

Information technology — Process Assessment —

Part 5: An exemplar Process Assessment Model

ICS 35.080

National foreword

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Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii to vi, pages 1 to 162, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 April 2006

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INTERNATIONAL STANDARD

ISO/IEC 15504-5

First edition
2006-03-01

Information technology — Process Assessment —

Part 5: An exemplar Process Assessment Model

Technologies de l'information — Évaluation des processus —

Partie 5: Un exemple de modèle d'évaluation de processus



Reference number
ISO/IEC 15504-5:2006(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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.

ISO/IEC 15504-5 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and system engineering*.

This first edition cancels and replaces ISO/IEC TR 15504-5:1998, which has been technically revised.

ISO/IEC 15504 consists of the following parts, under the general title *Information technology — Process Assessment*:

- *Part 1: Concepts and vocabulary*
- *Part 2: Performing an assessment*
- *Part 3: Guidance on performing an assessment*
- *Part 4: Guidance on use for process improvement and process capability determination*
- *Part 5: An exemplar Process Assessment Model*

The complete series replaces ISO/IEC TR 15504-1 to ISO/IEC TR 15504-9.

This Part of ISO/IEC 15504 is informative.

Introduction

This part of ISO/IEC 15504 provides an example of a Process Assessment Model for use in performing a conformant assessment in accordance with the requirements of ISO/IEC 15504-2.

An integral part of conducting an assessment is to use a Process Assessment Model constructed for that purpose, related to a Process Reference Model and conformant with the requirements defined in ISO/IEC 15504-2. ISO/IEC 15504-2 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 Process Reference Model 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 Process Reference Model need to be supported with a comprehensive set of indicators of process performance; and
- the capability levels and process attributes defined in ISO/IEC 15504-2 and its associated rating scale 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 in Part 5 contains a set of indicators to be considered when interpreting the intent of the Process Reference Model. These indicators may also be used when implementing a process improvement program or to help evaluate and select an assessment model, method, methodology or tools.

The Process Reference Model defined in ISO/IEC 12207 AMD1 and AMD2 has been used as the basis for the Process Assessment Model in this part.

As an exemplar, this Process Assessment Model embodies the core characteristics that could be expected of any Process Assessment Model consistent with ISO/IEC 15504-2. Nevertheless, use of this Process Assessment Model is not required to meet the requirements of ISO/IEC 15504; any other Process Assessment Models meeting the requirements of ISO/IEC 15504-2 may be used in a conformant assessment.

Within this part of ISO/IEC 15504:

- Clause 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;
- Clause 5 addresses the process dimension. It uses process definitions from ISO/IEC 12207 AMD1 and AMD2 to identify a Process Reference Model. The processes of the Process Reference Model are described in the Process Assessment Model in terms of purpose and outcomes and are grouped in three process categories. The Process Assessment Model expands the Process Reference Model process definitions by including a set of process performance indicators called base practices for each process. The Process Assessment Model also defines a second set of indicators of process performance by associating work products with each process. Annex B is also linked directly to clause 5 as it defines the work product characteristics;
- Clause 6 addresses the capability dimension. It duplicates the definitions of the capability levels and process attributes from ISO/IEC 15504-2, and expands each of the 9 attributes through the inclusion of a set of generic practices. These generic practices belong to a set of indicators of process capability, in association with generic resource indicators, and generic work product indicators;

- Annex A provides a statement of conformance of the Process Assessment Model to the requirements defined in ISO/IEC 15504-2;
- Annex B provides selected characteristics for typical work products to assist the assessor in evaluating the capability level of processes;
- Annex C contains style guides for defining base practices, work products and generic practices for adjusting the Process Assessment Model, and guidance explaining how to expand or adapt the model; and
- The Bibliography contains a list of informative references.

Information technology — Process Assessment —

Part 5: An exemplar Process Assessment Model

1 Scope

This informative part of ISO/IEC 15504:

- defines an exemplar Process Assessment Model that meets the requirements of ISO/IEC 15504-2 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 12207 AMD1 and AMD2 and the process attributes as defined in ISO/IEC 15504-2;
- provides guidance, by example, on the definition, selection and use of assessment indicators.

A Process Assessment Model 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 this part of ISO/IEC 15504 is not intended to be an all-inclusive set nor is it intended to be applicable in its entirety. Subsets that are appropriate to the context and scope of the assessment should be selected, and possibly augmented with additional indicators (see Annex C).

The Process Assessment Model in this part of ISO/IEC 15504 is directed at assessment sponsors and competent assessors who wish to select a model, and associated documented process method, for assessment (for either capability determination or process improvement). Additionally it may 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 Process Assessment Model meeting the requirements defined in ISO/IEC 15504-2 concerning models for process assessment may be used for assessment. Different models and methods may be needed to address differing business needs. The assessment model in this part of ISO/IEC 15504 is provided as an exemplar of a model meeting all the requirements expressed in ISO/IEC 15504-2.

NOTE **Copyright release for the Exemplar Process Assessment Model:** Users of this part of ISO/IEC 15504 may freely reproduce the detailed descriptions contained in the exemplar 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.

2 Normative references

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

ISO/IEC 12207:1995/Amd.1:2002; Amd.2:2004, *Information technology — Software life cycle processes*

ISO/IEC 15504-1:2004, *Information technology — Process assessment — Part 1: Concepts and vocabulary*

ISO/IEC 15504-2:2003, *Information technology — Process assessment — Part 2: Performing an assessment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 15504-1 apply.

4 Overview of the exemplar Process Assessment Model

4.1 Introduction

This part of ISO/IEC 15504 provides an exemplar Process Assessment Model that includes examples of assessment indicators.

The Process Reference Model defined in ISO/IEC 12207 AMD1 and AMD2, associated with the process attributes defined in ISO/IEC 15504-2, establish a Process Assessment Model 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 Process Assessment Model is a two-dimensional model of process capability. In one dimension, the process dimension, the processes are defined and classified into process categories. 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.

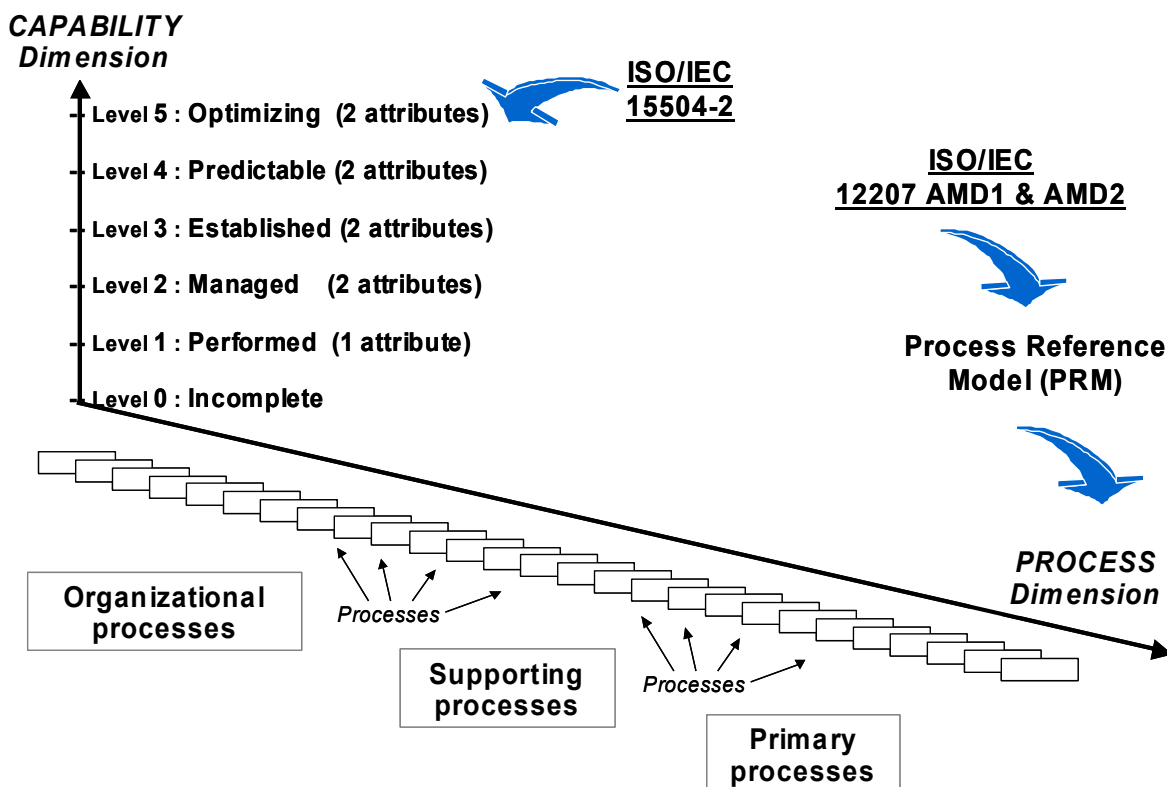


Figure 1 — Relationship between the Process Assessment Model and its inputs

Figure 1 shows the relationship between the general structure of the Process Assessment Model, ISO/IEC 15504-2 and ISO/IEC 12207 AMD1 and AMD2.

The Process Reference Model and the capability dimension defined in ISO/IEC 15504-2 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 Process Reference Model, and the process attribute definitions in ISO/IEC 15504-2, need to be supported with a comprehensive set of indicators of process performance and process capability that are used for assessment performance.

The exemplar Process Assessment Model defined in this part of ISO/IEC 15504 is conformant with the ISO/IEC 15504-2 requirements for a Process Assessment Model, and can be used as the basis for conducting an assessment of software engineering process capability.

In order to meet the requirements of ISO/IEC 15504-2, a documented process supporting other requirements of ISO/IEC 15504-2 is also required. This need may be met, for example, by the adoption of a supporting method for conducting assessments.

4.2 Structure of the exemplar Process Assessment Model

This clause describes the detailed structure of the Process Assessment Model and its key components.

This Process Assessment Model expands upon the Process Reference Model 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.

Clause 5, together with its associated Annex B, describes the components of the process dimension, and Clause 6 describes the components of the capability dimension. Annex A provides a demonstration of conformity that meets the requirements of ISO/IEC 15504-2.

ISO/IEC 15504-2 requires that processes included in a Process Reference Model satisfy the following:

"The fundamental elements of a Process Reference Model are the set of descriptions of the processes within the scope of the model. These process descriptions shall meet the following requirements:

- a) A process shall be described in terms of its Purpose and Outcomes.*
- b) In any description the set of process outcomes shall be necessary and sufficient to achieve the purpose of the process.*
- c) Process descriptions shall be such that no aspects of the measurement framework as described in clause 5 of this International Standard beyond level 1 are contained or implied."*

As processes are derived directly from ISO/IEC 12207 AMD1 and AMD2, these requirements are satisfied.

The Process Assessment Model includes processes, which are grouped in three process categories, identical to the process categories defined in ISO/IEC 12207 AMD1 and AMD2, which are:

- the Primary life cycle processes category;
- the Supporting life cycle processes category;
- the Organizational life cycle processes category.

Within a process category, processes are grouped at a second level according to the type of activity they address: the processes included in the same group contribute to a complementary area. These groups are defined in order to help assessors in defining the assessment scope in term of process selection.

4.2.1 Processes

Figure 2 lists the processes from ISO/IEC 12207 AMD1 and AMD2 that are included in the process dimension of the exemplar Process Assessment Model, and show their classification (for the purpose of this Process Assessment Model) into Process Categories and Process Groups.

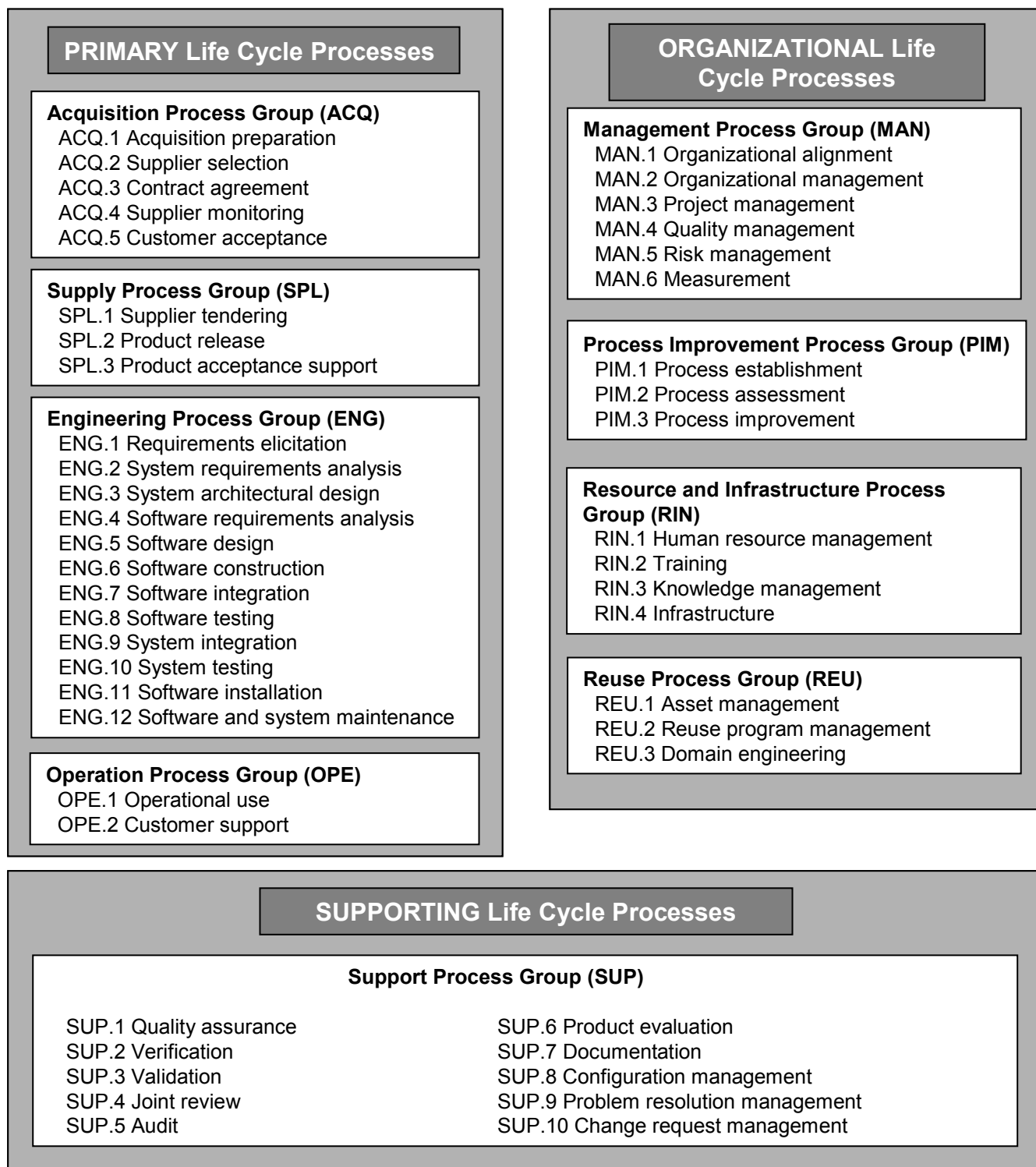


Figure 2 — Process Categories and Process Groups

The description of each Process Group includes a characterization of the processes it contains, followed by a list of the processes. Each process belonging to a Group is identified with a Process Identifier [ID] consisting of the Group abbreviated name and a sequential number of the process in that Group.

The Process Categories and Process Groups are described in more detail below.

4.2.1.1 Primary Life Cycle Processes Category

The **Primary Life Cycle Processes** consist of processes that serve primary parties during the life cycle of software. A primary party is one that initiates or performs the development, operation, or maintenance of software products. These primary parties are the acquirer, the supplier, the developer, the operator, and the maintainer of software products.

The Primary Life Cycle Processes Category contains the following four groups of processes:

- the Acquisition process group;
- the Supply process group;
- the Engineering process group;
- the Operation process group.

The **Acquisition** process group (ACQ) consists of processes performed by the customer, in order to acquire a product and/or a service.

Note: A supplier may also act as a customer when acquiring a product and/or service from another supplier.

This group includes the processes listed in Table 1.

Table 1 — Primary Life Cycle Processes – Acquisition process group

Process Identification	Process name	Source
ACQ.1	Acquisition preparation	ISO/IEC 12207 AMD1
ACQ.2	Supplier selection	ISO/IEC 12207 AMD1
ACQ.3	Contract agreement	ISO/IEC 12207 AMD2
ACQ.4	Supplier monitoring	ISO/IEC 12207 AMD1
ACQ.5	Customer acceptance	ISO/IEC 12207 AMD1

The **Supply** process group (SPL) consists of processes performed by the supplier in order to propose and deliver a product and/or a service.

Table 2 — Primary Life Cycle Processes – Supply process group

Process Identification	Process name	Source
SPL.1	Supplier tendering	ISO/IEC 12207 AMD2
SPL.2	Product release	ISO/IEC 12207 AMD2
SPL.3	Product acceptance support	ISO/IEC 12207 AMD2

This group includes the processes listed in Table 2.

The **Engineering** process group (ENG) consists of processes that directly elicit and manage the customer's requirements, specify, implement, and/or maintain the software product and its relation to the system.

This group includes the processes listed in Table 3.

Table 3 — Primary Life Cycle Processes – Engineering process group

Process Identification	Process name	Source
ENG.1	Requirements elicitation	ISO/IEC 12207 AMD1
ENG.2	System requirements analysis	ISO/IEC 12207 AMD1
ENG.3	System architectural design	ISO/IEC 12207 AMD1
ENG.4	Software requirements analysis	ISO/IEC 12207 AMD1
ENG.5	Software design	ISO/IEC 12207 AMD1
ENG.6	Software construction	ISO/IEC 12207 AMD1
ENG.7	Software integration	ISO/IEC 12207 AMD1
ENG.8	Software testing	ISO/IEC 12207 AMD1
ENG.9	System integration	ISO/IEC 12207 AMD1
ENG.10	System testing	ISO/IEC 12207 AMD1
ENG.11	Software installation	ISO/IEC 12207 AMD1
ENG.12	Software and system maintenance	ISO/IEC 12207 AMD1

The **Operation** process group (OPE) consists of processes performed in order to provide for the correct operation and use of the software product and/or service.

This group includes the processes listed in Table 4.

Table 4 — Primary Life Cycle Processes – Operation process group

Process Identification	Process name	Source
OPE.1	Operational use	ISO/IEC 12207 AMD1
OPE.2	Customer support	ISO/IEC 12207 AMD1

4.2.1.2 Supporting Life Cycle Processes Category

The **Supporting Life Cycle Processes** consist of processes that support another process as an integral part with a distinct purpose and contributes to the success and quality of the software project. A supporting process is employed and executed, as needed, by another process.

This group includes the processes listed in Table 5.

Table 5 — Supporting Life Cycle Processes - Support process group

Process Identification	Process name	Source
SUP.1	Quality assurance	ISO/IEC 12207 AMD1
SUP.2	Verification	ISO/IEC 12207 AMD1
SUP.3	Validation	ISO/IEC 12207 AMD1
SUP.4	Joint review	ISO/IEC 12207 AMD1
SUP.5	Audit	ISO/IEC 12207 AMD1
SUP.6	Product evaluation	ISO/IEC 12207 AMD1
SUP.7	Documentation	ISO/IEC 12207 AMD1
SUP.8	Configuration management	ISO/IEC 12207 AMD2
SUP.9	Problem resolution management	ISO/IEC 12207 AMD2
SUP.10	Change request management	ISO/IEC 12207 AMD2

NOTE The Usability process in ISO/IEC 12207 is not included. Where usability is a relevant attribute, or human engineering is a customer or product requirement, ISO TR 18529 provides a definition of human-centred design processes that complies with the requirements of ISO/IEC 15504-2.

4.2.1.3 Organizational Life Cycle Processes Category

The **Organizational Life Cycle Processes** consist of processes employed by an organization to establish and implement an underlying structure made up of associated life cycle processes and personnel and continuously improve the structure and processes. They are typically employed outside the realm of specific projects and contracts; however, lessons from such projects and contracts contribute to the improvement of the organization.

The Organizational Life Cycle Processes Category contains the following four groups of processes:

- the Management process group;
- the Process Improvement process group;
- the Resource and Infrastructure process group; and
- the Reuse process group.

The **Management** process group (MAN) consists of processes that contain practices that may be used by anyone who manages any type of project or process within a software life cycle.

This group includes the processes listed in Table 6.

Table 6 — Organizational Life Cycle Processes - MAN process group

Process Identification	Process name	Source
MAN.1	Organizational alignment	ISO/IEC 12207 AMD1
MAN.2	Organizational management	ISO/IEC 12207 AMD1
MAN.3	Project management	ISO/IEC 12207 AMD1
MAN.4	Quality management	ISO/IEC 12207 AMD1
MAN.5	Risk management	ISO/IEC 12207 AMD2
MAN.6	Measurement	ISO/IEC 12207 AMD1

The **Process Improvement** process group (PIM) consists of processes performed in order to define, deploy, assess and improve the processes performed in the organizational unit.

This group includes the processes listed in Table 7.

Table 7 — Organizational Life Cycle Processes - PIM process group

Process Identification	Process name	Source
PIM.1	Process establishment	ISO/IEC 12207 AMD1
PIM.2	Process assessment	ISO/IEC 12207 AMD1
PIM.3	Process improvement	ISO/IEC 12207 AMD2

The **Resource and Infrastructure** process group (RIN) consists of processes performed in order to provide adequate human resources and necessary infrastructure as required by any other process performed by the organizational unit.

This group includes the processes listed in Table 8.

Table 8 — Organizational Life Cycle Processes - RIN process group

Process Identification	Process name	Source
RIN.1	Human resource management	ISO/IEC 12207 AMD1
RIN.2	Training	ISO/IEC 12207 AMD1
RIN.3	Knowledge management	ISO/IEC 12207 AMD1
RIN.4	Infrastructure	ISO/IEC 12207 AMD2

The **Reuse** process group (REU) consists of processes performed in order to systematically exploit reuse opportunities in the organization's reuse programmes.

This group includes the processes listed in Table 9.

Table 9 — Organizational Life Cycle Processes - REU process group

Process Identification	Process name	Source
REU.1	Asset management	ISO/IEC 12207 AMD1
REU.2	Reuse program management	ISO/IEC 12207 AMD2
REU.3	Domain engineering	ISO/IEC 12207 AMD1

4.2.2 Process dimension

For the process dimension, all the processes in Figure 2 are included within the process dimension of the Process Assessment Model. The processes are classified into Process Categories and Process Groups. There are three Process Categories: Primary Life Cycle Processes, Organizational Life Cycle Processes and Supporting Life Cycle Processes. Each process in the Process Assessment Model 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 1 process capability where the expected outcomes are observable. The Process Groups and their associated processes are described in Clause 5.

4.2.3 Capability dimension

For the capability dimension, the process capability levels and process attributes are identical to those defined in ISO/IEC 15504-2.

Evolving process capability is expressed in the Process Assessment Model 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 ISO/IEC 15504-2.

There are six capability levels, incorporating nine process attributes.

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 1: Performed process

The implemented process achieves its process purpose.

Level 2: Managed process

The previously described Performed process is now implemented in a managed fashion (planned, monitored and adjusted) and its work products are appropriately established, controlled and maintained.

Level 3: Established process

The previously described Managed process is now implemented using a defined process that is capable of achieving its process outcomes.

Level 4: Predictable process

The previously described Established process now operates 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.

Within the Process Assessment Model, the measure of capability is based upon the nine process attributes (PA) defined in ISO/IEC 15504-2. 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 10.

Table 10 — Capability levels and process attributes

Process Attribute ID	Capability Levels and Process Attributes
	Level 0: Incomplete process
	Level 1: Performed process
PA 1.1	Process performance
	Level 2: Managed process
PA 2.1	Performance management
PA 2.2	Work product management
	Level 3: Established process
PA 3.1	Process definition
PA 3.2	Process deployment
	Level 4: Predictable process
PA 4.1	Process measurement
PA 4.2	Process control
	Level 5: Optimizing process
PA 5.1	Process innovation
PA 5.2	Continuous optimization

The process attributes are evaluated on a four point ordinal scale of achievement, as defined in ISO/IEC 15504-2. They provide insight into the specific aspects of process capability required to support process improvement and capability determination.

4.3 Assessment Indicators

The Process Assessment Model 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 are two types of assessment indicators: process capability indicators, which apply to capability levels 1 to 5 and process performance indicators, which apply exclusively to capability level 1. These indicators are defined in Clause 4.3.2.

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 capability indicators are:

- Generic Practice (GP);
- Generic Resource (GR);
- Generic Work Product (GWP).

As additional indicators for supporting the assessment of a process at Level 1, each process in the process dimension has a set of process performance indicators which is used to measure the degree of achievement of the process performance attribute for the process assessed.

The process performance indicators are:

- 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.

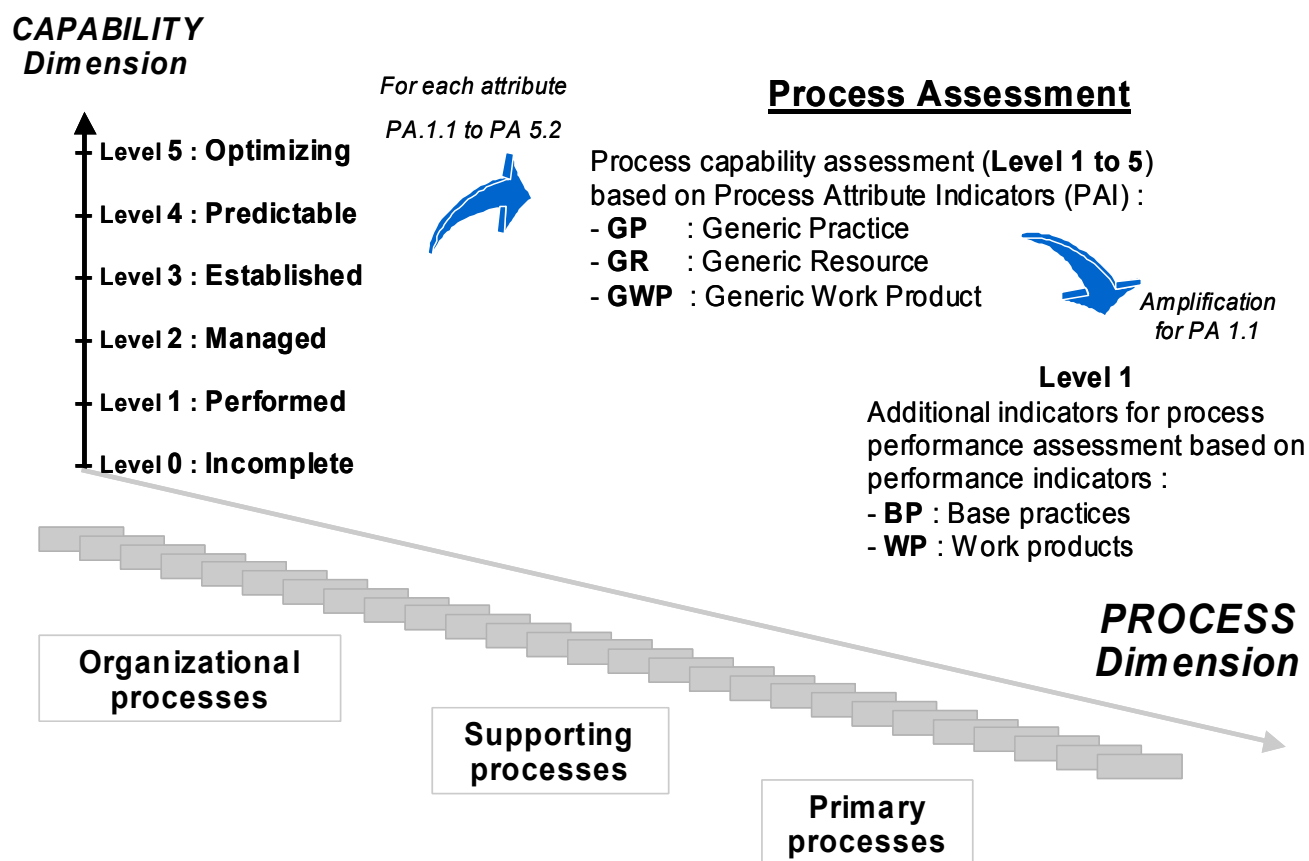


Figure 3 — Assessment indicators

The process performance and process capability indicators defined in the Process Assessment Model 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 3 shows how the assessment indicators are related to process performance and process capability.

4.3.1 Process Capability Indicators

The three types of process capability indicators related to levels 1 to 5 are identified in Figure 4. They are intended to be applicable to all processes.

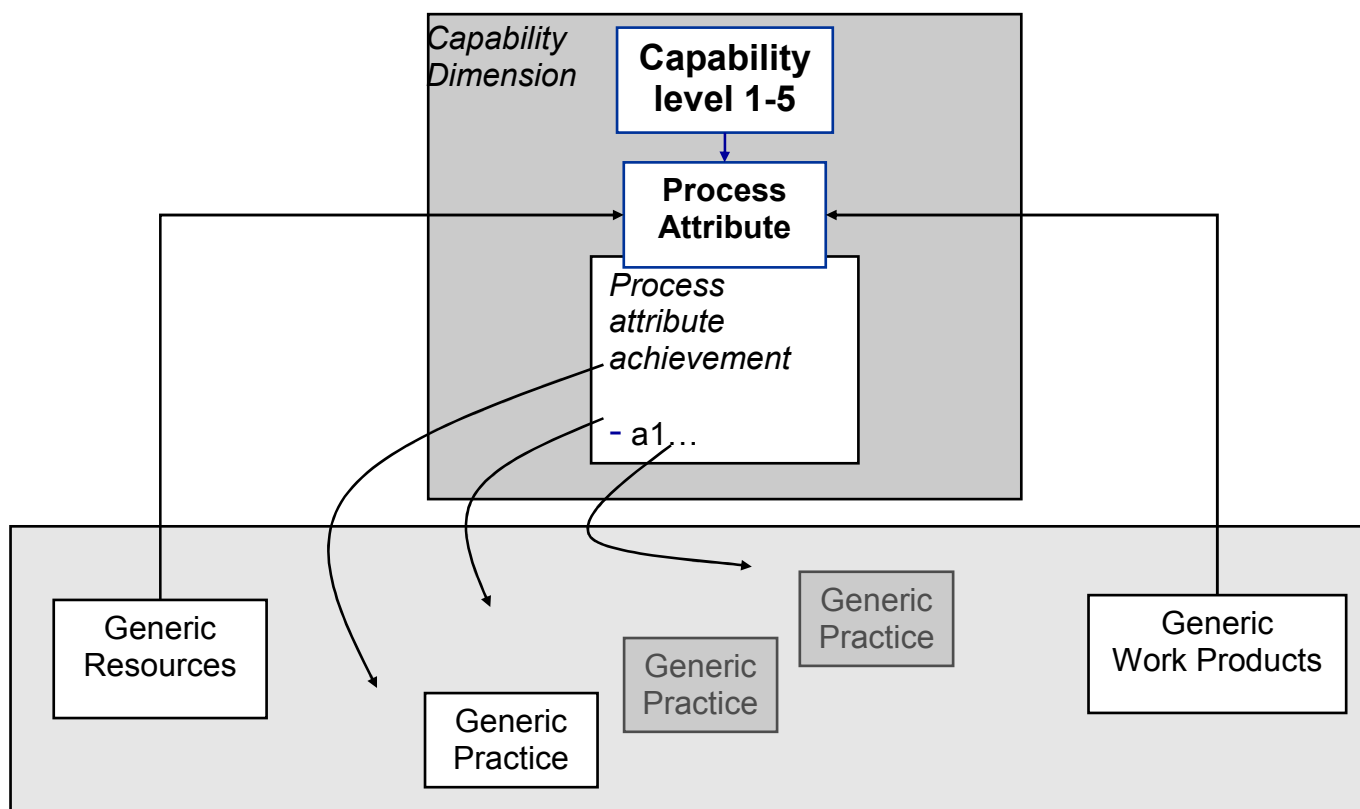


Figure 4 — Process capability indicators

All the process capability indicators relate to the process attributes defined in the capability dimension of the Process Assessment Model. They represent the type of evidence that would support judgments of the extent to which the attributes are achieved. Evidence of their effective performance or existence supports the judgment of the degree of achievement of the attribute. The generic practices are the principal indicators of process capability.

The **Generic Practice (GP)** indicators are activities of a generic type and provide guidance on the implementation of the attribute's characteristics. They support the achievement of the process attribute and many of them concern management practices, i.e. practices that are established to support the process performance as it is characterized at level 1.

During the evaluation of process capability, the primary focus is on the performance of the generic practices. In general, performance of all generic practices is expected for full achievement of the process attribute.

The **Generic Resource (GR)** indicators are associated resources that may be used when performing the process in order to achieve the attribute. These resources may include human resources, tools, methods and infrastructure. The availability of a resource indicates the potential to fulfil the purpose of a specific attribute.

NOTE The assessor should interpret the generic resources according to the process assessed; e.g. for PA2.1 resources (with identified objectives, responsibilities and authorities), an assessor would look for roles (with identified objectives, responsibilities and authorities) in primary and supporting processes, but for organisational processes would look for governance structures (e.g. mandated committees, positions) with identified objectives, responsibilities and authorities.

The **Generic Work Product (GWP)** indicators are sets of characteristics that would be expected to be evident in work products of generic types as a result of achievement of an attribute. The generic work products form the basis for the classification of the work products defined as process performance indicators; they represent basic types of work products that may be inputs to or outputs from all types of process.

These three types of indicators help to establish objective evidence of the extent of achievement of the specified process attribute.

Due to the fact that Level 1 capability of a process is only characterized by the measure of the extent to which the process purpose is achieved, the process performance attribute (PA.1.1) has a single generic practice indicator (GP.1.1.1). In order to support the assessment of PA.1.1 and to amplify the process performance achievement analysis, additional process performance indicators are defined in the Process Assessment Model.

4.3.2 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 may be used to identify the corresponding work product produced/used by the assessed organization.

Clause 5 contains a complete description of the processes, including the base practices and the associated work products.

Annex B.1 contains a list of generic work products together with the work product characteristics.

Annex B.2 contains a complete list of specific work products, with the generic work products for completeness. Similar to the concept of modularity in object orientation, the shared characteristics of a group of work products have been extracted into a generic work product. An assessor would refer to both the specific work product and the generic work product in the context of the specific work product (e.g. 02-01 Commitment / agreement characteristics + 02-00 Contract characteristics) when performing an assessment.

4.4 Measuring process capability

The process performance and process capability 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 5.

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 15504-2.

The output from a process assessment is a set of process profiles, one for each process within the scope of the assessment. A typical process profile is illustrated in ISO/IEC 15504-4. 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.

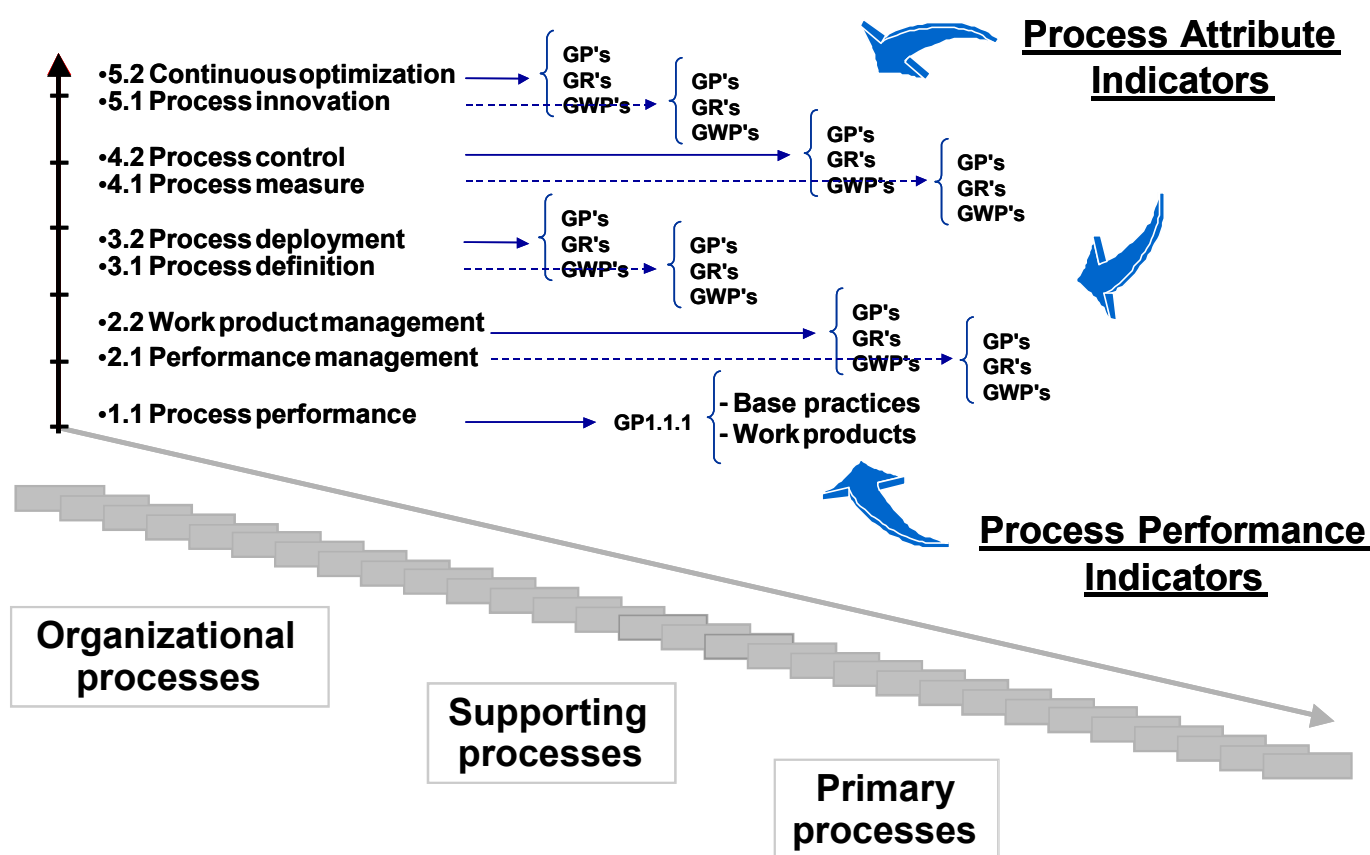


Figure 5 — Relationship between assessment indicators and process capability

5 The process dimension and process performance indicators (level 1)

This clause defines the processes and the process performance indicators, also known as the process dimension, of the Process Assessment Model. The processes in the process dimension can be directly mapped to the processes defined in the Process Reference Model.

The processes are classified (for the purpose of this Process Assessment Model) into Process Categories and Process Groups which are listed in Clause 4.

The individual processes are described in terms of Process Name, Process Purpose, and Process Outcomes as defined in ISO/IEC 12207 AMD1 and AMD2.

In addition, the process dimension of the Process Assessment Model provides information in the form of:

- 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; and
- 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 Annex B. The base practices and work products constitute the set of indicators of process performance.

The associated work products listed in this clause may 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 the Annex B.

5.1 The Acquisition Process Group (ACQ)

5.1.1 ACQ.1 Acquisition preparation

Process ID	ACQ.1
Process Name	Acquisition preparation
Process Purpose	The purpose of the Acquisition preparation process is to establish the needs and goals of the acquisition and to communicate these with the potential suppliers.
Process Outcomes	As a result of successful implementation of Acquisition preparation process: 1) the concept or the need for the acquisition, development, or enhancement is established; 2) the needed acquisition requirements defining the project needs are defined and validated; 3) the customer's known requirements are defined and validated; 4) an acquisition strategy is developed; and 5) supplier selection criteria are defined.
Base Practices	ACQ.1.BP1: Establish the need. Establish a need to acquire, develop, or enhance a system, software product or service. [Outcome: 1] ACQ.1.BP2: Define the requirements. Identify the customer / stakeholder requirements, including acceptance criteria, for a system and/or software product or service. [Outcome: 2, 3] ACQ.1.BP3: Review requirements. Analyze and validate the defined requirements against the identified needs. Validate the requirements to reduce risk of misunderstanding by the potential suppliers. [Outcome: 3] ACQ.1.BP4: Develop acquisition strategy. Develop a strategy for the acquisition of the product according to the acquisition needs. [Outcome: 4] NOTE: The strategy may include reference to the life cycle model, schedule, budget and selection criteria. ACQ.1.BP5: Define selection criteria. Establish and agree on supplier selection criteria and the means of evaluation to be used. [Outcome: 4, 5] ACQ.1.BP6 Communicate the need. Communicate the need for acquisition to interested parties through the identified channels. [Purpose; Outcome: 1]

Work Products	
Inputs	Outputs
05-02 Business Goals [Outcome: 1]	
	08-02 Acquisition plan [Outcome: 4]
	12-01 Request for proposal [Outcome: 4, 5]
	13-19 Review record [Outcome: 3]
	15-01 Analysis report [Outcome: 1, 2]
15-04 Market analysis report [Outcome: 2]	
15-19 Product needs assessment [Outcome: 1, 3, 4]	15-19 Product needs assessment [Outcome: 2, 3]
	17-03 Customer requirements [Outcome: 3]
	17-09 Product requirements [Outcome: 3]
	17-10 Service requirements [Outcome: 3]
	18-01 Acceptance criteria [Outcome: 2, 4]
	18-08 Supplier selection criteria [Outcome: 5]

5.1.2 ACQ.2 Supplier selection

Process ID	ACQ.2
Process Name	Supplier selection
Process Purpose	The purpose of the Supplier selection process is to choose the organization that is to be responsible for the delivery of the requirements of the project.
Process Outcomes	As a result of successful implementation of Supplier selection process: 1) the supplier selection criteria are established and used to evaluate potential suppliers; 2) the supplier is selected based upon the evaluation of the supplier's proposals, process capabilities, and other factors; and 3) an agreement is established and negotiated between the customer and the supplier.
Base Practices	ACQ.2.BP1: Evaluate stated or perceived supplier capability. Evaluate stated or perceived supplier capability against the stated requirements, according to the supplier selection criteria. [Outcome: 1] NOTE: See Acquisition preparation process (ACQ.1) for definition of supplier selection criteria. ACQ.2.BP2: Select supplier. Evaluate supplier's proposal against the stated requirements, according to the supplier selection criteria to select supplier. [Outcome: 2] ACQ.2.BP3: Prepare and negotiate agreement. Negotiate a supplier agreement that clearly expresses the customer expectations and the relative responsibilities of the supplier and customer. [Outcome: 3]

Work Products	
Inputs	Outputs
	02-01 Commitment / agreement [Outcome: 3]
	08-02 Acquisition plan [Outcome: 1]
09-04 Supplier selection policy [Outcome: 2]	09-04 Supplier selection policy [Outcome: 1]
12-01 Request for proposal [Outcome: 2]	
12-04 Supplier proposal response [Outcome: 2, 3]	
	13-04 Communication record [Outcome: 3]
	13-05 Contract review record [Outcome: 3]
13-09 Meeting support record [Outcome: 3]	13-09 Meeting support record [Outcome: 3]
	13-19 Review record [Outcome: 2]
	14-05 Preferred suppliers register [Outcome: 2]
	15-01 Analysis report [Outcome: 2]
15-13 Assessment report [Outcome: 2]	15-13 Assessment report [Outcome: 1]
	15-21 Supplier evaluation report [Outcome: 1, 2]
15-24 Audit report [Outcome: 2]	15-24 Audit report [Outcome: 1]
17-09 Product requirements [Outcome: 2]	
17-10 Service requirements [Outcome: 2]	
18-08 Supplier selection criteria [Outcome: 2]	18-08 Supplier selection criteria [Outcome: 1]

5.1.3 ACQ.3 Contract agreement

Process ID	ACQ.3
Process Name	Contract agreement
Process Purpose	The purpose of Contract agreement process is to negotiate and approve a contract / agreement that clearly and unambiguously specifies the expectations, responsibilities, work products / deliverables and liabilities of both the supplier(s) and the acquirer.
Process Outcomes	As a result of successful implementation of Contract agreement process: 1) a contract or agreement is negotiated, reviewed, approved and awarded to the supplier(s); 2) mechanisms for monitoring the capability and performance of the supplier(s) and for mitigation of identified risks are reviewed and considered for inclusion in the contract conditions; 3) proposers/tenderers are notified of the result of proposal/tender selection.
Base Practices	ACQ.3.BP1: Negotiate the contract / agreement. Negotiate all aspects of the contract / agreement with the supplier. [Outcome: 1] ACQ.3.BP2: Approve contract. The contract is approved by relevant stakeholders. [Outcome: 1] ACQ.3.BP3: Review contract for supplier capability monitoring. Review and consider a mechanism for monitoring the capability and performance of the supplier in the contract conditions. [Outcome: 2] ACQ.3.BP4: Review contract for risk mitigation actions. Review and consider a mechanism for the mitigation of identified risk in the contract conditions. [Outcome: 2] ACQ.3.BP5: Award contract. The contract is awarded to the successful proposer / tenderer. [Outcome: 1] ACQ.3.BP6: Communicate results to tenderers. Notify the results of the proposal / tender selection to proposers / tenders. After contract award, inform all tenderers of the decision. [Outcome: 3]

Work Products	
Inputs	Outputs
	02-00 Contract [Outcome: 1, 2]
	02-01 Commitment / agreement [Outcome: 1, 3]
08-19 Risk management plan [Outcome: 2]	
12-01 Request for proposal [Outcome: 1]	
12-04 Supplier proposal response [Outcome: 1]	
	13-04 Communication record [Outcome: 1, 3]
	13-05 Contract review record [Outcome: 1]
14-08 Tracking system [Outcome: 2]	
15-08 Risk analysis report [Outcome: 2]	15-08 Risk analysis report [Outcome: 2]
15-18 Process performance report [Outcome: 2]	
17-09 Product requirements [Outcome: 1]	
17-10 Service requirements [Outcome: 1]	

5.1.4 ACQ.4 Supplier monitoring

Process ID	ACQ.4
Process Name	Supplier monitoring
Process Purpose	The purpose of the Supplier monitoring process is to track and assess performance of the supplier against agreed requirements.
Process Outcomes	As a result of successful implementation of Supplier monitoring process: 1) joint activities between the customer and the supplier are performed as needed; 2) information on technical progress is exchanged regularly with the supplier; 3) performance of the supplier is monitored against the agreed requirements; and 4) agreement changes, if needed, are negotiated between the acquirer and the supplier and documented in the agreement.
Base Practices	ACQ.4.BP1: Establish and maintain communications link. Establish and maintain communications link between customer and supplier (i.e. define interfaces, schedule, agenda, messages, documents, meetings, joint review). [Outcome: 1, 2] ACQ.4.BP2: Exchange information on technical progress. Use the communication link to exchange information on technical progress of the supply, including the risks to successful completion. [Outcome: 1, 2] ACQ.4.BP3: Review supplier performance. Review performance aspects of the supplier (technical, quality, cost, and schedule) on a regular basis, against the agreed requirements. [Outcome: 3] ACQ.4.BP4: Monitor the acquisition. Monitor the acquisition against the agreed acquisition documentation, analysing the information from the reviews with the supplier, so that progress can be evaluated to ensure that specified constraints such as cost, schedule, and quality are met. [Outcome: 3] ACQ.4.BP5: Agree on changes. Changes proposed by either party are negotiated and the results are documented in the agreement. [Outcome: 4] NOTE: The handling of changes will be performed by Change request management process (SUP.10).

Work Products	
Inputs	Outputs
02-00 Contract [Outcome: 1]	
02-01 Commitment / agreement [Outcome: 3, 4]	02-01 Commitment / agreement [Outcome: 4]
	13-01 Acceptance record [Outcome: 3]
	13-04 Communication record [Outcome: 1]
13-09 Meeting support record [Outcome: 1]	13-09 Meeting support record [Outcome: 1]
13-14 Progress status record [Outcome: 2]	13-14 Progress status record [Outcome: 2]
13-16 Change request [Outcome: 4]	
13-17 Customer request [Outcome: 4]	
	13-19 Review record [Outcome: 2]
14-08 Tracking system [Outcome: 3]	
	15-01 Analysis report [Outcome: 3]
	15-21 Supplier evaluation report [Outcome: 3]

5.1.5 ACQ.5 Customer acceptance

Process ID	ACQ.5
Process Name	Customer acceptance
Process Purpose	The purpose of the Customer acceptance process is to approve the supplier's deliverable when all acceptance criteria are satisfied.
Process Outcomes	As a result of successful implementation of Customer acceptance: 1) the delivered software product and/or service are evaluated with regard to the agreement; 2) the customer's acceptance is based on the agreed acceptance criteria; and 3) the software product and/or service is accepted by the customer.
Base Practices	ACQ.5.BP1: Evaluate the delivered product. Carry out the evaluation of the product and/or service using the defined acceptance criteria. [Outcome: 1, 2] ACQ.5.BP2: Compliance with agreement. Resolve any acceptance issues in accordance with the procedures established in the agreement and confirm that delivered product or service complies with the agreement. [Outcome: 2] ACQ.5.BP3: Accept product. Accept the delivered product or service and communicate acceptance to the supplier. [Outcome: 3]

Work Products	
Inputs	Outputs
02-00 Contract [Outcome: 1]	
02-01 Commitment / agreement [Outcome: 1]	
08-01 Acceptance test plan [Outcome: 1, 2]	
08-02 Acquisition plan [Outcome: 1]	
11-00 Product [Outcome: 1, 3]	
	13-01 Acceptance record [Outcome: 3]
	13-07 Problem record [Outcome: 1]
	15-10 Test incident report [Outcome: 2]
17-03 Customer requirements [Outcome: 2]	
18-01 Acceptance criteria [Outcome: 2]	

5.2 Supply Process Group (SPL)

5.2.1 SPL.1 Supplier tendering

Process ID	SPL.1
Process Name	Supplier tendering
Process Purpose	The purpose of Supplier tendering process is to establish an interface to respond to customer inquiries and requests for proposal, prepare and submit proposals, and confirm assignments through the establishing of a relevant agreement / contract.
Process Outcomes	As a result of successful implementation of Supplier tendering process: 1) a communication interface is established and maintained in order to respond to customer inquiries and requests for proposal; 2) requests for proposal are evaluated according to defined criteria to determine whether or not to submit a proposal; 3) the need to undertake preliminary surveys or feasibility studies is determined; 4) suitable resources are identified to perform the proposed work; 5) a supplier proposal is prepared and submitted in response to the customer request; and 6) formal confirmation of agreement is obtained.
Base Practices	SPL.1.BP1: Establish communication interface. A communication interface is established and maintained in order to respond to customer inquiries or requests for proposal. [Outcome: 1] SPL.1.BP2: Perform customer enquiry screening. Perform customer enquiry screening to ensure source of lead is genuine, the nature or type of product or service is clearly established, and the right person is quickly identified to progress the lead. [Outcome: 1] SPL.1.BP3: Establish customer proposal evaluation criteria. Establish evaluation criteria to determine whether or not to submit a proposal based on appropriate criteria. [Outcome: 2] SPL.1.BP4: Evaluate customer request for proposal. Requests for proposal are evaluated according to appropriate criteria. [Outcome: 2] SPL.1.BP5: Determine need for preliminary evaluations or feasibility studies. Determine need for preliminary evaluations or feasibility studies to ensure that a firm quotation can be made based on available requirements. [Outcome: 3] SPL.1.BP6: Identify and nominate staff. Identify and nominate staff with appropriate competency for the assignment. [Outcome: 4] SPL.1.BP7: Perform preliminary overall estimation. Estimate total costs, resources, and needed delivery date. [Outcome: 4, 5] SPL.1.BP8: Prepare supplier proposal or tender response. A supplier proposal or tender is prepared in response to the customer request. [Outcome: 5] NOTE 1: This may involve the selection of an appropriate solution (organizational or technical) amongst several alternatives in order to best meet requirements. SPL.1.BP9: Negotiate contract / agreement with acquirer. Negotiate all relevant aspects of the contract / agreement with the acquirer. [Outcome: 5, 6] SPL.1.BP10: Establish confirmation of contract / agreement. Formally confirm the contract / agreement to protect the interests of both parties. [Outcome: 6] NOTE 2: The nature of the commitment should be agreed and evidenced in writing. Only authorized signatories should be able to commit to a contract.

Work Products	
Inputs	Outputs
	02-00 Contract [Outcome: 5, 6]
	02-01 Commitment / agreement [Outcome: 6]
05-02 Business goals [Outcome: 2]	
12-01 Request for proposal [Outcome: 1, 2, 3, 4, 5]	
	12-04 Supplier proposal response [Outcome: 5]
13-04 Communication record [Outcome: 1]	13-04 Communication record [Outcome: 1]
	13-05 Contract review record [Outcome: 6]
13-11 Personnel performance review record [Outcome: 4]	
	13-15 Proposal review record [Outcome: 2, 3]

5.2.2 SPL.2 Product release

Process ID	SPL.2
Process Name	Product release
Process Purpose	The purpose of Product release process is to control the availability of a product to the intended customer.
Process Outcomes	As a result of the successful implementation of Product release process: 1) the contents of the product release are determined; 2) the release is assembled from configured items; 3) the release documentation is defined and produced; 4) the release delivery mechanism and media is determined; 5) release approval is effected against defined criteria; 6) release products are made available to the intended customer; and 7) confirmation of release is obtained.

Base Practices	SPL.2.BP1: Define release products. The products associated with the release are defined, on the basis of agreement or development strategy. [Outcome: 1] NOTE 1: The software product release may include programming tools where these are stated. SPL.2.BP2: Prepare product for delivery. Update and prepare the deliverable product. Establish baseline for the product including user documentation, designs and the product itself. [Outcome: 2] NOTE 2: Product release may consist of software and hardware products constituting a system, or just a software product. SPL.2.BP3: Establish a product release classification and numbering scheme. A product release and classification is established based upon the intended purpose and expectations of the release. [Outcome: 2] SPL.2.BP4: Define the build activities and build environment. A consistent build process is established and maintained. [Outcome: 2] NOTE 3: A consistent build environment should be used based on an environment specification that is communicated to all relevant parties. SPL.2.BP5: Build the release from configured items. The release is built from configured items to ensure integrity. [Outcome: 2] NOTE 4: Where relevant the software product release should identify the target hardware revision before release. SPL.2.BP6: The type, level and duration of support for a release are communicated. The type, level and duration of a release is identified and communicated. [Outcome: 3] SPL.2.BP7: Determine the delivery media type for the release. The media type for product delivery is determined in accordance with the needs of the end user. [Outcome: 4] NOTE 5: The media type for delivery may be intermediate (placed on a media and delivered to customer), or direct (such as delivered in firmware as part of the package) or a mix of both. The release may be delivered electronically by placement on a server. The release may also need to be duplicated before delivery. SPL.2.BP8: Identify the packaging for the release media. The packaging for different types of media is identified. [Outcome: 4] NOTE 6: The packaging for certain types of media may need physical or electronic protection, for instance floppy disk mailers or specific encryption techniques. SPL.2.BP9: Define and produce the software product release documentation. Ensure that all documentation to support the release is produced, reviewed, approved and available. [Outcome: 3, 6] SPL.2.BP10: Ensure product release approval before delivery. Criteria for the product release are satisfied before release takes place. [Outcome: 5] SPL.2.BP11: Deliver the release to the intended customer. The product is delivered to the intended customer, with positive confirmation of receipt. [Outcome: 6, 7] NOTE 7: Confirmation of receipt may be achieved by hand, electronically, by post, by telephone or through a distribution service provider. NOTE 8: These practices are typically supported by the Configuration Management process (SUP.8). NOTE 9: Refer to ISO/IEC 9127 for guidance on packaging aspects of software product supply.
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Work Products	
Inputs	Outputs
01-00 Configuration item [Outcome: 2]	
	08-11 Logistics maintenance plan [Outcome: 4]
08-16 Release plan [Outcome: 3]	08-16 Release plan [Outcome: 3]
11-00 Product [Outcome: 1]	
	11-03 Product release information [Outcome: 1]
	11-04 Product release package [Outcome: 2, 3]
	13-06 Delivery record [Outcome: 6,7]
	13-13 Product release approval record [Outcome: 5]
	15-03 Configuration status report [Outcome: 2]
17-03 Customer requirements [Outcome: 1]	
	17-04 Delivery instructions [Outcome: 3]
18-06 Product release criteria [Outcome: 1, 5]	18-06 Product release criteria [Outcome: 7]
19-04 Product release strategy [Outcome: 4]	

5.2.3 SPL.3 Product acceptance support

Process ID	SPL.3
Process Name	Product acceptance support
Process Purpose	The purpose of Product acceptance support process is to assist the customer to achieve confidence in taking ownership of the product.
Process Outcomes	As a result of successful implementation of the Product acceptance support process: 1) the product is completed and delivered to the customer; 2) the product is put into operation in the customer's environment; and 3) customer acceptance tests and reviews are supported. NOTE: Incremental delivery would be in completed increments.
Base Practices	SPL.3.BP1: Support delivery of product to customer. The product is completed and handed over to the customer with detailed configurations and technical / operational documents. [Outcome: 1] SPL.3.BP2: Adapt product to customer's environment. The product shall be adapted and evaluated in parallel with the existing systems or processes until the acceptance test is passed. [Outcome: 2] SPL.3.BP3: Support customer product evaluation. Provide support for customer reviews and product testing. [Outcome: 3] NOTE: This base practice is closely related to process Joint review process (SUP.4). SPL.3.BP4: Provide training to customer. Provide training and support to the customer as specified in the contract. [Outcome: 3]

Work Products	
Inputs	Outputs
	01-01 Product configuration [Outcome: 1]
02-00 Contract [Outcome: 1]	
06-03 Installation guide [Outcome: 2]	
08-01 Acceptance test plan [Outcome: 3]	08-01 Acceptance test plan [Outcome: 3]
08-24 Training plan [Outcome: 3]	
10-03 Customer support procedure [Outcome: 3]	10-03 Customer support procedure [Outcome: 3]
11-04 Product release package [Outcome: 1]	
	13-01 Acceptance record [Outcome: 3]
	13-06 Delivery record [Outcome: 1]
	13-08 Installation record [Outcome: 2]
	13-19 Review record [Outcome: 3]
17-03 Customer requirements [Outcome: 2]	

5.3 Operation Process Group (OPE)

5.3.1 OPE.1 Operational use

Process ID	OPE.1
Process Name	Operational use
Process Purpose	The purpose of the Operational use process is to ensure the correct and efficient operation of the product for the duration of its intended usage and in its installed environment.
Process Outcomes	As a result of successful implementation of Operational use process: 1) operational risks for the product introduction and operation are identified and monitored; 2) the product is operated in its intended environment according to requirements; and 3) criteria for the operational use are developed that demonstrates compliance with the agreed requirements.
Base Practices	OPE.1.BP1: Identify operational risks. Identify and monitor risks to product operation. [Outcome: 1] OPE.1.BP2: Perform operational testing. Perform operational testing of each release of the product, assessing satisfaction against specified criteria. [Outcome: 2] OPE.1.BP3: Operate the product. Operate the product in its intended environment and in the specified way. [Outcome: 2] OPE.1.BP4: Develop criteria for operational use. Criteria for operational use are developed such that compliance with the agreed requirements can be demonstrated. [Outcome: 3] OPE.1.BP5: Monitor operational use. Provide the capability to monitor operational service on a regular basis, where appropriate against defined criteria. [Outcome: 3]

Work Products	
Inputs	Outputs
06-01 Customer manual [Outcome: 2]	
06-05 Product operation guide [Outcome: 1, 2]	06-05 Product operation guide [Outcome: 3]
07-02 Field measure [Outcome: 2]	07-02 Field measure [Outcome: 1, 2, 3]
07-07 Risk measure [Outcome: 1]	
07-08 Service level measure [Outcome: 2]	07-08 Service level measure [Outcome: 3]
11-03 Product release information [Outcome: 1, 2, 3]	
14-08 Tracking system [Outcome: 1]	
	15-08 Risk analysis report [Outcome: 1]
	15-09 Risk status report [Outcome 1]
17-03 Customer requirements [Outcome: 2, 3]	
	18-07 Quality criteria [Outcome: 3]

5.3.2 OPE.2 Customer support

Process ID	OPE.2
Process Name	Customer support
Process Purpose	The purpose of the Customer support process is to establish and maintain an acceptable level of service through assistance and consultation to the customer to support effective use of the product.
Process Outcomes	As a result of successful implementation of Customer support process: 1) service needs for customer support are identified and monitored on an ongoing basis; 2) customer satisfaction with both the support services being provided and the product itself is evaluated on an ongoing basis; 3) operational support is provided by handling customer inquiries and requests and resolving operational problems; and 4) customer support needs are met through delivery of appropriate services.
Base Practices	OPE.2.BP1: Establish product support. Establish a service by which the customer can raise problems and questions encountered in use of the product and receive help in resolving them. [Outcome: 1, 3] NOTE 1: The handling of problems will be performed by Problem resolution management process (SUP.9). OPE.2.BP2: Meet support needs. Provide training, documentation and other support services, as appropriate, to the user so that the product can be effectively used. [Outcome: 4] OPE.2.BP3: Monitor performance. Monitor the operational performance of the product in order to be aware of problems which might impact level of service.[Outcome: 1] OPE.2.BP4: Determine customer product satisfaction. Determine the level of customer satisfaction with the products received. [Outcome: 2] NOTE 2: This may involve, as appropriate, field performance data, surveys, interviews, and studies. In some instances the end-user of the product may be different from the customer of the product. In this case, both the customer and end-user satisfaction levels should be determined. OPE.2.BP5: Determine customer service satisfaction. Determine the level of customer satisfaction with the services received. [Outcome: 2] OPE.2.BP6: Communicate customer satisfaction. Communicate customer satisfaction data throughout the supplier organization, in a manner appropriate to the staff involved and the nature of the findings, and communicate to the customer. [Outcome: 2]

Work Products	
Inputs	Outputs
02-00 Contract [Outcome: 1]	
	03-04 Customer satisfaction data [Outcome: 2]
	07-01 Customer satisfaction survey [Outcome: 2]
07-08 Service level measure [Outcome: 1]	
10-03 Customer support procedure [Outcome: 3]	
	12-02 Retirement request [Outcome: 1]
13-07 Problem record [Outcome: 3]	13-07 Problem record [Outcome: 3]
13-17 Customer request [Outcome: 3]	
	15-14 Customer satisfaction report [Outcome: 2]
	15-20 Service level performance [Outcome: 4]
17-10 Service requirements [Outcome: 2]	17-10 Service requirements [Outcome: 1]

5.4 Engineering Process Group (ENG)

5.4.1 ENG.1 Requirements elicitation

Process ID	ENG.1
Process Name	Requirements elicitation
Process Purpose	The purpose of the Requirements elicitation process is to gather, process, and track evolving customer needs and requirements throughout the life of the product and/or service so as to establish a requirements baseline that serves as the basis for defining the needed work products. Requirements elicitation may be performed by the acquirer or the developer of the system.
Process Outcomes	As a result of successful implementation of Requirements elicitation process: 1) continuing communication with the customer is established; 2) agreed customer requirements are defined and baselined; 3) a change mechanism is established to evaluate and incorporate changes to customer requirements into the baselined requirements based on changing customer needs; 4) a mechanism is established for continuous monitoring of customer needs; 5) a mechanism is established for ensuring that customers can easily determine the status and disposition of their requests; and 6) enhancements arising from changing technology and customer needs are identified and their impact is managed.

Base Practices	ENG.1.BP1: Obtain customer requirements and requests. Obtain and define customer requirements and requests through direct and continuous solicitation of customer and user input. [Outcome: 1,4] NOTE 1: Requirements may also be obtained through review of customer business proposals, target operating and hardware environment, and other documents bearing on customer requirements. ENG.1.BP2: Understand customer expectations. Ensure that both supplier and customer understand each requirement in the same way. Review with customers their requirements and requests to better understand their needs and expectations and to check the feasibility and appropriateness of their requirements. [Outcome: 6] NOTE 2: Environmental, legal and other constraints that may be external to the customer need to be considered. NOTE 3: Examples of techniques to review with customers their requirements and requests include observation of existing systems, prototypes, simulations, models, technology demonstrations, document excerpts, scenario descriptions and dialogues. ENG.1.BP3: Agree on requirements. Obtain agreement across teams on the customer requirements, obtaining the appropriate sign-offs by representatives of all teams and other parties contractually bound to work to these requirements. [Outcome: 2] ENG.1.BP4: Establish customer requirements baseline. Formalize the customer requirements and establish as a baseline for project use and monitoring against customer needs. [Outcome: 2,3] ENG.1.BP5: Manage customer requirements changes. Manage all changes made to the customer requirements against the customer requirements baseline to ensure enhancements resulting from changing technology and customer needs are identified and that those who are affected by the changes are able to assess the impact and risks and initiate appropriate change control and risk mitigation actions. [Outcome: 4, 5] NOTE 4: The tracking of requirements is handled in Configuration management process (SUP.8). ENG.1.BP6: Establish customer query mechanism. Provide a means by which the customer can be aware of the status and disposition of their requirements changes. [Outcome: 5] NOTE 5: This may include joint meetings with the customer or formal communication to review the status for their requirements and requests. Refer to the Joint review process (SUP.4).
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Work Products	
Inputs	Outputs
02-01 Commitment / agreement [Outcome: 2]	
	13-00 Record [Outcome: 4, 5]
	13-04 Communication record [Outcome: 1, 4]
13-16 Change request [Outcome: 3, 6]	
13-17 Customer request [Outcome: 1, 3]	
	13-21 Change control record [Outcome: 3, 4]
	15-01 Analysis report [Outcome: 2, 3, 6]
17-03 Customer requirements [Outcome: 3]	17-03 Customer requirements [Outcome: 2, 3]

5.4.2 ENG.2 System requirements analysis

Process ID	ENG.2
Process Name	System requirements analysis
Process Purpose	The purpose of the System requirements analysis process is to transform the defined stakeholder requirements into a set of desired system technical requirements that will guide the design of the system.
Process Outcomes	As a result of successful implementation of System requirements analysis process: 1) a defined set of system functional and non-functional requirements describing the problem to be solved are established; 2) the appropriate techniques are performed to optimize the preferred project solution; 3) system requirements are analyzed for correctness and testability; 4) the impact of the system requirements on the operating environment are understood; 5) the requirements are prioritized, approved and updated as needed; 6) consistency and traceability is established between the system requirements and the customer's requirements baseline; 7) changes to the baseline are evaluated for cost, schedule and technical impact; and 8) the system requirements are communicated to all affected parties and baselined.
Base Practices	ENG.2.BP1: Establish system requirements. Use the stakeholder requirements as the basis for defining the required functions and capabilities of the system and document in a system requirements baseline. Consider feasibility of the project solution using appropriate techniques. [Outcome: 1, 2] NOTE 1: Appropriate techniques for solution analysis may include: feasibility studies, case studies, prototyping, formal languages and workshops. ENG.2.BP2: Optimize project solution. Appropriate techniques are performed to optimize the preferred solution. Consider and analyze alternate solutions to achieve an optimum project solution. [Outcome: 2] ENG.2.BP3: Analyze system requirements. Prioritize requirements and analyze the prioritized requirements for correctness, completeness, consistency, feasibility and testability, identifying the necessary elements of the system. Identify changes to the operating environment. [Outcome: 3, 4] NOTE 2: Any derived requirements are also identified. ENG.2.BP4: Evaluate and update system requirements. Evaluate the impact of proposed changes and new requirements for cost, schedule, risk and technical impact, approve or reject changes and new requirements, and update the system requirements baseline. [Outcome: 5, 7] ENG.2.BP5: Ensure consistency. Ensure consistency of requirements elicitation to system requirements analysis. Consistency is supported by establishing and maintaining traceability between customer requirements and the system requirements when needed. [Outcome: 6] ENG.2.BP6: Communicate system requirements. Establish communication mechanisms for dissemination of system requirements, and updates to requirements to all parties who will be using them. [Outcome: 8]

Work Products	
Inputs	Outputs
	13-04 Communication record [Outcome: 8]
13-16 Change request [Outcome: 7]	
13-17 Customer request [Outcome: 7]	
	13-21 Change control record [Outcome: 7]
	13-22 Traceability record [Outcome: 6]

Work Products	
Inputs	Outputs
	15-01 Analysis report [Outcome: 2, 3, 4, 7]
17-03 Customer requirements [Outcome: 1, 6]	
	17-08 Interface requirements [Outcome: 4]
	17-12 System requirements [Outcome: 1, 5]

5.4.3 ENG.3 System architectural design

Process ID	ENG.3
Process Name	System architectural design
Process Purpose	The purpose of the System architectural design process is to identify which system requirements should be allocated to which elements of the system.
Process Outcomes	As a result of successful implementation of System architectural design process: 1) a system architecture design is defined that identifies the elements of the system and meets the defined requirements; 2) the system's functional and non-functional requirements are addressed; 3) the requirements are allocated to the elements of the system; 4) internal and external interfaces of each system element are defined; 5) verification between the system requirements and the system architecture is performed; 6) the requirements allocated to the system elements and their interfaces are traceable to the customer's requirements baseline; 7) consistency and traceability between the system requirements and system architecture design is maintained; 8) the system requirements, the system architecture design, and their relationships are baselined and communicated to all affected parties.
Base Practices	ENG.3.BP1: Describe system architecture. Establish the top-level system architecture that identifies elements of hardware, software and manual-operations. [Outcome: 1] ENG.3.BP2: Allocate requirements. Allocate all system requirements to the elements of the top-level system architecture. [Outcome: 2, 3] ENG.3.BP3: Define interfaces. Develop and document the internal and external interfaces of each system element. [Outcome: 4] ENG.3.BP4: Verify system architecture. Ensure that the system architecture meets all stakeholder and system requirements. [Outcome: 5, 6] ENG.3.BP5: Evaluate alternative system architectures. Define evaluation criteria for architecture design. Evaluate alternative system architectures according to the defined criteria. Record the rationale for choosing the current system architecture. [Outcome: 1] NOTE: Evaluation criteria may include quality characteristics (modularity, maintainability, expandability, scalability, reliability, security and usability) and results of make-buy-reuse analysis. ENG.3.BP6: Ensure consistency. Ensure consistency of system requirements analysis to system architectural design. Consistency is supported by establishing and maintaining traceability between system requirements and the system architecture design when needed. [Outcome: 7] ENG.3.BP7: Communicate system architecture design. Establish communication mechanisms for dissemination of the system architecture design to all parties who will be using them. [Outcome: 8]

Work Products	
Inputs	Outputs
01-01 Product configuration [Outcome: 1]	
	04-06 System architecture design [Outcome: 1, 2, 3, 4]
	11-08 System element [Outcome: 1, 3, 6]
	13-04 Communication record [Outcome: 8]
	13-22 Traceability record [Outcome: 6, 7, 8]
	13-25 Verification results [Outcome: 5]
17-03 Customer requirements [Outcome: 6]	
17-08 Interface requirements [Outcome: 4, 6]	
17-12 System requirements [Outcome: 1, 2, 3, 5, 6, 7, 8]	

5.4.4 ENG.4 Software requirements analysis

Process ID	ENG.4
Process Name	Software requirements analysis
Process Purpose	The purpose of the Software requirements analysis process is to establish the requirements of the software elements of the system.
Process Outcomes	As a result of successful implementation of Software requirements analysis process: 1) the requirements allocated to the software elements of the system and their interfaces are defined; 2) software requirements are analyzed for correctness and testability; 3) the impact of software requirements on the operating environment are understood; 4) consistency and traceability are established between the software requirements and system requirements; 5) prioritization for implementing the software requirements is defined; 6) the software requirements are approved and updated as needed; 7) changes to the software requirements are evaluated for cost, schedule and technical impact; and 8) the software requirements are baselined and communicated to all affected parties.

Base Practices	ENG.4.BP1: Specify software requirements. Define and prioritize functional and nonfunctional requirements of the software elements of the system and their interfaces and document them in a software requirements specification. Analyze the software requirements for correctness, completeness, consistency, feasibility and testability. Identify any derived requirements. [Outcome: 1, 2, 5] NOTE 1: Software quality characteristics are described in ISO/IEC 9126-1. ENG.4.BP2: Determine operating environment impact. Determine the interfaces between the software requirements and other elements of the operating environment, and the impact that the requirements will have. [Outcome: 3] NOTE 2: The operating environment includes tasks performed by, or other systems used by, the intended users of the software product. ENG.4.BP3: Develop criteria for software testing. Use the software requirements to define acceptance criteria for the software product tests. Software product tests should demonstrate compliance with the software requirements. [Outcome: 2] ENG.4.BP4: Ensure consistency. Ensure consistency of system requirements analysis to software requirements analysis. Consistency is supported by establishing and maintaining traceability between system requirements and the software requirements when needed. [Outcome: 4] ENG.4.BP5: Evaluate and update software requirements. Evaluate the requirements with the customer, evaluate the impact of proposed changes for cost, schedule and technical impact, approve or reject changes, and update the software requirements specification. [Outcome: 6, 7] ENG.4.BP6: Communicate software requirements. Establish communication mechanisms for dissemination of software requirements, and updates to requirements to all parties who will be using them. [Outcome: 8]
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Work Products	
Inputs	Outputs
04-06 System architecture design [Outcome: 1]	
	13-04 Communication record [Outcome: 8]
13-16 Change request [Outcome: 6, 7]	
13-17 Customer request [Outcome: 6, 7]	
	13-21 Change control record [Outcome: 7]
	13-22 Traceability record [Outcome: 4]
	15-01 Analysis report [Outcome: 2, 3, 7]
	17-08 Interface requirements [Outcome: 1]
	17-11 Software requirements [Outcome: 1, 2, 4, 5, 6]
17-12 System requirements [Outcome: 1, 4]	

5.4.5 ENG.5 Software design

Process ID	ENG.5
Process Name	Software design
Process Purpose	The purpose of the Software design process is to provide a design for the software that implement and can be verified against the requirements.
Process Outcomes	As a result of successful implementation of Software design process: 1) a software architectural design is developed and baselined that describes the software elements that will implement the software requirements; 2) internal and external interfaces of each software elements are defined; 3) a detailed design is developed that describes software units that can be built and tested; and 4) consistency and traceability are established between software requirements and software design.
Base Practices	ENG.5.BP1: Describe software architecture. Transform the software requirements into a software architecture design that describes the top-level structure and identifies its major software elements. [Outcome: 1, 3] NOTE 1: Examples of major software elements include data storage and access (e.g. Database), communication mechanism, business logic and user interface. NOTE 2: In transforming software requirements into a software architecture design, alternative software architectures should be evaluated according to defined criteria. The rationale for choosing the current software architecture should be recorded. Evaluation criteria may include software quality characteristics (modularity, maintainability, expandability, scalability, reliability, security and usability) and results of make-buy-reuse analysis. ENG.5.BP2: Define interfaces. Specify and document the external and internal interfaces between the software elements. [Outcome: 2] ENG.5.BP3: Develop detailed design. Decompose the software architectural design into a detailed design for each software element describing all software units to be produced and tested. Document software units and interfaces in a software design document. [Outcome: 3] ENG.5.BP4: Analyze the design for testability. Analyze the design for correctness and testability to ensure that the software units can be built and tested. [Outcome: 3] ENG.5.BP5: Ensure consistency. Ensure consistency of software requirements analysis to software design. Consistency is supported by establishing and maintaining traceability between software requirements and the software design when needed. [Outcome: 4]

Work Products	
Inputs	Outputs
	04-01 Database design [Outcome: 3, 4]
	04-04 High level software design [Outcome: 1, 2, 4]
	04-05 Low level software design [Outcome: 2, 3, 4]
	11-02 Software element [Outcome: 1]
	13-22 Traceability record [Outcome: 4]
17-08 Interface requirements [Outcome: 2]	
17-11 Software requirements [Outcome: 1, 4]	
	17-13 Test design specification [Outcome: 3]

5.4.6 ENG.6 Software construction

Process ID	ENG.6
Process Name	Software construction
Process Purpose	The purpose of the Software construction process is to produce executable software units that properly reflect the software design.
Process Outcomes	As a result of successful implementation of Software construction process: 1) verification criteria are defined for all software units against their requirements; 2) software units defined by the design are produced; 3) consistency and traceability are established between software requirements and design and software units; and 4) verification of the software units against the requirements and the design is accomplished.
Base Practices	ENG.6.BP1: Develop unit verification procedures. Develop and document procedures and criteria for verifying that each software unit satisfies its design requirements. The verification procedure includes unit test cases, unit test data and code review. [Outcome: 1] ENG.6.BP2: Develop software units. Develop and document the executable representations of each software unit. Update test requirements and user documentation. [Outcome: 2] NOTE 1: User documentation includes preliminary versions of installation, operation and maintenance documentation. ENG.6.BP3: Ensure consistency. Ensure consistency of software design to software construction. Consistency is supported by establishing and maintaining traceability between software requirements and design and the software units when needed. [Outcome: 3] ENG.6.BP4: Verify software units. Verify that each software unit satisfies its design requirements by executing the specified unit verification procedures and document the results. [Outcome: 4] NOTE 2: Code can be verified by various techniques such as static code analysis, code review, etc.

Work Products	
Inputs	Outputs
03-07 Test data [Outcome: 4]	03-07 Test data [Outcome: 1]
04-04 High level software design [Outcome: 2, 3]	
04-05 Low level software design [Outcome: 2, 3]	
	06-01 Customer manual [Outcome: 2]
	08-25 Unit test plan [Outcome: 1]
	10-02 Test procedure [Outcome: 1]
11-05 Software unit [Outcome: 3, 4]	11-05 Software unit [Outcome: 2]
	13-19 Review record [Outcome: 4]
	13-22 Traceability record [Outcome: 3]
	14-04 Test log [Outcome: 4]
	15-10 Test incident report [Outcome: 4]
17-08 Interface requirements [Outcome: 1, 3]	
17-11 Software requirements [Outcome: 1, 3]	
17-13 Test design specification [Outcome: 1]	
17-14 Test case specification [Outcome: 2]	17-14 Test case specification [Outcome: 2]
18-03 Coding standard [Outcome: 2, 3, 4]	

5.4.7 ENG.7 Software integration

Process ID	ENG.7
Process Name	Software integration
Process Purpose	The purpose of the Software integration process is to combine the software units, producing integrated software items, consistent with the software design, that demonstrate that the functional and non-functional software requirements are satisfied on an equivalent or complete operational platform.
Process Outcomes	As a result of successful implementation of Software integration process: 1) an integration strategy is developed for software units consistent with the software design and the prioritized software requirements; 2) verification criteria for software items are developed that ensure compliance with the software requirements allocated to the items; 3) software items are verified using the defined criteria; 4) software items defined by the integration strategy are produced; 5) results of integration testing are recorded; 6) consistency and traceability are established between software design and software items; and 7) a regression strategy is developed and applied for re-verifying software items when a change in software units (including associated requirements, design and code) occur.
Base Practices	ENG.7.BP1: Develop software integration strategy. Develop the strategy for integrating software units considering the software requirements. Identify software items based on the software architecture and define a sequence or order for integrating and testing them. [Outcome: 1] NOTE: Examples for the order of software item integration include top-level items, bottom-level items, critical items, functional items, complete skeleton first and items as-available. ENG.7.BP2: Develop tests for integrated software items. Describe the tests to be run against each integrated software item, including the verification of the interfaces, indicating software requirements being checked, input data and verification criteria. [Outcome: 2] ENG.7.BP3: Integrate software item. Integrate the software units according to the integration strategy to form a software item. [Outcome: 4] ENG.7.BP4: Test integrated software items. Test each integrated software item on an operational platform or suitable equivalent platform, against the verification criteria, and record the results. Update user documentation as necessary. [Outcome: 3, 5] ENG.7.BP5: Ensure consistency. Ensure consistency of software design to software integration. Consistency is supported by establishing and maintaining traceability between software design and the software items when needed. [Outcome: 6] ENG.7.BP6: Regression test integrated software items. Develop a software regression test strategy for re-testing the integrated software items. If changes are made to software units, designs or requirements, carry out regression testing according to this strategy. [Outcome: 7]

Work Products	
Inputs	Outputs
01-03 Software item [Outcome: 6]	01-03 Software item [Outcome: 4]
03-07 Test data [Outcome: 3]	03-07 Test data [Outcome: 2]
04-04 High level software design [Outcome: 1, 6, 7]	
04-06 System architecture design [Outcome: 1, 6, 7]	
08-10 Software integration test plan [Outcome: 3, 4]	08-10 Software integration test plan [Outcome: 1, 2]

Work Products	
Inputs	Outputs
08-15 Regression test plan [Outcome: 2, 7]	08-15 Regression test plan [Outcome: 2, 7]
10-02 Test procedure [Outcome: 3, 7]	10-02 Test procedure [Outcome: 2]
	11-01 Software product [Outcome: 4, 7]
11-05 Software unit [Outcome: 4, 7]	
	13-22 Traceability record [Outcome: 6]
	14-04 Test log [Outcome: 3, 5, 7]
	15-10 Test incident report [Outcome: 3, 5, 7]
15-23 Test item transmittal report [Outcome: 3]	15-23 Test item transmittal report [Outcome: 2, 4]
17-02 Build list [Outcome: 4, 7]	17-02 Build list [Outcome: 1]
17-11 Software requirements [Outcome: 1, 2, 7]	
17-13 Test design specification [Outcome: 2]	17-13 Test design specification [Outcome: 2]
17-14 Test case specification [Outcome: 3, 7]	17-14 Test case specification [Outcome: 2]

5.4.8 ENG.8 Software testing

Process ID	ENG.8
Process Name	Software testing
Process Purpose	The purpose of the Software testing process is to confirm that the integrated software product meets its defined requirements.
Process Outcomes	As a result of successful implementation of Software testing process: 1) criteria for the integrated software is developed that demonstrates compliance with the software requirements; 2) integrated software is verified using the defined criteria; 3) test results are recorded; and 4) a regression strategy is developed and applied for re-testing the integrated software when a change in software items is made.
Base Practices	ENG.8.BP1: Develop tests for integrated software product. Describe the tests to be run against the integrated software product, indicating software requirements being checked, input data, and verification criteria. The set of tests should demonstrate compliance with the software requirements. [Outcome: 1] NOTE: Tests and test data can be developed during Software requirements analysis process (ENG.4), Software design process (ENG.5) and Software construction process (ENG.6). ENG.8.BP2: Test integrated software product. Test the integrated software product against the verification criteria, and record the results. Update user documentation as necessary. [Outcome: 2, 3] ENG.8.BP3: Regression test integrated software. Develop a software regression test strategy for re-testing the integrated software product. If changes are made to software items, carry out regression testing according to the strategy. [Outcome: 4]

Work Products	
Inputs	Outputs
03-07 Test data [Outcome: 2]	
04-04 High level software design [Outcome: 1]	
06-01 Customer manual [Outcome: 2]	06-01 Customer manual [Outcome: 3]
08-15 Regression test plan [Outcome: 4]	08-15 Regression test plan [Outcome: 4]
08-21 Software test plan [Outcome: 2]	08-21 Software test plan [Outcome: 1]
10-02 Test procedure [Outcome: 2]	10-02 Test procedure [Outcome: 1, 4]
11-01 Software product [Outcome: 2, 4]	
	14-04 Test log [Outcome: 3, 4]
	15-10 Test incident report [Outcome: 3, 4]
	15-11 Defect report [Outcome: 3, 4]
15-23 Test item transmittal report [Outcome: 2]	
17-02 Build list [Outcome: 2, 4]	
17-11 Software requirements [Outcome: 1, 4]	
17-13 Test design specification [Outcome: 1]	
17-14 Test case specification [Outcome: 2]	17-14 Test case specification [Outcome: 2]

5.4.9 ENG.9 System integration

Process ID	ENG.9
Process Name	System integration
Process Purpose	The purpose of the System integration process is to integrate the system elements (including software items, hardware items, manual operations, and other systems, as necessary) to produce a complete system that will satisfy the system design and the customers' expectations expressed in the system requirements.
Process Outcomes	As a result of successful implementation of System integration process: 1) a strategy is developed to integrate the system according to the priorities of the system requirements; 2) criteria is developed to verify compliance with the system requirements allocated to the system elements, including the interfaces between system elements; 3) the system integration is verified using the defined criteria; 4) a regression strategy is developed and applied for re-testing the system [elements] when changes are made; 5) consistency and traceability are established between the system design and the integrated system elements; and 6) an integrated system, demonstrating compliance with the system design and validation that a complete set of useable deliverable system elements exists, is constructed.

Base Practices	ENG.9.BP1: Develop system integration and regression test strategies. Develop strategies for integrating system elements consistent with the system architecture and requirements, and for re-testing system elements should a given system element be changed. [Outcome: 1, 4] ENG.9.BP2: Develop tests for system elements. Describe the tests to run against each system element, indicating requirements being checked, input data, system elements needed to perform the test, and verification criteria. [Outcome: 2] ENG.9.BP3: Integrate system elements. Integrate system elements according to the system integration strategy. [Outcome: 3] ENG.9.BP4: Test system elements. Test each system element and ensure that it satisfies its requirements, and document the results. [Outcome: 3] ENG.9.BP5: Regression test system elements. If changes are made to system elements, carry out regression testing as defined in the regression test strategy. [Outcome: 4] ENG.9.BP6: Ensure consistency. Ensure consistency of system architectural design to system integration. Consistency is supported by establishing and maintaining traceability between system designs and the system elements when needed. [Outcome: 5] ENG.9.BP7: Build complete system of system elements. Identify and integrate system elements to produce a complete system ready for system testing according to the system integration strategy. [Outcome: 6]
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Work Products	
Inputs	Outputs
03-07 Test data [Outcome: 3]	03-07 Test data [Outcome: 2]
04-06 System architecture design [Outcome: 1, 2, 4, 5]	
	08-07 System integration test plan [Outcome: 1, 2]
08-15 Regression test plan [Outcome: 4]	08-15 Regression test plan [Outcome: 4]
	08-22 System test plan [Outcome: 1, 2]
	10-02 Test procedure [Outcome: 1, 2, 4]
11-01 Software product [Outcome: 3, 6]	
11-06 System [Outcome: 3]	11-06 System [Outcome: 6]
11-08 System element [Outcome: 4, 5, 6]	
	13-22 Traceability record [Outcome: 5]
	14-04 Test log [Outcome: 3, 4]
	15-10 Test incident report [Outcome: 3, 4]
	15-11 Defect report [Outcome: 3, 4]
	15-23 Test item transmittal report [Outcome: 2]
17-02 Build list [Outcome: 3, 4, 6]	17-02 Build list [Outcome: 1]
17-12 System requirements [Outcome: 1, 2]	
17-13 Test design specification [Outcome: 1]	17-13 Test design specification [Outcome: 1]
17-14 Test case specification [Outcome: 2]	17-14 Test case specification [Outcome: 2]

5.4.10 ENG.10 System testing

Process ID	ENG.10
Process Name	System testing
Process Purpose	The purpose of the Systems testing process is to ensure that the implementation of each system requirement is tested for compliance and that the system is ready for delivery.
Process Outcomes	As a result of successful implementation of System testing process: 1) criteria for the integrated system is developed that demonstrates compliance with system requirements; 2) the integrated system is verified using the defined criteria; 3) test results are recorded; and 4) a regression strategy is developed and applied for re-testing the integrated system should a change be made to existing system elements.
Base Practices	ENG.10.BP1: Develop tests for system. Describe the tests to be run against the complete system, indicating system requirements being checked, input data, and validation criteria. [Outcome: 1] NOTE: This can be performed during System requirements analysis process (ENG.2). ENG.10.BP2: Test integrated system. Test the integrated system and ensure that it satisfies the system requirements, and record the results. [Outcome: 2, 3] ENG.10.BP3: Regression test integrated system. Develop a system regression test strategy for re-testing the system. If changes are made to system elements, carry out regression testing as defined in the system regression test strategy. [Outcome: 1, 4] ENG.10.BP4: Confirm system readiness. Ensure that the system is ready for delivery and communicate system test results to all affected parties. [Purpose]

Work Products	
Inputs	Outputs
03-07 Test data [Outcome: 2]	03-07 Test data [Outcome: 1]
06-01 Customer manual [Outcome: 2]	
08-15 Regression test plan [Outcome: 4]	08-15 Regression test plan [Outcome: 4]
08-22 System test plan [Outcome: 2]	08-22 System test plan [Outcome: 1, 4]
10-02 Test procedure [Outcome: 2]	10-02 Test procedure [Outcome: 1, 4]
11-06 System [Outcome: 2, 4]	
	14-04 Test log [Outcome: 3, 4]
	15-10 Test incident report [Outcome: 3, 4]
	15-11 Defect report [Outcome: 3, 4]
15-23 Test item transmittal report [Outcome: 2]	
17-02 Build list [Outcome: 2, 4]	
17-12 System requirements [Outcome: 1, 4]	
17-13 Test design specification [Outcome: 1]	
17-14 Test case specification [Outcome: 2]	17-14 Test case specification [Outcome: 2]

5.4.11 ENG.11 Software installation

Process ID	ENG.11
Process Name	Software installation
Process Purpose	The purpose of the Software installation process is to install the software product that meets the agreed requirements in the target environment.
Process Outcomes	As a result of successful implementation of Software installation process: 1) a software installation strategy is developed; 2) criteria for software installation is developed that demonstrates compliance with the software installation requirements; 3) the software product is installed in the target environment; and 4) assure that the software product is ready for use in its intended environment.
Base Practices	ENG.11.BP1: Develop installation strategy. Develop a software installation strategy to install the software product in the target environment in agreement with the customer and the operating organization. [Outcome: 1] NOTE 1: An important part of developing an installation strategy is to develop a strategy to return to the last working system version. In order to be able to re-install the last working version, a complete backup of the system should be made before starting the installation. ENG.11.BP2: Establish installation criteria. Based on the installation requirements, develop criteria for the environment where the software will be installed. [Outcome: 2] ENG.11.BP3: Specify the requirements for adaptation. Specify the requirements for adaptation of the system for its intended environment. [Outcome: 2] ENG.11.BP4: Adapt the system. Adapt the system to meet the requirements for operation. [Outcome 2] ENG.11.BP5: Install software product. Install the software product according to the software installation strategy. Document the events and results. [Outcome: 3] ENG.11.BP6: Confirm product readiness. Assure that the software product is ready for use in its intended environment. [Outcome: 4] NOTE 2: Software installation process is linked to Product acceptance support process (SPL.3).

Work Products	
Inputs	Outputs
04-06 System architecture design [Outcome: 1, 3]	
06-03 Installation guide [Outcome: 3]	06-03 Installation guide [Outcome: 1]
08-09 Installation and maintenance plan [Outcome: 3]	08-09 Installation and maintenance plan [Outcome: 1, 2]
10-02 Test procedure [Outcome: 3, 4]	10-02 Test procedure [Outcome: 1, 2]
11-01 Software product [Outcome: 1, 3, 4]	
	13-01 Acceptance record [Outcome: 4]
	13-07 Problem record [Outcome: 4]
	13-08 Installation record [Outcome: 3]
	13-19 Review record [Outcome: 4]
13-27 Retirement notification [Outcome: 1]	
	15-10 Test incident report [Outcome: 4]
17-11 Software requirements [Outcome: 1, 2]	
17-12 System requirements [Outcome: 1, 2, 4]	

5.4.12 ENG.12 Software and system maintenance

Process ID	ENG.12
Process Name	Software and system maintenance
Process Purpose	The purpose of the Software and system maintenance process is to modify a system/software product after delivery to correct faults, improve performance or other attributes, or to adapt to a changed environment. NOTE: The objective is to modify and/or retire existing system/software products while preserving the integrity of organizational operations.
Process Outcomes	As a result of successful implementation of the Software and system maintenance process: 1) a maintenance strategy is developed to manage modification, migration and retirement of products according to the release strategy; 2) the impact of changes to the existing system on organization, operations or interfaces are identified; 3) affected system/software documentation is updated as needed; 4) modified products are developed with associated tests that demonstrate that requirements are not compromised; 5) product upgrades are migrated to the customer's environment; 6) on request, products are retired from use in a controlled manner that minimizes disturbance to the customers; and 7) the system/software modification is communicated to all affected parties.
Base Practices	ENG.12.BP1: Develop maintenance strategy. Develop the strategy for managing modification, migration, and retirement of products consistent with the maintenance requirements, release strategy and possible warranty policies. [Outcome: 1] ENG.12.BP2: Analyze user problems and changes. Analyze user problems and requests and required changes, evaluating the possible impact of different options for modifying the existing system and software, system interfaces, and requirements. Document the selected solution. [Outcome: 2] NOTE: This Base Practice links to the Problem resolution management process (SUP.9). ENG.12.BP3: Implement and test modifications. Determine which products need to be changed. Implement, test and document the selected modifications, demonstrating that the system and software requirements and integrity will not be compromised by the upgrade. [Outcome: 3, 4] ENG.12.BP4: Upgrade user system. Migrate the upgraded system and software with applied modifications to the user's environment. Provide for, as appropriate: notification of the migration plans and activities; parallel operation of the old and new systems; and user training. Perform a post-operation review to assess the impact of the modification. [Outcome: 5] ENG.12.BP5: Retire software product. Following approval, retire the obsolete system from the user environment, providing for, as appropriate: notification of the retirement plans and activities; parallel operation with replacement systems; conversion of data to new or replacement systems; archiving of system and data files; and user training or support. [Outcome: 6] ENG.12.BP6: Communicate modifications. Establish communication mechanisms for dissemination of system and software modifications to all parties who will be affected. [Outcome: 7]

Work Products	
Inputs	Outputs
06-01 Customer manual [Outcome: 3]	
	08-01 Acceptance test plan [Outcome: 3]
	08-09 Installation and maintenance plan [Outcome: 1, 5]
08-15 Regression test plan [Outcome: 4]	08-15 Regression test plan [Outcome: 4]
08-16 Release plan [Outcome: 1]	08-16 Release plan [Outcome: 1, 5]
08-22 System test plan [Outcome: 4]	08-22 System test plan [Outcome: 4]
	11-03 Product release information [Outcome: 7]
	11-04 Product release package [Outcome: 5, 7]
11-06 System [Outcome: 1, 3, 4]	11-06 System [Outcome: 3, 4]
	11-07 Temporary solution [Outcome: 7]
12-02 Retirement request [Outcome: 6]	12-02 Retirement request [Outcome: 6]
	13-01 Acceptance record [Outcome: 7]
	13-04 Communication record [Outcome: 7]
13-07 Problem record [Outcome: 2]	
13-16 Change request [Outcome: 3, 4]	
13-17 Customer request [Outcome: 2, 6]	
	13-21 Change control record [Outcome: 2, 7]
	13-22 Traceability record [Outcome: 4]
	13-27 Retirement notification [Outcome: 6]
	14-01 Change history [Outcome: 7]
	15-01 Analysis report [Outcome: 7]
	15-10 Test incident report [Outcome: 4]
17-03 Customer requirements [Outcome: 2]	
17-05 Documentation requirements [Outcome: 3, 4]	
17-11 Software requirements [Outcome: 2]	
17-12 System requirements [Outcome: 2]	
19-04 Product release strategy [Outcome: 1]	19-04 Product release strategy [Outcome: 1, 5]
	19-06 Maintenance strategy [Outcome: 1]