Information technology — Software process assessment — Part 2: A reference model for processes and process capability

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Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) together form a system for worldwide standardization as a whole. 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 JTC1.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types :

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts ;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard ;

— type 3, where a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC TR 15504-2, which is a Technical Report of type 2, was prepared by Joint Technical Committee ISO/IEC JTC1, *Information technology*, Subcommittee SC7, *Software engineering*.

ISO/IEC TR 15504 consists of the following parts, under the general title *Information Technology - Software Process Assessment:*

— Part 1 : *Concepts and introductory guide* (informative)

— Part 2 : *A reference model for processes and process capability* (normative)

— Part 3 : *Performing an assessment* (normative)

— Part 4 : *Guide to performing assessments* (informative)

— Part 5 : *An assessment model and indicator guidance* (informative)

— Part 6 : *Guide to competency of assessors* (informative)

— Part 7 : *Guide for use in process improvement* (informative)

— Part 8 : *Guide for use in determining supplier process capability* (informative)

— Part 9 : *Vocabulary* (normative)

Annexes A to C of this part of ISO/IEC TR 15504 are for information only.

Introduction

This part of ISO/IEC TR 15504 documents the set of universal software engineering processes that are fundamental to good software engineering and that cover best practice activities, providing a reference model which can be used by the other parts of ISO/IEC TR 15504. The reference model describes processes that an organization may perform to acquire, supply, develop, operate, evolve and support software, and the process attributes that characterize the capability of those processes. In performing a process assessment, an assessor uses a model(s) of the processes being assessed that is compatible with this reference model, so that a common basis for judgment is employed. This document also describes the requirements that an assessment model(s) needs to address to be compatible with the reference model.

The purpose of the reference model is to provide a common basis for different models and methods for software process assessment, ensuring that results of assessments can be reported in a common context. The use of models compatible with the reference model will ensure a common context for the reporting of assessment ratings. The use of a common reference model forms a basis on which assessments can be compared.

The reference model architecture is two dimensional. The first dimension is the process dimension which is characterized by a set of purpose statements. The process purpose statements describe in measurable terms what has to be achieved in order to attain the defined purpose of the process. The processes have been defined in alignment with ISO/IEC 12207:1995, *Information Technology - Software Life Cycle Processes*. The second dimension is the process capability dimension which characterizes the level of capability that an organization unit has attained for a particular process, or which may be used by the organization unit as a target to be attained.

Within this part of the ISO/IEC TR 15504:

— clause 4, titled "Structure of the reference model", provides a detailed description of the structure and key components of the reference model ;

— clause 5, titled "The process dimension", categorizes life cycle processes into groups of process categories and then describes each process in terms of its purpose ;

— clause 6, titled "The capability dimension", defines the capability levels and process attributes that describe the capability of the processes listed in clause 5 ;

— clause 7, titled "Compatibility with the reference model", contains the requirements for demonstrating that a model of software processes and process capability is compatible with this reference model ;

— annex A contains a detailed mapping of the ISO/IEC 12207 to ISO/IEC TR 15504 processes ;

— annex B contains summary lists of the processes and the process attributes that comprise the reference model ;

— annex C contains a style guide for defining additional processes.

Information technology — Software process assessment — Part 2: A reference model for processes and process **capability**

1   Scope

This part of ISO/IEC TR 15504 defines a reference model for software processes and process capability that forms the basis for software process assessment. The reference model defines at a high level the fundamental objectives that are essential to good software engineering. The high-level objectives describe what is to be achieved, not how to achieve them.

This reference model is applicable to any software organization wishing to establish and subsequently improve its capabilities in the acquisition, supply, development, operation, evolution and support of software. The model does not presume particular organizational structures, management philosophies, software life cycle models, software technologies, or development methodologies.

The architecture of this reference model organizes the processes to help software personnel understand and use them for continuous improvement of the management of software processes.

For software process assessment, an assessor uses a more detailed model(s) compatible with this reference model, containing a comprehensive set of indicators of process performance and process capability, to make judgments about the capability of the organization's processes. This part of ISO/IEC TR 15504 specifies the requirements to be met in order for a model(s) to be compatible with the reference model.

ISO/IEC TR 15504 is not intended to be used in any scheme for the certification / registration of the process capability of an organization.

Table 1 shows the main audiences for this part of ISO/IEC TR 15504, why each group needs the reference model, and how and when it will be used.

NOTE   Copyright release for the Reference Model: Users of this part of ISO/IEC TR 15504 may freely reproduce the detailed descriptions contained in the reference model as part of any Assessment Model based upon the reference model, or as part of any demonstration of compatibility with this reference model, so that it can be used for its intended purpose.

2   Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC TR 15504. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/IEC TR 15504 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 9001:1994, *Quality Systems - Model for quality assurance in design, development, production, installation and servicing.*

ISO/IEC 12207:1995*, Information Technology - Software life cycle processes.*

ISO/IEC TR 15504-9 :1998, *Information technology – Software process assessment – Part 9 : Vocabulary.*

Table 1 — Use of this reference model.

Who	Why	How	When
Assessment Model Developers	Develop models compatible with the reference model	As a reference for the structure of the model	During the development of a model
	Demonstrate compatibility of a developed model with the reference model	As a set of criteria for demonstration of capability	Following development, and prior to use in conducting assessments
Software organization	Understand what to do to improve software processes	As a working guide to management about software processes and capabilities to implement	During the implementation of the organization's software processes
		As a reference guide to highlight process and process capability considerations	During the development/review of the organization's software processes and as a part of continuous improvement activities
		As a training document	During the development/review of the organization's software processes and as a part of continuous improvement activities
	Determine the capability of its processes for demonstration to customers	As a reference framework to permit a valid basis for comparison	As an internal initiative for marketing actions
			During response to call for proposal
	Understand which processes and capabilities an assessor may evaluate	As a process and process capability checklist	Prior to an assessment
Software process assessors	Conduct a conformant software process assessment of an organization	As a process and process capability checklist & develop the knowledge of the reference model	Prior to and during a software process assessment
	Establish compatibility of an assessment model	As a reference for the purpose of performing model compatibility	Prior to an assessment or assessment program
Tool Developers	Develop a software process assessment tool	As a reference for and requirements of an assessment tool	Prior to and during the development of an assessment tool

3   Terms and definitions

For the purposes of this part of ISO/IEC TR 15504, the definitions given in ISO/IEC TR 15504-9 apply.

4   Structure of the reference model

The reference model architecture is made up of two dimensions:

⎯ the **process dimension**, which is characterized by process purpose statements which are the essential measurable objectives of a process;

⎯ the **process capability dimension**, which is characterized by a series of process attributes, applicable to any process, which represent measurable characteristics necessary to manage a process and improve its capability to perform.

4.1 Process dimension

The reference model groups the processes in the process dimension into three life cycle process groupings which contain five process categories, according to the type of activity they address.

The **Primary life cycle processes** consist of the process categories **Customer-Supplier** and **Engineering** and are described as follows:

> The **Customer-Supplier** process category consists of processes that directly impact the customer, support development and transition of the software to the customer, and provide for the correct operation and use of the software product and/or service.

> The **Engineering** process category consists of processes that directly specify, implement, or maintain the software product, its relation to the system and its customer documentation.

The **Supporting life cycle processes** consist of the process category **Support** and this category is described as follows:

> The **Support** process category consists of processes which may be employed by any of the other processes (including other supporting processes) at various points in the software life cycle.

The **Organizational life cycle processes** consist of the process categories **Management** and **Organization** and are described as follows**:**

> The **Management** process category consists of processes which contain practices of a generic nature which may be used by anyone who manages any type of project or process within a software life cycle.

> The **Organization** process category consists of processes that establish the business goals of the organization and develop process, product, and resource assets which, when used by the projects in the organization, will help the organization achieve its business goals.

Process categories and processes provide a grouping by type of activity. Each process in the reference model is described in terms of a purpose statement. These statements comprise the unique functional objectives of the process when instantiated in a particular environment. The purpose statement includes additional material identifying the outcomes of successful implementation of the process. Satisfying the purpose of a process represents the first step in building process capability.

The reference model does not define how, or in what order, the elements of the process purpose statements are to be achieved. The process purposes will be achieved in an organization through various detailed activities, tasks and practices being carried out to produce work products. These performed tasks, activities and practices, and the characteristics of the work products produced, are the indicators that demonstrate whether the specific process purpose is being achieved.

4.2 Process capability dimension

Evolving process capability is expressed 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 characterized by a set of attribute(s) that work together to provide a major enhancement in the capability to perform a process. Each level provides a major enhancement of capability in the performance of a process. The levels constitute a rational way of progressing through improvement of the capability of any process.

There are six capability levels in the reference model.

Level 0: *Incomplete.*

> There is general failure to attain the purpose of the process. There are few or no easily identifiable work products or outputs of the process.

Level 1: *Performed.*

> The purpose of the process is generally achieved. The achievement may not be rigorously planned and tracked. Individuals within the organization recognize that an action should be performed, and there is general agreement that this action is performed as and when required. There are identifiable work products for the process, and these testify to the achievement of the purpose.

Level 2: *Managed.*

> The process delivers work products according to specified procedures and is planned and tracked. Work products conform to specified standards and requirements. The primary distinction from the Performed Level is that the performance of the process now delivers work products that fulfil expressed quality requirements within defined timescales and resource needs.

Level 3: *Established.*

> The process is performed and managed using a defined process based upon good software engineering principles. Individual implementations of the process use approved, tailored versions of standard, documented processes to achieve the process outcomes. The resources necessary to establish the process definition are also in place. The primary distinction from the Managed Level is that the process of the Established Level is using a defined process that is capable of achieving its process outcomes.

Level 4: *Predictable.*

> The defined process is performed consistently in practice within defined control limits, to achieve its defined process goals. Detailed measures of performance are collected and analyzed. This leads to a quantitative understanding of process capability and an improved ability to predict and manage performance. Performance is quantitatively managed. The quality of work products is quantitatively known. The primary distinction from the Established Level is that the defined process is now performed consistently within defined limits to achieve its process outcomes.

Level 5: *Optimizing.*

> Performance of the process is optimized to meet current and future business needs, and the process achieves repeatability in meeting its defined business goals. Quantitative process effectiveness and efficiency goals (targets) for performance are established, based on the business goals of the organization. Continuous process monitoring against these goals is enabled by obtaining quantitative feedback and improvement is achieved by analysis of the results. Optimizing a process involves piloting innovative ideas and technologies and changing non-effective processes to meet defined goals or objectives. The primary distinction from the Predictable Level is that the defined and standard processes now dynamically change and adapt to effectively meet current and future business goals.

The reference model alone cannot be used as the basis for conducting reliable and consistent assessments of process capability since the level of detail is not sufficient. The descriptions of process purpose and capability attributes in the reference model need to be supported with a comprehensive set of indicators of process performance and capability. In this way, consistent ratings of process capability will be possible. An exemplar model that incorporates such a set of indicators is provided as ISO/IEC TR 15504-5. Clause 7 of this part of

ISO/IEC TR 15504 sets out the requirements to be met by other process assessment models to be compatible with this reference model.

5 The process dimension

This clause provides a classification of the processes normally undertaken by organizations concerned with the development, maintenance, acquisition, supply and operation of software. The classification recognizes five process categories each of which contains a number of processes. The process categories and processes are strongly aligned with those defined in *ISO/IEC 12207, Information Technology - Software Life Cycle Process* (refer to Annex A for a mapping of 15504 to ISO/IEC 12207) but some additional processes not included in ISO 12207 are introduced.

Figure 1 provides an overview of the structure of the process dimension. It shows the three principal groupings of life cycle processes - primary, supporting and organizational - as defined in ISO 12207, and shows the process categories and processes within each grouping. Figure 1 is designed in a similar fashion to Figure 1 in ISO 12207, so that the similarities and differences between the two models are apparent. In particular, the linkage between the Supporting Processes concerned with Quality Assurance and Quality Control can be seen.

Primary life cycle processes

CUS.1 Acquisition
- Acquisition preparation
- Supplier selection
- Supplier monitoring
- Customer acceptance

CUS.2 Supply

CUS.4 Operation
- Operational use
- Customer support

CUS.3
Requirements elicitation

ENG.1 Development
- System requirements analysis and design
- Software requirements analysis
- Software design
- Software construction
- Software integration
- Software testing
- System integration and testing

ENG.2 System and software maintenance

Supporting life cycle processes

SUP.1 Documentation

SUP.2 Configuration management

SUP.3 Quality assurance

SUP.4 Verification

SUP.5 Validation

SUP.6 Joint review

SUP.7 Audit

SUP.8 Problem resolution

Organizational life cycle processes

MAN.1 Management

MAN.2 Project management

MAN.3 Quality management

MAN.4 Risk management

ORG.1 Organizational alignment

ORG.2 Improvement
- Process establishment
- Process assessment
- Process improvement

ORG.3 Human resource management

ORG.4 Infrastructure
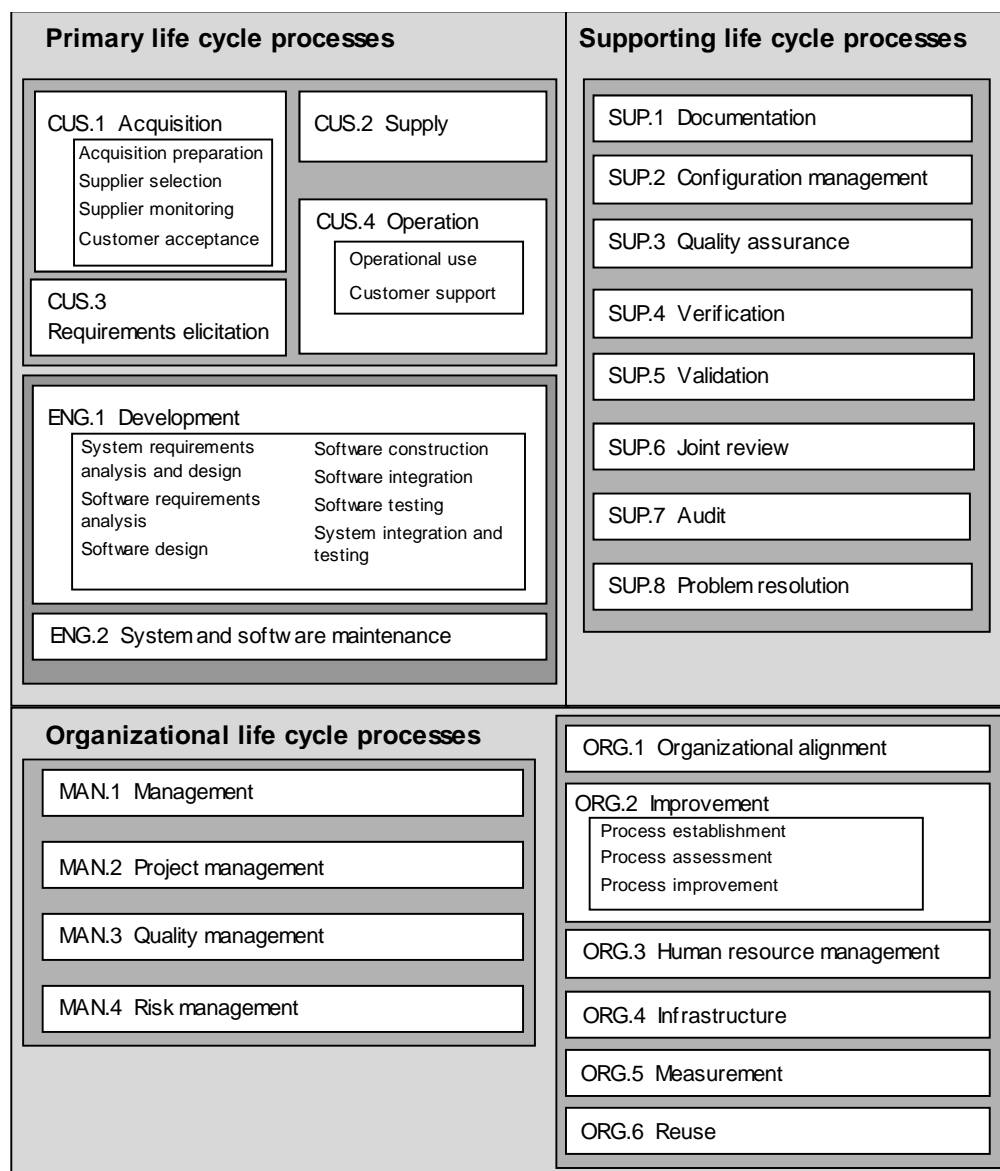
ORG.5 Measurement

ORG.6 Reuse

Figure 1 — The processes in the Process Dimension

The principal difference evident from Figure 1 is the presence in this reference model of a number of additional processes and the definition of two levels of process definition. The details of the differences are further described later in this clause. A complete list of the process categories and processes in the model is provided in Annex B.

The three life cycle process groupings are:

> The **Primary life cycle processes** consisting of the process categories **Engineering** and **Customer-Supplier**.

> The **Supporting life cycle processes** consisting of the process category **Support**.

> The **Organization life cycle processes** consisting of the process categories **Management** and **Organization**.

The five process categories are:

CUS	**Customer - Supplier**	**MAN**	**Management**
ENG	**Engineering**	**ORG**	**Organization**
SUP	**Support**		

The description of each process category includes a characterization of the processes it contains, followed by a list of the process names.

The individual processes are described in terms of six components:

Process Identifier   This identifies the process category and the sequential number within that category. The numbering scheme distinguishes between top-level processes and second-level processes. The identifier consists of two parts: a process category abbreviation (e.g. ENG for the Engineering process category) and a number (e.g. CUS.1 denotes the Acquisition process and CUS.1.2 denotes the Supplier Selection Process, a second level process which is a component process of the Acquisition Process).

Process Name   A descriptive phrase that encapsulates the principal concern of the process (e.g. Supplier Selection).

Process Type   There are five types of process. 3 top-level (basic, extended and new) and 2 second-level (component and extended component), and these are as follows:

> 1. *Basic* Processes identical in intent to the processes in ISO/IEC 12207;
> 2. *Extended* Processes that are expansions of ISO/IEC 12207 processes;
> 3. *New* Processes that are outside the scope of ISO/IEC 12207;
> 4. *Component* Processes (a group of one or more ISO/IEC 12207's activities from the same process);
> 5. *Extended Component* Processes that are one or more of ISO/IEC 12207's activities from the same process, with additional material. These would normally be *Component* Processes of *Extended* Processes.

Process Purpose   A paragraph that states the purpose of the process, indicating at a high level the overall objectives of performing the process. Optionally an additional paragraph may be included to further define the purpose statement.

Process Outcomes   A process outcome is an observable result of the successful implementation of a process. The process outcomes for each process are contained in a list which appears in the description of each process immediately after the phrase, "As a result of successful implementation of the process:"

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

The style guide in Annex C provides guidelines which may be used when extending process definitions or defining new processes.

5.1 Primary life cycle processes

The **Primary life cycle processes** consist of two process categories:

CUS   Customer-Supplier

ENG   Engineering

5.1.1   Customer-Supplier process category (CUS)

The *Customer-Suppli*er process category consists of processes that directly impact the customer, support development and transition of the software to the customer, and provide for the correct operation and use of the software product and/or service.

The processes belonging to the Customer-Supplier process category are:

> **CUS.1 Acquisition Process**
>
>> **CUS.1.1   Acquisition Preparation Process**
>>
>> **CUS.1.2   Supplier Selection Process**
>>
>> **CUS.1.3   Supplier Monitoring Process**
>>
>> **CUS.1.4   Customer Acceptance Process**
>
> **CUS.2 Supply Process**
>
> **CUS.3 Requirements Elicitation Process**
>
> **CUS.4 Operation Process**
>
>> **CUS.4.1   Operational Use Process**
>>
>> **CUS.4.2   Customer Support Process**

5.1.1.1   CUS.1   Acquisition process

Basic process

The purpose of the *Acquisition process* is to obtain the product and/or service that satisfies the need expressed by the customer. The process begins with the identification of a customer need and ends with the acceptance of the product and/or service needed by the customer. As a result of successful implementation of the process:

— acquisition needs, goals, acceptance criteria and acquisition strategies will be defined;

— a contract will be developed that clearly expresses the expectation, responsibilities and liabilities of both the customer and the supplier;

— a product and/or service will be produced that satisfies the customer's stated need;

— the acquisition will be monitored so that specified constraints such as cost, schedule and quality are met;

— supplier deliverables will be accepted.

5.1.1.2   CUS.1.1   Acquisition preparation process

Component process of CUS.1 - Acquisition process

The purpose of the *Acquisition preparation process* is to establish the needs and goals of the acquisition. As a result of successful implementation of the process:

— the concept or the need to acquire, develop, or enhance a system, software product, or software process will be established;

— the customer's software and/or system requirements will be produced;

— an acquisition strategy will be developed;

— acceptance criteria will be defined.

5.1.1.3   CUS.1.2   Supplier selection process

Component process of CUS.1 - Acquisition process

The purpose of the *Supplier selection process* is to choose the organization that will be responsible for the implementation of the project identified in CUS.1.1. As a result of successful implementation of the process:

— the acquisition requirements (e.g. request for proposal) will be produced;

— the supplier will be selected based upon the evaluation of the supplier's proposals;

— a contract will be established and negotiated between the customer and the supplier.

5.1.1.4   CUS.1.3   Supplier monitoring process

Component process of CUS.1 - Acquisition process

The purpose of the *Supplier monitoring process* is to monitor the supplier's activities during the development of the software product and/or service. As a result of successful implementation of the process:

— joint activities between the customer and the supplier will be performed as needed;

— information on technical progress will be exchanged regularly with the supplier;

— performance of the supplier will be monitored against the agreed requirements.

5.1.1.5   CUS.1.4   Customer acceptance process

Component process of CUS.1 - Acquisition process

The purpose of the *Customer acceptance process* is to approve the supplier's deliverable when all acceptance conditions are satisfied. As a result of successful implementation of the process:

— acceptance will be based on the acquisition strategy and conducted according to the agreed acceptance criteria;

— the delivered software product and/or service will be evaluated with regard to the agreed requirements.

5.1.1.6   CUS.2   Supply process

Basic process

The purpose of the *Supply process* is to provide software to the customer that meets the agreed requirements. As a result of successful implementation of the process:

— a response to customer's request will be produced;

— a contract will be established between the customer and the supplier for developing, packaging, delivering, and installing the software product and/or service;

— a software product and/or service that meets the agreed requirements will be developed by the supplier;

— the software product and/or service will be delivered to the customer and installed in accordance with the agreed requirements.

5.1.1.7 CUS.3 Requirements elicitation process

New process

The purpose of the *Requirements elicitation process* is to gather, process, and track evolving customer needs and requirements throughout the life of the software product and/or service so as to establish a requirements baseline that serves as the basis for defining the needed software work products. As a result of successful implementation of the process:

— continuing communication with the customer will be established;

— agreed customer requirements will be defined;

— a mechanism will be established to incorporate new customer requirements into the established requirements baseline;

— a mechanism will be established for continuous monitoring of customer needs;

— a mechanism will be established for ensuring that customers can easily determine the status and disposition of their requests;

— enhancements arising from changing technology and customer needs will be identified and their impact managed.

5.1.1.8 CUS.4 Operation process

Extended process

The purpose of the *Operation process* is to operate the software product in its intended environment and to provide support to the customers of the software product. As a result of successful implementation of the process:

— correct operation of the software in its intended environment will be evaluated;

— the software will be operated in its intended environment;

— assistance and consultation will be provided to the customers of the software product.

5.1.1.9 CUS.4.1 Operational use process

Extended component process of CUS.4 - Operation process

The purpose of the *Operational use process* is to ensure the correct and efficient operation of the software product for the duration of its intended usage and in its installed environment. As a result of successful implementation of the process:

— operational risks for the software introduction and operation will be identified and monitored;

— the software will be operated in its intended environment according to requirements;

— assurance will be provided that software capacities are adequate to meet customer needs.

5.1.1.10   CUS.4.2   Customer support process

Extended component process of CUS.4 - Operation process

The purpose of the *Customer support process* is to establish and maintain an acceptable level of service to the customer to support effective use of the software product. Assistance and consultation to the customer is provided as requested to support the operation of the software product. As a result of successful implementation of the process:

— customer support service needs will be identified and monitored on an ongoing basis;

— customer satisfaction with both the support services being provided and the product itself will be evaluated on an ongoing basis;

— operational support will be provided by resolving operational problems and handling customer inquiries and requests;

— customer needs will be met through delivery of appropriate services.

5.1.2   Engineering process category (ENG)

The *Engineering process category* consists of processes that directly specify, implement or maintain the software product, its relation to the system and its customer documentation. In circumstances where the system is composed totally of software, the Engineering processes deal only with the construction and maintenance of such software.

The processes belonging to the Engineering process category are:

    ENG.1   **Development process**

         ENG.1.1   **System requirements analysis and design process**

         ENG.1.2   **Software requirements analysis process**

         ENG.1.3   **Software design process**

         ENG.1.4   **Software construction process**

         ENG.1.5   **Software integration process**

         ENG.1.6   **Software testing process**

         ENG.1.7   **System integration and testing process**

    ENG.2   **System and software maintenance process**

5.1.2.1   ENG.1   Development process

Basic process

The purpose of the *Development process* is to transform a set of requirements into a functional software product or software-based system that meets the customer's stated needs. As a result of successful implementation of the process:

— a software product or software-based system will be developed;

— intermediate work products will be developed that demonstrate that the end product is based upon the requirements;

— consistency will be established between requirements and designs;

— evidence (for example, testing evidence) will be provided that demonstrates that the end product meets the requirements;

— the end product will be installed in the target operating environment and accepted by the customer.

NOTE   The requirements may be provided by operation of the *Acquisition process*, (CUS.1) or the *Requirements elicitation process* (CUS.3).

5.1.2.2   ENG.1.1   System requirements analysis and design process

Component process of ENG.1 - Development process

The purpose of the *System requirements analysis and design process* is to establish the system requirements (functional and non-functional) and architecture, identifying which system requirements should be allocated to which elements of the system and to which releases. As a result of successful implementation of the process:

— requirements of the system will be developed that match the customer's stated needs;

— a solution will be proposed that identifies the main elements of the system;

— the requirements will be allocated to each of the main elements of the system;

— a release strategy will be developed that defines the priority for implementing system requirements;

— the system requirements will be approved and updated as needed;

— the requirements, proposed solution, and their relationships will be communicated to all affected parties.

5.1.2.3   ENG.1.2   Software requirements analysis process

Component process of ENG.1 - Development process

The purpose of the *Software requirements analysis process* is to establish the requirements of the software components of the system. As a result of successful implementation of the process:

— the requirements allocated to software components of the system and their interfaces will be defined to match the customer's stated needs;

— analyzed, correct, and testable software requirements will be developed;

— the impact of software requirements on the operating environment will be understood;

— a software release strategy will be developed that defines the priority for implementing software requirements;

— the software requirements will be approved and updated as needed;

— consistency will be established between system requirements and design and software requirements;

— the software requirements will be communicated to all affected parties.

5.1.2.4   ENG.1.3   Software design process

Component process of ENG.1 - Development process

The purpose of the *Software design process* is to define a design for the software that implements the requirements and can be tested against them. As a result of successful implementation of the process:

— an architectural design will be developed that describes the major software components that will implement the software requirements;

— internal and external interfaces of each software component will be defined;

— a detailed design will be developed that describes software units that can be built and tested;

— consistency will be established between software requirements and software designs.

5.1.2.5 ENG.1.4 Software construction process

Component process of ENG.1 - Development process

The purpose of the *Software construction process* is to produce executable software units and to verify that they properly reflect the software design. As a result of successful implementation of the process:

— verification criteria will be defined for all software units against their requirements;

— software units defined by the design will be produced;

— consistency will be established between software requirements and design and software components;

— verification of the software units against the design will be accomplished.

NOTE   Part of this process is similar to the process *Verification process* (SUP.4).

5.1.2.6 ENG.1.5 Software integration process

Component process of ENG.1 - Development process

The purpose of the *Software integration process* is to combine the software units, producing integrated software items and to verify that the integrated software units properly reflect the software design. As a result of successful implementation of the process:

— an integration strategy will be developed for software units consistent with the release strategy;

— verification criteria for software items will be developed that ensure compliance with the software requirements allocated to the items;

— software items defined by the integration strategy will be produced;

— software items will be verified using the defined acceptance criteria;

— results of integration testing will be recorded;

— consistency will be established between software requirements and software items;

— a regression strategy will be developed for reverifying software items should a change in software units occur;

— regression testing will be carried out as necessary.

NOTE   Part of this process is similar to the process *Verification process* (SUP.4).

5.1.2.7 ENG.1.6 Software testing process

Component process of ENG.1 - Development process

The purpose of the *Software testing process* is to test the integrated software producing a product that will satisfy the software requirements. As a result of successful implementation of the process:

— acceptance criteria for integrated software will be developed that verify compliance with the software requirements;

— integrated software will be verified using the defined acceptance criteria;

— test results will be recorded;

— a regression strategy will be developed for retesting the integrated software should a change in software items be made;

— regression testing will be carried out as necessary.

5.1.2.8   ENG.1.7   System integration and testing process

Component process of ENG.1 - Development process

The purpose of the *System integration and testing process* is to integrate the software component with other components, such as manual operations or hardware, producing a complete system that will satisfy the customers' expectations expressed in the system requirements. The resources allocated to system integration should include someone familiar with the software component. As a result of successful implementation of the process:

— an integration strategy will be developed to build system unit aggregates according to the release strategy;

— acceptance criteria for each aggregate will be developed to verify compliance with the system requirements allocated to the units;

— system aggregates will be verified using the defined acceptance criteria;

— an integrated system demonstrating compliance with the system requirements (functional, non-functional, operations and maintenance) and validation that a complete set of useable deliverable components exists, will be constructed;

— test results will be recorded;

— a regression strategy will be developed for retesting aggregates or the integrated system should a change be made to existing components ;

— regression testing will be carried out as necessary.

NOTE   Part of this process is similar to the processes *Verification Process* (SUP.4) and *Validation process* (SUP.5).

5.1.2.9   ENG.2   System and software maintenance process

Basic process

The purpose of the *System and software maintenance process* is to manage modification, migration and retirement of system components (such as hardware, software, manual operations and network if any) in response to customer requests. The origin of requests might be a discovered problem or the need for improvement or adaptation. The objective is to modify and/or retire existing systems and/or software while preserving the integrity of organizational operations. As a result of successful implementation of the process:

— a maintenance strategy will be developed to manage modification, migration and retirement of system components according to the release strategy;

— the impact of organization, operations and interfaces on the existing system in operation will be defined;

— specifications, design documents and test strategies will be updated;

— modified system components will be developed with associated tests that demonstrate that the system requirements will not be compromised;

— system and software upgrades will be migrated to the customer's environment;

— on request, software and systems will be retired from use in a controlled manner that minimizes disturbance to the customers.

NOTE 1   The initial defined requirements may be provided by the *Requirements elicitation process* (CUS.3).

NOTE 2   This process interacts closely with other processes such as *Operation process* (CUS.4), *Customer support process* (CUS.4.2), and *Problem resolution process* (SUP.8).

5.2 Supporting life cycle processes

The **Supporting life cycle** processes consist of one process category:

SUP   Support
5.2.1   Support process category (SUP)

The *Support process category* consists of processes that may be employed by any of the other processes (including other supporting processes) at various points in the software life cycle.

The processes belonging to the Support process category are:

> **SUP.1   Documentation Process**
>
> **SUP.2   Configuration Management Process**
>
> **SUP.3   Quality Assurance Process**
>
> **SUP.4   Verification Process**
>
> **SUP.5   Validation Process**
>
> **SUP.6   Joint Review Process**
>
> **SUP.7   Audit Process**
>
> **SUP.8   Problem Resolution Process**

5.2.1.1   SUP.1   Documentation process

Extended process

The purpose of the *Documentation process* is to develop and maintain documents that record information produced by a process or activity. As a result of successful implementation of the process:

— a strategy identifying the documents to be produced during the life cycle of the software product will be developed;

— the standards to be applied for the development of documents will be identified;

— all documents to be produced by the process or project will be identified;

— the content and purpose of all documents will be specified, reviewed and approved;

— all documents will be developed and published in accordance with identified standards;

— all documents will be maintained in accordance with specified criteria.

NOTE   The process supports performance of the process attribute 2.2 in those instances where it is invoked.

5.2.1.2   SUP.2   Configuration management process

Basic process

The purpose of the *Configuration management process* is to establish and maintain the integrity of all the work products of a process or project. As a result of successful implementation of the process:

— a configuration management strategy will be developed;

— all items generated by the process or project will be identified, defined and baselined;

— modifications and releases of the items will be controlled;

— the status of the items and modification requests will be recorded and reported;

— the completeness and consistency of the items will be ensured;

— storage, handling and delivery of the items will be controlled.

NOTE   The process supports performance of the process attribute 2.2 in those instances where it is invoked.

5.2.1.3   SUP.3   Quality assurance process

Basic process

The purpose of the *Quality assurance process* is to provide assurance that work products and processes of a process or project comply with their specified requirements and adhere to their established plans. As a result of successful implementation of the process:

— a strategy for conducting the quality assurance process activities and tasks will be developed, implemented and maintained;

— evidence of quality assurance activities and tasks will be produced and maintained;

— problems or non-conformances with contract requirements will be identified;

— adherence of software products, processes and activities to the applicable standards, procedures and requirements will be verified objectively.

NOTE 1   To be unbiased, quality assurance must have organizational freedom and authority from persons directly responsible for developing the software product or executing the process.

NOTE 2   Quality assurance should be coordinated with, and may make use of, the results of other supporting processes such as Verification, Validation, Joint reviews, Audits, and Problem resolution.

NOTE 3   Establishment of a quality management system in accordance with ISO 9001 will establish a capable quality assurance process.

NOTE 4   The process supports performance of the process attributes 2.1 and 2.2 in those instances where it is invoked.

5.2.1.4   SUP.4   Verification process

Basic process

The purpose of the *Verification process* is to confirm that each software work product and/or service of a process or project properly reflects the specified requirements. As a result of successful implementation of the process:

— a verification strategy will be developed and implemented;

— criteria for verification of all required software work products will be identified;

— required verification activities will be performed;

— identified defects will be found and removed from software work products;

— results of the verification activities will be made available to the customer and other involved organizations.

NOTE 1   The process supports performance of the process attribute 2.1 and 2.2 in those instances where it is invoked.

NOTE 2   The process normally involves the performance of testing of the work products to ensure that they fulfil their intended use.

NOTE 3   The process is closely linked with performance of the *Software testing process* (ENG.1.6) and *System integration and testing process* (ENG.1.7).

NOTE 4   ISO/IEC 12207 contains specific requirements for the content of the verification plan.

NOTE 5   ISO/IEC 12207 contains specific criteria for verification activities that are dependent on the object of the verification activity.

NOTE 6   The process may involve performance of techniques including peer reviews, formal proof and traceability analysis, among others.

5.2.1.5   SUP.5   Validation process

Basic process

The purpose of the *Validation process* is to confirm that the requirements for a specific intended use of the software work product are fulfilled. As a result of successful implementation of the process:

—   a validation strategy will be developed and implemented;

—   criteria for validation of all required work products will be identified;

—   required validation activities will be performed;

—   all identified problems will be resolved;

—   evidence will be provided that the software work products as developed are suitable for their intended use;

—   results of the validation activities will be made available to the customer and other involved organizations.

NOTE 1   This process is closely linked with performance of the *System integration and testing process* (ENG.1.7).

NOTE 2   The process normally involves the performance of testing of the work products to ensure that they fulfil their intended use.

5.2.1.6   SUP.6   Joint review process

Basic process

The purpose of the *Joint review process* is to maintain a common understanding with the customer of the progress against the objectives of the contract and what should be done to help ensure development of a product that satisfies the customer. Joint reviews are at both project management and technical levels and are held throughout the life of the project. As a result of successful implementation of the process:

—   periodic reviews will be held at predetermined milestones;

—   the status and products of an activity of a process will be evaluated through joint review activities between the customers, suppliers and other stakeholders (or interested parties);

—   review results will be made known to all affected parties;

—   action items resulting from reviews will be tracked to closure.

NOTE 1   The process supports performance of the process attribute 2.1 in those instances where it is invoked.

NOTE 2   The process is most commonly invoked in circumstances where performance of a project is governed by a form of contract.

NOTE 3   ISO/IEC 12207 contains specific requirements for project management reviews and for technical reviews.

5.2.1.7   SUP.7   Audit Process

Basic process

The purpose of the *Audit process* is to independently determine compliance of selected products and processes with the requirements, plans and contract, as appropriate. As a result of successful implementation of the process:

— an audit strategy will be developed and implemented;

— audits will be held at predetermined milestones;

— compliance of selected software work products and/or services or processes with requirements, plans and contract will be determined according to the audit strategy;

— the conduct of audits by an appropriate independent party will be arranged;

— problems detected during an audit will be identified, communicated to those responsible for corrective action, and resolved.

NOTE 1   The process supports performance of the process attribute 2.1 in those instances where it is invoked.

NOTE 2   This process may be employed by any two parties, where one party (auditing party) audits the software products or activities of another party (audited party).

NOTE 3   ISO/IEC 12207 identifies specific software work products (and results of an activity) to be audited.

5.2.1.8   SUP.8   Problem resolution process

Basic process

The purpose of the *Problem resolution process* is to ensure that all discovered problems are analyzed and resolved and that trends are recognized. As a result of successful implementation of the process:

— the problem resolution activities will be identified to ensure that all discovered problems are analyzed and resolved;

— problem reports will be prepared upon detection of problems (including non-conformances) in a software product or activity;

— a mechanism will be provided for recognizing and acting on trends in problems identified.

NOTE   The process supports performance of the process attributes 2.1 and 2.2 in those instances where it is invoked.

5.3 Organizational life cycle processes

The **Organizational life cycle** processes consist of two process categories:

MAN   Management

ORG   Organization

5.3.1   Management process category (MAN)

The *Management process category* consists of processes that contain practices of a generic nature that may be used by anyone who manages any type of project or process within a software life cycle.

The processes belonging to the Management process category are:

    MAN.1 Management Process

    MAN.2 Project Management Process

      MAN.3 Quality Management

      MAN.4 Risk Management

5.3.1.1 MAN.1 Management process

Basic process

The purpose of the *Management process* is to organize, monitor, and control the initiation and performance of any processes or functions within the organization to achieve their goals and the business goals of the organization in an effective manner. As a result of successful implementation of the process:

— the activities and tasks that must be performed to achieve the purpose of the process or function will be identified;

— the feasibility of achieving process goals with available resources and constraints will be evaluated;

— the resources and infrastructure required to perform the identified activities and tasks will be established;

— activities will be identified and tasks will be implemented;

— performance of the defined activities and tasks will be monitored;

— work products resulting from the process activities will be reviewed and results analyzed and evaluated;

— action will be taken to modify the performance of the process or function when performance deviates from the identified activities and tasks or fails to achieve their goals;

— successful achievement of the purpose of the process or function will be demonstrated.

NOTE   This process supports performance of the process attributes 2.1 and 2.2 in those instances where it is invoked.

5.3.1.2 MAN.2 Project management process

New process

The purpose of the *Project management process* is to identify, establish, coordinate and monitor activities, tasks and resources necessary for a project to produce a product and/or service meeting the requirements. As a result of successful implementation of the process:

— the scope of the work for the project will be defined;

— the feasibility of achieving the goals of the project with available resources and constraints will be evaluated;

— the tasks and resources necessary to complete the work will be sized and estimated;

— interfaces between elements in the project, and with other projects and organizational units, will be identified and monitored;

— plans for execution of the project will be developed and implemented;

— progress of the project will be monitored and reported;

— actions to correct deviations from the plan and to prevent recurrence of problems identified in the project will be taken when project targets are not achieved.

NOTE   This process supports performance of the process attribute 2.1 in those instances where it is invoked.

5.3.1.3   MAN.3   Quality management process

New process

The purpose of the *Quality management process* is to monitor the quality of the project's products and/or services and to ensure that they satisfy the customer. The process involves establishing a focus on monitoring the quality of product and process at both the project and organizational level. As a result of successful implementation of the process:

— quality goals based on the customer's stated and implicit quality requirements will be established for various checkpoints within the project's software life cycle;

— an overall strategy will be developed to achieve the defined goals;

— identified quality control and assurance activities will be performed and their performance confirmed;

— actual performance against the quality goals will be monitored;

— appropriate action will be taken when quality goals are not achieved.

NOTE 1   This process supports performance of the process attributes 4.1 and 4.2 in those instances where it is invoked.

NOTE 2   This process goes beyond the quality control and assurance activities performed in *Quality assurance process* (SUP.3), to provide an overall approach to meeting the stated and implicit requirements of the customer.

5.3.1.4   MAN.4   Risk management process

New process

The purpose of the *Risk management process* is to identify and mitigate the project risks continuously throughout the life-cycle of a project. The process involves establishing a focus on monitoring of risks at both the project and organizational levels. As a result of successful implementation of the process:

— the scope of the risk management to be performed for the project will be determined;

— appropriate risk management strategies will be defined and implemented;

— risks to the project will be identified in the project strategy, and as they develop during the conduct of the project;

— the risks will be analyzed and the priority in which to apply resources to monitor these risks will be determined;

— risk metrics will be defined, applied, and assessed to determine the change in the risk state and the progress of the monitoring activities;

— appropriate action will be taken to correct or avoid the impact of risk.

NOTE   This process supports performance of the process attribute 2.1 in those instances where it is invoked.

5.3.2   Organization process category (ORG)

The *Organization process category* consists of processes that establish the business goals of the organization and develop process, product, and resource assets which, when used by the projects in the organization, help the organization achieve its business goals. Although organizational operations in general have a much broader scope than that of software process, software processes are implemented in a business context and, to be effective, require an appropriate organizational environment. Taken together, these organizational processes:

— build organizational infrastructure;

— take advantage of the best of what is available(best practices) in any one part of the organization (effective processes, advanced skills, quality code, good support tools);

— make the organizational best practices available to the entire organization;

— provide a basis for continuous improvement across the organization.

The processes belonging to the Organization process category are:

> **ORG.1 Organizational alignment process**
>
> **ORG.2 Improvement process**
>
>> **ORG.2.1**   **Process establishment process**
>>
>> **ORG.2.2**   **Process assessment process**
>>
>> **ORG.2.3**   **Process improvement process**
>
> **ORG.3 Human Resource Management process**
>
> **ORG.4 Infrastructure process**
>
> **ORG.5 Measurement Process**
>
> **ORG.6 Reuse Process**

5.3.2.1   ORG.1   Organizational alignment process

New process

The purpose of the *Organizational alignment process* is to ensure that the individuals in the organization share a common vision, culture and understanding of the business goals to empower them to function effectively. Although business re-engineering and Total Quality Management have a much broader scope than that of software process, software process improvement occurs in a business context and, to be successful, must address business goals. As a result of successful implementation of the process:

— a vision, mission, goals and objectives for the business will be made known to all employees;

— everyone in the organization understands their role in achieving the goals of the business and is able to perform that role.

NOTE 1   The process is outside the scope of ISO/IEC 12207. Some reasons are:

– The issue of overall business culture is beyond the scope of ISO/IEC 12207.

– The tailoring process and the guidance on tailoring and relations between processes and organizations presented in the ISO/IEC 12207 annexes address some of the issues related to the *Organizational alignment process*;

– From the perspective of ISO/IEC 12207, the ramifications of implementation of the *Organizational alignment process* are implicit and expected to be built into the contract for any specific project.

NOTE 2   This process supports performance of the process attributes 4.1 and 5.2 in those instances where it is invoked.

5.3.2.2   ORG.2   Improvement process

Basic process

The purpose of the *Improvement process* is to establish, assess, measure, control and improve a software life cycle process. As a result of successful implementation of this process:

— a set of organizational process assets will be developed and made available;

— the organization's process capability will be assessed periodically to determine the extent to which process implementation is effective in achieving the organization's goals;

— the effectiveness and efficiency of the organization's processes with respect to business goal achievement will be improved on an ongoing basis.

5.3.2.3 ORG.2.1 Process establishment process

Component process of ORG.2 - Improvement process

The purpose of the *Process establishment process* is to establish a suite of organizational processes for all software life cycle processes as they apply to its business activities. As a result of successful implementation of the process:

— a defined and maintained standard set of processes will be established, along with an indication of each process's applicability;

— the detailed tasks, activities and associated work products of the standard process will be identified, together with expected performance characteristics;

— a strategy for tailoring the standard process for the product or service will be developed in accordance with the needs of the project;

— information and data related to the use of the standard process for specific projects will exist and be maintained.

NOTE   This process supports performance of the process attribute 3.1 in those instances where it is invoked.

5.3.2.4 ORG.2.2 Process assessment process

Component process of ORG.2 - Improvement process

The purpose of the *Process assessment process* is to determine the extent to which the organization's standard software processes contribute to the achievement of its business goals and to help the organization focus on the need for continuous process improvement. As a result of successful implementation of the process:

— an efficient and effective process assessment method will exist to determine the current capability of the organization and its processes to produce products and services consistent with its business goals;

— the relative strengths and weaknesses of the organization's standard software processes will be understood;

— accurate and accessible assessment records will be kept and maintained;

— reviews of the organization's standard processes will be carried out at appropriate intervals to ensure their continuing suitability and effectiveness in light of assessment results.

NOTE   ISO/IEC TR 15504-3 defines an approach to the performance of this process.

5.3.2.5 ORG.2.3 Process improvement process

Component process of ORG.2 - Improvement process

The purpose of the *Process improvement process* is to continually improve the effectiveness and efficiency of the processes used by the organization in line with the business need. As a result of successful implementation of the process:

— changes to standard and defined processes will be made in a controlled way, with predictable results;

— the organization will effect improvements to its processes through activities such as process assessment and review;

— monitored software process improvement activities will be implemented in a coordinated manner across the organization;

— historical, technical and evaluation data will be analyzed and used to improve these processes, to recommend changes in projects, and to determine technology advancement needs;

— quality cost data will be collected, maintained, and used to improve the organization's processes as a monitoring activity, and to serve to establish the cost of prevention and resolution of problems and non-conformity in software products and services.

NOTE   This process supports performance of the process attributes 5.1 and 5.2 in those instances where it is invoked.

5.3.2.6   ORG.3   Human resource management process

Extended process

The purpose of the *Human resource management process* is to provide the organization and projects with individuals who possess skills and knowledge to perform their roles effectively and to work together as a cohesive group. As a result of successful implementation of the process:

— the roles and skills required for the operations of the organization and the project will be identified through timely review of the organizational and project requirements;

— training will be identified and conducted to ensure that all individuals have the skills required to perform their assignments, using mechanisms such as training strategies and materials;

— individuals with the required skills and competencies will be identified and recruited using mechanisms such as procedures, or they will be trained as appropriate to perform the organizational and project roles;

— effective interaction between individuals and groups will be supported;

— the work force will have the skills to share information and coordinate their activities efficiently;

— objective criteria will be defined against which group and individual performance can be monitored to provide performance feedback and to enhance performance.

NOTE   This process supports performance of the process attribute 3.2 in those instances where it is invoked.

5.3.2.7   ORG.4   Infrastructure process

Basic process

The purpose of the *Infrastructure process* is to maintain a stable and reliable infrastructure that is needed to support the performance of any other process. The infrastructure may include hardware, software, methods, tools, techniques, standards, and facilities for development, operation, or maintenance. As a result of successful implementation of the process:

— an infrastructure will be established that is consistent with and supportive of the applicable process procedures, standards, tools and techniques;

— the infrastructure will meet all requirements for functionality, performance, safety, security, availability, space, equipment, cost, time and data integrity.

NOTE   This process supports performance of the process attribute 3.2 in those instances where it is invoked.

5.3.2.8   ORG.5   Measurement Process

New process

The purpose of the *Measurement process* is to collect and analyze data relating to the products developed and processes implemented within the organizational unit, to support effective management of the processes, and to objectively demonstrate the quality of the products. As a result of successful implementation of the process:

— an appropriate set of measurements driven by the project and organizational goals will be identified;

⎯ data required will be collected and analyzed;

⎯ a collection of historical data relating to process implementation will be established and maintained;

⎯ measurements will be used to support decisions and provide an objective basis for communication between the interested parties.

NOTE 1   The process supports performance of the process attributes 4.1 and 4.2 in those instances where it is invoked.

NOTE 2   This process is closely linked to the *Project management process* (MAN.2).

5.3.2.9   ORG.6   Reuse process

New process

The purpose of the *Reuse process* is to promote and facilitate the reuse of new and existing software work products from an organizational and product/project perspective. As a result of successful implementation of the process:

⎯ reuse strategies will be defined;

⎯ reuse activities will be identified and established;

⎯ a reuse infrastructure (e.g., networks, configuration management, repositories, etc.) will be established and maintained.

6   The capability dimension

The capability dimension of the reference model defines a measurement scale for the process capability of any process. Process capability is defined on a six point ordinal scale that enables capability to be assessed from the bottom of the scale, **Incomplete**, through to the top end of the scale, **Optimizing**. The scale represents increasing capability of the performed process from performance that is not capable of achieving its process outcomes through to performance that is capable of meeting relevant process and improvement goals that are explicitly derived from the organization's business goals. The scale therefore defines a well-defined route for improvement for each individual process.

Within the capability dimension of the reference model, the measure of capability is based upon a set of process attributes (PA). Process attributes are used to determine whether a process has reached a given capability. Each attribute measures a particular aspect of the process capability. The attributes are themselves measured on a percentage scale and therefore provide a more detailed insight into the specific aspects of process capability required to support process improvement and capability determination.

NOTE 1   Although this measurement model may be applied to both a basic process and any of its component processes, there is no implied direct relationship between the capabilities of any of these processes. The preparation phase of an assessment should determine which processes - basic or its components - will be assessed. Guidance on this activity is contained in ISO/IEC TR 15504-4.

NOTE 2   The term, "process outcome", defined in Clause 5, is used extensively in Clause 6.

6.1 Level 0: Incomplete process

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

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

6.2 Level 1: Performed process

The implemented process achieves its process outcomes.

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

6.2.1 PA 1.1 Process performance attribute

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

⎯ the scope of work to be performed and work products to be produced are understood;

⎯ work products will be produced that support the achievement of the process outcomes;

6.3 Level 2: Managed process

The previously described *Performed process* now executes in a managed fashion (planned, tracked, verified and adjusted) based upon defined objectives.

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

6.3.1 PA 2.1 Performance management attribute

The extent to which the performance of the process is managed to produce work products that meet the defined objectives. As a result of full achievement of this attribute:

⎯ the objectives for the performance of the process will be identified (e.g. quality, time-scale, cycle time and resource usage);

⎯ the responsibility and authority for developing the work products of the process will be assigned;

⎯ the performance of the process will be managed to produce work products that meet the defined objectives.

6.3.2 PA 2.2 Work product management attribute

The extent to which the performance of the process is managed to produce work products that are appropriately documented, controlled and verified. As a result of full achievement of this attribute:

⎯ the requirements (functional and non-functional) of the specified work products of the process will be defined;

⎯ the requirements for the documentation and control of the work products will be defined;

⎯ the dependencies among the controlled work products will be identified;

⎯ work products will be appropriately identified and documented, and changes will be controlled.;

⎯ the work products will be verified and adjusted to meet the defined requirements.

6.4 Level 3: Established process

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

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

6.4.1 PA 3.1 Process definition attribute

The extent to which the performance of the process uses a process definition based upon a standard process to achieve the process outcomes. As a result of full achievement of this attribute:

⎯ a standard process including appropriate guidance on tailoring will be defined, that supports the execution of the managed process;

⎯ performance of the process will be conducted in accordance with appropriately selected and/or tailored standard process documentation;

— historical process performance data will be gathered to establish and refine the understanding of the process behaviour (e.g. in order to estimate the process performance resource needs);

— experiences of using the defined process will be used to refine the standard process.

6.4.2 PA 3.2 Process resource attribute

The extent to which the process draws upon suitable resources (for example, human resources and process infrastructure) that is appropriately allocated to deploy the defined process. As a result of full achievement of this attribute:

— roles, responsibilities and competencies required for performing the process will be identified and documented;

— the process infrastructure required for performing the process will be identified and documented;

— the required resources will be available, allocated and used to support the performance of the defined process.

6.5 Level 4: Predictable process

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

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

6.5.1 PA 4.1 Measurement attribute

The extent to which product and process goals and measures are used to ensure that performance of the process supports the achievement of the defined goals in support of the relevant business goals. As a result of full achievement of this attribute:

— product and process goals and measures will be identified in line with relevant business goals;

— product and process measures will be collected to monitor the extent to which the defined goals are met;

— process performance trends across the organization will be analyzed;

— process capability will be measured and maintained across the organization.

6.5.2 PA 4.2 Process control attribute

The extent to which the process is controlled through the collection, analysis, and use of product and process measures to correct, where necessary, the performance of the process to achieve the defined product and process goals. As a result of full achievement of this attribute:

— suitable analysis and control techniques will be identified;

— in-process product and process measures will be collected and analyzed to support control of process performance within defined limits;

— process performance will be managed quantitatively.

6.6 Level 5: Optimizing process

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

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

6.6.1   PA 5.1 Process change attribute

The extent to which changes to the definition, management and performance of the process are controlled to achieve the relevant business goals of the organization. As a result of full achievement of this attribute:

— the impact of all proposed changes will be assessed against the defined product and process goals of the defined and standard processes;

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

— the effectiveness of process change on the basis of actual performance will be evaluated against the defined product and process goals and adjustments made as needed.

6.6.2   PA 5.2 Continuous improvement attribute

The extent to which changes to the process are identified and implemented to ensure continuous improvement in the fulfilment of the relevant business goals of the organization. As a result of full achievement of this attribute:

— the process improvement goals for the process will be defined that support the relevant business goals of the organization;

— the sources of real and potential problems will be identified;

— improvement opportunities will be identified;

— an implementation strategy will be established and deployed to achieve the process improvement goals across the organization.

NOTE   For a process to attain the attributes associated with capability levels 2 to 5 there is usually a dependency on the performance of one or more of the processes in the Support, Management and Organization process categories defined in clause 5. The Managed level attributes are associated with the processes in the Management and Support process categories and the Established, Predictable and Optimizing level attributes with the processes in the Organization process category. Part 5 illustrates examples of suitable indicators to provide the objective evidence required to determine the attribute ratings.

6.7 Rating process attributes

6.7.1   Process attribute rating scale

A process attribute represents a measurable characteristic of any process as defined above.

The rating scale is a percentage scale from zero to one hundred percent that represents the extent of achievement of the attribute.

6.7.2   Process attribute rating scale calibration

The ordinal rating scale defined below shall be used to calibrate the levels of achievement of the defined capability of the process attributes.

N   Not achieved:

0% to 15% - There is little or no evidence of achievement of the defined attribute in the assessed process.

P   Partially achieved:

16% to 50% - There is evidence of a sound systematic approach to and achievement of the defined attribute in the assessed process. Some aspects of achievement may be unpredictable.

L   Largely achieved:

51% to 85% - There is evidence of a sound systematic approach to and significant achievement of the defined attribute in the assessed process. Performance of the process may vary in some areas or work units.

F Fully achieved:

86% to 100% - There is evidence of a complete and systematic approach to and full achievement of the defined attribute in the assessed process. No significant weaknesses exist across the defined organizational unit.

6.7.3 Process attribute ratings

Each process attribute assessed in an organizational unit, up to and including the highest capability level defined in the assessment scope, shall be accorded a rating using the attribute scale defined above.

NOTE   The set of process attribute ratings for a process forms the process profile for that process. The output of an assessment includes the set of process profiles for all assessed processes.

6.7.4 Referencing of process attribute ratings

Each process attribute rating shall be given a reference that records the process name and the process attribute assessed.

The identifier used shall enable the objective evidence used to determine the rating to be identified.

NOTE   The ratings may be represented in any format, such as a matrix or as part of a database, provided that the representation allows the identification of individual ratings according to this referencing scheme.

6.8 Process capability level model

6.8.1 Achievement of process capability levels

The capability level achieved by a process shall be derived from the attribute ratings for that process according to the process capability level model defined in table 2.

NOTE   The purpose of this requirement is to ensure uniformity of meaning when a process capability level is quoted for a process.

Table 2 — Capability level ratings

Scale	Process Attributes	Rating
Level 1	Process Performance	Largely or fully
Level 2	Process Performance	Fully
	Performance Management	Largely or fully
	Work Product Management	Largely or fully
Level 3	Process Performance	Fully
	Performance Management	Fully
	Work Product Management	Fully
	Process Definition and Tailoring	Largely or fully
	Process Resource	Largely or fully
Level 4	Process Performance	Fully
	Performance Management	Fully
	Work Product Management	Fully
	Process Definition and Tailoring	Fully
	Process Resource	Fully
	Process Measurement	Largely or fully
	Process Control	Largely or fully

Table 2 — Capability level ratings *(continued)*

Scale	Process Attributes	Rating
Level 5	Process Performance	Fully
	Performance Management	Fully
	Work Product Management	Fully
	Process Definition and Tailoring	Fully
	Process Resource	Fully
	Process Measurement	Fully
	Process Control	Fully
	Process Change	Largely or fully
	Continuous Improvement	Largely or fully

7 Compatibility with the reference model

7.1 Introduction

This part of ISO/IEC TR 15504 provides a route for the harmonization or migration of models for process assessment with the reference model. The requirements for compatibility enable comparison of outputs from assessments using different models and methods. This clause defines the requirements to be met by a model in order to claim compatibility with the reference model.

ISO/IEC TR 15504-5 contains an exemplar compatible model that meets the requirements of this clause. The exemplar model should be taken as an example of the level of detail that is necessary within an operational compatible model to enable reliable and repeatable performance of assessments.

7.2 Model purpose

A model shall be based on good software engineering and process management principles and be suitable for the purpose of assessing software process capability.

7.3 Model scope

7.3.1 A model shall encompass all, or a non-empty subset, of the set of processes in the process dimension of the reference model.

7.3.2 A model shall address all, or a continuous subset, of the levels (starting at level 1) of the capability dimension of the reference model for all of the processes within its scope.

It would be permissible for a model, for example, to address solely level 1, or to address levels 1, 2 and 3, but it would not be permissible to address levels 2 and 3 without level 1.

7.3.3 A model shall declare its scope of coverage in the terms of both the process and capability dimensions of the reference model.

7.4 Model elements and indicators

7.4.1 A model shall be based on a set of elements that explicitly address the purposes, as defined in the reference model, of all the processes within the scope of the model, and that demonstrate the achievement of the process attributes within the capability level scope of the model.

7.4.2 In the process dimension, the detailed elements of the model shall constitute a set of indicators of process performance that focus attention on the effective implementation of processes through their work products.

7.4.3 In the capability dimension, the detailed elements shall constitute a set of indicators of process capability that focus attention on the process management practices that realize the process attributes.

7.5 Mapping

7.5.1 A model shall provide an explicit mapping from the fundamental elements of the model to the processes and process attributes of the reference model.

7.5.2 The mapping shall be complete, clear and unambiguous and shall substantiate the declaration of the scope of coverage.

7.5.3 In the process dimension, the mapping shall include the mapping of the indicators of process performance within the model to the purposes of the processes in the reference model.

7.5.4 In the capability dimension, the mapping shall include the mapping of the indicators of process capability within the model to the definitions of the process attributes in the reference model.

The mapping requirement enables assessment models that are structurally different to be related to the reference model.

7.6 Translation

A compatible model shall provide a formal and verifiable mechanism for converting data collected against the compatible model into a set of process attribute ratings for each reference model process directly or indirectly assessed as defined in 6.7 of this part of ISO/IEC TR 15504, and in ISO/IEC TR 15504-3.

Annex A
(informative)

Mapping of ISO/IEC 12207 to the reference model

Table A.1 — 12207 to 15504 Mapping

12207	12207 Processes & activities	15504	15504 processes	Type
5.	*Primary life cycle processes*			
5.1	Acquisition process	CUS.1	Acquisition process	basic
5.1.1	Initiation	CUS.1.1	Acquisition preparation process	component
5.1.2	Request-for-Proposal [-tender] preparation	CUS.1.2	Supplier selection process	component
5.1.3	Contract preparation and update	CUS.1.2	Supplier selection process	component
5.1.4	Supplier monitoring	CUS.1.3	Supplier monitoring process	component
5.1.5	Acceptance and completion	CUS.1.4	Customer acceptance process	component
5.2	Supply process	CUS.2	Supply process	basic
5.2.1	Initiation	CUS.2	Supply process	basic
5.2.2	Preparation of response	CUS.2	Supply process	basic
5.2.3	Contract	CUS.2	Supply process	basic
5.2.4	Planning	CUS.2	Supply process	basic
5.2.5	Execution and control	CUS.2	Supply process	basic
5.2.6	Review and evaluation	CUS.2	Supply process	basic
5.2.7	Delivery and completion	CUS.2	Supply process	basic
		CUS.3	Requirements elicitation process	new
5.3	Development process	ENG.1	Development process	basic
5.3.1	Process implementation	ENG.1	Development process	basic
5.3.2	System requirements analysis	ENG.1.1	System requirements analysis and design process	component
5.3.3	System architectural design	ENG.1.1	System requirements analysis and design process	component
5.3.4	Software requirements analysis	ENG.1.2	Software requirements analysis process	component
5.3.5	Software architectural design	ENG.1.3	Software design process	component
5.3.6	Software detailed design	ENG.1.3	Software design process	component
5.3.7	Software coding and testing	ENG.1.4	Software construction process	component

Table A.1 — 12207 to 15504 Mapping *(continued)*

12207	12207 Processes & activities	15504	15504 processes	Type
5.3.8	Software integration	ENG.1.5	Software integration process	component
5.3.9	Software qualification testing	ENG.1.6	Software testing process	component
5.3.10	System integration	ENG.1.7	System integration and testing process	component
5.3.11	System qualification testing	ENG.1.7	System integration and testing process	component
5.3.12	Software installation	CUS.2	Supply process	basic
5.3.13	Software acceptance support	CUS.2	Supply process	basic
5.4	Operation process	CUS.4	Operational use process	basic
5.4.1	Process implementation	CUS.4.1	Operational use process	extended component
5.4.2	Operational testing	CUS.4.1	Operational use process	extended component
5.4.3	System operation	CUS.4.1	Operational use process	extended component
5.4.4	User support	CUS.4.2	Customer support process	extended component
5.5	Maintenance process	ENG.2	System and software maintenance process	basic
5.5.1	Process implementation	ENG.2	System and software maintenance process	basic
5.5.2	Problem and modification analysis	ENG.2	System and software maintenance process	basic
5.5.3	Modification implementation	ENG.2	System and software maintenance process	basic
5.5.4	Maintenance review/acceptance	ENG.2	System and software maintenance process	basic
5.5.5	Migration	ENG.2	System and software maintenance process	basic
5.5.6	Software retirement	ENG.2	System and software maintenance process	basic
6.	*Supporting life cycle processes*			
6.1	Documentation process	SUP.1	Documentation process	extended
6.1.1	Process implementation	SUP.1	Documentation process	extended
6.1.2	Design and development	SUP.1	Documentation process	extended
6.1.3	Production	SUP.1	Documentation process	extended

Table A.1 — 12207 to 15504 Mapping *(continued)*

12207	12207 Processes & activities	15504	15504 processes	Type
6.1.4	Maintenance	SUP.1	Documentation process	extended
6.2	Configuration management process	SUP.2	Configuration management process	basic
6.2.1	Process implementation	SUP.2	Configuration management process	basic
6.2.2	Configuration identification	SUP.2	Configuration management process	basic
6.2.3	Configuration control	SUP.2	Configuration management process	basic
6.2.4	Configuration status accounting	SUP.2	Configuration management process	basic
6.2.5	Configuration evaluation	SUP.2	Configuration management process	basic
6.2.6	Release management and delivery	SUP.2	Configuration management process	basic
6.3	Quality assurance process	SUP.3	Quality assurance process	basic
6.3.1	Process implementation	SUP.3	Quality assurance process	basic
6.3.2	Product assurance	SUP.3	Quality assurance process	basic
6.3.3	Process assurance	SUP.3	Quality assurance process	basic
6.3.4	Assurance of quality systems	SUP.3	Quality assurance process	basic
6.4	Verification process	SUP.4	Verification process	basic
6.4.1	Process implementation	SUP.4	Verification process	basic
6.4.2	Verification	SUP.4	Verification process	basic
6.5	Validation process	SUP.5	Validation process	basic
6.5.1	Process implementation	SUP.5	Validation process	basic
6.5.2	Validation	SUP.5	Validation process	basic
6.6	Joint review process	SUP.6	Joint review process	basic
6.6.1	Process implementation	SUP.6	Joint review process	basic
6.6.2	Project management reviews	SUP.6	Joint review process	basic
6.6.3	Technical reviews	SUP.6	Joint review process	basic
6.7	Audit process	SUP.7	Audit process	basic
6.7.1	Process implementation	SUP.7	Audit process	basic
6.7.2	Audit	SUP.7	Audit process	basic
6.8	Problem resolution process	SUP.8	Problem resolution process	basic
6.8.1	Process implementation	SUP.8	Problem resolution process	basic
6.8.2	Problem resolution	SUP.8	Problem resolution process	basic
7.	*Organizational life cycle processes*			
7.1	Management process	MAN.1	Management process	basic

Table A.1 — 12207 to 15504 Mapping *(continued)*

12207	12207 Processes & activities	15504	15504 processes	Type
7.1.1	Initiation and scope definition	MAN.1	Management process	basic
7.1.2	Planning	MAN.1	Management process	basic
7.1.3	Execution and control	MAN.1	Management process	basic
7.1.4	Review and evaluation	MAN.1	Management process	basic
7.1.5	Closure	MAN.1	Management process	basic
		MAN.2	Project management process	new
		MAN.3	Quality Management Process	new
		MAN.4	Risk Management Process	new
		ORG.1	Organizational alignment process	new
7.2	Infrastructure process	ORG.4	Infrastructure process	basic
7.2.1	Process implementation;	ORG.4	Infrastructure process	basic
7.2.2	Establishment of the infrastructure	ORG.4	Infrastructure process	basic
7.2.3	Maintenance of the infrastructure	ORG.4	Infrastructure process	basic
7.3	Improvement process	ORG.2	Improvement process	basic
7.3.1	Process establishment	ORG.2.1	Process Establishment process	component
7.3.2	Process assessment	ORG.2.2	Process assessment process	component
7.3.3	Process improvement	ORG.2.3	Improvement process	component
7.4	Training process	ORG.3	Human Resource management process	extended
7.4.1	Process implementation	ORG.3	Human Resource management process	extended
7.4.3	Training plan implementation	ORG.3	Human Resource management process	extended
7.4.2	Training material development	ORG.3	Human Resource management process	extended
		ORG.5	Measurement process	new
		ORG.6	Reuse process	new

Annex B
(informative)

Process and process attribute tables

Table B.1 — Processes and process categories

Process Category		Process	
ID	**Title**	**ID**	**Title**
Primary Life Cycle processes			
CUS	**Customer Supplier process category**		
		CUS.1	Acquisition (basic)
		CUS.1.1	Acquisition preparation (component)
		CUS.1.2	Supplier selection (component)
		CUS.1.3	Supplier Monitoring (component)
		CUS.1.4	Customer Acceptance (component)
		CUS.2	Supply (basic)
		CUS.3	Requirements Elicitation (new)
		CUS.4	Operation (extended)
		CUS.4.1	Operational use (extended component)
		CUS.4.2	Customer support (extended component)
ENG	**Engineering process category**		
		ENG.1	Development (basic)
		ENG.1.1	System requirements analysis and design (component)
		ENG.1.2	Software requirements analysis (component)
		ENG.1.3	Software design (component)
		ENG.1.4	Software construction (component)
		ENG.1.5	Software integration (component)
		ENG.1.6	Software testing (component)
		ENG.1.7	System integration and testing (component)
		ENG.2	System and software maintenance (basic)

Table B.1. - Processes and process categories *(continued)*

Process Category		Process	
ID	Title	ID	Title
Supporting Life Cycle processes			
SUP	**Support process category**		
		SUP.1	Documentation (extended)
		SUP.2	Configuration management (basic)
		SUP.3	Quality assurance (basic)
		SUP.4	Verification (basic)
		SUP.5	Validation (basic)
		SUP.6	Joint review (basic)
		SUP.7	Audit (basic)
		SUP.8	Problem resolution (basic)
Organizational Life Cycle processes			
MAN	**Management process category**		
		MAN.1	Management (basic)
		MAN.2	Project management (new)
		MAN.3	Quality Management (new)
		MAN.4	Risk Management (new)
ORG	**Organization process category**		
		ORG.1	Organizational alignment (new)
		ORG.2	Improvement process (basic)
		ORG.2.1	Process establishment (component)
		ORG.2.2	Process assessment (component)
		ORG.2.3	Process improvement (component)
		ORG.3	Human resource management (extended)
		ORG.4	Infrastructure (basic)
		ORG.5	Measurement (New)
		ORG.6	Reuse (New)

Table B.2 — Capability levels and process attributes

ID	Title
Level 1	**Performed Process**
PA 1.1	Process performance attribute
Level 2	**Managed Process**
PA 2.1	Performance management attribute
PA 2.2	Work product management attribute
Level 3	**Established Process**
PA 3.1	Process definition attribute
PA 3.2	Process resource attribute
Level 4	**Predictable Process**
PA 4.1	Process measurement attribute
PA 4.2	Process control attribute
Level 5	**Optimizing Process**
PA 5.1	Process change attribute
PA 5.2	Continuous improvement attribute

Annex C
(informative)

Style guide for defining processes

This Annex describes the guidelines to be used when extending process definitions or defining additional processes.

A process description consists of several components:

a) a process identifier (e.g. CUS.1, CUS.1.1);

b) the name of the process (e.g., Supplier selection process);

c) the process type;

d) a first paragraph stating the purpose of the process;

e) additional optional paragraphs;

f) a list of descriptions of the outcomes of the process;

g) optional informative notes regarding the process and its relation to other processes and elements of ISO/IEC TR 15504-2.

C.1 Process identifier

The process identifier appears on same line as and immediately before name of process.

The process identifier identifies its process category and number within that category. The numbering scheme distinguishes between top-level processes and second-level processes.

Process identifiers consist of two components: a process category abbreviation and a number:

⎯ The abbreviation is the initial three letters of the first word in the name of the category.

⎯ The number is a sequence number for the process, using a simple decimal representation to distinguish between top-level and second-level processes (e.g. within the Customer Supplier Category (CUS) the Acquisition Process is CUS.1 and the Supplier Selection Process (a second-level process which is a component process of Acquisition) is CUS.1.2).

C.2 Name of process

The name of the process should identify what the process is concerned with.

The name should be a descriptive phrase, which encapsulates the principal concern of the process. Examples are the Supply process, the Development process, the Software design process.

Name of process appears on same line and immediately following the process identifier.

C.3 Type of process

There are five types of process. 3 top-level (basic, extended and new) and 2 second-level (component and extended component) and these are as follows:

a) *Basic*   Processes identical in intent to the processes in ISO/IEC 12207;

b) *Extended*   Processes that are expansions of ISO/IEC 12207 processes;

c) *New*   Processes that are outside the scope of ISO/IEC 12207;

d) *Component* Processes that contain a group of one or more activities from a single process in ISO/IEC 12207;

e) *Extended component*   Processes that contain one or more activities from a single process in ISO/IEC 12207, with additional material. These would normally be *Component* processes of *Extended* processes.

The process type appears alone, on the line following the process identifier and name, and should be given as *Basic process, New process, Extended process, Component process (of process id, process name)*, or *Extended component process (of process id, process name).*

C.4 Process purpose

A single paragraph stating the purpose of performing the process describing at a high level the overall objectives of performing the process. This is the first paragraph following the process type.

C.5 Additional optional paragraphs

Additional paragraphs as appropriate that:

—— clarify what was said in the purpose paragraph;

—— describe inputs/outputs to other processes;

—— describe when the process is invoked; and/or

—— give the correct terminology.

C.6 Descriptions of the outcomes of the process

A process outcome is an observable result of the successful implementation of a process. The process outcomes for each process are contained in a list which appears in the description of each process immediately after the phrase, "As a result of successful implementation of the process:". By evaluating the attainment of the process outcomes, an assessor can form a judgment of the capability of the process.

Process outcomes will normally be worded as descriptive statements. An outcome statement will describe one of the following:

—— production of an artefact;

—— a significant change of state;

—— meeting of specified constraints - e.g., requirements, goals, etc.

Process outcomes cover performance of the relevant activities from ISO/IEC 12207.

C.7   Optional informative notes

One or more informative notes regarding the relationship between the process and other processes, and other elements of ISO/IEC TR 15504-2 (e.g., capability levels) can be added.