ECSS-Q-HB-80-02 Part 1A
8 October 2010

Space product assurance

Software process assessment and improvement – Part 1: Framework

ECSS Secretariat
ESA-ESTEC
Requirements & Standards Division
Noordwijk, The Netherlands

Foreword

This Handbook is one document of the series of ECSS Documents intended to be used as supporting material for ECSS Standards 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.

The material in this Handbook gives a framework in terms of description and recommendation on how to organize and perform the work for processes assessment in order to assess capability and settle improvements in an organisation.

This handbook has been prepared by the ECSS-Q-80-02 Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

Disclaimer

Published by: ESA Requirements and Standards Division
ESTEC, P.O. Box 299,
2200 AG Noordwijk
The Netherlands

Table of contents

Figures

Tables

Introduction

This handbook provides a framework for the assessment and improvement of software processes for the European space industry and organizations, weather customers or suppliers.

The framework presented in this handbook is called SPiCE for Space (S4S). As its name already mentions, S4S is based on SPICE (Software Process Capability dEtermination), a major international initiative to support the development of ISO/IEC 15504. In turn, ISO/IEC 15504 provides a common internationally recognized framework for the terminology and reference process assessment description.

The process assessment and improvement standardization efforts within the SPICE project have tried to be as general as possible, to be applicable to all domains, including the space domain. The space software development processes are not substantially different from software processes in some other application domains (e.g. defence, public transport), therefore S4S uses the material provided in ISO/IEC 15504 'as is' as much as possible.

The major benefits of using a standardized approach to process assessment and improvement are that it can:

- lead to a common understanding of the use of process assessment for process improvement and capability determination;
- facilitate capability determination in procurement;
- contribute to increase the efficiency and competitiveness of an organization
- be controlled and regularly reviewed in the light of experience of use;
- be changed and improved only by international consensus;
- encourage harmonization of existing schemes

Nevertheless, a number of requirements were identified from the ECSS Standards which appear to be unique, or which are of particular importance for space software processes. All space requirements not adequately represented within the ISO/IEC 15504 process assessment model were addressed and incorporated into S4S.

This Handbook provides the instruments and information to determine the level of process performance and capability, to improve the software processes identifying the changes or additions that should be done, and to ensure that all ECSS requirements are met for a given project. ECSS Standards impose requirements on processes but do not constitute process descriptions themselves.

S4S can be used by an organization to:

- understand the state of its own processes for process improvement;
- determine the suitability of its own processes for a particular requirement or class of requirements;
- determine the suitability of another organization's processes for a particular contract or class of contracts;
- improve weaknesses of organization's processes.

As such, this handbook should be of interest to quality managers, project managers, or software process improvement managers of companies and organizations currently within the space domain or who wish to enter the space domain.

S4S allows managers to focus on particular areas for process improvement.

Organisations performing their own internal assessments can choose to assess a single project, a business unit, or the entire organization, as deemed appropriate. The assessment responsible can select which processes to assess up to which capability level.

Organisations willing to improve their overall quality require using a proven, consistent and reliable method for assessing the state of their processes. They need also the means to use the results as part of a coherent improvement programme. The use of process assessment and improvement within an entire organization enables:

- a culture of constant improvement and the establishment of proper mechanisms to support and maintain that culture;
- the definition and implementation of processes to meet business goals;
- to better control resources, cost and schedule;
- to increase the quality of products and processes;
- to increase the efficiency and competitiveness of an organization.

Customers can also benefit from the use of process assessment and improvement. Its use as means for capability determination or in a conformance assessment can:

- reduce uncertainties in selecting suppliers of software by enabling the risks associated with the supplier's capability to be identified before contract award;
- enable appropriate controls to be put in place for risk containment;
- provide a quantified basis for choice in balancing business needs, requirements and estimated project cost against the capability of competing suppliers.

1
Scope

This handbook defines methods for process assessment and improvement that may be used to meet the requirements on process assessment and improvement of the ECSS-Q-ST-80C subclause 5.7. These methods constitute a clear and proven way of implementing those requirements. Alternative methods can be used provided that they meet the detailed instructions provided in this handbook for recognition of software process assessment schemes and results and process improvement.

This handbook provides a detailed method for the implementation of the requirements of the ECSS-Q-ST-80C for software process assessment and improvement. It also establishes detailed instructions for alternative methods intended to meet the same ECSS-Q-ST-80C requirements.

The process assessment and improvement scheme presented in this handbook is based on and conformant to the ISO/IEC 15504 International Standard. In designing this process assessment and improvement scheme the ISO/IEC 15504 exemplar process assessment model was adopted and extended to address ECSS specific requirements.

The methods provided in this handbook can support organizations in meeting their business goals and in this context they can be tailored to suit their specific needs and requirements. However when used to claim compliance with relevant requirements in ECSS-Q-ST-80C only the steps and activities explicitly marked as recommended in this handbook may be omitted or modified.

2 References

ISO/IEC 15504: 2003-2006	Information technology – Process assessment Part 1: Concepts and vocabulary (normative) Part 2: Performing an assessment (normative) Part 3: Guidance on performing an assessment (informative) Part 4: Guidance on use for process improvement and process capability determination (informative) Part 5: An exemplar process assessment model (informative)
ISO/IEC 12207: 2004 Amd 1/Amd2	Information Technology – Software life cycle processes

List of ECSS documents defining the Process Reference Model

ECSS-S-ST-00-01	ECSS System - Glossary of terms
ECSS-M-ST-10C rev.1	Space project management - Project planning and implementation
ECSS-M-ST-10-01C	Space project management - Organization and conduct of reviews
ECSS-M-ST-40C rev.1	Space project management - Configuration and information management
ECSS-M-ST-60C	Space project management - Cost and schedule management
ECSS-M-ST-80C	Space project management - Risk management
ECSS-Q-ST-10C	Space product assurance - Product assurance management
ECSS-Q-ST-10-04C	Space product assurance - Critical-item control
ECSS-Q-ST-10-09C	Space product assurance - Nonconformance control system
ECSS-Q-ST-20C	Space product assurance - Quality assurance
ECSS-Q-20-07A	Space product assurance - Quality assurance for test centres

ECSS-Q-ST-30C	Space product assurance - Dependability
ECSS-Q-ST-40C	Space product assurance - Safety
ECSS-Q-ST-80C	Space product assurance - Software product assurance
ECSS-E-ST-10C	Space engineering - System engineering general requirements
ECSS-E-ST-10-02C	Space engineering - Verification
ECSS-E-10-03A	Space engineering - Testing
ECSS-E-ST-40C	Space engineering - Software

3
Terms, definitions and abbreviated terms

3.1 Terms from other documents

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

3.2 Terms specific to the present document

3.2.1 accreditation

procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks

[ISO Guide 2]

3.2.2 assessment indicator

an objective attribute or characteristic of a practice or work product that supports the judgment of the performance of, or capability of, an implemented process

[ISO/IEC 15504-1]

3.2.3 assessment instrument

a tool or set of tools that is used throughout an assessment to assist the assessor in evaluating the performance or capability of processes and in handling assessment data and recording the assessment results

[ISO/IEC 15504 Part 1]

3.2.4 assessment method

process and associated set of procedures and supporting instruments that guide and support the performance of a process assessment meeting defined requirements

3.2.5 assessment process

set of interrelated activities to plan, manage and execute an assessment

NOTE Includes definition of these activities, of their input and output, and of their interrelationships

3.2.6 assessment purpose

a statement, provided as part of the assessment input, which defines the reason for performing the assessment

[ISO/IEC 15504 Part 1]

3.2.7 assessment scope

a definition of the boundaries of the assessment, provided as part of the assessment input, encompassing the organizational limits of the assessment, the processes to be included, and the context within which the processes operate (see process context)

[ISO/IEC 15504 Part 1]

3.2.8 base practice

an activity that, when consistently performed, contributes to achieve the purpose of a particular process

[ISO/IEC 15504 Part 5]

NOTE This term corresponds to ECSS detailed activities or tasks.

3.2.9 capability dimension

the set of process attributes comprising the capability aspects of the reference model of processes and process capability

[ISO/IEC 15504 Part 1]

3.2.10 capability profile

representation of all achieved processes capability levels derived from the processes attribute ratings for the assessed processes respectively

NOTE See process capability level rating.

3.2.11 certification

procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements

[ISO Guide 2]

3.2.12 certified S4S assessor

person who is in possession of a certificate, granted by a certification body, attesting that he meets the criteria to perform assessments conformant with the methods in this Handbook

3.2.13 competent assessor

an assessor who has demonstrated the competencies to conduct an assessment and to monitor and verify the conformance of a process assessment

[ISO/IEC 15504 Part 1]

3.2.14 conformant assessment model

an operational model, used for performing assessments, which meets the defined requirements (for model purpose, scope, elements and indicators, mapping to the reference model, and translation of results) for conformance

[ISO/IEC 15504 Part 1]

3.2.15 defined process

a process that is managed (planned, monitored and adjusted), tailored from the organization's set of standard processes according to the organization's tailoring guidelines

NOTE A defined process has a maintained process description; and contributes work products, measures, and other process improvement information to the organization's process assets. A project's defined process provides a basis for planning, performing, and improving the project's tasks and activities.

[ISO/IEC 15504 Part 1]

3.2.16 generic practice

a management activity that addresses the implementation of a specific process attribute associated to any capability level from level 2 up to level 5

[ISO/IEC 15504 Part 5]

3.2.17 generic practice indicator

activity of a generic type that provides guidance on the implementation of process attribute's characteristics

[ISO/IEC 15504 Part 5]

3.2.18 generic resource indicator

associated resource that may be used when performing a process in order to achieve a process attribute's outcomes

[ISO/IEC 15504 Part 5]

3.2.19 generic work-product indicator

A work product that is typically related to the enactment of the process, when it achieves the process attribute outcomes

[ISO/IEC 15504 Part 5]

3.2.20 implemented process

basis on which the performance of, or capability of, a process is assessed

3.2.21 indicator (assessment indicator)

an objective attribute or characteristic of a practice or work product that supports the judgment of the performance of, or capability of, an implemented process

[ISO/IEC 15504 Part 1]

3.2.22 organizational unit

the part of an organization that is the subject assessed

NOTE 1 An organizational unit deploys one or more processes that have a coherent process context and operates within a coherent set of business goals.

NOTE 2 An organizational unit is typically part of a larger organization, although in a small organization, the organizational unit may be the whole organization. An organizational unit may be, for example:

- a specific project or set of (related) projects;
- a unit within an organization focused on a specific life cycle phase (or phases) such as acquisition, development, maintenance or support;
- a part of an organization responsible for all aspects of a particular product or product set.

[ISO/IEC 15504 Part 1]

3.2.23 process assessment

a disciplined evaluation of an organization's processes against a model compatible with the reference model

[ISO/IEC 15504 Part1]

3.2.24 process assessment model

a model describing life cycle processes, based on good engineering and process management principles and suitable for the purpose of assessing process capability

[ISO/IEC 15504 Part 1]

3.2.25 process attribute

a measurable characteristic of process capability applicable to any process

[ISO/IEC 15504 Part 1]

3.2.26 process attribute rating

a judgment of the level of achievement of the defined capability of the process attribute for the assessed process

[ISO/IEC 15504 Part 1]

3.2.27 process capability

the ability of a process to achieve a required goal or contribute (along with other processes) to the achievement of required goal

[ISO/IEC 15504 Part 1]

3.2.28 process capability determination

a systematic assessment and analysis of selected software processes within an organization against a target capability, carried out with the aim of identifying the strengths, weaknesses and risks associated with deploying the processes to meet a particular specified requirement

[ISO/IEC 15504 Part 1]

3.2.29 process capability level

a point on the six-point ordinal scale (of process capability) that represents the increasing capability of the performed process; each level builds on the capability of the level below

[ISO/IEC 15504 Part 1]

3.2.30 process capability level rating

a representation of the achieved process capability level derived from the attribute ratings for an assessed process

[ISO/IEC 15504 Part 1]

3.2.31 process category

a set of processes addressing the same general area of activity

NOTE The process categories address five general areas of activity: customer-supplier, engineering, support, management, and organization.

[ISO/IEC 15504 Part 1]

3.2.32 process context

the set of factors, documented in the assessment input, that influence the judgment, comprehension and comparability of process attribute ratings

[ISO/IEC 15504 Part 1]

3.2.33 process dimension

the set of processes comprising the functional aspects of the reference model of processes and process capability

NOTE 1 The process dimension is provided by an external Process Reference Model in 15504-2.

NOTE 2 The processes are grouped into categories of related activities in 15504-5.

[ISO/IEC 15504 Part 1]

3.2.34 process improvement

action taken to change an organization's processes so that they more effectively meet the organization's business needs

[ISO/IEC 15504 Part 1]

3.2.35 process improvement action

an action planned and executed to improve all or part of the process

NOTE A process improvement action can contribute to the achievement of more than one process goal.

[ISO/IEC 15504 Part 1]

3.2.36 process improvement project

any subset of the process improvement programme that forms a coherent set of actions to achieve a specific improvement

[ISO/IEC 15504 Part 1]

3.2.37 process performance

the extent to which the execution of a process achieves its purpose

[ISO/IEC 15504 Part 1]

3.2.38 process profile

the set of process attributes ratings for an assessed process

[ISO/IEC 15504 Part 1]

3.2.39 process purpose

the high level measurable objectives of performing the process and the likely outcomes of effective implementation of the process

[ISO/IEC 15504 Part 1]

NOTE It corresponds to ECSS processes or detailed activities or tasks.

3.2.40 process reference model

a model comprising definitions of processes in a life cycle described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes

[ISO/IEC 15504 Part 1]

3.2.41 process tailoring

to make, alter, or adapt a process description for a particular end. For example, a project tailors its defined process from the organization's set of standard processes to meet the objectives, constraints, and environment of the project

[CMMI]

3.2.42 provisional assessor

a person who has the skills and competencies to carry out assessments under the guidance and supervision of a competent assessor

[ISO/IEC 15504 Part 1]

3.2.43 reference method

minimum set of instructions for performing process assessments

3.2.44 standard process

the set of definitions of the basic processes that guide all processes in an organization

NOTE 1 These process descriptions cover the fundamental process elements (and their relationships to each other) that must be incorporated into the defined processes that are implemented in projects across the organization. A standard process establishes consistent activities across the organization and is desirable for long-term stability and improvement.

NOTE 2 The organization's set of standard processes describes the fundamental process elements that will be part of the projects' defined processes. It also describes the relationships (for example, ordering and interfaces) between these process elements.

[ISO/IEC 15504 Part 1]

3.2.45 tailored process

a defined process developed by tailoring a standard process definition

[ISO/IEC 15504 Part 1]

NOTE Tailoring is a process by which individual requirements or specifications, standards and related documents are evaluated and made applicable to a specific project. This process can result in deletion, addition or modification of requirements.
[ECSS-S-ST-00-01]

3.2.46 target capability

the capability level that represents the organization's objective for each process while advancing through the capability levels

NOTE Capability determination assessments can be performed without target capability requirements.

3.2.47 work product

an artefact associated with the execution of a process

NOTE A work product might be used, produced or changed by a process.

[ISO/IEC 15504 Part 1]

NOTE It corresponds to ECSS expected outputs.

3.3 Abbreviated terms

For the purpose of this document, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AS	Assessment Sponsor
AP	Assessment Participants
AP	Assessment Participants
AT	Assessment Team
ATL	Assessment Team Leader
CMMI	Capability Maturity Model Integration
ECSS	European Cooperation for Space Standardization
GPI	Generic Practice Indicator
IEC	International Electrotechnical Commission
IPL	Improvement Project Leader
IPM	Improvement Programme Manager
ISO	International Organisation For Standardization
LAC	Local Assessment Coordinator
OU	Organisational Unit
PA	Process Attribute
PCI	Process Capability Indicator
PAQ	Pre-Assessment Questionnaire
PO	Process Owner
QAI	Quality Assurance Institute
S4S	SPICE for Space
SPI	Software Process Improvement
SPIG	Software Process Improvement Group
SPICE	Software Process Improvement and Capability dEtermination
TM	Top Management
TN	Technical Note

4
Organisation and purpose

4.1 Organization of this handbook

This handbook is organized in eight main clauses:

- Clause 1: Scope of the handbook
- Clause 2: Normative references
- Clause 3: Terms, definitions and abbreviated terms
- Clause 4: Introduction to the organization and purpose of space software process assessment
- Clause 5: Space software process assessment model
- Clause 6: Space software process assessment
- Clause 7: Space software process improvement
- Clause 8: Recognition of assessment schemes and results

Annex A provides proposed target capability profiles for different dependability and safety classes.

Annex B provides templates for some of the assessment process work product.

Annex C provides useful bibliography.

4.2 Relation to Standards

4.2.1 Relation versus the ECSS family

4.2.1.1 Relation to software engineering

ECSS-E-ST-40C which covers all aspects of space software engineering from requirements definition to retirement are matched with the S4S model provided by this handbook.

Requirements related to system engineering are also used from the ECSS-E-ST-10C.

4.2.1.2 Relation to software product assurance

One of the S4S's goals is to provide support to the implementation of ECSS-Q-ST-80C subclause 5.7 requirements related to process assessment and improvement and subcontractor selection and control.

ECSS-Q-ST-80C standard presents software product assurance requirements to be met in a particular space project to provide confidence to the customer and to the suppliers that developed or reused

software satisfies the requirements throughout the system lifetime. In particular, to ensure the software is developed to perform properly and safely in the operational environment meeting the quality objectives agreed for the project.

The requirements from ECSS-Q-ST-80C are matched with the S4S scheme provided by this handbook.

In addition, ECSS-Q-ST-80C provides requirements about a metrics programme that shall be used to manage the development and to assess the quality of the development process. The performance of software process assessments can be used to assess the quality of the software processes.

Several requirements related to general Product Assurance, Dependability and Safety that are also applicable to software are also used by the process model defined in part 2.

4.2.1.3 Relation to project management

The ECSS-M branch defines the requirements to be applied to the management of space projects. ECSS-E-ST-40C and ECSS-Q-ST-80C describe how the ECSS-M standards apply to the management of software projects.

Special attention is given to the interfaces with the ECSS-M-ST-80C standard about risk management.

The risk management process can benefit from inputs from the process assessment in aspects related to, for example, how to address project and organizational risks arising from inappropriate process management. And vice-versa, the software process improvement process can benefit with the use of inputs coming from the risk management process, for example to substantiate the recommendations for improvement actions by demonstrating the risks of not implementing the actions.

4.2.2 Relation versus ISO/IEC

As already mentioned above, in forming the S4S model for space software processes, the ISO/IEC 15504 Part 5, exemplar assessment model that is compatible with the ISO/IEC 12207 process reference model, was adopted as-is, including all process indicators from ISO/IEC 15504 Part 5. The Part 2 which provides the method for assessment was used in full to built the present part of the handbook.

ECSS requirements were analysed and compared to processes and base practices within S4S. ECSS software processes are shown in Figure 1.of the ISO/IEC 15504 Part 5. New base practices and even new processes were created to complete the process model with additional requirements enforced by the software requirements for space.

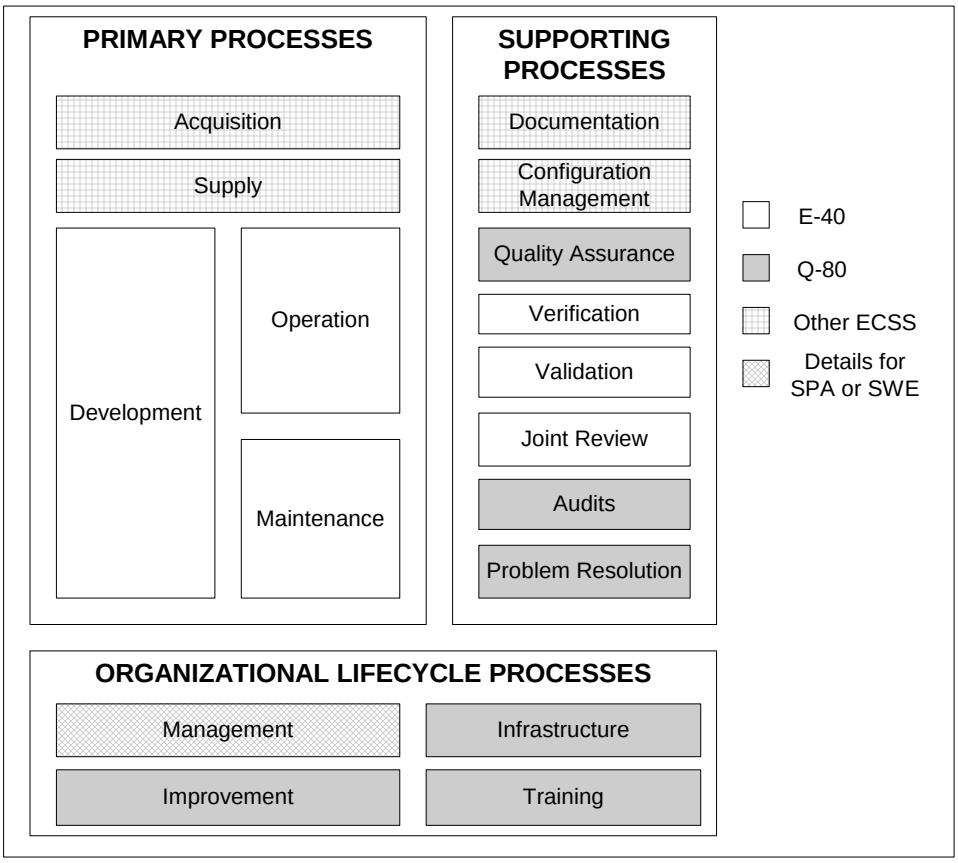


Figure 1 SW life cycle processes in ECSS Standards (ECSS-E-ST-40C and ECSS-Q-ST-80C)

The formulation of the requirements of both the ECSS-E-ST-40C and ECSS-Q-ST-80C standards takes into account the ISO/IEC 12207:1995 standard. All ECSS activities or expected outputs missing in the ISO/IEC 15504 exemplar process assessment model, that is based on the ISO/IEC 12207/Amd 2:2004, are reflected and added to the process dimension as new processes, base practices, work products, or work product characteristics. These new processes and process indicators properly incorporate space software requirements into the S4S assessment model. In adding new elements to the process dimension, the level of granularity found in the ISO/IEC 15504 exemplar process assessment model was maintained with no conflict with ECSS structure and requirements.

4.3 S4S process assessment and improvement overview

4.3.1 S4S architecture

The S4S assessment model expands the ISO/IEC 15504 exemplar process assessment model by a) adding new processes in the process dimension, which are specified by the ECSS Standards, and by b) adding the definition and use of assessment indicators. Indicators for process performance are the base practices, the work products, and the work product characteristics.

The capability dimension is taken as provided in the ISO/IEC 15504 exemplar assessment model. Indicators for process capability are generic practice, generic resource, generic work-product, and related processes.

Part 2 of ISO/IEC 15504 defines the requirements for process reference models and process assessment models that forms the basis for any model to be used for software process assessments. Any model conformant with the requirements for process assessment models may be used for such assessments, since the output of conformant assessments can be translated into comparable results.

The S4S process assessment model architecture described in clause 5 extends into two dimensions:

- the process dimension, which is characterized by process purposes which are the essential measurable objectives of a process;
- the process capability dimension, which is characterized by a series of process attributes, applicable to any process, which represent measurable characteristics of a process.

The S4S assessment scheme provides a complete software process assessment method for the comprehensive and objective evaluation of all software related activities required by the ECSS-M, -E, and -Q series of space standards. The method described in clause 6 of this handbook can be used by or on behalf of a space software supplier to improve its own processes, determine the capability of another organization's processes or determine that its own processes meet ECSS requirements. S4S is defined to be a conformant process assessment with regard to ISO/IEC 15504.

The S4S method defines how to perform the assessment itself, the different roles and responsibilities for the different activities for the performance of the assessment process and some templates for the assessment outputs.

This handbook includes instructions for defining requirements for competencies of assessors. To ensure successful assessments, it is important that the assessment team leader be a competent assessor.

4.3.2 S4S assessment purposes

S4S process assessment can have three types of purposes for its use:

- Process capability determination (subclause 6.3.3):: this purpose is concerned with analysing the proposed capability of selected processes often against a defined (in the assessment scope) target capability level. Capability determination can be meaningful without a target profile. One example of such a scenario is an organization wanting to have a documented capability profile to support bids for contracts. A proposed target capability level can be based on the results of relevant previous process assessments, or can be based on an assessment carried out for the purpose of establishing the proposed capability.
- Process improvement (subclause 6.3.4 and clause 7): this purpose provides the means of characterizing the current practice within an organizational unit in terms of the capability of the selected processes. Analysis of the assessment results in the light of the organization's business needs, identifies strengths, weaknesses and risks inherent in the processes. This, in turn, leads to the ability to determine whether the processes are effective in achieving their goals, and to identify significant causes of poor quality, or overruns in time or cost. These provide the drivers for prioritizing improvements to processes.
- Conformance assessment (subclause 6.3.5):: these assessments can be performed by or on behalf of an organization with the purpose of determining the conformance of its own processes to the ECSS requirements. ECSS conformance assessments are based on the interpretation of both the data to be collected and on the scheme for rating to be used in the process assessment. There are base practices and work products associated with ECSS requirements that become “mandatory” indicators in an ECSS conformance assessment.
  Instead, in assessments for process improvement or capability determination, these and all other indicators simply support the assessor’s judgement and are not verified individually.

4.4 Use of other schemes and standards

Other software process assessment and improvement schemes are being used by European organizations and industry for the purpose of assessment and improvement of software processes. These other schemes generally do not cover all ECSS specific requirements for space systems.

From the above, it is clear that a set of rules is then needed on how to recognize the assessment scheme used as well as the results obtained from its use (including the ones performed using S4S itself).

Compatibility rules and how to get recognition of the validity of the scheme used, including the use of other schemes like CMMI (specifying the additions needed) to cover any specific gap with respect to space requirements is presented in clause 8 of this handbook as well as rules for the recognition of the results obtained through the use of S4S or through the use of other assessment and improvement schemes like: CMMI, or ISO/IEC 15504 Part 5.

5
S4S process assessment model

5.1 Introduction

This clause uses the ISO/IEC 15504 framework to define the S4S process assessment model. The resulting S4S assessment model takes into account space specific requirements as stated in the ECSS-M, -E and -Q series of space standards.

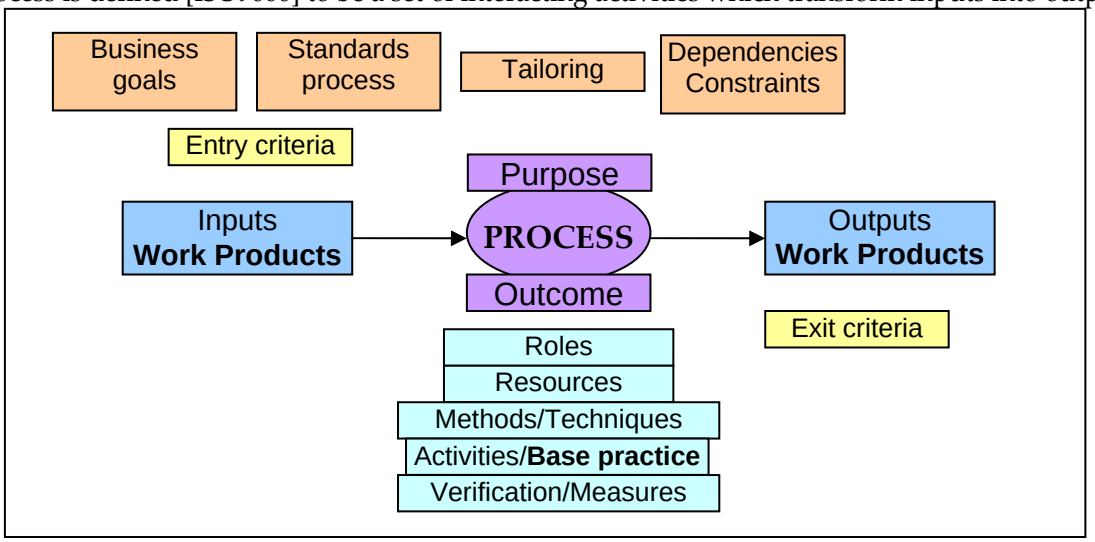
This clause defines the software process assessment model which architecture is composed by two main components: the process dimension and the capability dimension. Any model conformant with the requirements of ISO/IEC 15504 Part 2 (see clause 8 of this handbook) can be used for such assessments, since the output of conformant assessments can be translated into comparable results.

The process assessment model architecture extends into two dimensions:

- The process dimension, characterized by both process purposes which are the essential measurable purpose of a process; and process outcomes. Different process categories can be identified in the process dimension being in turn composed of groups of processes. Each basic process within each group is described in terms of the following five aspects: process identifier, process name, process purpose, process outcomes, process notes.
- The process capability dimension, characterized by a series of process attributes, applicable to any process and which represent measurable characteristics of the process performance capability.

5.2 S4S process dimension

A process is defined [ISO9000] to be a set of interacting activities which transform inputs into outputs.



The S4S process assessment model groups all processes relevant for software into three process categories as shown in Table 1:

- Primary life cycle processes
- Supporting life cycle processes
- Organizational life cycle processes

Table 1 S4S process categories and groups

Process categories	Process groups	Description
Primary life cycle processes	Acquisition	Processes that are directly performed by the customer in order to acquire a product, a service or both.
	Supply	Processes performed by the supplier in order to supply a product, a service or both.
	Operation	Processes that support the transition of the product to the customer, and provide for correct operation and use of the software product a service or both.
	Engineering	This process group consists of processes that directly elicit and manage the customer's requirements, specify, implement or maintain the software product and its relation to the system.
Supporting life cycle processes	Supporting	Processes that provide assurance that work products and processes conform to predefined provisions and plans

Process categories	Process groups	Description
Organizational life cycle processes	Management	Processes that contain practices of a generic nature that can be used by anyone who manages any type of project or process within a software life cycle.
	Process improvement	Processes that define, deploy and improve the processes performed in the organizational unit.
	Resource and Infrastructure	Processes that provide adequate human resources and necessary infrastructure as required by any other process performed by the organizational unit.
	Reuse	Processes that systematically exploit reuse opportunities in organization's reuse programs

The process categories and all their processes, included in the process dimension of the process assessment model, are listed in Table 2.

Table 2 S4S set of processes

Primary life cycle processes	
Acquisition process group(ACQ)	ACQ.1 Acquisition preparation ACQ.2 Supplier selection ACQ.3 Contract agreement ACQ.4 Supplier monitoring ACQ.5 Customer acceptance ACQ.6(*) Contract maintenance
Supply process group (SPL)	SPL.1 Supplier tendering SPL.2 Product release SPL.3 Product acceptance support
Operation process group (OPE)	OPE.1 Operational use OPE.2 Customer support
Engineering process group (ENG)	ENG.1 Requirements elicitation ENG.2 System requirements analysis ENG.3 System architecture design ENG.4 Software requirements analysis ENG.5 Software Design ENG.6 Software construction ENG.7 Software integration ENG.8 Software testing ENG.9 System integration ENG.10 System testing ENG.11 Software installation ENG.12 Software and system maintenance
Supporting life cycle processes	

Supporting process (SUP)	SUP.1 Quality assurance SUP.2 Verification SUP.3 Validation SUP.4 Joint review SUP.5 Audit SUP.6 Product evaluation SUP.7 Documentation SUP.8 Configuration management SUP.9 Problem resolution SUP.10 Change request management SUP.11(*) Safety and dependability assurance SUP.12(*) Independent software verification and validation
Organizational life cycle processes	
Management process group (MAN)	MAN.1 Organizational alignment MAN.2 Organization management MAN.3 Project management MAN.4 Quality management MAN.5 Risk management MAN.6 Measurement MAN.7(*) Information management
Process improvement process group (PIM)	PIM.1 Process establishment PIM.2 Process assessment PIM.3 Process Improvement
Resource and infrastructure process group (RIN)	RIN.1 Human resource management RIN.2 Training RIN.3 Knowledge management RIN.4 Infrastructure
Reuse process group (REU)	REU.1 Asset Management REU.2 Reuse program management REU.3 Domain engineering
(*) : processes added in this handbook w.r.t. the ones in ISO/IEC 15504 Part 5	

Each process is described in the following terms in the Process Model (Part 2):

- **Process identifier**: This identifies the process category and the sequential number within that category. The identifier consists of two parts: a process group abbreviation (e.g. ENG for the engineering process group) and a number (e.g. ACQ.2 denotes the supplier selection process, a process from the acquisition process group).
- **Process name**: A descriptive phrase that encapsulates the main concern of the process (e.g. Supplier selection).
- **Process purpose**: A paragraph that states the purpose of the process describing at a high level the overall purpose of performing the process. Optionally an additional paragraph may be included to further define the purpose statement.
- **Process outcome**: A process outcome is an observable result of the successful implementation of a process. The process outcomes for each process are contained in a list which appears in the

description of each process immediately after the phrase, "As a result of successful implementation of the process:"

- **Process notes**: An optional list of informative notes regarding the process and its relation to other processes.

Then, the description of each process is complemented with a comprehensive set of indicators of process performance, called **base practices** and a list of expected **work products**. A base practice is an activity that addresses explicitly at least one of the stated outcomes of a particular process. Consistently performing the base practices associated with a process leads to a successful performance of the process.

Table 3 Process description components

Process description component	ECSS term
Process ID + Process name	Requirements, process, activity or task name
Process purpose	Requirement, process, activity or task definition
Process outcome	Requirements, process or activity definition
Process notes	
Base practices	
Input work products	Expected outputs as resulting from the execution of other activities or tasks which are defined as inputs to activities or tasks
Output work products	Expected outputs as resulting from the execution of the activity or task

For each base practice:

Base practice description component	ECSS term
Base practice ID	
Base practice name	Activity or task name
Base practice purpose	Activity or task definition
Base practice notes (S4S notes are printed in italics)	

The base practices are described at an abstract level, usually in one sentence. This sentence describes "what" should be done without specifying "how". Implementing only the base practices of a process represents merely the first step in building process capability, but the base practices represent the unique, functional activities of the process, even if that performance is not systematic.

Input and output work products are associated with each process. The performance of the base practices can thus be verified through examination of these work products.

The requirements from ECSS Standards or activities from space software processes were matched with S4S process assessment model processes and base practices.

In addition, the process dimension was augmented with space specific processes and base practices. All of the exemplar software process assessment model work products in ISO/IEC 15504 Part 5 are

embedded in S4S, as they were either matched with the expected outputs of ECSS requirements or, where no match was found, remain in S4S as-is. New work products and work product characteristics were created to represent ECSS outputs not covered by the ISO/IEC 15504 exemplar model. These new processes and process indicators properly incorporate space software requirements into the S4S process assessment model.

5.3 The capability dimension

5.3.1 General

The capability dimension defines a measurement scale for the capability of any process. A six point ordinal scale is defined, representing an increasing capability of the performed process. At the bottom end of the scale, process performance does not achieve the purpose of the process, while at the top end of the scale, process performance is capable to meet relevant process and improvement goals that are explicitly derived from the organization's business goals. The scale therefore derives a well-defined route for improvement for each individual process.

5.3.1.1 Capability level

The scale adopted in this handbook is the one from ISO/IEC 15504 Part 5. There are no space specific modifications.

- **Level 0: Incomplete process**
  The process is not implemented, or fails to achieve its process purpose. At this level there is little or no evidence of any systematic achievement of the process purpose. Systematic achievement is characterized by the routine performance of necessary actions and the presence of appropriate input and output work products which, collectively, ensure that the process purpose is achieved. Determination of a process as being level 0 is largely based on the lack of adequate objective evidence to consider it to be operating.

- **Level 1: Performed process**
  The implemented process achieves its purpose. The process achieves its purpose through:

  a. the performance of necessary actions and

  b. the presence of appropriate input and output work products which, collectively ensure that the purpose is achieved.

  Capability level 1 focuses exclusively on the extent to which the outcomes defined for the process are achieved. A process outcome describes one or more of the following:

  - production of an artefact;
  - a significant change of state;
  - meeting of specified constraints, e.g. requirements or goals.

  Accordingly, assessors need to focus their attention on work products and actions which relate to one or more of the above process outcomes, depending on the nature of the particular process outcome being considered.

- **Level 2: Managed process**
  The previously described Performed process is now implemented in a managed fashion and its work products are appropriately established, controlled and maintained. The primary distinction from the Performed Level is that the performance of the process is now planned,

monitored and adjusted to deliver work products that fulfil expressed requirements. Thus, the essential elements of the managed process are the management of its performance and the explicit focus on work product management. The critical role that proactive management of these two aspects of the process fulfils is to increase assurance that what is produced is what is needed and that the process operates in a more predictable manner.
The proactive management of the process results in artefacts, activities or both which are verifiable (e.g. planning and plans, monitoring mechanisms and adjustments to the process based upon the results of comparison of the planned versus actual performance of the process).

- **Level 3: Established process**
  The previously described Managed process is now implemented using a defined process capable of achieving its process outcomes. The process is performed using a defined process tailored from an established and maintained standard process. The standard process identifies resources – both human and infrastructure – needed for performance of the process, and these are incorporated into the defined process. Appropriate data are collected to identify opportunities for understanding and improving both the standard process and the defined process.
  The primary distinction from the Managed Level is that the process of the Established Level is a defined process tailored from a standard process.
  Capability level 3 provides the foundation for progression to the next level of process capability by establishing a standard process which is tailored and effectively deployed along with the infrastructure needed to provide the basis for a closed loop feedback cycle for process improvement.

- **Level 4: Predictable process**
  The previously described Established process now operates within defined limits to achieve its process outcomes. The Predictable process operates consistently within defined limits to achieve its process outcomes; in addition, its implementation is supported and driven through quantitative information derived from relevant measurement. The performance of processes which operate at capability level 4 are quantitatively managed and behave in predictable ways to support overall business goals. Special causes of variation in performance are addressed.
  The primary distinction from the Established Level is that the defined process is now performed consistently within defined limits to achieve its process outcomes.

- **Level 5: Optimizing process**
  The previously described Predictable process is continuously improved to meet relevant current and projected business goals. The Optimizing process is changed and adapted in an orderly and intentional manner to effectively respond to changing business goals; this takes place on an ongoing basis. This level of process capability depends fundamentally on the quantitative understanding of process behaviour that is the hallmark of a predictable process.
  A process operating at capability level 5 exhibits three critical behaviours that distinguish it from a predictable process. Firstly, a proactive focus on continuous improvement in the fulfilment of both current and projected (relevant) business goals of the organizational unit; that is, an intentional and planned effort to improve the effectiveness and efficiency of the process. Secondly, an orderly and planned approach to identifying appropriate changes to the process and introducing them so as to minimize undesired disruption to the operation of the process. Finally, the effectiveness of the changes is evaluated against actual results and adjustments are made as necessary to achieve desired product and process goals.
  Performance of the predictable process is continuously improved to meet current and projected business goals. Quantitative objectives for improvement of process performance are established, based on the relevant business goals of the organizational unit. Data are collected and analysed to identify opportunities for best practice and innovation; common causes of variation in

performance are identified and addressed.
Optimizing a process involves piloting innovative ideas and technologies and changing non-effective processes to meet defined goals or objectives.
The primary distinction from the Predictable Level is that the defined and standard processes now dynamically change and adapt to effectively meet current and projected business goals.

5.3.1.2 Process attributes and rating scale

Within the capability dimension of the software process assessment model, the measure of capability is based upon a set of process attributes (Table 4). Process attributes are used to determine whether a process has reached a given capability. Each attribute measures a particular aspect of the process capability. There is no ordering between process attributes.

The process attributes are themselves evaluated on a four point ordinal scale of achievement and therefore provide a more detailed insight into the specific aspects of process capability to support process improvement and capability determination.

- **N -** *Not achieved*: 0 % to 15 % - There is little or no evidence of achievement of the defined attribute.
- **P -** *Partially achieved*: 16 % to 50 % - There is evidence of a sound systematic approach to and achievement of the defined attribute. Some aspects of achievement can be unpredictable.
- **L -** *Largely achieved*: 51 % to 85 % - There is evidence of a sound systematic approach to and significant achievement of the defined attribute. Performance of the process can vary in some areas or work units.
- **F -** *Fully achieved*: 86 % to 100 % - There is evidence of a complete and systematic approach to and full achievement of the defined attribute. No significant weaknesses exist across the defined organizational unit.

The capability level achieved by a process is derived from the attribute ratings for that process according to the process capability level algorithm defined in the following table.

Table 4 Capability levels and process attributes

	Process Capability Level					
Process Attributes (PA)	**0**	**1**	**2**	**3**	**4**	**5**
PA.1.1 Process performance	N or P	L or F	F	F	F	F
PA.2.1 Performance management			L or F	F	F	F
PA.2.2 Work product management			L or F	F	F	F
PA.3.1 Process definition				L or F	F	F
PA.3.2 Process deployment				L or F	F	F
PA.4.1 Process measurement					L or F	F
PA.4.2 Process control					L or F	F
PA.5.1 Process innovation						L or F
PA.5.2 Process optimization						L or F

The presence of base practices, work products, and work product characteristics, provide evidence of the performance of the processes associated with them. Similarly, the presence of generic practices provides evidence of process capability.

Additional support for process capability determination from levels 2 to 5 are described in the form of assessment indicators to be used when assessing the above process attributes. These assessment indicators are of one of the following types:

- **Generic practice**: management activity that addresses the implementation of a specific process attribute associated to any capability level 2 to 5.
- **Generic resource**: resource associated to a process, that can be used when performing the process in order to achieve its outcomes. These resources can be human resources, tools, methods and infrastructure.
- **Generic work-product**: a work product that is typically related to the enactment of the process, when it achieves the process attribute outcomes. These work products are subsets of the work products defined as process performance indicators. They are generally produced by related-processes, which contribute to the considered attribute achievement. This aspect is strongly related to the links that exist between processes and the capability levels of the process assessment model.
- **Related processes**: the related-processes indicators identify processes from the process dimension of the process assessment model, linked with the attribute: performance of such a process supports the organizational units ' other processes to achieve the outcomes of the considered attribute.

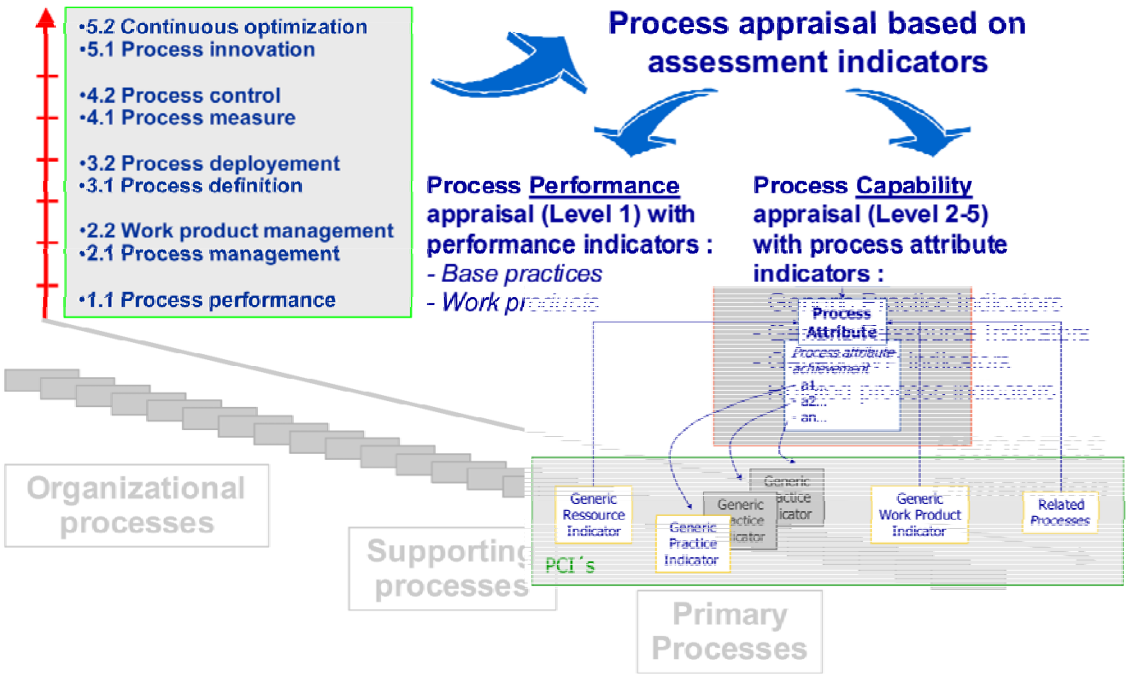


Figure 2 Relationship between assessment indicators and process capability.

The following subclauses present the process attribute indicators related to the process attributes and capability levels defined in the process capability dimension of the S4S model. These process attribute indicators together with the work product characteristics are the indicators of process capability and are the means of achieving the capabilities addressed by process attributes.

Specific indicators are linked to each process attribute as shown in this subclause. The indicators of process capability (detailed in Part 2 of this handbook) help to establish objective evidence about the degree of achievement of the process attribute.

The capability dimension of the model consists of six capability levels as mentioned above.

NOTE The process performance indicators related to each of the process attributes listed below are detailed in part 2 of this handbook.

5.3.2 Level 0: Incomplete process

The process is not implemented, or fails to achieve its process outcomes.

At this level there is little or no evidence of any systematic achievement of any of the defined attributes.

5.3.3 Level 1: Performed process

The implemented process achieves its process outcomes.

The following attribute of the process demonstrates the achievement of this level.

5.3.3.1 PA 1.1 Process performance attribute

Thus attribute represents the extent to which the process achieves the process outcomes by transforming identifiable input work products to produce identifiable output work products. As a result of full achievement of this attribute:

a. the process achieves its defined outcomes.

5.3.4 Level 2: Managed process

The previously described Performed process now executes in a managed fashion (planned, tracked, verified and adjusted) and its work products are appropriately established, controlled and maintained based upon defined objectives.

The following attributes of the process demonstrate the achievement of this level.

5.3.4.1 PA 2.1 Performance management attribute

This attribute represents the extent to which the performance of the process is managed. As a result of full achievement of this attribute:

a. objectives for the performance of the process are identified;

b. performance of the process is planned and monitored;

c. performance of the process is adjusted to meet plans;

d. responsibilities and authorities for performing the process are defined, assigned and communicated;

e. resources and information necessary for performing the process are identified, made available, allocated and used;

f. interfaces between the involved parties are managed to ensure both effective communication and also clear assignment of responsibility.

5.3.4.2 PA 2.2 Work product management attribute

This attribute represents the extent to which the work products produced by the process are appropriately managed. As a result of full achievement of this attribute:

a. requirements for the work products of the process are defined;

b. requirements for documentation and control of the work products are defined;

c. work products are appropriately identified, documented, and controlled;

d. work products are reviewed in accordance with planned arrangements and adjusted as necessary to meet requirements.

NOTE 1 Requirements for documentation and control of work products may include requirements for the identification of changes and revision status, approval and re-approval of work products, and the making relevant versions of applicable work products available at points of use.

NOTE 2 The work products referred to in this subclause are those that result from the achievement of the process outcomes.

5.3.5 Level 3: Established process

The previously described Managed process now performs using a defined process that is based upon software engineering principles and capable of achieving its process outcomes.

The following attributes of the process demonstrate the achievement of this level.

5.3.5.1 PA 3.1 Process definition attribute

This attribute represents the extent to which a standard process is maintained to support the deployment of the defined process, and as a result of full achievement of this attribute:

a. a standard process, including appropriate tailoring guidelines, is defined that describes the fundamental elements that are incorporated into a defined process;

b. the sequence and interaction of the standard process with other processes is determined;

c. required competencies and roles for performing a process are identified as part of the standard process;

d. required infrastructure and work environment for performing a process are identified as part of the standard process;

e. suitable methods for monitoring the effectiveness and suitability of the process are determined.

f. A standard process can be used as-is when deploying a defined process, in which case tailoring guidelines do not apply.

5.3.5.2 PA 3.2 Process deployment attribute

The process deployment attribute is a measure of the extent to which the standard process is effectively deployed as a defined process to achieve its process outcomes. As a result of full achievement of this attribute:

a. a defined process is deployed based upon an appropriately selected (and tailored if needed) standard process;

b. required roles, responsibilities and authorities for performing the defined process are assigned and communicated;

c. personnel performing the defined process are competent on the basis of appropriate education, training, and experience;

d. required resources and information necessary for performing the defined process are made available, allocated and used;

e. required infrastructure and work environment for performing the defined process are made available, managed and maintained;

f. appropriate data are collected and analysed as a basis for understanding the behaviour of, and to demonstrate the suitability and effectiveness of the process, and to evaluate where continuous improvement of the process can be made.

NOTE Competency results from a combination of knowledge, skills and personal attributes that are gained through education, training and experience.

5.3.6 Level 4: Predictable process

The previously described Established process now performs consistently within defined limits to achieve its process outcomes.

The following attributes of the process demonstrate the achievement of this level.

5.3.6.1 PA 4.1 Process measurement attribute

This attribute represents the extent to which measurement results are used to ensure that performance of the process supports the achievement of relevant process performance objectives in support of defined business goals. As a result of full achievement of this attribute:

a. process information needs in support of relevant defined business goals are established;

b. process measurement objectives are derived from process information needs;

c. quantitative objectives for process performance in support of relevant business goals are established;

d. measures and frequency of measurement are identified and defined in line with process measurement objectives and quantitative objectives for process performance;

e. results of measurement are collected, analysed and reported in order to monitor the extent to which the quantitative objectives for process performance are met;

f. measurement results are used to characterize process performance.

NOTE 1 Information needs can typically reflect management, technical, project, process or product needs.

NOTE 2 Measures can be either process measures or product measures or both.

5.3.6.2 PA 4.2 Process control attribute

This attribute represents the extent to which the process is quantitatively managed to produce a process that is stable, capable, and predictable within defined limits. As a result of full achievement of this attribute:

a. analysis and control techniques are determined and applied where applicable;

b. control limits of variation are established for normal process performance;

c. measurement data are analysed for special causes of variation;

d. corrective actions are taken to address special causes of variation;

e. control limits are re-established (as necessary) following corrective action.

5.3.7 Level 5: Optimizing process

The previously described Predictable process now dynamically changes and adapts to meet relevant current and projected business goals effectively.

The following attributes of the process demonstrate the achievement of this level.

5.3.7.1 PA 5.1 Process innovation attribute

This attribute represents the extent to which changes to the process are identified from analysis of common causes of variation in performance, and from investigations of innovative approaches to the definition and deployment of the process. As a result of full achievement of this attribute:

a. process improvement objectives for the process are defined that support the relevant business goals;

b. appropriate data are analysed to identify common causes of variations in process performance;

c. appropriate data are analysed to identify opportunities for best practice and innovation;

d. improvement opportunities derived from new technologies and process concepts are identified;

e. an implementation strategy is established to achieve the process improvement objectives.

5.3.7.2 PA 5.2 Process optimization attribute

This attribute represents the extent to which changes to the definition, management and performance of the process result in effective impact that achieves the relevant process improvement objectives. As a result of full achievement of this attribute:

a. impact of all proposed changes is assessed against the objectives of the defined process and standard process;

b. implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon;

c. effectiveness of process change on the basis of actual performance is evaluated against the defined product requirements and process objectives to determine whether results are due to common or special causes.

6
Process assessment method

6.1 Introduction

This clause describes the S4S assessment method to assess space software processes. This method fully conforms to the requirements of ISO/IEC 15504 Part 2.

According to ISO/IEC 15504, the use of process assessment can have two different objectives: capability determination and process improvement, as shown in Figure 3. A third objective is defined in S4S which is to determine the conformance of an organizational unit's processes to the ECSS reference model.

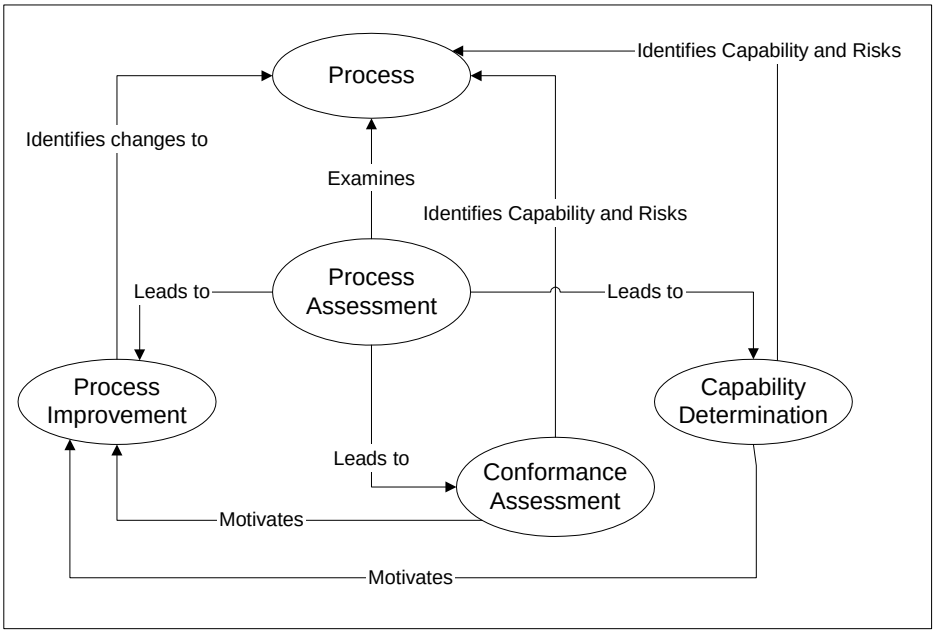


Figure 3 S4S process assessment purposes

- **Process improvement**
  Process assessment provides the means of characterizing the current practice within an organizational unit in terms of process capability. Analysis of the results in the light of the organization's business needs identifies strengths, weaknesses and risks inherent in the processes. This, in turn, leads to the ability to determine whether the processes are effective in achieving their goals, and to identify significant causes of poor quality, or overruns in time or cost. These provide the drivers for prioritizing improvements to processes.
- **Process capability determination**
  Process capability determination is concerned with analysing the capability of selected

processes, normally against a target process capability profile, in order to identify the risks involved in undertaking a project using the selected processes.

- **Conformance to ECSS requirements**
  A S4S assessment can also be used to determine that an organization or project's processes conform to ECSS requirements. The activities of conformance assessments are the same as those of assessments for process improvement or capability determination, with some variations in data collection and rating.

Detailed guidance for the performance of process assessments for each different purpose is provided in subclause 6.3.

The following subclauses outline:

- the assessment process definition, and then
- the guidance for the process assessment for process improvement, capability determination assessments and ECSS conformance assessments. Additions and alterations to the basic method are described for each of the specific purposes.
- the instructions for defining requirements for competencies of assessors are introduced in subclause 6.4.

6.2 Assessment process definition

6.2.1 Introduction

This subclause defines the detailed process definition for any S4S process assessment. Each process major step and activities is represented following the notation defined in Figure 4 (a simplification of the one provided in the [ECSS-Pmod] study) including all responsible roles, activities, input and outputs of all activities:

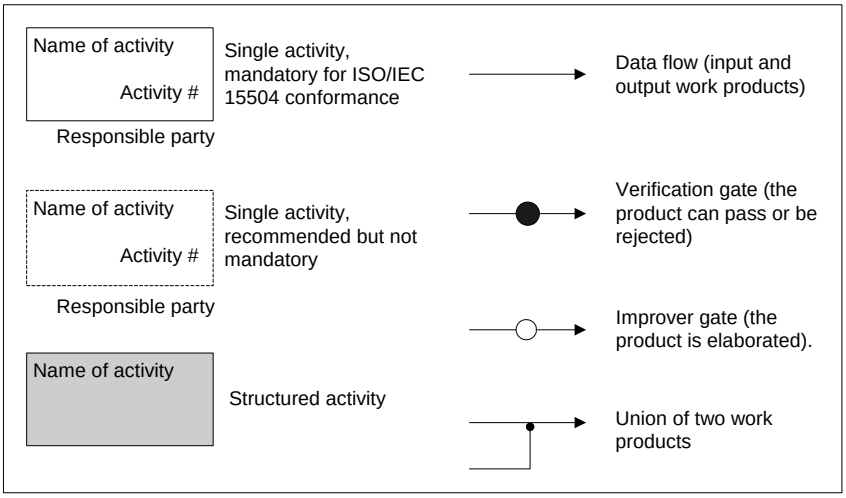


Figure 4 Process diagram notation

An assessment is divided into the following eight activities:

- initiation,
- planning,
- briefing,
- data acquisition,
- data validation,
- process rating,
- reporting and
- inputs to the risk management process.

A detailed breakdown of each activity into tasks is found in the next subclauses. Diagrams of the assessment process are provided in Figure 5.

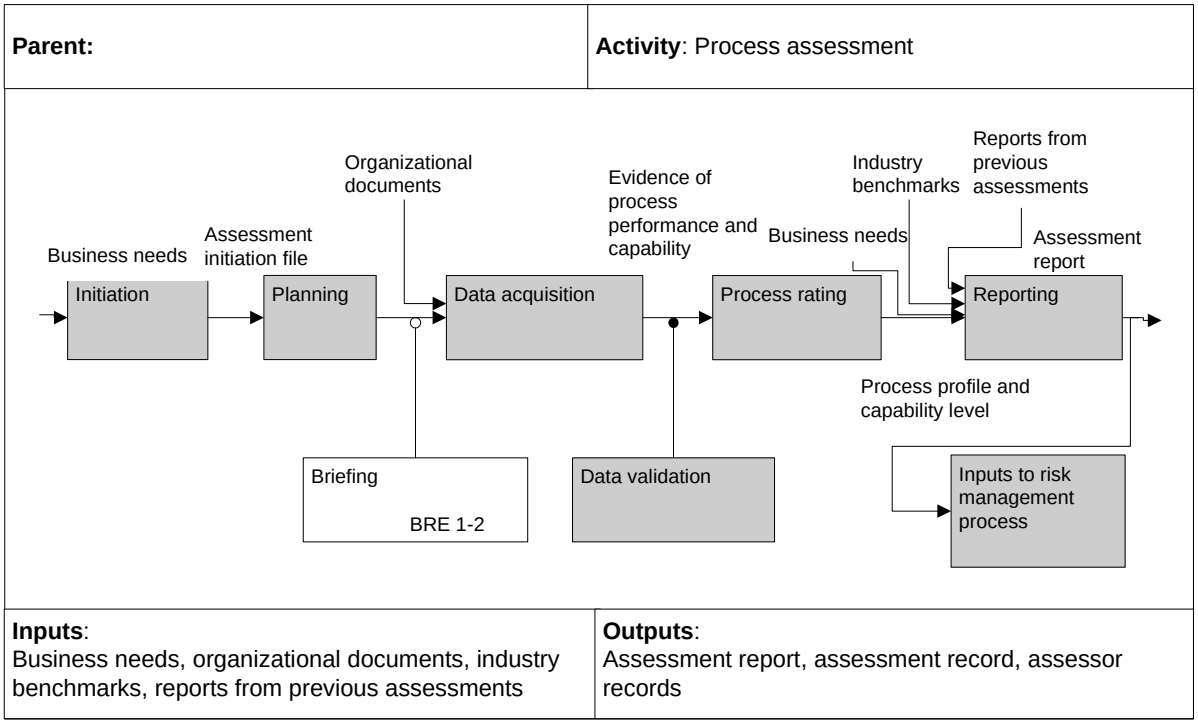


Figure 5 The assessment process definition

Throughout this subclause, the S4S assessment activities, roles or work products are marked with symbols found at the end of lines of text.

The following symbols are used in this subclause in order to keep the traces of the source from which the different phrases/requirements are from and to be used for the conformance statements:

❶: The preceding phrases/requirements are justified by requirements of the normative parts of ISO/IEC 15504

❷: The preceding phrases/requirements are justified by information from guidance parts of ISO/IEC 15504

❸: The preceding phrases/requirements are justified by best industry practice

❹: The preceding phrases/requirements are justified by requirements from ECSS Standards

Each assessment process activity is presented following the same layout used for the definition of the S4S process dimension including:

- Objective of each activity,
- detailed steps and
- input and output work products.

Each detailed step includes in turn:

- its objective,
- the expected outputs and
- the roles responsible for their performance (see subclause 6.2.3 for details on assessment process roles).

All detailed steps defined are uniquely identified to correspond to the different boxes defined in the diagrams.

The participant parties for the different activities are defined using the following acronyms:

AP	assessment participants
AS	assessment sponsor
AT	assessment team
ATL	assessment team leader
LAC	local assessment coordinator
OU	organizational unit

Detailed information about these roles is provided in subclause 6.2.3. The responsible party of the activities is put between ().

6.2.2 Assessment process

6.2.2.1 Assessment initiation

The assessment process begins with a set of preparatory steps identifying the sponsor, defining the purpose of the assessment (why it is being carried out), the scope of the assessment (which processes are being assessed, of which organizational unit, in which context), the assessment approach, what constraints, if any, apply to the assessment, and any additional information to be gathered. The assessment participants and the assessment team are chosen together with the roles of team members. All assessment inputs are defined and approved by the sponsor. The assessment initiation detailed steps are drawn here after.

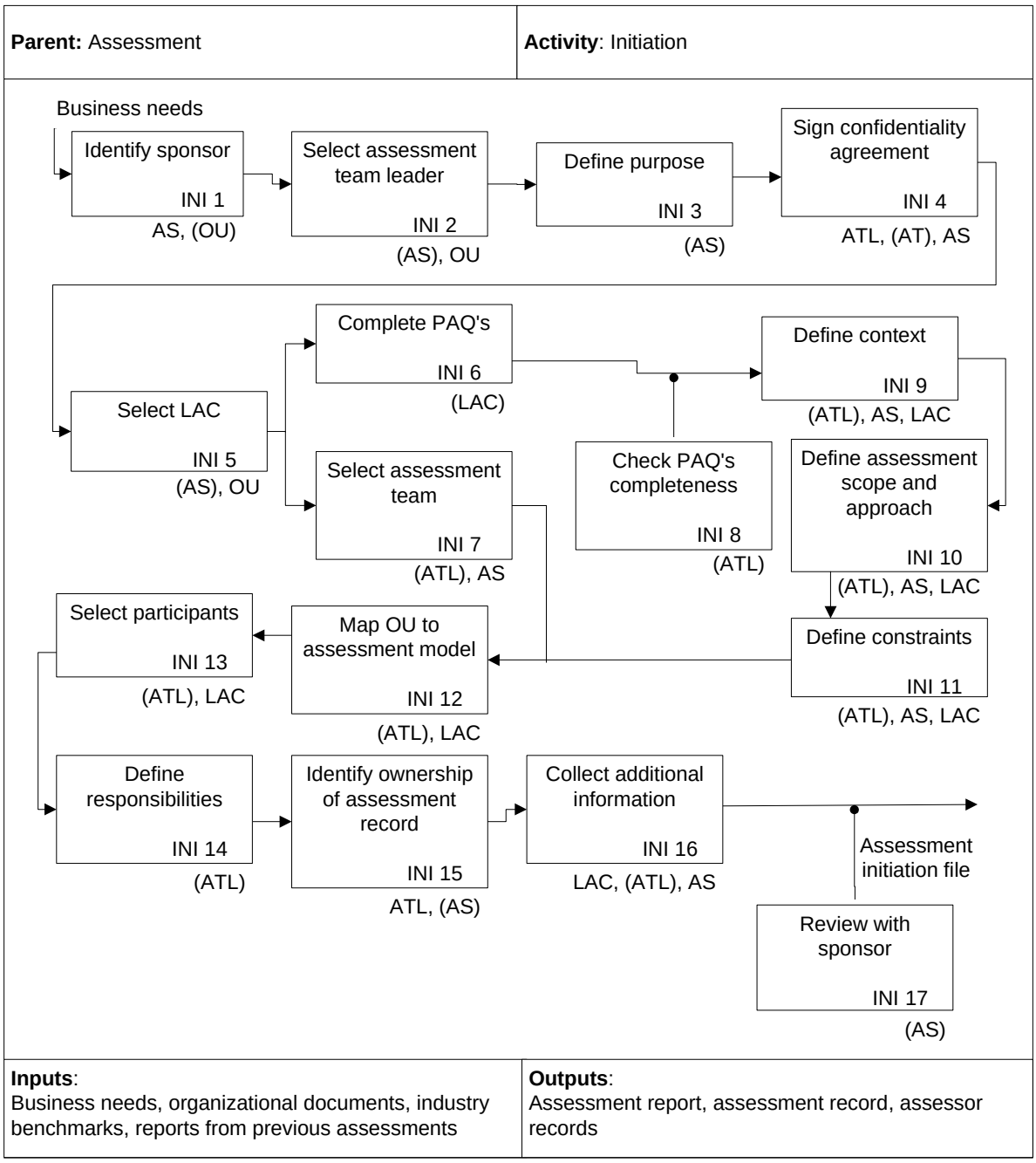


Figure 6 Assessment initiation

Objective Establish the needs, goals and team of the assessment.

Detailed steps

INI 1 **Identify sponsor** **Role: AS, (OU)**

Recognize and document the identity of the sponsor and the sponsor's relationship to the organizational unit being assessed. ❶

INI 2 **Select assessment team leader** **Role: (AS), OU**

Select who leads the assessment team and ensure that the persons nominated possess the required competency and skills. ❶

INI 3 **Define purpose** **Role: (AS)**

Define the assessment purpose including alignment with business goals. Ensure that business needs are available as input to the assessment. ❶

INI 4 **Sign confidentiality agreement** **Role: ATL, (AT), AS**

Sign confidentiality agreement. Identify and sign the conditions of confidentiality covering assessment input and output products ❸

INI 5 **Select LAC** **Role: (AS), OU**

Select the local assessment coordinator. The local assessment coordinator (LAC) manages the assessment logistics and interfaces between the organizational unit and the assessment team. See subclause 6.2.3 on assessment actors and roles. ❸

INI 6 **Complete PAQs (recommended activity)** **Role: (LAC)**

Submit the pre-assessment questionnaires to the local assessment coordinator. The pre-assessment questionnaires (PAQs) help structure the on-site interviews and the scope of the assessment by gathering information about the organization and projects of the assessed unit. One PAQ-organization and one PAQ-project per project to be assessed should be completed by the LAC. Input from the PAQs can also support possible improvements in development productivity and process quality. ❸

INI 7 **Select assessment team** **Role: (ATL), AS**

Build the assessment team and assign team roles. ❶ The team consists of at least one assessor in addition to the team leader. ❸ Assessment team members ensure a balanced set of skills (see assessment actors and roles, subclause 6.2.3) required to perform the assessment. All assessors are competent or provisional assessors (see subclause 6.4.5) and have access to the assessment input, to any other relevant information and to guidance on assessment techniques or tools. ❶

INI 8 **Check the PAQs for completeness (recommended task)** **Role: (ATL)**

Check the returned PAQs for completeness.

INI 9 **Define context** **Role:(ATL), AS, LAC**

Define the context. Identify factors in the organizational unit that affect the assessment process and the validity of comparisons of assessment results (the pre-assessment questionnaires can be used as input). These factors include, at a minimum:

- the size of the organizational unit,
- the demographics of the organizational unit,
- the application domain of the products or services of the organizational unit,
- the size, criticality and complexity of the products or services,
- the quality characteristics of the products. ❶

NOTE In ISO/IEC 15504, the assessment context is part of the assessment scope.

INI 10 **Define the assessment scope and approach** **Role: (ATL), AS, LAC**

Define the assessment scope including the processes to be investigated within the organizational unit, the highest capability level to be investigated for each process within the assessment scope and the organizational unit that deploys these processes. ❶ This activity includes as well the definition of the assessment approach.

A subset of the processes performed by the organizational unit can be selected for assessment. For processes describing cross-organizational activities, the source of data to be used for rating is defined and documented.

The assessment cost can constrain the definition of the scope.

INI 11 **Define constraints** **Role: (ATL), AS, LAC**

Specify constraints placed on the freedom of choice of the assessment team regarding the conduct of the assessment and use of assessment outputs. The assessment constraints can include:

- availability of key resources,
- the maximum amount of time to be used for the assessment,
- specific processes or organizational units to be excluded from the assessment,
- the minimum, maximum or specific sample size or coverage that is desired for the assessment,
- the ownership of the assessment outputs and any restrictions on their use,
- controls on information resulting from a confidentiality agreement, ❶
- definition of data consolidation criteria, ❸
- definition of validation criteria and methods (e.g. data corroboration). ❸

INI 12 **Map OU to assessment model** **Role: (ATL), LAC**

Map the organizational unit processes to the process assessment model. Establish a correspondence between the organizational unit's processes specified in the assessment scope and the processes in the S4S assessment model. ❶ This can be achieved with the assistance from the local assessment coordinator. Identify any conflicting nomenclature between the OU and the assessment model. ❸

INI 13 **Select participants** **Role: (ATL), LAC**

Select the assessment participants from within the organizational unit. ❶ The participants represent adequately the processes in the assessment scope. ❸

INI 14 **Define responsibilities** **Role: (ATL)**

Define the responsibilities of all individuals participating in the assessment. ❶ Assign tasks to individuals.

INI 15 **Identify ownership of assessment record** **Role: ATL, (AS)**

Identify ownership of the assessment record and the person responsible for signing the assessor logs. The sponsor may designate another actor to accept the assessment record and to sign the logs. If so, this is documented. ❸

INI 16 **Collect additional information** **Role: (ATL), LAC, AS**

Identify any additional information that the sponsor requests to be gathered during the assessment. Examples include measurement data or staff feedback on certain organizational issues. ❶

INI 17 **Review with sponsor** **Role: (AS)**

Review all inputs with the assessment sponsor and obtain sponsor approval. ❸

EXPECTED OUTPUT: Assessment initiation file

Any changes in assessment inputs are confirmed with the sponsor and documented in the assessment record. ❶

Work products of the initiation phase

Input work products	Output work products
Business needs	Pre-assessment questionnaire Assessment initiation file

6.2.2.2 Assessment planning

The assessment process continues with a set of planning steps identifying a plan that includes all activities, resources, tools to perform the assessment.

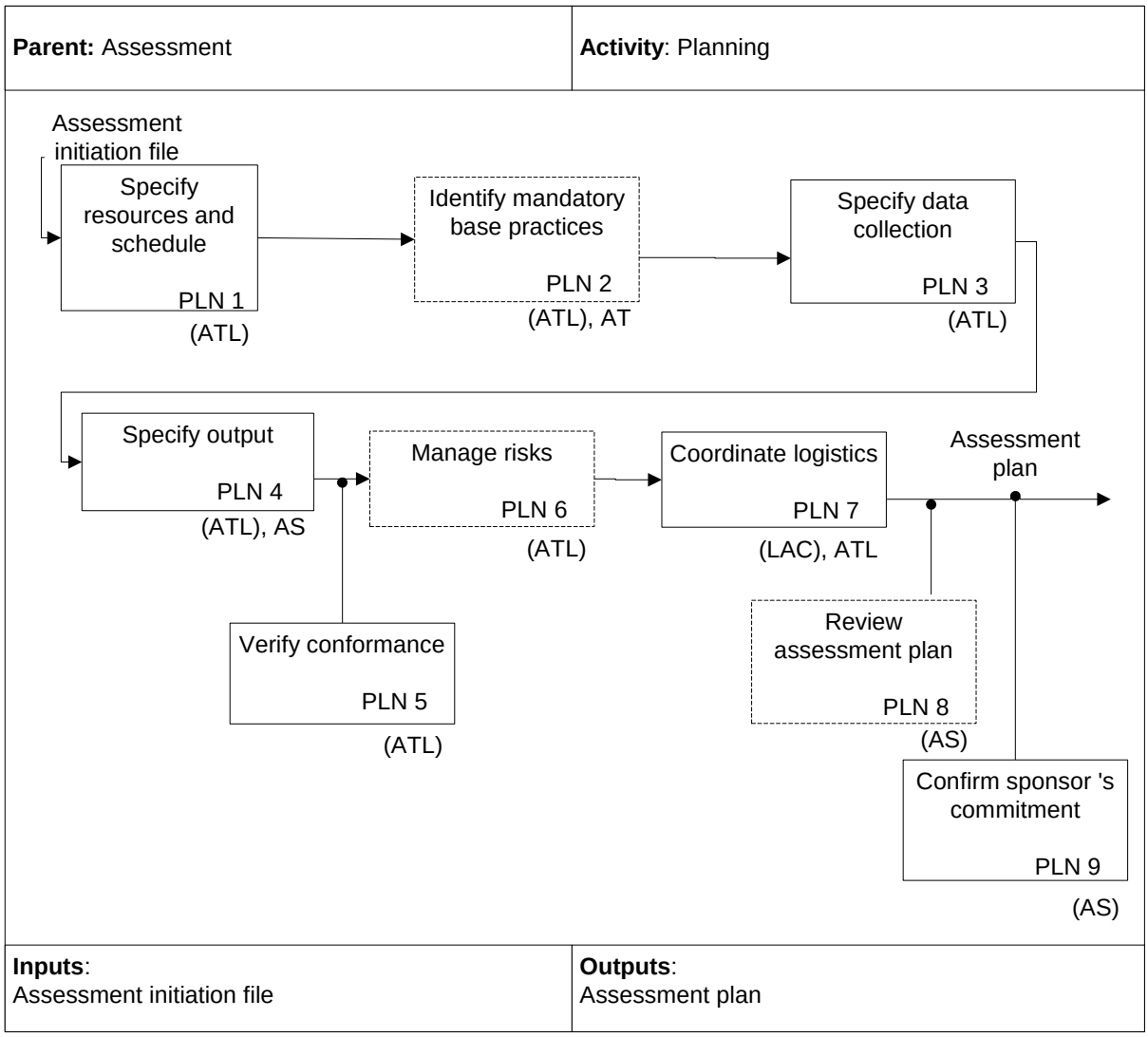


Figure 7 Assessment planning

Objective Define and document a plan describing all activities performed in conducting the assessment including:

- Using the project scope, resources needed to perform the assessment.
- The OU processes, mapped to the assessment model.
- The method of collating, reviewing, validating and documenting all information needed for the assessment
- A tool to collect and store the information.
- Coordination with participants in the organizational unit.

Detailed steps

PLN 1 Specify resources and schedule **Role: (ATL)**

Determine the needed resources and schedule for the assessment From the scope, identify the time and resources needed to perform the assessment ❶. Resources can include the use of equipment at the OU such as overhead projectors. ❸

PLN 2 Identify mandatory base practices (recommended activity) **Role: (ATL), AT**

Identify mandatory base practices (for ECSS conformance assessments only). Base practices are mandatory, if they are required by applicable ECSS Standards, contracts or organizational documents. Performance of all mandatory base practices is assessed for capability level one for each process. ❹

PLN 3 **Specify data collection** **Role: (ATL)**

Define how the assessment data is intended to be collected, recorded, stored, analysed and presented. Select assessment instrument to support handling of data. To ensure optimum performance (effectiveness and efficiency), instruments and tools should be selected or designed to match the assessment process. Ensure that all confidentiality requirements are met. ❶

PLN 4 **Specify output** **Role: (ATL), AS**

Define the planned outputs of the assessment. A report of the assessment results is part of the outputs. An assessment record is also specified. ❶

PLN 5 **Verify conformance** **Role: (ATL)**

Verify conformance to requirements. Detail the measures to ensure that the assessment meets all of the requirements in the standard, and, in particular, how an assessment record is intended to be established so that conformance can be verified at a later date. ❶

PLN 6 **Manage risks (recommended task)** **Role: (ATL)**

Potential risk factors and mitigation strategies are communicated to the sponsor. Throughout the assessment, all identified risks should be monitored. Potential risks can be: changes in the commitment of the sponsor, changes to the assessment team, organizational changes, new standard processes, changes to the assessment purposes or scope, resistance or unwillingness of the organizational unit members, lack of resources for assessment, and confidentiality. ❸

PLN 7 **Coordinate logistics** **Role: (LAC), ATL**

Coordinate assessment logistics with the LAC. Ensure the compatibility and the availability of technical equipment at the OU. Confirm that identified workspace and scheduling requirements are met. ❸

PLN 8 **Review assessment plan (recommended task)** **Role: (AS)**

Review and obtain acceptance of the plan. The sponsor identifies who is nominated to approve the assessment plan. The plan, including the assessment schedule and logistics for site visits is reviewed and approved by that authority. ❸

EXPECTED OUTPUT: *Assessment plan*

PLN 9 **Confirm sponsor's commitment** **Role: (AS)**

Confirm the sponsor's commitment to proceed with the assessment. ❶

Work products of the initiation phase

Input work products	Output work products
Assessment initiation file	Assessment plan

6.2.2.3 Briefing (recommended activities)

The assessment team leader reviews the plan with the assessment team and presents it to the organizational unit.

Objective The team presents an overview of the assessment method to the organizational unit.

BRF 1 **Brief the assessment team❸** **Role: (ATL)**

The ATL ensures that the team understands the requirements for a conformant assessment, the assessment inputs and outputs, and is proficient in using the selected assessment instrument. ❶ Ensure that the team knows about the assessment input. ❸

BRF 2 **Brief the organizational unit** **Role: (ATL)**

The ATL: explains the assessment purpose, scope, constraints, and model; stresses the confidentiality policy and the benefit of assessment outputs; presents the assessment schedule; ensures that the staff understands what is being undertaken and their role in the process; answers any questions or concerns that they can have. Potential participants and anyone who intends to see the presentation of the final results should be present at the briefing session. ❸

Work products of the briefing phase

Input work products	Output work products
Assessment plan Briefing material	

6.2.2.4 Data acquisition

a. The assessment team collects evidence of process performance in a systematic and ordered manner.

b. This assessment data should be gathered with the aid of a tool.

c. Data is gathered primarily through interviews. Organizational documents are examined to corroborate participants' testimony. The strategy and techniques for the selection, collection, analysis of data and justification of the ratings are explicitly identified and demonstrable.

d. Each process identified in the assessment scope is assessed on the basis of objective evidence. The objective evidences gathered for each attribute of each process assessed are analysed to meet the assessment purpose and scope. Objective evidence that supports the assessors' judgement of process attribute ratings is recorded and maintained in the assessment record. This record provides evidence to substantiate the ratings and to verify compliance with the requirements.

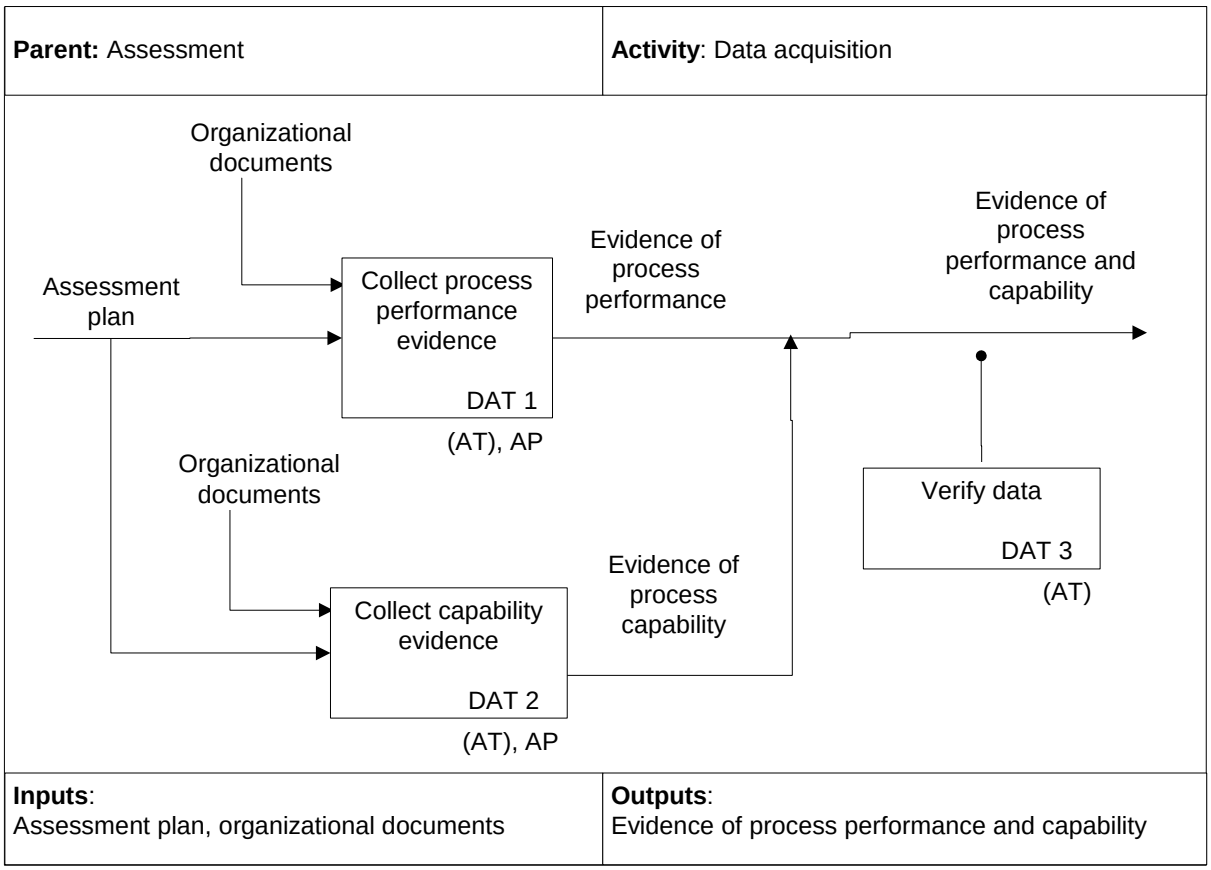


Figure 8 Data acquisition

Objective Collection of evidence of process performance in a systematic and ordered manner.

Detailed steps

DAT 1 **Collect process performance evidence** **Role: (AT), AP**

Collect evidence of process performance for each process within the scope. Evidence includes observation of work products and their characteristics, testimony from the process performers, and observation of the infrastructure established for the performance of the process. ❶

EXPECTED OUTPUT: Assessment records: evidence of process performance

DAT 2 **Collect capability evidence** **Role: (AT), AP**

Collect evidence of process capability for each process within the scope. ❶ See above.

The purpose of work product observation is not to detect errors; however, if work products are flawed, this can be an indication of low process capability. ❸

EXPECTED OUTPUT: Assessment records: evidence of process capability

DAT 3 **Verify data** **Role: (AT)**

Verify the completeness of the data. Ensure that for each process assessed, evidence exists to meet the assessment purpose and scope. ❶

EXPECTED OUTPUT: *Assessment records: evidence of process performance and capability*

Work products of the data acquisition phase

Input work products	Output work products
Organizational documents Assessment plan	Evidence of process performance and capability

6.2.2.5 Data validation

The assessment team validates the evidence before using it to assign process ratings.

The assessment team ensures that the data is accurate, objective and that it covers the assessment scope, including seeking information from first hand, using independent sources, using past assessment results, and holding feedback sessions to validate the information collected.

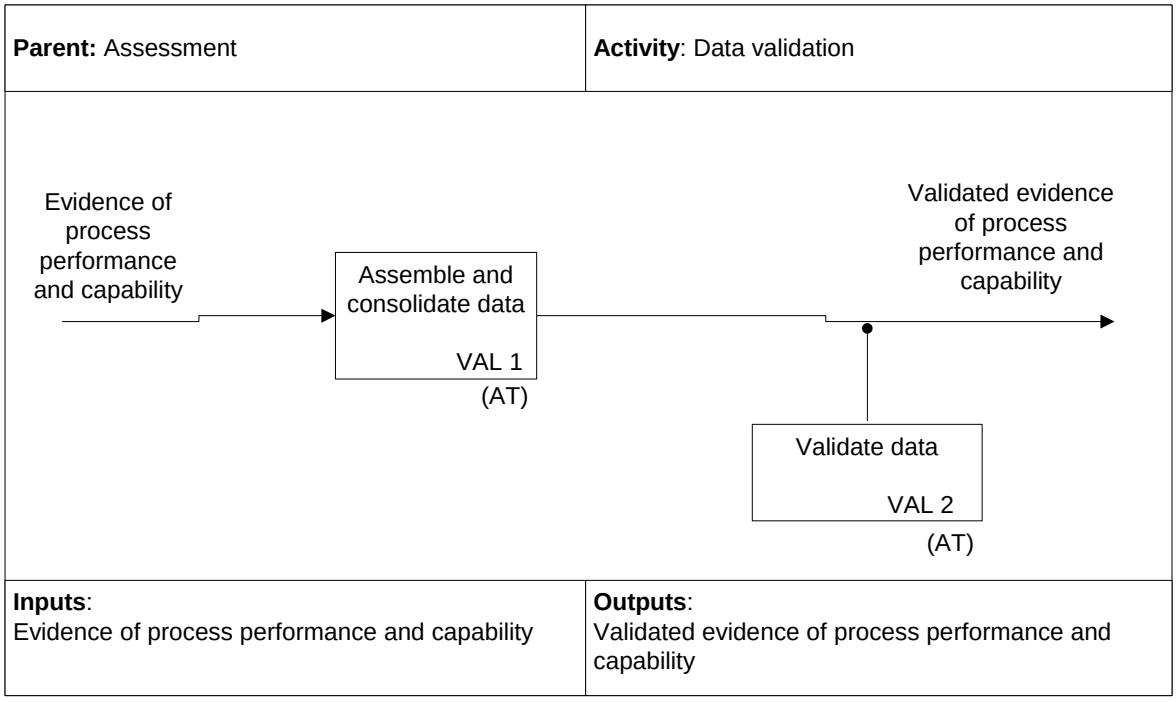


Figure 9 Data validation

Objective Validation of evidence for the assessment rating

Detailed steps

VAL 1 **Assemble and consolidate data** **Role: (AT)**

For each process, relate the evidence to defined process indicators. Relate the indicators to the appropriate process attributes. ❸

VAL 2 **Validate data** **Role: (AT)**

Ensure that the data collected is correct, objective and that the validated data provides complete coverage of the assessment scope. ❶

EXPECTED OUTPUT: *Assessment records: Validated evidence of process performance and capability*

Work products of the data validation phase

Input work products	Output work products
Evidence of process performance and capability	Assessment records: Validated evidence of process performance and capability

6.2.2.6 Process rating

For each process assessed, a rating is assigned for each process attribute up to and including the highest capability level defined in the assessment scope.

The rating scale, described in the handbook, ensures the consistency and repeatability of the ratings.

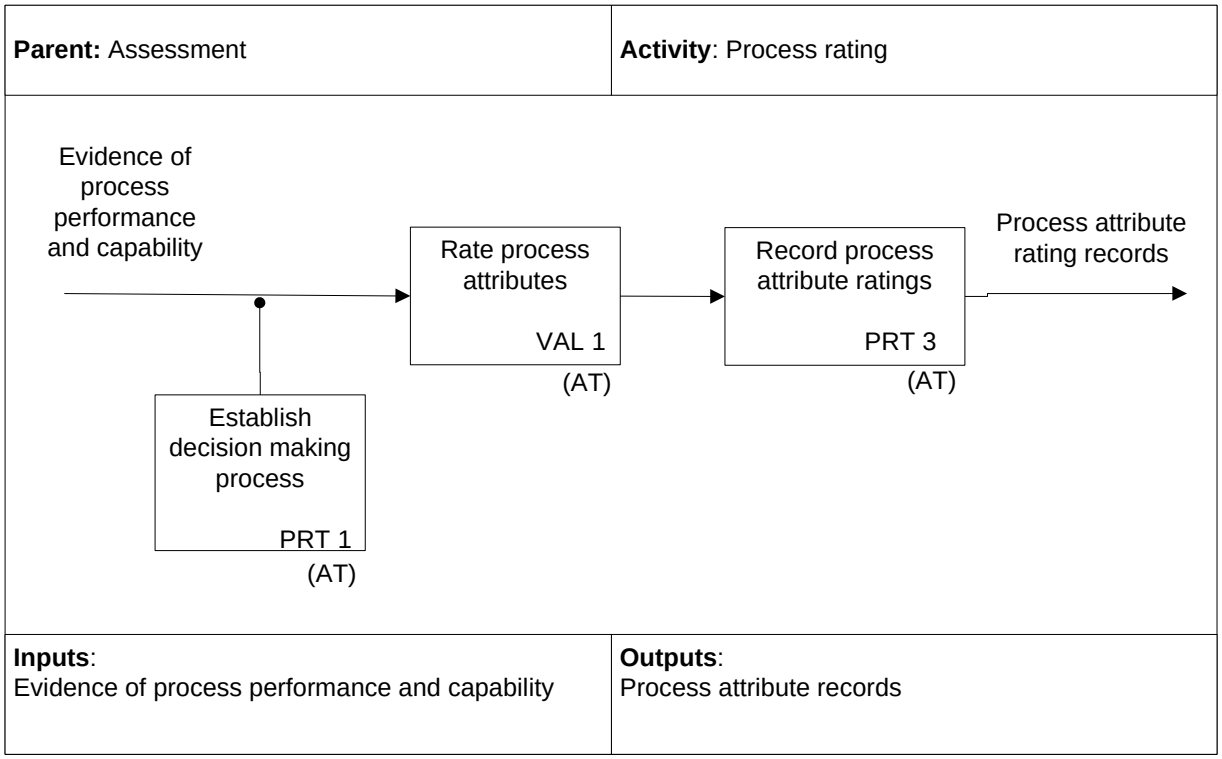


Figure 10 Process rating

Objective Process attribute rating and capability determination

Detailed steps

PRT 1 **Establish decision making process** **Role: (AT)**

Establish the decision-making process used to reach agreement on the ratings (e.g. consensus of the assessment team or majority vote). Document this process in the assessment report. ❶

PRT 2 **Rate process attributes** **Role: (AT)**

For each process assessed, assign a rating to each process attribute (see scale in subclause 5.3.1). Use the defined set of assessment indicators in the assessment model assessment to support the assessors' judgement. ❶

The rating is usually performed up to the targeted capability level requested in the profile for this process and no more.

The process context, recorded in the assessment input, influences how an assessor judge and rate the process attributes for an implemented process. ❸

When more than one instance of a process is assessed, the assessor uses the recorded assessment information collected on all of the instances to make a judgement on the rating of each of the process attributes assessed for that process. ❸

PRT 3 **Record process attribute ratings** **Role: (AT)**

Record the set of process attribute ratings as the process profile and calculate the capability level rating for each process using the capability level attribute model (see subclause 5.3.1). Traces are maintained between the attribute rating and the objective evidence used to determine the rating. For each process attribute rated, the relationship between the indicators and the objective evidence is maintained. ❶

In assessments for the purpose of process improvement a list of unachieved or incomplete indicators related to each process attribute should be collected.

EXPECTED OUTPUT: *Assessment records: Process attribute rating records*

Work products of the process rating phase

Input work products	Output work products
Assessment records: Validated evidence of process performance and capability	Assessment records: Process attribute rating records

6.2.2.7 Assessment reporting and recording

The assessment results are documented and reported to the participants and the sponsor. The assessment results are analysed and presented in a report and also cover any key issues raised during the assessment such as observed areas of strength and weakness, findings of high risk, or the unsuitability of an assessed process for its intended purpose.

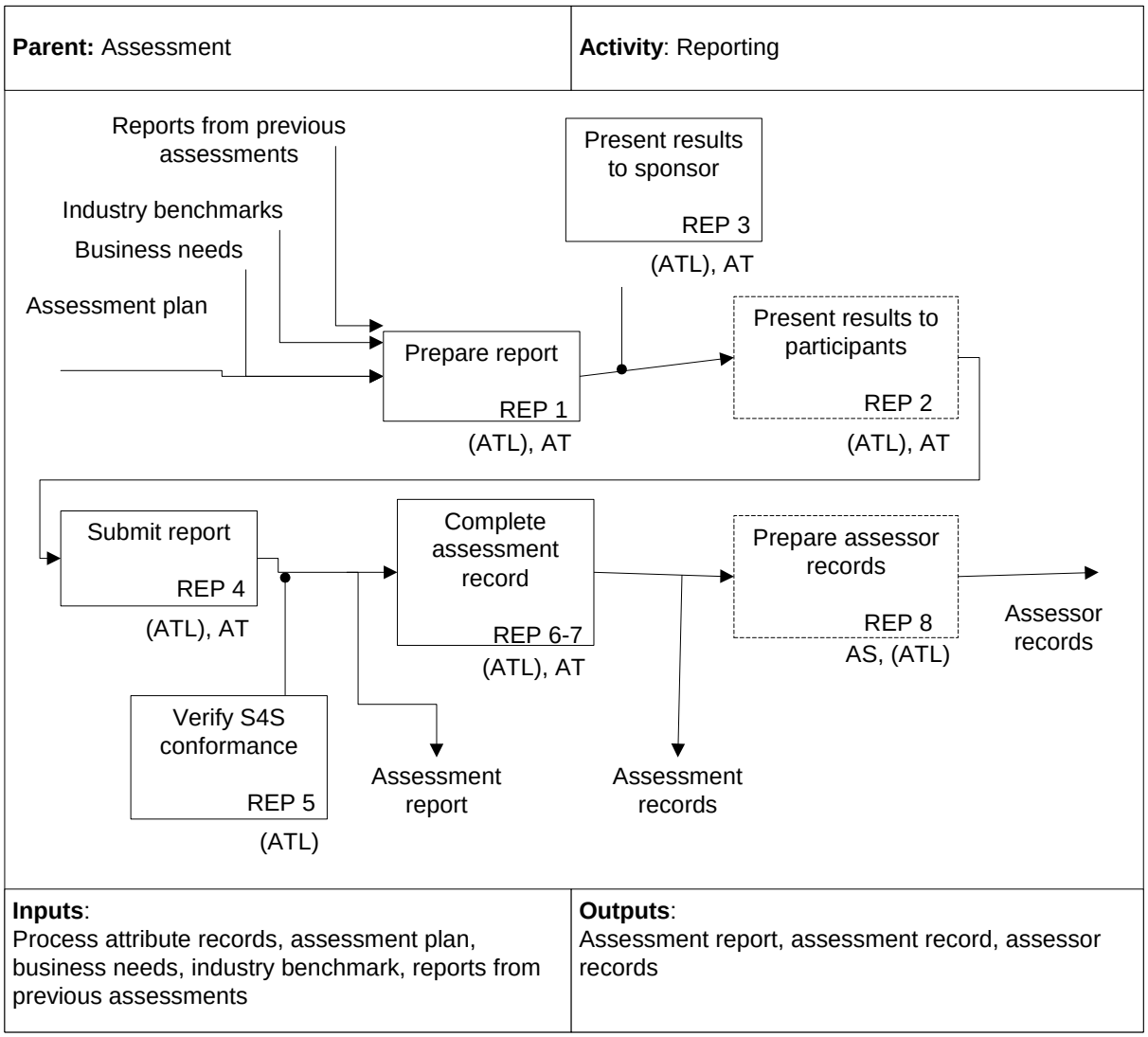


Figure 11 Reporting

Objective Document both the assessment results and detailed records

Detailed steps

REP 1 **Prepare report** **Role: (ATL), AT**

Summarize the findings of the assessment, highlighting the process profiles, key results, observed strengths and weaknesses, identified risk factors, and potential improvement actions. For assessments for the purpose of process improvement the report should also contain the list of unachieved or incomplete indicators. Compare the results of the current assessment to those of previous assessments, or to any industry benchmarks available. Relate the findings to the original purpose of the assessment. ❶

EXPECTED OUTPUT: *Assessment report*

REP 2 **Present results to participants (recommended task)** **Role: (ATL), AT**

Present the assessment results to the participants. Focus the presentation on defining the capability of the processes assessed. For processes with capability level 0, ensure that participants view and understand the underlying process attribute ratings. In general, encourage the organizational unit to accept the results, highlighting both strengths and weaknesses and seeking input to a proposed action plan. ❸

REP 3 **Present results to sponsor** **Role: (ATL), AT**

Present the assessment results to the sponsor. ❶

REP 4 **Submit report** **Role: (ATL), AT**

Submit the assessment report to the sponsor. ❶

EXPECTED OUTPUT: *Assessment report*

REP 5 **Verify S4S conformance** **Role: (ATL)**

Verify and document that the assessment was performed according to the S4S process and instructions. ❶

REP 6 **Complete the assessment record** **Role: (ATL), AT**

Incorporate key findings into the assessment record. Verify that the assessment record is complete and satisfies this handbook's instructions. ❶

EXPECTED OUTPUT: *Assessment records*

REP 7 **Submit assessment record** **Role; (ATL), AT**

Provide the assessment record to the sponsor for retention and storage. ❶

REP 8 **Prepare assessor records** **Role: AS, (ATL)**

Prepare and sign assessor records. For each assessor, records to prove the participation in the assessment are produced. The records are signed by the sponsor or the authority selected in INI15. ❷

EXPECTED OUTPUT: *Assessor records*

Work products of the assessment reporting and recording phase

Input work products	Output work products
Process attributes Process profiles and capability level rating Business needs Industry benchmarks Assessment plan Reports from previous assessments	Assessment records Assessment report Assessor records

6.2.2.8 Inputs to the risk management process (recommended activity)

ECSS-M-ST-80C defines the principles and requirements for risk management in space projects. Project risk management identifies, assesses, reduces, accepts, and controls space project risks in a systematic, proactive, comprehensive and cost effective manner, taking into account the project's technical and programmatic constraints. Risks ranked according to their influence on the project success allow direct management attention of both the customer and the supplier to the essential issues.

The risk management process can benefit from inputs from the process assessment in aspects related to:

- identification of processes potentially originating a project risk
- supporting an evaluation of the likelihood of the potential risk by providing the gap between the actual profile and the target profile, to be interpreted with respect to the capability level the process has

The results of an assessment bring information on the capability of processes with respect to their determined respective purpose. These results can help characterize the process infrastructure environment into which a project is going to be executed. These results allow determining a factor of risk level aggravation or reduction.

In this context, the approach should focus on those processes which can have a direct influence on project risks.

For example, the capability level of the following processes can influence the management and quality aspects of the overall project:

- MAN.3 - Project management process
- MAN.4 - Quality management process
- MAN.5 - Risk management process

The capability level of the following processes can influence on common source risks like: requirement definition and stability, interface uncertainties, schedule and budget constraints, human resources shortfall, introduction of new technology, shortfalls in externally supplied components and services, lack of proper configuration management.

- ENG.1 - Requirements elicitation,
- ENG.2 - System requirements analysis
- ENG.3 - System architectural design
- ENG.4 - Software requirements analysis,
- ENG.9 - System integration
- ENG.10 - System testing,
- MAN.3 - Project management,
- RIN.1 - Human resource management,
- RIN.4 - Infrastructure,
- ACQ.4 - Supplier monitoring,
- SUP.2 - Verification,
- SUP.3 – Validation,
- SUP.8 - Configuration management;

As it can be seen, MAN.3 is referred both as part of the processes directly influencing the main project objectives, and part of the processes related to the main common sources of risks. It is therefore a critical process with respect to the risk factor that can be deducted from an assessment.

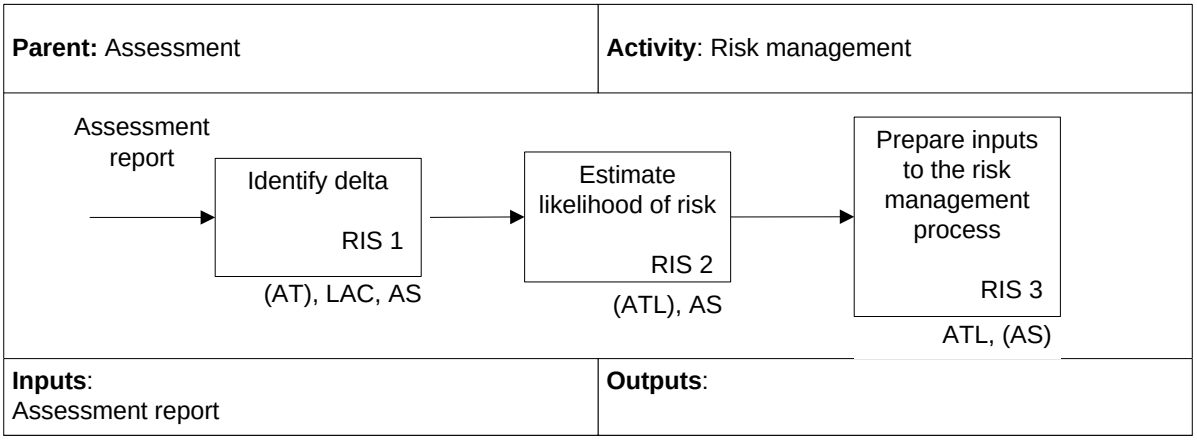


Figure 12 Inputs to the risk management process

Objective Define inputs for the overall risk management process

Detailed steps

RIS 1 Identify delta **Role: (AT), LAC, AS**

The comparison between the target and the actual profiles can be used to highlight the presence of already known risks but also of potential risks which were not yet identified as such.

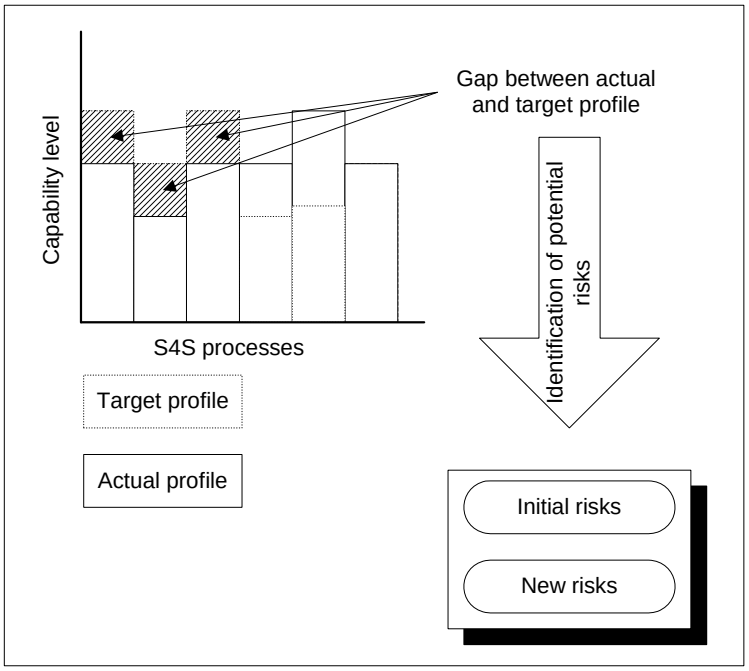


Figure 13 Use of target and actual profiles

RIS 2 Estimate likelihood of risk **Role: (ATL), AS**

The differences (delta) between the actual process profile and the target profile can contribute differently to the overall likelihood, if occurring, at different capability

should be the weight for the likelihood of the potential associated risk. For example, should capability level 3 be neutral with respect to the risk factor, justified by the fact that the level 3 is the one where the processes are established at the organization level, implying a unified way of working by the different projects, then, below that level, there are additional risks incurred by the projects. Level 0 of process capability leads to a non-acceptable risk. On the contrary, above the level 3, the quality of the implemented processes is such that one can assume a reduction of the risks threatening a project.

A general impact line can be defined as follows:

Process attribute where gap occurs	Potential impact	Seriousness of impact
1.1 Process performance	• missing work products; unpredictable product quality (most severe impact)	Highest
2.1 Performance management	• cost or time overruns, inefficient use of resources, • general uncertainty over whether time and cost goals	
2.2 Work product management	• unpredictable work product integrity, uncontrolled versions, increased support costs, integration problems and increased re-work costs,	
3.1 Process definition	• inefficient work practices reduced cost effectiveness • inconsistent performance between projects • no foundation for organization wide process improvement • limited opportunities for organizational learning	
3.2 Process deployment	• lack of adequate and appropriate skills, competencies and infrastructure when needed	
4.1 Measurement	• inability to detect performance problems early • key production processes not supporting mission and vision of organization • uncertainty concerning the extent to which business goals and objectives are being accomplished	
4.2 Process control	• inability to manage the process proactively to achieve desired business results • inability to predict process performance with confidence	

5.1 Continuous improvement	• process improvement goals not clearly and quantitatively expressed • inefficient application of process improvement resources • missed opportunities for improvement	
5.2 Process change	• inability to respond quickly and effectively to changes in business environment leading to missed opportunities • inability to grasp new business opportunities or react to technical innovation	Lowest

RIS 3 **Prepare inputs to the risk management process** **Role: ATL, (AS)**

These general considerations can be used as a basis for expert judgement along with the local organizational unit constraints.

Therefore, when comparing an actual profile and a target one, the potential risk of each of these profiles can be documented and then the interpretation of the delta becomes significant using the above mentioned likelihood regarding the process capability level.

Work products of the inputs to the risk management process phase

Input work products	Output work products
Assessment report (assessment records should also be considered where possible)	

6.2.3 Assessment actors and roles

6.2.3.1 Introduction

In this subclause, the responsibilities of the actors in an S4S assessment are described. See also the assessment process flowchart diagrams in 6.2.2 where each assessment activity is assigned an actor responsible for its performance.

6.2.3.2 Assessment sponsor (AS)

The sponsor provides the budget for the assessment and ensures availability of resources (assessors, Local Assessment Coordinator -LAC and participants).

The sponsor's responsibilities include:

- verify that the assessor who takes responsibility for and oversee the assessment (the Assessment Team Leader -ATL) has the required competence and skills
- ensure that human resources (both assessors and participants as well as access to any other relevant resources) are made available to conduct the assessment ❶
- retain the assessment report and record and sign the assessor records at the end of the assessment ❶. This may also be done by a person designated by the sponsor

The sponsor should review and approve the progress of the assessment team at defined milestones during the assessment process. ❸

6.2.3.3 Local assessment coordinator (LAC)

The organizational unit appoints a local assessment coordinator. The LAC's responsibilities include:

- ensure the needed assessment logistics and liaisons with the OU. The logistics can include the rooms for discussions, presentations, appropriate audio-visual equipment, word processing facilities, escort requirements, access to facilities, and lodging for external members of the assessment team ❸
- complete the pre-assessment questionnaire with the assistance from others if needed ❸
- support the definition of the assessment scope and constraints during the initiation activities
- provide copies of ECSS, and any other applicable input standards on site
- provide participants with a list of documents to bring for each process interview

6.2.3.4 Assessment team leader (ATL)

a. The assessment team leader ensures that the assessment is conducted in accordance with the assessment process defined by this handbook ❸ and is conformant to its instructions ❶. The assessment team leader's responsibilities include:
   - planning each step, tasks and resources of the assessment ❸,
   - representing and managing the assessment team ❸,
   - confirming the sponsors commitment ❶,
   - ensuring that each member of the assessment team has the knowledge and skills required for his allocated responsibility ❶
   - checking the returned PAQs for completeness ❸,
   - leading the assessment kick-off meeting and the feedback meeting❸,
   - assuring the quality of the assessment team's performance and work products ❸,
   - verifying that the assessment is planned and performed according to the S4S process and instructions ❸
   - verifying, that all instructions for an S4S conformant assessment are met ❶.

b. The assessment team leader assembles the inputs to initiate the assessment, and makes the assessment plan. If resources permit, the assessment team leader should make a pre-assessment site visit during the initiation or planning phases, but this is optional.

c. The assessment team leader verifies that all members of the assessment team have the appropriate knowledge and skills and, during data acquisition, guides the assessment team in applying S4S.

d. The assessment team leader ensures that participants in the assessment are briefed on the purpose, scope and approach of the assessment.

e. On completion of the assessment, the assessment team leader verifies and documents that the instructions are met.

f. The assessment team leader meets the criteria for competent assessor for space projects (see subclause 6.4) ❶❸.

6.2.3.5 Other assessors in the Assessment Team (AT)

a. Each assessor in the team is responsible, for his allocated part of the assessment. Assessor duties include:

- assessing the processes assigned to them,
- ensuring that the participants understand the purpose and outcome of each of the processes to be assessed,
- collecting data in a sensitive, clear and non-threatening way with reference to the assessment instrument,
- working within schedule to exercise their judgement on the adequacy of the baseline practices within their processes in line with the organizational unit's characteristics,
- documenting supporting observations and references to evidence that emerges during the interviews ❸

b. Assessors participating in the assessment have access to the documentation on how to perform the defined assessment activities (e.g. this handbook, the assessment plan.) and the required competence to use any instruments or tools chosen to support the assessment ❶.

c. Each assessor meets the criteria described in subclause 6.4.

6.2.3.6 Technical specialists (AT)

Technical specialists may be involved in the assessment team to enhance the team knowledge and strength. A specialist need not be a certified assessor. Depending on the responsibilities defined in the assessment plan, the specialist can simply provide additional information before, during or after data acquisition, or can participate actively in interviews and rating. Specialists can be helpful, for example, when assessing organizational units producing highly critical software ❸.

6.2.3.7 Observers

The assessment team may be accompanied by observers. These observers are not members of the assessment team. An observer does not play any part in an assessment but may access all the data gathering and evaluation activities. An observer does not need to be a certified assessor. Observers will be due to respect the confidentiality of the assessment. ❸ Depending on the context, the number of Observers should be limited to no more than 2 per interview.

6.2.3.8 Assessment participants (AP)

Participants from the OU provide evidence of process performance and capability in the form of interviews, documentation, and group feedback. ❸ The selection of interviewees should be representative of the Organizational Unit (OU) being assessed. If the participants are representative of the organizational unit then the assessment results are more likely to provide an accurate view of the process capability. ❷

Examples of participants include project management, process performers, and practitioners. Project management offers the management view of the process. Process performers understand how the work is performed, understand the processes in use, can identify differences in processes, and understand the relationship between different levels of processes. Practitioner group discussions give the perspective of working professionals. ❸

6.2.3.9 Organizational unit (OU)

An organizational unit can be a single project, a company's business unit, or an entire company.

6.3 Assessment process guidance

6.3.1 Introduction

This subclause contains specific guidance for the definition of the scope and purpose of each assessment (e.g. processes to be assessed, who performs an assessment and why) for each type of purpose: compliance with ECSS Standards, capability determination and benchmarking and improvement.

There are several drivers for the definition of the scope of the assessment, such as use of the assessment (conformance, capability determination or improvement), organizational units to be assessed, organizational constraints, planning and budget constraints, and business objectives.

This subclause provides guidance to schedule an assessment, discusses the scope, participant preparation, interviewing techniques, and the scoring and rating mechanism. It also provides an overview of the available assessment instruments.

6.3.2 Selection of assessment purpose

The needs and business goals of space organizations are often centred on achieving enhanced customer satisfaction and greater competitiveness while meeting critical schedule deadlines. There are many different reasons (i.e. purpose) to perform a S4S assessment. Examples are:

- **Capability determination**: An organizational unit intends to supply software demonstrating specific target capability profiles are achieved (e.g. supply of software of a specific criticality class can require a more demanding specific target capability profile for certain process than supplying non-critical software). Capability determination should be performed as well when an organization wants to prepare for the ISO9000 certification.
- **Process improvement**: An organizational unit wants to improve its space software processes (process improvement). For organizations with a dependence on software, key management concerns like higher software quality, lower development and maintenance costs, reduced development times, and increased predictability and controllability of software products and processes, become drivers that initiate software process improvement throughout the organization.
- **Conformant assessment**: When a customer wants to verify conformance of his supplier to ECSS Standards an ECSS conformance assessment is performed. This assessment is always based on a capability determination assessment results to then analyse its conformance to ECSS specific requirements.

6.3.3 Assessment guidance for capability determination

6.3.3.1 Introduction

The following subclauses define specific guidance for some of the steps defined in subclause 6.2 when the purpose of the assessment is 'capability determination' providing references to the exact activity identification (as defined in subclause 6.2).

6.3.3.2 Assessment purpose (INI 3)

There are many different reasons to perform a S4S assessment. The assessment purpose should always be aligned with the business needs of the sponsor. If business needs are not defined at assessment initiation, they should be written down before defining the assessment purpose (see INI3).

6.3.3.3 Selecting the assessment team (INI 7)

The assessment team members may be selected by the sponsor or by the assessment team leader.

6.3.3.4 Assessment scope (INI 10)

Normally not all processes in the process assessment model are included in the assessment scope, and often it is useful to limit the scope in this manner. For instance, the sponsor's attention can be focussed on one or more critical processes or on processes that are candidates for improvement actions. In other instances, an acquirer can evaluate the capabilities of suppliers only for the processes related to the tender or contract requirements.

The sponsor can also truncate the capability dimension by reducing the number of capability levels within the assessment scope for each process. However, the scale always starts at level 1 and include all the capability levels up to the highest one selected.

Before defining the scope of the assessment, it is important to understand the contractual obligations of the project(s) to be assessed. In space contracts, an organizational unit often shares responsibility for the performance of a given software process with its customer. Clarifying the contractual responsibilities early in the initiation phase ensures that appropriate processes are chosen for assessment.

The sponsor determines which processes are most important to meeting the specified requirement (for process capability determination) or business goals (for process improvement). The sponsor can list these selected processes within a target capability profile. The sponsor can state - for each selected process - which process attributes are evaluated, and - for each process attribute - what achievement rating or capability level is deemed necessary. Only process attribute achievement ratings of 'fully achieved' or 'largely achieved' should be set; 'not required' should be noted against any process attributes deemed not necessary. "Partially achieved" should not be set since this indicates that some aspects of achievement are unpredictable - as defined in ISO/IEC 15504-2.

The target capability is the one that the sponsor judges represents an acceptable process risk to the implementation of the specified requirement, or to the organization's business goals. An example of target capability is provided in Table 5 below.

Table 5 Sample target capability

Processes selected from process assessment model	Process attributes	Process attribute rating required
ENG.1 Requirements elicitation	all process attributes up to and including Level 2: Managed process (i.e. PA1.1, PA2.1, PA2.2)	Fully achieved
ACQ.2 Supplier selection	all up to and including Level 3: Established process	For CL1 and CL2 fully achieved and for CL3 largely achieved

One example of a simple approach to establishing target capability - based on ISO/IEC 12207 as the reference model - is set out in the Table 6 below.

Table 6 Establishing a target profile

Step	Action	Rationale
Step 1 - Identify a set of initial selected processes	Select the primary life cycle processes, excluding any processes not relevant to the specified requirement, and taking into account the generic characteristics of the software (e.g. size, complexity, and expected usage) Consider selecting those processes that are related to specific process attributes and therefore can contribute to their achievement.	The processes with in the ISO/IEC 12207 reference model which contribute most directly to the delivery of products and services model, which contribute most directly to the delivery of products and services, are the primary life cycle processes.
Step 2 - Set default process attribute ratings for the set of initial selected processes	Set all process attribute ratings for the first three capability levels to fully achieved	This approach ensures that selected processes are fully performed; that management practices are in place to reduce unpredictability, missed deadlines, budget overspend and reduced output quality; and that processes are deployed following the proven best practice, thus providing confidence that future performance is consistent with past accomplishments
Step 3 - Review and adjust the default process attribute ratings for each selected process	Add attribute ratings for Level 4 or Level 5; or remove attribute ratings for Level 3	Adding process attributes from Level 4 and Level 5 for some processes is sometimes justified to reduce performance risks. Sometimes, deleting process attributes from Level 3 is justified

Step	Action	Rationale
Step 4 - Add further processes, plus process attribute ratings for each	Add supporting life cycle processes and organizational life cycle processes	Many process attributes are related to supporting life cycle processes and organizational life cycle processes For example, if the performance management attribute (PA2.1) is included for a process within the engineering process category, then the project management process may also be included as a selected process. The target capability for supporting life cycle processes and organizational life cycle processes is determined by the extent to which they support process attributes applying to the initial set of selected processes. Other supporting life cycle processes and organizational life cycle processes can also be included in the target capability statement where they are relevant to the specified requirement.

In addition, when processes are chosen for assessment, that describe activities occurring across the organization, the source of the data used for evaluation is specified as part of the scope. For processes from the organizational category, such as MAN.6 Measurement, objective evidence gathered during the evaluation of other processes in the assessment scope can be considered for rating. For SUP.7 Documentation, for example, the assessment team may limit the evidence considered only to those documents and documentation procedures gathered while investigating the other processes in the assessment scope. Alternatively, the decision can be taken to comprehensively examine all types of documents produced by the OU. During the initiation, it is important to document what type of evidence to consider for the rating of these cross-organizational processes.

When specifying the context of the assessment, defining clearly the organizational unit being considered deserves special care. Depending on the assessment purpose, an organizational unit can be a single project, a company's business unit, or an entire company. The assessment team and the sponsor should come to a mutual understanding of what is meant by organizational unit. This definition is essential for rating the process attributes representing higher capability levels, such as PA.3.1.

Part of the information to define the assessment context and scope may be taken from the pre-assessment questionnaires.

After the scope of the assessment is determined, the process definitions should be reviewed by the LAC and he should check with the selected project responsibles that the selected processes are actually performed respectively.

A typical problem encountered at this stage is that project documents are generally not available before on-site visit (either due to confidentiality constraints or un-availability of electronic versions). The mitigating action can be to schedule at least one day during on-site visit, before starting with interviews, for assessment team to examine project documents and ask the LAC to gather documents

in advance. Another possible mitigation action can be to ensure that someone from project team is on call to walk assessors through documents.

6.3.3.5 Data and data validation criteria (INI 11)

Because of its impact on resources like budget and time, the criteria for objective evidence and the method of validating the evidence are defined in the initiation phase. The type of objective evidence, which is acceptable, depends on the assessment purpose and the assessment context. If the assessment purpose is process improvement, the expert testimony of process performers or owners during interviews can be adequate to serve as objective evidence. If the assessment purpose is to evaluate supplier capability, for example as a requirement to entering into a contractual relationship with a satellite prime contractor, objective evidence should be documented and corroboration of the evidence should be performed. In such cases, one approach can be to require that any data be confirmed by two independent sources.

6.3.3.6 Defining ownership and responsibilities for assessment outputs (INI 11)

During the initiation phase, ownership of the assessment report and record is defined. For self-assessments, the sponsor retains the report and records at the end of the assessment. In assessments performed by outside parties, for confidentiality reasons, other persons may be designated as the owner of assessment outputs.

The signer of assessor logs is also identified and documented during the initiation. The sponsor of the assessment signs the logs. If the sponsor is also a member of the assessment team, the LAC or the sponsor's supervisor should be designated in his place.

The signed copy of the assessment report should be delivered to the LAC for third party assessments. When the assessment is a self-assessment or a second party assessment the need for a signed copy of the assessment report should be defined at this initiation activity.

6.3.3.7 Mapping the OU to the S4S model (INI 12)

During the planning, the assessment team leader works with the LAC to create a mapping between the processes of the S4S model and the processes of the organizational unit. This mapping is a useful tool for understanding the way that work is performed within the OU. In addition, the mapping enables the assessment team to be already familiar with the OU terminology during the on-site period. In making the OU mapping, the assessment team leader uses documents that reflect the OUs procedures, such as the quality manual, and maps the described activities to the S4S processes in the assessment scope. An example of an OU mapping for a single process is shown below.

Process	OU quality manual
ACQ.1 Acquisition preparation	Acquisition requirements are defined in SP.34 Issue 5 Rev. B. Acceptance activities are defined in section 4.6 of the Sw PA requirements

6.3.3.8 Selecting participants (INI 13)

For each process assessed, participants who are responsible for performing the process are selected from the relevant project or OU. Note that the activities described by a given process can be divided

among several people. In these cases several staff members should be interviewed to gather evidence. For example, when assessing SUP.9, problem resolution management, developers, testers, and possibly a quality assurance engineer can be interviewed to cover all roles performing the process. To assess basic process performance of SUP.8 configuration management, both the project configuration management responsible as well as the OU configuration manager can be interviewed. Note that for all processes assessed up to capability level 3 and higher, the management responsible for the process can be interviewed to collect evidence for rating the higher levels.

6.3.3.9 Assessment schedule (PLN 1)

In the planning phase, the assessment team specifies further how and within what time the different activities are intended to be performed.

In particular, the on-site processes (briefing, data acquisition, data validation, process rating and reporting) should be prepared carefully to avoid expensive and time-consuming corrections to the plan.

Next figure shows a typical assessment schedule, indicating the different phases as described in the previous chapter. A process improvement project can be initiated at the end of the assessment. See clause 7, for further information on planning and performing process improvement.

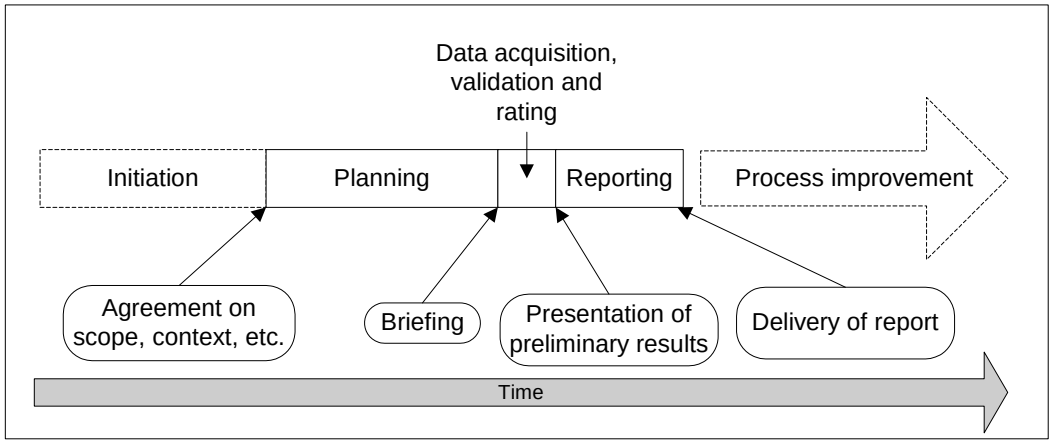


Figure 14 Sample assessment schedule

An assessment covering a subset of the processes listed in clause 5 can be performed in 8-10 weeks, from the kick-off meeting to the final report. The on-site phase, which includes briefing, data acquisition, validation, process rating and participant presentation takes typically more than 50% of the total effort, but not more than 20% of the calendar time. Therefore, detailed and careful planning of the on-site phase is of particular importance.

If the schedule allows, at least one week between approval of the assessment plan and the beginning of the on-site phase should be scheduled.

For a small assessment focusing on four to five processes, interviews can be performed in a single day, with discussion and rating on the following day. For a medium assessment of ten to twelve processes, the on-site phase of interviews and rating requires approximately four days.

6.3.3.10 Assessment data collection (PLN 3)

For efficient data acquisition, assessment participants should be provided with a detailed schedule for the interviews a reasonable period before the on-site information gathering. The assessment team

should request that participants come to the interviews prepared with supporting documentation and records regarding the processes that they are representing.

6.3.3.11 Verify conformance to requirements (PLN 5)

If the organizational unit to be assessed does not perform a project that is tied to ECSS Standards, work products and processes require an explicit mapping to this handbook. This can be established based on the analysis of organizational documents or based on discussion with some of the process performers.

6.3.3.12 Briefing (BRF 1 and BRF 2)

Before data collection begins, both the assessment team and the OU are briefed on the assessment purpose and their respective roles. During the briefing, participants are informed of the purpose of the assessment and how it is intended to be performed.

6.3.3.13 Data collection (DAT 1)

The assessment team conducts data acquisition, validation, and process rating. Interviews typically take about one hour per process. The schedule assumes carefully planned logistics, a focused assessment team and well-informed participants.

Interviews can be divided into the following three phases: clarification, collection, and consolidation. The assessor gives the participants a copy of the process description at the beginning of the interview so they can read through it with the interview leader. For each process, the assessor first clarifies the terminology used and defines the scope of the process to be assessed. Before continuing, the assessor should verify that the participants understand the purpose of the processes being evaluated. To facilitate data collection, the assessor asks questions about process performance that allows interviewees to speak generally about the implementation of the process. Otherwise participants can be interviewed in small groups (number of participants ≈ number of interviewers). The interviews should first focus on the performance of the base practices, with the presence of work products checked. The interviewer should not form a series of "yes or no" questions out of the base practices, but instead initiate and guide a discussion with the participant. Once evidence of process performance is obtained, the interviews focuses on the process capability covering all levels defined in the assessment scope.

Finally, to consolidate findings, the assessor concludes by giving a short summary of the information obtained from the interview, and asks for participant confirmation. Feedback at this stage clears up any misunderstanding and provides missing information.

To keep the interviews focused on the assessment context, it can be beneficial to have a member of the organizational unit with a general knowledge of the entire project present during the interviews. The project managers of the assessed projects should be generally available for brief consultations throughout the on-site phase.

If using an electronic data recording system during the on-site phase, ensure that appropriate backup measures are in place. The assessment data file should be backed-up regularly.

6.3.3.14 Rating of process attributes (PRT 2)

To support the rating of the process attributes, the assessment model provides a set of indicators for the process and the capability dimension. The indicators may be used as informal checklists. Presence of all indicators is not required to fully achieve the corresponding process attribute. In particular, a process can be fully performed (Capability Level 1) although some of the base practices are not

performed, if this does not reflect significant weaknesses in the performance of the process and if the purpose of the process is met. To ensure an objective rating, the assessors will always take into account the process context and the context of the organizational unit being assessed.

Performing a preliminary rating of process attributes may be used to try to identify missing or conflicting evidence thus supporting data validation.

The highest capability level to assess for each process is defined as part of the assessment scope during the initiation phase. However, if the assessment team finds that an organizational unit is not achieving full or even largely ratings on lower capability levels, evaluating higher levels can be stopped. In this case, the assessment team leader consults the sponsor and consider redefining the scope of the assessment. No change to the assessment scope can be done without the approval of the sponsor and without being properly documented.

The evaluation of process attribute PA2.2 can be supported by explicit checklists or by review criteria known by all reviewers to review certain key work products such as plans, or requirements documents.

Detailed guidance to the assessors in determining the achievement of level 4 (measured) through the analysis of metrics collected by a software organizational unit, in particular to rate the process "MAN.6 Measurement" is provided in reference [SPEC].

On completion of data gathering and rating, some time (e.g. half a day) can be anticipated for clarifying open questions. All interviewees should be available on call for clarifying open questions.

6.3.3.15 Process profiles (PRT 3)

In conformance to requirements in ISO/IEC 15504, S4S assessments produce a set of process attribute ratings, or process profiles, for each of the processes investigated. The example in Figure 15 shows the ratings of each of the nine process attributes for five processes assessed.

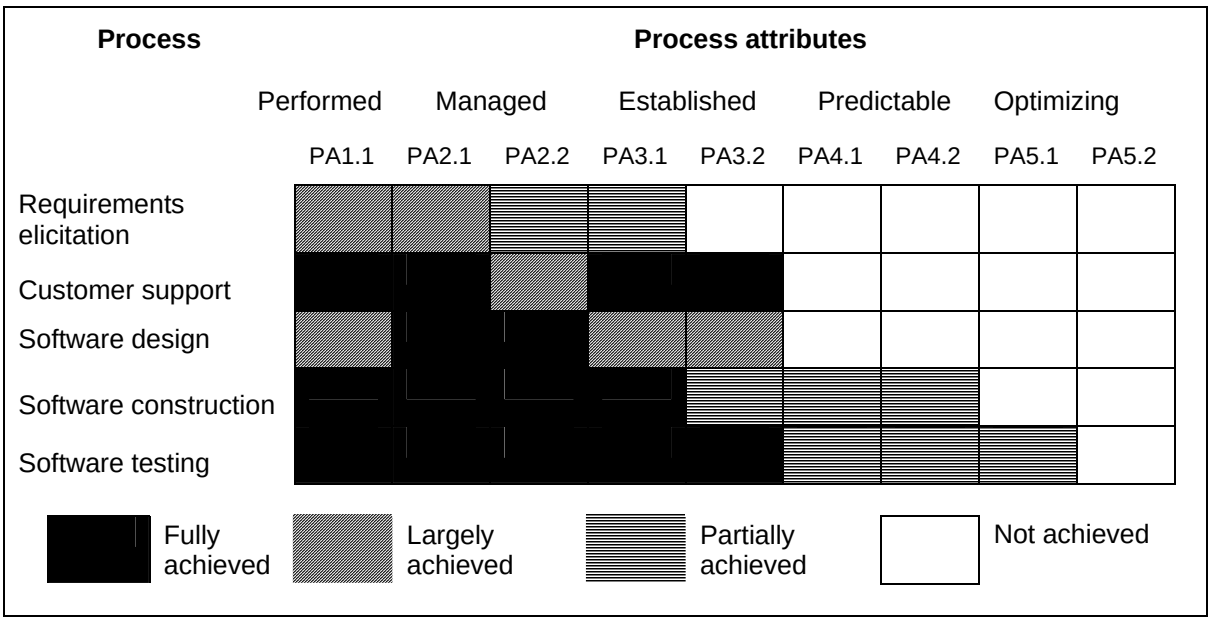


Figure 15 Example of process profile

6.3.3.16 Assessment instruments

In any assessment, information is collected, recorded, stored, collated, processed, analysed, retrieved and presented. In general, a documented assessment process is supported by various instruments and tools for information gathering, processing and presentation. For some assessments, the support tools and instruments can be manual and paper-based (forms, questionnaires, or checklists). In some cases the volume and complexity of the assessment information is considerable, resulting in the need for computer-based support tools. ❷

Regardless of the form of the supporting instruments and tools, their objectives are to help an assessor perform an assessment in a consistent and reliable manner, reducing assessor subjectivity and helping to ensure the validity, usability and comparability of assessment results. In order to achieve these objectives, the instruments and tools should make the assessment model and its indicators accessible to the assessors. ❷

6.3.3.17 Act on results

If the process capability determination is carried out by an organization to determine the capability of its own processes for a particular requirement or class of requirements, then the sponsor can initiate a process improvement initiative to address any process-oriented risk issues identified. ❷

6.3.4 Assessment for process improvement

6.3.4.1 Introduction

Most of the assessment phases (initiation, planning, briefing, data acquisition, data validation, process rating and reporting) remain as described in subclause 6.3.3. For process improvement assessments a few additions to the guidance follow.

6.3.4.2 Assessment scope (INI 10)

The scope of the assessment for process improvement should cover all processes selected for improvement, and each process should be assessed at least up to its desired capability level in the target profile.

6.3.4.3 Data acquisition (DAT 1 and DAT 2)

In assessments with the objective of process improvement following the method described in this handbook, more detail should be recorded. In particular, the critical process indicators (base practices, work products, and management practices) that are not performed are noted.

6.3.4.4 Process rating (PRT 1)

The rating scheme in subclause 5.3 remains the same in that: Not all indicators and their evidence should be present in order to fully achieve the corresponding process attribute. In particular, a process is fully performed (level 1) although some of the base practices are not performed, if this does not reflect significant weaknesses in the performance of the process and if the purpose of the process is met. Similarly, not all work products listed as outputs of a given process need to be observed. The assessment team, as always, use their expert judgement and the contractual obligations or in-house procedures to determine which base practices and work products are used for achievement of the process purpose. However, in cases where essential base practices are not performed or listed work products are not produced, these unachieved process indicators should be clearly indicated in the

assessment record. In particular, anytime the assessment team rates a process attribute as less than "Fully" achieved on any given process, the unachieved process indicators leading to the reduced rating should be recorded.

In addition, for unachieved or incomplete indicators, the assessment team records at which level (or levels) in the organization improvements should be defined (e.g., project level, organizational unit or business unit). Certain base practices or practices are applicable both to specific project environments and to the organization as a whole. The base practices of SUP.8 configuration management are a good example. A "Largely" achieved rating at level one here can be the result of a flawed project-specific configuration management scheme or of an inadequate configuration management scheme within the entire OU. Recording the organizational level helps guide future improvement suggestions.

Producing a complete list of unachieved or incomplete indicators allows a SPI group (potentially different from the Assessment Team) to use the results of the assessment, that is to build an objective set of improvement actions, and also to have a very precise view of the risks of not implementing these improvement actions

6.3.5 Assessment for ECSS conformance

6.3.5.1 Introduction

A space software process assessment can be performed by or on behalf of an organizational unit with the purpose of determining the conformance of its own processes to the ECSS requirements. In ECSS conformance assessments, the same phases of initiation, planning, briefing, data acquisition, data validation and reporting occur as in assessments for process improvement or capability determination. Identical data is collected for evaluation.

The main difference lies in the interpretation of the data and in the scheme for rating. Process indicators in the model that are associated with ECSS requirements play a different role in a conformance assessment, as their performance will be verified. In addition, process performance, the lowest process attribute, may not be rated “Fully” or “Largely” for a process unless all mandatory indicator (base practice or work product) are present. In this sense, these associated indicators become “mandatory” indicators in an ECSS conformance assessment. In assessments for process improvement or capability determination, these and all other indicators simply support the assessor’s judgement and are not verified individually. The following subclauses describe how these mandatory indicators affect planning, data acquisition, rating and reporting in an ECSS conformance assessment.

6.3.5.2 Planning for mandatory base practices (PLN 2)

During the planning phase, an additional task is applicable for an ECSS conformance assessment. It is important at this phase for the assessment team leader, with the help of the local assessment coordinator, to identify all mandatory indicators (see task PLN.2). In the assessment model, a large set of indicators is provided to the assessor, which help rate the performance of each process. In the process dimension, these indicators are base practices, work products and work product characteristics. Many of these process dimension indicators refer to requirements in the ECSS Standards. These indicators serve as a guide for the assessor, however, in an ECSS conformance assessment those indicators which reference applicable ECSS requirements will be identified and verified.

For a given project to be assessed, the contractual obligations and internal company policy is carefully analysed to determine which instructions are applicable to the assessment context. If a given ECSS

requirement is applicable to the project (via contractual obligations or in-house standards) then the corresponding indicator is "mandatory".

The assessment team leader takes into account any specific tailoring of ECSS Standard for any specific project (It is important to consider that the ECSS project-tailored requirements can be new, deleted or modified). The assessment team leader traces the modifications of the tailored ECSS Standards towards the S4S process assessment model.

The cross reference matrix is provided in Part 2 for each base practice to the ECSS requirements references.

ECSS references often add information to further specify the generic indicator. To verify compliance with the full ECSS instantiation of the indicator can require more in-depth questioning and document examination. The time for data collection and validation in an ECSS conformance assessment is longer than in other assessments.

6.3.5.3 Data acquisition (DAT 1 and DAT 2)

If the purpose of the assessment is ECSS conformance determination, the assessment team interviews each participant separately to ensure the corroboration of data.

6.3.5.4 Process rating (PRT 1)

For each process in a space software process assessment, all mandatory indicators need to be present in order to achieve a rating of “fully” or “largely” at capability level 1.

The tailoring of ECSS Standards can make some activities applicable to software of certain criticality.

In addition, and after process ratings, capability determination is analysed and interpreted with respect to the tailored ECSS requirements applicable for a specific project and the defined target capability profiles. All non-compliances after the initial capability assessment are documented and interpreted for that specific project and its tailored applicable ECSS requirements:

1. A process missing a base practice or a work output since that specific project tailored out that corresponding activity from the ECSS Standards, is identified and rated accordingly as if that base practice or work product is not defined for that process.
2. Added processes, base practices or work outputs (already added to the assessment model at the beginning of the assessment) are analysed carefully to cross-check the evaluated ratings with respect to the real applicable ECSS tailored requirements for that project and their target profiles.
3. Modified processes, base practices or work outputs (already traced to any existing process defined in the model at the beginning of the assessment) are analysed to check evaluated ratings with respect to the real applicable ECSS tailored requirements for that project

6.3.5.5 Act on results

If the process assessment has been carried out to determine the suitability of another organization's processes for a particular contract or class of contracts, then the sponsor should take into account the assessment of process-oriented risk not only in making contract award decisions, but also when establishing contractual commitments related to ongoing risk management activities. ❷

6.4 Competency of assessors

6.4.1 Introduction

This subclause includes instructions for defining requirements for competencies of assessors performing S4S conformant assessments. In addition, this subclause presents one way in which competency can be verified through certification.

6.4.2 Gaining competency

6.4.2.1 General

Assessments are performed by individuals:

- with an adequate mix of education, training and experience on relevant processes,
- who have access to appropriate documented guidance on how to perform the defined assessment activities,
- who have the competencies to use the tools chosen to support the assessment.

6.4.2.2 Key relationships

Figure 16 shows the key relationships pertaining to the demonstration and validation of the competencies of assessors. These can be articulated as follows:

a. Assessors demonstrate their competency to carry out assessments.

b. Competency results from:

c. the knowledge of the processes;

d. skills in the principle technologies of this handbook including: the Process Reference Model; Process Assessment Model(s), methods and tools; and rating processes;

e. personal attributes which contribute to effective performance.

f. The knowledge, skills and personal attributes are gained by a combination of education, training and experience.

g. An alternative to the demonstration of competency is to validate an intending assessor's education, training and experience.

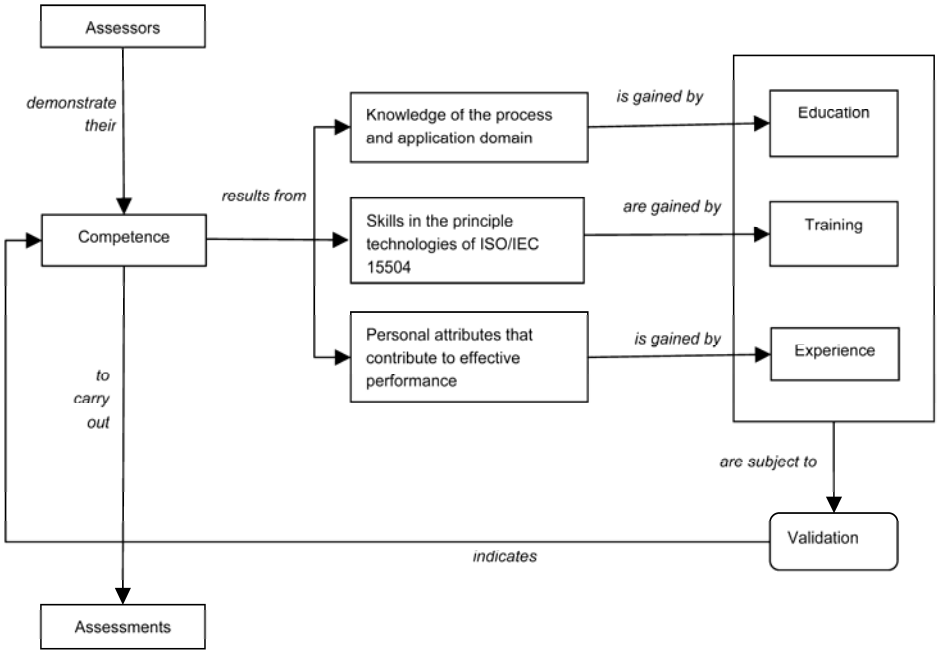


Figure 16 Demonstration and validation of assessor's competency [ISO/IEC 15504]

6.4.2.3 Levels of competency

Two levels of competency are defined:

a. Provisional assessors have reached the acceptable levels of education, training, including S4S specific training, and experience but have not necessarily participated in S4S conformant assessments.

1. A provisional assessor should be trained and experienced in the process as well as in process assessment.
2. A provisional assessor should have received training that satisfies the guidance of this handbook.
3. A provisional assessor should also have evidence of an acceptable level of education.
4. Competency instructions specific for S4S assessors are provided in subclause 6.4.5. The list provided here below refers to general requirements for ISO/IEC 15504 conformant model software process assessors.

   Acceptable levels of education can comprise:

   - Courses offered by a college or university
   - Professional courses organized by recognized local or international bodies
   - Vendor sponsored courses
   - Employer sponsored courses

   Acceptable levels of training can comprise:

   - Training provided by recognized local or international bodies
   - Training provided by vendors and trainers

b. Competent assessors have participated in S4S conformant assessments. A record should be maintained documenting education, training and experience.

6.4.3 Maintaining competency

To maintain their competency, assessors should update their knowledge, skills and personal attributes by engaging in activities such as education, training and relevant professional activities as well as performing further S4S conformant assessments. This should be reflected in the log mentioned in subclause 6.2.

6.4.4 Verification of competency

a. Assessment team members other than the team leader performing a S4S conformant assessment may be provisional or competent assessors. The competency of team members should be verified by the competent assessor before assigning roles and responsibilities for performing the assessment.

b. Assessment team leaders leading conformant S4S assessments is requested to be a competent assessors. The competency of the assessment team leader is verified by the sponsor.

c. A means of verifying competency of assessors may be through certification.

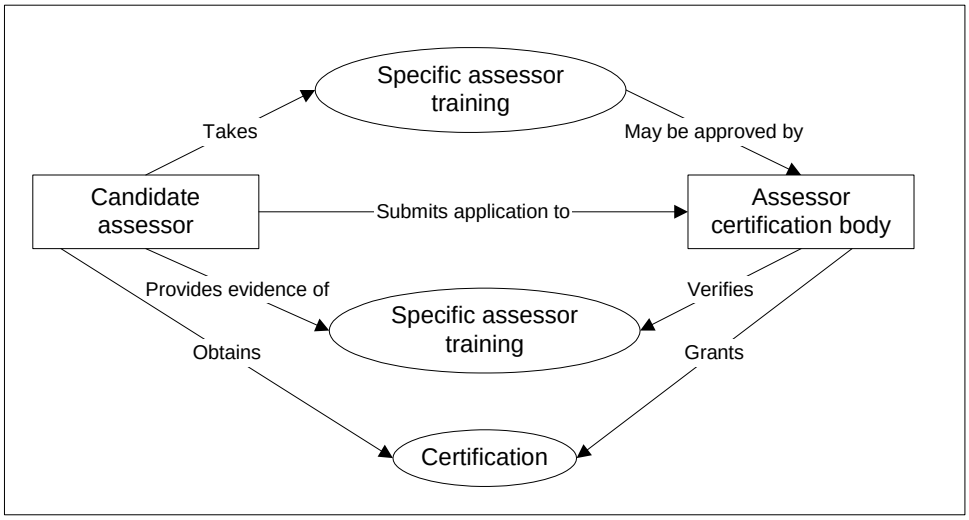


Figure 17 Basic organization of a certification scheme

6.4.5 Assessor competence instructions

An example of specific requirements for competence of assessors performing S4S conformant assessments is proposed here after.

Table 7 Example of assessor competence requirements

	Provisional assessor	Competent assessor
Academic requirements	• Completed secondary or high school education or equivalent • Educated to degree level in a numerate or technical discipline	• As for provisional assessor

	Provisional assessor	Competent assessor
Work experience	At least three years full time appropriate experience (excluding training) in one or more of the following process contexts: • Highly critical software development projects • Safety related systems development projects • Space systems development projects • Work experience to have been completed in the last six years.	At least six years full time appropriate experience (excluding training) in one or more of the following process contexts: • Highly critical software development projects • Safety related systems development projects • Space systems development projects • Work experience to have been completed in the last ten years.
Formal S4S training	• Successfully completed the S4S Assessor Training course delivered by an approved S4S Training provider. • Passed the S4S Assessor Training course examination • Course completion and examination to have been completed in the last three years prior to initial application	• As for provisional assessor

6.4.6 Assessor experience instructions

Requirements may be established on the assessment experience of a competent assessor, for example:

a. Minimum number of S4S assessment hours: 120 h

b. Minimum number of S4S assessments: 4

c. Period in which assessment performed: Last 2 years

d. Minimum number of assessments as assessment team leader: 2

NOTE 1 To achieve competency, provisional assessors may act as assessment team leaders when supervised by a competent assessor.

NOTE 2 Maintenance of certification can be based on maintaining the above requirements.

7
Process improvement

7.1 Introduction

The first part of this clause 7 describes the process improvement process and the necessary guidance for its successful implementation (subclauses 7.2, 7.3 and 7.4, respectively). Subclause 7.5 includes the instructions from the process improvement process needed for the recognition of the process improvement cycle.

This subclause provides an introduction to process improvement and contains an introduction to the motivation for and implementation of process improvement.

The software improvement cycle described here contributes to achieving the objective and outcomes of the S4S process PIM.3, 'Process Improvement'.

Software process improvement is best considered as a continuous process, where an organization moves continually around an improvement cycle. Within this cycle improvement is accomplished in a series of steps or specific improvement actions such as introducing new or changed practices into software processes or removing old ones. An important step in the improvement cycle, however, is the execution of some form of data gathering to establish the initial state, and subsequently to confirm the improvements. The overall cycle for a continuous software process improvement process is composed by the activities drawn below.

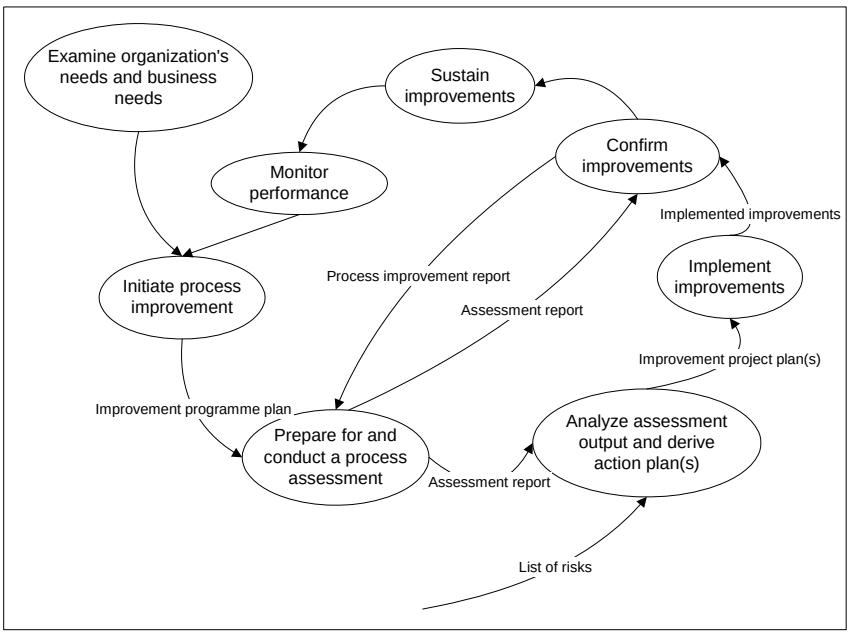


Figure 18 Process improvement cycle

Particular emphasis here is placed on the derivation of corrective actions based on the assessment results. A method to identify corrective actions and organize them into projects is presented in this clause 7. This method is further extended incorporating process based risk analysis which supports the prioritization of corrective actions.

7.2 Process improvement cycle

7.2.1 Introduction

This subclause defines the detailed process definition for any process improvement. Each process major step and activities is represented following the notation defined in clause 6.2, including all responsibles, activities, input and outputs of all activities.

An improvement cycle can be divided into the following activities:

a. examine the organization's needs and business goals;

b. initiate process improvement;

c. prepare for and conduct a process assessment;

d. analyse assessment output and derive action plan(s);

e. implement improvements;

f. confirm improvements;

g. sustain improvements;

h. monitor performance.

A detailed breakdown of each activity into tasks is found in the next subclauses.

The responsible party for the different activities is defined using the following acronyms:

AT	assessment team
IPL	improvement project leader
IPM	improvement programme manager
OU	organizational unit
SPIG	software process improvement group
PO	process owner
TM	top management

Different roles can be involved in a given step. Some can be responsible for it, others contribute or participate always and others participate or not depending on the circumstances. The responsible role is represented in each step between (). The roles whose participation is optional are presented in *italics*.

Detailed information about these roles is provided in subclause 7.2.3.

Diagrams of the improvement cycle are provided in 7.2.2.

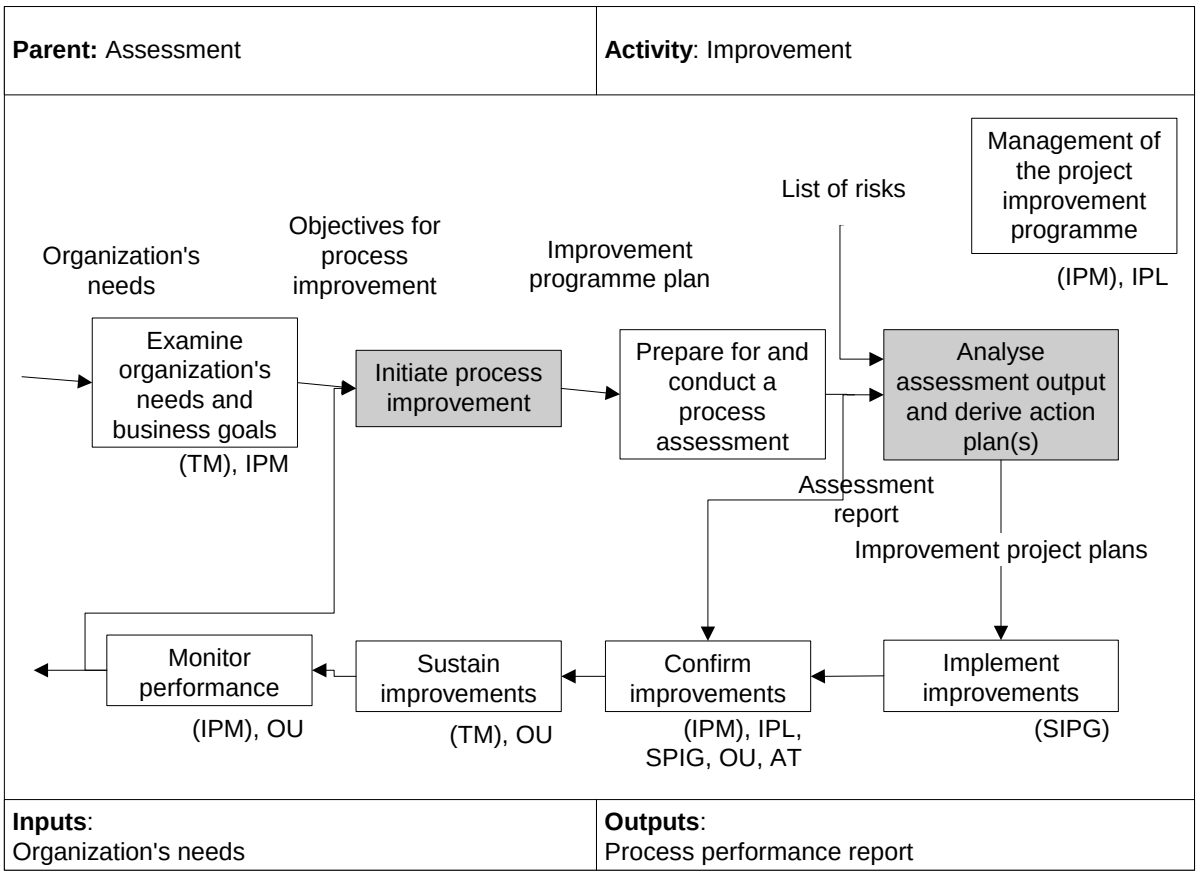


Figure 19 Improvement cycle

Throughout this subclause, the improvement cycle activities, roles or work products are indicated in the detailed steps below.

All detailed steps defined are uniquely identified to correspond to the different boxes defined in the diagrams.

7.2.2 Process improvement process

7.2.2.1 Examine the organization's needs and business goals Role: (TM), IPM

Objective To identify the organization's needs and business goals relevant to process improvement.

Guidance

It is extremely important to identify business issues or goals with regard to software at the beginning of a software process improvement cycle. Awareness on the importance of software and the necessity of investing in SPI are equally important. Guided interviews with local management (business, marketing, technical, and quality) can be organized to understand which business drivers (typically among quality, cost, schedule or product issues) are of the highest priority. A high correlation has been found between lasting programs and business management involvement (and understanding) from the beginning. If the organizational readiness is perceived as low, the software process improvement should be postponed.

The needs and business goals of an organization are often centred on achieving enhanced customer satisfaction, greater competitiveness and improved business value associated with delivery of software or information systems. For organizations with a dependence on software, these key management concerns become drivers that initiate software process improvement throughout the organization with goals of higher software quality, lower development and maintenance costs, shorter time to market, and increased predictability, their commitment to get the ISO 9000 certification and controllability of software products and processes.

Where possible quantitative indicators of the achievement of the business goals should be identified and used to establish success/failure criteria for the process improvement programme. Examples of these indicators can be, for example, measurements of customer satisfaction, or delays in deliveries. It is important that they are related to the business goals and not to the improvement programme only.

EXPECTED OUTPUT: *Objectives for the process improvement*

Work products of the business goals examination phase

Input work products	Output work products
Organization's needs	Objectives for the process improvement

7.2.2.2 Initiate process improvement

In this step, an overall software process improvement programme plan is developed identifying the phases of the improvement and defining goals for each phase. In the following steps, process improvement projects are initiated based on assessment results and are described in improvement project plans. The overall co-ordination of these individual projects is described in the improvement programme plan.

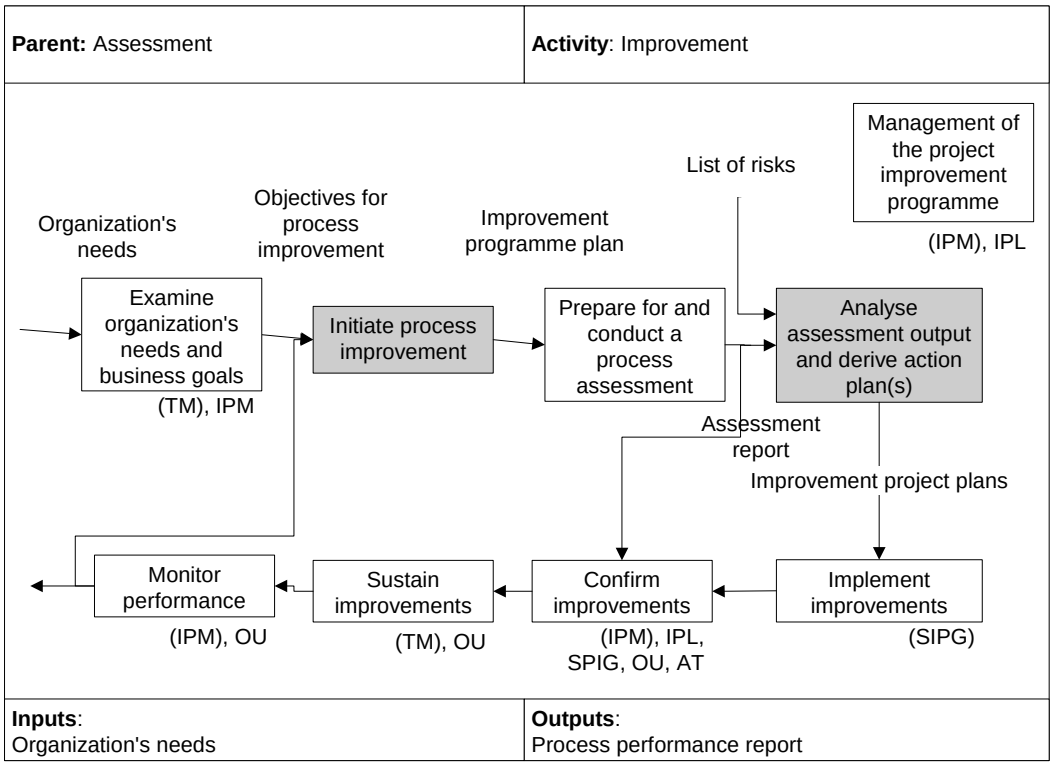


Figure 20 Initiate process improvement

Objective To develop and document an overall plan describing all activities performed in conducting the improvement programme including:

- The improvement strategy including the improvement life cycle
- The processes and target capabilities subject of the improvement programme
- The programme scope, and the resources necessary to carry out the improvement programme.
- The identification of interfaces and dependencies

Detailed steps

IPI 1 **Determine improvement strategy** **Roles: (IPM), TM**

Evaluate options available for achieving the goals of the improvement process, and determine, on the basis of risks and opportunities, which strategy and life cycle model to adopt.

IPI 2 **Define target profile** **Roles: (IPM), *AT*, TM**

Select the set of software processes that are targeted by the improvement programme and the capability levels that are considered as needed to satisfy the OU business needs.

IPI 3 **Define the scope of work and estimate resources** **Role: (IPM), *TM***

Define the work to be undertaken for the improvement, and determine if achievement of the goals of the improvement is feasible with available resources and constraints.

IPI 4 **Identify dependencies and interfaces** **Role: (IPM)**

Identify interfaces and dependencies between elements in the improvement process.

IPI 5 **Identify roles and responsibilities** **Role: (IPM)**

Produce a documented overall plan for the improvement programme.

IPI 6 **Document the improvement programme plan** **Role: (IPM)**

Produce a documented overall plan for the improvement programme.

EXPECTED OUTPUT: *Improvement programme plan*

IPI 7 **Improvement programme plan review** **Role: (IPM), *OU*, TM**

Gain consensus and reach agreement on the overall improvement programme.

Guidance

Process improvement programmes and projects should be managed in the same way as any other project in the organization. This includes definition of objectives, proper planning, allocation of resources, identification of risks, or progress tracking.

Based on an analysis of these needs and goals, processes in the S4S process model (see annex A) are selected for improvement and target capability levels are defined for these key processes. This target capability profile represents the organization's desired levels of capability for S4S processes. A strategy for defining target profiles is provided in subclause 6.3. Sample target profiles for software criticality classes A-D, are also provided in Annex A.

Usually, the duration of one iteration of the process improvement cycle is defined by the time between two assessments. Since the delta-assessment should demonstrate measurable increase of capability levels, this time should not be less than 9 months. Next table provides a rough time scale for one iteration.

Table 8 Typical improvement cycle time-scale

Step	Activity	Output Work Products	Number of weeks
1	Examine the organization's needs and business goals	Objectives for the process improvement	1-3
2	Initiate process improvement	Process improvement programme plan	1-3
	Milestone: Process improvement programme plan review	Approved process improvement plan	
3	Prepare for and conduct a process assessment	Assessment report, Process profiles	5-8
4	Analyse assessment output and derive improvement project plan(s)	Project plan(s) aligned with the process improvement programme plan	1-3
	Milestone: Process improvement project plan review.	Approved and updated process improvement project plan	
5	Implement improvements	Improvement programme and project progress report(s)	15-30
6	Confirm improvements	Improvement action final report(s)	1-2
	Milestone: Process improvement project reports review.	Approved improvement project and programme final report(s)	
7	Sustain improvements	Improvement deployment plans	15-40
8	Monitor performance	Process performance reports, Process improvement proposals	Continuous
	Milestone: Process performance review	Approved process performance reports, approved process improvement proposals	

Work products of the improvement process initiation phase

Input work products	**Output work products**
Objectives for the process improvement	Improvement programme plan

7.2.2.3 Prepare for and conduct a process assessment Role: (see subclause 6.2)

Objective To measure the actual capability of the OU. See subclause 6.2.

Work products of the S4S process assessment phase

Input work products	Output work products
Improvement programme plan	Assessment Report

7.2.2.4 Analyse assessment output and derive action plan(s)

Information collected during the assessment, in particular the process attribute ratings, the unachieved indicators and the results of risk analysis are studied in the light of the organization's needs to:

- identify areas for improvement;
- set qualitative software process goals, and quantitative improvement targets;
- derive improvement project plans, and integrate them with the improvement programme plan.

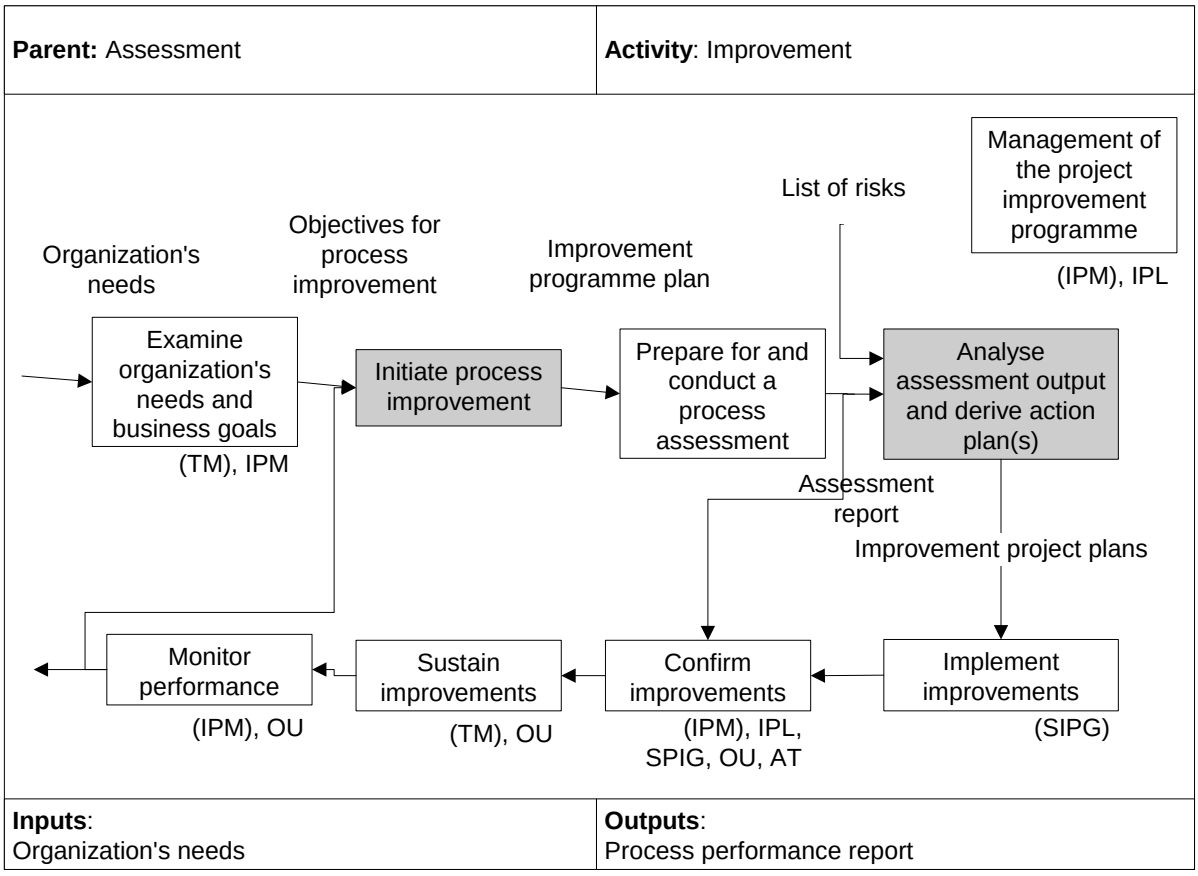


Figure 21 Analyse assessment output and derive action plan(s)

Objective To identify areas of improvement, set qualitative software process goals and quantitative improvement targets, derive improvement project plan(s), and integrate it with the process improvement programme plan.

Detailed steps

ARD 1 **Compile unachieved indicators** **Role: (AT)**

Analyse the gap between the measured capability and the target capability for each process and produce a list of those unachieved indicators that lead to the gap.

Guidance

After the S4S assessment results are complete, the gap between the target and the measured capability profile is analysed for the unachieved or incomplete indicators. For each process attribute rating that does not reach the target rating the assessment record is used to "trace backwards" to identify the unachieved indicators (base practices, generic practices, generic resources and generic work products), that resulted in the deficient ratings for each process as noted during the assessment. Of course, process attributes where the measured rating is higher than or equal to the target level are disregarded.

In assessments for the purpose of process improvement this activity, although conceptually part of this step, is best performed while generating process ratings (see clause 6.2.2.6) and the results should be recorded in the assessment report.

EXPECTED OUTPUT: *List of unachieved indicators*

ARD 2 **Derive the list of corrective actions** **Role: (IPM), AT**

Translate the list of unachieved indicators into a list of actions that allow achieving those indicators.

Guidance

The responsibility for this step lies with the PIM but it can actually be performed by the AT.

In this step, a list of corrective actions is compiled based on the unachieved indicators. From these unachieved indicators, corrective actions are derived. The corrective actions specify what to do and not how to do it. Corrective actions are derived differently for unachieved base practices or work products then for unachieved generic practice, generic resources and generic work products.

Unachieved base practices or work products are added directly to the corrective action list. The most simplistic approach is to turn unachieved base practices and work products into a "to-do" action list. In some cases, the organizational unit was simply not aware that they had to perform certain activities, and, in these cases, this approach can be successful. However, in many cases, an underlying problem prevents the project or organizational unit from fully achieving the indicator(s), although project staff can be fully aware that this is undesired. In these cases, it is more important to analyse the unachieved indicators to determine the root cause of the indicators' absence. From this analysis, meaningful corrective actions are derived.

If an unachieved indicator was noted at both project organizational unit levels, two corrective actions can be derived from it, so that each relevant level of the organization is addressed.

Note that at this stage, corrective actions in this list simply specify what should be done and not how the actions should be implemented. These suggestions are noted for future use, but the final method of implementation is determined during subsequent steps, based on input from many sources.

EXPECTED OUTPUT: *List of corrective actions*

ARD 3 **Sort and group corrective actions** **Role: (IPM), SPIG**

Group the corrective actions based on relationships and interdependencies between them.

Guidance

Once the corrective actions have been identified, the next step is to group actions together based on relationships and interdependencies between them. Meaningful sorting categories depend strongly on the OU or company context. A few examples of criteria that can be used for sorting follow:

Project versus OU: Corrective actions can be sorted by the level of the organization they impact (i.e., project level, management, quality assurance, business unit). This is a useful distinction, as typically in practice improvements at different levels of the organization are implemented by different groups of process performers.

Related indicators: If several actions concern a single topic, it is sometimes beneficial to group them together. If several project-level actions surround a topic like configuration management, for example, it is best to group these into a single project. Also, corrective actions can be grouped if they affect a single work product or class of work products in the project or organization. By combining corrective actions in cases like these, an integrated approach is assured. It is important to consider that base practices and work products from different processes can be related.

Process attribute indicators across processes: If the similar process attribute indicators are not achieved across several processes, they can be treated most effectively as a separate group. For example, low ratings of process attribute 3.2. 'Process deployment' across several processes can be due to an overall lack of project resources. Thus a set of unachieved indicators identified in the assessment can be symptoms of a single problem best tackled at the organizational level.

For these cases of systematic deviations between the target and the actual state for a given process attribute, it is more efficient to concentrate on improving those processes that support the unachieved generic practices. Should, for example, GPI.3.2.1 "Deploy a defined process that satisfies the context specific requirements of the use of the standard process." be systematically not achieved, focus on the process PIM.1 'Process Establishment' for guidance in process improvement can help.

EXPECTED OUTPUT: *Grouped corrective actions*

ARD 4 **Seek management support for improvement** **Role: (IPM), TM, *AT***

Ensure commitment from top management for the availability of resources to implement the expected improvements.

Guidance

a. At this point of the phase there is a clear identification of problems and solutions. More concrete commitment from management should be gained concerning the resources upon which the improvement actions are drawn.

b. A meeting should be arranged with top management during which the assessment results and corrective actions are presented in summarized form, and the framework is defined for future improvements. The S4S assessor judgement

can be used to guide this discussion.

c. Detailed cost estimates are not yet important; instead a rough estimate of the resources management ready to allocate should be obtained, in addition to the time frame in which expected improvements are expected to occur. This base knowledge is used to prioritize the actions and focus the action planning.

d. If external staff is intended to support the improvement efforts, an initial estimate of the internal versus external effort that is allocated should be agreed, keeping in mind that a certain amount of internal effort is crucial to realize improvements. Industry experience suggests that during the planning of improvements, the amount of external manpower needed is larger than the internal one, but that, during the rollout and training phases, this situation is reversed. External support can be used to great benefit in implementing improvements, but cannot be successful without internal effort as well.

ARD 5 Classify and prioritize action groups Role: (IPM), SPIG, *OU*, *AT*

To classify the corrective actions into action groups that can be implemented as one or more improvement projects and establish priorities for implementation.

Guidance

a. Until this step, it is possible to perform the analysis with a small assessor or process group. However, once a list of basic grouped actions is defined, more members of the organization should be involved to validate and prioritize the action groups and brainstorm ideas for their implementation. Involving process performers in these activities ensures the selection of the most relevant improvements and facilitates their ultimate buy-in within the organization. Prioritization and initial development of action plans (the next step) can be best accomplished through workshops with the process performers who ultimately take the responsibility to perform the improvement actions. Together, workshop participants can discuss the identified action groups and brainstorm ideas.

b. Proposed implementations should be evaluated according to their effort to implement and the severity of the problem they correct. Through weighing these two parameters, actions can be prioritized to reflect the organization's business goals.

c. Improvement projects should be classified as short, medium, and long-term actions. Typically, short term improvements take less than one man week to implement, medium term take less than one man-month, and long term require more than one month, but these definitions can be tailored to the organization. The timeframe for implementing the selected improvement projects can be estimated based on the resources management is willing to allocate for implementation and dependencies to other initiatives within the organization This activity should be performed through workshops involving a larger group than software process improvement group.

d. Prioritization should consider the effort to implement actions and the importance of the problems that they correct.

   The prioritization allows also establishing which action groups are actually intended to be addressed and which not. It is often impractical or impossible to implement all identified improvement actions with the resources available.

e. The following considerations regard the interfaces between the software process improvement and the risk management process defined in ECSS-M-ST-80C.

Process based risk analysis is a key input in this step and therefore it should be performed according to the OU risk management process if it exists. Evaluation of the likelihood and severity or risks associated to processes not reaching their target capabilities should be explicitly performed and considered as an input to this step.

Without the use of inputs coming from the risk management process, the process improvement plan and actions, after an assessment, are either based on expert judgement of the assessment team, or driven by the need to reach a process capability level. With the use of inputs from the risk management process, the recommendations for improvement actions can be sustained by demonstrating the risks of not implementing the actions.

f. The results of an assessment provide objective information of which processes or aspects of processes limit the capability of the organization. In particular the assessment results can provide very detailed information on, for instance, the specific practices, or items. (indicators) that prevent processes from reaching their intended capability. The number of these unachieved indicators can be very large and they can range very widely in importance, or scope. The question is, however, which indicators and processes are the best candidates for implementing improvements. Are they the most significant ones even if they are difficult to implement in a short term? The ones that can provide a short-term benefit? The criteria can be many and the decision is often difficult.

EXPECTED OUTPUT: *Set of proposed improvement projects addressing the classified action groups.*

ARD 6 Develop improvement project plan(s) Role: (IPM), SPIG, *OU*

To elaborate and complete the plan(s) for the improvement projects identified in the previous step.

Guidance

Improvement action groups with the highest priority are selected for implementation and form the basis of individual process improvement projects. Members of the improvement group may be allocated to one or more of the improvement projects.

The task of developing the improvement project plans is performed by the SIPG but the ultimate responsibility lies on the PIM.

The activities of the SPIG include:

a. Defining success criteria for each action and determine how progress is intended to be measured.

b. Deciding how to implement the improvement actions by evaluating a number of scenarios if not already done in the previous step.

c. Defining the means to identify and monitor the risks for the proposed actions.

d. Estimating the resources (human and others) required and the benefits expected from the project.

e. Developing the work breakdown structure.

f. Establishing project schedule.

g. Identifying responsibilities for the actions and agree upon the responsibilities with those affected by the actions. In particular the responsibility and involvement of the affected PO needs to be addressed.

h. Identifying support, consultancy, recruitment and training needs.

The results of these activities are reflected in process improvement plans.

As mentioned earlier, initial action planning can be accomplished through a workshop, although further refinement of plans should be done afterwards.

EXPECTED OUTPUT: *Improvement project plan(s)*

ARD 7 **Obtain management approval of improvement project plans** **Role: (IPM), IPL**

To have the plan(s), including the improvement schedule, resources and logistics for its implementation, reviewed by Top Management.

Guidance

In order to proceed with the improvement projects, management approval is obtained. Getting management approval is a responsibility of the PIM although the IPL is involved in these activities. Improvement group members are prepared to make a business case for improvement. When arguing the case for improvements it is important to include not only the financial benefits provided by the improvement but also the costs of not implementing the improvement.

Work products of the activities of the Analyse assessment output and derive action plan(s)

Input work products	Output work products
Assessment Report List of risks	Improvement project plan(s)

7.2.2.5 Implement improvements Role: (SPIG)

Objective To implement the process improvement projects.

Guidance

Within the overall improvement programme plan, several process improvement projects can be initiated. The co-ordination of these individual projects is described in the (updated) improvement programme plan

Each improvement project can be concerned with implementing one or more process improvement actions. Such projects can, not only cover initial implementation of improvements as described in this section, but the subsequent steps. Four main tasks are involved in each process improvement project:
selecting the operational approach to implementation;
preparing and agreeing the process improvement project plan (a detailed implementation plan);
implementing the process improvement actions according to the process improvement project plan;
monitoring the process improvement project.

a. Improvement projects should be managed and monitored as any other project in the OU. They should have a manager (the Improvement Project Leader) and team members specifically assigned.

b. At each of the milestones in the project or programme, the achieved results should be evaluated against the business goals of the organization.

c. All plans and documents should be updated continuously with the progress of the improvement cycle. The master document is the process improvement programme plan. Specific improvement projects implementing specified actions groups are guided by their corresponding improvement project plan.

d. Regular reporting of the plan's progress and achievements is essential for the success of the improvement process. These reports should show the actual and target values of the measures used to evaluate the progress, evaluate impacts of the improvement actions, provide data on the effort and resources expended, and re-evaluate the risks, costs and benefits associated with the improvement process.

e. In many cases, some coaching or consultancy by external experts should be done to supervise and accompany the improvement plan.

EXPECTED OUTPUT: *Implemented improvements*

Work products of the activities of the implement improvements

Input work products	Output work products
Improvement project plan(s)	Implemented improvements

7.2.2.6 Confirm improvements Role: (IPM), IPL, SPIG, OU, *AT*

Objective To confirm that the implemented actions achieve the expected improvement.

Guidance

The improvement actions should be tried in pilot projects before general deployment. The preferred means of confirming improvement is to subject the pilot projects to a process assessment. Only equivalent capability profiles can be compared. Capability profiles can be considered equivalent when:

A complete bi-directional mapping exists between both sets of processes and capability scales

A mechanism is defined to allow translation of capabilities from one profile to the other

EXPECTED OUTPUT: *Process improvement report*

Work products of the activities of the confirm improvements

Input work products	Output work products
Implemented improvements	Process improvement report

7.2.2.7 Sustain improvements Role: (TM), OU

Objective To sustain the achieved improvement across the organization.

Guidance

After improvement has been confirmed, the software process needs to be sustained at the new level of performance. The improved process should be deployed and used by all those for whom it is applicable. In some cases the deployment of improved processes can be simple but not in others and the strategy and impact of deployment needs consideration. This deployment is properly planned and the needed resources assigned to it.

7.2.2.8 Monitor performance Role: (IPM), OU

Objective To monitor continuously the performance of the organization's software process.

Guidance

After this step the improvement cycle can be re-initiated by reviewing the business objectives and improvement programme planning as part of a continuing process improvement plan.

When initiating another improvement cycle a different process assessment model can be used. In this case a comparison is performed between the two assessment models in order to be able to compare and define the new target initial capability profile for this new cycle with respect to the initial one.

Improvements are a responsibility of the PIM but any other role within the organizational unit can have this responsibility for continuous improvement for a permanent basis (e.g. the software quality assurance responsible).

EXPECTED OUTPUT: *Process performance report*

Work products of the activities of the monitor performance

Input work products	Output work products
	Process performance report

7.2.2.9 Management of the process improvement project Role: (IPM), IPL

Objective To manage the process improvement programme and the process improvement projects during all its execution

Guidance

This activity is not a step in the improvement cycle. It is applied for the overall cycle as a continuous activity through the following tasks:

a. Activities for managing the process improvement programme are planned and documented prior to its execution.

b. Resources for managing the process improvement project are planned prior to its execution.

c. Monitoring and directing of the process improvement programme are performed during all its execution.

7.2.3 Roles and responsibilities

It is important to have clear definition of roles and responsibilities in an improvement plan. Seven main roles can be identified.

7.2.3.1 Top management (TM)

The responsibilities of top management include:

a. defining the mission, objectives and needs of the organization;

b. preparing the business plan, including software process improvement goals, resource estimates and time scales;

c. approving the process improvement plan;

d. assigning responsibilities for process improvement projects;

e. ensuring that the appropriate resources to support process improvement are provided;

f. monitoring improvement results to ensure targets have been met;

g. initiating and supporting activities aimed at institutionalising improved processes;

h. regularly reviewing the overall process improvement plan to ensure its continued appropriateness to the business;

i. fostering changes in values, attitudes, and behaviour to support software process improvement.

7.2.3.2 Improvement programme manager (IPM)

The IPM's responsibilities across organizational boundaries include:

a. establishing systematic software process measurements including both software process assessments, and effectiveness measurements;

b. evaluating measurement results;

c. setting software process improvement targets, and agreeing these with the process owner and the organizational units involved;

d. identifying improvement actions and gaining the agreement of the process owner and the organizational units involved;

e. naming the project leader for each process improvement project;

f. participating in development of process improvement project (action) plans with those responsible for each improvement project, the process owners and the organizational units involved;

g. monitoring the progress of improvement projects towards their targets;

h. supporting continuation of software process improvement;

i. reviewing the software process improvement process itself in the light of the lessons learned.

7.2.3.3 Improvement project leader (IPL)

The IPL's responsibilities in a specific improvement project include:

a. preparing and updating the process improvement project plan in consultation with the owner of the process to be improved and representatives of the organizational units involved;

b. obtaining the approval of the process owners for the process improvement project (action) plan and the changes to the processes;

c. acquiring physical and human resources for implementing the process improvement project plan;

d. organising the implementation project in consultation with the owners of the process to be improved and representatives of the organizational units involved;

e. monitoring and controlling the implementation process;

f. reporting the status of the implementation for both the process owners and top management.

7.2.3.4 Software process improvement group (SPIG) members

These are the members of the process improvement project teams and their responsibilities include:

a. collaborating in the analysis and sorting of improvement actions

b. collaborating in the classification and prioritization of action groups and the definition of improvement projects

c. collaborating in the establishment of the improvement project plan

d. carrying out the tasks assigned to them in the improvement projects (detailed in the project plans)

e. reporting on their activities to their improvement project leader

7.2.3.5 Process owners (PO)

Responsibilities of a process owner include:

a. providing information and measurements on the current process status

b. promoting awareness and collaborative communication between internal users and external customers about the improvement action

c. supporting the planning of the process improvement and improvement action

d. approving the process improvement project (action) plans

e. participating in improvement activities

f. monitoring and confirming the improvement results

7.2.3.6 (Staff of the) Organizational unit (OU)

Responsibilities within the organizational units involved in software process improvement include:

a. participating in the review of the improvement programme plan if required

b. participating in the classification and prioritization of action groups if required

c. collaborating in the development of improvement project plans if required

d. supporting the collection of information on process performance (e.g. by participating in assessments)

e. sustaining process performance by implementing OU processes

7.2.3.7 Assessment team (AT)

The responsibilities of the assessment team are described in subclause 6.2.3.5.

7.3 Special considerations for the success of process improvement

7.3.1 Ensuring the ongoing commitment of management

The responsibility for leadership and for creating the environment for continuous process improvement belongs to all levels of management, but particularly to the highest. Senior management should be aware of how the success of the organization depends on quality software and the ability to improve software processes.

The commitment of middle management can pose a particular risk to successful process improvement, particularly in less mature organizations. Largely concerned with meeting project commitments in the short term, middle management can pay little attention to process improvement benefits, which tend to be medium to long term, and often resent diverting scarce project resources to process improvement projects. A mitigation strategy to counter the risk is to ensure that senior management is committed to the costs and impact of process assessment activities and improvement actions on the projects to which they are applied.

Process assessment can identify areas of weakness in management responsibility and leadership as being a risk to the software process in general. An appropriate response is to raise the awareness amongst senior and middle managers of importance of software and software process improvement, possibly through training initiatives.

Furthermore, analysis can suggest the need to change the role of middle management. Instilling teamwork principles and placing the emphasis on communication can change the relationship between middle managers and development teams from enforcement to facilitation, and from imposing ideas to helping teams develop their own ideas. The management approach should take account of the specific characteristics of software staff and software development work. Software production, requiring educated staff and high intellectual engagement, provides better results in a cooperative environment.

Improvement suggestions are often not considered important if they go beyond the organizational unit resources or if they do not appear vital to the success of the current project.

7.3.2 Values, attitudes and behaviour

Effective process improvement often implies a new set of shared values, attitudes and behaviour, which can include:

a. focusing attention on both external and internal customer satisfaction;

b. targeting employee satisfaction by establishing an appropriate recognition system;

c. involving the entire software supply chain in process improvement, from suppliers to customers;

d. demonstrating management commitment, leadership and involvement by communicating purpose and goals;

e. emphasizing process improvement as a part of everyone's job and helping everybody to gain an understanding of how individual activities can be beneficially channelled towards the common goals of the team;

f. considering quality, cost and time scale goals as priorities to improve processes;

g. establishing open communication with access to data and information;

h. promoting teamwork and respect for the individual;

i. objectively measuring process performance and making decisions based on realistic metrics agreed by all parties in the organization.

Process assessment can help an organization to understand which changes should be done regarding values, attitudes and behaviour. If current values, attitudes and behaviour do not contribute to meeting the organization's needs, the process improvement plan should include appropriate cultural change.

7.3.3 Short term benefits

Improvement actions that yield clear short term benefits, particularly if the organization is new to process improvement, are desirable in order to encourage acceptance of the process improvement plan.

7.3.4 Collection of baseline data

The collection of historical performance data (schedule, cost, quality) should be one of the first improvement actions within a rather stable organization (no major technological or business-domain change for the last couple of years) to achieve a baseline for comparison. Both external (visible to customers like number of complaints or time to deliver) and internal indicators (e.g. defect detection rate over different phases) should be collected. In environments where former projects are irrelevant in terms of contents, size or technology (of development), only fundamental project management metrics are defined together with improvement actions and the on-going life cycle phase.

7.3.5 Information policy

It is important to keep the organizational unit regularly informed about progress and benefits of the improvement plan. This can be done by presentations, discussion meetings, reviews, or info-boards. Also, feedback from the organizational unit to the process improvement management should be possible, for example through informal discussions, problem reports, or process improvement proposals.

7.3.6 Select and use pilot projects

A task force should be established with specific projects according to the life cycle phase they are about to start.

7.3.7 Incremental implementation

During the action planning, increments containing a set of well-defined practices to be implemented in a 3-4 month timeframe should be defined. Each increment can be composed of a preparation phase, a piloting phase on selected projects and a deployment phase across the organization. If iterations are planned and monitored carefully, a few of such increments can be implemented in cascade (steps 5-8 in Figure 18), before performing a delta assessment (step 3).

7.3.8 Training, mentoring, coaching

a. The management should, whenever possible, be educated on SPI concepts and expectations.

b. Top management should, whenever possible, be briefed up-front on the rationale behind SPI, the whole improvement process and timeframe, the costs and the potential benefits in the short, mid or long term.

c. Inject external expertise into projects for coaching improvement actions. When adequately managed (transfer of knowledge to an internal process engineering group planned, full-time presence of external expert for some months, consultants trained and followed-up by corporate) this approach is very efficient. This is particularly suitable by accelerating the impact of the program on the projects where the software engineering skills are low.

d. On-going education and training should be provided for everyone. Education and training programmes should be given to create and maintain an environment where process improvement can flourish.

e. The effectiveness of education and training should be regularly assessed. Training separated from the use of the newly acquired skills is rarely effective. The assessment results include ratings related to the extent to which staff have received suitable training in the processes they use, which should be taken into account when planning improvement actions.

f. Training in process improvement concepts, specifically, increases the organization's readiness for process improvement. Important concepts that should be covered include process and quality concepts, process improvement concepts, process management skills, tools and techniques for process improvement, cultural change skills and supporting skills.

g. Project leaders should be trained in essential software management practices. Such training is not intending to teach project leaders state of the art but to provide them with a set of essential principles, rules illustrated by some selected well-known techniques that they can straightway apply at the end of the course.

h. Such a training course should cover processes like system and software requirements engineering, project management, quality assurance and configuration management.

7.3.9 Communication and teamwork

a. Organizational, language, and personal barriers that are causing a lack of communication and teamwork should be looked for when analysing assessment results, thereby interfering with the effectiveness and efficiency of the software process.

b. In order to achieve communication and teamwork the focus should be on trust and skills. Good teamwork skills improve the ability to perform activities with the high degree of parallel work typical of software projects.

c. Training should be considered as a means of improving the quality and effectiveness of teamwork skills.

d. Before conducting an assessment, agreement is reached over ownership and confidentiality of the results and other information gathered during the assessment. This helps to build the necessary trust for effective process improvement.

e. The individuals and groups responsible for the processes which are being assessed should be made aware that the objective is to improve the processes, and not to assign blame to individuals. The assessment findings should be communicated and discussed with the interviewees before finalizing any recommendations. Unless this is done, individuals or groups can reject the findings, and can resist changes arising from the findings, thereby jeopardizing the outcome.

7.3.10 Recognition

a. The recognition process and reward system can help to encourage attitudes and behaviour necessary for successful process improvement. The definition of an appropriate recognition and reward system, consistent with the effort needed to achieve the improvement goals, should therefore be considered when planning improvement actions.

b. The reward system should be designed in such a manner that it recognizes group performance and teamwork and avoids promoting destructive internal competition.

7.4 Software process improvement failure factors

7.4.1 Exclusive top-down or bottom-up improvement

Improvements can neither be exclusively implemented by management directives or by spontaneous engagement of some highly motivated engineers. It is extremely important that all parties in the organizational unit drive the improvement programme. In any case, lack of management commitment and understanding is the most likely reason for the failure of a process improvement plan.

7.4.2 Unsuitable pilot project

Pilot projects should be representative and of reasonable size and impact. On the one hand, the pilot should not provide too many risks to the primary process of the organization, but on the other hand it should not be too free from obligations.

7.4.3 Confining to training

Training of staff can be very ineffective when not followed by supervision and coaching on the job. Training requirements should become an integral part of the process improvement project plans, conformant to the purposes set for the improvement actions.

7.4.4 Confining to CASE tools

CASE tools can give support for an improved process but processes need to have a certain degree of maturity before the tools are applied. No process is performed automatically by tools.

7.4.5 Confining to capability levels

There is a belief that SPI is a level certification exercise. Hence goals are set to reach a certain level of capability for all processes within a defined number of years. Target capability profiles are fine, but they need to be derived from and supported by the organization's needs. They should not be perceived as the ultimate stand-alone goal.

7.4.6 Too many promises

Never raise unrealistic expectations about the period in which visible results can be obtained. In the short term, small successes should be envisaged to keep people motivated.

7.4.7 Late impact

Another major obstacle is the late impact of the program on projects both for daily practices and performance (often as a consequence of missing management commitment). Management starts to lose patience and practitioners lose the momentum gained during the assessment.

7.5 Recognition of process improvement

7.5.1 Introduction

a. This subclause contains instructions for the recognition of the improvement not only when using the improvement cycle presented in this handbook but when using other improvement processes.

b. The recognition of an improvement cycle can be performed by either recognizing the performance of the improvement process steps or by the recognition of the improvement results.

c. The requirements for the recognition of process improvement can be performed based on the detailed activities and improvement process used. In addition, the confirmation of the achievement of any improvement can be performed through the comparison of the initial process assessment results and the re-assessment results performed after the implementation of the improvements. In this case, any step performed to implement improvements between the initial assessment and the re-assessment is independent of the factual records of the final improvements.

d. The results of any improvement process is obtained from the performance of recognized assessment schemes.

e. The results of these assessments performed are recognized themselves.

f. Clause 8 of this handbook presents detailed information about the recognition instructions of the use of assessment schemes for the space domain. It presents as well instructions for the recognition of the results obtained from using recognized assessment schemes.

g. Re-assessments should be performed using the same assessment scheme. If this is not the case, compatible assessments are used and recognized results are compared.

h. Both, the results of the initial assessment and the re-assessment are available.

7.5.2 The process improvement cycle

7.5.2.1 General

a. The process improvement cycle is conducted according to a documented process improvement process that is capable of meeting the process improvement purpose.

b. The documented process improvement process contains at minimum the following activities:

7.5.2.2 Initiate process improvement

An overall software process improvement programme plan is developed (see 7.2.2.2), including at minimum the following activities:

- determine improvement strategy;
- define target profile;
- examine organization's needs and business goals;
- define scope of the work and estimate resources;
- identify dependencies and interfaces;
- identify roles and responsibilities;
- document improvement programme plan;
- an improvement program plan review.

7.5.2.3 Prepare for and conduct a process assessment

The actual capability of the OU is determined performing a conformant assessment (as defined in subclause 6.2 or meeting the instructions in clause 8).

7.5.2.4 Analyse assessment output and derive action plan(s)

Information collected during the assessment, in particular the process attribute ratings, the unachieved indicators and the results of risk analysis are analysed and action plan(s) is (are) derived, including at minimum the following activities:

- compile unachieved indicators, producing a list of unachieved indicators;
- derive the list of corrective actions, producing a list of corrective actions;
- sort and group corrective actions, producing a list of grouped corrective actions;
- classify and prioritize actions groups considering business goals for producing a set of proposed improvement projects addressing the classified action groups;
- seek management support for improvement;
- develop and document improvement project plans;
- obtain management approval of improvement project plans.

7.5.2.5 Implement improvements

a. Process improvement project(s) is performed across the organization.

b. At each of the milestones in the project or programme, the achieved results are evaluated against the business goals of the organization;

c. All plans and documents are updated as needed with the progress of the improvement cycle; regular reporting of the plan's progress and achievements is essential for the success of the improvement process;

d. As a result of the completion of this activity, a process improvement report is obtained.

7.5.2.6 Confirm improvements

There are no instructions for this phase.

7.5.2.7 Sustain improvements

Deployment of achieved improvements is properly planned and resources assigned to it.

7.5.2.8 Review improvement programme

a. Business goals and improvement programme planning are reviewed as part of a continuing improvement plan;

b. A management report of the process improvement programme (at least, one per cycle) is produced and reviewed.

7.5.2.9 Management of the process improvement project

a. Activities for managing the process improvement programme are planned and documented prior to its execution.

b. Resources for managing the process improvement project are planned prior to its execution.

c. Monitoring and directing of the process improvement programme are performed during all its execution.

8 Recognition of assessment schemes and results

8.1 Introduction

This clause contains instructions on how to get recognition from the use of assessment schemes.

8.2 Recognition of assessment schemes

8.2.1 General

The instructions for recognition enable comparison of outputs from assessments performed by different organizations having using different requirements and scope. This subclause defines the instructions to be met by an assessment in order to claim recognition with respect to the S4S model.

8.2.2 Recognition of the use of S4S

Recognition of the use of S4S can be achieved by providing evidence that the method in clause 6.2 and the process assessment model established in Part 2 have been applied as described (without tailoring) in this handbook by competent assessors (see subclause 6.4).

8.2.3 Recognition of other schemes

a. In order to ensure that assessment results are translatable into an S4S process profile in a repeatable and reliable manner, process assessment models adhere to certain instructions.

b. A process assessment model contains a definition of its purpose, scope and elements; its mapping to the measurement framework and specified process reference model(s); and a mechanism for consistent expression of results.

c. A process assessment model is considered suitable for the purpose of assessing process capability by conforming to subclauses 8.2.3.2, 8.2.3.3 and 8.2.3.4 below.

8.2.3.2 Process assessment model scope

a. A process assessment model is related to at least one process from the specified process reference model(s).

b. A process assessment model addresses, for a given process, all, or a continuous subset, of the levels (starting at level 1) of the measurement framework for process capability for each of the processes within its scope. A model may, for example, address solely level 1, or to address levels 1, 2 and 3, but it may not address levels 2 and 3 without level 1.

c. A process assessment model declares its scope of coverage in the terms of:
   1. the selected process reference model(s);
   2. the selected processes taken from the process reference model(s);
   3. the capability levels selected from the measurement framework.

8.2.3.3 Process assessment model indicators

A process assessment model is based on a set of indicators that explicitly addresses the purposes and outcomes, as defined in the S4S Process reference model, of all the processes within the scope of the process assessment model; and that demonstrates the achievement of the process attributes within the capability level scope of the process assessment model. The indicators focus attention on the implementation of the processes in the scope of the model.

8.2.3.4 Mapping process assessment models to process reference models

A process assessment model provides an explicit mapping from the relevant elements of the model to the processes of the S4S Process assessment model (provided in part 2) and to the relevant process attributes of the measurement framework.

The mapping is complete, clear and unambiguous. The mapping of the indicators within the process assessment model provides:

a. the purposes and outcomes of the processes in the S4S Process reference model;

b. the process attributes (including all of the results of achievements listed for each process attribute) in the measurement framework.

This enables process assessment models that are structurally different to be related to the S4S Process reference model.

8.2.3.5 Recognition of assessment methods

This clause sets out the instructions for an assessment or assessments recognized as the one within this handbook. The instructions help to ensure that the assessment output is self-consistent and provides evidence to substantiate the ratings.

a. The assessment is conducted according to a documented assessment process that is capable of meeting the assessment purpose.

b. The documented assessment process contains at minimum the following activities:

c. The assessment input is defined prior to the data collection phase of an assessment and approved by the sponsor of the assessment.

d. At a minimum, the assessment input specifies:
   1. the identity of the sponsor of the assessment and the sponsor's relationship to the organizational unit being assessed,
   2. the assessment purpose including alignment with business goals,
   3. the assessment scope including;
      (a) the processes to be investigated within the organizational unit;

(b) the highest capability level to be investigated for each process within the assessment scope;
(c) the organizational unit that deploys these processes;
(d) the context which, as a minimum, includes:
- the size of the organizational unit,
- the demographics of the organizational unit,
- the application domain of the products or services of the organizational unit,
- the size, criticality and complexity of the products or services,
- the quality characteristics of the products

4. the assessment constraints which can include:
(a) availability of key resources,
(b) the maximum amount of time to be used for the assessment,
(c) specific processes or organizational units to be excluded from the assessment,
(d) the minimum, maximum or specific sample size or coverage that is desired for the assessment,
(e) the ownership of the assessment outputs and any restrictions on their use,
(f) controls on information resulting from a confidentiality agreement.
5. the identity of the model(s) used within the assessment, i.e. S4S;
6. the identity of the assessors, including the competent assessor with specific responsibilities for the assessment;
7. the criteria for competence of the assessor responsible for the assessment;
8. the identity of interviewees and support staff with specific responsibilities for the assessment;
9. any additional information to be collected during the assessment to support process improvement or process capability determination, e.g. specific data (or metrics) that is needed to quantify the organization's ability to meet a particular business goal.

e. Any changes in the assessment input is agreed with the sponsor and documented in the assessment record.

f. The sponsor of the assessment verifies that the assessor responsible for and overseeing the assessment (the competent assessor) has the required competence and skills.

g. The sponsor ensures that resources (both assessors and interviewees) are made available to conduct the assessment.

h. The competent assessor confirms the sponsor's commitment to proceed with the assessment.

i. The competent assessor ensures that the assessment is conducted in accordance with the instructions of subclause 6.2.1 of this handbook.

j. The competent assessor ensures that participants in the assessment are briefed on the purpose, scope and approach of the assessment.

k. Assessors participating in the assessment have access to appropriate documented guidance on how to perform the defined assessment activities and the necessary competence to use any instruments or tools chosen to support the assessment.

l. The competent assessor ensures that all members of the assessment team have appropriate knowledge and skills.

m. On completion of the assessment, the competent assessor verifies and document that the instructions have been met.

n. The assessment is conducted according to a documented process that is capable of meeting the assessment purpose.

o. The assessment process contains at minimum the following activities:

1. **Planning A** plan for the assessment is developed and documented, specifying at minimum:
   (a) the inputs defined in this handbook;
   (b) the activities to be performed in conducting the assessment;
   (c) the resources and schedule assigned to these activities;
   (d) the selection and defined responsibilities of the assessors and organization participants in the assessment;
   (e) the criteria for verification of the performance of the instructions; and
   (f) a description of the planned assessment outputs.
2. **Data collection** Data needed for evaluating the processes within the scope of the assessment are collected in a systematic and ordered manner, applying at minimum the following:
   (a) The strategy and techniques for the selection, collection, analysis of data and justification of the ratings are explicitly identified and are demonstrable;
   (b) Correspondence is established between the organizational unit's processes specified in the assessment scope through the compatible model(s) used for assessment to the processes defined in the S4S reference model in clause 5 of this handbook;
   (c) Each process identified in the assessment scope is assessed on the basis of objective evidence;
   (d) The objective evidences gathered for each attribute for each process assessed meet the assessment purpose and scope;
   (e) Objective evidences, based on the indicators, that supports the assessors' judgement of process attribute ratings are recorded and maintained to provide the basis for verification of the ratings.
3. **Data validation** The data collected are validated to:
   (a) confirm that the evidence collected is objective;
   (b) ensure that the objective evidence is sufficient and representative to cover the scope and purpose of the assessment;
   (c) ensure that the data as a whole is consistent.
4. **Process attribute rating** A rating is assigned based on validated data for each process attribute.
   (a) The set of process attribute ratings is recorded as the process profile for the defined organization unit;
   (b) during the assessment, the defined set of assessment indicators in the Process Assessment Model is used to support the assessors' judgement in rating process attributes in order to provide the basis for repeatability across assessments;
   (c) the decision-making process (e.g. consensus of the assessment team or majority vote), that is used to derive rating judgements is recorded.
   (d) traceability is maintained between an attribute rating and the objective evidence used in determining that rating;
   (e) for each process attribute rated, the relationship between the indicators and the objective evidences is recorded.
5. **Reporting** The assessment results, including at minimum the outputs specified below, are documented and reported to the Assessment Sponsor or to their delegated representative.
   Information which is pertinent to the assessment and supports understanding and

using the output of the assessment are compiled and included in the assessment record for retention by the sponsor.

At a minimum, the assessment record contains:

(a) the date of the assessment;
(b) the assessment input;
(c) the identification of the objective evidence gathered;
(d) the assessment approach used;
(e) the set of process profiles resulting from the assessment (i.e. one profile for each process assessed);
(f) the identification of any additional information collected during the assessment that was identified in the assessment input to support process improvement or process capability determination.

8.3 Recognition of S4S results

a. This subclause introduces instructions for the recognition of the results obtained through the use of the assessment scheme presented in this handbook.

b. For the recognition of any S4S assessment results, strict application of the assessment model and method presented by this handbook will be demonstrated and documented,

c. The assessors are competent assessors.

d. Information which is pertinent to the assessment and supports understanding the output of the assessment are compiled and included in the assessment record for retention by the sponsor and are made available to the authorities certifying recognition of results.

e. At a minimum, the assessment record contains:
   1. the date of the assessment;
   2. the assessment input;
   3. the identification of the objective evidence gathered;
   4. the assessment approach used;
   5. the set of process profiles resulting from the assessment (i.e. one profile for each process assessed);
   6. the identification of any additional information collected during the assessment that was identified in the assessment input to support process improvement or process capability determination.

Annex A
Examples of target profiles (informative)

A.1 General

In this Annex, target profiles of process capability are proposed for different classes of software criticality. Capability targets are suggested here for all of the space software processes but it is up to each organization to determine which processes are most relevant for its business goals.

The software criticality (A, B, C, D) is primarily defined based on the severity of the consequences of system failures (ref. ECSS-Q-ST-80C Table D-1).

A.2 Rationale behind target profiles

Software process improvement requires an understanding of the current process and clear goals for improvement within an organization. A software process assessment produces an understanding of the current process in the form of a process capability profile. Clear goals for improvement can be expressed as target capability profiles. A comparison between current and target capability profiles readily highlights key areas for improvement and can be used to identify necessary actions to reach goals. A method for a complete software process improvement programme is given in above subclause 7. Target capability profiles can be defined for use in software process improvement or for determining supplier capability. Target capability profiles can also be used in conjunction with software product certification as described within the [SPEC] method (Software Product Evaluation and Certification) defined in ESA.

Target profiles in this handbook are defined based on software criticality classes. The procedure followed to establish these target profiles has been to identify typical risks that happen in space projects and identify which practices and processes mitigate each risk. Based on this correlation of processes and risks and the risk indexes estimated for each one the capability level for each process and criticality class is derived.

Table A-1: Proposed target profile

Process ID	Process Title	Software Criticality Class			
		A	B	C	D
ACQ.1	Acquisition preparation	2	2	2	0
ACQ.2	Supplier selection	4	3	2	1
ACQ.3	Contract agreement	1	1	1	1
ACQ.4	Supplier monitoring	4	3	2	2
ACQ.5	Customer acceptance	2	2	2	1

Process ID	Process Title	Software Criticality Class			
		A	B	C	D
ACQ.6	Contract maintenance	1	1	1	0
SPL.1	Supplier tendering	0	0	0	0
SPL.2	Product release	2	2	1	0
SPL.3	Product acceptance support	1	1	1	1
OPE.1	Operational use	4	3	2	1
OPE.2	Customer support	4	3	1	0
ENG.1	Requirements elicitation	4	3	2	1
ENG.2	System requirements analysis	4	3	3	2
ENG.3	System architectural design	4	3	2	1
ENG.4	Software requirements analysis	4	3	3	2
ENG.5	Software design	4	3	2	0
ENG.6	Software construction	3	2	1	0
ENG.7	Software integration	2	2	1	0
ENG.8	Software testing	3	3	2	2
ENG.9	System integration	1	1	1	0
ENG.10	System testing	2	2	2	1
ENG.11	Software installation	1	1	0	0
ENG.12	Software and system maintenance	4	3	3	1
SUP.1	Quality assurance	2	2	2	0
SUP.2	Verification	2	2	2	1
SUP.3	Validation	2	2	2	2
SUP.4	Joint review	4	3	2	0
SUP.5	Audit	2	1	1	0
SUP.6	Product evaluation	2	2	2	0
SUP.7	Documentation	2	2	2	1
SUP.8	Configuration management	4	3	2	0
SUP.9	Problem resolution management	2	2	2	0
SUP.10	Change request management	3	3	2	0
SUP.11	Safety and dependability assurance	2	2	1	0
SUP.12	Independent software verification and validation	4	3	2	0
MAN.1	Organizational alignment	2	2	1	0
MAN.2	Organization management	2	2	1	0
MAN.3	Project management	4	3	3	1
MAN.4	Quality management	1	1	1	0
MAN.5	Risk management	2	2	2	0
MAN.6	Measurement	2	2	1	0

Process ID	Process Title	Software Criticality Class			
		A	B	C	D
MAN.7	Information management	1	1	1	0
PIM.1	Process establishment	1	1	1	0
PIM.2	Process assessment	1	1	1	0
PIM.3	Process improvement	1	1	1	0
RIN.1	Human resource management	2	2	2	0
RIN.2	Training	1	1	1	0
RIN.3	Knowledge management	1	1	0	0
RIN.4	Infrastructure	3	2	2	0
REU.1	Asset management	2	2	1	0
REU.2	Reuse programme management	1	1	1	0
REU.3	Domain engineering	1	1	1	0

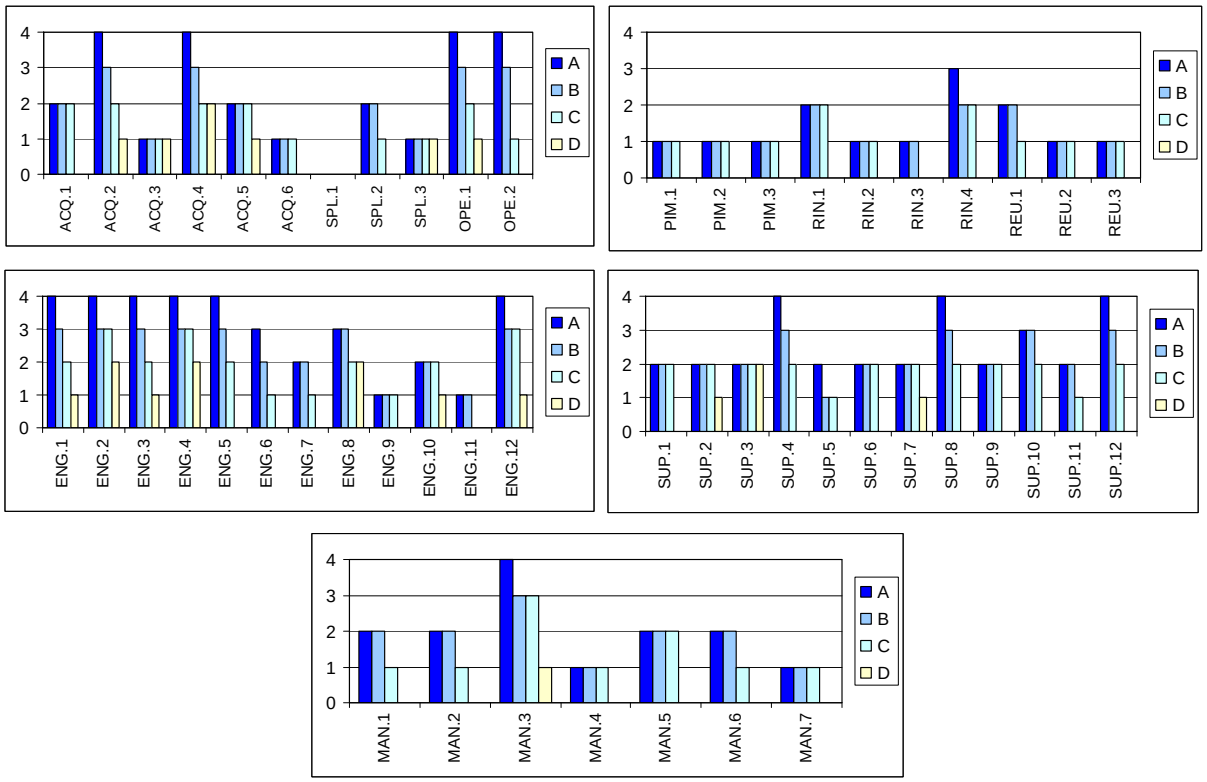


Figure 22 Suggested target profile according to software criticality

A.3 Use of target profiles in verifying the capability of software projects or supplier organisations

a. Organisations can use target profiles to verify that individual projects or organisational units that develop software of a certain criticality class have software processes in place of adequate capability. Such organisations can be suppliers performing self-assessments, or customers of space software certifying their suppliers. In both cases, assessment results can be compared with target profiles to effectively determine gaps in capability and provide suggestions for process improvement.

b. When used in this fashion, target profiles should be tailored for use according to the objectives of the space software process assessment. In addition, projects should only be assessed on those processes for which they are responsible within the context of their statement of work. Processes that do not fall under the responsibility of the project should be excluded from the assessment scope and from the applicable target profile.

c. In assessments where the objective is to verify that an organisational unit has adequate capability to produce software of a given criticality class, all processes can be included in the scope. The actual processes selected depend on the objective and focus of the assessment. The results of the assessment can be compared with the corresponding target profile for that criticality class to determine if the capability measured is acceptable.

Annex B
Recommendations for the content of SW process assessment outputs

This handbook refers to a number of documents that are outputs of the software assessment process and improvement methods. The specific structure of most of these documents is left to the assessors and organizations involved in the different activities, however contents of some documents have a particular relevance in confirming the correct application of the methods described or in confirming compliance with requirements in ECSS-Q-ST-80 or ISO/IEC 15504.

B.1 Assessment plan

B.1.1 Purpose and objective

The assessment plan defines the assessment purpose, inputs and outputs, roles of participants, responsibilities, context, constraints, risks, schedule and logistics for the assessment to be undertaken at the organizational unit.

After approval by the assessment sponsor the assessment plan becomes an agreement between the assessment team and assessment participants.

B.1.2 Scope and content

The assessment plan provides the information presented in the following sections.

<1> Scope

The assessment plan states its scope and applicability. In particular it identifies unambiguously the assessment to which it corresponds.

<2> Purpose

The assessment plan states its purpose.

<3> Document organization

The assessment plan describes what the rest of the document contains and explain how it is organised.

<4> Normative and informative references

The assessment plan lists the applicable and informative references that have a bearing on the performance of the assessment.

<5> Definitions and abbreviations

The assessment plan includes a list of abbreviated terms used in it and definitions of terms with a meaning specific to it.

<6> Assessment purpose

The assessment plan identifies the primary purpose of the assessment according to the purposes listed in Part 1 of this Standard.

The assessment plan describes any secondary purposes that the assessment may have.

Where the assessment is part of a programme of assessments or support a formal improvement initiative, the assessment plan should identify and describe briefly such programme or initiative.

<7> Organizational unit

The assessment plan defines the organizational unit in scope of the assessment defined by it. This definition lists the projects, teams, organisations, units or entities that make up the organizational unit.

<8> Assessment scope

The assessment plan defines the scope of the assessment. The scope of the assessment is defined by listing the processes from the Process Assessment Model that will be rated as part of the assessment and each of the specific projects, teams, organisations, units or other entities in which that process will be assessed.

Where specific processes are assessed in more than one entity the assessment plan also specifies if and how the information from different entities is accumulated to generate ratings. For example, if a given process in assessed in two projects either separate or common ratings may be generated for that process.

For each process instance to be rated the assessment plan also states the maximum capability level up to which Process Attributes are rated (i.e. capability levels for which evidence is intended to be collected).

The assessment plan also specifies any additional information that is intended to be collected as part of the assessment to support any secondary purpose of the assessment.

<9> Context

The assessment plan describes the context of the assessment by providing information on the entities from which information is being collected that can be relevant to the performance of the assessment.

Examples of such information are:

- Team size (number of staff)
- Duration (months)
- Project size (total effort spent or planned to be spent)
- Location
- Business Unit
- Demographics (e.g. nr of employees in the Business Unit)
- Application domain (e.g. space, ground)
- Complexity of the project
- Criticality of the product

- Quality characteristics
- Project phase at the time of the assessment
- Applicable standards

<10> Schedule

The assessment plan establishes the schedule for the assessment. The schedule lists all the major assessment events happening prior and after the on-site period(s), including at least their planned or actual dates, responsible person or entity, and location.

For the on-site period the schedule lists for each day the activities (e.g. interviews, briefings, document examination) that will take place together with, at least, their start and end times, participants and location (where location changes for different activities).

<11> Assessment participants

a. Sponsor

The assessment plan identifies the sponsor of the assessment and provide at least the following sponsor's information:

— Full contact information (at least name, address, phone and fax numbers, email address)

— Organization represented by the sponsor

— Position or relationship of the sponsor to that organization

b. Local assessment co-ordinator

The assessment plan provides the complete contact information for the local assessment co-ordinator (for example name, company or organisation, address, phone and fax numbers and email address).

c. Assessment team

The assessment plan lists the members of the assessment team and their roles within the team. For each member of the assessment team at least the name, role in the team, organisation to which the member belongs and basic contact information are provided.

d. Other participants

The assessment plan lists the members of the organizational unit that will be involved in the assessment by providing information either as interviewees or in other ways.

For each participant at least the following information is provided:

— Name

— Role in the project(s) or entity(ies) relevant to the assessment

— Where relevant (e.g. interviewees) processes whose rating the participant is supporting

— Basic contact information

e. Responsibilities

The assessment plan describes the responsibilities of each of the roles involved in the assessment. Typical responsibilities of the different roles involved in an assessment are described in Part 1 of this Standard.

<12> Confidentiality arrangements

The assessment plan describes the confidentiality arrangements to be applied to the assessment. In particular it describes which confidentiality agreement documents are intended to be used, who is responsible for signing them and by when (always before the on-site period) they are intended to be signed.

The assessment plan also identifies any special arrangements concerning confidentiality of assessment results and ownership of assessment outputs.

<13> Constraints

The assessment plan describes any special general and project specific constraints placed on the assessment.

Possible constraints may include: availability of key resources, the maximum amount of time to be used for the assessment, specific processes or organisational units to be excluded from the assessment, the minimum, maximum or specific sample size or coverage that is desired for the assessment, the ownership of the assessment outputs and any restrictions on their use, or controls on information resulting from a confidentiality agreement.

<14> Risks

The assessment plan lists all the risks, relevant to the performance of the assessment, general or project or process specific, identified during the planning of the assessment together with the defined mitigation strategies for each risk.

<15> Logistics

The assessment plan describes all the logistics that need to be put in place at each location (where more than one is needed) for the performance of the assessment.

Possible logistics to consider are:

- Intranet access for the assessment team
- Availability of computer projectors and other equipment
- Needed printed copies of documents
- On line access to documentation repositories

<16> Assessment performance

The assessment plan introduces the steps and activities involved in the performance of the assessment.

The following activities are listed in this chapter:

- Assessment initiation
- Planning
- Briefing
- Data acquisition
- Data validation
- Process rating
- Reporting

a. Briefings

The assessment plan describes clearly when and how briefings for both the assessment team and the organisational unit are intended to take place.

b. Data acquisition

The assessment plan describes clearly how the assessment data is intended to be collected, recorded, stored, analysed and presented.

c. Data validation

The assessment plan describes clearly how completeness of data for the assessment purpose and scope is intended to be assured and what steps are intended to be taken, if necessary, to acquire additional data.

d. Rating

The assessment plan describes clearly when ratings are intended to be generated for each process in scope of the assessment and how these ratings are intended to be established by the assessment team (e.g. round table discussion and consensus).

e. Reporting

The assessment plan describes clearly when, to whom, by whom and how the results of the assessment are intended to be reported.

The assessment report is produced using the table of content in annex B.2 of this document.

<17> Conformance verification

The assessment plan describes how the assessment team leader intends to verify, after completion of the assessment, that all requirements for conformance to this standard have been met.

<18> Assessment record

The assessment plan identifies the contents of the assessment record.

The assessment plan also identifies the agreed recipient for the Assessment Record.

<19> Assessor records

The assessment plan specifies the requirements to produce the assessor records and when and by whom (when this responsibility is delegated by the Sponsor) they are intended to be signed.

B.2 Assessment report

B.2.1 Purpose and objective

The assessment report reports the activities, results, suggestions, recommendations and conclusions resulting from the performance of a software process assessment carried out following the method described in Part 1 of this Standard.

B.2.2 Scope and content

The assessment plan provides the information presented in the following sections.

<1> Scope

The assessment report states its scope and applicability. In particular it identifies unambiguously the assessment to which it corresponds.

<2> Purpose

The assessment report states its purpose.

<3> Document organisation

The assessment report describes what the rest of the document contains and explain how it is organised.

<4> Normative and informative references

The assessment report lists the applicable and informative references that have a bearing on the performance of the assessment.

<5> Definitions and abbreviations

The assessment report includes a list of abbreviated terms used in it and definitions of terms with a meaning specific to it.

<6> Executive summary

The assessment report includes a summary of the key topics of the report.

<7> Assessment input

The assessment report describes the inputs used for the assessment.

a. Assessment purpose

   The assessment report identifies the primary purpose of the assessment according to the purposes listed in Part 1 of this Standard.

   The assessment report describes any secondary purposes that the assessment may have.

   Where the assessment is part of a programme of assessments or support a formal improvement initiative, the assessment report should identify and describe briefly such programme or initiative.

b. Organizational unit

The assessment report defines precisely the organizational unit in scope of the assessment performed. This definition lists the projects, teams, organisations, units or entities that make up the organizational unit.

c. Assessment scope

The assessment report defines precisely the scope of the assessment. The scope of the assessment is defined by listing the processes from the Process Assessment Model that were rated as part of the assessment and each of the specific projects, teams, organisations, units or other entities in which that process was assessed.

Where specific processes were assessed in more than one entity the assessment report also specifies if and how the information from different entities was accumulated to generate ratings. For example, if a given process was assessed in two projects either separate or common ratings were generated for that process.

For each process instance rated the assessment report also states the maximum capability level up to which Process Attributes were rated (i.e. capability levels for which evidence was collected).

The assessment report also specifies any additional information that was collected as part of the assessment to support any secondary purpose of the assessment.

d. Assessment participants

1. Sponsor

The assessment report identifies the sponsor of the assessment and provide at least the following sponsor's information:

- Full contact information (at least name, address, phone and fax numbers, email address)
- Organization represented by the sponsor
- Position or relationship of the sponsor to that organization

2. Local assessment co-ordinator

The assessment plan provides the complete contact information for the local assessment co-ordinator (for example name, company or organisation, address, phone and fax numbers and email address).

3. Assessment team

The assessment plan lists the members of the assessment team and their roles within the team. For each member of the assessment team at least the name, role in the team, organisation to which the member belongs and basic contact information are provided.

4. Other participants

The assessment report lists the members of the organizational unit that were specifically involved in the assessment by providing information either as interviewees or in other ways.

The assessment report highlights any deviation from the participants listed in the assessment plan and the reason for such deviation.

For each participant at least the following information is provided:

- Name
- Role in the project(s) or entity(ies) relevant to the assessment

- Where relevant (e.g. interviewees) processes whose rating the participant is supporting
- Basic contact information.

<8> Assessment performance

a. Schedule

The assessment report lists the major events that took place prior, during and after the on-site period(s) of the assessment. Significant deviations from the schedule presented in the assessment plan are highlighted.

b. Confidentiality

The assessment report describes the confidentiality arrangements that were applied to the assessment. In particular it specifies which confidentiality agreements were used, when were they signed and by whom.

The assessment report section also describes any special arrangements concerning confidentiality of assessment results and ownership of assessment outputs.

The assessment report highlights any difference between the arrangements actually implemented and those described in the assessment plan.

c. Briefings

The assessment report describes the briefings that took place during the assessment. This includes assessment team briefings prior and during the on-site period, briefings to the organizational unit during the on-site period and briefings provided by organizational unit members to support the collection of data.

d. Data acquisition and verification

The assessment report describes the means that were used to collect evidence of process performance and capability. These can include:

— Pre-assessment questionnaires providing general information about the organisation and the project to be assessed

— Interviews using prepared checklists and questions based on the indicators provided by the Process Assessment Model

— Feedback of findings to the interviewees at the end of each interview

— Briefings provided by the organizational unit

— Document examination

— Verification and validation of collected data against documents during and after the interviews

The assessment report describes how the evidence was recorded (e.g. assessment tool and assessor notes) and how the collected evidence was correlated with performance and capability indicators in the PAM.

e. Assessment tool

The assessment report states the tool(s) that were used to support the assessment performance and any specific ways in which they were used (e.g. special software configuration).

f. Data validation

The assessment report specifies how completeness of data for the assessment purpose and scope was ensured and what steps were taken, if they were necessary, to acquire additional data.

g. Rating

The assessment report specifies how were the ratings be established by the assessment team (e.g. round table discussion and consensus).

The assessment report also includes the following description of the rating scale:

"Process Attributes are rated on a percentage scale 0 % - 100 % that relates to the following four point achievement scale:

— 0 % - 15 % N; Not achieved: There is little or no evidence of achievement of the defined attribute.

— 16 % - 50 % P; Partially achieved: There is evidence of a sound systematic approach to the achievement of the defined attribute.

— 51 % - 85 % L; Largely achieved: There is evidence of a sound systematic approach to and significant achievement of the defined attribute.

— 86 % - 100 % F; Fully achieved: There is evidence of a complete and systematic approach to and full achievement of the defined attribute."

h. Reporting

The assessment report describes how reporting was performed. It describes any (e.g. in an oral presentation) preliminary presentation of results, any draft reports and the final report (the document to which this DRD applies). The purpose and audience or recipients of each reporting activity is specified.

i. Assessment outputs

The assessment report lists the outputs from the assessment. The listed outputs includes at least:

— Completed pre-assessment questionnaires where these have been used

— Assessment plan

— Confidentiality agreements

— Assessment report

— Assessment records

— Assessor records

j. Additional information collected

The assessment report provides a summary of additional information collected. Deviations between additional information actually collected and that are specified in the assessment plan are highlighted.

<9> Assessment results

a. Assumptions

The assessment report states any general assumptions made by the assessment team in rating the Process Attributes. These can include specific interpretations of performance or capability indicators, specific interpretation of the scope of processes, exclusion of specific indicators due to the context of the assessment or others.

b. Process profiles

The assessment report contains the process profiles (process attribute ratings on the four point scale for each process) obtained during the assessment.

For each process the assessment report:

— States the capability level achieved (by name and number, i.e. Performed, level 1);

— States for each Process Attribute in scope of the assessment that was not rated as Fully, the rating achieved and the specific reasons (including missing indicators and associated evidence or lack thereof) that prevented the rating from being rated as Fully;

— Should state for each Process Attribute in scope of the assessment all evidence that contributed to its rating (i.e. in addition to the evidence mentioned in the previous bullet and including Process Attributes rated as Fully).

c. Capability levels

The assessment report states the capability profiles (process capability versus processes) obtained from the process profiles.

<10> Compilation of assessment data

The assessment report should present the main conclusions obtained by the assessment team from the assessment results (ratings and capability levels).

The assessment report may also contain specific analyses based on the assessment results like for example comparisons with other assessments, comparisons with a target profile or comparisons between process groups or categories.

<11> Observations

The assessment report may present, in an itemised form, the observed strengths, weaknesses and opportunities for improvement identified by the assessment team during the performance of the assessment.

NOTE The improvement opportunities mentioned in this section correspond to the perceptions by the assessment team during the performance of the assessment is do not constitute an improvement programme or plan since they are not based on proper analyses and planning.

<12> Supporting information

For assessments for the purpose of process improvement the assessment report provides a compilation of unachieved indicators for each of the process ratings in scope of the assessment.

The assessment report contains or reference the definitions of the Process Attributes.

The assessment report should contain or reference an explanation of the definitions of the Process Attributes.

The assessment report contains or reference the definitions of the Capability Levels.

The assessment report contains or reference a description of the algorithm used to convert the Process Attributes into Capability Levels.

The assessment report may contain any additional supporting information deemed necessary by the assessment team to meet the purposes of the objective (e.g. analysis of additional information collected).

B.3 Assessor record

B.3.1 Purpose and objective

The assessor record is a cumulative record of the training, professional experience and assessment experience in the use of the ECSS-Q-HB-80-02 assessment method for one assessor. This is a key document to provide evidence of assessor competence.

B.3.2 Scope and content

<1> Assessment experience

The assessor record contains a summary of assessments performed indicating:

a. Begin and end dates for on-site period(s)

b. Assessed organization

c. List of processes in scope of the assessment

d. Highest capability level assessed

e. Primary purpose of the assessment

f. Role in the assessment (e.g. assessor or assessment team leader)

g. Sponsor: name and organization

h. Number of hours spent by the assessor excluding planning, reporting and follow-up activities

i. Process Assessment Model used (including version)

j. Process assessment method used (including version of the reference document)

<2> Training

The assessor record includes for each training item recorded the following:

a. Title or the training item

b. Brief description of the contents of the training

c. Brief justification of its relevance to ECSS-Q-HB-80-02 assessor competence

d. Number of ours spent on the training item

e. Name and contact information of the training provider

<3> Professional activities

The assessor record summarises the professional activities relevant to the assessment and space domain relevant to maintaining assessor competence and additional to assessment experience and training mentioned in the previous sections.

It can include attending professional seminars; giving presentations; teaching or developing courses; engaging in professional association activities; publishing articles or books; self training or education using this Standard or ISO 15504; and active involvement or leadership in an organisational unit's improvement team.

For each professional experience item the assessor record lists:

a. Start and end dates of the item

b. Brief description of the activity

c. Brief justification of the relevant of the item to maintaining assessor competence

d. Location or organization where the item took place

<4> Assessor logs

For each assessment recorded, the assessor log duly signed by the assessment sponsor or person nominated by him is attached to the assessor record.

Each assessor log contains:

a. Assessor's name and full contact information and role in the assessment

b. Organizational unit in scope of the assessment

c. Processes assessed by the assessor

d. Number of assessment hours (spent by the assessor excluding planning, reporting and follow up)

e. Assessment team size

f. Process Assessment Model used (including version)

g. Sponsor's name, full contact information, organisation and role in the organisation

h. Person designated to sign the log if different from the sponsor and according to the assessment plan dispositions

i. Signature of the sponsor or designated person

Annex C
Bibliography

[S4S]	PASCON Contract nr. 10662/93/NL/NB WO6-CCN5 project results – TN7A, TN7B, TN7C and TN8
[CMMI-s]	Capability Maturity Model® Integration (CMMISM), Version 1.1 CMMISM for Software Engineering (CMMI-SW, V1.1) Staged Representation. Software Engineering Institute. August 2002.
[CMMI-c]	Capability Maturity Model® Integration (CMMISM), Version 1.1 CMMISM for Software Engineering (CMMI-SW, V1.1) Continuous Representation CMU/SEI-2002-TR-028. Software Engineering Institute. August 2002.
[ARC]	Appraisal Requirements for CMMISM, Version 1.1 (ARC, V1.1) CMU/SEI-2001-TR-034 ESC-TR-2001-034. Software Engineering Institute. December 2001
[TickIT]	The TickIT guide. Using ISO9001:2000 for Software Quality Management Systems Construction, Certification and Continual Improvement. DISC TickIT office. UK. Jan 2001 Issue 5.0
[ISO 9000]	ISO/IEC 9000:2000, Quality Management Systems. Series
[IDEAL]	IDEALSM: A User's Guide for Software Process Improvement. Handbook CMU/SEI-96-HB-001. February 1996. Software Engineering Institute Carnegie Mellon University
[SPEC]	Analysis, specification and verification/validation of software requirements for dependability and safety critical software in space projects. Software Product Evaluation and Certification. ESTEC Contract No: 12650/97/NL/NB(SC). Project results
ISO9126	Information Technology – Software product quality
ISO Guide 2	Standardization and related activities – General vocabulary: 1996
[ECSS-Pmod]	ESA/ESTEC Contract nr. 1278/98/NL/PA. ECSS Software process modelling PMod Final Report , SD-RP-AI-0214, Issue 3, February 1997
[INTACS]	International Assessor Certification Scheme