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Life Cycle Management — System Life Cycle Processes

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Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Introduction

The composition and nature of present day systems have changed. Almost every present-day system contains, is modelled by, and/or is supported by computer technology. This increasing utilization of the computer and software has led to new opportunities but also to new problems. As a result, the combination of hardware, software and humans has increased system complexities to an unprecedented level. This necessitates a fresh viewpoint.

There are several factors contributing to these complexities. Some are due to the inherent differences among hardware, software and humans. Others are essentially due to a lack of harmonization and integration of the involved disciplines such as science, engineering, management and finance. This situation has created difficulties in the management and engineering of systems. There is a definite need for a common framework that can be used to improve communication and cooperation between divers disciplines and enable modern systems to be created, utilized and managed in an integrated, coherent fashion. This International Standard provides such a common framework.

The framework covers the life cycle of man-made systems, created and utilized for the benefit of man. This life cycle spans the conception of ideas through to the retirement of a system. It provides the processes for acquiring and supplying system products and services that are configured from one or more of the following types of system component: hardware, software and humans. In addition, this framework provides for the assessment and improvement of the life cycle.

The processes in this International Standard form a comprehensive set from which an organization may construct life cycle models appropriate to the product and service types and markets in which they trade. An organization, depending on its purpose, can select and apply an appropriate subset to fulfil that purpose.

This International Standard may be used in one or more of the following modes:

(a) By an organization -- to establish an environment of desired processes that can be supported by an infrastructure of methods, procedures, techniques, tools and trained personnel. The organization may then employ this environment to run and control its projects and progress systems through their life cycle stages. This mode may be used to assess conformance of a declared, established environment with this International Standard.

(b) By a project, within an organization -- to select, structure, employ and perform the elements of the established environment to provide products and services. This mode may be used also to assess conformance of the project with the declared, established environment.

(c) By an acquirer and a supplier, via an agreement -- to select, agree on and perform the processes and activities in this International Standard. This mode may also be used to assess conformance of the acquirer's and the supplier's performances with the agreement.

This International Standard contains a Clause that describes the key concepts it uses, a normative Clause that defines the requirements for the System Life Cycle Processes, a Clause that provides an example of the use of Stages in life cycles and two Annexes: Annex A, which provides requirements for its tailoring; Annex B which shows its relationship with ISO/IEC 12207:1995.

Life Cycle Management — System Life Cycle Processes

1 Scope

1.1 Purpose

This International Standard establishes a common framework for describing the life cycle of systems and a complete set of well-defined processes and associated terminology. The processes may be applied throughout the life cycle for managing and performing the conception, development, production, utilization, support and retirement of systems. This is accomplished through the involvement of all interested parties with the ultimate goal of achieving customer satisfaction.

This International Standard also provides for the definition, control and improvement of the life cycle processes used within an organization or a project. An acquirer organization and a supplier organization may use this framework for acquiring and supplying systems products and services.

This International Standard concerns those systems that are man-made and are configured with one or more of the following: hardware, software and humans.

1.2 Field Of Application

This International Standard applies to the conception, development, production, utilization, support, and retirement of systems and to the acquisition and supply of system products and services, whether performed internally or externally to an organization.

There is a wide variety of systems in terms of their purpose, domain of application, complexity, size, novelty, adaptability, quantities, locations, life spans and evolution. This variety is apparent in the detail of the life cycles of systems. This standard is concerned with describing the processes that comprise the life cycle of any system and thus applies to one-of-a-kind systems, mass produced systems or customized adaptable systems.

The processes in this International Standard may be used as a basis for establishing business environments (methods, techniques and tools). This International Standard may be used by a single party itself in a self-imposed mode or in a multi-party situation. The parties may be from the same organization or from different organizations; the situation may range from an informal agreement to a formal contract.

1.3 Limitations

This International Standard does not detail the life cycle processes in terms of methods or procedures required to meet the objectives and requirements.

This International Standard does not detail the described documentation in terms of name, format, explicit content, and recording media of documentation.

This International Standard is intended neither to be in conflict with any organization’s policies, procedures, and standards nor with any National laws and regulations. However, any such conflict needs to be resolved before using this International Standard.

2 Conformance

The normative requirements in this International Standard are contained in Clause 6 and Annex A. There are three ways to conform or comply with the provisions of this International Standard. Any claim of conformance or compliance is cited in only one of the three forms described below:

2.1 Full Conformance

Full conformance for a declared set of processes is achieved by demonstrating that the requirements and outcomes or the requirements and objectives of the declared set of processes have been satisfied.

2.2 Tailored Conformance

When this standard is used as a basis for establishing a set of processes that do not qualify for full conformance, the clauses of the standard are to be selected in accordance with the tailoring process prescribed in Annex A. Tailored conformance means that the selected purpose and outcomes or requirements and outcomes have been satisfied.

2.3 Conformance With An Agreement

When this standard is used for an agreement between an acquirer and a supplier, clauses of the standard are selected for incorporation in the agreement in accordance with the tailoring process prescribed in Annex A. In this case, compliance with the agreement can be claimed, but conformance with the standard cannot be claimed.

3 Normative Reference(s)

The following standards contain provisions, which, through reference in this text constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9001: 2000 Quality Management Systems – Requirements.

ISO/IEC 12207: 1995 Life Cycle Management – Software Life Cycle Processes.

4 Term(s) and Definition(s)

4.1
acquirer
an organization that acquires or procures a system, product or service, from a supplier

NOTE an acquirer could be termed a buyer, customer, owner, user or purchaser

4.2
activity
a set of actions that consume time and resources and whose performance is necessary for a system to move from one event to the next

[Based on IEEE 610 Standard Computer Dictionary]

4.3
agreement
the mutual acknowledgement of terms and conditions under which a working relationship is conducted

4.4
baseline
a specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development, and that can be changed only through formal change control procedures

[IEEE 610 Standard Computer Dictionary]

4.5
data package
any related group of objects that is viewed or structured as a unit

[OED]

4.6
enabling system
system, other than the system of interest, that complements the system during its life cycle stages but does not contribute directly to its functionality, e.g. when the system enters the production stage, an (enabling) production system is required

NOTE Each enabling system has a life cycle of its own, which is initiated by the system of interest's requirement for it. This International standard is applicable to each enabling system when, in its own right, it is treated as the system of interest.

4.7
enterprise
that part of an organization responsible for meeting the needs of stakeholders in the organization, especially when trading a product or service in a competitive environment

4.8
facility
the physical means or equipment for facilitating the performance of an action, e.g. buildings, instruments, tools

4.9
life cycle
the evolution with time of the system from conception to disposal

4.10
life cycle model
a framework of processes and activities concerned with the life cycle, which also acts as a common reference for communication and understanding

4.11
operator
an individual or an organization who contributes to the functionality of a system and draws on knowledge and/or procedures to contribute the function

NOTE 1 The role of operator and the role of user may be vested, simultaneously or sequentially, in the same individual or organization.

NOTE 2 An individual operator combined with knowledge and/or procedures may be considered as a component of the system.

4.12
organization
a company, corporation, firm, enterprise or institution, or parts thereof, whether incorporated or not, public or private, that has it own functions and administration

4.13
process
a system of activities which use resources to transform inputs to outputs

[ISO 9000: 2000]

4.14
project
an undertaking with pre-specified objectives, magnitude and duration

[ISO 2382-20]

4.15
stage
the high level life cycle classification used to facilitate management of a system

NOTE 1 Stages may be overlapping

NOTE 2 Compare with phase groupings of activities and tasks by Project Management during the execution of a project activities

4.16
stakeholder
an interested party having a right, share or claim in the system or in its possession of qualities that meet their needs

4.17
subsystem
any system that is part of a larger system

[ISO 15026]

4.18
supplier
an organization that enters into a contract with the acquirer for the supply of a system, product or service

4.19
system
an object consisting of interrelated or interacting elements

[ISO 9000: 2000 CD2]

NOTE In practice, a system is 'in the eye of the beholder' and the interpretation of its meaning is frequently clarified by the use of an associative noun, e.g. product system, aircraft system. Alternatively the word system may be substituted simply by a context dependent synonym, e.g. product, aircraft, though this may then obscure a system principles perspective.

4.20
trade-off
decision making actions that select from various requirements and alternative solutions on the basis of net benefit to the stakeholders

4.21
user
individual or group who is the intended beneficiary of system use

NOTE This is commonly considered to include the suppliers and the operators of enabling systems.

4.22
validation
confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled

[ISO 9000: 2000]

4.23
verification
confirmation by examination and provision of objective evidence that specified requirements have been fulfilled

[ISO 9000: 2000]

5 Standard Overview

This Clause is included to highlight and to help explain essential concepts on which this International Standard is based. This Clause does not contain any application guidance.

5.1 Systems

The systems considered in this International Standard are man-made, created and utilized to provide services in defined environments for the benefit of users and other stakeholders. These systems may be composed of one or more of hardware, software, humans, associated processes and naturally occurring entities. In practice, they will be thought of as products or services.

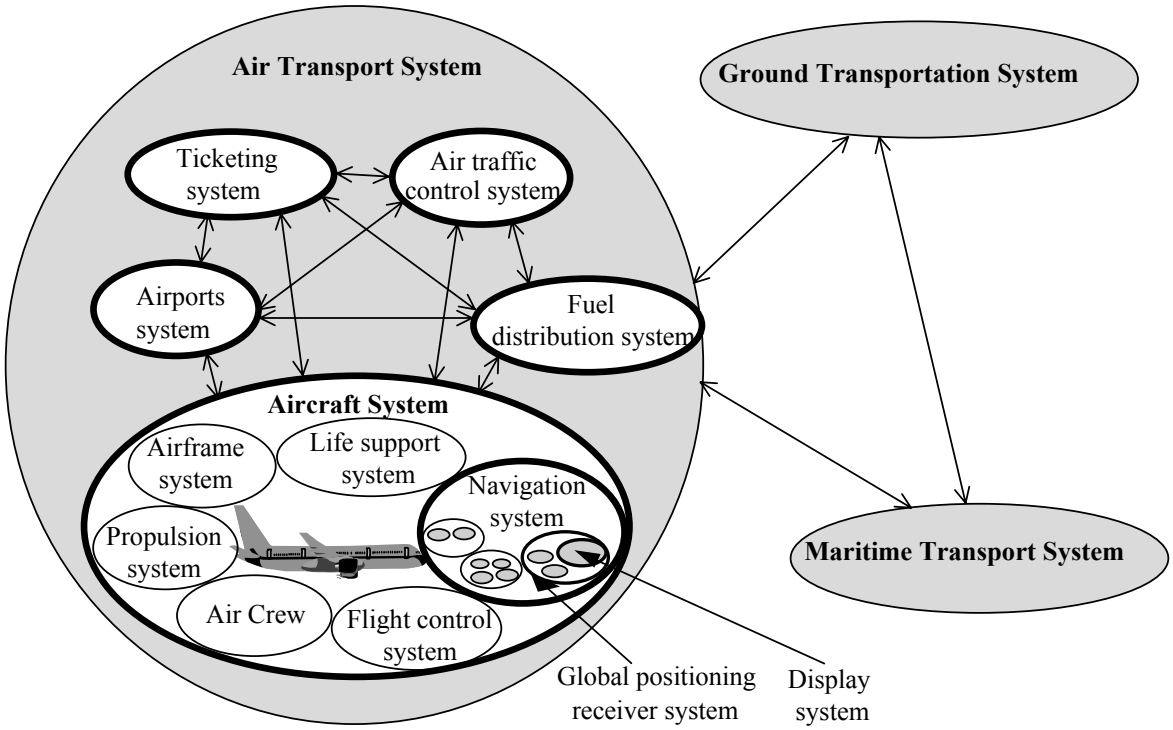

Figure 1 — Typical system view of the transportation sector

The perception and definition of a particular system, its architecture and its components depend on an observer's interests and responsibilities. Figure 1 exemplifies the multitude of perceivable systems in the transportation sector. It illustrates:

1) the importance of defined boundaries that encapsulate meaningful need and practical solution;

2) the hierarchical perception of system physical structure;

3) that an entity at any level in a hierarchical structure may be viewed as a system;

4) that a system comprises a fully integrated, defined set of subordinate systems, termed components;

5) the interactions between components that give rise to characteristic properties at a system's boundary;

6) that humans can be viewed as users external to a system, e.g. air crew and navigation system, and/or as a components within a system, e.g. air crew and aircraft;

7) that a system may be viewed both as a product (looking inward at its boundary) and a set of services (when viewed from outside its boundary).

Whatever the boundaries chosen to define the system, the concepts and models in this International Standard are generic and permit a practitioner to correlate or adapt individual instances of life cycles to its system principles.

In this International Standard humans are considered both as users and/or as components of a system. In the first case the human user is a beneficiary of the operation of the system. In the second case the human is an operator carrying out specified system functions. There are numerous reasons for including humans in systems, for example, because of their special skills, because of a need for flexibility, for legal purposes. Consequently, human component(s) contribute to the performance and characteristics of very many systems. Whether user or operator, humans are highly complex, with behaviour that is frequently difficult to predict, and they need protection from harm. This requires the System Life Cycle Process to address human element factors in the areas of: Human Factors Engineering, System Safety, Health Hazard Assessment, Manpower, Personnel and Training. These issues are addressed by particular activities and iteration in the life cycle, and are described in more detail in ISO 13407 and ISO TR 18529.

5.2 System Life Cycle Processes

Every system has a life cycle. The life cycle of a system begins with a conceptualization of a need for the system, progresses through its realization, utilization and evolution, and ends in its retirement. This progression of a system through its life cycle is achieved as the result of actions, performed and managed by people in organizations, using processes for their performance. These processes, termed Life Cycle Processes in this International Standard, may be invoked at any time during the life cycle. The functions they perform are defined in terms of specific purposes and outcomes, and the set of activities which constitute the process.

Life cycle are built from processes that are based on principles of modularity (maximal cohesiveness of the functions of a process and minimal coupling among processes) and ownership (a process is under a responsibility).

The detailed purpose and order of use of these processes throughout the life cycle is influenced by multiple factors, including social, trading, organizational and technical considerations, each of which may vary during the life of a system. An individual system life cycle is thus, itself, a complex system of processes that will normally possess concurrent, iterative, recursive and time dependent characteristics.

Figure 2 introduces the system life cycle processes. Each life cycle process can be invoked, as required, at any time throughout the life cycle and there is no definitive order in their use. The structure of presentation in Figure 2 does not therefore imply any precedence or sequence of application of the processes. The grouping, however, does reflect underlying models used in the International Standard.

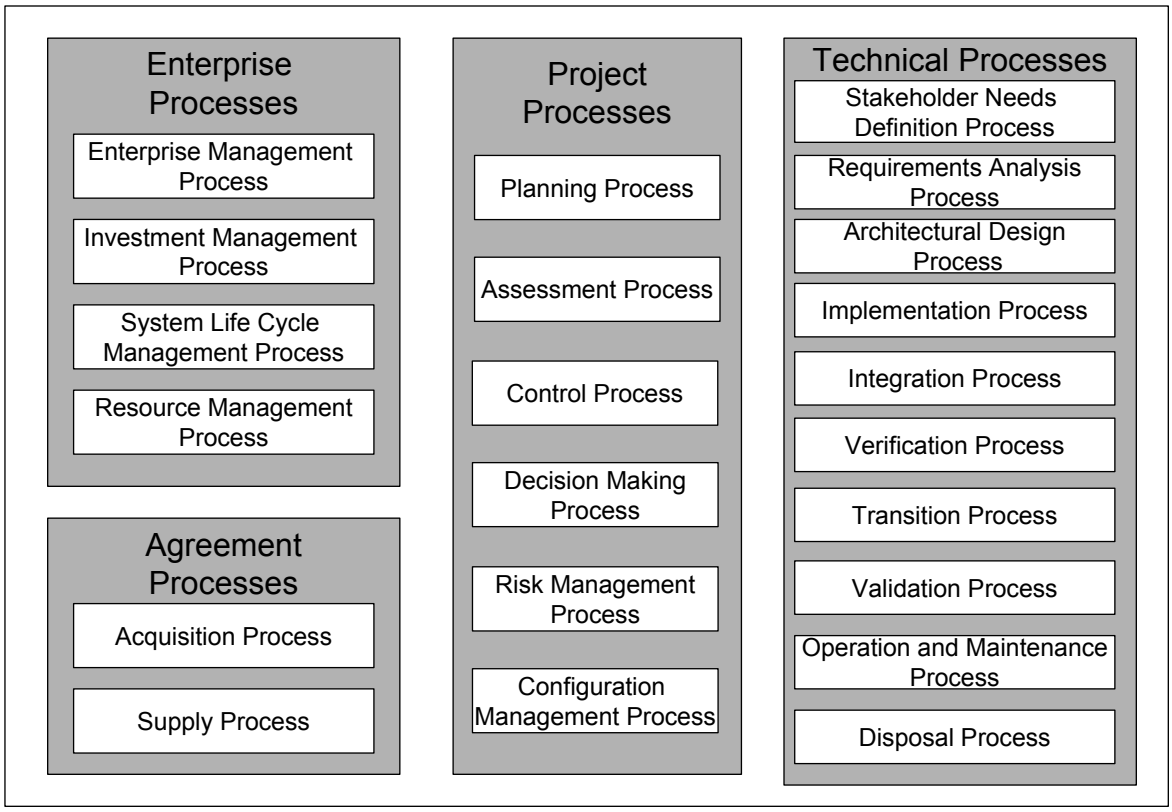

Figure 2 — The processes in the system life cycle

5.3 Organizational Interactions

Organizations are producers and consumers of systems, i.e. they trade products and services. One organization may, acting as an acquirer, task another, acting as a supplier, for products or services using an agreement. This is achieved using the Agreement Processes (see Figure 3).

Generally, organizations act simultaneously and/or successively as both acquirers and suppliers of systems. For example, in Figure 3, the vertical relationship of Organizations A and B may be considered to represent organizations in a supply chain, trading during a stage in a life cycle. Similarly, the horizontal relationship of Organizations A and C may be considered to represent organizations with successive responsibility for stages in a life cycle.

Typically, organizations distinguish different areas of managerial responsibility and action; together, these areas contribute to the organization's overall capability to trade. This International Standard employs a process model based on three primary organizational areas (or levels) of responsibility: enterprise, project and technical. Within each organization, a coordinated set of enterprise, project and technical processes contribute to the effective creation and use of systems, and therefore to achieving the organizations goals.

The Agreement Processes may be used with less formality to achieve intra-organization trading between different areas of responsibility (see Figure 3).

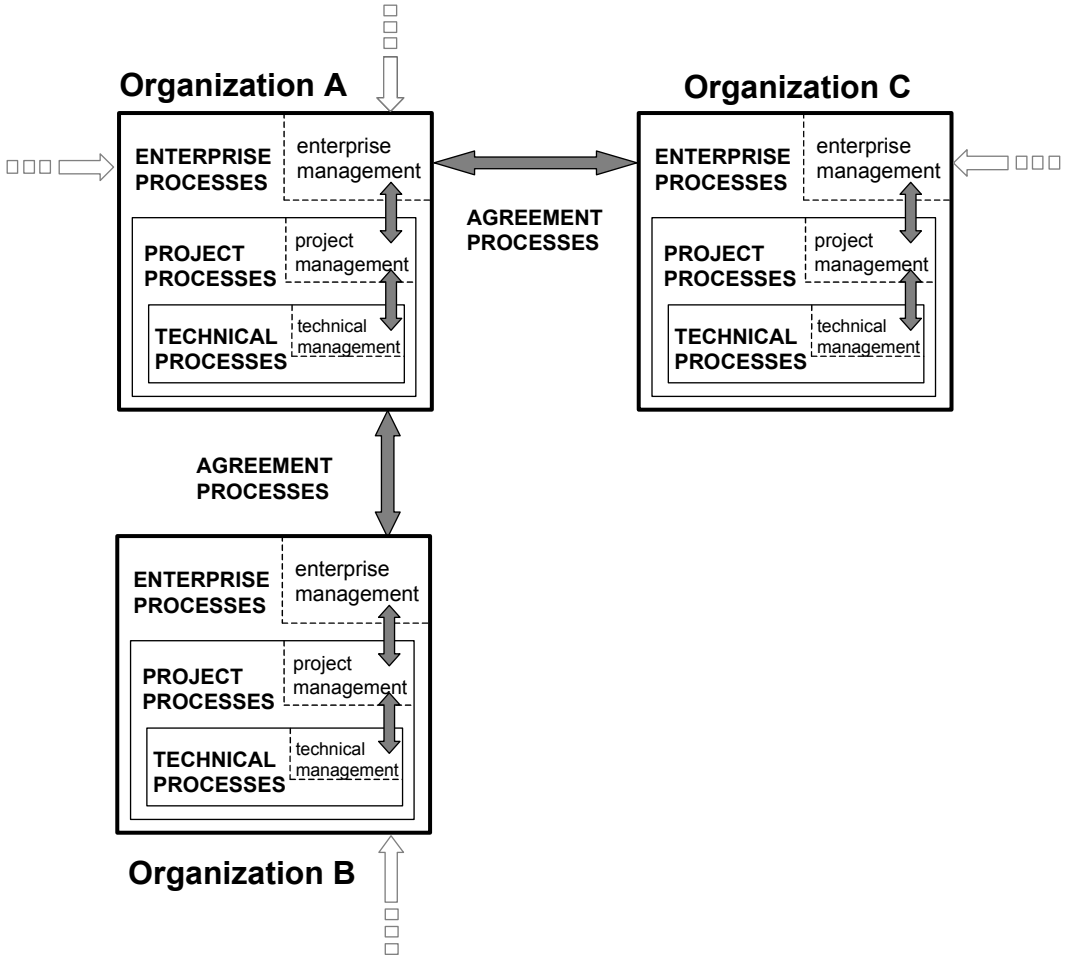

Figure 3 — Enterprise, project and technical functions in cooperating organizations

5.4 Enterprise, Project and Technical Processes.

The Enterprise Processes are concerned with ensuring that the needs and expectations of the organization's interested parties are met. The Enterprise Processes are typically concerned with the organization's business strategy, with its strategic provision/deployment of resources and assets and with its management of risks in competitive or uncertain situations, e.g. commercial markets. Responsibility for these processes is typically at the highest level in the organization.

The Enterprise Processes create a strong enterprise image for many organizations and imply commercial and profit-making motives. Nevertheless, the Enterprise Processes are equally relevant to non-profit organizations, who also are accountable to interested parties, are responsible for resources and encounter risk in their undertakings. This International Standard may thus be applied to non-profit organizations as well to profit-making organizations.

The Project Processes are concerned with managing the resources and assets allocated by enterprise management and with applying them to fulfil the agreements that the organization enters into. They relate to the management of projects, in particular to planning in terms of cost, timescales and achievements, to the checking of actions to ensure that they comply with plans and performance criteria, and to the identification and selection of corrective actions that recover progress and achievement. Typically several projects may co-exist in any one organization. The Project Processes may be employed to deliver, at a corporate level, the provision of an organization's infrastructure, e.g. facilities, services, technology base.

The Technical Processes are concerned with the actions that transform the needs of stakeholders first into a product and then, by applying that product, to providing a service as, when and where needed in order to achieve customer satisfaction. They are applied in order to create and use a system, whether it is in the form of a model or is a finished product, and they apply at any level in a hierarchy of systems.

5.5 Hierarchy in Systems, Projects and Process Use

Each system in the hierarchy illustrated in Figure 1 could be the responsibility of a separate project. Thus there may be (and typically is) a strong correlation between levels of detail in the architectural structure and levels of responsibility in a hierarchy of projects. Each project has responsibility for acquiring and using level(s) of system composition beneath it and creating and supplying to the level of system above it. Commonly, projects exist in separate organizations, and in this general case the vertical acquirer/supplier structure in Figure 3 emerges.

The processes in this International Standard may be used by any organization acquiring and using and/or creating and supplying a system and they apply at any level in a system's hierarchy. The outputs of one level, whether information, artefacts or services, are an input to the level below and result in a corresponding response, again information, artefact or service. The use (recursively) of the same underlying set of processes to describe an organization's business, project and technical actions at each level of detail in a system's architecture and is a key aspect of the application of this International Standard.

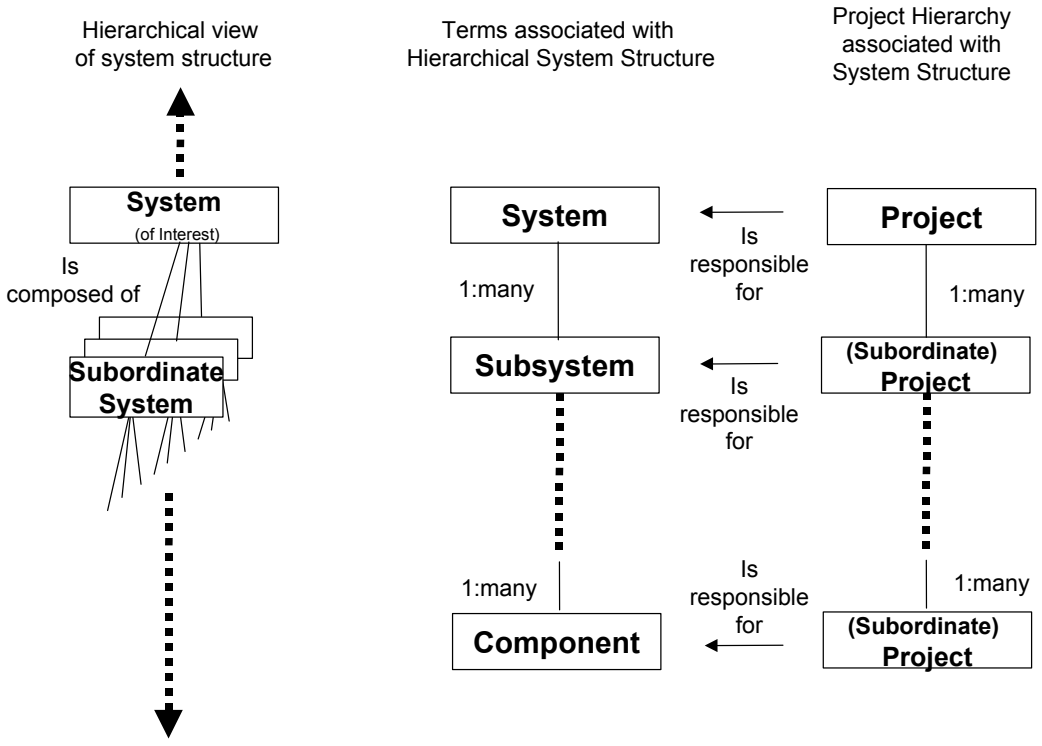

Figure 4 — System and Project Hierarchies

Any particular organization normally views its system as the system of interest, and whilst it may influence higher system levels it does not have responsibility for them. However, it does have responsibility for the subordinate systems that constitute its system of interest, and consequently for the output of projects at all levels beneath. However, in practice, the risks associated with acquiring subordinate systems typically diminish with descending level and eventually are no longer of undue concern to the particular organization. At this level (possibly different down different paths of system decomposition) a subordinate system is viewed as a component whose detail may remain hidden. Between the system (of interest) level and the component level, intermediate levels may remain a concern. They are

normally thought of as subsystems, having functional and structural detail that is important and cannot be hidden, and in which the particular organization is directly and actively involved.

NOTE 1 From the system level viewpoint, components often appear as being at the level where specialist disciplines or particular implementation technology practices contain the risks.

NOTE 2 A particular organization may have responsibility for a system and its subsystems (perhaps in different projects) and only acquire components from other organizations.

5.6 Life Cycle Stages

Life cycles vary according to the nature, purpose, use and prevailing circumstance of the system. Nevertheless, despite a necessary and apparently limitless variety in system life cycles, there is an underlying, essential set of characteristic life cycle stages that exists in the complete life cycle of any system. Each stage has a distinct purpose and contribution to the whole life cycle and is to be considered when planning and executing the system life cycle. The stages provide a framework within which enterprise management has high level visibility and control of the project and technical processes.

The stages describe the major progress and achievement milestones of the system through its life cycle; they give rise to the primary decision gates of the life cycle. These decision gates are used by organizations to contain the inherent uncertainties and risks associated with costs, schedule and functionality when they create or utilize a system.

LIFE CYCLE STAGES	PURPOSE	DECISION GATES
CONCEPT	Identify stakeholders' needs Explore concepts Propose viable solutions	Decision Options: - Execute next stage - Continue this stage - Go to previous stage - Hold project activity - Terminate project
DEVELOPMENT	Refine system requirements Create solution description Build system Verify and validate system	
PRODUCTION	Mass produce system Inspect and test	
UTILIZATION	Operate system to satisfy users' needs	
SUPPORT	Provide sustained system capability	
RETIREMENT	Store, archive or dispose the system	

Figure 5 — Life cycle stages, objectives and decisions

Figure 5 shows a commonly encountered example of life cycle stages. Also shown is the principal purpose(s) of each of these stages and the possible decision options used to manage the achievement and risk associated with progression through the life cycle.

Organizations employ stages differently to satisfy contrasting business and risk mitigation strategies. Using stages concurrently and in different orders can lead to life cycle forms with distinctly different characteristics. Sequential, incremental or evolutionary life cycles forms are frequently used; alternatively, a suitable hybrid of these may be developed. The selection and development of such life cycle forms by an organization depend on several factors, including the nature and complexity of the system, the stability of requirements, the technology opportunities, the need for different system capabilities at different times and the availability of budget and resources.

5.7 Life Cycle Dynamics

A system is synergistic, so too is its life cycle. Just as all the components of the system contribute to the system as a whole, so each stage of the life cycle needs to be considered during any other stage of the life cycle. As a consequence, the contributing parties need to coordinate and cooperate with each other throughout the life cycle. This synergism in the system, in its life cycle stages and amongst the functional contributors is necessary for successful enterprise, project and technical actions and, ultimately, for systems to fully meet needs in a sustainable manner.

The life cycle of a man-made system may be thus seen from two points of view. One view, that of the system itself, sees the actions and results of the processes progressing the system through its principal characteristic stages. The other view, that of organizational functions or roles, sees the life cycle processes as actions harmonized with the actions of other functional contributions at any point in the system's lifetime. These two perspectives are shown in Figure 6.

Personnel ↓ Contribute to →		LIFE CYCLE STAGES					
		CONCEPT	**DEVELOPMENT**	**PRODUCTION**	**UTILIZATION**	**SUPPORT**	**RETIREMENT**
ROLES	**CONCEIVERS**	Needs, Concepts, Feasibility	Consistency, Viability	Consistency, Viability	Consistency, Viability	Consistency, Viability	Consistency, Viability
	DEVELOPERS	Compatibility, Feasibility	Engineering, Solutions, Practicability	Consistency, Viability	Consistency, Viability	Consistency, Viability	Consistency, Viability
	PRODUCERS	Compatibility, Feasibility	Compatibility, Feasibility	Fabrication, Assembly, Verification	Consistency, Viability	Consistency, Viability	Consistency, Viability
	USERS	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Operation, Usage, Validation	Consistency, Viability	Consistency, Viability
	SUPPORTERS	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Installation, Maintenance, Logistics	Consistency, Viability
	RETIRERS	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Compatibility, Feasibility	Reuse, Archiving, Destruction

Figure 6 — Role views and system stages of the life cycle

The basic theme in Figure 6 is: perform the primary functions of the stage (shaded, diagonal boxes); coordinate the contributions of different functional contributors in each life cycle stage (the columns) ; keep in mind the decisions made in past stages and anticipate the needs of future stages (rows).

In Figure 6, each column represents the harmonized contributions of an integrated team, comprising contributions from (ideally) each different functional role and having responsibility for that stage (and possibly others) in the life cycle. Each row may be viewed as representing the through-life thinking and decision-making responsibilities of that contributing function or role, for example, consideration of the impact of current decisions on subsequent stages. The terms in the boxes describe the responsibilities of each organizational function or role at each stage in the life cycle.

NOTE The shaded sequence in Figure 5 gives rise to the 'waterfall' view of life cycles. This is a simplified and more restricted view of the system life cycle that does not convey the concepts and the benefits of integrated team contributions and through life thinking.

5.8 Enabling Systems

Throughout the life cycle of a system that is of interest, essential services are required from systems that are not directly a part of the operational environment, e.g. production system, training system. Each of these systems

enables a stage of the system of interest to be conducted and they facilitate progression through the system life cycle. These enabling systems contribute indirectly to the services provided by the system of interest when it is being utilized.

As with any system, an enabling systems also has its own life cycle. Each enabling system's life cycle is linked and synchronized to that of the system of interest, in particular, when a need for it is specified during conception of the system of interest, or later if lead times permit, and when the enabling system is operated to provide its particular service to the system of interest, see Figure 7.

Each enabling system may itself be considered as a system of interest, having in turn its own enabling systems, and this permits this International Standard to be applied to enabling systems.

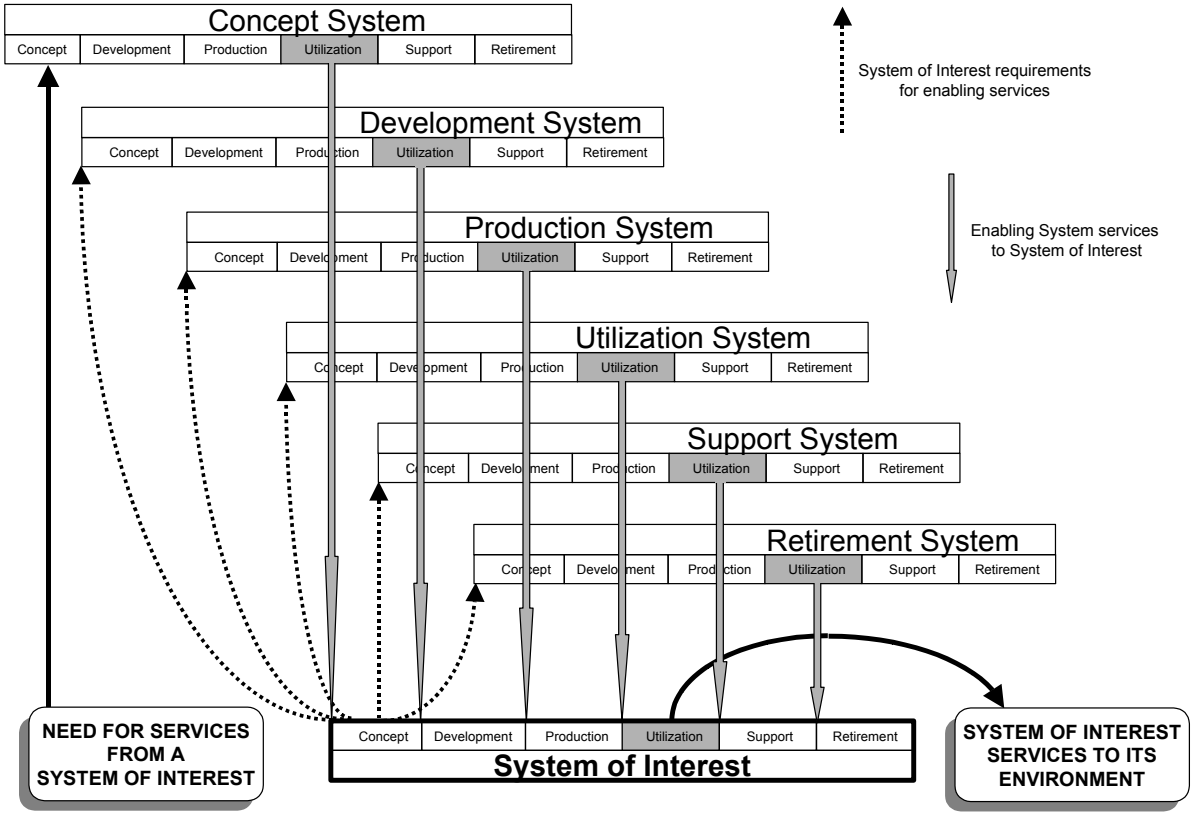

Figure 7 — System interaction with Typical Enabling Systems

6 System Life Cycle Processes

This Clause describes requirement for the four groups of life cycle processes. It defines their purposes and outcomes, and the activities required to achieve them. The processes are conducted selectively to fulfil the objectives of the stages. The four process groups are as follows:

1) Enterprise processes;

2) Agreement processes;

3) Project management processes;

4) Technical processes.

6.1 Enterprise Processes

The Enterprise Processes manage the organization's capability to acquire and supply system products or services through the initiation, support and control of projects. They provide the resources and infrastructure necessary to support projects and ensure the satisfaction of organizational objectives and established agreements.

The Enterprise Processes consist of the following:

1) Enterprise Management Process;

2) Investment Management Process;

3) System Life Cycle Management Process;

4) Resource Management Process.

6.1.1 Enterprise Management Process

6.1.1.1 Enterprise Management Purpose

The Enterprise Management Process defines, documents, and maintains the policies and procedures as needed for the organization's business with respect to the scope of this Standard.

6.1.1.2 Enterprise Management Outcomes

1) Strategic and tactical plans and objectives that guide the setting of policies and procedures for implementation of the requirements of this International Standard.

2) Policies and procedures for system life cycle management including quality management, assurance, and control in accordance with ISO 9001.

3) Roles, responsibilities and authorities to facilitate effective system life cycle management.

6.1.1.3 Enterprise Management Activities

The organization shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Enterprise Management Process.

1. Establish the enterprise strategic plans that identify the business objectives to be achieved, the areas of business to be pursued, and the significant goals to be accomplished.

2. Establish tactical plans for each business area that identify the short term objectives which contribute to achieving strategic objectives, and the projects that will be undertaken to accomplish the strategic objectives.

3. Prepare system life cycle policies and procedures that implement the requirements of this Standard and are consistent with strategic and tactical plans.

NOTE The actual range and detail of the system life cycle implementation within a project will be dependent upon the complexity of the work, the methods used, and the skills and training of personnel involved in performing the work. A project is expected to appropriately tailor policy and procedure implementation to project requirements.

4. Appoint a member of the organization's management who has defined authority for implementation of this International Standard. Define, integrate, and communicate the roles, responsibilities and authorities to facilitate implementation of system life cycle processes and effective system life cycle management.

5. Assess the impact of strategic and tactical plans to identify how the Enterprise must change in order to achieve its objectives. Prepare a plan for effecting the change and assign to change agents.

6. Define a schedule of internal audits of the system life cycle and related processes, review the system life cycle policies and procedures according to this plan to confirm their continuing suitability, adequacy and effectiveness, and make changes as appropriate.

7. Communicate the enterprise change management plan to all personnel, and implemented it to change jobs, infrastructure, work processes and operating procedures so that the Enterprise may continue to successfully execute the strategic and tactical plans and objectives.

6.1.2 Investment Management Process

6.1.2.1 Investment Management Purpose

The Investment Management Process wins business and initiates sufficient and suitable projects to sustain the organization's business. Projects are initiated, adequately funded, and their achievement monitored to confirm they deserve to continue.

6.1.2.2 Investment Management Outcomes

1) Qualification and selection of the right business opportunities.

2) Initiation of projects based on sound business practices, within the capability of the organization, and with acceptable risk and potential benefit to the organization.

3) Continuance of projects that are meeting agreement and stakeholder requirements.

4) Termination or redirection of projects not meeting agreement or stakeholder requirements.

5) Allocation of organization financial resources for approved projects.

6.1.2.3 Investment Management Activities

The organization shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Investment Management Process.

1. Establish new business opportunities, ventures or undertakings consistent with the business strategy and tactical plans of the organization.

2. Initiate new acquisition projects.

3. Initiate new supply projects.

4. Identify the expected outcomes of the projects.

5. Allocate resources for the achievement of project objectives.

6. Identify any multi-project interfaces which must be managed or supported by the project. This includes the use of enabling systems used by more than one project and the use of common components by more than one project.

7. Specify the project reporting, and review milestones which will govern the project's execution.

8. Evaluate ongoing projects to confirm that: a) projects are making progress towards achieving established outcomes; b) projects are complying with project directives; c) projects are being conducted according to established plans and procedures; and d) projects remain viable, for example continuing system need, practicable system implementation, acceptable investment benefits.

9. Consider cancellation or suspension of projects whose disadvantages to the organization and/or risks outweigh the benefits for continued investments.

6.1.3 System Life Cycle Processes Management Process

6.1.3.1 System Life Cycle Processes Management Purpose

The System Life Cycle Processes Management Process assures that the processes used across projects are consistent and that there is effective sharing and coordination of resources, information and technologies.

6.1.3.2 System Life Cycle Processes Management Outcomes

1) A standard set of processes and related methods and tools to be implemented in projects in accordance with organization policies and procedures.

2) Determination of the effectiveness, strengths and deficiencies of each process as applied by projects.

3) Improvements to enhance effectiveness of implemented standard processes.

4) Sharing of lessons learned among projects with respect to technologies, methods and tools.

5) Reduced risk exposure of the organization and its individual projects.

6.1.3.3 System Life Cycle Processes Management Activities

The organization shall implement the following activities in accordance with applicable organization policies and procedures with respect to the System Life Cycle Processes Management Process.

1. Establish standard sets of system life cycle processes for applicable system life cycle stages.

2. Establish acceptable tailoring policies and procedures, with approval requirements.

3. Deploy standard processes to projects through organization standards, guides, manuals, policies and procedures.

4. Establish metrics that determine performance of the implemented standard process.

5. Monitor process execution, store and analyze process metrics, and identify trends with respect to enterprise criteria.

6. Determine opportunities for improvement of standard process implementation.

7. Make necessary improvements to processes.

8. Determine and implement multi-project management aids such as: a) communication channels; b) use of existing off-the-shelf products and services in development or improvement projects; and c) convenient and reliable source of productivity-improving information for ongoing projects.

9. Control multi-project management interfaces to resolve schedule conflicts: a) of capacity in organizational infrastructure and supporting services and resources among ongoing projects and b) from project personnel serving on more than one project.

6.1.4 Resource Management Process

6.1.4.1 Resource Management Purpose

The Resource Management Process provides the services and resources needed to support organization goals and processes and project requirements, while meeting the needs of the organization's personnel.

6.1.4.2 Resource Management Outcomes

1) Establishment of appropriate resource services needed to establish, implement, and improve the implementation of projects.

2) Supply of educated, trained, and experienced personnel qualified to perform assigned process activities within projects.

6.1.4.3 Resource Management Activities

The organization shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Resource Management Process.

1. Maintain and manage the pool of personnel necessary to staff ongoing projects. Confirm the requisite training and skill enhancement activities are conducted to provide qualified staff to projects.

2. Recruit personnel with experience levels and skills necessary to properly staff projects, when existing staff is not available or not trainable to meet project needs.

3. Provide projects with personnel that have levels of competence, e.g. skills, experience, applicable education and training, appropriate to achieving conformity of the system, product and/or service.

4. Provide training and education to improve the skill set of personnel, and support the career paths for technical and project management personnel.

5. Evaluate the performance of personnel to determine their skill proficiency, their motivation and self-direction, their ability to work in a team environment, their readiness to accept more challenging positions, or their need to be retrained, reassigned or terminated.

6. Motivate staff, for example through career development and reward mechanisms.

7. Define and maintain information database(s) in order to implement the requirements of this Standard across the organization. Procedures for managing information consider access and protection of information to assure integrity and availability.

8. Determine and provide the resource infrastructure support needed to implement the requirements of this Standard within the organization and provide project support.

9. Define and implement those human and physical factors of the work environment needed to implement the requirements of this Standard within the organization.

6.2 Agreement Processes

This Subclause specifies the requirements for the establishment of agreements with organizational entities external to the organization and internal to the organization.

The Agreement Processes consist of the following:

a) Acquisition Process – used by acquiring organizations;

b) Supply Process – used by supplying organizations.

These processes define the activities necessary to establish an agreement between two organizations. If the Supply Process is invoked it provides the means for conducting a project in which the result is a product (system, subsystem, component) or a service which is delivered to the acquirer. If the Acquisition Process is invoked it provides the means for conducting business with a supplier of products which are delivered for use, as an operational system, in support of an operational system, or as an element of the system being developed by the project.

6.2.1 Acquisition Process

6.2.1.1 Acquisition Process Purpose

The Acquisition Process establishes an agreement to acquire system product and services, manages the acquirer/supplier relationship during acquisition and accepts system products and services delivered by a supplier.

6.2.1.2 Acquisition Process Outcomes

1) A selected supplier.

2) An agreement to acquire a system according to specified schedule, cost and performance criteria.

3) A definition of how and by whom responsibility for the acquired system will be assumed.

4) The acceptance of a system that conforms with the agreement.

5) Payment or other agreed consideration.

6.2.1.3 Acquisition Process Activities

The acquirer shall implement the following activities in accordance with applicable organizational policies and procedures with respect to the Acquisition Process:

1. Establish a plan for how the acquisition will be conducted, including reference to the life cycle model, a schedule of milestones and selection criteria for selecting a suitable supplier.

2. Prepare a request for proposal which details the products or services to be acquired, the business practices which suppliers are expected to comply with, and the selection criteria for selecting a supplier.

3. Release the request for proposal to one or more potential suppliers. In the case of several potential suppliers, this solicitation is announced in a manner that identifies potential suppliers and creates a fair competitive environment.

4. Evaluate and compare submitted proposals against the established selection criteria. The rationale for rating each proposal is documented for the record so that suppliers may be informed why they were not selected.

5. Negotiate an agreement between the acquirer and supplier. This agreement may range in formality from a legal and binding contract to a verbal understanding. Appropriate to the level of formality, the agreement establishes the product or service requirements, development and delivery milestones, acceptance conditions, exception handling procedures, and payment schedules so that both parties of the agreement understand the basis for

executing the agreement. Rights and restrictions associated with technical data, copyrights and patents are noted in the agreement. The negotiation is complete when the terms of an agreement offered by the supplier are accepted by the acquirer.

6. The acquirer monitors the execution of the agreement to confirm that the supplier is performing its duties according to the agreement. Projected cost, performance, or schedule risks are monitored, and the impact of undesirable outcomes on the organization evaluated. Variations to the terms of the agreement are re-negotiated as necessary.

7. The acquirer inspects, assesses or tests the delivered products or services to confirm that they comply with the agreement. When the supplied products or services have satisfied the conditions of the agreement, the acquirer concludes the agreement. Exceptions that arise during the conduct of the agreement or with the delivered products or services are resolved according to the procedures established in the agreement.

6.2.2 Supply Process

6.2.2.1 Supply Process Outcomes

The Supply Process establishes an agreement to supply a system, product or services, manages the supply and confirms that the system, product and services, is acceptable to an acquiring organization.

6.2.2.2 Supply Process Outcomes

1) An acquirer for a system.

2) An agreement for supply of a system according to specified timescales, cost and performance criteria.

3) The delivery of a system product and/or the establishment of a system service that conforms with the agreement.

4) Transfer of responsibility for the acquired system.

5) Receipt of payment or other consideration.

6.2.2.3 Supply Process Activities

The supplier shall implement the following activities in accordance with applicable organizational policies and procedures with respect to the Supply Process:

1. Establishes a plan for how to respond to a solicitation, including a schedule of milestones, and decision criteria for submitting a proposal.

2. Prepare a proposal which satisfies the solicitation, presents a sound plan for achieving the desired product or service performance objectives, is competitively priced and benefits the Supplier's interested parties.

NOTE The technical processes may need to be appropriately completed to arrive at a satisfactory/feasible concept on which to base the proposal.

3. The acquirer and supplier negotiate an agreement. This agreement may range in formality from a legal and binding contract to a verbal understanding. The Supplier confirms that the product or service requirements, development and delivery milestones and acceptance conditions are achievable, and that exception handling procedures and payment schedules are acceptable and establish a basis for executing the agreement without unnecessary risks.

4. Execute and conclude the agreement according to the Supplier's established project plans and in accordance with the negotiated agreement. This invokes the Supplier's project management and technical processes.

5. The Supplier monitors the execution of the agreement to confirm that it is performing its duties according to the agreement. Projected cost, performance, or schedule risks are monitored and the impact of undesirable outcomes on the organization are evaluated.

6.3 Project Management Processes

The project management processes are used to establish and evolve project plans, to assess actual achievement and progress against the plans and to control execution of the project through to fulfilment. Individual Project Management Processes may be invoked at any time in the life cycle and at any level in a hierarchy of projects, as required by plans or unforeseen events. The Project Management Processes may be applied with greater rigour and formality when projects involve high risk.

The Project Management Processes consist of the following processes:

a) Planning Process;

b) Assessment Process;

c) Control Process;

d) Decision Making Process;

e) Risk Management Process;

f) Configuration Management Process.

NOTE 1 The Planning, Assessment and Control Process together are key to all management practise. They correspond to the plan, check and act steps of the Plan, Do, Check, Act cycle evident in the management of any undertaking, ranging from a complete organization down to a single life cycle process and its activities. In this International Standard, the project has been chosen as the undertaking they are described in terms of. Nevertheless, their principles can be applied in any area of an organization's management (see Figure 3).

NOTE 2 In the project context, the Planning, Assessment and Control Process have a strategic nature and relate to key, usually recurrent, periods in the project's life. However, the processes for decision management, risk management, and configuration management are management actions that are continuously present throughout a project. These are independently defined in this International Standard.

6.3.1 Planning Process

6.3.1.1 Planning Process Purpose

The Planning Process is applied to scope the project activities, identify work packages, configuration items and deliverables, establish schedules for work package conduct, including technical plans, and allocate resources to accomplish work packages.

6.3.1.2 Planning Process Outcomes

1) Project planning information that defines budget and resource allocation, achievement schedules and the overall technical approach, including the technical process to be employed.

2) Roles, responsibilities and authorities of project team members.

3) Specification of materials, facilities and enabling system services necessary to achieve the plan.

4) Work directives to team members in accordance with project plan.

5) Project quality requirements and commitments.

6) Effective, workable quality management plans.

6.3.1.3 Planning Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Planning Process.

1. Identify the project objectives and constraints in terms of quality, cost, time and stakeholders satisfaction. Identify each objective with a level of detail that permits selection, tailoring and implementation of the appropriate processes and activities.

2. Define the project scope on the basis of the stages in the whole system life cycle. Confirm that the project includes all the relevant activities required to satisfy enterprise decision criteria and complete the project successfully.

3. Establish a work breakdown structure based on the system architecture. Describe each subsystem or component of the system architecture, appropriate processes and activities with a level of detail that is consistent with the identified project and product risks. Group related tasks in the work breakdown structure into work packages. Work packages identify the work items being developed and/or produced and the associated tasks to be performed.

4. Based on project goals and work estimates, establish a project schedule. This defines the duration and sequence of project activities, achievement milestones, resources employed and the reviews necessary to achieve timely completion of the project. Define the life cycle stage decision gates, delivery dates and major dependencies on external inputs or outputs. Define the time intervals between internal project reviews in accordance with organizational policy on issues such as business and product criticality, schedule and technical risks.

5. Establish the project costs based on, for example, the project schedule, labour estimates, infrastructure costs, procurement items, acquired service and enabling system estimates, and on budget reserves for risk management.

6. Establish the structure of authorities and assign responsibilities for project personnel, ensuring effective use of human resources and drawing on functions that contribute to all stages of the system life cycle. Define the project organization, staff acquisition, development of staff skill and methods of team working.

7. Define the infrastructure and services required by the project. Specify capacity, negotiate its availability and allocate it to project tasks. Include facilities, tools, communications and information technology assets. Specify enabling systems requirements for the life cycle stage.

8. Plan the acquisition of materials, goods and enabling system services supplied from outside the project. Include, as necessary, plans for solicitation, supplier selection, acceptance, contract administration and contract closure. Employ the agreement processes for the planned acquisitions.

9. Prepared a usability plan to describe how the system will be assessed to have achieved an acceptable level of customer satisfaction at each stage in the lifecycle.

NOTE The usability plan addresses, for each stage, which parts/aspects are to be studied, what scenario(s) (situations, customers, users, methods) explored, and how the study will be conducted (i.e. procedures, data gathering and analysis, criteria selection and results interpretation).

10. Define the project data to be generated and collected, identifying its source and timing. Define the data to be analyzed, identifying the schedule of analysis and the recipients of the resultant information, for example, relevant members of the project team, enterprise functions in the organization and customers, as agreed. Define the project information storage and archiving for audit and knowledge retention purposes paying due regard to the quality, integrity and security of this information.

11. Define project quality objectives that are consistent with the organization’s quality management system. Assure their achievement by establishing project quality management plans.

12. Define, establish, perform and maintain project quality management actions in accordance with ISO 9001 and with organization policies and procedures. Define and establish individual project factors requiring additional local quality assurance responsibilites, resouces and procedures.

6.3.2 Assessment Process

6.3.2.1 Assessment Process Purpose

The Assessment Process evaluates periodically and at major events, as defined by the project plans, the progress and achievements against plans and overall business objectives. It monitors risks relevant to the successful achievement of a project and the adherence to accepted professional practices and procedures. This process includes the conduct of technical reviews, reviews with enterprise management and reviews with customers. Where significant variances are detected, information is communicated for management action.

6.3.2.2 Assessment Process Outcomes

1) Status of technical progress and achievement against schedules.

2) Status of technical progress and achievement against resource utilization.

3) Status of technical progress and achievement against technical performance measures.

4) Predictions of costs and timescales to complete project tasks/achieve project deliveries.

5) Status of performance indicators selected by the project .

6) Project reports to enterprise management.

7) Reports (as agreed) to acquirers.

8) Current perception of risks.

9) Verified conformance to agreements.

10) Customer satisfaction information.

11) Quality status reports.

6.3.2.3 Assessment Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Assessment Process.

1. Assess the continuing consistency and relevance of project plans.

2. Assess project progress using defined project metrics, based on estimated achievement and milestone completion.

3. Collect and evaluate at planned times, actual or estimated labour, material and service costs and compare against project cost profiles and estimates.

4. Assess the effectiveness of the project team roles and structure, using where possible objective measures, e.g. project achievement, efficiency of resource use. Assess the adequacy of team member competencies and skills to satisfy project roles and accomplish project task. Assess the effectiveness and value of supporting training.

5. Evaluate the adequacy and availability of the project infrastructure and services at defined intervals to confirm that intra-organizational commitments are satisfied.

6. Monitor and evaluate the availability of acquired subsystem/components, materials and enabling system services. Determine variances with project schedule and cost estimates. Establish that no variance to cost, availability and performance specifications is anticipated or has occurred.

7. Evaluate the effectiveness of data gathering, processing and dissemination. Analyze variances between expected results and assessment results to detect trends and identify root causes. Assess the quality of the data gathered, the value of the information derived, its timeliness and its benefit to recipients.

8. Conduct reviews, audits and inspection against project plans in accordance with defined schedules to demonstrate conformance of actions and outcomes to the quality management plans. Define metrics being used and data gathered to permit objective assessment of customer satisfaction. Record non conformances of product, service and process.

6.3.3 Control Process

6.3.3.1 Control Process Purpose

The Control Process is applied to control project execution against plans, act to correct detected deviations, manage intermediate and final configuration items, manage risks threatening successful project completion and achieve readiness to proceed to the next stage of the system's life cycle. The Control Process manages the resolution of problems, the redirection of work to overcome obstacles, responses to changing circumstances and the corrective action to counter identified variances.

6.3.3.2 Control Process Outcomes

1) Intervention if variances in planned achievement exceeds agreed bounds.

2) Preventive and/or corrective actions that re-direct the project in order to achieve its objectives and minimize adverse consequences.

3) A requirement for project re-planning when project objectives or constraints have changed or when planning assumptions are shown to be invalid.

4) Project authorization to progress (or not) from one scheduled milestone or event to the next.

6.3.3.3 Control Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Control Process.

1. Define and perform corrective actions and/or preventive actions to achieve the goals and outputs of project tasks that have deviated outside acceptable or defined limits.

2. Evolve with time the scope, definition and the related work breakdown structure of the project in response to the corrective action decisions taken and the estimated changes they introduce.

3. Define and perform corrective actions and/or preventive actions to achieve quality objectives and related tasks, when deficiencies have been detected by assessments.

4. Re-allocate personnel to correct any inadequacy or unavailability.

5. Re-deploy and re-assign tools and project infrastructure assets when inadequacy or unavailability has been detected.

6. Act to correct defective provision of acquired goods and services through constructive interaction with supplier or by new supplier selection.

7. Define corrective actions and/or preventive actions to disseminate or improve dissemination of information. Define new metrics, data gathering and analysis where information provided fails to effectively detect non compliance, faults and adverse trends.

8. Take preventive and corrective actions in the case of non conformance by the system product or service to agreements and/or quality plans. Perform corrective actions to the implementation and execution of the life

cycle processes when non conformances are traced to them. Document these actions and review to confirm their adequacy and timeliness.

6.3.4 Decision Making Process

6.3.4.1 Decision Making Process Purpose

The Decision Making Process is employed to identify, analyze and resolve opportunities or problems, whatever their nature or source, encountered during the life cycle of a system. It identifies and selects in a timely manner from alternative courses of action in order to reach specified or optimized outcomes. It records decisions and their rationale to inform audits, variance analysis and future decision making.

6.3.4.2 Decision Making Process Outcomes

1) Problems and opportunities identified and recorded.

2) Corrective action to resolve problems.

3) Optimized courses of action.

4) Reports on resolution and decision rationale.

5) Record of problem and opportunity trends.

6.3.4.3 Decision Making Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Decision Making Process.

1. Define categories of decision and identify responsible parties. Define a prioritization scheme within and between the categories.

2. Report, categorize and record detected problems or opportunities promptly and objectively. Rank problems or opportunities in terms of their adverse or their beneficial impact in order to prioritize responses. Select and declare decision making strategies. Record, track and report problem and opportunity status.

3. Inform relevant parties of the existence of a problem or opportunity in order to draw on experience and knowledge. From changes, distinguishing or exceptional circumstances, event sequences, associations, experience, etc. isolate and describe the cause for a problem or opportunity.

4. Using the defined decision strategy, systematically evaluate courses of alternative action. Identify objective outcomes with measurable success criteria. In the case of problems, undertake corrective action to either eliminate the adverse event or to reduce its consequences to a level designated as tolerable by the party responsible for the decision category. In the case of opportunities, assess the balance of beneficial and adverse consequences of the alternative actions to arrive at an improvement in, or an optimization of, a current situation.

5. Maintain records of problems and their disposition as stipulated in agreements or organizational procedures. Evaluate dispositions of decisions and resultant actions to confirm that problems have been effectively resolved, adverse trends have been reversed and opportunities taken advantage of. Records decisions in a manner that permits auditing and learning from experience.

6.3.5 Risk Management Process

6.3.5.1 Risk Management Purpose

The Risk Management Process is conducted to identify, assess and mitigate hazards resulting from any uncertain event that may occur and result in adverse consequences to system cost, schedule and technical characteristics and thereby affect stakeholders.

6.3.5.2 Risk Management Outcomes

1) Risk management plan.

2) Risks identified, categorized, prioritized and status allocated.

3) Appropriate risk management strategies defined.

4) Action taken to mitigate or avoid the impact of risk.

6.3.5.3 Risk Management Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Risk Management Process.

1. Establish a risk management plan, to include the assumptions, responsibilities, review strategy and authorizations. Where appropriate, plan the actions to satisfy the requirements of regulatory bodies.

2. Define the risks in terms of their dimensions, e.g. technical, programmatic, organizational, financial, information quality. Within these dimensions, define the method for expressing risks in suitable terms.

3. Identify risks to predict what could go wrong and would adversely affect the system and the organization. Identify the initiating events associated with each risk in each risk category. Define the interrelationships between sources of risk where there is any coupling. This may be based on project/product histories, checklists, questionnaires and expert analysis.

4. Conduct a frequency analysis of initiating event occurrence to identify the likelihood of risk occurrence.

5. Evaluate the impact of the risks and define their possible adverse consequences. Prioritize the risks in terms of their likelihood and possible impact. Define a threshold of tolerability for each risk category.

6. Plan a response for each risk based in the tolerability of the event. This is based on the impact of the event on the system stakeholders, including acquiring and supplying organizations. Where tolerable, accept the risk and take no action. Where an avoidance strategy can be identified, and that action has a balance of cost, schedule and performance benefit to the organization, then take the avoidance action. Where neither of these actions is possible, follow a risk mitigation strategy.

7. Define metrics that measure change in risk state, e.g. residual financial/legal exposure of organization, and the progress of risk mitigation actions assessed. When initiating events occur, evaluate the level of success. Develop technical and business performance measurement plans, with appropriate metrics, and compared to best-in-class industry benchmarks to provide continuing verification of the effectiveness and degree of anticipated and actual achievement.

8. Maintain a register of risk throughout the life of the system. Define the current perception of risks, related to actions and budgets. This record maintains the history of the system risks in order to assist decisions, and becomes a reference for an evolving design or for future, related systems.

6.3.6 Configuration Management Process

6.3.6.1 Configuration Management Process Purpose

The Configuration Management Process is applied throughout the system life cycle in order to identify, define, record and baseline the definition of the system, its subsystems and components, to control their modification and release, record and report the status of modification requests, and ensure the continuing integrity of the system definition.

6.3.6.2 Configuration Management Process Outcomes

1) A configuration management plan.

2) System, subsystems and components identified, defined and baselined.

3) Controlled storage, handling and release of system, subsystems and components.

4) Record of modification requests and actions to system, subsystems and components and their status.

6.3.6.3 Configuration Management Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Configuration Management Process.

1. Define authorities for the deposition of, access to, release of and control of changes to configuration items. Define the locations of storage, their environment and, in the case of information, storage media in accordance with designated levels of integrity, security and safety. Define the criteria or events for commencing configuration control and baselining evolving configurations. Plan an audit schedule and the responsibilities for ensuring continuous integrity and security of the configured items.

2. Identify those system entities that are configuration control items. Distinguish them by unique, durable identifiers or markings, where appropriate according to relevant standards and product sector conventions, such that the configured items are unambiguously traceable to their specifications or equivalent, documented descriptions.

3. Record and hold configuration information with an appropriate level of integrity and security, taking into account the nature of the configured items. Document the authorities and permissions relating to a configuration state of an item under configuration control together with the data identifying and describing the configuration. Configuration descriptions conform, where possible, to product or technology standards. Ensure that configuration information permits forwards and backwards traceability to other baselined configuration states.

4. Establish a change control authority to provide coordinated review, evaluation and disposition of documented and justified change proposals to configured items. Consolidate the evolving configuration state(s) of configuration items to form documented baselines at designated times or under defined circumstances. Record the steps of system configuration, the rationale for the baseline and associated authorizations in configuration baseline data. Maintain configuration records through the system life cycle and archive them according to agreements or relevant legislation.

5. Manage the recording, retrieval and consolidation of the current configuration status and all preceding configurations to confirm information correctness, timeliness, integrity and security.

6. Routinely audit the quality and correctness of the configuration information and, where necessary, take corrective actions to recover information integrity.

6.4 Technical Processes

The Technical Processes are used to define the need for a system, to transform that need into an effective product, to permit consistent reproduction of the product where necessary, to utilize the product to provide the required services, to sustain the provision of those services and, when the product is retired from service, to dispose of that product.

The Technical Processes provide the activities that enable enterprise and project functions to optimize the system benefits and reduce the system risks that arise from technical decisions and actions. These activities enable products and services to possess the timeliness and availability, the cost effectiveness, and the functionality and usability required by acquiring and supplying organizations. They also enable products and services to conform to the expectations or legislated requirements of society, including health, safety, security and environmental factors.

The Technical Processes consist of the following processes:

a) Stakeholder Requirements Definition Process;

b) Requirements Analysis Process;

c) Architectural Design Process;

d) Implementation Process;

e) Integration Processes;

f) Verification Process;

g) Transition Process;

h) Validation Process;

i) Operation and Maintenance Process;

j) Disposal Processes.

6.4.1 Stakeholder Requirements Definition Process

6.4.1.1 Stakeholder Requirements Definition Purpose

The Stakeholder Requirements Definition Process is performed to define the need for a system that can provide services to users and other stakeholders in a defined environment. This is achieved by developing a model, frequently textual, that concentrates on system purpose and behaviour and is described in the context of the operational environment and conditions. The stakeholder requirements identify the parties involved with the system throughout its life cycle and express their needs, wants, desires and expectations, together with the constraints they and the operational environment impose. This involves capturing, clearly articulating and managing the requirements of each and every stakeholder, or stakeholder class, in a form that permits continuous tracing of decisions to their needs throughout the life cycle. During the life cycle, needs may change and reviews maintain the currency of Stakeholder Requirements. The Stakeholder Requirements are the reference against which each and every resulting operational system services is validated in order to confirm that the system fulfils needs.

6.4.1.2 Stakeholder Requirements Definition Outcomes

1) A definition of the requirements, desires and expectations of the stakeholders.

2) A definition of the context of use of users and operators including their capabilities, capacities, environments.

3) A basis for negotiating and agreeing to supply a system service or product.

4) A basis for validating that a system service meets the needs of stakeholders.

6.4.1.3 Stakeholder Requirements Definition Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Stakeholder Requirements Definition Process.

1. Identify the individual stakeholders or stakeholder classes who have a legitimate interest in the system throughout its life cycle. This includes, but is not limited to, users, supporters, developers, producers, trainers, maintainers, disposers, acquirer and supplier organizations, regulatory bodies and members of society. Where direct communication is not practicable, e.g. consumer products and services, representatives or designated proxy stakeholders are selected, e.g. marketing.

2. Elicit Stakeholder Requirements, expressed in terms of the needs, wants, desires expectations and perceived constraints of identified stakeholders, using a suitable quality model, for example ISO 9126. Include the needs and constraints imposed by society, the constraints imposed by an acquiring organization and the capabilities and limiting characteristics of operator staff. Exclude unjustified constraints on system solution options. Cite the sources, including solicitation documents or agreements, and, where possible, their justification and rationale. State the assumptions of stakeholders and the value they place on the satisfaction of their requirements. For each Stakeholder Need, determine the stakeholders' measures of effectiveness so that operational system performance can be measured and assessed for conformance.

NOTE 1 The organization that creates the system is also a stakeholder and their additional stakeholder requirements introduce enterprise and project constraints and practises, such as business policy and procedures, concept reuse, reuse of components and existing design, reuse of production, support and retirement enabling systems.

NOTE 2 The Stakenholder Requirements Definition Process may depend on participatory activities from stakeholders, such as examination of exploratory prototypes or partial implementations of the system.

3. Define use sequences to identify a complete set of services for different operational scenarios and environments. Analyze the operation of the system in its intended environment to identify requirements which may not have been formally specified by any of the stakeholders, for example, legal, regulatory and social obligations. Analyze the social and organizational influences on users and operators that could affect system use or constrain its design. The context analysis include the activities which users perform to achieve system goals, the relevant characteristics of the end-users of the system (e.g. expected training, degree of fatigue), the physical environment (e.g. available light, temperature) and any equipment to be used (e.g. protective or communication equipment).

4. Analyze the ability of humans to interact with the system. Determine a complete and meaningful set of usability requirements, analyzing, as a minimum, the most effective, efficient, and reliable human performance and human-machine interactions. Specify the criteria for acceptable ease of use, efficiency of use and the extent to which the system prevents operator or user errors. Where possible use applicable standards, e.g. ISO 9241, and accepted professional practices in order to define:

    a) Physical, mental, and learned capabilities;

    b) Work place, environment and facilities;

    c) Normal, unusual, and emergency conditions;

    d) Operator training;

    e) Integration of human performance into system design and operations;

    f) Safety critical human actions and how the consequences of error are addressed;

    g) Opportunities for automation to enhance the performance of operators.

5. If justified by risk identification, specify system requirements and functions that could impact safety. These include methods of operations and support, health and safety, threats to property and environmental influences. Applicable standards and accepted professional practices are used.

6. If justified by risk identification, analyze all applicable areas of system security, including physical, procedural, communications, computers, and emissions. Identify functions that could impact the security of the system, including access and damage to protected personnel, properties and information, compromise of sensitive information, and denial of approved access to property and information. Specify the required security functions, including mitigation and containment, referencing applicable standards and accepted professional accepted professional practices where mandatory or relevant.

7. If justified by risk identification, analyze and specify stakeholder requirements and functions that relate to critical qualities other than health and safety.

8. Analyze the complete set of elicited requirements to resolve conflicts and any contradictory, ambiguous, inconsistent, incongruous and unverifiable requirements. Identify requirements that cannot be realized or are impractical to achieve.

9. Feed back the analyzed requirements to applicable stakeholders to ensure that the needs and expectations have been adequately captured and expressed. Establish that the Stakeholder Requirements are comprehensible to all originators, that they are expressed correctly and that the resolution of conflict in the requirements has not corrupted or compromised stakeholder intentions.

10. Record the stakeholder requirements in a form suitable for management through the life cycle and beyond. These records retain changes of need and their origin throughout the system life cycle, they act as an information source for trade-off decisions and, in the case of persistent stakeholder needs, form a source of knowledge for requirements for subsequent systems.

11. Review the Stakeholder Requirements at key decision times in the life cycle to ensure that account is taken of any changes of need.

6.4.2 Requirements Analysis Process

6.4.2.1 Requirements Analysis Process Purpose

The Requirements Analysis Process transforms the stakeholder, needs-driven view of desired system services into a technical view of a required system product(s) that could deliver those services. The resulting System Requirement specifies from the developer's perspective what the system is required to do in order to satisfy stakeholder needs. The objective is to build a representation of a future system product(s) that will meet stakeholder needs and that, as far as constraints permit, avoids implementation issues. The system requirements are the basis for tests that verify the conformance of a supplied system to the designers' intended solution.

NOTE System Requirements depend heavily on abstract representations of proposed system characteristics and may employ multiple modelling techniques and perspectives to give a sufficiently complete description of the desired system technical requirements.

6.4.2.2 Requirements Analysis Process Outcomes

1) A statement of the technical problem that must be solved.

2) System requirements that are a basis for establishing the design solution of the system architecture.

3) System requirement that are a basis for verifying compliance of the realized system with its technical description.

6.4.2.3 Requirements Analysis Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Requirement Analysis Process.

1. Define the functional boundary of the system in terms of the external behaviour and properties to be provided, i.e. the system's stimuli and its responses to user and environment behaviour. The required interactions between the system and its environment are analyzed and described in terms of interface constraints such as mechanical, electrical, mass, thermal, data, procedural, data flows. This establishes the expected system behaviour, expressed in quantitative terms, at its boundary.

2. Define each function that the system is required to perform, how well the system is required to perform that function, the conditions under which the system is to be capable of performing the function, the conditions under which the system is to commence performing that function and the conditions under which the system is to cease performing that function. Conditions for the performance of functions may incorporate reference to states and required modes of operation of the system.

3. Technical performance metrics are defined to enable the assessment of technical achievement. Critical performance metrics, by which the system will be deemed successful, are associated with each measure identified in the stakeholder needs, and are analyzed and defined; if not met they may represent a project cost, schedule or performance risk.

4. Analyze and define safety considerations, including those relating to methods of operation and maintenance, environmental influences and personnel injury. Each safety function and its associated safety integrity, expressed in terms of the necessary risk reduction, is specified and allocated to designated safety-related systems. Use applicable standards concerning occupational safety and environmental protection.

5. Analyze security considerations including those related to compromise and protection of sensitive information, data and material. The security related risks are defined, including, but not limited to, administrative, personnel, physical, computer, communication, network, emanations and environmental areas using, as appropriate applicable security standards.

6. If justified by risk identification, analyze and specify system requirements and functions that relate to critical qualities other than health, safety and security.

7. Analyze the integrity of the system requirements. Each system requirement statement is checked to establish that it is unique, complete, unambiguous, consistent with all other requirements, implementable and verifiable. Deficiencies, conflicts and weaknesses are identified and resolved within the complete set of system requirements. The resulting set of system requirements is analyzed to confirm that they are complete, consistent, achievable (given current technologies or knowledge of technological advances) and expressed at an appropriate level of detail. Confirm that they are a necessary and sufficient response to stakeholder requirements and a necessary and sufficient input to other processes, in particular Architectural Design.

8. Demonstrate traceability between the system requirements and the stakeholder requirements. This traceability is established both forwards and backwards, i.e. all achievable stakeholder requirements are met by one or more system requirements, and all system requirements meet or contribute to meeting at least one stakeholder requirement. The system requirements are held in an appropriate information database that permits traceability to stakeholder needs and architectural design.

9. Document, and maintain through the system life cycle, the set of system requirements together with the associated rationale, decisions and assumptions.

6.4.3 Architectural Design Process

6.4.3.1 Purpose

Architectural design synthesizes a solution that satisfies system requirements, expressed as a set of separate problems of manageable, conceptual and, ultimately, realizable proportions. Architectural design involves identifying and exploring one or more implementation strategies at a level of detail consistent with the system's technical and commercial requirements and risks. From this, a design solution is defined in terms of the requirements for a complete set of technically and commercially viable components from which the system is configured. The architectural design is also a basis for planning and devising an assembly and test strategy that will detect and diagnose faults during the integration steps.

NOTE 1 Architectural design encapsulates and defines areas of solution, hides unnecessary detail and establishes a basis for detection/correction of errors throughout the system life cycle.

NOTE 2 Successive applications of the Architectural Design Process and the Requirements Analysis Process are repeated for subsystems until a component level is identified and at which an appropriate component development standard is used

6.4.3.2 Architectural Design Process Outcomes

1) Component requirement documents that specify the configuration of components and interfaces that comprise an optimized system design having regard to risk and opportunity.

2) Data that informs the decision to develop, reuse or procure components off-the-shelf.

3) Data that informs how best to employ humans to achieve an optimized system performance.

4) A basis for demonstrating compliance of the configured system, and intermediate build configurations, with its design description(s).

5) Design information to inform change decisions to system architecture and future system design.

6.4.3.3 Architectural Design Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Architectural Design Process.

1. Partition the system functions identified in Requirements Analysis and allocate them to elements of system architecture. The resulting architectural design is analyzed to establish design criteria for each element, in terms of the system's physical, performance, behavioural, durability and sustainable service characteristics.

2. Determine which system requirements are allocated to operators. This determination includes the following factors, as a minimum, for the most effective, efficient, and reliable human performance and human-machine interactions. Guidance is given in ISO 13407.

    a) Physical, mental, and learned capabilities;

    b) Work place, environment, and facilities;

    c) Normal, unusual, and emergency conditions;

    d) Operator training for performing the tasks;

    e) Integration of human performance into system design and operations.

3. Determine whether hardware and software elements exist as off-the-shelf components that satisfy the design and interface criteria. Evaluate design elements that are not readily available in order to determine if an element is to be developed, or if existing components will be re-used. Establish the costs, schedule, and technical risks associated with these make-or-buy decisions.

4. Evaluate competing designs, exploring them to a level of detail that permits comparison against the technical specifications expressed in the System Requirements and the performance, costs, timescales and risks expressed in the Stakeholder Requirements. By evaluating the system characteristics achieved using different candidate components in the system architecture, the trade-off decisions lead toward an optimized design. Trade-off formalizes the selection of different, competing solution implementations and results in the definition of a structured set of existing or realizable components.

5. Define and document the interfaces between components and at the system boundary with a level of detail and control appropriate to the creation, use and evolution of the system. Define the need for interface documentation from parties responsible for external interfacing entities. Where applicable, human-system and human-human interfaces are also defined and controlled. Interface definition conform to recognized product sector or international standards where these exist, e.g. ISO 9241 in the case of human-computer interfaces.

6. Review the architectural design to verify that the selected architecture solution is consistent and complete with respect to the set of technical requirements and derived technical requirements for which the solution is being engineered or reengineered.

7. Describe each component only in terms of its individual behaviour, its interfaces and unavoidable implementation constraints. These specifications are the basis of the system solution and an origin for component acquisition agreements. They are the basis for defining acceptance/validation of the components, whether produced, reused or acquired. Guidance on software component specification is in ISO/IEC 12207, Subclause 5.3.5.

8. Hold the architectural design information in an appropriate information database. This records the structural and functional partitioning, interface and control definitions and the design decisions and conclusions, with traceability to the requirements baseline. The architectural design baseline enables review in the event of

change throughout the life cycle, as well as informing any subsequent re-use of the architecture. It is also the information source from which integration tests are defined.

6.4.4 Implementation Process

6.4.4.1 Implementation Process Purpose

The Implementation Process implements a component required in an acquirer's system. This may be achieved by designing, making and testing a novel component, making and testing a new component according to an existing design or adapting and testing an existing component. The Implementation Process continues the design undertaken at the system/subsystem levels by performing detailed design in accordance with a selected implementation technology(ies) and by employing appropriate technical specialism(s) or discipline(s). The component is fabricated and/or assembled according to the selected implementation technology(ies). A fabricated or adapted component is tested against criteria derived from the component characteristics defined in an agreement.

NOTE 1 The component may be viewed as a subsystem by the acquirer and/or a system by the supplier.

NOTE 2 Just as with the processes at the system/subsystem levels, alternative strategies may be used for the order and iteration of the activities at the component level, for example as described in ISO/IEC TR 15271.

6.4.4.2 Implementation Process Outcomes

1) Delivered component conformant to an agreement for its supply

2) Design, configuration and performance specifications for the component

3) Design, fabrication and test data on the component

4) Qualification data (in the case of regulated products)

6.4.4.3 Implementation Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Implementation Process.

1. Analyze the architectural design specifications, together with the relevant constraints and establish component requirements that drive the supply of each of a complete set of components. Constraints may be specified in the agreement, e.g. acquirer furnished materials or component for adaptation, or they may be self-imposed supplier constraints, e.g. common component supply to multiple acquirers, use of existing fabrication facilities.

2. Design and document the component in detail so that, by employing the selected technical discipline(s) and implementation technology(ies), it may be implemented. Design decisions are recorded, including the techniques and materials selected for fabrication and/or operator characteristics. This is conducted in accordance with standards that govern their relevant implementation technology, technical discipline or product sector

   a) Hardware Design.

   Hardware components are designed in accordance with established procedures, standards and regulations.

   b) Software Design.

   Software components are designed in accordance with ISO/IEC 12207.

   c) Human Task Design.

   Human tasks are designed in accordance with established procedures, standards and regulations. Identify and specify the training required for operators to perform tasks.

NOTE Analyze and define the human factor constraints, such as physical space limits, climatic limits, eye movement, reach, information rates and ergonomics. They affect the operator interactions with other system components and the user interfaces to the system throughout the life cycle. Operator usability factors are also analyzed. Guidance is provided in ISO 6385: 1981, ISO 10075.

3. Fabricate components in accordance with standards that govern the relevant implementation technology, technical discipline or product sector and take account of applicable safety, security and environmental guidelines or legislation. Alternatively, components may be bought off-the-shelf.

   a) Hardware Fabrication.

   The fabricated hardware components are evaluated to assess their producibility and to derive necessary design modifications based upon fabrication tolerances and verification uncertainties. Hardware elements are fabricated and certified to establish their conformance to the design criteria specified in the data package.

   b) Software Coding.

   Software components are coded, compiled, and inspected to certify their conformance with the design criteria specified in the data package. ISO/IEC 12207 is applicable.

   c) Operator Training

   Deliver appropriate training to prepare operators for performing tasks in accordance with required performance standards and operational procedures, e.g. accepted good practice, health and safety legislation.

4. Integrate the component in accordance with applicable interface control descriptions and defined assembly procedures, using specified integration facilities.

5. Verify the component in accordance with standards that govern its relevant implementation technology, technical discipline or product sector. Where appropriate, qualification of the component is conducted according to legal, regulatory or product sector requirements.

NOTE Depending on the system, this may include operator accreditation, for example, pilot licence.

6.4.5 Integration Process

6.4.5.1 Integration Process Purpose

The Integration Process assembles the verified components to create the system product specified in the System Requirements. It informs design actions of the practical constraints and limitations resulting from integration facilities.

NOTE Successive applications of the Integration Process and the Verification Process are repeated for components and subsystems at successive levels until the system level.

6.4.5.2 Integration Process Outcomes

1) A system integration plan.

2) Specified enabling integration systems.

3) The assembled system product capable of being verified against System Requirements.

4) Corrective action reports.

6.4.5.3 Integration Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Integration Process.

1. Define an assembly sequence and strategy that minimizes system integration risks. This strategy may permit verification against a sequence of progressively more complete component configurations and be consistent with a fault isolation and diagnosis strategy. It defines the schedule of component availability and the availability of the verification facilities, including jigs, conditioning facilities, assembly equipment.

2. Receive components from their supplier(s) or withdrawn from storage in accordance with agreed schedules. They are handled in accordance with relevant health, safety and security considerations.

3. Verify the components by inspection or test against acceptance criteria specified in an agreement and accept or reject accordingly. The conformance/non-conformance data is documented. Reject components are identified as such and handled in conformance with defined procedures.

4. Integrate the components to establish the interface connections between them. Integration is conducted according to the defined assembly procedures, using specified integration facilities, including jigs, conditioning and disposable assembly materials. This follows an assembly strategy that minimizes system integration risk and may progressively build confidence in the ultimate conformance of the fully integrated system product. It may give rise to intermediate assembly configurations that exhibit verifiable physical characteristics, interactions with humans or information/resource flows that may assist fault isolation and diagnosis.

5. Record integration results in an appropriate information database. This includes non conformance correction due to the integration strategy, the integration enabling system(s) or manual assembly errors. Analyze the data to enable corrective or improvement actions to the integration strategy and its execution.

6.4.6 Verification Process

6.4.6.1 Verification Process Purpose

Through assessment of the system product, verification demonstrates that its behaviour and characteristics comply with its specified design requirements. Verification provides the information required to effect the remedial actions that correct failings in the realized system or the processes that act on it. The Verification Process informs design actions of the practical constraints and limitations of verification facilities.

NOTE Verification demonstrates through assessment of the system product that the system, as made, is ‘right’, i.e. fulfils the specified design.

6.4.6.2 Verification Process Outcomes

1) Verification Plans.

2) Confirmation that the system product conforms to system requirements.

3) Specified tests derived from system requirements

4) Non conformance reports which provide information for corrective action.

6.4.6.3 Verification Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Verification Process.

1. Define the strategy for verifying the system product. The context and purpose for each instance of verification is defined, e.g. verifying the design, ability to build the design correctly, ability to reproduce the system, ability to correct a fault arising, ability to predict failures. The nature and scope of the verification action, e.g. reviews, inspections, audits, comparisons, static tests, dynamic tests, demonstrations (or a combination thereof) depend on the Life Cycle Stage, e.g. whether a model, prototype or actual product is being verified, on risks, e.g. novelty, safety, technical and commercial criticality issues, and on the agreement and organizational constraints.

2. Define verification plans based on system requirements. The plans account for the sequence of configurations defined in the integration strategy and, where appropriate, take account of disassembly strategies for fault

diagnosis. The schedule typically defines risk-managed verification steps that progressively build confidence in compliance of the fully-configured product. The plans specify the enabling equipment, facilities and services, together with their acceptance criteria.

3. Conduct verification to detect in the realized system the existence of random and systematic non conformance to system requirements. Verification is undertaken in a manner, consistent with organizational constraints, such that uncertainty in the replication of verification actions, conditions and outcomes is minimized. Objective and authenticated records of verification actions and outcomes are made.

4. In accordance with agreement terms or organizational objectives, conduct verification to isolate that part of the system giving rise to a non conformance. Fault diagnosis is conducted to a level of resolution consistent with cost effective remedial action, including re-verification following defect correction, and/or organizational quality improvement actions.

5. Collect, classify and collate verification data according to criteria defined in the verification strategy. This categorizes non conformances according to their source and corrective action/owner. The verification data is analyzed to detect essential features such as trends and patterns of failure, evidence of systematic failings and emerging threats to system services.

6.4.7 Transition Process

6.4.7.1 Transition Process Purpose

The Transition Process installs the verified system in its operational location(s) according to an agreed schedule, together with the utilization stage enabling systems, e.g. operating system, support system, operator training system, user training system, as defined in agreements, in order to establish the capability to provide the system services specified by the stakeholder needs.

6.4.7.2 Transition Process Outcomes

1) The system product installed in its operational location.

2) The system capable of being operated at the location(s) and time(s) stated in terms of stakeholder needs.

3) A system service sustainable by enabling systems.

NOTE The utilization stage enabling systems ensure continuous service during utilization through, for example, continuous availability of operators, adaptable operating procedures, remedial maintenance actions, provisioning of consumable materials, system adaptations.

4) Continuity of service, in the case of changeover from an existing system.

6.4.7.3 Transition Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Transition Process.

1. Prepare transition plans for system capability availability in accordance with agreements. These plans are communicated to all service providers who enable a sustainable system service during utilization.

2. Prepare the site of operation in accordance with installation requirements. Site preparation is conducted in accordance with applicable health, safety, security and environmental regulations.

3. Deliver the system for installation at the correct location and time, accounting for intermediate storage needs.

4. Install the system in its operational location(s) and interfaced to its environment according to its system specification.

5. Demonstrate and/or confirm, in accordance with operating procedure, the competence of operators and, where applicable, health and safety legislation and regulatory body requirements. Confirm that trained or certified

operators are aware of the system in its operational location and state through a defined programme of familiarization.

6. Bring the system into a state of operational readiness, with operators and systems that enable the utilization stage to be fully functioning and integrated with the system. Demonstrate that the system is capable of containing its operational level of consumable materials. Where agreed, maintain continuous service capacity and quality when the system replaces an existing system that is being retired. During a specified period of changeover, concurrent operation, manage the transfer of services so that continuing conformance to persistent stakeholder needs is achieved.

7. Record the installation data, including the operational configuration, anomalies detected, actions taken and lessons learned. Post implementation reporting includes flaws in the system requirements as well as technical features. Where inconsistencies exist at the interface between the system, its specified operational environment and systems that enable the utilization stage, the deviations lead to corrective actions and/or requirement changes.

6.4.8 Validation Process

6.4.8.1 Validation Process Purpose

The Validation Process is conducted to provide objective evidence that the services provided by the system when in use comply with the needs of the stakeholders and are defined in the requirements documents contained in the agreement to acquire the system. Where variances are identified, these are recorded and guide corrective actions. Since validation is a comparative assessment against needs, it also results in confirmation that stakeholders', and in particular the users', needs were correctly identified and requested ; again variances lead to corrective actions. System validation is normally ratified by stakeholders.

NOTE 1 Validation demonstrates through assessment of the system services presented to the stakeholders that the 'right' system has been created, i.e. is fit for purpose.

NOTE 2 Validation may also be conducted to confirm that the system not merely satisfies all operational, functional and usability requirements, but also satisfies the often less formally expressed, but sometimes overriding, attitudes, experience and subjective test which comprise customer satisfaction.

NOTE 3 Validation takes place from the earliest stage of a life cycle. For example paper prototypes, simulations or mock-ups of the system in a corresponding representation of its environment may be used to validate at the concept stage.

6.4.8.2 Validation Process Outcomes

1) A system validation strategy.

2) Specified tests derived from stakeholder needs.

3) Confirmation that the system services needed by stakeholders are available to them.

4) Confirmation that the stakeholder requirements faithfully describe the required system services.

5) Non conformance reports capable of guiding corrective actions.

6.4.8.3 Validation Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Validation Process.

1. Define the strategy for validating the system services in its operational environment and achieving customer satisfaction. This will depend on the Life Cycle Stage, e.g. whether a model, prototype or actual product is being verified, on risks, e.g. novelty, safety, technical and commercial criticality issues, and on the agreement and organizational constraints and the stakeholder requirements.

NOTE Where stakeholder needs cannot be specified in advance or change frequently, repeated Validation of (often rapidly developed) increments in system evolution may be employed to refine Stakeholder Requirements and mitigate risks in the correct identification of need. For example, ISO 13407 describes an iterative life cycle which involves users.

2. Plan validation based on the stakeholder requirements. Where appropriate, define validation steps, e.g. various operational states, scenarios and missions, that progressively build confidence in compliance of the installed system and assist diagnosis of any non compliance. Specify the purpose, conditions and conformance criteria for each test. Specify any enabling equipment, facilities and services, together with their acceptance criteria. Where representations of the operational environment are used, e.g. virtual or synthetic environments, specify their acceptance criteria and limitations.

3. Conduct validation to detect in the system services the existence of random and systematic non conformance to stakeholder requirements. Validation is undertaken in a manner, consistent with organizational constraints, such that uncertainty in the replication of validation actions, conditions and outcomes is minimized. Objective and authenticated records of validation actions and outcome are to be made.

4. As appropriate to agreement terms or organizational objectives, conduct validation to isolate that part of the system giving rise to a non conformance. This may result in the need for corrective action and/or changes in quality management policy. The sources of non conformance may be: incorrect performance of validation tests; incorrect validation test specification; deficient system service; or incorrect, outdated or newly discovered stakeholder needs. Fault resolution is conducted to a level of resolution consistent with cost effective remedial action, including re-validation following defect correction and/or organizational quality improvement actions.

5. Collect, classify and collate validation data according to criteria defined in the validation strategy. This categorizes non conformances according to their source and corrective action owner. The validation data is analyzed to detect essential features such as trends and patterns of failure, evidence of systematic failings, emerging threats to system services.

6.4.9 Operation and Maintenance Process

6.4.9.1 Operation and Maintenance Process Purpose

The Operation and Maintenance Process enables staffing and training personnel for operation and maintenance activities, operating the system, maintaining the system, monitoring the system and the operator-system performance, and recording problems for analysis.

6.4.9.2 Operation and Maintenance Process Outcomes

1) Operation Strategy and Plans.

2) Maintenance Strategy and Plans.

3) Trained staff with operator and maintainer skills.

4) A sustained system service meeting stakeholder needs.

5) Reports identifying a need for corrective design changes.

6) Fault and component lifetime data.

6.4.9.3 Operation and Maintenance Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Operation and Maintenance Process.

1. Develop and define the operation strategy for the system in order to achieve customer satisfaction. This strategy considers the levels and skills of the required operators and any imposed business requirements that maximise the effectiveness of the system.

2. Develop and define the preventative and corrective maintenance strategy for the system in its operational environment in order to achieve customer satisfaction. Base this on architectural design, integration, verification and manufacturing information and on any fault information available from comparable systems. This strategy considers the tolerable out-of-service periods, repair response times, logistics, disassembly constraints, and fault isolation and repair strategies.

3. Prepare operation plans, specifying enabling systems, facilities, procedures or services required to support the operation of the system. The operation plans take account of specified staffing requirements (numbers of individuals, the knowledge, skills and experience required) and any relevant legislation regarding health and safety, security and the environment. Training requirements and schedules for both instructors and operators may be a key component of operation plans. If the system warrants a separate training system to enable operator training, then requirements for an enabling system for training are specified

4. Prepare a maintenance plan that specifies schedules and/or resources required to perform preventative and corrective maintenance, identifying any constraining consequences upon the operation of the system, for example, suspension of the system services, restricted services. Schedule preventative maintenance actions that reduce the likelihood of system failure without undue loss of services. Specify the requirements for any enabling systems used during maintenance of the system. Define the number and type of replacement components to be stored, their storage locations and conditions, their anticipated replacement rate, their storage life and renewal frequency. Specify skill and personnel levels required to effect repairs and replacements.

5. Define the procedures for fault correction and/or replacement of components/subsystems, including their disassembly strategy, fault diagnosis techniques, and re-assembly and testing sequences, taking account of maintenance staff requirements and any relevant legislation regarding health and safety, security and the environment. Define problem reporting and fault recording to ensure that individual events and histories of behaviour are collated to support future preventative and corrective maintenance.

6. Assign personnel to be system operators. Ensure they are qualified in accordance with competency criteria defined in the operator specifications. The knowledge, skill and experience requirements for operators is used to guide the personnel selection criteria, their training, and where relevant, their accreditation and certification. Selection and preparation of instructors to perform training that employs the operational system may be an aspect of staffing.

7. Conduct training of operators to enhance their knowledge of system operation. Training may address exceptional aspects of system operation, including how to cope with and contain system failures. Training may involve simulations or computer-based training that may be a training mode of the operational system and may impact service availability.

8. The system, integrated as appropriate with operations enabling systems, is activated in accordance with the operation plans. This is conducted in accordance with health and safety regulations applicable to users and operators, with security considerations and regulations and with due regard to environmental factors.

9. Apply the system in its intended operational context to achieve its intended purpose.

10. Monitor operations to ensure that the system is operated in accordance with the operations plans, in a safe manner and compliant with legislated guidelines concerning occupational safety and environmental protection. Monitor the system operation to confirm that performance is inside acceptable parameters, that hardware components have not exceeded their useful life and that the effects of operating the system on operating and maintenance personnel (including staff turnover, operator stress and fatigue) do not exceed permissible or acceptable bounds.

11. Confirm that logistics actions satisfy the required replenishment levels so that stored components meet repair rates and planned schedules. Monitor the availability of spares, their transportation and their continued integrity during storage. Acquire, train and accredit, as necessary, personnel to maintain operator numbers and skills.

12. Perform preventative maintenance by replacing or servicing subsystems/components prior to failure, according to planned schedules and maintenance procedures.

13. Perform failure identification actions when a non compliance has occurred in the delivered system services. Diagnose the cause of the failure, identifying whether it is due to a fault in the system product or a change of need. Investigate operating procedures, the operator environment and human-machine interfaces to determine whether human error contributed to failure.

14. Where corrective action is required to remedy failings due to random component faults, isolate the failing down to the planned level of component/subsystem replacement, replace and verify correct system performance. Where corrective action is required due to previously undetected systematic faults, e.g. a software component fault, raise a problem report to inform a potential development and/or production action.

15. Where corrective action is required to remedy failings due to changed need, agree whether to introduce minor hardware or software adaptations or modified operator action, whether to change the Stakeholder Requirements, whether to change the design and/or implementation of the system, or whether to tolerate diminished system services.

16. Analyze problem reports to a level of detail sufficient to identify the root cause of failure, together with any contributing factors, and to estimate the useful life of degradable components. Maintain a history of problem reports, corrective actions, and trends to inform operation, maintenance or redesign actions and other projects creating or utilizing similar systems, subsystems or components.

6.4.10 Disposal Process

6.4.10.1 Disposal Process Purpose

The Disposal Process is applied to deactivate and remove the system from operational service, consigning it to a final condition and returning the environment to its original or an acceptable condition. System elements are destroyed, stored and/or reclaimed in an environmentally sound manner.

6.4.10.2 Disposal Process Outcomes

1) The systems and its components destroyed, stored, reclaimed or recycled.

2) The environment returned to its original or an agreed state.

3) Knowledge archive on system creation and operation.

6.4.10.3 Disposal Process Activities

The project shall implement the following activities in accordance with applicable organization policies and procedures with respect to the Disposal Process.

1. Deactivate the system to prepare it for removal from operation. Interfaces to other systems, e.g. power, fuel, are disconnected in accordance with disassembly instructions and relevant health, safety and security ledgislation. The System is broken-down into manageable elements to facilitate its removal for reuse, recycling, reconditioning, overhaul or destruction.

2. Withdraw operating staff from the system and record relevant operating knowledge. Remove the system or its elements from the operational environment for reuse, recycling, reconditioning, overhaul or destruction. This is conducted in accordance with relevant safety, security and environmental standards, directives and laws.

3. Reuse elements of the systems which have useful life remaining, either in their current condition or following overhaul, or transfer to other organizations for future use. Where appropriate, recondition system components to extend their useful life use. Reallocate or redeploy operators.

4. Where the system or its components are to be stored, specify containment facilities, storage locations inspection criteria and storage periods, in accordance with relevant safety, security and environmental standards, directives and laws.

5. Conduct destruction of the system or its elements, as necessary, to reduce the amount of waste treatment or to make the waste easier to handle. Define the destruction services required in order to melt, crush, incinerate or

demolish the systems or its elements. Erase unwanted data and act to safeguard secure knowledge and skills possessed by operators.

6. Confirm that no detrimental health, security and environmental factors exist following disposal, taking due regard of agreements and of relevant safety, security and environmental standards, directives and laws.

7. Archive information gathered through the lifetime of the system to permit audits and reviews in the event of legacy threats to health, safety, security and the environment and to permit future system creators and users to build a knowledge base from past experiences.

7 System Life Cycle Management

This Clause describes a framework for the detailed modelling of system life cycles using the system life cycle processes described in Clause 6.

7.1 Establishing Life Cycle Models And Responsibilities

A life cycle model shall be established. This life cycle model includes one or more stage models, as needed. Objectives, purpose and outcomes shall be defined for each stage. The model(s) is assembled as a sequence that may overlap and/or iterate the life cycle stages as appropriate for the scope, magnitude and complexity of the system. The processes and activities are selected, tailored as appropriate and employed in a stage to fulfil the objectives of that stage.

7.2 A Life Cycle Example

Stages are illustrated in this International Standard using a commonly encountered example of life cycle stages. This example is partitioned into six stages, which are listed as follows and described in terms of their purpose and outcomes:

1) Concept stage;

2) Development stage;

3) Production stage;

4) Utilization stage;

5) Support stage;

6) Retirement stage.

Different organizations may undertake different stages in the life cycle. However, each stage is conducted by the organization responsible for that stage with due consideration of the available information on life cycle plans and decisions made in preceding stages. Similarly, the organization responsible for a stage records the assumptions and decisions made regarding subsequent stages in the life cycle.

7.2.1 Concept Stage

The Concept Stage begins with initial recognition of a need or a concept for a new system or for the modification to an existing system. This is an initial exploration, fact finding, and planning period, when economic, technical, strategic, and market bases are assessed through customer/market survey, feasibility analysis and trade-off studies. Customer/user feedback to the need is solicited.

One or more alternative solutions to meet the identified need or concept are developed through analyzes, feasibility evaluations, estimations (such as of cost, schedule, marketing, intelligence, and logistics), trade-off

studies, and experimental or prototype development and demonstration. The need for one or more enabling systems for development, production, operations, support and retirement of the system solution(s) is identified and candidate solutions included in the evaluation of alternatives in order to arrive at a balanced, life cycle solution. Customer/user feedback to concept is solicited.

Typical outputs are stakeholder requirements, preliminary systems requirements, outline design solutions in the form of drawings, models, prototypes, etc., and concept plans for enabling systems including cost estimates and preliminary project schedules. Decisions are made whether to continue with the implementation of one promising solution in the Development Stage or cancel further work.

It is presumed that the organization has available the methods, techniques, tools and competent human resources to undertake market/economic analysis and forecasting, feasibility analysis, trade-off analysis, technical analysis, cost estimation, modelling, simulation, and prototyping.

7.2.1.1 Concept Stage Purpose.

To assess new business opportunities and develop preliminary systems requirements and a viable design solution.

7.2.1.2 Concept Stage Outcomes.

The outcomes of the Concept Stage are listed below:

1) The identification of new system concepts that offer new capabilities, enhanced overall performance or improved life cycle costs.

2) An assessment of feasible system concepts and solutions, including enabling systems throughout the life cycle, for closure against both technical and business stakeholder objectives.

3) The preparation and baselining of stakeholder requirements and preliminary systems requirements (technical specifications for the selected system concept and usability specifications for the envisaged human-system interactions).

4) Refinement of the objectives for stages of the System Life Cycle Model.

5) Risk identification, assessment and mitigation plans for stages of System Life Cycle Model.

6) Identification and initial specification of the infrastructure of enabling systems needed throughout the life of the system.

7) Decision criteria for exiting the Concept Stage.

8) Plans and exit criteria the next stage.

9) Current risks and mitigating actions identified

10) Transition to Development or the next stage in the system life cycle model.

7.2.2 Development Stage

The Development Stage begins with sufficiently detailed technical refinement of the system requirements and the design solution and transforms these into one or more viable products that enable a service during the Utilization Stage. This stage is the period when the system is produced in prototype. The hardware, computers, software, operators, are specified, analyzed, designed, fabricated, integrated, tested and evaluated and the requirements for production, training, and support facilities. This stage also ensures that the aspects of future stages (production, utilization, support, and retirement) are considered and incorporated into the design through the involvement of all interested parties. Feedback is solicited from stakeholders and

those who will produce, operate, use, support, and retire the system. Outputs are a system, or a prototype of the final system, together with the data package and qualification results.

Planning for this stage begins in the preceding Stage(s) to ensure that the organization has available, or can establish, an infrastructure of development enabling systems, consisting of methods, techniques, tools and competent human resources to undertake analysis, modelling and simulation, prototyping, design, integration, test and documentation. These items are developed or acquired in order to be available when needed to support development.

7.2.2.1 Development Stage Purpose

To develop a system that meets acquirer performance requirements and can be produced, evaluated, operated, supported and retired.

7.2.2.2 Development Stage Outcomes

The outcomes of the Development Stage are listed below:

1) Evaluated and refined system requirements, budget and project schedule baseline.

2) A system architecture comprised of subsystems, hardware components, software components and humans and their interfaces (internal and external).

3) Confirmation that the system meets all system requirements and is producible, operable, supportable and capable of retirement.

4) Refined, and baselined requirements for the enabling systems.

5) Technical data package, including as appropriate: 1) hardware diagrams, drawing, models, and simulations; 2) software design documentation; 3) production plans 4)operating instructions; 5) training manuals for operators; and 6) maintenance procedures.

6) Refined objectives for the Production, Utilization, Support, and Retirement stages.

7) Commencement of the development of enabling systems required to execute the next stage in the life cycle model.

8) Plans and exit criteria for the next stage.

9) Current risks and mitigating actions identified

10) Transition to Production or the next stage in the system life cycle model.

7.2.3 Production Stage

The Production Stage begins with the approval to produce the system. The system may be individually produced, assembled, integrated, and tested, as appropriate, or may be mass produced. Planning for this stage begins in the preceding Stage(s). Production may continue throughout the remainder of the system's life cycle. During this stage, the product may undergo enhancements or redesigns, and the enabling systems may need to be reconfigured and production staff re-trained in order to continue producing an evolving system.

It is presumed that the organization has available the production infrastructure, consisting of production equipment, tools, procedures and competent human resource . These items are developed or acquired in order to be available when needed to enable Production.

This stage may overlap with a Development Stage, with the Utilization Stage and with a Support Stage.

7.2.3.1 Production Stage Purpose

To produce or manufacture the system products, to produce related supporting and enabling system products as needed.

7.2.3.2 Production Stage Outcomes

The outcomes of the Production Stage are listed below:

1) Qualification of the production capability.

2) Acquisition of resources, material and components to support the target production quantity goals.

3) The system product produced according to approved and qualified production data packages.

4) Packaged product transfer to distribution channels or customers.

5) Decision criteria for exiting the next stage.

6) Current risks and mitigating actions identified

6) Transition to Utilization or the next stage in the system life cycle model.

7.2.4 Utilization Stage

The Utilization Stage begins with the installation and use of the system product. These items are installed and used at the intended operational sites. Planning for this stage begins in the preceding Stage(s). This stage ends with the end-of-life retirement of the system, its products or services.

This stage includes those processes related to use of the system products to provide services, as well as monitoring performance and identifying, classifying and reporting of anomalies, deficiencies, and failures. The response to identified problems includes taking no action; maintenance and minor (low cost/temporary) modification (reference Support Stage); major (permanent) modification and system life extensions (reference Development and Production Stages), and end-of-life retirement (reference Retirement Stage).

During this stage the system, products or services can evolve giving rise to different configurations. The user operates the different configurations and the responsible product supplier manages the status and descriptions of the various versions and configurations of the system products or services in use.

It is presumed that the organization has available the operational infrastructure which includes facilities, equipment, trained personnel, and instruction manuals and procedures. These items are to be developed or acquired in order to be available when needed to support utilization.

7.2.4.1 Utilization Stage Purpose.

To operate and use the system products and services for intended use within intended environments and ensure continued operational effectiveness.

7.2.4.2 Utilization Stage Outcomes.

The outcomes of the Utilization Stage are listed below:

1) Trained personnel with the competence to operate or use the system and provide operational services.

2) Organizational interfaces with support and maintenance organizations.

3) An installed system that is capable of being operated and providing sustainable operational services.

4) System performance monitoring and assessment to confirm conformance to system service objectives.

5) Identification of problems or deficiencies, informing appropriate organization (development, production, or support) of the need for corrective action.

6) Decision criteria for exiting the next stage.

7) Transition to Retirement or the next stage in the system life cycle model.

7.2.5 Support Stage

The Support Stage begins with providing maintenance, logistics and other support for the system operations and use. Planning for this stage in the preceding Stage(s). This stage is completed with the disposition of the operational system products, decommissioning of support system products, and termination of support services.

This stage includes those processes related to operating the support system and providing support services to users of the operational system products and services. This stage also includes monitoring performance of the support system and services and the identification, classification, and reporting of anomalies, deficiencies, and failures of the support system and services. Actions to be taken as a result of identified problems include maintenance and minor modification of the support system and services, major modification of the support system or services (reference Development and Production Stages), and end of life disposition of the support system and services (reference Retirement Stage).

During this stage the support system and services can evolve under different versions or configurations. The support organization operates the different versions or configurations and the responsible product agency manages the status and descriptions of the various versions and configurations of the support system and services in use.

It is presumed that the organization has available the support which includes the support sites, facilities, equipment and tools, trained support personnel; and maintenance manuals and procedures. The items making up the support infrastructure are developed and acquired in order to be ready when needed to support the system.

7.2.5.1 Support Stage Purpose.

To provide logistics, maintenance, and support services that enable continued system operation and a sustainable service.

7.2.5.2 Support Stage Outcomes.

The outcomes of the Support Stage are listed below:

1) Trained personnel who will maintain and provide other support services.

2) Organizational interfaces with the operating and production organizations that ensure problem resolution and corrective actions.

3) Maintained system product and services and the provision of all related support services, including logistics, to the operational sites.

4) Provide product and service maintenance and correct design deficiencies.

5) A spare parts inventory sufficient to satisfy operational availability goals.

6) Plans and decision criteria for exiting the next stage.

7) Current risks and mitigating actions identified.

7) Transition to Retirement or the next stage in the system life cycle model.

7.2.6 Retirement Stage

The Retirement Stage covers withdrawal from service, decommissioning, archiving, disposal and other related functions. Planning for the Retirement Stage begins in the preceding Stage(s). This stage begins when a system item is taken out of service. The stage continues throughout the active use of the system items within each stage of the life cycle. This stage is completed with the end of life of the operational system products and, as appropriate, the termination of related services and decommissioning of development, production, operations and support system products.

This stage includes those processes related to operating the retirement system and also includes monitoring performance of the retirement system and the identification, classification, and reporting of anomalies, deficiencies, and failures of the retirement system. Actions to be taken as a result of identified problems include maintenance and minor modification of the retirement system (reference Support Stage), major modification of the retirement system (reference Development and Production Stages), and end of life disposition of the retirement system (reference Retirement Stage).

It is presumed that the organization has available the infrastructure to support retirement, including retirement facilities, tools and equipment, personnel trained in retirement actions, retirement procedures and, as appropriate, access to recycling, disposal or containment facilities. The items making up the retirement infrastructure are developed and acquired in order to be ready when needed to perform retirement functions.

This stage is applicable whenever an operational or enabling system product reaches its end of service life. Such end of service life can take the form of replacement by a new system, irreparable wear, catastrophic failure, no longer useful to the user or operator, or it is not cost effective to continue operating and supporting the system.

7.2.6.1 Retirement Stage Purpose.

To provide for the removal of a system (or a system item or a by-product) and related operational and support services and to operate and support the retirement system itself.

7.2.6.2 Retirement Stage Outcomes.

The outcomes of the Retirement Stage are listed below:

1) Trained personnel who will provide retirement services.

2) Required system decommissioning, including disposal, refurbishing, or recycling, in accordance with applicable laws and regulations.

3) Removal of waste.

4) Disposal actions conducted in a manner that complies with applicable health, safety and environmental guidelines and regulations.

5) Environment returned to original or agreed state.

Annex A
(normative)
Tailoring Process

This Annex provides requirements for the tailoring of this International Standard.

A.1 Tailoring Process

The Tailoring Process is applied to this International Standard to provide for particular circumstances or factors that:

a) surround an organization that is employing this International Standard in an agreement;

b) influence a project that is required to meet an agreement in which this International Standard is referenced.

A.2 Tailoring Process Outcomes

1) A life cycle model defined in terms of Stages and the contributions they make.

2) Descriptions of individual Life Cycle Stages that influence the fulfilment of an agreement to supply a system product or service.

3) Definitions of modified or new System Life Cycle Processes.

A.3 Tailoring Process Activities

If this International Standard is tailored, then the organization or project shall perform the following activities in accordance with applicable policies and procedures with respect to the Tailoring Process.

1. Identify and document the circumstances that influence tailoring. These influences include, but are not limited to:

   a) stability of, and variety in, operational environments;

   b) risks, commercial and/or performance, to the concern of interested parties;

   c) system novelty, size and complexity;

   d) commencement date and duration of utilization;

   e) system integrity issues such as safety, security, usability, availability;

   f) emerging technology opportunities;

   g) profile of budget and organization resources available;

   h) availability of services of enabling systems.

2. In the case of system critical properties, take due account of the life cycles structures recommended or mandated by standards relevant to the dimension of the criticality.

3. Solicit inputs from all parties affected by the tailoring decisions. This includes, but may not be limited to:

   a) the system stakeholders;

b) the interested parties to an agreement made by the organization;

c) the contributing organizational functions.

4. Make tailoring decisions in accordance with the Decision Making Process.

5. Define a suitable system life cycle model that permits the system to be created and utilized in a manner that conforms to the system services needed or the system product specified.

6. Identify a life cycle model in terms of Stages, their identities, their purposes and the outcomes they accomplish as a result of the application of the Life Cycle Processes within each Stage.

   a) The exemplary Stages described in this International Standard may be individually selected and used to define the identity, purposes, and outcomes of Stages that form part of a selected life cycle model.

   b) Alternatively, Life Cycle Stages described in this International Standard may be individually selected, identified and modified, as necessary, to achieve changed purpose and outcomes. Document the changes made.

   c) Alternatively, define and document any new Stage(s) in terms of its identity, purpose and outcomes. Each new Stage is assessed to confirm its contribution to a complete and consistent life cycle.

7. Select the Life Cycle Processes that require tailoring in order to satisfying the Life Cycle Stage outcomes.

   d) The Life Cycle Processes described in this International Standard may be individually selected, identified and modified , as necessary, to achieve changed purpose and outcomes. Document the changes made.

   e) Alternatively, define and document any additional Life Cycle Process(es) in terms of its identity, purpose and outcomes. Each new Life Cycle Process is assessed to confirm its contribution to a Stage.

Annex B
(informative)

Relationship between ISO/IEC 15288 and ISO/IEC 12207 : 1995

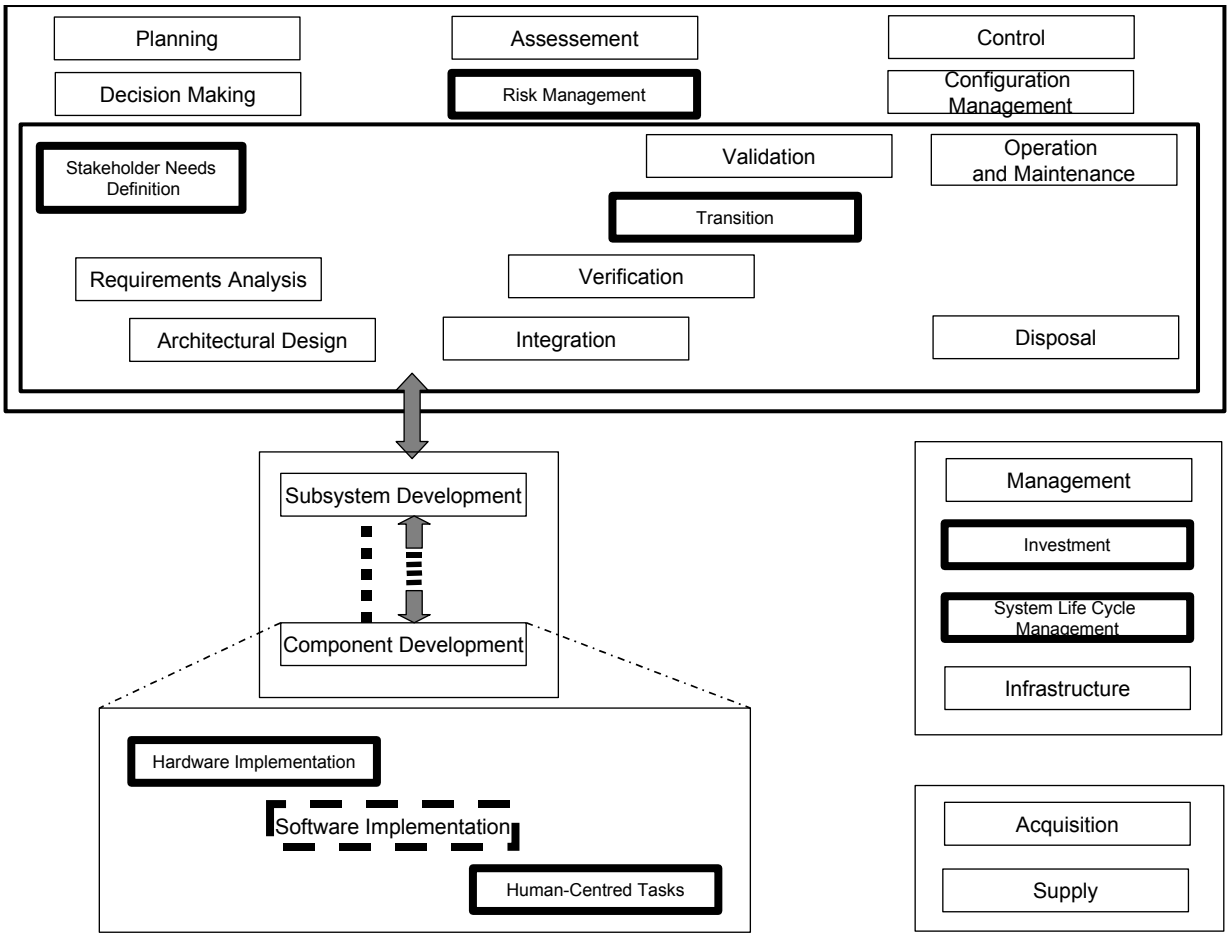

Figure B.1 — Relationship between ISO/IEC 15288 and ISO/IEC 12207

Figure B.1 illustrates key processes in ISO/IEC 15288 that are found in ISO/IEC 12207. The emphasis and detail differs, but the system principles are applied similarly and their description, in terms of processes used to build life cycle models, are also similar. The processes with heavy borders are treated with greater emphasis in ISO/IEC 15288 ; the process with the dotted border are treated with greater emphasis in ISO/IEC 12207. The other processes have similar levels of treatment in both International Standards.

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ISO 6385: 1981 Ergonomic principles in the design of work systems

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ISO 10075 Ergonomic principles related to mental work-load

ISO 9241 – part 2 Task requirements for work with VDTs

ISO 13407 Human-centred design process for interactive systems

IEC 61508 Functional safety of electrical/electronic/ programmable electronic safety-related systems

ISO/IEC TR 15271 Guide for ISO/IEC 12207 (Software life cycle processes)