development plan [MGT; SRR, PDR]
Q80-5.6.3.2	Purchasing data [MGT; SRR, PDR]
Q80-5.7.2	Descriptions of choices of development equipment in the software development plan [MGT; SRR, PDR]
Q80-6.2.1.1,	
Q80-6.2.1.2,	
Q80-6.2.1.3	Software development plan [MGT; SRR, PDR]
Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.1	Definition of methodology and tools in the software development plan [MGT; SRR, PDR]

Q80-7.2.4.5	Configuration management for software reuse file [MGT; SRR, PDR]

A.6.4 MGT contents at CDR

Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]

A.6.5 MGT contents at QR

Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]

A.6.6 MGT contents at AR

Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]

A.6.7 MGT contents at ORR

Q80-6.2.4.2	Software configuration management [MGT; SRR, PDR, CDR, QR, AR, ORR]

A.7 Maintenance File (MF)

A.7.1 General

The MF is a maintainer generated file that describes the planning and status of the maintenance, migration and retirement activities

A.7.2 MF contents at ANY milestone

E40-5.8.2.3b	Problem and nonconformance report [MF]
E40-5.8.3.1	Modification analysis report and problem analysis report [MF]
E40-5.8.3.2	Modification analysis report and problem analysis report [MF]
E40-5.8.3.3	Modification analysis report and problem analysis report [MF]
E40-5.8.3.4	Modification analysis report and problem analysis report [MF]
E40-5.8.4.1	Modification identification [MF]
E40-5.8.6a	Baseline for changes [MF]
E40-5.8.6b	Baseline for changes [MF]
E40-5.8.7.2	Migration plan [MF]
E40-5.8.7.3	Migration plan [MF]
E40-5.8.8.1	Retirement plan [MF]
E40-5.8.8.2	Retirement notification to operator [MF]
E40-6.2.13a	Maintenance plan [MF]
E40-6.2.13b	Long term maintenance solutions [MF]

A.7.3 MF contents at PDR

E40-5.2.3.5	Elements of the software maintenance plan [MF; PDR]

A.7.4 MF contents at QR

E40-5.8.2.1	Maintenance plan – plans and procedures [MF; QR]

E40-5.8.2.2	Maintenance plan - applicability of development process procedures, methods, tools and standards [MF; QR]
E40-5.8.2.3a	Maintenance plan - problem reporting and handling [MF; QR]
E40-5.8.2.4	Maintenance plan - configuration management process [MF; QR]
Q80-6.3.7.1,	
Q80-6.3.7.2,	
Q80-6.3.7.4	Maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.5	Rules for submission of maintenance reports - maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.6,	
Q80-6.3.7.7	Maintenance records [MF; QR, AR, ORR]

A.7.5 MF contents at AR

Q80-6.3.7.1,	
Q80-6.3.7.2,	
Q80-6.3.7.4	Maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.5	Rules for submission of maintenance reports - Maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.6,	
Q80-6.3.7.7	Maintenance records [MF; QR, AR, ORR]

A.7.6 MF contents at ORR

Q80-6.3.7.1,	
Q80-6.3.7.2,	
Q80-6.3.7.4	Maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.5	Rules for submission of maintenance reports - Maintenance plans - assurance [MF; QR, AR, ORR]
Q80-6.3.7.6,	
Q80-6.3.7.7	Maintenance records [MF; QR, AR, ORR]

A.8 Operational Doumentation (OP)

A.8.1 General

The operations process is a system level activity, defined by the customer's requirements for the space system.The corresponding software engineering process is therefore not independent engineering activity, but is a support process at system level. Hence, the outputs of the process are contributions to system level outputs, and the outputs below are therefore either integrated with the software development documentation, or controlled and developed as part of a system documentation tree. The outputs are identified and grouped below.The system level documentation tree defines how the documents are included.

A.8.2 OP contents at ANY review

E40-5.7.2.2b	Problem and nonconformance report [OP]

A.8.3 OP contents at ORR

E40-5.2.6.1	Operational plan [OP; ORR]

E40-5.2.6.2b	Operational plan [OP; ORR]
E40-5.7.2.1	Operational plan - plan and standards [OP; ORR]
E40-5.7.2.2a	Operational plan - procedures for problem handling [OP; ORR]
E40-5.7.2.2.b	Problem and nonconformance report [OP]
E40-5.7.2.3	Operational plan - operational testing specifications [OP; ORR]
E40-5.7.3.1a	Operational testing results [OP; ORR]
E40-5.7.3.1b	Software delivery [OP; ORR]
E40-5.7.3.2a	Validation of operational requirements [OP; ORR]
E40-5.7.3.2b	Demonstration criteria [OP; ORR]

A.9 Product Assurance File (PAF)

A.9.1 General

The PAF contains documents related to planning and definition of requirements and activities related to software product assurance activities and processes. Depending on the size and nature of the project, the following sub-documents can be separate clauses or separate volumes of the PAF.

A.9.2 PAF contents at ANY milestone

Q80-5.3.4-a	Preliminary alert information [PAF]
Q80-5.3.4-b	Alert information [PAF]
Q80-5.5.1-a	Results of pre-award audits [PAF]
Q80-5.5.1-b	Records of procurement sources [PAF]
Q80-5.8.1	Software process assessment plan [PAF]
Q80-5.8.2	Software process assessment procedure [PAF]
Q80-5.8.3	Software process assessment records [PAF]
Q80-5.8.4	Software process assessment records: strengths and weaknesses [PAF]
Q80-5.8.5	Software process assessment records: quality data [PAF]
Q80-5.8.6	Software process assessment records: improvement plan [PAF]
Q80-5.8.7	Software process assessment records: updates to process or project documentation [PAF]

A.9.3 PAF contents at SRR

Q80-5.1.2-a	Responsibility, authority and interrelation of personnel managing, performing and verifying work affecting quality [PAF; SRR]
Q80-5.1.2-b	External and internal interfaces and responsibilities of each organization [PAF; SRR]
Q80-5.1.2-c	Lower level supplier performing delegated product assurance tasks [PAF; SRR]
Q80-5.1.3	Software product assurance resource requirements [PAF; SRR]
Q80-5.1.4.1	Software product assurance manager [PAF; SRR]
Q80-5.1.5.2	Records of training and experience [PAF; SRR]

Q80-5.3.1.1, Q80-5.3.1.4	Software product assurance plan [PAF; SRR]
Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.1.6	Compliance matrix [PAF; SRR]
Q80-5.3.2.1, Q80-5.3.2.4, Q80-5.7.3.5, Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.3	Audit plan and schedule [PAF; SRR]
Q80-5.3.5.1-a	Nonconformance control system [PAF; SRR]
Q80-5.3.5.3	Point in the software lifecycle from which the nonconformance procedures apply – software product assurance plan [PAF; SRR]
Q80-5.5.2.1, Q80-5.5.2.2	Software product assurance requirements for subcontractors [PAF; SRR, PDR]
Q80-5.5.4	Evidence of dependability and safety criticality classification [PAF; SRR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.1.1, Q80-6.1.5, Q80-6.1.6, Q80-6.1.7, Q80-6.1.8	Software development life–cycle definition or reference [PAF; SRR]
Q80-6.1.9	Software development and maintenance lifecycle definition [PAF; SRR]
Q80-6.2.1.4	Identification of plans and their preparation and update time-scales [PAF; SRR]
Q80-6.2.2.5	Software criticality analysis report [PAF; SRR, PDR]
Q80-6.2.5.1, Q80-6.2.5.2, Q80-6.2.5.3	Details of metrics in software product assurance plan [PAF; SRR, PDR, CDR]
Q80-6.2.6.2, Q80-6.2.6.3, Q80-6.2.6.4, Q80-6.2.6.5, Q80-6.2.6.6,	

Q80-6.2.6.7, Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9, Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12, Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.3	Design standards [PAF; SRR]
Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.4.7	Means and organization in the software product assurance plan [PAF; SRR, PDR, CDR]
Q80-7.1.4, Q80-7.1.5	Products metrics specification and justification in software product assurance plan [PAF; SRR, PDR]
Q80-7.1.8	Product metrics specification and justification in software product assurance plan [PAF; SRR, PDR]
Q80-7.2.2.3-a.	Product quality requirements reflected in coding and design standards [PAF; SRR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

A.9.4 PAF contents at PDR

Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.1, Q80-5.3.2.4, Q80-5.7.3.5, Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.6.1, Q80-5.3.6.2	Software problem reporting procedures [PAF; PDR]
Q80-5.5.2.1, Q80-5.5.2.2	Software product assurance requirements for subcontractors [PAF; SRR, PDR]
Q80-5.5.3.3, Q80-5.5.3.4	Subcontractors' software product assurance plan [PAF; PDR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.7.3.1,	

Q80-5.7.3.2	Justification included or referenced in the product assurance file [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.1.6, Q80-6.2.1.7, Q80-6.2.1.8	Procedures and Standards [PAF; PDR]
Q80-6.2.2.2	List of critical components [PAF; PDR]
Q80-6.2.2.5	Software criticality analysis report [PAF; SRR, PDR]
Q80-6.2.3.1, Q80-6.2.3.2	Definition of measures and verification activities in software product assurance plan [PAF; PDR, CDR]
Q80-6.2.3.3, Q80-6.2.3.4	Definition of measures and verification activities in software product assurance plan [PAF; PDR, CDR]
Q80-6.2.5.1, Q80-6.2.5.2, Q80-6.2.5.3	Details of metrics in software product assurance plan [PAF; SRR, PDR, CDR]
Q80-6.2.5.4, Q80-6.2.5.5, Q80-6.2.5.6	Metrics reports in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.6.2, Q80-6.2.6.3, Q80-6.2.6.4, Q80-6.2.6.5, Q80-6.2.6.6, Q80-6.2.6.7, Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9, Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12, Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.4	Design and coding rules for numerical accuracy [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.2.5, Q80-6.3.2.6, Q80-6.3.2.8	Results in software product assurance reports [PAF; PDR, CDR]
Q80-6.3.2.7	Description of checks in the software product assurance plan [PAF; PDR, CDR]
Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]

Q80-6.3.2.9-b	Results in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.1	Coding standards [PAF; PDR]
Q80-6.3.3.2,	
Q80-6.3.3.3,	
Q80-6.3.3.4	Coding standards and description of tools [PAF; PDR]
Q80-6.3.3.7,	
Q80-6.3.3.8	Description of measurements and tools [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.9	Description of measurements and synthesis in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.1,	
Q80-6.3.4.2	Assurance activities for testing [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.7	Means and organization in the software product assurance plan [PAF; SRR, PDR, CDR]
Q80-6.3.4.23,	
Q80-6.3.4.25,	
Q80-6.3.4.26,	
Q80-6.3.4.27,	
Q80-6.3.4.28	Contribution to the test plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.3.1,	
Q80-7.1.3.2	Software quality models [PAF; PDR]
Q80-7.1.4,	
Q80-7.1.5	Products metrics specification and justification in software product assurance plan [PAF; SRR, PDR]
Q80-7.1.6,	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.7,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.8	Product metrics specification and justification in software product assurance plan [PAF; SRR, PDR]
Q80-7.1.9,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.10	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.12	Report of the analysis of software behaviour in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.13,	Report of the analysis and metrics in the software product assurance plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.14	Records of data collection analysis and results and actions for improvement [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

Q80-7.5.1	Procedures described or referenced in the software product assurance plan [PAF; PDR]
Q80-7.5.2	Marking described or referenced in the software product assurance plan [PAF; PDR]

A.9.5 PAF contents at CDR

Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.1,	
Q80-5.3.2.4,	
Q80-5.7.3.5,	
Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.7.3.1,	
Q80-5.7.3.2	Justification included or referenced in the product assurance file [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.2.3	List of critical components [PAF; CDR, QR, AR, ORR]
Q80-6.2.3.1,	
Q80-6.2.3.2	Definition of measures and verification activities in software product assurance plan [PAF; PDR, CDR]
Q80-6.2.3.3,	
Q80-6.2.3.4	Definition of measures and verification activities in software product assurance plan [PAF; PDR, CDR]
Q80-6.2.5.1,	
Q80-6.2.5.2,	
Q80-6.2.5.3	Details of metrics in software product assurance plan [PAF; SRR, PDR, CDR]
Q80-6.2.5.4,	
Q80-6.2.5.5,	
Q80-6.2.5.6	Metrics reports in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.6.2,	
Q80-6.2.6.3,	
Q80-6.2.6.4,	
Q80-6.2.6.5,	
Q80-6.2.6.6,	
Q80-6.2.6.7,	
Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9,	

Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12,	
Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.4	Design and coding rules for numerical accuracy [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.2.5,	
Q80-6.3.2.6,	
Q80-6.3.2.8	Results in software product assurance reports [PAF; PDR, CDR]
Q80-6.3.2.7	Description of checks in the software product assurance plan [PAF; PDR, CDR]
Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-b.	Results in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.7,	
Q80-6.3.3.8	Description of measurements and tools [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.9	Description of measurements and synthesis in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.1,	
Q80-6.3.4.2	Assurance activities for testing [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.3,	
Q80-6.3.4.5,	
Q80-6.3.4.6,	
Q80-6.3.4.8	Collected data and analysis of the results in the software product assurance report [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.7	Means and organization in the software product assurance plan [PAF; SRR, PDR, CDR]
Q80-6.3.4.10,	
Q80-6.3.4.14,	
Q80-6.3.4.15,	
Q80-6.3.4.16	Statement of compliance with test plans and procedures [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.23,	
Q80-6.3.4.25,	
Q80-6.3.4.26,	
Q80-6.3.4.27,	
Q80-6.3.4.28	Contribution to the test plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.6,	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]

Q80-7.1.7,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.9,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.10	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.12	Report of the analysis of software behaviour in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.13	Report of the analysis and metrics in the software product assurance plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.14	Records of data collection analysis and results and actions for improvement [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

A.9.6 PAF contents at QR

Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.1,	
Q80-5.3.2.4,	
Q80-5.7.3.5,	
Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.7.3.1,	
Q80-5.7.3.2	Justification included or referenced in the software product assurance file [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.2.3	List of critical components [PAF; CDR, QR, AR, ORR]
Q80-6.2.5.4,	
Q80-6.2.5.5,	
Q80-6.2.5.6	Metrics reports in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.6.2,	
Q80-6.2.6.3,	
Q80-6.2.6.4,	
Q80-6.2.6.5,	
Q80-6.2.6.6,	
Q80-6.2.6.7,	
Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9,	

Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12,	
Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.4	Design and coding rules for numerical accuracy [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-b.	Results in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.7,	
Q80-6.3.3.8	Description of measurements and tools [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.9	Description of measurements and synthesis in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.1,	
Q80-6.3.4.2	Assurance activities for testing [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.3,	
Q80-6.3.4.5,	
Q80-6.3.4.6,	
Q80-6.3.4.8	Collected data and analysis of the results in the software product assurance report [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.10,	
Q80-6.3.4.14,	
Q80-6.3.4.15,	
Q80-6.3.4.16	Statement of compliance with test plans and procedures [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.23,	
Q80-6.3.4.25,	
Q80-6.3.4.26,	
Q80-6.3.4.27,	
Q80-6.3.4.28	Contribution to the test plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.6,	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.7,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.9,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.10	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.12	Report of the analysis of software behaviour in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]

Q80-7.1.13~~,~~	Report of the analysis and metrics in the software product assurance plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.14	Records of data collection analysis and results and actions for improvement [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

A.9.7 PAF contents at AR

Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.1.5	Quality measures for the operations and maintenance processes in the software product assurance plan [PAF; AR]
Q80-5.3.2.1,	
Q80-5.3.2.4,	
Q80-5.7.3.5,	
Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.7.3.1,	
Q80-5.7.3.2	Justification included or referenced in the software product assurance file [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.2.3	List of critical components [PAF; CDR, QR, AR, ORR]
Q80-6.2.5.4,	
Q80-6.2.5.5,	
6.2.5.6	Metrics reports in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.6.2,	
Q80-6.2.6.3,	
Q80-6.2.6.4,	
Q80-6.2.6.5,	
Q80-6.2.6.6,	
Q80-6.2.6.7,	
Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9,	
Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12,	
Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.4	Design and coding rules for numerical accuracy [PAF; PDR, CDR, QR, AR, ORR]

Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-b	Results in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.7,	
Q80-6.3.3.8	Description of measurements and tools [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.9	Description of measurements and synthesis in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.1,	
Q80-6.3.4.2	Assurance activities for testing [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.3,	
Q80-6.3.4.5,	
Q80-6.3.4.6,	
Q80-6.3.4.8	Collected data and analysis of the results in the software product assurance report [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.10,	
Q80-6.3.4.14,	
Q80-6.3.4.15,	
Q80-6.3.4.16	Statement of compliance with test plans and procedures [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.23,	
Q80-6.3.4.25,	
Q80-6.3.4.26,	
Q80-6.3.4.27,	
Q80-6.3.4.28	Contribution to the test plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.30	Contribution to the test plan [PAF; AR]
Q80-6.3.5.1	Contribution to the installation plan [PAF; AR]
Q80-6.3.6.1	Contribution to the operational plan [PAF; AR]
Q80-6.3.6.2	Contribution to the validation of the operational requirements [PAF; AR]
Q80-7.1.6,	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.7,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.9,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.10	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.12	Report of the analysis of software behaviour in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.13	Report of the analysis and metrics in the software product assurance plan [PAF; PDR, CDR, QR, AR, ORR]

Q80-7.1.14	Records of data collection analysis and results and actions for improvement [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

A.9.8 PAF contents at ORR

Q80-5.3.1.3	Software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.1,	
Q80-5.3.2.4,	
Q80-5.7.3.5,	
Q80-5.3.2.2	Assessment of the quality of software development process in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.3.2.3	Assessment of the quality of software product in the software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.6.5	Receiving inspection report [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-5.7.3.1,	
Q80-5.7.3.2	Justification included or referenced in the software product assurance file [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.2.3	List of critical components [PAF; CDR, QR, AR, ORR]
Q80-6.2.5.4,	
Q80-6.2.5.5,	
Q80-6.2.5.6	Metrics reports in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.2.6.2,	
Q80-6.2.6.3,	
Q80-6.2.6.4,	
Q80-6.2.6.5,	
Q80-6.2.6.6,	
Q80-6.2.6.7,	
Q80-6.2.6.8	SPA reports and software problem reports [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.9,	
Q80-6.2.6.10	Review and inspection procedures [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.2.6.12,	
Q80-6.2.6.13	Review and inspection records [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.4	Design and coding rules for numerical accuracy [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-a	Description of checks in the software product assurance plan [PAF; SRR, PDR, CDR, QR, AR, ORR]
Q80-6.3.2.9-b	Results in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]

Q80-6.3.3.7, Q80-6.3.3.8	Description of measurements and tools [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.3.9	Description of measurements and synthesis in software product assurance reports [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.1, Q80-6.3.4.2	Assurance activities for testing [PAF; PDR, CDR, QR, AR, ORR]
Q80-6.3.4.3, Q80-6.3.4.5, Q80-6.3.4.6, Q80-6.3.4.8	Collected data and analysis of the results in the software product assurance report [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.10, Q80-6.3.4.14, Q80-6.3.4.15, Q80-6.3.4.16	Statement of compliance with test plans and procedures [PAF; CDR, QR, AR, ORR]
Q80-6.3.4.23, Q80-6.3.4.25, Q80-6.3.4.26, Q80-6.3.4.27, Q80-6.3.4.28	Contribution to the test plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.6,	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.7,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.9,	Report of the analysis and metrics in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.10	Report of the analysis and remedial actions in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.12	Report of the analysis of software behaviour in the software product assurance report [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.13~~,~~	Report of the analysis and metrics in the software product assurance plan [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.1.14	Records of data collection analysis and results and actions for improvement [PAF; PDR, CDR, QR, AR, ORR]
Q80-7.3.2	Software product assurance report [PAF; SRR, PDR, CDR, QR, AR, ORR]

A.10 System level documentation

A.10.1 General

The system level documentation is governed by the ECSS system engineering standard. The relevant input for software elements at system level are found in subclause 5.2. In the special case where the customer is himself a software supplier (a product consisting solely of software) for the next higher level in the system product tree, the *customer* becomes a *supplier* at that level and the requirements of this current standard are applied recursively for that case.

A.10.2 DDF contents at SRR

E40-5.2.3.1a	System design [DDF-system level; SRR]

A.10.3 DJF contents at SRR

E40-5.2.4.4	Requirements justification [DJF-system level; SRR]
E40-5.2.3.1b	System design to system requirements conformance [DJF-system level; SRR]
E40-5.2.3.1c	System requirements to system design traceability [DJF-system level; SRR]

Annex B (informative)

References to other ECSS Standards

Referenced ECSS Standard	**clause / page(s)**
ECSS-E-00	*cl4* / 20, 28
ECSS-E-10	*cl4* / 24, 28
ECSS-E-10A	*cl5* / 33
ECSS-E-10-01	*cl4* / 28
ECSS-E-40-01	*cl6* / 61
ECSS-E-40-03	*cl6* / 67
ECSS-E-40-04	*cl5* / 36
ECSS-E-70	*cl4* / 25, 29
ECSS-M	*cl4* / 27
ECSS-M-00	*cl4* / 27
ECSS-M-00A	*cl5* / 54, 55, 56
ECSS-M-00-02	*cl4* / 29
ECSS-M-00-03	*cl4* / 27
ECSS-M-10	*cl4* / 27; *cl5* / 49
ECSS-M-20	*cl4* / 20, 27; *cl5* / 55
ECSS-M-30	*cl4* / 21, 27; *cl5* / 37, 47, 60
ECSS-M-40	*cl4* / 28; *cl5* / 39, 48, 50
ECSS-M-50	*cl4* / 28
ECSS-M-60	*cl4* / 28
ECSS-M-70	*cl4* / 28
ECSS-P-001	*cl3* / 13
ECSS-Q-20A	*cl5* / 47
ECSS-Q-30	*cl3* / 13
ECSS-Q-40	*cl3* / 13

ECSS-Q-80	*cl4* / 20, 27; *cl5* / 36; *cl6* / 69
ECSS-Q-80B	*cl5*/ 32, 41, 47, 54, 55, 56, 58, 59; *cl6*/ 68

Annex C (informative)

Tailoring guidelines

C.1 Introduction

The ECSS family of standard is intended to be tailored for each individual project. This Standard lists exhaustively the requirements for the best practices in space software engineering. The purpose of this clause is to give the customer general guidelines on tailoring this standard for a specific project.

The goal of the tailoring is to select, modify or add adequately requirements in order to reach the optimised ratio quality and the actual project peculiarities. The technical, management and operational factors discussed in the following subclauses provide for the examples of the software project peculiarities to the considered, to perform tailoring of this Standard.

C.2 How to tailor

The first step is therefore to understand the requested level of quality for the project, which starts with the characterisation of the project, the identification of the needed processes, and the characterisation of the product.

ECSS-M-00-02 provides for indication on the general way to tailor an ECSS standard, in particular the tailoring process and the tailoring templates. The templates are generic and deserve a more concrete description of the so-called programmatic and technical factors.

For space software, there are some examples where the full application of this Standard can be tailored and then refined on the basis of software project details (the tailoring factors). The main influencing factors are the following:

- Technical factors:
  - novelty of the domain of application;
  - complexity of the software and the system;
  - criticality level;
  - size of the software;
  - reusability required of the software being developed;
  - interface to system development projects;
  - degree of use of COTS or existing software;
  - maturity of the COTS and completeness or stability of the user requirements.

- Operational factors:
  - type of application (e.g. platform, payload, and experiment);
  - number of potential users of the software;
  - criticality of the software as measured by the consequences of its failure;
  - expected lifetime of the software;
  - number of sites where the software is used;
  - operation, maintenance, migration and retirement constraints.
- Management factors:
  - amount of time and effort required to develop the software;
  - budget requirements for implementing and operating the software;
  - accepted risk level for the project;
  - type of life cycle;
  - schedule requirements for delivering the software;
  - number of people required to develop, operate and maintain the software;
  - complexity of the organisation;
  - experience of the supplier;
  - financial resource.

For each particular project additional factors may be used.

The tailoring can be made during a short discussion between the software engineering engineer and the software project manager. The software engineering engineer first asks a set of questions to the project manager, in order to set up the scope of the tailoring (i.e. the characteristics of the project that influence the selection or not of each requirements). Examples of questions are:

- Who are the customer, the supplier, the user, the maintainer, and the operator? Does the customer intend to delegate some tasks to the supplier?
- Where is the complexity of the project, in the requirements or in the design?
- What level of validation is necessary? Should the product be perfect at delivery, or is some room allowed for the user to participate to the tests, or is it a prototype that will be dropped later on (or reused in the next phase)?
- What level of verification is necessary? Is it necessary to verify the requirements, or the code, or the test definition?
- What visibility into the design is wished? Does the project manager want to know everything on the detailed design and unit test, or does he trust the supplier for a part of the lifecycle?
- Consequently, what are the necessary reviews to be selected into the project? Is it acceptable to merge some of them (as QR and AR, or SRR and PDR) or to waive others (as CDR or DDR)?
- How much are COTS involved? Is the project an assembly of COTS products where the COTS acceptance and integration shall have the emphasis?
- Is the software critical? Is it included into an hardware environment?
- How is organised the maintenance? Is it included fully in the current contract, or is the maintenance limited to the guarantee period?

Then the requirements in clauses 5 and 6 are reviewed and made or not applicable in a table.

The tailoring of this Standard results in a short document including the project characteristics (as a justification for the tailoring) and the tailoring table.

Note that several subclauses are anyhow mandatory for any project, e.g. the production of a minimum set of software requirements, a PDR to review them, and the production of the code.

The tables in this annex propose tailoring templates for space software. These are only samples. Each subclause of this Standard is reviewed and tailored, on the basis of the identified factors at project level. The first table is organized per subclause of this Standard and the second one is organized in accordance with the ECSS-M-00-02 template, i.e. per tailoring factor.

C.3 Who tailors?

The tailoring of this Standard is implicitly a task of the Customer. When preparing the Invitation to Tender, the Customer may propose a tailored version of the standard as an indication of the level of software engineering that is required for the project. However, some tailoring factors (such as criticality, detailed design complexity) may only be known after the grant of the contract. The Supplier will also have to be part of the tailoring process and the resulting document will be baselined in the RB (at SRR). The Customer may also subcontract the tailoring to the Supplier, then review and accept the tailored version.

C.4 Tailoring templates

The tailoring conditions and possibilities identified in tables C-1 and C-2 are general (i.e. “a project is small”, “the budget is low”), and, as such, provide only an indication of what they can be. The real projects characteristics are utilized in order to identify the tailoring conditions and possibilities in the exercise of instantiation of this Standard

Table C-1 provides an example of tailoring conditions and possibilities for each subclause of this Standard.

Table C-1:

Subclause	Tailoring condition	Tailoring possibility
5.2.2.1 System requirement specification	If the system is pure software.	The system requirement specification is reduced to user or customer requirements (the software requirement baseline).
	If the project is small.	The software requirement baseline may be merged with the software specification (software technical baseline).
5.2.2.2 System and functional criticality analysis	If the system is not critical.	It does not exist.
5.2.3.1 Introduction	If the system is pure software	It does not exist.
5.2.3.2 System partitioning	If the system is pure software	It does not exist.
5.2.4.2 Qualification engineering requirements	If the system is pure software	It does not exist
5.2.4.3 software validation requirements at system level	If the system is pure software.	It does not exist.

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.2.4.4 Requirements baseline verification	If the complexity of the system is low.	The verification may be limited to the supplier reading and commenting.
5.2.4.5 System requirements review	If the customer and the supplier are the same organisational unit because the project is small enough.	The SRR may be waived in favour of the PDR.
5.2.5.1 Identification of software observability requirements	If the system is pure software.	It does not exist.
5.2.5.2 Control and data interfaces for system level integration	If the system is pure software.	It does not exist.
5.2.5.3 Data medium requirements for integration	If the system is pure software.	It does not exist.
5.2.5.4 Identification of development constraints	If the system is pure software.	It does not exist.
5.2.5.5 Identification of customer's inputs for software integration into the system.	If the system is pure software.	It is limited to the workstation running the software.
5.2.5.6 Identification of supplier's outputs for software integration into the system	If the system is pure software.	It does not exist.
5.2.5.7 Planning of supplier support to system integration	If the system is pure software.	It does not exist.
5.2.6.1 Phasing and management		Depends on 5.7 tailoring
5.2.6.2 System requirements definition for software operations		Depends on 5.7 tailoring
5.2.7 software maintenance		Depends on 5.8 tailoring
5.3.2.1 Definition of software life cycle phases		Mandatory
5.3.2.2 Software life cycle identification		Mandatory
5.3.2.3 Identification of inputs and outputs associated to each phase		Mandatory
5.3.2.4 Identification of documentation relevant to each milestone		Mandatory

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.3.2.5 Identification of interfaces between the development and maintenance processes	If the software is not maintained.	It does not exist.
5.3.2.6 Software requirements baseline at the SRR	If the customer and the supplier are the same organisational unit because the project is small enough.	The SRR may be waived in favour of the PDR.
5.3.2.7 Software technical specification phase	If the software is small enough and with a straightforward architecture (e.g. a set of services).	The specification and the software architectural design may be merged.
5.3.2.8 Preliminary design review		Mandatory
5.3.2.9 Critical design review	If the project is small enough and if the design is not complex.	The CDR may be waived.
5.3.2.10 Software verification and validation process	Tailored according to 5.9 If the criticality is low and the budget is low.	The verification may be selective or waived.
	If the software is a prototype.	The validation may be less intensive or waived (validation by the users) because integration is more intensive
5.3.2.11 Qualification review	If both verification and validation have been waived.	QR is meaningless. Otherwise, QR is mandatory.
5.3.2.12 Acceptance review	If the customer and the supplier are the same organizational unit because the project is small enough.	The AR may be merged with the QR.
	If the V&V environment is the same as the operational environment.	The AR may be merged with the QR.
5.3.3.1 Interface definition	If the system is only software.	They do not exist.
	If the system interface has no possibility to evolve	They may be waived.
	If the budget is low and the complexity is low.	They may be waived.
5.3.3.2 Interface management procedures	If the system is only software.	They do not exist.
	If the system interface has no possibility to evolve	They may be waived.
	If the budget is low and the complexity is low.	They may be waived.
5.3.4.1 Software technical budget and margin philosophy definition	If the technical budget is unlimited (e.g. memory size, computer throughput, and response time).	It may be waived.

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.3.4.2 Software technical budget management	If the technical budget is unlimited (e.g. memory size, computer throughput, and response time).	It may be waived.
5.4.2.1 Establishment and documentation of software requirements		Mandatory. Outputs are tailored as appropriate for the project needs.
5.4.2.2 software logical model definition	If the complexity of the system is low.	It may be waived.
5.4.2.3 Identification of requirement unique identifier	If both verification and validation have been waived for all the versions of the software.	Requirement identification is not useful and it may be waived.
5.4.2.4 Software requirements evaluation	If the budget is low and the criticality is low.	It may be waived.
5.4.3.1 Transformation of software requirements into a software architecture	If the software is a set of relatively independent services.	The requirement and the software architectural design may be merged.
	If the design is a tree, but with a low complexity.	The software architectural design and the detailed design may be merged.
5.4.3.2 Software design description		Mandatory
5.4.3.3 Software design documentation		Mandatory
5.4.3.4 Development and documentation of the software interfaces	If the software is a set of relatively independent services.	The requirement and the software architectural design interface can be merged.
	If the interfaces complexity is low.	The interfaces of the software architectural design and detailed design may be merged.
5.4.3.5 Evaluation of reuse of predeveloped software	If the software do not intend to use any COTS, MOTS or others already developed software components	It may be waived.
5.4.3.6 Definition and documentation of the software integration requirements and plan	If the software is a set of relatively independent services, or if there is little or no interface.	The plan may be waived.
	If the complexity of the interface is low.	The plan may be delayed to 5.5.2.5.
5.4.3.7 Evaluation of the software architectural design and the interface design	If the budget is low and the criticality is low.	The verification may be waived.
5.4.3.8 Conducting a preliminary design review		Mandatory

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.4.4.1 software verification and validation planning	Tailored as per 5.3.2.10 V&V tailoring. If the budget is low and the criticality is low.	The verification plan may be waived.
	If the software is a prototype.	The validation may be less intensive or waived (validation by the users) because integration is more intensive
5.5.2.1 Detailed design of each software component	If the design is a tree, but with a low complexity.	The software architectural design and the detailed design can be merged.
5.5.2.2 Development and documentation of the software interfaces detailed design	If the interfaces complexity is low.	The interfaces of the software architectural design and the detailed design can be merged.
5.5.2.3 Development and documentation of the software user manual	If the budget is low.	This may be delayed up to 5.5.4.3
5.5.2.4 Definition and documentation of the software unit test requirements and plan	If the budget is low or if the criticality is low.	The plan may be waived.
5.5.2.5 Updating of the the software integration test requirements and plan.	If the software is a set of relatively independent services.	The plan may be waived.
5.5.2.6 Evaluation of the software detailed design and test requirements	If the budget is low and the criticality is low.	The verification may be waived.
5.5.3.1 Development and documentation of the software units, tests procedures and test data		Mandatory.
5.5.3.2 Software unit testing	If the budget is low and the criticality is low.	The unit test reports may remain not formally documented.
	If the stubs needed to unit test a component are equivalent to the real components.	The unit test of this component may be replaced by the integration test of this component and its related components.
5.5.3.3 Software user manual updating	If the budget is low.	The update may be delayed up to 5.5.4.3
5.5.3.4 Updating of the software integration test requirements and plan	If the software is a set of relatively independent services	The plan may be waived.

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.5.3.5 Code and unit test results evaluation	If the budget is low and the criticality is low	The verification may be waived.
5.5.4.1 Software integration test plan development	If the software is a set of relatively independent services or there is little or no interface	The integration may be simplified or waived.
5.5.4.2 Software units and software component integration and testing	If the budget is low and the criticality is low	The integration test reports may remain not documented.
5.5.4.3 Software user manual updating		Mandatory if there is no validation. May be delayed to 5.9.5.3 otherwise
5.5.4.4 Software integration activities results evaluation.	If the budget is low and the criticality is low	The verification may be waived.
5.5.5.1 Software validation with respect to the technical specification	If the system is pure software,. If the project is small	It may be waived when TS=RB
5.5.5.2 Conducting a critical design review	If the budget is low and the criticality is low	The CDR may be waived.
5.6.2 Validation with respect to the requirements baseline		Mandatory. Either at QR or AR.
5.6.3.1 Conducting a qualification review		See 5.3.2.11
5.6.3.2 Conducting an acceptance review		See 5.3.2.12
5.6.4.1 Preparation and updating of the software product	If the budget is low	The delivery preparation may be simplified.
5.6.4.2 Supplier's provision of training and support		Only if appropriate
5.6.4.3 Installation planning		Only when installation is required.
5.6.4.4 Installation activities reporting		Only when installation is required.
5.6.5.1 Acceptance test planning		Mandatory.
5.6.5.2 Acceptance test execution		Mandatory.
5.6.5.3 Executable code generation and installation	If no automatic code is generated	It may be waived
5.6.5.4 Supplier's support to customer's acceptance		Only in the terms tailored.

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.6.5.5 Evaluation of acceptance testing	If the budget is low and the criticality is low.	It may be waived.
5.7.2.1 Operational plans and standards development	If the operation of the software is of low complexity.	The operational plan and standards development may be waived.
5.7.2.2 Problem handling procedures definition	If the operation of the software is of low complexity.	
5.7.2.3 Operational testing definition	If the operation of the software is of low complexity.	The operational testing may be waived in favour of the acceptance testing.
5.7.3.1 Operational testing execution	If the operation of the software is of low complexity.	The operational testing may be waived in favour of the acceptance testing.
5.7.3.2 Software operational requirements demonstration	If the operation of the software is of low complexity.	The software operational requirements demonstration may be waived in favour of the acceptance testing.
5.7.4 Software operation		Mandatory
5.7.5.1 User's assistance		Tailored on a case by case basis
5.7.5.2 Handling of user's requests		Tailored on a case by case basis
5.7.5.3 Provisions of work-around solutions		Tailored on a case by case basis
5.8.2.1 Software maintenance process planning	If the software is not maintained	The maintenance process planning may be waived.
5.8.2.2 Software maintenance process procedures, methods and standards	If the software is not maintained.	This may be waived.
5.8.2.3 Problem reporting and handling	If the software is not maintained	This may be waived
5.8.2.4 Implementation of configuration management process	If the software is not maintained	This may be waived
5.8.3.1 Problem analysis	If the software is not maintained.	This may be waived.
5.8.3.2 Problem verification	If the software is not maintained.	This may be waived
5.8.3.3 Development of options for modifications	If the software is not maintained.	This may be waived
5.8.3.4 Documentation of problem, analysis and implementation	If the software is not maintained.	This may be waived

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.8.3.5 Customer approval of selected modification options	If the software is not maintained.	This may be waived
5.8.4.1 Analysis and documentation of product modification	If the software is not maintained.	This may be waived.
5.8.4.2 Documentation of software product changes	If the software is not maintained.	This may be waived
5.8.4.3 Invoking of software engineering process for modification implementation	If the software is not maintained.	This may be waived.
5.8.5.1 Definition of inflight modification capability for flight software		Only for flight software.
5.8.5.2 Definition of functional performance requirements for inflight modification		Only for flight software.
5.8.6 Maintenance review and acceptance	If the organisation is simple.	The acceptance may be waived.
5.8.7.1 Applicability of this Standard to software migration	If migration is not necessary.	This may be waived. Otherwise, it is mandatory in a more or less formal way.
5.8.7.2 Migration planning and execution	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.7.3 Contribution to the migration plan	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.7.4 Preparation for migration	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.7.5 Notification of transition to migrated system	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.7.6 Post-operation review	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.7.7 Maintenance and accessibility of data of former system	If migration is not necessary.	This may be waived Otherwise, it is mandatory in a more or less formal way.
5.8.8.1 Retirement planning	If the software is not retired independently from the system.	This may be waived. Otherwise, it is mandatory in a more or less formal way.

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.8.8.2 Notification to the operator of retirement plan	If the software is not retired independently from the system.	This may be waived. Otherwise, it is mandatory in a more or less formal way
5.8.8.3 Identification of requirements for software retirement	If the software is not retired independently from the system.	This may be waived. Otherwise, it is mandatory in a more or less formal way
5.8.8.4 Maintenance and accessibility to data of the retired product	If the software is not retired independently from the system.	This may be waived. Otherwise, it is mandatory in a more or less formal way
5.9.2 Verification process implementation	If the budget is low and the criticality is low.	The verification may be waived.
5.9.2.1 Determination of the verification effort for the project	If the budget is low and the criticality is low.	Only necessary if verification is needed
5.9.2.2 Establishment of the verification process, methods and tools	If the budget is low and the criticality is low.	Only necessary if verification is needed
5.9.2.3 Selection of the organization responsible for conducting the verification	If the budget is low and the criticality is low.	Only necessary if independent verification is needed
5.9.2.4 Development and documentation of a verification plan covering the software verification activities	If the budget is low and the criticality is low.	Only necessary if verification is needed
5.9.3.1 Determination of the validation effort for the project	If the budget is low and the criticality is low.	The validation plan can be merged with the software development plan
5.9.3.2 Establishment of a validation process	If the budget is low and the criticality is low.	The validation plan can be merged with the software development plan
5.9.3.3 Selection of a validation organization	If the budget is low and the criticality is low.	Only necessary if an independent validation is needed.
5.9.3.4 Development and documentation of a validation plan	If the budget is low and the criticality is low.	The validation plan can be merged with the software development plan
5.9.4.1 Verification of software requirements	If the budget is low and the criticality is low	This activity may be waived
5.9.4.2 Verification of the software architectural design	If the budget is low and the criticality is low	This activity may be waived
5.9.4.3 Verification of the software detailed design	If the budget is low and the criticality is low	This activity may be waived
5.9.4.4 Verification of code	If the budget is low and the criticality is low	This activity may be waived

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
5.9.4.5 Verification of software integration	If the budget is low and the criticality is low	This activity may be waived
5.9.4.6 Verification of software documentation	If the budget is low and the criticality is low	This activity may be waived
5.9.4.7 Evaluation of test specifications		Traceability of the existing requirements input (RB or TS) to the validation tests is mandatory
5.9.4.8 Verification of software validation with respect to the technical specifications and the requirements baseline	If the budget is low and the criticality is low	This activity may be waived
5.9.4.9 Problem and nonconformance handling		Mandatory in a more or less formal way for the selected verification activities
5.9.5.1 Development and documentation of a a software validation testing specification	If the budget is low and the criticality is low.	The validation may be limited to a given coverage target, e.g. by validating only the nominal behaviour.
5.9.5.2 Conducting the validation tests	If the budget is low.	The validation report may remain non-documented.
5.9.5.3 Evaluation of the design, code, tests, test results, and software user manual	If the budget is low and the criticality is low	This activity may be waived
5.9.5.4 Updating the software user manual	If the budget is low and the criticality is low.	The verification may be waived.
5.9.5.5 Problem and nonconformance handling		Mandatory, in a more or less formal way.
5.9.5.6 Test readiness review	If the budget is low and the criticality is low.	The verification may be waived.
5.9.6.1 Introduction		As per review tailoring
5.9.6.2 Support to software reviews		As per review tailoring
5.9.6.3 Technical reviews	If the life cycle is of type concurrent engineering or with short and numerous incremental steps	The reviews will be defined as a set of periodic meetings whose last one only includes the formal review success. The authorisation to start the next phase disappears.
6.2.2.1 System observability requirements definition	If not flight software	It may be waived
6.2.2.2 Software observability data definition	If not flight software	It may be waived

Table C‐1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
6.2.2.3 Criteria to define observability requirements	If not flight software	it may be waived
6.2.3. System level integration of software: system database	If not flight software	It may be waived
6.2.4.1 Detailed design review planning	If not flight software	It may be waived
6.2.4.2 CDR plan for flight software	If not flight software	It may be waived
6.2.5.1 Definition of a software logical model	If not flight software	It may be waived
6.2.5.2 Definition of behavioural view for space reactive software	If not flight software	It may be waived
6.2.5.3 Man‐machine interface (MMI) prototype for interactive software	If not flight software for manned space systems	It may be waived
6.2.6.1 Schedulability analysis	If not flight software	It may be waived
6.2.6.2 Technical budgets management	If not flight software	It may be waived
6.2.6.3 Software behaviour modelling and verification techniques	If not flight software	It may be waived
6.2.6.4 Design feasibility demonstration	If not flight software	It may be waived
6.2.7.1 Software architectural design contents	If not flight software	It may be waived
6.2.7.2 Software design method	If not flight software	It may be waived
6.2.7.3 Selection of a computational model	If not flight software	It may be waived
6.2.7.4 Description of software dynamic behaviour	If not flight software	It may be waived
6.2.8.1 Production of software items physical model	If not flight software	It may be waived
6.2.8.2 Utilization of methods for software static design	If not flight software	It may be waived
6.2.8.3 Description of the dynamic aspects of physical model	If not flight software	It may be waived

Table C-1: *(continued)*

Subclause	Tailoring condition	Tailoring possibility
6.2.8.4 Utilization of description techniques for the software behaviour	If not flight software	It may be waived
6.2.8.5 Determination of design methods consistency	If not flight software	It may be waived
6.2.9.1 Schedulabilty analysis refinement	If not flight software	It may be waived
6.2.9.2 Technical budgets management	If not flight software	It may be waived
6.2.9.3 Behavioural model verification	If not flight software	It may be waived
6.2.10 Verification of design: feasibility of testing	If not flight software	It may be waived
6.2.11.1 Schedulabilty analysis refinement	If not flight software	It may be waived
6.2.11.2 Technical budget update	If not flight software	It may be waived
6.2.12 Evaluation of Validation: complementary system level validation	If not flight software	It may be waived
6.2.13 Maintenance: long term maintenance	If not flight software	It may be waived
6.3 Ground segment software		
6.4.2.1 Definition of constraints for software to be reused	When software is not built to be reused	It may be waived
6.4.2.2 Definition of methods and tools for software to be reused	When software is not built to be reused	It may be waived
6.4.2.3 Evaluation of potential reuse of software	If software is not intended to be reused	It may be waived
6.4.3.1 Analysis of potential reusabilty	If software is not intended to be reused	It may be waived
6.4.3.2 Software acquisition process implementation	If no COTS or MOTS are not a part of the software to be produced	It may be waived
6.5.2 Establishment of the need for a MMI mock up	If not interactive space software	It may be waived
6.5.3 MMI Standards and guidelines definition	If not interactive space software	It may be waived
6.5.4 MMI software mock up development	If not interactive space software	It may be waived

Table C-2 provides the same content than table C-1, but it is sorted per tailoring condition

Table C-2:

Tailoring condition	E-40 requirement	Tailoring possibility
No condition	5.2.6.1 Phasing and management	Depends on 5.7 tailoring.
	5.2.6.2 System requirements definition for software operations	Depends on 5.7 tailoring.
	5.2.7 Software maintenance	Depends on 5.8 tailoring.
	5.3.2.1 Definition of software life cycle phases	Mandatory.
	5.3.2.2 Software life cycle identification	Mandatory.
	5.3.2.3 Identification of inputs and outputs associated to each phase	Mandatory.
	5.3.2.4 Identification of documentation relevant to each milestone	Mandatory.
	5.3.2.8 Preliminary design review	Mandatory.
	5.4.2.1 Establishment and documentation of software requirements	Mandatory. Outputs are tailored as appropriate for the project needs.
	5.4.3.2 Software design description	Mandatory.
	5.4.3.3 Software design documentation	Mandatory.
	5.4.3.8 Conducting a preliminary design review	Mandatory.
	5.5.3.1 Development and documentation of the software units, test procedures and test data	Mandatory.
	5.5.4.3 Software user manual updating	Mandatory if there is no validation. May be delayed to 5.9.5.3 otherwise.
	5.6.2 validation with respect to the requirement baseline	Mandatory. Either at QR or AR.
	5.6.3.1 Conducting a qualification review	See 5.3.2.11
	5.6.3.2 Conducting an acceptance review	See 5.3.2.12
	5.6.4.2 Supplier's provision of training and support	Only if appropriate
	5.6.4.3 installation planning	Only when installation is required.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
	5.6.4.4 installation activities reporting	Only when installation is required.
	5.6.5.1 Acceptance test planning	Mandatory.
	5.6.5.2 Acceptance test execution	Mandatory.
	5.6.5.4 Supplier's support to customer acceptance	Only in the terms tailored.
	5.7.4 Software operation	Mandatory.
	5.7.5.1 User's assistance	Tailored on a case by case basis.
	5.7.5.2 Handling of user's requests	Tailored on a case by case basis.
	5.7.5.3 Provisions of work around solutions	Tailored on a case by case basis.
	5.8.5.1 Definition of inflight modification capability for flight software	Only for flight software
	5.8.5.2 Definition of functional performance requirements for inflight modification	Only for flight software
	5.9.4.7 Evaluation of test specifications	Traceability of the existing requirements input (RB or TS) to the validation tests is mandatory
	5.9.4.9 Problems and nonconformance handling	Mandatory in a more or less formal way for the selected verification activities
	5.9.5.5 Problem and non-conformance handling	Mandatory, in a more or less formal way.
	5.9.6.1 Introduction	As per review tailoring
	5.9.6.2 Support to software reviews	As per review tailoring
If both Verification and Validation have been waived	5.3.2.11 Qualification Review	QR is meaningless. Otherwise, QR is mandatory.
If both Verification and Validation have been waived for all the versions of the software	5.4.2.3 Identification of requirement unique identifier	Requirement identification is not useful and it may be waived.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If migration is not necessary	5.8.7.1 Application of this Standard to software migration	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.2 Migration planning and execution	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.3 Contribution to the migration plan	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.4 Preparation for migration	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.5 Notification of transition of migrated system	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.6 Post-operation review	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.7.7 Maintenance and accessibility of data of former system	This may be waived. Otherwise, it is mandatory in a more or less formal way.
If no automatic code is generated	5.6.5.3 Executable code generation and installation	It may be waived
If the budget is low	5.5.2.3 Development and documentation of the software user manual	The update may be delayed up to 5.5.4.3
	5.5.3.3 software user manual updating	The update may be delayed up to 5.5.4.3
	5.6.4.1 Preparation and updating of the software product	The delivery preparation may be simplified.
If the budget is low and the complexity is low	5.3.3.1 Interface definition	They may be waived.
	5.3.3.2 Interface management procedures	They may be waived.
If the budget is low and the criticality is low	5.4.2.4 Software requirements evaluation	It may be waived.
	5.4.3.7 Evaluation of the software architectural design and the interface design	The verification may be waived.
	5.5.2.4 Definition and documentation of the software interfaces detailed design	The plan may be waived.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
	5.5.2.6 Evaluation of the detailed design and test requirements	The verification may be waived.
	5.5.3.2 Software unit testing	The unit test reports may remain not documented.
	5.5.3.5 Code and unit test results evaluation	The verification may be waived.
	5.5.4.2 Software units and software components integration tests	The integration test reports may remain not documented.
	5.5.4.4 Software integration activities results evaluation	The verification may be waived.
	5.5.5.2 Conducting a critical design review	The CDR may be waived.
	5.6.5.5 Evaluation of acceptance testing	It may be waived.
	5.9.5.1 Development and documentation of a software validation testing specification	The validation may be limited to a given coverage target, e.g. by validating only the nominal behaviour.
	5.9.5.4 Evaluation of the design,code,test test results and software user manual	The verification may be waived.
	5.9.2 Verification process implementation	The verification may be waived.
	5.9.2.1 Determination of the verification effort for the project	Only necessary if verification is needed
	5.9.2.2 Establishment of the verification process, methods and tools	Only necessary if verification is needed
	5.9.2.3 Selection of the organization responsible for conducting the verification	Only necessary if verification is needed
	5.9.2.4 Development and documentation of a verification plan covering the software verification activities	Only necessary if verification is needed
	5.9.3.1 Determination of the validation effort for the project	The validation plan can be merged with the software development plan
	5.9.3.2 Establishment of a validation process	The validation plan can be merged with the software development plan
	5.9.3.3 Selection of a validation organization	Only necessary if an independant validation is needed
	5.9.3.4 Development and documentation of a validation plan	The validation plan can be merged with the software development plan

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
	5.9.4.1 Verification of software requirements	This activity may be waived
	5.9.4.2 Verification of the software architectural design	This activity may be waived
	5.9.4.3 Verification of the software detailed design	This activity may be waived
	5.9.4.4 Verification of code	This activity may be waived
	5.9.4.5 Verification of software integration	This activity may be waived
	5.9.4.6 Verification of software documentation	This activity may be waived
	5.9.4.8 Verification of software validation with respect to the technical specifications and the requirements baseline	This activity may be waived
	5.9.5.1 Developemnt and documentation of a software validation testing specification	The validation may be limited to a given coverage target, e.g. by validationg only the nominal behaviour
	5.9.5.3 Evaluation of the design, code, tests, tests results, and software user manual	This activity may be waived
	5.9.5.4 Updating the software user manual	This activity may be waived
	5.9.5.6 Test readiness review	This activity may be waived
If the complexity of the interface is low	5.4.3.4 Development and documentation of software interface design	The software architectural design interface and detailed design may be merged.
	5.4.3.6 Definition and documentation of the software integration requirements and test plan	The plan may be delayed to 5.5.2.5.
	5.5.2.2 Development and documentation of the software interfaces detailed design	The software architectural design interface and detailed design can be merged.
If the complexity of the system is low	5.2.4.4 Requirements baseline verification	The verification may be limited to the supplier reading and commenting.
	5.4.2.2 Software logical model definition	It may be waived.
If the customer and the supplier are the same organizational unit because the project is small enough	5.2.4.5 System requirements review	The SRR may be waived in favour of the PDR.
	5.3.2.6 Software requirement baseline at SRR	The SRR may be waived in favour of the PDR.
	5.3.2.12 Acceptance review	The AR may be merged with the QR.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If the design is a tree, but with a low complexity	5.4.3.1 Transformation of software requirements into a software architecture	The software architectural design and the detailed design may be merged.
	5.5.2.1 Detailed design of each software component	The software architectural design and the detailed design can be merged.
If the life cycle is of type concurrent engineering or with short and numerous incremental steps	5.9.6.3 Technical reviews	The reviews will be defined as a set of periodic meetings whose last one only includes the formal review success. The authorisation to start the next phase disappears.
If the operation of the software is of low complexity	5.7.2.1 Operational plans and standards development	The operational plan and standards development may be waived.
	5.7.3.1 Operational testing execution	The operational testing may be waived in favour of the acceptance testing.
If the organization is simple	5.8.6 Maintenance review acceptance	The acceptance may be waived.
If the project is small	5.2.2.1 System requirement specification	The software requirement baseline may be merged with the software specification (software technical baseline).
	5.5.5.1 Software validation with respect to the technical specification	It may be waived when TS=RB.
If the project is small enough and if the design is not complex	5.3.2.9 Critical design review	The CDR may be waived.
If the software is a prototype	5.3.2.10 Software verification and validation process	The validation may be less intensive or waived (validation by the users) because integration is more intensive
	5.4.4 software verification and validation planning	The validation may be less intensive or waived (validation by the users) because integration is more intensive

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If the software is a set of relatively independent services	5.4.3.1 Transformation of software requirements into a software architectural design	The requirement and the software architectural design may be merged.
	5.4.3.4 Development and documentation of the software interfaces	The requirement and the software architectural interface design can be merged.
	5.4.3.5 Development and documentation of software user manual	The software architectural design interface and the software user manual may be merged.
	5.5.2.5 Updating of the software integration test requirements and plan	The plan may be waived.
	5.5.3.4 Updating of the software integration test requirements and plan	The plan may be waived.
If the software is a set of relatively independent services or there is little or no interface	5.5.4.1 Software integration test plan development	The integration may be simplified or waived.
	5.4.3.6 Definition and documentation of the software integration requirements and test plan	The plan may be waived.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If the software is not maintained	5.8.2.1 Software maintenance process planning	This may be waived
	5.8.2.2 Software maintenance process procedures, methods and standards	This may be waived
	5.8.2.3 Problem reporting and handling	This may be waived
	5.8.2.4 Implementation of configuration management process	This may be waived
	5.3.2.5 Identification of interfaces between the development and maintenance processes	It does not exist.
	5.8.3.1 Problem analysis	The analysis may be waived. Otherwise it is mandatory, in a more or less formal way.
	5.8.3.2 Problem verification	This may be waived
	5.8.3.3 Developemnt of options for modifications	This may be waived
	5.8.3.4 Documentation of problem, analysis and implementation	This may be waived
	5.8.3.5 Customer approval of selected modification options	This may be waived
	5.8.4.1 Analysis and documentation of product modification	This may be waived
	5.8.4.2 Documentation of software product changes	This may be waived
	5.8.4.3 Invoking of software engineering process for modification implementation	This may be waived
If the software is not retired independently from the system	5.8.8.1 Retirement planning	This may be waived. Otherwise, it is mandatory in a more or less formal way.
	5.8.8.2 Notification to the operator of a retirement plan	This may be waived Otherwise, it is mandatory in a more or less formal way
	5.8.8.3 Identification of requirements for software retirement	This may be waived Otherwise, it is mandatory in a more or less formal way
	5.8.8.4 Maintenance and accessibility to data of the retired product	This may be waived Otherwise, it is mandatory in a more or less formal way

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If the software is small enough and with a straightforward architecture (e.g. a set of services)	5.3.2.7 Software technical specification phase	The specification and the software architectural design may be merged.
If the stubs needed to unit test a component are equivalent to the real components	5.5.3.2 Software unit testing	The unit test of this component may be replaced by the integration test of this component and its related components.
If the system interface has no possibility to evolve	5.3.3.1 Interface definition	They may be waived.
If the system interface has no possibility to evolve	5.3.3.2 Interface management procedures	They may be waived.
If the system is not critical	5.2.2.2 System and functional criticality analysis	It does not exist.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
If the system is pure software	5.3.3.1 Interface definition	They do not exist.
	5.3.3.2 Interface management procedures	They do not exist.
	5.2.2.1 System requirement specification	The system requirement specification is reduced to user or customer requirements (the software requirement baseline).
	5.2.3.1 Introduction	It does not exist.
	5.2.3.2 System partitioning	It does not exist.
	5.2.4.2 Qualification engineering requirements	It does not exist.
	5.2.4.3 Software validation requirements at system level	It does not exist.
	5.2.5.1 Identification of software observability requirements	It does not exist.
	5.2.5.2 Control and data interfaces for system level integration	It does not exist.
	5.2.5.3 Data medium requirements for integration	It does not exist.
	5.2.5.4 Identification of development constraints	It does not exist.
	5.2.5.5 Identification of customer's inputs for software integration into the system	It is limited to the workstation running the software.
	5.2.5.6 Identification of supplier's output for software integration into the system	It does not exist.
	5.2.5.7 Planning of supplier support to system integrations	It does not exist.
If the technical budget is unlimited (memory size, computer throughput, response time)	5.3.4.1 Software technical budget and margin philosophy definition	It may be waived.
	5.3.4.2 Software technical budget management	It may be waived.
If the V&V environment is the same as the operational environment	5.3.2.12 Acceptance Review	The AR may be merged with the QR.
Tailored according to 5.9. If the criticality is low and the budget is low	5.3.2.10 Software verification and validation processes	The verification may be selective or waived.

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
Tailored as per 5.3.2.10 V&V tailoring. If the budget is low and the criticality is low	5.4.4 software verification and validation	The verification plan may be waived.
If not flight software	6.2.2.1 System observability requirements definition	It may be waived
	6.2.2.2 Software observability data definition	It may be waived
	6.2.2.3 Criteria to define observability requirements	It may be waived
	6.2.3 System level integration of software: system data base	It may be waived
	6.2.4.1 Detailed design review planning	It may be waived
	6.2.4.2 CDR plan for flight software	It may be waived
	6.2.5.1 Definition of a software logical model	It may be waived
	6.2.5.2 Definition of behavioural view for space reactive software	It may be waived
	6.2.6.1 Schedulability analysis	It may be waived
	6.2.6.2 Technical budgets management	It may be waived
	6.2.6.3 Software behaviour modelling and verification techniques	It may be waived
	6.2.6.4 Design feasibility demonstration	It may be waived
	6.2.7.1 Software architectural design contents	It may be waived
	6.2.7.2 Software design method	It may be waived
	6.2.7.3 Selection of a computational model	It may be waived
	6.2.7.4 Description of software dynamic behaviour	It may be waived
	6.2.8.1 Production of software items physical model	It may be waived
	6.2.8.2 Utilization of methods for software static design	It may be waived
	6.2.8.3 Description of the dynamic aspects of physical model	It may be waived
	6.2.8.4 Utilization of description techniques for the software behaviour	It may be waived

Table C-2: (continued)

Tailoring condition	E-40 requirement	Tailoring possibility
	6.2.8.5 Determination of design methods consistency	It may be waived
	6.2.9.1 Schedulability analysis refinement	It may be waived
	6.2.9.2 Technical budgets management	It may be waived
	6.2.9.3 Behavioural model verification	It may be waived
	6.2.10.1 Evaluation of testing feasibility	It may be waived
	6.2.11.1 Schedulabilty analysis refinement	It may be waived
	6.2.11.2 Technical budget update	It may be waived
	6.2.12 Evaluation of validation: complementary system level validation	It may be waived
	6.2.13 Maintenance: long term maintenance	It may be waived
If not flight software for manned space systems	6.2.5.3 Man-machine interface (MMI) prototype for interactive software	It may be waived
	6.3 Ground segment software	
When software is not built to be reused	6.4.2.1 Definition of constraints for software to be reused	It may be waived
	6.4.2.2 Definition of methods and tools for software to be reused	It may be waived
If software is not intended to be reused	6.4.2.3 Evaluation of potential reuse of software	It may be waived
	6.4.3.1 Analysis of potential reusabilty	It may be waived
If no COTS or MOTS are not a part of the software to be produced	6.4.3.2 Software acquisition process implementation	It may be waived
If not interactive space software	6.5.2 Establishment of the need for a MMI mock-up	It may be waived
	6.5.3 MMI standards and guidelines definition	It may be waived
	6.5.4 MMI software mock-up development	It may be waived

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[1)] To be published.