
**Software and systems engineering —
Certification of software and systems
engineering professionals —**

**Part 3:
Systems engineering**

*Ingénierie du logiciel — Certification des professionnels de
l'ingénierie du logiciel —*

Partie 3: Ingénierie des systèmes





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Foreword

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

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

A list of all parts in the ISO/IEC 24773 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The ISO/IEC 24773 series addresses the certification of professionals in software and systems engineering. ISO/IEC 24773-1 contains general requirements for such certification schemes. This document contains requirements specific to certification schemes for systems engineering professionals.

The concepts, and requirements for certification schemes contained in ISO/IEC 24773-1 and ISO/IEC 17024 apply to this document.

Software and systems engineering — Certification of software and systems engineering professionals —

Part 3: Systems engineering

1 Scope

This document elaborates requirements and recommendations for certifications schemes based on ISO/IEC 24773-1, which are specific to the domain of systems engineering.

2 Normative reference

The following documents are referred to in the text in such a way that some or all their content constitutes requirements 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 17024, *Conformity assessment — General requirements for bodies operating certification of persons*

ISO/IEC 24773-1:2019, *Software and systems engineering — Certification of software and systems engineering professionals — Part 1: General requirements*

ISO/IEC TS 17027, *Conformity assessment — Vocabulary related to competence of persons used for certification of persons*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 17024, ISO/IEC TS 17027, ISO/IEC 24773-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

system

combination of interacting elements organized to achieve one or more stated purposes

Note 1 to entry: A system is an integrated set of elements, subsystems, or assemblies that accomplish a defined objective. These elements include products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements in combination organized to achieve one or more stated purposes (see INCOSE Systems Engineering Handbook^[2]).

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.46, modified — The original notes 1, 2 and 3 to entry have been removed; a new note 1 to entry has been added.]

5.3.2 Reference body of knowledge

The reference BOK is the INCOSE Systems Engineering Handbook^[2], which describes the following knowledge areas (i.e., processes, methods and activities) in systems engineering:

- a) Generic Life Cycle Stages
- b) Agreement Processes
- c) Technical Processes
- d) Technical Management Processes
- e) Organizational Project Enabling Processes
- f) Tailoring process and Application of Systems Engineering
- g) Cross-Cutting Systems Engineering Methods
- h) Specialty Engineering Activities

Refer to [Annex A](#) for elaboration of these knowledge areas. See [Table A.1](#).

5.3.3 Alternate body of knowledge

If the scheme contains another BOK (i.e. “alternative BOK”) other than the reference BOK identified in [5.3.2](#), the knowledge areas of the alternate BOK identified in the scheme shall be mapped to knowledge areas of the reference BOK. The scheme shall demonstrate that the alternative BOK covers the scope of the reference BOK as defined by the knowledge areas in [5.3.2](#), with rationale supporting any reduction in depth of coverage.

5.3.4 Other technical knowledge

Where additional technical knowledge is required by the professional targeted by the scheme, beyond the core systems engineering knowledge defined in the reference BOK, the scheme shall define it, and address these topics with an additional or augmented BOK.

The other elements of the scheme (statement of target professionals; their typical tasks; skills; and competencies) should be consistent with the expanded knowledge requirements of the scheme.

5.3.5 Domain knowledge

In addition to the knowledge of system engineering, the scheme may address domain knowledge which is appropriate to the defined scope of the certification. That is, when a certification scheme targets professionals to be certified in systems engineering operating in a particular domain (industry or technical domain), it shall include knowledge items and knowledge content for that domain in the scheme’s BOK (ISO/IEC 24773-1:2019, 6.4.2.5).

The scheme shall document all related domain specific knowledge and any differences or distinctions from the reference BOK.

5.3.6 Verification of knowledge

The scheme shall document the method for verifying an applicant’s understanding of the BOK. Understanding of the reference BOK may be examined by prescribed testing or accredited coursework.

5.4 Skills

5.4.1 Identification of skills

The scheme shall identify and define the specific skills by a professional to be certified in systems engineering. These may be drawn from the following list of skills:

- a) Requirements Engineering
- b) System and Decision Analysis
- c) Architecture/ Design Development
- d) Systems Integration
- e) Verification and Validation
- f) System Operation and Maintenance
- g) Technical Planning
- h) Technical Monitoring and Control
- i) Acquisition and Supply
- j) Information and Configuration Management
- k) Risk and Opportunity Management
- l) Lifecycle Process Definition and Management
- m) Specialty Engineering
- n) Organizational Project Enabling Activities

Refer to [Annex B](#) for elaboration of these skills. See [Table B.1](#).

5.4.2 Assessment of skills

The scheme shall document the method for assessment of the skills identified in [5.4.1](#). This may include any combination of the methods cited in ISO/IEC 24773-1:2019, 5.6.

The scheme shall define measures for depth and breadth of coverage of the identified skill sets needed to be demonstrated to certify a professional systems engineer.

5.5 Competence

The scheme shall identify systems engineering specific competencies required for the target SE professional. These may be drawn from the competencies defined in the INCOSE Systems Engineering Competency Framework^[3] or an equivalent framework. These competencies are grouped into the following competency areas:

- a) Core – underpin engineering as well as systems engineering.
- b) Management – the ability to perform tasks associated with controlling and managing systems engineering activities. This includes tasks associated with the management processes identified in INCOSE Systems Engineering Handbook^[2].
- c) Technical - the ability to perform tasks associated with the suite of technical processes identified in INCOSE Systems Engineering Handbook^[2].

- d) Integrating - recognize systems engineering as an integrating discipline, joining activities and thinking from specialists in other disciplines to create a coherent whole.

Refer to [Annex C](#) for elaboration of these competency areas. See [Table C.1](#).

5.6 Professional attributes

The scheme shall identify the generic competencies of ISO/IEC 24773-1:2019 6.5.6. These may be augmented by the professional competencies identified in the INCOSE Systems Engineering Competency Framework^[3] that are well-established within the human resources (HR) domain.

5.7 Certification renewal

Pursuant to ISO/IEC 24773-1:2019, 6.7.2 and 6.7.3, the scheme shall require periodic assessment of evidence of continuing professional development (CPD) that is related to the competencies defined in [5.4](#) and [5.5](#) as the basis of recertification.

Annex A

(informative)

Elaboration of SE knowledge areas

Table A.1 — Elaboration of knowledge areas

Systems engineering knowledge areas	Systems engineering knowledge sub-areas
Generic Life Cycle Stages	Life Cycle characteristics, stages, approaches
Agreement Processes	Acquisition Process, Supply Process
Technical Management Processes	Project Planning Process, Project Assessment and Control Process, Decision Management Process, Risk Management Process, Configuration Management Process, Information Management Process, Measurement Process, Quality Assurance Process
Technical Processes	Business or Mission Analysis Process, Stakeholder Needs and Requirements Definition Process, System Requirements Definition Process, Architecture Definition Process, Design Definition Process, System Analysis Process, Implementation Process, Integration Process, Verification Process, Transition Process, Validation Process, Operation Process, Maintenance Process, Disposal Process
Organizational Project Enabling Processes	Life Cycle Model Management Process, Infrastructure Management Process, Portfolio Management Process, Human Resource management Process, Quality Management Process, Knowledge Management Process
Tailoring process and Application of Systems Engineering	Tailoring Process, Tailoring for Specific Product Sector or Domain Application, Application of Systems Engineering for Product Line Management, Application of Systems Engineering for Services, Application of Systems Engineering for Entities, Application of Systems Engineering for Very Small and Micro Entities
Cross-Cutting Systems Engineering Methods	Modeling and Simulation, Model-Based Systems Engineering, Functions-Based Systems Engineering Method, Object-Oriented Systems Engineering Method, Prototyping, Interface Management, Integrated Product and Process Development, Lean Systems Engineering, Agile Systems Engineering
Specialty Engineering Activities	Affordability/Cost-Effectiveness/Life Cycle Cost Analysis, Electromagnetic Compatibility, Environmental Engineering/Impact Analysis, Interoperability Analysis, Logistics Engineering, Manufacturing and Producibility Analysis, Mass Properties Engineering, Reliability, Availability, and Maintainability, Resilience Engineering, System Safety Engineering, System Security Engineering, Training Needs Analysis, Usability Analysis/Human Systems Integration, Value Engineering

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Annex B (informative)

Elaboration of skills

Table B.1 — Elaboration of skills

SE skills	Principle SE activities associated with the SE skills
Requirements Engineering	Preparing for or managing a Business or Mission analysis; Defining a Problem or opportunity space; Characterizing a solution space; Evaluating alternative solution classes; Preparing for Stakeholder Needs & Requirements Definition; Defining stakeholder needs; Developing Operational Concept and other Life Cycle concepts; Transforming needs into stakeholder requirements; Analyzing Stakeholder Requirements; Managing Stakeholder needs and requirements definition; Preparing for System Requirements Definition; Defining System Requirements; Analyzing System Requirements; Managing System Requirements.
System and Decision Analysis	Preparing, performing and managing a system analysis; Decision Management, including Preparing for System Engineering Decisions; Analyzing decision information; Making and managing SE decisions.
Architecture/Design Development	Preparing for architecture definition; Developing architecture viewpoints; Developing models and views of candidate architectures; Relating architecture to design; Assessing candidate architectures; Managing the selected architecture; Preparing for design definition; Assessing alternatives for obtaining system elements; Establishing design characteristics and design enablers; Managing a system design.
Systems Integration	Preparing, performing and managing system element implementation; Identifying, agreeing and managing system-level interfaces; Preparing and performing Integration; Managing integration results.
Verification and Validation	Preparing and performing Verification; Managing verification results; Preparing and performing Validation; Managing Validation results; Preparing for and performing System Transition; Managing results of System Transition; Obtaining Qualification, Certification and Acceptance.
System Operation and Maintenance	Preparing for Operation; Managing results of Operation; Performing and supporting System/ Product Operation; Preparing for and performing Maintenance; Performing Logistics Support; Managing results of maintenance and logistics; Preparing for, performing and finalizing system disposal.
Technical Planning	Defining an SE project; Planning an SE project and its technical management; Activating an SE project; Identifying and recording tailoring influences and mandated structures; Obtaining input from parties affected by the tailoring strategy; Making Tailoring decisions and selecting life cycle processes.
Technical Monitoring and Control	Planning for SE project assessment and control; Assessing SE projects; Controlling projects from an SE perspective; Preparing for and performing System Measurement; Preparing for system Quality Assurance; Performing system product or service evaluations.
Acquisition and Supply	Acquisition, including: Preparing for system/element acquisition; Advertising the acquisition and selecting the supplier; Establishing, maintaining and monitoring an acquisition agreement; Accepting a product or service from a supplier; Supply, including: Preparing for supply; Responding to a tender; Establishing, maintaining and executing a supply agreement; Delivering and supporting a product or service.
Information and Configuration Management	Planning Configuration Management; Performing Configuration Identification; Performing Configuration Change Management; Performing Configuration Status Accounting; Performing Configuration Evaluation; Performing Release Control; Information Management, including Preparing for and performing information management. Planning
Risk and Opportunity Management	technical risk and opportunity management; Managing the technical risk profile; Analyzing, Treating and Monitoring technical risks and opportunities

SOURCE: INCOSE systems engineering professional (SEP) certification program

Table B.1 (continued)

SE skills	Principle SE activities associated with the SE skills
Lifecycle Process Definition and Management	Establishing Lifecycle Processes including defining and implementing Lifecycle Models; Assessing Lifecycle Processes and Models; Improving Lifecycle Processes and Models.
Specialty Engineering	Performing professional-level Systems Engineering activities associated with one or more Specialty Engineering area(s). Typical Specialty Engineering areas include but are not limited to: Affordability/Cost- Effectiveness/Life Cycle Cost analysis; Electromagnetic Compatibility Analysis; Environmental Engineering/Impact Analysis; Interoperability Analysis; Logistics Engineering; Manufacturing and Producibility Analysis; Mass Properties Engineering; Reliability, Availability and Maintainability analysis; Resilience Engineering; System Safety Engineering; System Security Engineering; Training Needs Analysis; Usability Analysis/Human Systems Integration; Value Engineering.
Organizational Project Enabling Activities	Infrastructure Management, including establishing and maintaining the Infrastructure; HR Management, including identifying and developing SE Skills, acquiring and providing SE skills for projects; Quality Management including planning and assessing Quality Management, Performing Quality Management corrective and preventative actions; Knowledge Management, including Planning Knowledge Management, Sharing Knowledge and skills throughout the organization, Managing Knowledge, skills and knowledge assets; Project Portfolio Management at Organizational level, including defining and authorizing SE projects, evaluating a portfolio of SE projects and terminating SE projects.
SOURCE: INCOSE systems engineering professional (SEP) certification program	

Annex C

(informative)

Elaboration of competency areas

Table C.1 — Elaboration of competency areas

SE competency areas	Systems engineering competencies
Core	Systems Thinking Lifecycles Capability Engineering General Engineering Critical Thinking Systems Modelling and Analysis
Management	Planning Monitoring and Control Decision Management Concurrent Engineering Business & Enterprise Integration Acquisition and Supply Information Management Configuration Management Risk and Opportunity Management
Technical	Requirements Definition System Architecting Design for... Integration Interfaces Verification Validation Transition Operation and Support
Integrating	Project Management Finance Logistics Quality

Table C.1 *(continued)*

SE competency areas	Systems engineering competencies
Professional	Communications Ethics and Professionalism Technical Leadership Negotiation Team Dynamics Facilitation Emotional Intelligence Coaching and Mentoring

Annex D

(informative)

Exemplar mappings of competencies to skills and knowledge

Table D.1 — Exemplar mapping of knowledge to skills

[illegible]

Table D.2 — Exemplar mapping of skills to competencies

[illegible]

Bibliography

- [1] ISO/IEC/IEEE 15288:2015, *Systems and software engineering — System life cycle processes*
- [2] INCOSE. *Systems Engineering Handbook: A Guide for System Lifecycle Processes and Activities*. Wiley, Fourth Edition, 2015
- [3] INCOSE *Systems Engineering Competency Framework, version 1.0*
- [4] Washington Accord, <https://www.ieagreements.org/accords/washington/>

