TECHNICAL REPORT

ISO/IEC TR 29110-3-1

First edition
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Systems and software engineering — Lifecycle profiles for Very Small Entities (VSEs) —

Part 3-1: Assessment guide

Ingénierie des systèmes et du logiciel — Profils de cycle de vie pour très petits organismes (TPO) —

Partie 3-1: Guide d'évaluation

Reference number
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

This first edition of ISO/IEC TR 29110-3-1 cancels and replaces ISO/IEC TR 29110-3:2011, which has been technically revised.

The full list of parts of ISO/IEC 29110 is available here.

Introduction

Very Small Entities (VSEs) around the world are creating valuable products and services. For the purpose of this International Standard, a Very Small Entity (VSE) is an enterprise, an organization, a department, or a project having up to 25 people. Since many VSEs develop and/or maintain system and software components used in systems, either as independent products or incorporated in larger systems, a recognition of VSEs as suppliers of high quality products is required.

According to the Organization for Economic Co-operation and Development (OECD) SME and Entrepreneurship Outlook report (2005), "Small and Medium Enterprises (SMEs) constitute the dominant form of business organization in all countries world-wide, accounting for over 95 % and up to 99 % of the business population depending on country". The challenge facing governments and economies is to provide a business environment that supports the competitiveness of this large heterogeneous business population and that promotes a vibrant entrepreneurial culture.

From studies and surveys conducted, it is clear that the majority of International Standards do not address the needs of VSEs. Implementation of and conformance with these standards is difficult, if not impossible. Consequently, VSEs have no, or very limited, ways to be recognized as entities that produce quality systems/system elements including software in their domain. Therefore, VSEs are excluded from some economic activities.

It has been found that VSEs find it difficult to relate International Standards to their business needs and to justify the effort required to apply standards to their business practices. Most VSEs can neither afford the resources, in terms of number of employees, expertise, budget, and time, nor do they see a net benefit in establishing over-complex systems or software lifecycle processes. To address some of these difficulties, a set of guides has been developed based on a set of VSE characteristics. The guides are based on subsets of appropriate standards processes, activities, tasks, and outcomes, referred to as profiles. The purpose of a profile is to define a subset of International Standards relevant to the VSEs' context; for example, processes, activities, tasks, and outcomes of ISO/IEC/IEEE 12207 for software; and processes, activities, tasks, and outcomes of ISO/IEC/IEEE 15288 for systems; and information products (documentation) of ISO/IEC/IEEE 15289 for software and systems.

VSEs can achieve recognition through implementing a profile and by being audited against ISO/IEC 29110 specifications.

The ISO/IEC 29110 series of standards and technical reports can be applied at any phase of system or software development within a lifecycle. This series of standards and technical reports is intended to be used by VSEs that do not have experience or expertise in adapting/tailoring ISO/IEC/IEEE 12207 or ISO/IEC/IEEE 15288 standards to the needs of a specific project. VSEs that have expertise in adapting/tailoring ISO/IEC/IEEE 12207 or ISO/IEC/IEEE 15288 are encouraged to use those standards instead of ISO/IEC 29110.

ISO/IEC 29110 is intended to be used with any lifecycle such as: waterfall, iterative, incremental, evolutionary, or agile.

The ISO/IEC 29110 series, targeted by audience, has been developed to improve system or software and/or service quality, and process performance. See Table 1.

Table 1 — ISO/IEC 29110 target audience

ISO/IEC 29110	**Title**	**Target audience**
Part 1	Overview	VSEs and their customers, assessors, standards producers, tool vendors, and methodology vendors
Part 2	Framework	Profile producers, tool vendors, and methodology vendors Not intended for VSEs
Part 3	Assessment guide	VSEs and their customers, assessors, accreditation bodies
Part 4	Profile specifications	VSEs, customers, standards producers, tool vendors, and methodology vendors
Part 5	Management and engineering guide	VSEs and their customers

If a new profile is needed, ISO/IEC 29110-4 and ISO/IEC TR 29110-5 can be developed with minimal impact to existing documents.

ISO/IEC TR 29110-1 defines the terms common to the ISO/IEC 29110 series. It introduces processes, lifecycle and standardization concepts, the taxonomy (catalogue) of ISO/IEC 29110 profiles, and the ISO/IEC 29110 series. It also introduces the characteristics and needs of a VSE, and clarifies the rationale for specific profiles, documents, standards, and guides.

ISO/IEC 29110-2 introduces the concepts for systems and software engineering profiles for VSEs. It establishes the logic behind the definition and application of profiles. For standardized profiles, it specifies the elements common to all profiles (structure, requirements, conformance, assessment). For domain-specific profiles (profiles that are not standardized and developed outside of the ISO process), it provides general guidance adapted from the definition of standardized profiles.

ISO/IEC TR 29110-3 defines certification schemes, assessment guidelines, and compliance requirements for process capability assessment (ISO/IEC 33xxx), conformity assessments (ISO/IEC 17xxx), and self-assessments for process improvements. ISO/IEC TR 29110-3 also contains information that can be useful to developers of certification and assessment methods and developers of certification and assessment tools. ISO/IEC TR 29110-3 is addressed to people who have direct involvement with the assessment process, e.g. the auditor, certification, and accreditation bodies, and the sponsor of the audit, who need guidance on ensuring that the requirements for performing an audit have been met.

ISO/IEC 29110-4-m provides the specification for all profiles in one profile group that are based on subsets of appropriate standards elements.

ISO/IEC TR 29110-5-m-n provides a management and engineering guide for each profile in one profile group.

The future ISO/IEC TR 29110-6-x provides management and engineering guides not tied to a specific profile.

Figure 1 describes the International Standards (IS) and Technical Reports (TR) of ISO/IEC 29110 and positions the parts within the framework of reference. Overview, assessment guide, management, and engineering guide are available from ISO as freely available Technical Reports (TR). The Framework document, profile specifications, and certification schemes are published as International Standards (IS).

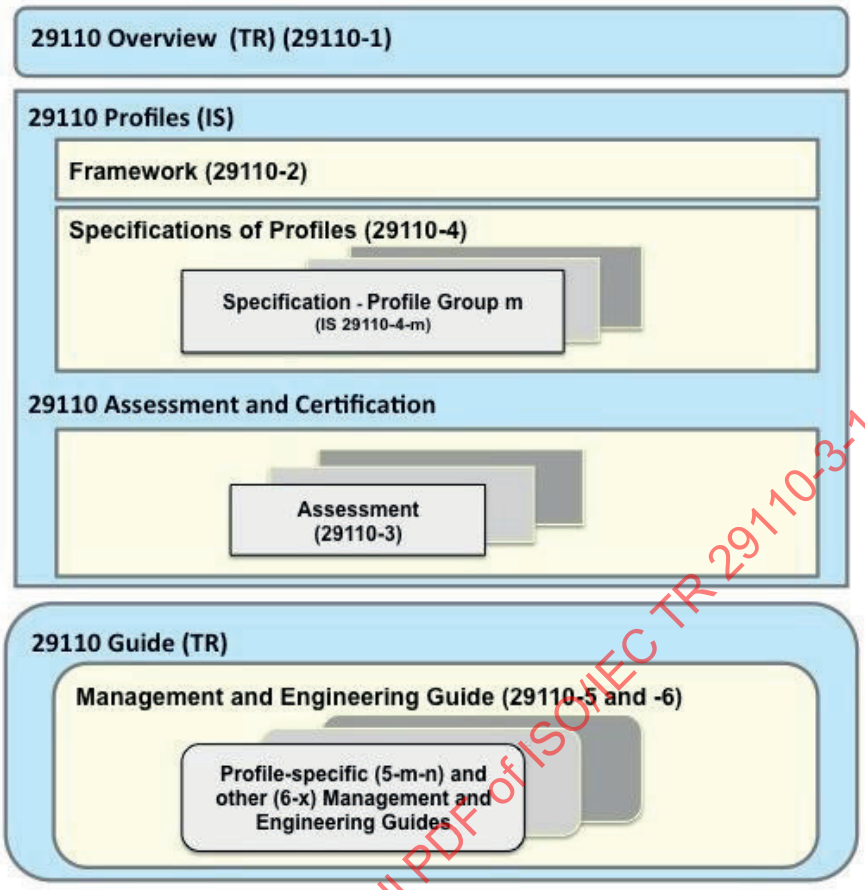


Figure 1 — ISO/IEC 29110 Series

Systems and software engineering — Lifecycle profiles for Very Small Entities (VSEs) —

Part 3-1: Assessment guide

1 Scope

1.1 Fields of application

This part of ISO/IEC 29110 defines the process assessment guidelines needed to meet the purpose of defined Very Small Entity (VSE) profiles. It is applicable to all VSE profiles and is compatible with ISO/IEC 33002.

The possible uses of this part of ISO/IEC 29110 are as follows.

a) Assessment to evaluate the process capabilities. This is when an organization wants an assessment execution in order to obtain a process profile of the implemented processes.

b) Supplier's capability assessment. This is when a customer asks for a third party to conduct an assessment in order to obtain a process profile of the implemented process by the system or software development and maintenance supplier. The customer chooses the processes to be assessed depending on the services to be contracted.

1.2 Target audience

The target audience of this part of ISO/IEC 29110 is primarily those who perform process assessments of VSEs. This part of ISO/IEC 29110 also contains information that can be useful to developers of assessment methods and assessment tools.

This part of ISO/IEC 29110 is addressed to people who have a direct relation with the assessment process based on the VSE profiles, e.g. the assessors and the sponsor of the assessment, who need guidance on ensuring that the requirements for performing an assessment have been met.

It is intended that ISO/IEC TR 29110-1 and ISO/IEC 29110-2 be read first when initially exploring VSE profile documents.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC TR 29110-1, *Software engineering — Lifecycle profiles for Very Small Entities (VSEs) — Part 1: Overview*

ISO/IEC 33001:2015, *Information technology — Process assessment — Concepts and terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC TR 29110-1, ISO/IEC 33001 and the following apply.

3.1
process quality
ability of a process to satisfy stated and implied stakeholder needs when used in a specified context

[SOURCE: ISO/IEC 33001:2015, 3.4.8]

3.2
process quality level
representation of the achieved level of a process quality characteristic derived from the process attribute ratings for an assessed process

[SOURCE: ISO/IEC 33001:2015, 3.4.9, modified]

3.3
organizational profile
set of process profiles defined in the ISO/IEC 29110- series

Note 1 to entry: The profiles will conform to the organizational maturity levels that will correspond to the basic, intermediate, and advanced profiles (as defined in ISO/IEC 29110- series).

4 Conventions and abbreviated terms

4.1 Naming, diagramming, and definition conventions

None.

4.2 Abbreviated terms

BP Base Practice

PA Process Attributes

PAM Process Assessment Model

PRM Process Reference Model

5 Process assessment framework

These guidelines apply to VSE process assessments. The assessment, as defined in this part of ISO/IEC 29110, has two purposes.

— To evaluate the process capability based on a two-dimensional assessment model containing a process dimension and the process quality dimension. The process dimension refers to the processes defined in each VSE profile which are provided by an external Process Reference Model (PRM). The process quality dimension consists of a Process Measurement Framework comprising Process Quality Levels, their associated Process Attributes, and the rating scale.

— To evaluate whether an organization fulfils the targeted VSE profile based on the evaluated capabilities for the processes.

For an official recognition, the conformity assessments should be carried out following a process assessment process satisfying the requirements of ISO/IEC 33002 and described in Clause 6. For self-assessments emphasizing identification of process improvements, other approaches can be applied (additional information can be found in other parts of ISO/IEC 29110 specifically dedicated to self-assessment).

According to ISO/IEC 33001, a process assessment is a disciplined evaluation of an organizational unit's processes against a Process Assessment Model (PAM). In this context, the Process Assessment Model consists of a subset of process purposes and outcomes of a Process Reference Model, and the process

attributes, quality levels and rating scale that are defined in the correspondent Process Assessment Model. A Process Reference Model is, for instance, ISO/IEC/IEEE 12207 and the applicable subset is defined in a Specification of a profile, for instance, ISO/IEC 29110-4-1. The applied Process Assessment Model needs to be conformant to ISO/IEC 33002. The result of a process assessment is represented as a set of process attribute ratings, i.e. a process profile. Figure 2 illustrates the relevant documents and data for a process applicable to VSE process assessment.

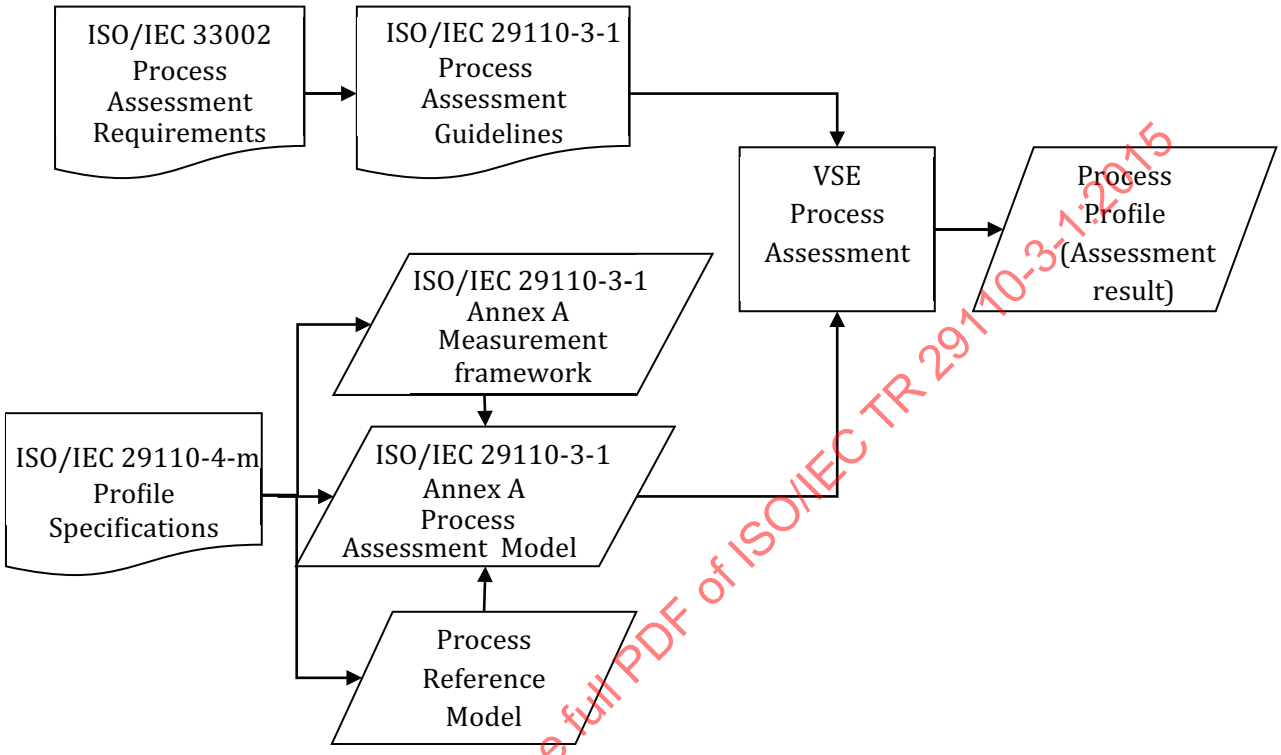


Figure 2 — Elements of VSE process assessment

ISO/IEC 33002 sets out the minimum requirements for performing a process assessment that ensure consistency and repeatability of the ratings. The requirements help to ensure that the process assessment output is self-consistent and provides evidence to substantiate the ratings and to verify conformance with the requirements.

Self-assessments are typically performed to identify process improvement opportunities or to check current status of the organization's performance. Self-assessments in VSEs are outside the scope of this part of ISO/IEC 29110.

6 VSE process assessment

6.1 Performing an assessment

6.1.1 Introduction

In performing a process assessment based on ISO/IEC 29110, the requirements expressed in ISO/IEC 33002 are intended to be satisfied in full. This Clause provides additional guidance related specifically to the process assessment in VSEs.

A process assessment is conducted according to a documented process that is capable of meeting the process assessment purpose. The key elements of a documented assessment process are closely tied to the requirements for performing an assessment, defined in ISO/IEC 33002. The documented

assessment process is the set of instructions for conducting the process assessment. A documented assessment process addresses the following aspects of the conduct of a process assessment:

— incorporate as a minimum, the tasks defined in ISO/IEC 33002;

— identify the classes of process assessment for which the documented assessment process can be applied, and the nature and extent of tailoring associated with each class addressed by the documented process;

— define the criteria for ensuring coverage for both the defined organizational scope and the defined process scope for the assessment, in terms of the strategy for collecting and analysing data;

— identify or define the approach to be taken in performing the generation of process attribute ratings, including (where applicable) the aggregation of observations and/or characterisations across the elements of the assessment.

6.1.2 Assessment inputs

Process assessment inputs as specified in ISO/IEC 33002:2015, 4.4 are to be defined. In conducting process assessments of VSEs based on ISO/IEC 29110-4-m, the following issues are expected.

— The process scope of the process assessment [ISO/IEC 33002:2015, 4.4.1 (d) (1, 2)] should be determined by the target VSE Profile specified for the process assessment.

— The organizational scope of the process assessment [ISO/IEC 33002:2015, 4.4.1 (d) (3)] should be typically be the entire VSE; however, where the VSE deploys a small number of clearly distinct projects or functions, the scope can be limited to a single project or function.

— In defining the process assessment context [ISO/IEC 33002:2015, 4.4.1 (d) (4)], the process assessment plan should take into account the VSE business and engineering context and be affordable for a VSE.

— In defining the process assessment constraints [ISO/IEC 33002:2015, 4.4.1 (g)], the specific nature of the VSE should be explored to establish constraints on availability of resources or data that might affect the reliability of the process assessment.

6.1.3 Roles and responsibilities

Typically, the process assessment team for VSE process assessment process consists of at least one lead assessor or a lead assessor with other assessors. The assessors should be familiar with the VSE characteristics.

6.1.4 The assessment process

The activities to be performed will be determined by the chosen documented assessment process tailored as necessary. The documented process for the process assessment of a VSE should address all of the required activities defined in ISO/IEC 33002:2015, 4.2.

Specific concerns of relevance to process assessment of VSEs include the following:

Plan the assessment

Typically, the schedule for process assessment of a VSE will need to take account of the availability of key resources. The level of resources required for the process assessment should be determined according to the resources available to the VSE.

Collect the data

The strategy for data collection should take account of the nature of the work performed within the VSE, and of the nature of the items of objective evidence that will typically be available. Often, process assessments in VSEs rely heavily on testimony from performers of the processes; however, to the best

extent possible, the assessors should endeavour to obtain other supporting objective evidence drawn from the VSE work products.

Validate the data

The key issue in data validation in process assessment of a VSE is ensuring that the data collected is representative of the normal operations of the enterprise.

Derive results

In conducting process attribute rating, the assessors should focus on the extent to which the evidence obtained addresses the processes and process attributes being rated. The requirement for traceability between the rating and the evidence employed [ISO/IEC 33002:2015, 4.2.1 e) 1)] is relevant here.

Report the assessment

The assessors should ensure that the report to the sponsor of the process assessment covers the full scope of the VSE Profile employed in the process assessment.

6.2 Use of the assessment results

The process assessment results can be used to:

a) evaluate the process quality levels of an organization,

b) determine the improvement opportunities, in order to enhance the organization's ability to meet its business goals by improving efficiency and quality of its products and services. The findings can be used as a base to perform the improvement plan,

c) benchmark the process quality levels with other organizations in the market, and

d) select a supplier based on the supplier's quality level assessment.

6.3 Achievement of a VSE Profile

This subclause provides guidance on how to determine whether an organization fulfils a VSE Profile. The determination is based on the evaluated quality levels for the processes within each VSE Profile. ISO/IEC 29110-4-m defines the conformance requirements.

The requirements for the profiles are defined in ISO/IEC 29110-4-m. The corresponding quality levels to be evaluated for each profile can be derived from the respective parts of ISO/IEC 29110-4-m. At minimum, all mandatory elements of the VSE profile, as defined in ISO/IEC 29110-4-m, need to be considered in the process assessment.

For example, to achieve the software basic profile, the assessed processes need to achieve quality level one as defined in Annex A. This means that the implemented process achieves its process purpose and its defined outcomes. For example, for VSE Generic basic profile for software, the applicable process purposes are documented in ISO/IEC 29110-4-1 (Process Reference Model for the Basic Profile):

— Project Management process;

— Software Implementation process.

NOTE Process Reference Models are now to be contained in ISO/IEC 29110-4-m.

The related outcomes of the Process Reference Model are documented in Annex A (supported by ISO/IEC 29110-5-m-n under the process specific Objectives). A detailed mapping of the profile process elements to ISO/IEC/IEEE 15288, ISO/IEC/IEEE 12207, and other base standards are provided in ISO/IEC 29110-4-m.

6.4 Application of Process Assessment Models

Use of ISO/IEC 33004 compliant Process Assessment Model (PAM) ensures that the process assessment results are comparable, reliable, and repeatable. The assessor should confirm that the applied PAM is suitable for assessing the process capability in the context of VSEs.

The applied PAM should have a set of indicators that address the process purpose and outcomes, and demonstrate the achievement of the required capability level.

ISO/IEC 29110-4-m Specifications for VSE profiles document a detailed mapping of process elements between ISO/IEC 29110-5-m-n and the Process Reference Model in of ISO/IEC 29110-4-m, respectively.

A VSE specific PAM can be derived by selecting those process assessment indicators relevant to the corresponding process outcomes defined in ISO/IEC 29110-4-m. An exemplar Process Assessment Model for the VSE Processes and profiles is provided in Annex A of this part of ISO/IEC 29110.

Annex A
(informative)

Measurement framework and Process Assessment Model

A.1 Introduction

This Annex provides both the measurement framework and the Process Assessment and Maturity Model for the evaluation of the process quality attributes of the processes defined in the ISO/IEC 29110 series for VSEs.

A.2 sets out the measurement framework that can be used in the assessment of process capability and organizational profile for very small entities. The requirements for process capability and organizational profile scales defined in this Annex form a structure which:

a) facilitates self-assessment,

b) provides a basis for use in process improvement and capability determination,

c) takes into account the context in which the assessed process is implemented,

d) produces a process capability scale,

e) is applicable across all application domains and mainly for a very small entities, and

f) can provide an objective benchmark between organizations.

The requirements from ISO/IEC 33003 for measurement frameworks and ISO/IEC 33004 for maturity models are embedded verbatim in the text A.2 respectively for compliance verification (see below A.2.9 and A.2.11). Those verbatim requirements are enclosed in a box for ease identification.

A.3 provides an example of a PAM for use in performing a conformant assessment in accordance with the requirements of ISO/IEC 33004.

An integral part of conducting an assessment is to use a PAM constructed for that purpose, related to a PRM and conformant with the requirements defined in ISO/IEC 33002. ISO/IEC 33002 provides a framework for process assessment and sets out the minimum requirements for performing an assessment in order to ensure consistency and repeatability of the ratings.

A PRM cannot be used alone as the basis for conducting consistent and reliable assessments of process capability since the level of detail is not sufficient. Therefore:

— the descriptions of process purpose and process outcomes provided by the PRM need to be supported with a comprehensive set of indicators of process performance;

— the capability levels and process attributes and the rating scale defined in above A.2 need to be supported with a set of indicators of process capability.

Used in this way, in conjunction with a documented process, consistent and repeatable ratings of process capability will be possible.

This Process Assessment Model contains a set of indicators to be considered when interpreting the intent of the PRM. These indicators can also be used when implementing a process improvement program or to help evaluate and select an assessment model, method, methodology, or tools.

The PRM defined in ISO/IEC 29110-4-1 has been used as the basis for the PAM in this part of ISO/IEC 29110.

The Process Assessment Model embodies the core characteristics that could be expected of any PAM consistent with ISO/IEC 33004.

Within A.3:

— A.3.4 provides a detailed description of the structure and key components of the PAM, which includes two dimensions: a process dimension and a capability dimension; assessment indicators are introduced in this Clause;

— A.3.5 addresses the process dimension. It uses process definitions from ISO/IEC 29110-4-m to identify a PRM. The processes of the PRM are described in the PRM in terms of purpose and outcomes and are grouped in three process categories. The PAM expands the PRM process definitions by including a set of process performance indicators called base practices for each process;

— A.3.5 addresses the capability dimension. It duplicates the definitions of the capability levels and process attributes from A.2 above and expands each of the process attributes through the inclusion of a set of practices and work products indicators;

— A.3.6 provides selected characteristics for typical work products to assist the assessor in evaluating the capability level of processes;

— A.3.7 provides a statement of compliancy of the PAM to the requirements defined in ISO/IEC 33004, where these requirements are verbatim enclosed on a box for ease identification.

A.2 Measurement Framework for assessment of process capability and organizational profile for VSEs

A.2.1 Introduction

A.2 sets out the measurement framework that can be used in the assessment of process capability and organizational profile for VSEs.

The requirements for process capability and organizational profile scales defined in this part of ISO/IEC 29110 form a structure which:

a) facilitates self-assessment,

b) provides a basis for use in process improvement and capability determination,

c) takes into account the context in which the assessed process is implemented,

d) produces a process capability scale,

e) is applicable across all application domains and mainly for a very small entities, and

f) can provide an objective benchmark between organizations.

A.2.2 Overview

The capability to perform a process to a specific level of performance depends on well-established principles. A.2 sets out those principles that are common to all domains. The process capability measurement framework described in this Annex is expressed in terms of a set of process attributes. Each process attribute is defined in terms of a set of process attribute outcomes which can be evaluated to indicate the extent of achievement of the process attribute. The process attributes are organized into process capability levels, ranging from Incomplete (in which the process does not achieve its defined process outcomes) to Performed (in which the process fulfils its purpose and outcomes).

The result of an assessment, using a PAM that incorporates this process measurement framework, will be a set of process profiles - ratings of the achievement of the set of process attributes for each process in the scope of the assessment. The result can also be expressed in terms of the capability level ratings achieved for each process in the assessment scope. A capability level rating does not guarantee that an

organization will perform its processes at any given process capability level, simply that it is capable of performing its processes at that level.

A.2.3 Measurement Framework for processes for VSEs

This Clause defines a Measurement Framework for the assessment of process capability. The Measurement Framework provides a schema for use in characterizing the capability of an implemented process with respect to a PAM.

Within this process measurement framework, the measure of capability is based upon a set of Process Attributes (PA). Each attribute defines a measurable property of process capability. The extent of process attribute achievement is characterized on a defined rating scale. The process capability level for an assessed process is derived from the set of process attribute ratings represented in the process profile.

Although process attributes are defined in such a way that they can be rated independently of one another, this does not imply that there are no other relationships between them, e.g. the achievement of one process attribute can be associated with the achievement of another process attribute within the process measurement framework.

A.2.4 Process capability levels and process attributes

Process capability is defined on a two-point ordinal scale that enables capability to be assessed from the bottom of the scale, **Incomplete**, through to the top end of the scale, **Performed**. The scale represents increasing capability of the implemented process, from failing to achieve the process purpose through to achieving the process purpose and outcomes.

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.

Level ALPHA: Performed process

The implemented process achieves its process purpose. The following attribute of the process demonstrates the achievement of this level:

PA 1 Process performance attribute

The process performance attribute is a measure of the extent to which the process purpose is achieved. As a result of full achievement of this attribute:

a) the process achieves its defined outcomes.

A.2.5 Process attribute rating scale

Within this process measurement framework, a process attribute is a measureable property of process capability. A process attribute rating is a judgement of the degree of achievement of the process attribute for the assessed process.

A process attribute is measured using an ordinal scale as defined below.

N Not achieved:

There is little or no evidence of achievement of the defined process attribute in the assessed process.

P Partially achieved:

There is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Some aspects of achievement of the process attribute can be unpredictable.

L Largely achieved:

There is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Some weaknesses related to this process attribute can exist in the assessed process.

F Fully achieved:

There is evidence of a complete and systematic approach to, and full achievement of, the defined process attribute in the assessed process. No significant weaknesses related to this process attribute exist in the assessed process.

The ordinal scale defined above shall be understood in terms of percentage achievement of a process attribute.

The corresponding percentages shall be the following:

N Not achieved 0 % to ≤ 15 % achievement;

P Partially achieved > 15 % to ≤ 50 % achievement;

L Largely achieved > 50 % to ≤ 90 % achievement;

F Fully achieved > 90 % to ≤ 100 % achievement.

A.2.6 Process attribute rating method

A process outcome is the observable result of successful achievement of the process purpose.

A process attribute outcome is the observable result of achievement of a specified process attribute.

Process outcomes and process attribute outcomes can be characterized as an intermediate step to providing a process attribute rating.

When performing rating, the rating method employed shall be specified relevant to the class of assessment, that for VSE process assessments is of R3 (as defined in ISO/IEC 33020), where: Process attribute rating across assessed process instances shall be made without aggregation.

A.2.7 Process capability level model

The process capability level achieved by a process shall be derived from the process attribute ratings for that process according to the process capability level model defined in Table A.1.

Table A.1 — Process capability level ratings

Scale	Process Attributes	Rating
Level ALPHA	PA.1 Process Performance	Fully

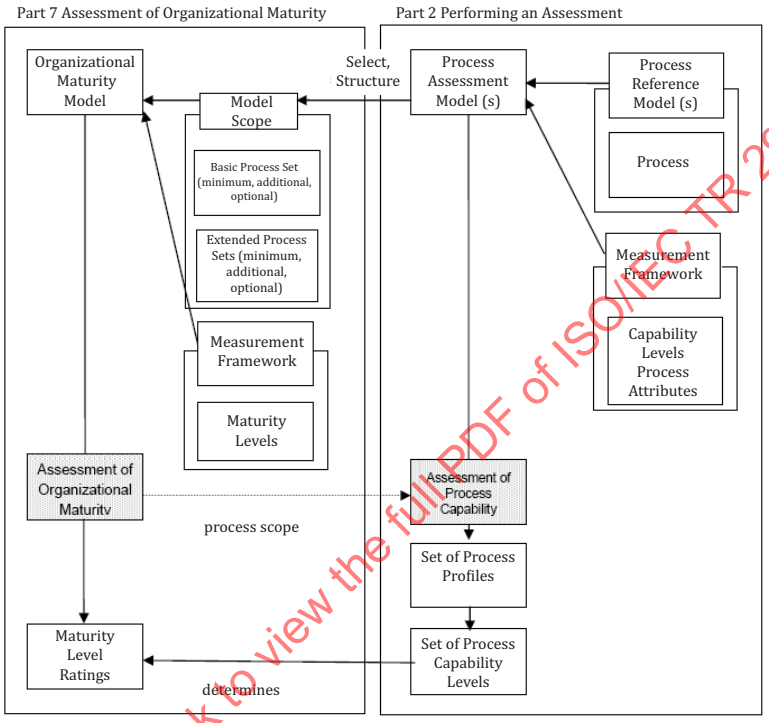
A.2.8 A Measurement Framework for Organizational Profiles

This Clause defines a Measurement Framework for the assessment of organizational profile. Organizational profile is measured on a two-point ordinal scale from Low profile – the Immature Organization, through to the Basic Profile. The scale represents the extent to which the organization has explicitly and consistently performed its basic key processes.

The scale for organizational profile retains the semantic intent of the process Capability Levels that are defined in subclauses above of A.2. The framework for process capability characterizes the ability of a process to meet current or projected business goals; the framework of organizational profile characterizes the extent to which an organization consistently implements sets of processes within a defined scope. Thus, the two frameworks while consistent, characterize different attributes of separate entities – the process and the organization. The Measurement Framework provides a schema for use in characterizing the profile of an organization with respect to a specified PAM.

Within this Measurement Framework, each level of Organizational Profile is characterized by the demonstration of achievement of specified levels of Process Capability in process sets drawn from the specified Process Assessment Model(s) (see A.3).

Processes in ISO/IEC 29110-4-1 can be categorized into one set based on its contributions to the business goals of the organization. The set of fundamental processes that support the primary activities of the organization is called the basic process set. Each organizational profile Level beyond level Basic is characterized by the implementation, at an appropriate level of Process Capability, of a further set of processes that drive the achievement of the capabilities relevant to each Profile Level. These are called extended process sets.



NOTE Amended from ISO/IEC TR 15504-7:2008.

Figure A.1 — Relationship between assessment of process capability and derivation of Organizational Profile

Figure A.1 above shows the relationship between the Organizational Profile Model and the specified PAM(s) when an assessment of organizational profile is conducted. The key elements are the defined components of the relevant Process Reference Models and the Measurement Frameworks, shown in Figure A.1 as nested boxes. These components are used to construct models supporting the assessment of Process Capability and Organizational Profile. The definition of the Organizational Profile Model scope and the selection of the basic and extended process sets are made in the context of the Organizational Profile Model. Once the assessment has been planned employing an Organizational Profile Model based upon one or more conformant Process Assessment Models, the assessment is performed using the specified PAM(s) to obtain the set of process profiles. The process Capability Levels, derived from the process profiles, are then transformed into an Organizational Profile Level rating according to the rules for deriving Profile Levels from Capability Levels.

Organizational profile is expressed on a scale from Profile Level 0 (immature) through Basic Profile Level aligned as follows.

Level 0 Organization- Immature

The organization does not demonstrate effective implementation of its processes that are fundamental to support the organization's primary activities

At least one process in the basic process set is assessed at Capability Level 0.

Basic organizational profile

The basic organizational profile is the implementation of one project, performing the processes identified as belonging to the basic profile at level ALPHA. The organization demonstrates achievement of the purpose of the processes that are fundamental to support the organization's primary activities.

As a result of achieving this level, the organization:

a) implements the processes required to support the organization's primary activities;

b) performs sets of activities and tasks that achieve the purposes of these processes.

All processes in the basic process set are assessed at Capability Level ALPHA or higher.

A.2.9 Compliance verification of above Measurement framework requirements

This Clause presents how the measurement framework presented above fulfils all requirements for a process measurement framework (defined in ISO/IEC 33003). Where text has been quoted from ISO/IEC 33003, that text is enclosed in a box for ease of identification.

Conceptualization

A process capability level is characterized by one or more process attributes, which are formative measures of the process capability. Process attributes are required in order to construct the process capability. Process attributes are demonstrated by achievement of the process attribute outcomes, which are reflective measures.

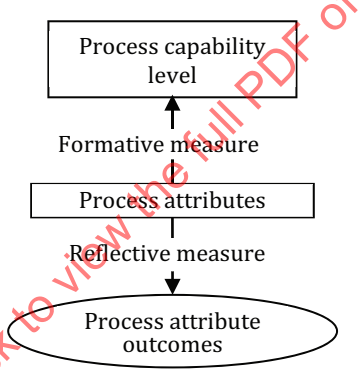


Figure A.2 — Formative and reflective measures of process capability

The concept of process capability does not provide a measure of anything other than process capability formed by process attributes. For example, process capability does not infer anything about organizational performance.

e) A process measurement framework shall identify and address a single process quality characteristic;

The measurement framework is defined for the single process quality characteristic of software quality.

f) A process quality characteristic in a process measurement framework shall be defined on the basis of a multidimensional construct;

The process measurement framework is a construct comprised of one process attribute.

g) A process quality characteristic in a process measurement framework shall be defined as a set of process attributes;

The process measurement framework is a construct comprised of one process attribute.

h) Each process attribute shall define a property of the process quality characteristic;

The property defined by each process attribute is described in A.2.4.

i) Each process attribute that is not directly measurable shall be considered as a construct;

Each process attribute in this measurement framework is a construct and defined in A.2.4.

j) Process attributes in a process measurement framework shall be defined as either reflective or formative;

The process attributes of this measurement framework are formative.

k) The process measurement framework shall document the policies and assumptions underlying its use and application;

The policies and assumptions underlying the use and application of this process measurement framework are set out in A.2.1 and A.2.2.

Construct definition

l) The construct definition shall define the meaning of the process quality characteristic and its process attributes in a process measurement framework;

The meaning of the process quality characteristic and its process attributes are given in A.2.4.

m) The construct definition shall clarify the specification of the process quality characteristic and its process attributes as dimensions;

The specifications of the process quality characteristic and its process attributes are given in A.2.4.

n) The construct definition shall provide a guide for the operationalization of the process quality characteristic and its process attributes;

Operationalization of the process quality characteristic and its process attributes is given in A.2.4.

o) The construct definition shall state the scales of composite measures such as categorical (e.g. a series of ordinal values such as capability level) or numeric;

The scales of composite measures in this measurement framework are given in A.2.5.

p) At least one of the process attributes shall comprise the achievement of the defined process purpose and process outcomes for the process; this is termed the process performance attribute;

The process performance attribute (PA 1) comprises the achievement of the defined process purpose through achievement of the process outcomes for that process.

Operationalization

q) All process attributes shall be defined according to their construct specification;

The process attributes are defined in A.2.4; the descriptions follow a common approach, described in A.2.3.

r) Achievement of process attributes shall be verifiable through objective evidence.

In the process performance attribute, the achievement of process outcomes is demonstrable based on objective evidence.

Construct specification examination

Construct specifications of the process quality characteristic and its associated process attributes shall be examined through operationalization and with rationale.

Each Process Attribute is operationalized through a set of base or derived measures depending on the class of assessment (see A.2.6 and A.2.7).

Scoring process attributes

a) The process attributes shall be scored;

The unit of measurement is specified in A.2.5.

b) A measurement scale, i.e. nominal, ordinal, interval, or ratio, shall be defined for the process attributes;

The measurement scale for base measures are ordinal, defined in A.2.5.

c) A measurement method shall be identified that objectively assigns value to each measure.

The method for assigning a value to the measure of process capability is described in A.2.7.

Aggregation

a) All aggregations required within the measurement framework shall be identified;

Aggregation methods are defined in A.2.6.

b) Aggregation methods shall be specified;

Aggregation methods are defined in A.2.6.

c) Aggregation methods shall be statistically valid.

Rationales for the validity of aggregation methods in this international standard are given in A.2.6.

d) Aggregation methods shall utilize consistent measurement scales;

Aggregation methods are defined in A.2.6.

e) Aggregation methods shall be consistent with the measurement framework policies and assumptions; f) Aggregation methods shall be consistent with construct specifications.

Consistency with policies and assumptions and with the construct specifications is described in A.2.6.

Sensitivity analysis

a) Sensitivity analysis shall be performed for measurement scales of base and derived measures.

Sensitivity of the process capability scale was tested during the SPICE Trials (Jung 2001; SPICE Trials, 1999) as well as the Moprosoft experiences. The investigations included inter-rater agreement and internal consistency, both of which were found to be acceptable. The possibility of increasing internal

consistency was investigated by varying the four category scale to a three or two category scale by combining either the middle two ratings [N, (P, L), F] or the outer two ratings [(N, P), (L, F)]. The current four-category scale cannot be improved by reduction to a three- or two-category scale.

Sensitivity of process capability level ratings was investigated during the SPICE Trials and reported in the Interim Report (SPICE Trials, 1998) as well as in the Moprosoft trials. Overall the investigation concluded that distortion downward of the capability level rating had greater effect than distortion upwards, but that guidance should be provided to assessors concerning the potential effects of distortion.

b) Sensitivity analysis shall be performed for aggregation methods.

Some sensitivity analysis data related to aggregation is available in the SPICE Trials reports (SPICE Trials, 1998); however, its relevance to the current approach is limited. The issue of aggregation was examined in detail during the development of the International Standard.

c) Sensitivity analysis shall be performed for weights, if applicable.

Weights are not used in this measurement framework so are not applicable.

Requirements for the validity of process measurement frameworks

Reliability and validity

Process measurement frameworks shall state their reliability and validity claims and how those claims shall be investigated

Post hoc statistical analysis has been performed to validate process measurement frameworks. Validation has been performed during the SPICE trials conducted during standard development.

The measurement method and capability scale were tested during the SPICE trials. There has been no change to the concepts of the measurement scale that would invalidate the process capability scale or the findings of the trial.

Conformance clause of ISO/IEC 33003

A process measurement framework shall be in conformity with the requirements of this International Standard

When data are available during trials and/or after the publication of a framework, rigorous statistical analyses will be required for all the applicable requirements.

The results of such analyses are documented in the following references:

— *H.-W. Jung, et al., "Findings from Phase 2 of the SPICE trials," Software Process: Improvement and Practice, vol. 6, pp. 205-242, 2001.*

— *SPICE Trials (1999), SPICE Phase 2 Trials Final Report, ISO/IEC/JTC1/SC7/WG10*

— *SPICE Trials (1998), SPICE Phase 2 Trials Interim Report, ISO/IEC/JTC1/SC7/WG10*

A.2.10 Profile/Maturity Levels from Capability Levels for software processes in ISO/IEC 29110-4-1 for VSEs

The profile levels (or Maturity levels) for the software processes within a VSE are defined in ISO/IEC 29110-4-1. In the main content of this ISO/IEC 29110-3-1, both the scope of application and its use with respect to a process quality characteristic associated with business success in the domain of application are explained.

Based on the Measurement Framework for assessment of process capability and organizational profile for very small entities (VSEs) defined in A.2, the rating of Organizational Profile shall be derived from a set of process profiles in the following manner:

a) An assessment of process capability, compliant to the requirements of ISO/IEC 33002 and meeting the requirements of A.2 shall be conducted.

d) The process scope of the assessment shall embrace all of the processes in the basic process sets defined in the selected Organizational Profile Model.

e) All Process Attributes up to and including the highest relevant Capability Level shall be rated for all processes in the scope of the assessment.

f) Process Capability Level Ratings shall be derived for all processes in the scope of the assessment according to A.2.5 and A.2.6.

g) The Profile Level achieved by an organization shall be derived from the process Capability Level ratings according to the following rule:

   1) To achieve Organizational Basic Profile Level, all processes assigned to Basic profile shall achieve process Capability Level ALPHA or higher.

The organizational profile achieved by a VSE shall be derived from the process attribute ratings for each process according to the organizational profile model defined in Table A.2.

Table A.2 — Organizational profile ratings

Scale	Process	Process capability	Process Attributes	Rating
Basic Profile	Project Management	ALPHA	VSE Process Performance	F
	Software Implementation	ALPHA	VSE Process Performance	F

A.2.11 Compliance verification of the Organizational Profile

This Clause verifies how the defined Organizational Profile or Maturity Model meets the requirements for conformance defined in ISO/IEC 33004. The Organizational Profile or Maturity Model can be used in the performance of assessments that meet the requirements of ISO/IEC 33002. It can also be used as a guide for an Organizational Profile or Maturity Model developer.

For ease of reference, the requirements from ISO/IEC 33004 are embedded verbatim in the text of this Clause and that text is enclosed in a box, for ease of identification.

They should not be construed as normative elements of this Annex.

Since this Organizational Profile or Maturity Model has been explicitly constructed to be an elaboration of the Process Assessment Model defined in A.3, the conformance claim is relatively simple. For other models, particularly ones with a different architecture, the demonstration of conformance can be more difficult.

7.3.1 A maturity model shall document the community of interest of the maturity model and the actions taken to achieve consensus within that community of interest:

a) the relevant community of interest shall be characterized or specified;

b) the extent of achievement of consensus shall be documented;

c) if no actions taken to achieve consensus, a statement to this effect shall be documented.

The Organizational Maturity Model is designed for the specific domain of the software industry, specific for VSE organizations; as a part of an International Standard, the standardization process includes approaches designed to achieve consensus within the community of interest.

7.3.2 The maturity model shall define:

a declaration of scope of application;

its use with respect to a process quality characteristic associated with business success in the domain of application.

In above A.2.10, the scope of application and its use are declared.

7.3.3 A maturity model shall be based upon one or more specified process assessment models that utilize a common process measurement framework for the specified process quality characteristic.

The Organizational Maturity Model is based upon A.2. The Process Assessment Model for software processes for VSEs. Conformance of the PAM is demonstrated in A.3 below.

The Organizational Maturity Model contains all processes contained in ISO/IEC 29110-4-1 and in A.2. These are assigned to basic process sets.

The Organizational Maturity Model addresses all of the maturity levels defined in the measurement framework.

7.3.4 Scale of organizational process maturity

A maturity model shall define an ordinal scale for organisational process maturity.

A maturity model shall specify a maturity level for each point on the ordinal scale.

A maturity model shall specify a continuous set of maturity levels, representing increasing levels of organizational process maturity, starting at the basic maturity level.

A maturity level shall be defined with a unique identification and description.

A maturity level shall be characterized by the demonstration of achievement of a set of process profile(s).

In above A.2.10, the maturity levels are declared.

7.3.5 Process descriptions

A set of processes from the specified process assessment model(s), that represent operations seen as essential for achievement for the specified level of maturity, shall be selected and assigned to each maturity level in the maturity model.

Basic process set

A set of processes, shall be selected from the specified process assessment model(s) that represent operations seen as essential for business success in the domain. This set of processes shall be termed the basic process set for the maturity model.

The basic maturity level (maturity level 1) shall be represented by achievement of the process performance attribute for all processes in the basic process set.

Extended process sets

Sets of processes shall be selected from the specified process assessment model(s), for all levels above the basic level in the maturity model, that represent operations seen as essential for achievement for the specified level of maturity. These shall be termed the extended process sets for the maturity model.

Additional processes

A basic or extended process set may include additional processes that:

are required for assessments with a particular scope of application, and

are optional depending on the particular circumstances of the organization.

A maturity model shall include specifications of the particular circumstances for inclusion of any additional processes in the basic and extended process sets.

In above A.2.10, the process set is defined and its uses are declared. The processes drawn from ISO/IEC 29110-4-1 that constitute the basic process set are listed in Table A.2, along with their status and the conditions under which they are to be applied. No extended process set is defined for this measurement framework

7.3.6 Rules for deriving maturity level from process quality level

The basic maturity level shall be represented by achievement of the process performance attribute for all processes in the basic process set.

A maturity model shall define the rules for deriving an organizational process maturity level rating from the set of process profiles that result from an assessment.

In above A.2.10, the rules for deriving maturity level from process quality level are defined.

A.3 Exemplar Process Assessment Model for VSEs

A.3.1 Introduction

A.3 provides an example of a PAM for use in performing a conformant assessment in accordance with the requirements of ISO/IEC 33004.

An integral part of conducting an assessment is to use a PAM constructed for that purpose, related to a PRM and conformant with the requirements defined in ISO/IEC 33002. ISO/IEC 33002 provides a framework for process assessment and sets out the minimum requirements for performing an assessment in order to ensure consistency and repeatability of the ratings.

A PRM cannot be used alone as the basis for conducting consistent and reliable assessments of process capability since the level of detail is not sufficient. Therefore:

— the descriptions of process purpose and process outcomes provided by the PRM need to be supported with a comprehensive set of indicators of process performance, and

— the capability levels and process attributes and the rating scale defined in above A.2 need to be supported with a set of indicators of process capability.

Used in this way, in conjunction with a documented process, consistent, and repeatable ratings of process capability will be possible.

This Process Assessment Model contains a set of indicators to be considered when interpreting the intent of the PRM. These indicators can also be used when implementing a process improvement program or to help evaluate and select an assessment model, method, methodology or tools.

The PRM defined in ISO/IEC 29110-4-1 has been used as the basis for the Process Assessment Model in this part of ISO/IEC 29110.

This PAM embodies the core characteristics that could be expected of any PAM consistent with ISO/IEC 33004.

Within A.3:

— A.3.4 provides a detailed description of the structure and key components of the process assessment model, which includes two dimensions: a process dimension and a capability dimension; assessment indicators are introduced in this Clause;

— A.3.5 addresses the process dimension. It uses process definitions from ISO/IEC 29110-4-1 to identify a PRM. The processes of the PRM are described in the PAM in terms of purpose and outcomes and are grouped in three process categories. The PAM expands the PRM process definitions by including a set of process performance indicators called base practices for each process;

— A.3.5 addresses the capability dimension. It duplicates the definitions of the capability levels and process attributes from A.1 above and expands each of the process attributes through the inclusion of a set of practices and work products indicators;

— A.3.6 provides selected characteristics for typical work products to assist the assessor in evaluating the capability level of processes;

— A.3.7 provides a statement of compliancy of the PAM to the requirements defined in ISO/IEC 33004.

A.3.2 Scope

This A.3:

— defines a PAM that meets the requirements of ISO/IEC 33004 and that supports the performance of an assessment by providing indicators for guidance on the interpretation of the process purposes and outcomes as defined in ISO/IEC 29110-4-1 (processes included in the Basic Profile for VSEs) and the process attributes as defined in above A.2 (our MF);

— provides guidance, by example, on the definition and use of assessment indicators.

A PAM comprises a set of indicators of process performance and process capability. The indicators are used as a basis for collecting the objective evidence that enables an assessor to assign ratings. The set of indicators included in A.3 is intended to be an all-inclusive set and is it intended to be applicable in its entirety.

The PAM in A.3 (this PAM) is directed at assessment sponsors and lead assessors who wish to select a model, and associated documented process method, for assessment (for either capability determination or process improvement). Additionally, it can be of use to developers of assessment

models in the construction of their own model, by providing examples of good software engineering and management practices.

Any PAM meeting the requirements defined in ISO/IEC 33004 concerning models for process assessment may be used for assessment. Different models and methods can be needed to address differing business needs. The assessment model in A.3 is provided as a model meeting all the requirements expressed in ISO/IEC 33004.

NOTE Copyright release for the PAM: Users of A.3 can freely reproduce the detailed descriptions contained in the assessment model as part of any tool or other material to support the performance of process assessments, so that it can be used for its intended purpose.

A.3.3 Overview of the Process Assessment Model

A.3 provides a PAM that includes assessment indicators.

The PRM defined in ISO/IEC 29110-4-1, associated with the process attributes defined in A.2, establishes a PAM used as a common basis for performing assessments of software engineering process capability, allowing for the reporting of results using a common rating scale.

The PAM is a two-dimensional model of process capability. In one dimension, the process dimension, the processes are defined in ISO/IEC 29110-4-1 (the PRM). In the other dimension, the capability dimension, a set of process attributes grouped into capability levels is defined. The process attributes provide the measurable characteristics of process capability.

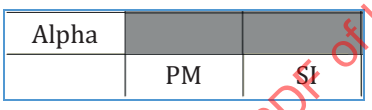


Figure A.3 — Bi-dimensional PAM for the software basic profile

The PRM and the capability dimension defined in A.2 cannot be used alone as the basis for conducting reliable and consistent assessments of process capability since the level of detail provided is not sufficient. The descriptions of process purpose and outcomes in the PRM, and the process attribute definitions in A.2, need to be supported with a comprehensive set of indicators of process performance and process capability that are used for assessment performance.

The PAM defined in A.3 is conformant with the ISO/IEC 33004 requirements for a PAM, and can be used as the basis for conducting an assessment of software engineering process capability for VSEs.

A.3.4 Structure of the Process Assessment Model

This Clause describes the detailed structure of the PAM and its key components.

This PAM expands upon the PRM by adding the definition and use of assessment indicators. Assessment indicators comprise indicators of process performance and process capability and are defined to support an assessor's judgment of the performance and capability of an implemented process.

A.3.4.1 Processes

Figure A.4 lists the processes from ISO/IEC 29110-4-1 that are included in the process dimension of the PAM.

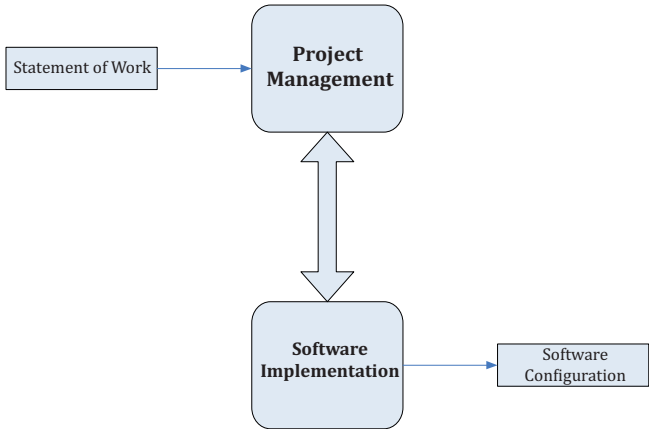


Figure A.4 — Process included in the software Basic profile

A.3.4.2 Process dimension

For the process dimension, all the processes in Figure A.4 above are included within the process dimension of the PAM. Each process in the PAM is described in terms of a purpose statement. These statements contain the unique functional objectives of the process when performed in a particular environment. A list of specific outcomes is associated with each of the process purpose statements, as a list of expected positive results of the process performance.

Satisfying the purpose statements of a process represents the first step in building a level ALPHA process capability where the expected outcomes are observable.

A.3.4.3 Capability dimension

For the capability dimension, the process capability levels and process attributes are identical to those defined in A.2, the Measurement Framework (MF).

Evolving process capability is expressed in the PAM in terms of process attributes grouped into capability levels. Process attributes are features of a process that can be evaluated on a scale of achievement, providing a measure of the capability of the process. They are applicable to all processes. Each process attribute describes a facet of the overall capability of managing and improving the effectiveness of a process in achieving its purpose and contributing to the business goals of the organization.

A capability level is a set of process attribute(s) that work together to provide a major enhancement in the capability to perform a process. The levels constitute a rational way of progressing through improvement of the capability of any process and are defined in A.2 (the MF).

There are two capability levels, incorporating one process attribute:

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.

Level Alpha: Performed process

The implemented process achieves its process purpose.

Within the PAM, the measure of capability is based upon the one process attributes (PA) defined in A.2 (the MF). Process attributes are used to determine whether a process has reached a given capability. Each attribute measures a particular aspect of the process capability.

At each level there is no ordering between the process attributes; each attribute addresses a specific aspect of the capability level. The list of process attributes is shown in Table A.3 below.

Table A.3 — Capability levels and process attributes

Process Attribute ID	Capability Levels and Process Attributes
	Level 0: Incomplete process
	Level alpha: Performed process
PA.1	Process performance

The process attributes are evaluated on a four point ordinal scale of achievement, as defined in A.1 (the MF). They provide insight into the specific aspects of process capability required to support process improvement and capability determination.

A.3.4.4 Assessment Indicators

The PAM is based on the principle that the capability of a process can be assessed by demonstrating the achievement of process attributes on the basis of evidences related to assessment indicators.

There is one type of assessment indicators: process performance indicators, which apply exclusively to capability level ALPHA. These indicators are defined in A.2.

The process attributes in the capability dimension have a set of process capability indicators that provide an indication of the extent of achievement of the attribute in the instantiated process. These indicators concern significant activities, resources, or results associated with the achievement of the attribute purpose by a process.

The process performance indicators are used to measure the degree of achievement of the process performance attribute for the process assessed.

The process performance indicators are the following:

— Base Practice (BP);

— Work Product (WP).

The performance of Base Practices (BPs) provides an indication of the extent of achievement of the process purpose and process outcomes. Work Products (WPs) are either used or produced (or both), when performing the process.

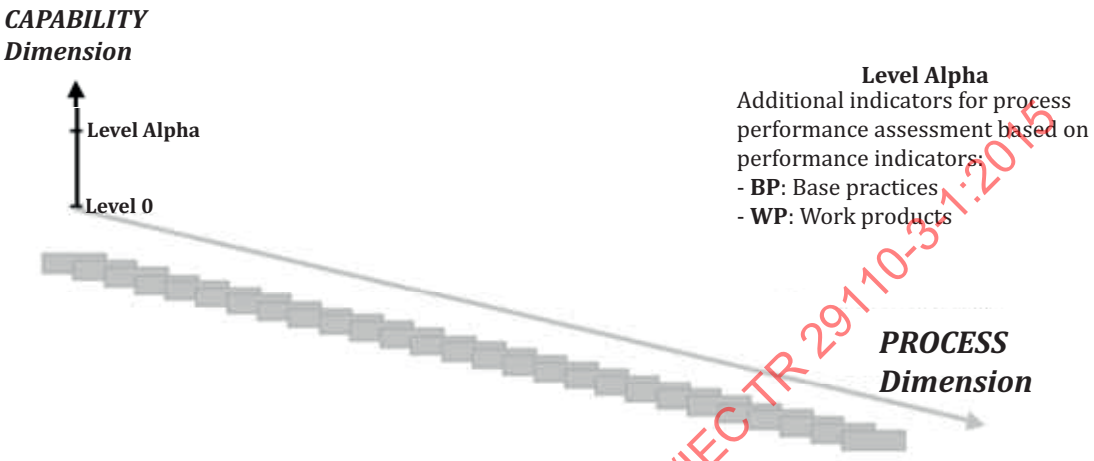


Figure A.5 — Assessment indicators

The process performance indicators defined in this PAM represent types of objective evidence that might be found in an instantiation of a process and therefore could be used to judge achievement of capability.

Figure A.5 shows how the assessment indicators are related to process performance.

A.3.4.5 Process Performance Indicators

There are two types of process performance indicators; Base Practice (BP) indicators and Work Product (WP) indicators. Process performance indicators relate to individual processes defined in the process dimension of the process assessment model and are chosen to explicitly address the achievement of the defined process purpose.

Evidence of performance of the base practices, and the presence of work products with their expected work product characteristics, provide objective evidence of the achievement of the purpose of the process.

A base practice is an activity that addresses the purpose of a particular process. Consistently performing the base practices associated with a process will help the consistent achievement of its purpose. A coherent set of base practices is associated with each process in the process dimension. The base practices are described at an abstract level, identifying "what" should be done without specifying "how". Implementing the base practices of a process should achieve the basic outcomes that reflect the process purpose. Base practices represent only 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. The performance of a process produces work products that are identifiable and usable in achieving the purpose of the process. In this assessment model, each work product has a defined set of example work product characteristics that may be used when reviewing the work product to assess the effective performance of a process. Work product characteristics can be used to identify the corresponding work product produced/used by the assessed organization.

A.3.5 contains a complete description of the processes, including the base practices and the associated work products.

A.3.6 contains a complete list of specific work products. An assessor would refer to the specific work product when performing an assessment.

A.3.4.6 Measuring process capability

The process performance indicators in this model give examples of evidence that an assessor might obtain, or observe, in the performance of an assessment. The evidence obtained in the assessment, through observation of the implemented process, can be mapped onto the set of indicators to enable correlation between the implemented process and the processes defined in this assessment model. These indicators provide guidance for assessors in accumulating the necessary objective evidence to support judgments of capability. They are not intended to be regarded as a mandatory set of checklists to be followed.

An indicator is defined as an objective characteristic of a practice or work product that supports the judgment of the performance or capability of an implemented process. The assessment indicators, and their relationship to process performance and process capability, are shown in Figure 6 below.

Assessment indicators are used to confirm that certain practices were performed, as shown by observable evidence collected during an assessment. All such evidence comes either from the examination of work products of the processes assessed, or from statements made by the performers and managers of the processes.

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

The evidence obtained should be recorded in a form that clearly relates to an associated indicator, so that the support for the assessor's judgment can be readily confirmed or verified as required by ISO/IEC 33002.

The output from a process assessment is a set of process profiles, one for each process within the scope of the assessment. Each process profile consists of a set of the process attribute ratings for an assessed process. Each attribute rating represents a judgment by the assessor of the extent to which the attribute is achieved. To improve the reliability and repeatability of the assessment, the judgments of the assessor are based on a coherent set of recorded objective evidences.

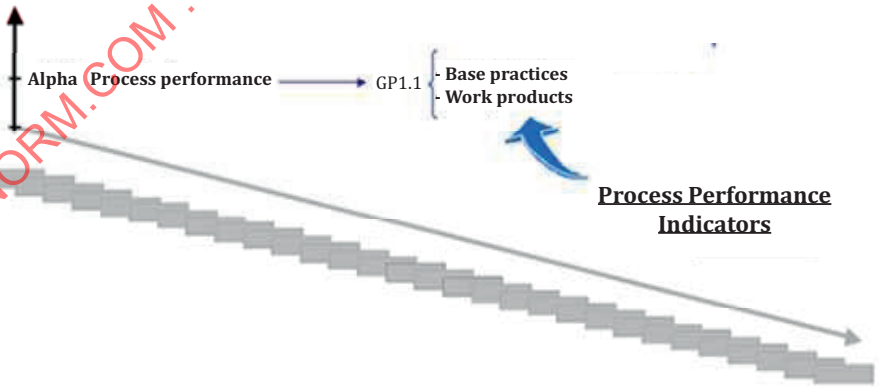


Figure A.6 — Relationship between assessment indicators and process capability

A.3.5 The process dimension and process performance indicators (level Alpha)

This Clause defines the processes and the process performance indicators, also known as the process dimension, of the PAM. The processes in the process dimension can be directly mapped to the processes defined in the Process Reference Model. It also includes the rules of assessment indicators identification.

The processes are listed in A.3.4.

The individual processes are described in terms of Process Name, Process Purpose, and Process Outcomes as defined in ISO/IEC 29110-4-1 (PRM).

In addition, the process dimension of the PAM provides information in the form of the following:

a) a set of base practices for the process providing a definition of the tasks and activities needed to accomplish the process purpose and fulfil the process outcomes; each base practice is explicitly associated to a process outcome;

b) a number of input and output work products associated with each process and related to one or more of its outcomes;

c) characteristics associated with each work product.

The process purposes, outcomes, the base practices, and the work products associated with the processes are included in this Clause. The work product characteristics are contained in A.3.6. The base practices and work products constitute the set of indicators of process performance.

The associated work products listed in this Clause can be used when reviewing potential inputs and outputs of an organization's process implementation.

The associated work products provide objective guidance for potential inputs and outputs to look for, and objective evidence supporting the assessment of a particular process. A documented assessment process and assessor judgment is needed to ensure that process context (application domain, business purpose, development methodology, size of the organization, etc.) is explicitly considered when using this information. This list should not be considered as a checklist of what each organization must have but rather as an example and starting point for considering whether, given the context, the work products are necessary and contributing to the intended purpose of the process.

These work products are identified with their work product identifier number as used in A.3.6.

A nomenclature for assessment indicators is defined in order to identify them unambiguously and relate them to the architecture of the model. The nomenclature for base practices facilitate the identification of the processes, the base practices that belong to each process.

Each practice is assigned an identifier consisting of a multi-part alphanumeric code.

Base practices used in this exemplar assessment model provide a definition of the tasks and activities needed to accomplish the process purpose and fulfill the process outcomes. A base practice is identified with the following sequence: PI.BPPN. Where the codes are the following:

— PI process identifier (2 letters) (e.g. PM for Project Management);

— BP the text "BP" used to signify Base Practice.

A.3.5.1 PM. Project Management

Table A.4 — Software project management process base practices indicators

Process ID	PM
Process Name	Project Management
Process Purpose	The purpose of the Project Management process is to establish and carry out in a systematic way the Tasks of the software implementation project, which allows complying with the project's Objectives in the expected quality, time and costs.
Process Outcomes	a) the scope of the work for the project shall be defined; b) the tasks and resources necessary to complete the work shall be estimated (schedule, effort, cost, duration); c) planning for the execution of the project shall be developed according to the scope and the tasks defined; d) a software version control strategy shall be developed; e) planning shall be reviewed and agreed by the customer; f) progress of the project against the planning shall be monitored and reported; g) risks shall be identified and monitored during the conduct of the project; h) changes shall be addressed, analysed and evaluated for cost, schedule and technical impact; i) relevant items of software configuration shall be identified and controlled including their storage, baseline, handling, and modifications; j) releases of items shall be controlled and made available to relevant stakeholders; k) product shall be completed and delivered to the customer as planning; l) meetings with the work team and the customer shall be held to guarantee that work done complies with the project requirements and planning ; m) agreements resulting from meetings shall be registered and tracked; n) actions to correct planning problems and unachieved targets (schedule, effort, cost, duration) shall be taken; o) project closure shall be performed to get the customer acceptance;
Base Practice	PM.BP1 Review the Statement of Work [Outcome: a] PM.BP2 Define with the Customer the Delivery Instructions of each one of the Deliverables specified in the Statement of Work. [Outcome: e] PM.BP3 Identify the specific Tasks to be performed in order to produce the Deliverables and their Software Components identified in the Statement of Work. Include Tasks in the SI process along with verification, validation, and reviews with Customer and Work Team Tasks to ensure the quality of work products. Identify the Tasks to perform the Delivery Instructions. Document the Tasks. [Outcome: b] PM.BP4 Establish the Estimated Duration to perform each task. [Outcome: b] PM.BP5 Identify and document the Resources: human, material, equipment, and tools, standards, including the required training of the Work Team to perform the project. Include in the schedule the dates when Resources and training will be needed. [Outcome: b] PM.BP6 Establish the Composition of Work Team assigning roles and responsibilities according to the Resources. [Outcome: b]

Table A.4 *(continued)*

Process ID	PM
	PM.BP7 Assign estimated start and completion dates to each one of the Tasks in order to create the Schedule of the Project Tasks taking into account the assigned Resources, sequence and dependency of the Tasks. [Outcome: b] PM.BP8 Calculate and document the project Estimated Effort and Cost. [Outcome: b] PM.BP9 Identify and document the risks which may affect the project. [Outcome: g] PM.BP10 Document the Version Control Strategy in the Project Plan. [Outcome: d] PM.BP11 Generate the Project Plan integrating the elements previously identified and documented. [Outcome: c] PM.BP12 Include Product Description, Scope, Objectives, and Deliverables in the Project Plan. [Outcome: c] PM.BP13 Verify and obtain approval of the Project Plan. Verify that all Project Plan elements are viable and consistent. The results found are documented in a Verification Results and corrections are made until the document is approved by PM. [Outcome: c] PM.BP14 Review and accept the Project Plan. Customer reviews and accepts the Project Plan, making sure that the Project Plan elements match with the Statement of Work. [Outcome: e] PM.BP15 Establish the Project Repository using the Version Control Strategy. [Outcome: d] PM.BP16 Monitor the Project Plan execution and record actual data in Progress Status Record. [Outcome: e] PM.BP17 Analyse and evaluate the Change Request for cost, schedule and technical impact. The Change Request can be initiated externally by the Customer or internally by the Work Team. Update the Project Plan, if the accepted change does not affect agreements with Customer. Change Request, which affects those agreements, needs to be negotiated by both parties (see PM.2.4) [Outcome: h] PM.BP18 Conduct revision meetings with the Work Team, identify problems, review risk status, record agreements, and track them to closure. [Outcome: l, m] PM.BP19 Conduct revision meetings with the Customer, record agreements and track them to closure. Change Request initiated by Customer or initiated by Work Team, which affects the Customer, needs to be negotiated to reach acceptance of both parties. If necessary, update the Project Plan according to new agreement with Customer. [Outcome: l, m] PM.BP20 Perform backup according to the Version Control Strategy. [Outcome: i] PM.BP21 Perform Project Repository recovery using the Project Repository Backup, if necessary. [Outcome: i] PM.BP22 Evaluate project progress with respect to the Project Plan, comparing: — actual Tasks against planned Tasks; — actual results against established project Objectives; — actual resource allocation against planned Resources; — actual cost against budget estimates; — actual time against planned schedule; — actual risk against previously identified. [Outcome: e] PM.BP23 Establish actions to correct deviations or problems and identified risks concerning the accomplishment of the plan, as needed, document them in Correction Register and track them to closure. [Outcome: n] PM.BP24 Identify changes to requirements and/or Project Plan to address major deviations, potential risks or problems concerning the accomplishment of the plan, document them in Change Request and track them to closure. [Outcome: h, i]

Table A.4 *(continued)*

Process ID	PM
	PM.BP25 Formalize the completion of the project according to the Delivery Instructions established in the Project Plan, providing acceptance support and getting the Acceptance Record signed. [Outcome: o] PM.BP26 Update Project Repository. [Outcome: i, j] PM.BP27 Perform delivery according to Delivery Instructions. [Outcome: k]

Table A.5 — Software project management process work products indicators

Work Products	
Inputs	Outputs
	1 Acceptance Record [Outcome: o]
2 Change Request [Outcome: i, h]	2 Change Request [Outcome: g, h, i, m]
3 Correction register [Outcome: l, m]	3 Correction register [Outcome: h]
4 Delivery instructions [Outcome: k]	4 Delivery instructions [Outcome: a]
	6 Meeting Record [Outcome: e, l, m]
7 Project status record [Outcome: e, h, i, l, m, n]	7 Project status record [Outcome: e]
8 Project Plan [Outcome: d, e, g, i, k, l, m, o]	8 Project Plan [Outcome: b, c, e, g, i, l, m]
9 Project Repository [Outcome: k]	9 Project Repository [Outcome: d, j]
	10 Project repository backup [Outcome: i]
14 Software Configuration [Outcome: k, o]	14 Software Configuration [Outcome: g, j]
16 Statement of Work [Outcome: a, b]	
	20 Verification results [Outcome: e]
22 Version control strategy [Outcome: c, d, j]	22 Version control strategy [Outcome: d]

A.3.5.2 SI. Software Implementation

Table A.6 — Software Implementation process base practices indicators

Process ID	SI
Process Name	Software Implementation
Process Purpose	The purpose of the Software Implementation process is the systematic performance of the analysis, design, construction, integration, and tests activities for new or modified software products according to the specified requirements.

Table A.6 *(continued)*

Process ID	SI
Process Outcomes	a) software requirements shall be defined; b) software requirements shall be analysed for correctness and testability; c) software requirements shall be agreed by the customer; d) software requirements shall be baselined and communicated to work team and customer; e) software architectural and detailed design shall be developed and baselined; f) software architectural and detailed design shall describe the software components and their internal and external interfaces; g) software components defined by the detailed design shall be produced; h) unit test shall be performed to verify the consistency with requirements and the detailed design; i) software shall be produced by integrating software components; j) software shall be tested and verified, the results shall be recorded; k) consistency and traceability between software requirements, software architectural, software detailed design and software components shall be established; l) defects identified in reviews, traceability analysis, tests and verifications shall be corrected; m) software configuration shall be integrated, baselined and stored in the project repository;
Base Practice	SI.BP1 Document or update the Requirements Specification. Identify and consult information sources (Customer, users, previous systems, documents, etc.) in order to get new requirements. Analyse the identified requirements to determinate the Scope and feasibility. Generate or update the Requirements Specification [Outcome: a, b] SI.BP2 Verify and obtain approval of the Requirements Specification. Verify the correctness and testability of the Requirements Specification and its consistency with the Product Description. Additionally, review that requirements are complete, unambiguous, and not contradictory. The results found are documented in a Verification Results and corrections are made until the document is approved by AN. If significant changes were needed, initiate a Change Request. [Outcome: b] SI.BP3 Validate and obtain approval of the Requirements Specification Validate that Requirements Specification satisfies needs and agreed upon expectations, including the user interface usability. The results found are documented in a Validation Results and corrections are made until the document is approved by the CUS. [Outcome: c] SI.BP4 Incorporate the requirements specification to the software configuration in the baseline [Outcome: d] SI.BP5 Document or update the Software Design. Analyse the Requirements Specification to generate the architectural design, its arrangement in subsystems and Software Components defining the internal and external interfaces. Describe in detail, the appearance and the behaviour of the interface, based on the Requirements Specification in a way that Resources for its implementation can be foreseen. Provide the detail of Software Components and their interfaces to allow the construction in an evident way. Generate or update the Traceability Record. [Outcome: e, f, k] SI.BP6 Verify and obtain approval of the Software Design.

Table A.6 *(continued)*

Process ID	SI
	Verify correctness of Software Design documentation, its feasibility and consistency with their Requirement Specification. Verify that the Traceability Record contains the adequate relationships between requirements and the Software Design elements. The results found are documented in a Verification Results and corrections are made until the document is approved by DES. If significant changes were needed, initiate a Change Request. [Outcome: f]
	SI.BP7 Establish or update Test Cases and Test Procedures for integration testing based on Requirements Specification and Software Design. Customer provides testing data, if needed. [Outcome: j]
	SI.BP8 Verify and obtain approval of the Test Cases and Test Procedures. Verify consistency among Requirements Specification, Software Design and Test Cases and Test Procedures. The results found are documented in a Verification Results and corrections are made until the document is approved. [Outcome: j]
	SI.B9 Update the Traceability Record incorporating the Test Cases and Test Procedures. [Outcome: j, k]
	SI.BP10 Incorporate the Software Design, and Traceability Record to the Software Configuration as part of the baseline. Incorporate the Test Cases, and Test Procedures to the Project Repository. [Outcome: k, m]
	SI.BP11 Construct or update Software Components based on the detailed part of the Software Design. [Outcome: g]
	SI.BP12 Design or update unit test cases and apply them to verify that the Software Components implements the detailed part of the Software Design. [Outcome: h]
	SI.BP13 Correct the defects found until successful unit test (reaching exit criteria) is achieved. [Outcome: h]
	SI.BP14 Update the Traceability Record incorporating Software Components constructed or modified. [Outcome: k]
	SI.BP15 Incorporate Software Components and Traceability Record to the Software Configuration as part of the baseline. [Outcome: k, m]
	SI.BP16 Integrates the Software using Software Components and updates Test Cases and Test Procedures for integration testing, as needed. [Outcome: i, j
	SI.BP17 Perform Software tests using Test Cases and Test Procedures for integration and document results in Test Report. [Outcome: j]
	SI.BP18 Correct the defects found and perform regression test until exit criteria is achieved. [Outcome: l]
	SI.BP19 Updates the Traceability Record, if appropriate. [Outcome: k]
	SI.BP20 Incorporate the Test Cases and Test Procedures, Software, Traceability Record, Test Report to the Software Configuration as part of the baseline. [Outcome: m]
	SI.BP21 Document the Maintenance Documentation or update the current one. [Outcome: m]
	SI.BP22 Verify and obtain approval of the Maintenance Documentation.
	Verify consistency of Maintenance Documentation with Software Configuration. The results found are documented in a Verification Results and corrections are made until the document is approved. [Outcome: m]
	SI.BP23 Incorporate the Maintenance Documentation as baseline for the Software Configuration. [Outcome: m]

Table A.7 — Software Implementation process work products indicators

Work Products	
Inputs	Outputs
	2 Change Request [Outcome: b, f]
	5 Maintenance Documentation [Outcome: m]
8 Project Plan [Outcome: a, b]	
11 Requirements Specification [Outcome: b, c, d, e, f, j, k]	11 Requirements Specification [Outcome: a, b, c]
12 Software [Outcome: j, k, l, m]	12 Software [Outcome: i, j, l]
13 Software components [Outcome: h, j, k, m]	13 Software components [Outcome: g, h]
14 Software Configuration [Outcome: m]	14 Software Configuration [Outcome: d, k, m]
15 Software Design [Outcome: g, j, k, m]	15 Software Design [Outcome: e, f]
17 Test cases and test procedures [Outcome: j, l, m]	17 Test cases and test procedures [Outcome: j]
18 Test report [Outcome: l, m]	18 Test report [Outcome: j, l]
19 Traceability Record [Outcome: g, j, k, l, m]	19 Traceability Record [Outcome: k]
	20 Verification results [Outcome: b, f, j, m]
	21 Validation results [Outcome: c]

A.3.6 Work product characteristics

Work product characteristics listed in A.3.6 can be used when reviewing potential inputs and outputs of process implementation. The characteristics are provided as guidance for the attributes to look for, in a particular sample work product, to provide objective evidence supporting the assessment of a particular process. A documented process and assessor judgment is needed to ensure that the process context (application domain, business purpose, development methodology, size of the organization, etc.) is considered when using this information. Work products and their characteristics should be considered as a starting point for considering whether, given the context, they are contributing to the intended purpose of the process, not as a check-list of what every organization must have.

Table A.8 — Work product identification

WP ID	WP Name	WP Characteristics
1	Acceptance record	Documents the Customer acceptance of the Deliverables of the project. It can have the following characteristics: — record of the receipt of the delivery; — identifies the date received; — identifies the delivered elements; — records the verification of any Customer acceptance criteria defined; — identifies any open issues (if applicable);— signed by receiving Customer.
2	Change request	Identifies a Software, or documentation problem or desired improvement, and requests modifications. It can have the following characteristics: — Identifies purpose of change; — Identifies request status (new, accepted, rejected); — Identifies requester contact information; — Impacted system(s); — Impact to operations of existing system(s) defined;