Information Technology Engineers Skill Standards

Application Systems Engineer

Contents

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1. Overview

1.1 Background of developing the "Information Technology Engineers Skill Standards"

At present, great hopes are placed on information technology as the sources of industry regeneration and new economic growth.   This is because the roles of IT have been expanded from the tools for manufacturing cost reduction and service speedup to those for effective collaboration among enterprises and the creation of new industries.   From now on, the rise or fall of an enterprise will be determined by quality of computerization investment.   It is therefore an urgent matter to bring up engineers who construct advanced information systems and those who utilize them.

In view of this, the Central Academy of Information Technology has repeated a study on how to bring up, evaluate, and select good engineers who can show their practical ability on actual jobs.   As a conclusion, the academy decided to establish the "information technology engineers skill standards" centering on the criteria to determine whether the required jobs can be performed adequately or not.

1.2 Significance and objective of developing the "Information Technology Engineers Skill Standards"

The results of surveys that the Central Academy of Information Technology has conducted on information processing engineers have suggested an important issue to be solved in the industrial world and by educational institutions such as schools.   The issue is the establishment of the guidelines that clearly define what the industrial and educational worlds are expecting to get.   While these guidelines need to define the level of knowledge, skills and capability to be equipped with by IT personnel (engineers) who do the actual jobs in the industrial world, they need to define the models of IT engineers who can be accepted internationally, and the ways how schools and other educational institutions should conduct education training on the basis of these models.   One example of the guidelines is the "Skill Standard for IT Engineers" developed by the Northwest Center for Emerging Technologies (NWCET) as part of the establishment of "Skill Standards" by the US Department of Labor.

The "Information Technology Engineers Skill Standards" have been developed as a tool that solves the issue mentioned above, and apply to all the sections of the information technology engineers examinations as criteria to evaluate the skills of engineers who have been brought up.   The application of this skill standard is significant for the industrial world in "recruiting human resources with the guaranteed ability to do actual jobs."   For educational institutions such as schools, this is significant for "understanding and confirming the knowledge, ability, and the achievement levels of the engineers required by enterprises."   For government agencies, this is significant for "grasping the technical level of the entire industrial world."

1.3　Configuration of the "Information Technology Engineers Skill Standards"

The "Information Technology Engineers Skill Standards" is a tool that provides information about knowledge and skill needed to do jobs such as building, operational control, usage and evaluation of IT system in organizations such as corporations.　It also provides indicators to determine the outcome of jobs. "Information Technology Engineers Examinations: Overview of the New System" and "Information Technology Engineers Examinations: Scope of Examinations" describe knowledge, technology (technical knowledge), and ability that information processing engineers need to have, and performance indicators (listed in 1), 2), and 3) below).　The established skill standards describe these points more specifically by consulting actual jobs.

1) Roles and jobs
2) Expected technical levels
3) Scopes of examinations: examination in the morning and that in the afternoon
   (The above information can be downloaded to access http://www.jitec.jipdec.or.jp/.)

The "Information Technology Engineers Skill Standards" consists of three kinds of technical information described below.　In this standard, individual skill standards are established for each examinees classified according to examination categories.

(1) Key activities

This chapter describes jobs that are keys unique to each examination categories.　It describes the "roles and jobs" in 1) above more specifically.

(2) Skill criteria

This chapter describes what knowledge and skill should be used to do the key activities in (1) above, and also describe performance indicators to determine what outcome should be obtained.　It describes "expected technical levels" in 2) above more specifically.

(3) Body of knowledge

This chapter systematically describes common knowledge independent of examination categories and knowledge needed to do the key activities in (1) above.　This chapter also covers the "scopes of examinations" in 3) above.

1.4 Image of an "Application Systems Engineer" and Skill Standards

These skill standards are provided to apply the framework of the aforementioned information technology engineers' skill standards to "application systems engineers."

(1) Image of applicable persons

Application systems engineers are supposed to prepare external design documents (system structure design documents and software design documents) and to design business processes based on information system conceptual plans and system plans prepared by systems analysts, in typical information system development projects, under the direction of project managers. In these basic processes they are required to have the ability to develop sophisticated systems by using their skills in advanced business analysis and system structure (architecture) design.

In addition, application systems engineers are responsible for successfully performing a series of works up to program development component design, detailed design, program implementation (module coding, unit test, integration test, and system tests as they guide software development engineers and fundamental information technology engineers).

(2) Skill Standard

The skill standards below apply to application systems engineers.

1) IT common body of knowledge

2) Application systems engineer

- Key activities, skill standards, practical body of knowledge, and core body of knowledge

2.   Key Activities

Key activities refer to a sequence of phases that represent application systems engineers' basic activities involved in information system development projects. In this skill standard, this sequence of phases in which they are involved is referred to as "information system development process."

The information system development process is divided into 8 basic activities shown in Figure 2-1.
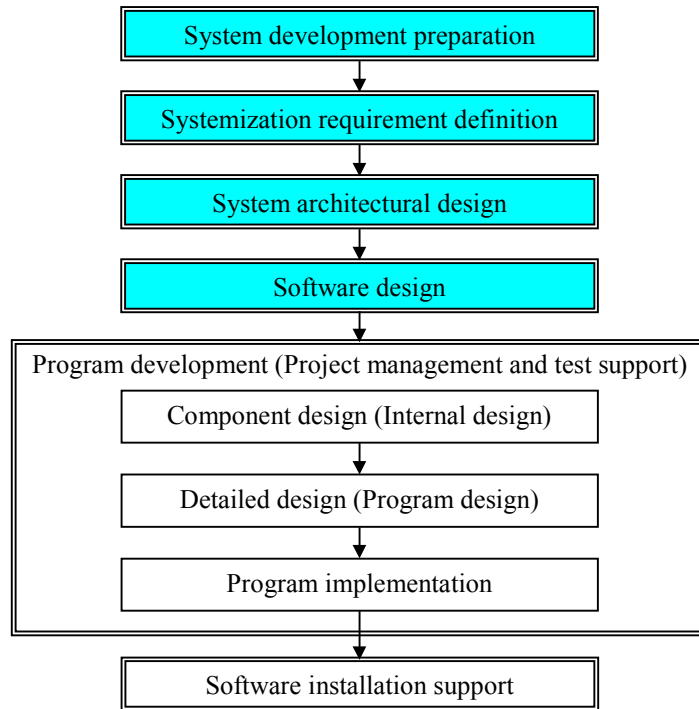

Fig. 2-1   Information System Development Process

Each activity is further divided into more detailed activities called tasks. The information system development process in this skill standard takes the following form.

Activity	Task		Job outline
1. Act 1	1-1	Task 1	x x x x x x x x x x x x x x
	1-2	Task 2	x x x x x x x x x x x x
	1-3	Task 3	x x x x x x x x x x
2. Act 2	2-1	Task 1	x x x x x x x x x x x
	2-2	Task 2	x x x x x x x x x x x x x
	2-3	Task 3	x x x x x x x x x x x x x x x x
	2-4	Task 4	x x x x x x x x x x x x

Application systems engineers are responsible mainly for the four activities preceding "Component design" as shown in Fig. 2-1. Considering roles and activities assigned to them in "Information Processing Engineer Test - the Overview of the New System," however, they are also supposed to play an important role in developing programs and planning and supporting integration tests. Thus, application systems engineers are required to have the additional ability to lead and support "Component design (Internal design)," "Detailed design (Program design)," and "Program implementation." The job leading and guiding these three activities is named generically "Program development."

(Note 1) The information system development process includes "Activity common to different tests" other than the activities in Figure 2-1.

(Note 2) In Figure 2-1, activities in a single box are those which application systems engineers have the ability to conduct as prerequisite, activities in a double box are those in which they are involved, and activities in a shaded box are those which they mainly perform.

(Note 3) According to "the system development process commonly applied to fundamental information technology engineers, software design and development engineers, and application systems engineers" in "The Skill Standard for Information Processing Engineers - Software Design & Development Engineers" and "The Skill Standard for Information Processing Engineers - Fundamental Information Technology Engineers" released on July 31, 2000, those activities preceding "Software design" in Figure 2-1 are categorized into three activities: "User requirement analysis and systemization requirement definition," "System development preparation" and "System design (External design)." The 3 activities were changed into four activities in this skill standard in order to make the structure closer to SLCP-JCF98. At present, the change is applied only to application systems engineers. But it will be also applied to software design and development engineers and fundamental information technology engineers in the future.

(Note 4) The combination of "System structure design" and "Software design" in Figure 2-1 is equivalent to "External design" in "Information Processing Engineer Test - the New System."

[Information system development job process]

Activity	Task		Job outline
1. System development preparation	1-1	Support systematization planning	Understand information strategies in the context of business strategies and support systematization planning from the viewpoint of system development.
	1-2	Decide software life cycle models for the development	Decide software life cycle models appropriate for the scope and scale of the project.
	1-3	Prepare the development environment	Establish the development environment by selecting standards, techniques, tools, and other necessities used in the system development process.
	1-4	Make a plan for executing the development process	Define the scope of the project and make a concrete plan for executing the development process.
2. Systematization requirement definition	2-1	Collect and analyze information for user requirement definition	Analyze problems associated with the existing systems and new users' needs to clarify user requirements (This task consists mainly of deciding what to survey, making surveys, analyzing the results to classify systematization requirements, defining prerequisites and constraints, finding solutions, and defining the scope of systemization.)
	2-2	Divide work process and define terms	Review work process to divide into detailed work steps and define interfaces between them. Define terms related to them.
	2-3	Define systematization requirements	Define the following points and clarify system requirements which meet user requirements, and document them. • The purpose and scope of systematization • Functions and performance required of the system • Business, organization, and user requirements for the system • Reliability requirements • Security requirements • Human factors, interface, and operational requirements • Maintenance requirements • System configuration requirements • Design conditions and validation requirements • Development environment • Quality, costs and expected effects • Transition and validation requirements • Basic requirements for main databases and data items

Activity	Task		Job outline
	2-4	Evaluate systematization requirements	Make technical evaluations of systematization requirements in terms of the traceability of user requirements, consistency with user requirements, test arrangements, and the feasibility of the system design and operation and maintenance.
	2-5	Prepare a systematization requirement document and make a joint review	Prepare a systematization requirement definition document, and review it with users.
3. System architectural design	3-1	Decide a system architecture	Clarify hardware, networks, software, and handwork which constitute the architecture compliant with systemization requirements, and assign system requirements to appropriate components. Formulate the system structure components with respective system requirements in writing.
	3-2	Evaluate the system architecture	Evaluate the system structure and the assignment of requirements in terms of traceability to system requirements, conformity with system requirements, the suitability of design standards and design techniques to be used, the feasibility of software components which meet assigned requirements, and the feasibility of operation and maintenance.
	3-3	Prepare a system architecture design document and conduct a joint review	Prepare a system structure design document and review it with users.
	3-4	Evaluate commercial packages	Evaluate the performance and suitability of commercial packages which are used to develop software components.
	3-5	Establish a test policy	Establish a test policy and system validation requirements which are appropriate for system requirements and the structure, and formulate them in writing.
	3-6	Prepare a flowchart of detailed work	Define the work flow by input, processing, output, and responsible organization according to the scopes of systemization and handwork. Formulate the defined work flow in writing.
	3-7	Design operational details	Review operational details including responsible organizations, staff needed, operational system, and operational procedures and put them in writing.
	3-8	Prepare an operational guide and conduct a joint review	Prepare operational manuals (user manuals (outlined version)) after reviewing operational procedures which consist of computing operations including user operations such as input and output. Review the manuals with users and prepare the final versions.

Activity	Task		Job outline
4. Software design	4-1	Define software requirements	Define the following software requirements including quality characteristics, and document them. • Performance and physical characteristics • Specifications of functions and performance including environmental requirements for software execution • Software items and interfaces with peripheral systems • Data definition and database requirements • Security specifications • Human factor specifications • Requirements for user documents, user operation and execution • Validation requirements • Installation and acceptance requirements • User maintenance requirements
	4-2	Evaluate software requirements	Evaluate software requirements in terms of traceability to system requirements and system design, external and internal consistency with system requirements, the ease of test planning, the feasibility of the software design, and the feasibility of operation and maintenance.
	4-3	Prepare software design documents and conduct a joint review	Based on software requirements, prepare a software design document which describe codes, logical data, screens, reports, and interfaces with external systems and conduct joint reviews. After completing the reviews, establish a baseline for requirements for software.
	4-4	Establish a software validation test policy	Establish a validation test policy for software items and software validation requirements, and document them.
5. Program development	5-1	Project management	Guide fundamental information technology engineers and software design and development engineers in component design, detailed design, and program implementation, and perform designing and development works.
	5-2	Unit and integration test support	Guide fundamental information technology engineers and software design & development engineers in unit and integration tests and have them conduct testing.
6. Software installation support	6-1	Install software	Make a software installation plan and follow the plan to install completed software.
	6-2	Support user acceptance tests	Support users to do acceptance review and test of the delivered products.
	6-3	Educate, train, and support users	Provide users with basic education and training as well as support.

Activity	Task	Job outline
7. Activities common to different tests	7-1　Make a test plan	Make an overall test plan at the stage of systemization requirement definition, and establish a quality control policy for the project. Based on the overall test plan, make detailed test plans, at the stages of design and implementation.
	7-2　Establish test procedures	Define test requirements and prepare test specifications. Establish test procedures and prepare test data. Develop test programs, if necessary.
	7-3　Conduct tests	Conduct tests based on the test specifications. When an error occurs, correct the source coding and test its object code and complete the code again.
	7-4　Document test results and receive approval	Document test results, and review them for validity, and receive approval.

(Note 1) Validity requirements refer to requirements for tests to confirm that the system meets predetermined requirements.

(Note 2) 'Traceability' means that it is possible to trace back to the previous stage and confirm how the requirements from the previous stage were met at that stage.

3.   Skill Criteria

Skill criteria represent a guideline tool or a list to determine whether application systems engineers successfully implemented a project using proper steps, techniques, knowledge and skills included in the information system development process described in the Key activities.

In the skill criteria list, an indicator ('performance indicator') regarding what sort of results need to be attained as performing the job for each 'task' of each activity is shown with the knowledge ('required knowledge') and skill ('required skill') to perform the job.

[Considerations in the application of skill criteria]

- Application systems engineers are responsible mainly for the four activities preceding "Component design" in the series of skill criteria listed on the next page onward. Thus, skill criteria for the four activities are selected mainly applied to them.
- "Information Processing Engineer Test - The Overview of the New System" states that application systems engineers are also required to have the ability to manage lower-level engineers in the activities following "Software design." Therefore, it is assumed that skill criteria for those activities are applied to them.

[Application Systems Engineers Skill Criteria]

1. System development preparation				
No.	**Task**	**Performance indicators**	**Required knowledge**	**Required ability**
1-1	Support systematization planning	• Target business flow and data handled in the business process have been identified from the viewpoint of system construction, and business process flowchart has been prepared. • The functions, data, system structures, maintenance and operational procedures, and quality of all the existing systems associated with target business have been identified and data on them has been confirmed so that they can be utilized to re-construct business functions. • System functions to support business functions have been clarified. • A list of architecture, databases, and networks and their outlines have been cleanly prepared.	• Knowledge of user business processes • Knowledge of notations of business processes and information • Knowledge of system analysis methods • Knowledge of architecture, hardware, and software • Knowledge of databases and networks • Knowledge of notations of relationships among system components	• Ability to collect necessary information from users • Ability to analyze target business and understand the process flow • Ability to grasp the types of information input to or output from a specific business processes • Ability to analyze the system • Ability to consider the overall structure of the system appropriate for target business. • Ability to describe the conceptual system in an easy-to-understand language
1-2	Decide software life cycles for the development	• Software life cycle models which are appropriate for system characteristics, development periods, budgets, and resources to be used, have been adopted. • The development process has been clarified.	• Knowledge of the effects of system characteristics on development methods • Knowledge of development periods, budgets, and resources • Knowledge of software life cycle models • Knowledge of relationships between models and processes	• Ability to determine the scale, scope and complexity of the system • Ability to estimate the time and cost required to develop the system • Ability to select software life cycle models which are appropriate for the project • Ability to tailor processes as necessary.

1-3	Prepare the development environment	• Elements required to execute the development process and support process have been identified. • Proper development standards, development methods, tools, and programming languages for these elements have been selected.	• Knowledge of the execution of each process • Knowledge of development standards • Knowledge of development methods • Knowledge of tools, middleware, and programming languages • Knowledge of hardware	• Ability to select, and tailor processes in the light of resources and budgets • Ability to identify development environment elements which need special attention. • Ability to select a development environment required of each process
1-4	Make a plan for executing the development plan	• For the entire system development, the time to execute, methods and resources to be used have been clarified. • What to produce in each process has been identified. • Resources for development have been assigned so that they can be used effectively. • Issues related to security and risk have been identified and countermeasures against them have been prepared.	• Knowledge of the documentation of the execution plan • Knowledge of each process, resources to be used and the workload for each process. • Knowledge of risk management • Knowledge of security • Knowledge of project management	• Ability to make an execution plan for each process • Ability to grasp the entire processes and balance the individual process plans • Ability to plan efficient staff assignment • Ability to evaluate the skills of staff • Ability to predict risks • Ability to take countermeasures against risks

2. Systemization requirement definition				
No.	**Task**	**Performance indicators**	**Required knowledge**	**Required ability**
2-1	Collect and analyze information for user requirement definition	• The current organization, procedures, and work volume have been identified. • Files, databases, and data have been identified. • Screens and reports have been identified. • Problems associated with the existing business systems have been identified and analyzed. • A new work flow has been prepared. • A new work model has been analyzed and mapped a work flow. • Systematization needs have been identified. • Prerequisites and constraints have been identified. • Solutions and the scope of systematization have been defined. • The scope and purpose of target business to be modeled and data handled have been defined.	• Knowledge of user business processes and terms related to them • Knowledge of methods for collecting information • Knowledge of business analysis methods • Knowledge of modeling techniques • Knowledge of system engineering • Knowledge of the organization	• Ability to identify a key person or a main information source among users • Ability to implement information collection methods and procedures • Ability to decide the necessary volume of information to be collected • Ability to model and analyze business processes • Ability to categorize systemization needs, prerequisites, and constraints • Ability to determine whether the system satisfies the requirements
2-2	Breakdown work and define terms	• Work contents have been analyzed and divided into detailed steps. • The procedures of individual work steps and interfaces between them have been identified. • Terminology related to business process has been defined.	• Knowledge of business analysis methods • Knowledge of user business processes and terms related to them	• Ability to understand work contents • Ability to divide the work process into proper steps • Ability to clarify these work steps • Ability to express the concept in simple words

| 2-3 | Define systematization requirements | • The aim and scope of systemization have been defined.
• The functions and ability of the system have been defined.
• Business processes, organization, and user requirements have been identified.
• Requirements in terms of reliability, safety, human factors, interfaces have been identified.
• Security requirements have been identified.
• Operation and maintenance requirements have been identified.
• System configuration conditions have been defined.
• Design conditions and validation requirements have been identified.
• The development environment has been established.
• The quality, cost, and expected effects of the system have been considered.
• System requirements and validation requirements at the time of system transition have been established.
• Basic requirements for main databases and data items have been identified.
• All the above items are documented as systematization requirements. | • Knowledge of systematization and system integration
• Knowledge of system functions and operation
• Knowledge of the development process and ability.
• Knowledge of software quality requirements
• Knowledge of quality assurance
• Knowledge of security technology
• Knowledge of program tests
• Knowledge of development environment such as middleware, tools, and programming languages
• Knowledge of cost estimation
• Knowledge of methods for estimating expected effects
• Knowledge of process control
• Knowledge of databases
• Knowledge of networks
• Knowledge of human factors
• Knowledge of interfaces | • Ability to translate user requirements into systematization requirements
• Ability to detect contradicting requirements and find solutions
• Ability to apply effective technologies to requirements
• Ability to analyze the importance of data
• Ability to distinguish different types of risks
• Ability to apply effective technologies to requirements
• Ability to analyze the correctness and consistency of information
• Ability to coordinate individual requirements
• Ability to document defined contents in an easy-to-understand language
• Ability to select efficient test methods |

| 2-4 | Evaluate systematization requirements | • Traceability from obtained needs has been ensured.
• The consistency of obtained needs has been ensured.
• A plan to test requirements has been made.
• It has been established that system requirements will be met.
• It has been established that operation and maintenance will be feasible.
• The requirements for the system and design are complete and there are no conflicts among requesters.
• The requirements agree to what is required for the entire systematization project.
• The compatibility and mutual dependence of the requirements have been identified. | • Knowledge of the objective of the system construction
• Knowledge of basic system functions
• Knowledge of test methods of the system
• Knowledge of system prototyping
• Knowledge of system simulation
• Knowledge of system operation and maintenance
• Knowledge of review methods | • Ability to translate user operation requirements into system operation requirements
• Ability to associate obtained needs with system requirements
• Ability to design effective prototyping
• Ability to design effective simulation
• Ability to explain operation and maintenance methods
• Ability to analyze the correctness and consistency of information
• Ability to conduct reviews
• Ability to coordinate and adjust contradicting requirements
• Ability to obtain consensus among the stakeholders |
| 2-5 | Prepare a systematization requirement definition document and conduct a joint review | • Systematization requirements have been clearly described.
• Those concerned have participated in the joint review.
• Participants in the review have been provided with points to review.
• The results have been documented.
• All the participants in the review have understood the systemization requirements definition and has agreed to them. | • Knowledge of how to conduct reviews
• Knowledge of the system development and operation environments
• Knowledge of items to be included in the systematization requirement definition document and of the considerations to be made | • Ability to clearly describe important items
• Ability to select a communication method for effectively reviewing the systemization requirement definition document and to conduct review effectively
• Ability to fairly evaluate opposing opinions
• Ability to identify problems and find appropriate solutions.
• Ability to coordinate those concerned and to obtain their consensus |

No.	Task	Performance indicators	Required knowledge	Required ability
3. System structure design				
3-1	Decide a system structure	• Hardware components, software components, and manual works have been clarified. • All the systematization requirements have been allocated to hardware, software, and manual works. • The system has been properly divided into subsystems. • Candidates of system structures have been considered and the technical and cost trade-off and risk have been analyzed. • The suitability of the top candidate of the system structure to the project has been explained and those concerned have reached consensus. • The results of the above considerations have been documented.	• Knowledge of hardware • Knowledge of software • Knowledge of target business processes • Knowledge of cost estimation • Knowledge of risk involved in the project • Knowledge of the concept and technology of system structure design • Knowledge of what is included in the system structure design document.	• Ability to correctly document system structures • Ability to evaluate each candidate of the systematization plan and to explain it to those concerned • Ability to identify core requirements for the selected system structure. • Ability to do technical selection with due consideration to the cost effectiveness • Ability to allocate systemization requirements following consistent criteria
3-2	Evaluate the system structure	• Traceability from systematization requirements has been ensured. • Consistency with systematization requirements has been ensured. • The suitability of design standards and methods used has been established. • The feasibility of software component items which meet assigned requirements has been established. • The feasibility of operation and maintenance has been established.	• Knowledge of design standards and methods • Knowledge of the development method of software component items • Knowledge of operation and maintenance • Knowledge of the review method	• Ability to interpret system requirements and associate them with the system structure • Ability to analyze the logical consistency of the system and construct it • Ability to grasp the core of problems and solve them. • Ability to conduct reviews • Ability to coordinate and adjust contradicting requirements • Ability to form consensus among stakeholders

3-3	Prepare a system structure design document and conduct a joint review	• A system structure has been clearly specified. • Those concerned have participated in the joint review. • Participants in the review have been provided with points to review • The results of the review have been documented. • All the participants in the review understood the systematization requirements and agreed to them.	• Knowledge of how to conduct reviews • Knowledge of system development and operation environments • Knowledge of what is included in the system structure design document and points that need special attention.	• Ability to clearly describe important items • Ability to select a communication method for reviewing systematization requirements effectively and to conduct reviews effectively • Ability to fairly evaluate opposing opinions • Ability to identify problems and find appropriate solutions. • Ability to coordinate those concerned and obtain consensus among them
3-4	Evaluate commercial packages	• Commercial packages appropriate for the systematization purpose have been selected. • Commercial packages have been objectively compared and evaluated against systematization requirements. • Costs and maintenance required through the whole software life cycle have been considered.	• Knowledge of the types of commercial packages and their characteristics • Knowledge of how to estimate life cycle costs • Knowledge of technical and market trends of commercial packages	• Ability to establish evaluation points appropriate for systematization requirements • Ability to objectively conduct evaluation • Ability to present evaluation results in plain language
3-5	Establish a system test policy	• A test policy at the system level which corresponds to systematization requirements has been established. • The test policy at the system level which is appropriate for the system structure has been established. • The test policy has been documented.	• Knowledge of test methods • Knowledge of test tools • Knowledge of systemization requirements • Knowledge of target business processes	• Ability to formulate a system test policy according to the concept of systematization • Ability to extract points to confirm the systems practicality • Ability to obtain consensus on the test policy among the stakeholders

3-6	Prepare a detailed business process flow	• The scope and purpose of target business processes and data have been defined. • The flow of business processes has been made clear. • Input and output, processing, and a responsible organization have been clarified for each work process. • The scope and division of systemization and manual works have been defined. • The business process flow has been documented.	• Knowledge of business process analysis • Knowledge of notations of process flow • Knowledge of the methodology of business process model development • Knowledge of the methodology of data model development • Knowledge of simulation method	• Ability to understand target business processes • Ability to collect information from users and organize it. • Ability to obtain an agreement from those concerned • Ability to explain study results to those concerned • Ability to develop business process models and data models following model development methods • Ability to construct simulation models
3-7	Design business operational details	• The organization and staff that are involved in the target business processes have been identified. • The operational arrangements and procedures have been defined. • Appropriate business rules have been adopted.	• Knowledge of the organization theories • Knowledge of business constraints • Knowledge of business process execution • Knowledge of system operation	• Ability to study the organization structure • Ability to review system operation • Ability to ensure the consistency of the system with business processes • Ability to balance interests of those concerned • Ability to explain study results to those concerned
3-8	Prepare business operational guide and conduct a joint review	• Operational procedures including user business operations and system input/output have been defined. • How to use the system and the images of screens and reports based on systemization requirements have been provided. • Those concerned have participated in the reviews. • All the participants have agreed to the procedures, which have been finalized. • The review results have been documented.	• Knowledge of notations of business operation procedures • Knowledge of user business processes • Knowledge of system operation • Knowledge of how to conduct reviews	• Ability to describe operational procedures in concise and clear language • Ability to select a communication method appropriate for the review of user manuals and to conduct reviews effectively • Ability to define reports and operational procedures which support users' needs • Ability to conduct coordination and obtain consensus among those concerned

No.	Task	Performance indicators	Required knowledge	Required ability
4. Software design				
4-1	Define software requirements	• Functions and performance including environmental requirements have been defined. • Interfaces between subsystems have been identified. • User interfaces such as screens, reports, and files have been defined. • The software to develop will be made available. • Security specifications have been defined. • Human factor specifications have been defined. • Requirements for data and databases have been clarified. • Requirements associated with the installation and acceptance of software products have been clarified. • User documents have been defined. • User operation and execution requirements have been clarified. • Validation requirements to ensure that all the requirements have been implemented have been clarified. • Operation and maintenance procedures, effects on the environment, and safety specifications to avoid damage to humans have been defined. • User maintenance requirements have been clarified.	• Knowledge of software performance prediction • Knowledge of networks • Knowledge of databases • Knowledge of security technology • Knowledge of human factors • Knowledge of GUI and GUI development tools • Knowledge of ERP • Knowledge of test methods • Knowledge of software quality characteristics • Knowledge of operation and maintenance • Knowledge of quality assurance • Knowledge of software documents	• Ability to correctly document software requirements • Ability to clarify conditions under which the software is to be used • Ability to analyze linkage between subsystems • Ability to grasp users' needs and reflect them in the system • Ability to understand business processes • Ability to grasp what is necessary for business operation • Ability to simulate operation and maintenance • Ability to analyze threat and select appropriate countermeasures • Ability to analyze data and data structure and put together requirements • Ability to summarize the network configuration required • Ability to arrange software installation procedures

4-2	Evaluate software requirements	• Traceability from systematization requirements and system design has been ensured. • External consistency with systematization requirements has been ensured. • The internal consistency of each software component item has been ensured. • Tests on validation requirements can be properly established. • Software design is feasible. • Operation and maintenance are feasible.	• Knowledge of methods for developing software component items • Knowledge of operation and maintenance • Knowledge of networks • Knowledge of databases • Knowledge of GUI and GUI tools • Knowledge of ERP • Knowledge of test methods • Knowledge of software quality characteristics • Knowledge of operation and maintenance • Knowledge of security technology • Knowledge of human factors • Knowledge of quality assurance • Knowledge of software documents	• Ability to interpret systemization requirements and system design and to associate them with software requirements • Ability to judge totally • Ability to analyze the consistency of software and construct it • Ability to grasp the core of problems and solve them • Ability to conduct reviews • Ability to coordinate and adjust contradicting requirements • Ability to obtain consensus among stakeholders
4-3	Prepare a software design document and conduct a joint review	• Software requirements have been all specified as software design documents. • Those concerned have participated in the joint review. • The review results have been documented. • All the review participants have agreed and a baseline has been established.	• Knowledge of methods to describe software design documents • Knowledge of development process • Knowledge of development models • Knowledge of how to conduct reviews	• Ability to make non-information technology engineers correctly understand software specifications • Ability to explain technical information in the context of its effect on business processes • Ability to select a communication method for efficiently reviewing system design and for conducting review effectively • Ability to adjust different opinions and obtain consensus among those concerned
4-4	Establish a software validation test policy	• User requirements have been assessed against system requirements in terms of functionality, reliability, usability, and economical efficiency, and test items have been completely established. • A test policy to efficiently test the system has been formulated.	• Knowledge of test specification design • Knowledge of test tools • Knowledge of test methods	• Ability to establish a test policy which is suitable to the characteristics of software component items • Ability to identify key points of software component items and to establish a method for checking them • Ability to establish a test method which is cost effective

5.	Program development			
No.	**Task**	**Performance indicators**	**Required knowledge**	**Required ability**
5-1	Project management	• Components have been designed as planned. • Detailed design has been completed as planned. • Programs have been implemented as planned.	• Knowledge of project management • Knowledge of the estimation of workload • Knowledge of process control • Knowledge of component design • Knowledge of detailed design • Knowledge of program implementation	• Ability to direct fundamental information technology engineers and software design and development engineers • Ability to lead a team • Ability to analyze the progress of the process on the basis of quantitative data • Ability to take measures against risk
5-2	Unit and integration test support	• Test items necessary and sufficient for confirming the validity of the system have been established. • Tests have been conducted according to the test guidance. • The test results have been documented and recorded. • The causes of problems, if any, have been identified and appropriate measures have been taken.	• Knowledge of test methods • Knowledge of test-related documents • Knowledge of validation methods	• Ability to confirm that tests are being conducted properly • Ability to lead a team • Ability to make the significance of tests understood • Ability to select test items appropriately • Ability to determine how to address defects • Ability to have tests conducted efficiently

6. Software installation support

No.	Task	Performance indicators	Required knowledge	Required ability
6-1	Install software	• A plan to install software in the user operational environment has been made and documented. • Resources and information required to install software have been identified. • The above resources and information have been arranged to be made available.	• Knowledge of users' existing systems • Knowledge of software installation • Knowledge of the parallel operation of the existing systems and new ones	• Ability to make a plan to minimize the effects of the installation of software on the existing user environment • Ability to help users in launching the system • Ability to document and make clear operating procedures
6-2	Support user acceptance tests	• Test procedures have been prepared and documented for the users. • Tests have been conducted according to the test plan. • Test results have been documented.	• Knowledge of the method of describing test procedures • Knowledge of user operations involved in their business processes	• Ability to provide acceptance support required by users • Ability to explain test procedures so that users can understand them intelligibly
6-3	Educate, train and support users	• A user training plan has been made and documented. • Users have been provided with initial and continuous training, and support.	• Knowledge of user software operations • Knowledge of the levels of knowledge that users have of basic operations	• Ability to plan training, and support corresponding to users' ability to handle software • Ability to train and support users

7. Activity common to different tests				
No.	Task	Performance indicators	Required knowledge	Required ability
7-1	Make a test plan	• A proper overall test plan has been made. • Organization that conducts tests has been decided. • Items to be tested has been identified. • The following points have been identified: the scope, purpose, setup, schedule, testers methods; methods to design test data; test environments; criteria to evaluate test results; the documentation of test results; actions to be taken against problems identified during tests.	• Knowledge of the quality assurance of software • Knowledge of the reliability of software • Knowledge of test scheduling • Knowledge of the organizing test setup • Knowledge of test methods • Knowledge of the design and preparation of test data • Knowledge of method to evaluate test results • Knowledge of the documentation of test results • Knowledge of the construction of test environments • Knowledge of facilities and tools used for tests	• Ability to plan to build quality into products in the system development process • Ability to make rational test schedule • Ability to estimate resources and staff required to conduct tests • Ability to select test methods appropriate for the nature of the project
7-2	Establish test procedures	• Test specifications based on test requirements have been properly formulated in writing. • Test conditions have been established. • Those concerned have reviewed test procedures and reached an agreement.	• Knowledge of test methods • Knowledge of hardware, software and networks • Knowledge of databases • Knowledge of security • Knowledge of test tools • Knowledge of quality assurance	• Ability to select appropriate test methods • Ability to determine appropriate test items in consideration of cost effectiveness • Ability to efficiently establish test procedures • Ability to prepare test procedures so that failures can be localized. • Ability to obtain consensus among those concerned

7-3	Conduct tests	• It has been confirmed that the system works as intended. • Tests has been conducted as scheduled, in accordance with test procedures.	• Knowledge of test procedures • Knowledge of test methods • Knowledge of test tools • Knowledge of quality assurance	• Ability to evaluate test results • Ability to identify bugs or failures and to solve and correct them • Ability to investigate and analyze the situations and propose appropriate solutions • Ability to organize processes and the results systematically and to document detailed backups • Ability to evaluate the performance of the system • Ability to evaluate the usability of the system • Ability to evaluate test procedures
7-4	Document test results and receive approval	• All test results have been correctly documented and reported to those concerned. • Problems identified during the test process have been documented and reported correctly	• Knowledge of the documentation of test results • Knowledge of error analysis and solution process • Knowledge of report forms of test results • Knowledge of quality assurance	• Ability to evaluate automated test tools • Ability to evaluate the sufficiency of tests • Ability to propose improvements in test procedures

4. Body of Knowledge

Body of knowledge for application systems engineers is organized into a hierarchical structure of knowledge required of them to successfully implement key activities described in the previous chapter and to address various problems such as lower quality, increases in costs, and prolonged development periods grouped together by technical or problem solving themes.

Body of knowledge required of application systems engineers consists of the following two types of knowledge:

1) IT common body of knowledge

2) Working and core knowledge required of application systems engineers

"IT common body of knowledge" of 1), which is required not only of application systems engineers but also of engineers of the other test categories, is dealt with in a separate volume. For more information on common knowledge of IT, refer to "Information Technology Engineer Skill Standards - IT common body of knowledge".

According to "Information Technology Engineer Examination - Scope of Examination", application systems engineers are required to have the following levels of knowledge for 5 categories which constitute IT common body of knowledge.

"II. Computer system (Level II)"
"III. System development and operation (Level III)"
"VI. Security (Level II)"

"VII. Standardization (Level II)"
"VIII. Informationalization and Management (Level III)"

In "working and core knowledge required of application systems engineers" of 2), working knowledge consists of:
A. General knowledge required of application systems engineers,
B. System architectural design and
C. Software design,
where knowledge required to execute each activity is arranged in order of process.

"General knowledge required of application systems engineers" is incorporated in that application systems engineers, who help higher ranked engineers in system planning, are required to have a good knowledge of requirements for the construction process of information system development initiatives, what to produce, and procedures to follow and to partly assume the task of project management. System structure design and Software design are fields in which they should show their ability to the maximum.

Note: Though knowledge covered by "working and core knowledge required of application systems engineers" basically corresponds to "Information Technology Engineer Examination - Scope of Examination", "general knowledge required of application systems engineers" covers knowledge beyond what tests will cover. This is intended to expect them to lead the use of advanced and efficient software development technology in information system development.

[Application systems engineers practical body of knowledge and core body of knowledge]

Knowledge field	Major classification	Intermediate classification	Minor classification
A. General knowledge required of application systems engineers			
	1 The basics of systems		
		1.1 System architecture	
			1.1.1 Separation of hardware from software
			1.1.2 Separation of software from operators
		1.2 Hardware	
			1.2.1 Large general purpose machine
			1.2.2 Workstation
			1.2.3 PC server
			1.2.4 PC
		1.3 Software	
			1.3.1 OS
			1.3.2 Middleware
			1.3.3 Development support tools
			1.3.4 ERP
			1.3.5 Commercial applications
			1.3.6 Programming languages
		1.4 Database	
			1.4.1 Types of databases
			1.4.2 Normalization
			1.4.3 The logical design of data
			1.4.4 Data integrity
			1.4.5 Backup and recovery
			1.4.6 Data security
		1.5 Network	
			1.5.1 Network architecture
			1.5.2 Network security
			1.5.3 C/S
			1.5.4 WWW system

2	**Software development model**		
	2.1	Software life cycle model (JIS × 0160)	
			2.1.1 Process
			2.1.2 SLCP-JCF98
	2.2	Software development model	
			2.2.1 Waterfall model
			2.2.2 Spiral model
			2.2.3 Incremental model
			2.2.4 RAD
			2.2.5 Reengineering model
			2.2.6 Cycle model
3	**Project management**		
	3.1	Sizing	
			3.1.1 Empirical estimation method
			3.1.2 Boundary value method
			3.1.3 Function point method
			3.1.4 Feature point method
			3.1.5 Object point method
	3.2	Estimation of workload	
			3.2.1 Analogical estimation method
			3.2.2 PUTNUM
			3.2.3 COCOMO
			3.2.4 COCOMO II
			3.2.5 Application construction model
	3.3	Process management	
			3.3.1 Schedule management
			3.3.2 Cost management
			3.3.3 Resource management
	3.4	Quality control	
			3.4.1 ISO 9000 series
			3.4.2 ISO 15504
			3.4.3 CMM
	3.5	Review method	
			3.5.1 Peer review
			3.5.2 Joint review
			3.5.3 Walkthrough
			3.5.4 Prototyping and trial

Knowledge field	Major classification	Intermediate classification	Minor classification
B. System architectural design			
	1 Requirement analysis		
		1.1 Business process analysis	
			1.1.1 Survey method
			1.1.2 The types and characteristics of organization structures
			1.1.3 Business process modeling technique
			1.1.4 Business process analysis method
			1.1.5 Notations of business process flow
		1.2 System definition	
			1.2.1 The scope of the system
			1.2.2 Setting the aim of the software project
			1.2.3 Software project requirements
		1.3 Systematization requirement definition	
			1.3.1 Operational function and performance requirements
			1.3.2 Security requirements
			1.3.3 Operation requirements
			1.3.4 Maintenance requirements
			1.3.5 System transition requirements
			1.3.6 Requirements for databases
			1.3.7 Requirements for networks
			1.3.8 Human factor requirements
		1.4 Validation requirements	
			1.4.1 Subjects for validation
			1.4.2 Validation method
	2 Business process design		
		2.1 Detailed business process flow preparation	
			2.1.1 Business process modeling
			2.1.2 Method for organizing input or output data
			2.1.3 Notations of detailed business processes
		2.2 Detailed business process design	
			2.2.1 The types of organization structures
			2.2.2 Man machine interface
			2.2.3 System operation
			2.2.4 Business rules

		2.3 Preparation of business process procedures	
			2.3.1 The notations of operational procedures
			2.3.2 The method to display operation screens and to output reports
			2.3.3 The format of user manuals
3 System architectural design			
		3.1 Selection of system architecture	
			3.1.1 Selection of system architecture
			3.1.2 Hardware configuration
			3.1.3 Software configuration
			3.1.4 ERP and COTS
			3.1.5 Network configuration
		3.2 Logical data model	
			3.2.1 Hierarchical model
			3.2.2 Network model
			3.2.3 Relational model
		3.3 Security	
			3.3.1 Threat analysis
			3.3.2 Security technology
			3.3.3 Network security

Knowledge field	Major classification	Intermediate classification	Minor classification
C. Software design			
	1 Software requirements		
		1.1 Function specifications of subsystems and interface design	
			1.1.1 Division into subsystems
			1.1.2 Definition of subsystem function specifications
			1.1.3 Definition of interfaces between subsystems
		1.2 User interface design	
			1.2.1 GUI design technique
			1.2.2 GUI design tool
			1.2.3 Report design technique
		1.3 Data design	
			1.3.1 File design technique
			1.3.2 Database design technique
			1.3.3 Database related tool
		1.4 Security design	
			1.4.1 Security policy
			1.4.2 Security requirements
			1.4.3 Security implementation method
	2 Operation and maintenance requirements		
		2.1 Design requirements concerning operation	
			2.1.1 Acceptable performance from human factor viewpoint
			2.1.2 Handling incorrect operation
			2.1.3 Countermeasures against failures
		2.2 Design requirements concerning maintenance	
			2.2.1 Routine maintenance requirements
			2.2.2 Maintenance at the time of converting (replacing) hardware
			2.2.3 Upgrade of COTS and other tools
			2.2.4 Defects
			2.2.5 System scalability

3 Test requirements		
	3.1 Test policy	
		3.1.1 All item tests 3.1.2 Main path test 3.1.3 Abnormal process test 3.1.4 Overload test 3.1.5 Security test
	3.2 Test plan	
		3.2.1 Test organizations 3.2.2 Test plan documents 3.2.3 Test guidance documents
	3.3 Test results	
		3.3.1 Test result reports 3.3.2 Corrective actions and confirmation methods