TECHNICAL REPORT

ISO/IEC TR 19760

Systems engineering — A guide for the application of ISO/IEC 15288 (System life cycle processes)

Ingénierie systèmes — Un guide pour l'application de l'ISO/CEI 15288 (processus de cycle de vie des systèmes)

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Foreword

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

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

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

In exceptional circumstances, the joint technical committee may propose the publication of a Technical Report of one of the following types:

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

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

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

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 Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 19760, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and system engineering*.

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Systems engineering — A guide for the application of ISO/IEC 15288 (System life cycle processes)

1 Scope

1.1 Purpose

This Technical Report provides guidance for the application of ISO/IEC 15288 *Systems engineering — System life cycle processes* (referred to as the International Standard) to systems and projects of various size and type. This Technical Report can be used as a companion document to the International Standard.

This Technical Report elaborates on factors that should be considered when applying the International Standard. It does this in the context of the various illustrative ways in which the International Standard may be applied. Also, lists within this Technical Report are not meant to be exhaustive but to provide the user with examples to consider.

The guidance contained in this Technical Report may be tailored as appropriate to the system and project using guidance in Annex A of the International Standard and 4.4 of this Technical Report.

This Technical Report is intended to provide appropriate links to other ISO documents for supporting application of the International Standard and to aid in assessing the effectiveness of the application of the International Standard.

Not all areas of the International Standard are meant to have equal treatment in this Technical Report. More specific information is provided where providing such information will help in the application of the International Standard. This Technical Report is not meant to provide how-to guidance for each area of the International Standard.

1.2 Audience

This Technical Report is applicable to audiences such as identified below:

a) those who apply the International Standard;

b) those who use the International Standard for a specific system;

c) those who prepare organizational and specific domain standards based on the International Standard.

1.3 Prerequisites

The list below provides prerequisites for users of this Technical Report:

a) availability of ISO/IEC 15288;

b) familiarity with ISO/IEC 15288;

c) familiarity with relevant organizational and project policies;

d) general knowledge of project management, systems engineering and system life cycle models.

2 Normative references

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

ISO/IEC 15288, *Systems engineering — System life cycle processes*

ISO/IEC 12207, *Information technology — Software life cycle processes*

ISO/IEC TR 15271, *Information technology — Guide for ISO/IEC 12207 (Software life cycle processes)*

ISO/IEC 15504 (all parts), *Information technology — Software process assessment*

ISO 9001:2000, *Quality management systems — Requirements*

3 Context of this Technical Report

3.1 Overview

This clause has two objectives. The first objective is to provide an overview of the dynamic utilization of the International Standard with respect to key concepts and processes. Illustrated in this clause are the relationships between types of systems, system life cycles and the application of agreement, enterprise, project and technical processes. The second objective is to give pointers to the various clauses of this Technical Report that provide guidance to a user for applying the International Standard concepts and processes.

3.2 Context of the International Standard

Organizations need to be able to conduct commerce in systems (including their associated products and services). The International Standard facilitates commerce by providing the common framework for establishing and executing agreements between system acquirers and suppliers with respect to developing, using, and managing a system within the defined life cycle of that system. The International Standard is applicable to organizations, enterprises and projects whether they act as the acquirer or the supplier of a system.

The context of the International Standard is illustrated in Figure 1.

A single project may involve multiple organizations working together as partners. Such a project should use the International Standard to establish common terminology, information flows and interfaces among the several organizations to enhance communications.

When an organization applies the International Standard to a particular system, that system becomes the system-of-interest. The system-of-interest has a life cycle that consists of multiple stages through which the system passes during its lifetime, denoted s1, s2, … sn. Typical stages, as described in Annex B of the International Standard, are concept, development, production, utilization, support and retirement. The management of the progression from one stage to another and the engineering activities associated with providing appropriate work products and decision-making information is described in Clause 6 of this Technical Report.

A number of enabling systems are deployed throughout the system life cycle to provide the system-of-interest with support as needed. Each life cycle stage prior to system use (concept stage, development stage, and production stage) can require an enabling system. Enabling systems that cooperate with the system-of-interest during its utilization, support and retirement stages can be needed, as well. It is important to note that an enabling system has its own life cycle and that when the International Standard is applied to it, it then becomes a system-of-interest. The role and use of enabling systems are described in 5.2.3, 5.3.1.4, and 6.2.5 of this Technical Report.

The International Standard is applicable at any level of the structure associated with a system-of-interest. As a system is decomposed recursively into its system elements, the processes of the International Standard may be used for each system and system element in the system structure. Each system and system element has a life cycle of its own and its own set of enabling systems. This system structure is described in 5.2.1 of this Technical Report.
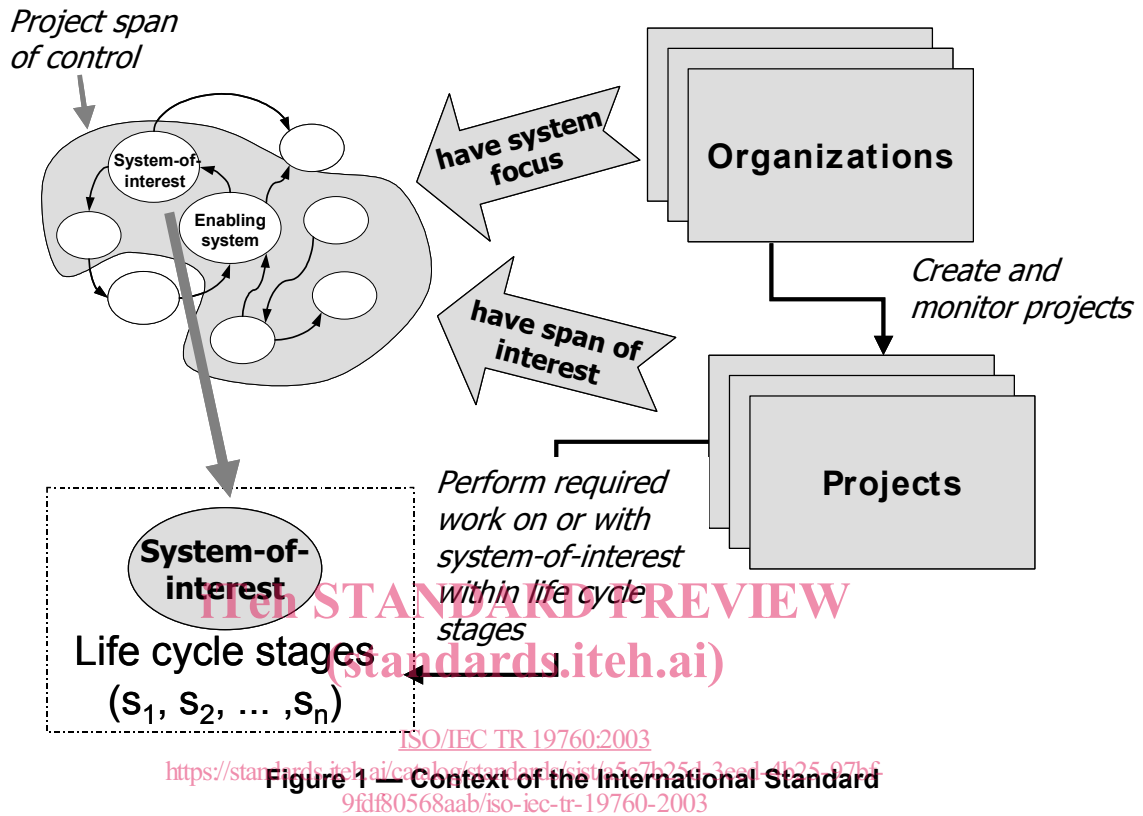

Figure 1 — Context of the International Standard

In order to perform needed operations and transformations upon systems during their life cycles, the organization creates and monitors projects. Projects have defined scope, resources (including time) and focus. The scope can involve managing all of the stages of the life cycle, a subset of the stages, one or more defined processes or one or more process activities. The time scale can be of varying duration, for example one hour or tens of years. The focus of the project is related to the system-of-interest and its systems and system elements in some form of system structure or stage partitioning. Related project concepts are described in 5.3 of this Technical Report and system life cycle concepts are described in 5.4.

Organizations focus on systems that are created by projects within the organization or in conjunction with other organizations. Projects have a span of interest that includes the system-of-interest and its related enabling systems. Some enabling systems are under direct control of the project. The system-of-interest and those enabling systems make up the project span of control. The span of interest is described in 5.3.1.4.

The work performed by projects is on or with the system-of-interest within one or more system life cycle stages. The scope of the International Standard includes the definition of an appropriate life cycle for a system, the selection of processes to be applied throughout the life cycle and the application of these processes to fulfil agreements and achieve customer satisfaction.

The International Standard can be applied to all types of systems and system elements consisting of one or more of the following: hardware, software, humans, processes, procedures, facilities, and naturally occurring entities. The use of the International Standard for systems within this broad scope is one of its main advantages.

The use of the International Standard may be adapted to accommodate the varying project requirements in treating system life cycles. This may be performed by adjusting the scope as described in 4.2 and tailoring described in 4.4 of this Technical Report and Annex A of the International Standard.

3.3 Process categories of the International Standard

The four process groups of the International Standard as well as the primary relationships between the groups are portrayed in Figure 2. The role of the Enterprise and Project group processes is to achieve the project goals within applicable life cycle stages to satisfy an agreement. Enterprise processes provide enabling resources and infrastructure that are used to create, support, and monitor projects and to assess project effectiveness. The project processes ensure that adequate planning, assessment, and control activities are performed to manage processes and life cycle stages.

Appropriate processes are selected from the Technical Processes and used to populate projects in order for the project to perform life cycle related work.
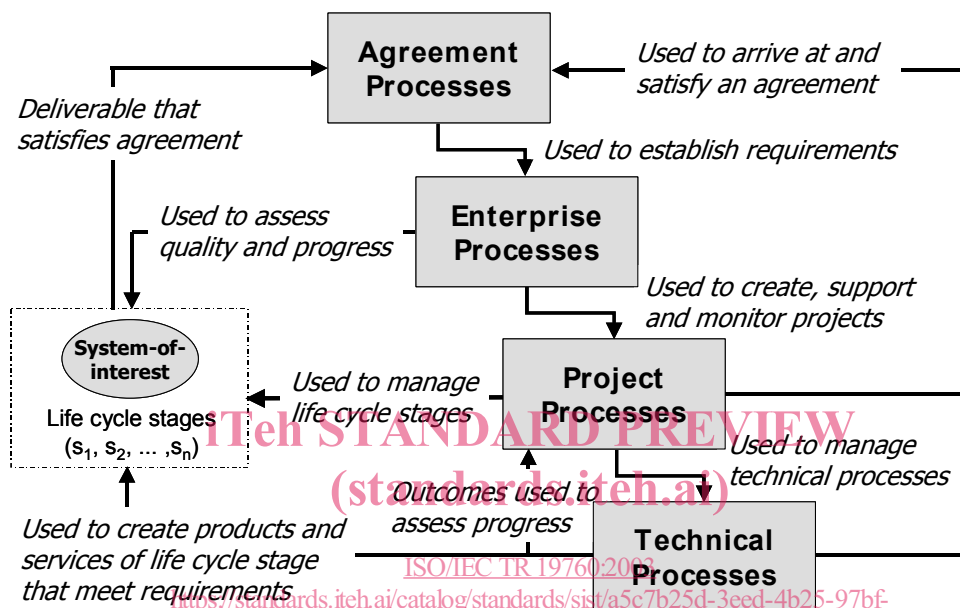
Figure 2 — Role of International Standard processes

Projects may need to establish relationships with other projects within the organization, as well as those in other organizations. Such relationships are established through the agreement processes of acquisition and supply as shown in Figure 3. The degree of formality of the agreement is adapted to the internal or external business relationships between projects. An example and discussion of the use of the agreement processes is provided in 5.3.1.3 of this Technical Report.
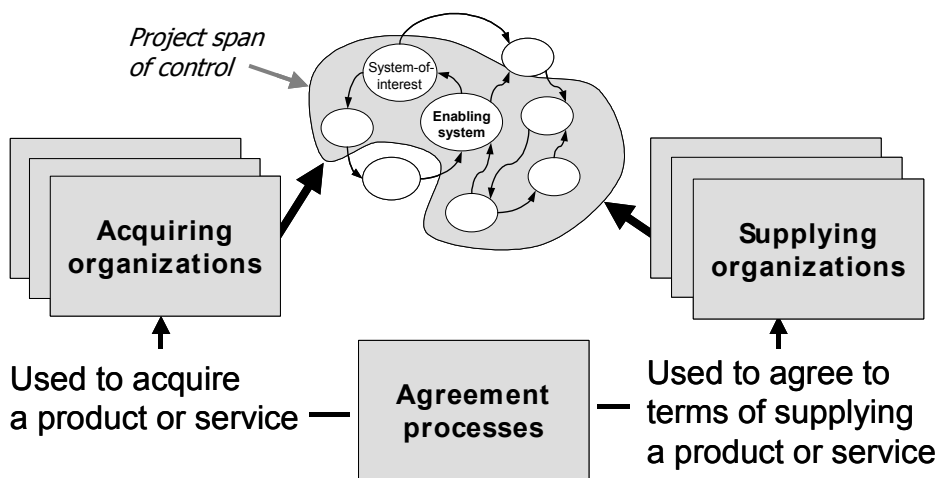
Figure 3 — Use of agreement processes

4   Use of the International Standard

4.1   Overview

The International Standard can be used for one or more of the following reasons.

a)   A specific project can use the International Standard for engineering, utilizing, supporting or retiring a system-of-interest.

b)   An organization can use the International Standard for supporting and controlling the operation of one or more of the system life cycle stages.

c)   A domain organization or other organization can use the International Standard for developing domain-specific or organization-specific standards. These can address the engineering of systems, the management of engineering activities or the operation of one of the system life cycle stages.

d)   Multiple organizations can use the International Standard as a basis for joint projects.

## 4.2   Concept of use

4.2.1   General

Each organization is driven by the nature of its business, its social responsibilities, and its business strategy. These provide constraints on available business opportunities that the organization and its enterprises can exploit. To help exploit opportunities the enterprise establishes policies and procedures to guide the performance of projects. To help establish these policies and procedures, and to determine the resources needed by the enterprise, the International Standard can be used to provide specific standardized processes for use within one or more life cycle models.

A suggested use concept is illustrated in Figure 4. This figure provided the basis for tailoring the scope of the International Standard for one of the specific uses of 4.1.

4.2.2   Scope tailoring

For example, if an enterprise that does development only and is not involved in the utilization, support, or retirement life cycle stages, that enterprise could tailor the scope of the International Standard accordingly. The policies and procedures called for in the non-applicable parts of the International Standard would not be included in the organization's policies and procedures. Additionally, inputs such as those listed below can help shape the policies and procedures of an enterprise:

a)   life cycle model and related entry or exit criteria used by the enterprise for decision making as well as for establishing milestone reviews of a project;

b)   resource availability and the resources the enterprise is willing to commit;

c)   expertise and skills available to the enterprise to provide enterprise products and services;

d)   technology available for enterprise products and services.

4.2.3   Process tailoring

When a project is established to satisfy a set of stakeholder requirements or acquirer specifications, processes included in the enterprise policies and procedures or in the International Standard itself can be tailored according to the scope, size and funding of the work to be done. Planning the work of the project can be dependent on factors such as the following:

a) the team structure required by enterprise policy and procedures or by the acquirer and the enterprise culture in which teams exist and perform;

b) requirements and schedules established in the agreement with the acquirer;

c) the specific life cycle model to be used for performing the processes of the life cycle;

d) the resources made available to the project by the enterprise.

Figure 4 illustrates application of tailored technical and management processes from the International Standard within a project context. The enterprise processes of the International Standard can also be selected for application at the enterprise level.
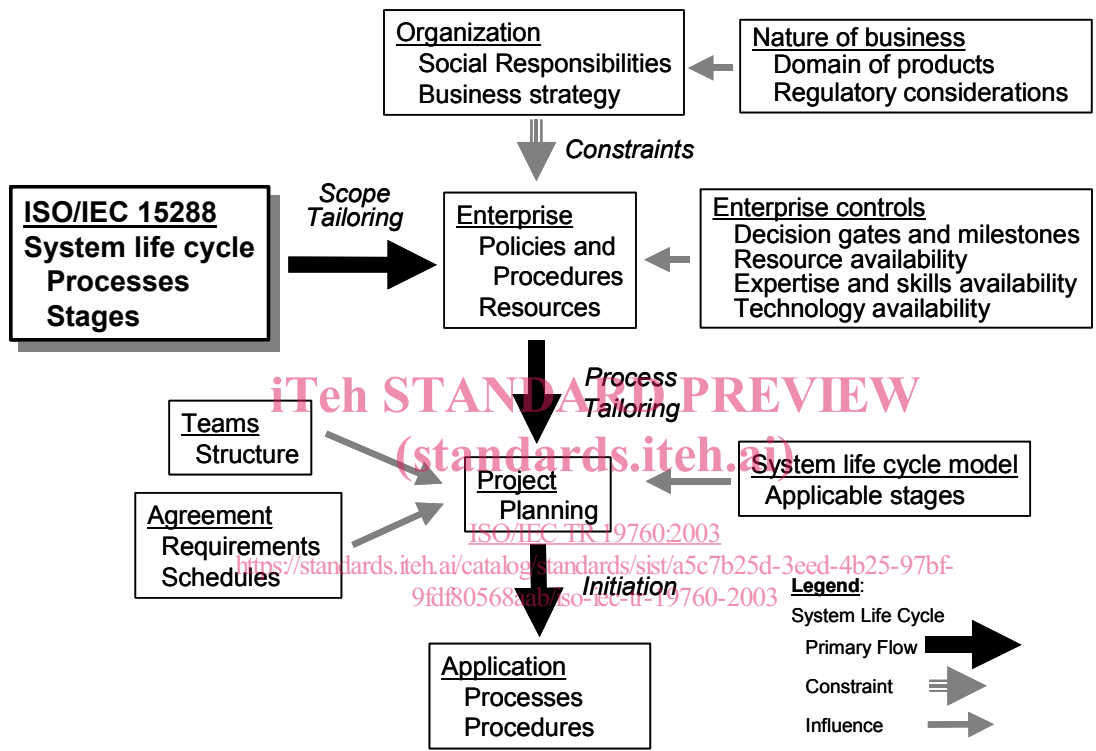
Figure 4 — Concept of use

4.3   Planning for use

The International Standard can be considered for a specific project with a set duration or for a continuous work effort conducted by an organization.

The following are examples of items to consider while planning use of the International Standard.

a) The scope of the work effort such as:

1) a single project either internal to the organization or an enterprise within the organization, or as part of a multi-party agreement;

2) concentration on some key processes or a single process where there is expected to be some gain for the organization or enterprise;

3) concentration on a single life cycle stage to carry out the operation of that stage.

b)   Identification and listing of stakeholders such as:

1)   intended users or customers of the work products, applicable systems or services;

2)   providers of enabling systems;

3)   other interested parties who have an interest or stake in the products or services;

4)   sources of requirements (including constraints).

c)   Desired outcomes such as:

1)   work products (for example system-of-interest, paper report, digital data, hardware or software configuration item, waste material or procedure document);

2)   services or capabilities to be delivered or demonstrated at the end of the project and at specific milestones.

d)   Special considerations such as:

1)   systems technologies that focus on software, hardware, humans, processes or procedures;

2)   system utilization including single use, repeated use and continuous use;

3)   system fabrication, for example one-of-a-kind, replicated or mass-produced;

4)   system topologies such as networks (for example a corporate global network), system of systems (for example a command and control or telecommunication system) and long-lived systems (for example those that never reach an end of use life such as electric power service);

5)   methods and tools that enable implementation of the processes throughout the life cycle.

e)   Goals and objectives of the project such as:

1)   specific objectives identified by milestones;

2)   long-term utilization goals related to the work and work products, especially with respect to the use of a system.

f)   Project strategy such as:

1)   how the project will be carried out, including any agreement considerations;

2)   how work packages will be planned, assessed and controlled;

3)   how work products will be planned, evaluated and controlled;

4)   how work and changes will be authorized;

5)   major milestone decision or event points (for example management reviews, meetings, pilot tests, deployments and deliveries) with milestone entry or exit criteria.

g)   Requirements and constraints such as:

1)   specific functional and performance requirements for capabilities of or data from a system, including special attributes and usability expectations or concerns;

2)   policies, priorities and constraints that will affect meeting the cost, schedule and quality requirements and objectives of the project;

3) core organizational technologies that will affect system requirements or other work product requirements and constraints; applicable organizational processes, standards and specifications (including source and availability); product implementation risks; and how information of required quality (including different product versions) will be captured, stored and controlled;

4) applicable system life cycle stage activities (for example development, pilot testing, full production, retirement) and expected outputs (for example. deliverables, work products and management reviews);

5) relevant stage entry or exit criteria, including expected level of system maturity, level of acceptable risks and management review concerns;

6) project start-up and end dates, including milestone dates associated with approval and progress reviews and pilot tests, as applicable;

7) management structure, including participants and their roles;

8) exclusions of organizations or persons (if applicable), including when the exclusion is or is not valid;

9) level of security classification and other security considerations, if applicable;

10) expected deliverables at milestones, at end of project and during project performance;

11) environment, recycling and reuse issues.

The information from a) through g) above should be appropriately documented. Based on the above documented information, appropriate detailed action planning should be performed to generate appropriate plans that can guide application of the International Standard.

4.4 Tailoring

4.4.1 General

When the International Standard is used by an enterprise to form a set of policies and procedures governing project work, then tailoring may be used to appropriately reduce or extend the scope of the International Standard as necessary for the business strategy and kind of business for which the policies and procedures are framed.

When the International Standard is used by a project, then tailoring may be used to appropriately consider the peculiar characteristics of the project, life cycle stage or agreement. Since each project has to consider and demonstrate the benefits of what it does to satisfy stakeholder requirements, there is a need to concentrate on the relevant processes and activities and the expected outcomes, including specific output documentation.

Tailoring takes the form of deletion, alteration or addition. Careful consideration should be given to dropping factors of the International Standard that do not add value to the process, system-of-interest or system element.

When tailoring is done, it may be important to ensure that applicable conformance requirements of the International Standard are met (see Clause 2 of the International Standard).

4.4.2 Tailoring considerations

The objectives and requirements of an agreement should define the context of application of the International Standard. To assist in defining the level of detail and effort required for execution of some processes, the following should be considered in tailoring:

a) the life cycle stage and the applicable exit criteria;

b) the mission profiles, operational scenarios and operational concepts for each major functional requirement of the system-of-interest;

c) the set of measures of effectiveness, with relative importance, by which the acquirer typically determines satisfaction of the requirements;

d) empirical data that describes the constraints and risks that could affect the project and enterprise, including budget, resources, competition and schedule;

e) the technology base and any limitations on the use of technologies.

Additional tailoring considerations can be found in the conformance requirements of Clause 2 and Annex A of the International Standard.

4.4.3   Tailoring guidance

Either the organizational unit responsible for forming policies and procedures, or the project team or individual assigned to plan the project can be responsible for completing appropriate tailoring. To aid tailoring the following factors affecting the project effort should be helpful.

a) Project requirements such as the required work, schedule, funding and technical requirements (for example functional requirements, performance requirements and interface requirements) can drive stage timing and the definition of the system under consideration. These can also drive the criticality of the system and its enabling systems.

b) The applicable processes of the International Standard that apply to the domain, business of the organization and type of enterprise (for example supplier, user, acquirer, or other stakeholder) should be included in project plans. Other processes that are not in the International Standard can be required by an agreement, or they can be required by the nature of the project, the applicable system or the type of organization. These processes may be added, complete with their purpose, outcomes and activities.

c) Activities for each applicable process and the expected outcomes of each activity should be selected. Depending on the size and scope of the project, the type of enterprise and whether an unprecedented system is the object of the project, one or more of the International Standard activities for a process could possibly not apply. Likewise, outcomes and activities may be added to a process when needed to meet agreement requirements or to meet unique requirements for a system. See Annex A of this Technical Report for sources of such additional activity detail.

d) Tasks, methods and tools required for activity completion should be determined. The applicable tasks, methods and available tools are not included in the International Standard. These may be added by the project or organization during planning for an adopted process. See Annex A of this Technical Report for sources of additional task detail.

e) Reporting and technical review requirements applicable to the life cycle stage or stipulated in the governing agreement or in organizational policies and procedures should be considered.

f) Project measurement requirement provisions should be included for the collection and reporting of key measures by which project progress will be evaluated.

g) Requirements related to activities and tasks involving specialty engineering and functional disciplines may be integrated in appropriate processes. These processes include requirements (special requirements or critical project and system requirements) and life cycle stage entry or exit criteria (for example safety, security, human factor engineering, design, software development, production, test and logistics). Specialty and functional plans that are needed to ensure completion of project work may be included in work definition.

h) Applicable standards, policies and procedures, regulations and laws can be the source of additional process and activity requirements to add to the work definition, even though not included in the