

American Society for Quality (ASQ) Software Quality Engineer Certification Program

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7.1 ASQ Background

The American Society for Quality (ASQ), formerly the American Society for Quality Control (ASQC), is a society of individual and organizational members dedicated to the ongoing development, advancement, and promotion of quality concepts, principles, and techniques. ASQ's vision is to be the world's recognized champion and leading authority on all issues related to quality.¹

The origin of ASQ goes back to the United States' entry into World War II, which greatly increased demand for war supplies and the need for weapons perfection. The U.S. War Production Board sought help in improving production and quality from those skilled in applying statistical methods. As the prominence of quality control grew, representatives from different factories and industries responsible for the quality of manufactured products formed groups in various parts of the country to share information. In 1946, 17 local quality control societies formed the American Society for Quality Control. ASQ has grown to more than 130,000 individual members and membership is open to anyone interested in quality.

ASQ is governed by an elected board of directors and their mission is to "facilitate continuous improvement and increased customer satisfaction by identifying, communicating, and promoting the use of quality principles, concepts, and technology; and thereby be recognized throughout the world as the leading authority on and champion for quality."

ASQ members belong to one of 246 local sections, which are organized geographically to serve members and community needs on the local level. Located throughout

1. ASQ Web Page <http://www.ASQ.org>

the United States, Canada, and Mexico, sections provide ASQ members with the opportunity to meet others interested in quality to discuss common issues and concerns and to share ideas. Sections hold monthly meetings and many sections also provide members with a newsletter that includes articles about quality-related issues and information about certification, conferences, and training courses. Many sections also provide outreach to their community and are involved with local businesses, schools, and government agencies promoting quality concepts.

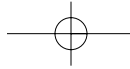
ASQ members may also join a division or a technical committee that serves the needs of members involved with specific industries and applications. For example, the Software Division provides specialized training, information, and professional programs for those interested in applying quality principles to the field of software development. The Software Division has responsibility for the following activities and services:

- Developing the software quality engineer certification program
- Sponsoring the annual International Conference on Software Quality
- Co-sponsoring the World Congress on Software Quality
- Publishing a quarterly newsletter
- Maintaining liaison with national and international standards bodies such as ANSI and ISO
- Interacting with other professional software organizations such as IEEE and the Association for Computing
- Cooperating with academia to make educational resources available to the software quality profession
- Reviewing tools and techniques for improving the quality of software products

7.2 ASQ Certification Program

The ASQ certification program was developed to recognize individuals who have demonstrated proficiency within a specific area called the *Body of Knowledge*. In the 25-plus years of the certification program, more than 55,000 professionals have become certified in one or more of the following seven certification areas:

- **Mechanical Inspector Certification**—Designed for those who, under professional direction, can evaluate hardware documentation, perform laboratory procedures, inspect products, measure process performance, record data, and prepare formal reports.
- **Quality Auditor Certification**—Designed for those who understand the standards and principles of auditing and the auditing techniques of examining, questioning, evaluating, and reporting to determine quality systems adequacy.



- **Quality Engineer Certification**—Designed for those who understand the principles of product and service quality evaluation and control.
- **Quality Manager Certification**—Designed for those who understand quality principles and standards in relation to organization and human resource management.
- **Quality Technician Certification**—Designed for those who can analyze quality problems, prepare inspection plans and instruction, select sampling plan applications, and apply fundamental statistical methods for process control.
- **Reliability Engineer Certification**—Designed for those who understand the principles of performance evaluation and prediction to improve product/systems safety, reliability, and maintainability.
- **Software Quality Engineer Certification**—Designed for those who understand software quality development, implementation, inspection, testing, verification, and validation, and can implement software development and maintenance processes and methods.

The ASQ membership identifies the certification program as one of the most important activities of the Society and the program has become a marketplace requirement for quality professionals.

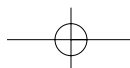
7.2.1 What is Certification?

Certification is a formal recognition that an individual has demonstrated proficiency in a subject at a point in time. ASQ certification requires education and/or work experience in a specific field and demonstrated knowledge through the successful completion of a written examination. Certification is NOT a license or registration. It is peer recognition of competence because the certified individual has passed an examination developed by industry subject matter experts covering the most important aspects of a specific professional area.

7.2.2 Why Become Certified?

For an individual, certification can be an important step in career advancement. Certification helps to ensure that professional skills are kept current, provides credibility in a job interview, and can lead to higher pay and faster career growth. Leonard Turi, owner of TMS Consulting Services, Inc., states: “Certified candidates are requested for more interviews and placed on consulting jobs sooner and for longer duration.”² This is not to say that individuals without certification cannot get a job, but companies are increasingly looking for highly qualified candidates and the impact of making a wrong hiring decision can be detrimental.

2. *Chicago Tribune*, February 9, 1997, Carol Kleiman



For organizations, the global business environment requires the maximum utilization of technology to remain competitive. Companies need a tool to accurately assess and choose the best Information Technology (IT) professionals to help an organization reach its goals and objectives. Many organizations are turning to certification as a way to help make hiring and promotion decisions. Over 125 companies have formally recognized ASQ certification as a way to ensure their workforce is proficient in the principles and practices of quality. Supporting certification also demonstrates a commitment to quality and an investment in the future of these highly skilled employees.

An International Data Corp survey of more than 250 Information Technology managers found definite advantages to having certified personnel. Although it is difficult to quantify the benefits of certification, most IT managers surveyed believe that certified personnel are worth higher salaries, almost \$10,000 per year over non-certified personnel.³

People would not think of having surgery performed by a doctor who failed to pass the board exam or go to an attorney who has been disbarred. Yet, we do not hesitate to place the successful utilization of technology and survival of companies in the hands of IT professionals who may or may not have demonstrated any degree of competence. Certification provides a professional badge of competence and a mark of excellence.

7.2.3 What is a Certified Software Quality Engineer (CSQE)?

The ASQ definition of a Certified Software Quality Engineer is “a professional who has a comprehensive understanding of software quality development and implementation; has a thorough understanding of software inspection, testing, verification, and validation; and can implement software development and maintenance processes and methods.”

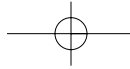
7.2.4 What Qualifications are Necessary to Become a CSQE?

The requirements for a Certified Software Quality Engineer fall into three categories:

1. **Education and Experience**

The candidate for certification must have eight years of on-the-job experience in one or more of the Body of Knowledge topics (see Section 7.5, What is in the Body of Knowledge?). At least three of those years must have been in a decisionmaking, technical, professional, or management position. Up to five years of the eight-year experience requirement will be waived if the

3. Info Canada, June 1996



7.3 How Is the Certification Exam Developed?

175

candidate has completed a degree from a college, university, or technical school with accreditation recognized by ASQ.

2. **Proof of Professionalism**

Proof of professionalism may be demonstrated by one of the following: membership in ASQ, registration as a Professional Engineer, or signatures of two ASQ members verifying the candidate's qualifications as a practitioner of quality.

3. **Examination**

The successful candidate must pass a four-hour written examination. Each examination consists of 160 multiple-choice questions that cover all topics in the Certified Software Quality Engineer Body of Knowledge.

7.3 How Is the Certification Exam Developed?

The process for establishing a new ASQ certification is a multistep process spanning several years.

The chart in Figure 7-1 depicts the steps necessary to develop a new ASQ certification examination. This chart is followed by a detailed explanation of each step.

7.3.1 A. Proposal for New Certification

Initiation of a new ASQ certification requires a sponsoring group. Usually a Division or Technical Committee within ASQ is that sponsoring group. The sponsoring group must document how their new proposed certification meets each of the following seven criteria:

1. The discipline shall be a unique area of quality technology generally practiced in the quality profession. This involves addressing how this proposed certification is substantially different from any existing examination.
2. The discipline shall be generic in nature, generally applicable to the production of any product by any process and/or to the rendering of any service.
3. The discipline shall have a substantial and authoritative Body of Knowledge in the public domain describing proven principles and practices of the technology. A draft bibliography is developed to identify available sources of the discipline.
4. The discipline shall be consistent with ASQ objectives, policies, and procedures.
5. Training in the principles and practices of the technology shall be readily available on a geographically dispersed basis. This could be addressed by a list of available training.

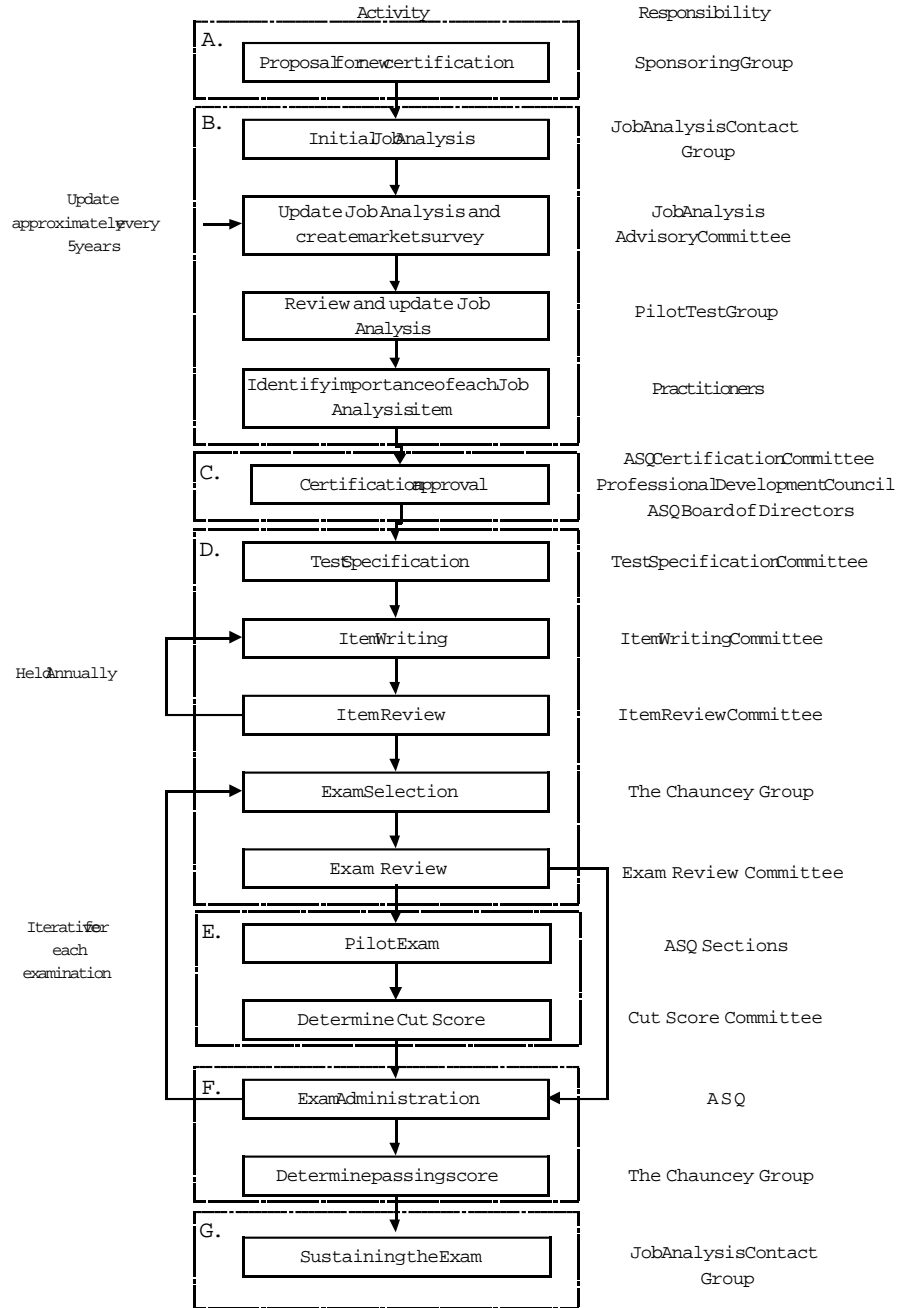
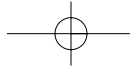


Figure 7-1 Certification development process.



6. The area of technology shall have the commitment and active support of one or more ASQ Divisions or Technical Committees with the capacity of providing adequate testing criteria for proficiency in the technology.
7. There must be a definable and continuing market and a justified need on a broad geographic basis for certification. This would include the projected market size, market growth and percentage of the market that is expected to pursue the new certification. This information may be gathered by conducting a market research analysis.

The ASQ Certification Committee may give tentative approval for the Division/Technical Committee to proceed with the next step, or they may request additional information before approval is given.

7.3.2 B. Job Analysis

The Job Analysis defines the major tasks that a certified individual would be expected to be able to perform and the associated knowledge and skill set. Conducting the initial Job Analysis is the responsibility of the Division/Technical Committee proposing the new certification.

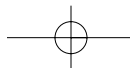
Several groups are necessary to complete the Job Analysis:

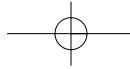
Job Analysis Contact Group. This committee consists of 10–12 individuals who are considered industry experts in the discipline of the new certification. Telephone interviews are conducted by The Chauncey Group (a subsidiary of Educational Testing Service) to obtain their input for the initial Job Analysis Survey instrument.

Job Analysis Advisory Committee. This committee consists of 10–12 experienced practitioners in the discipline of the new certification and meets for two days to review and revise the Job Analysis survey. A supplemental document is created with market survey questions that will provide evidence of a demand for the certification.

Pilot Test Group. This committee consists of five to six experienced practitioners in the discipline of the new certification and meets to review the draft Job Analysis Survey for clarity of directions, time required to complete the survey, and understanding of the survey rating process that will be used to determine the importance of each item.

The final version of the Job Analysis Survey is sent to a randomly selected group of 1000–2000 practitioners in the discipline of the new certification. These practitioners include members of the ASQ Division/Technical Committee, attendees





at related conferences, or members of other related professional societies. Their responsibility is to provide professional opinion on the level of importance of each item as a necessary part of the certification discipline.

The Chauncey Group analyzes the responses received from the surveys and issues a preliminary report that indicates whether each item in the questionnaire should be included in the Body of Knowledge for the certification, excluded from the Body of Knowledge, or is marginal. Members of the Job Analysis Advisory Committee and the Executive Committee of the Division/Technical Committee review these results and make a final recommendation for inclusion or exclusion of each item in the certification Body of Knowledge.

The Chauncey Group then issues a final report describing the Job Analysis process, the method of data analysis, and a summary of the results including inclusion/exclusion recommendations for the Body of Knowledge. The ASQ Certification Committee reviews this report and then determines the final content of the Body of Knowledge.

7.3.3 C. Certification Approval

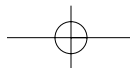
Upon completion of the Job Analysis, the Division/Technical Committee updates its proposal on how the certification meets the seven criteria for a new certification. A representative of the Division/Technical Committee presents the proposal to the ASQ Certification Committee. If approved, the representative presents the certification proposal to the Professional Development Council. If the new certification is approved, the representative will present the proposal to the ASQ Board of Directors. When approval is given by the ASQ Board of Directors, the certification becomes an official ASQ Certification and the ASQ national assumes future responsibility for the certification.

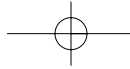
A key point to note is that up until this time, all expenses incurred by the participating practitioners are covered by their respective organizations or the individual. This highlights the initial industry and individual support necessary for a new ASQ certification. From this point forward, participant expenses are reimbursed by ASQ, but individuals who participate in the exam development process volunteer their time.

7.3.4 D. Creating the Examination

Several steps are necessary to create the initial examination and some of these steps are repeated for subsequent examinations, as shown in the chart.

Test Specification. This committee consists of 10–12 experienced practitioners in the discipline of the certification. This group takes the results of the Job Analysis and creates the Body of Knowledge for the certification. They also define





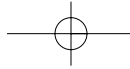
the mechanism for administering the examination. This includes the number of questions that will be included in the examination, the distribution of these questions over the Body of Knowledge, the format of the examination (for example, multiple choice questions, short answer questions, or a combination) and the mechanism for delivery (paper and pencil or computerized testing). The Test Specifications are used for all examinations that occur until the Job Analysis is updated and a revised Body of Knowledge developed.

Item Writing. This committee consists of 25–35 experienced practitioners in the discipline of the certification. This group is responsible for writing the actual examination questions. This is a very tedious activity because each question must test a specific area of the Body of Knowledge and have not only a correct answer (key), but also three viable incorrect answers (distracters) that someone without the specific knowledge could possibly select as a correct answer. For each question, a written justification must be documented explaining why the key is the correct answer as well as why the distracters are incorrect. In addition, specific references in the literature must be documented that support the topic being tested to show that this information is publicly available in the literature to a person taking the examination.

Not only must the chairperson for this committee find 25–35 willing volunteers, but must also make sure there is representation for each of the areas in the Body of Knowledge. The large committee is divided up into smaller groups, each concentrating on a specific area of the Body of Knowledge. It is not unusual for a question to take several hours to write, review with other experts in the group, rewrite, and obtain sign-off by each person in the small group. This committee demands a large commitment from the participants, since the sessions take place on Friday, Saturday, and Sunday. The group leaves on Sunday feeling very exhausted! Item writing sessions are typically held annually to ensure that the questions available for the examination are kept current.

Item Review. This committee consists of 12–14 experienced practitioners in the discipline of the certification. This group reviews each examination question for wording, accuracy, and validity. Approved questions are added to the pool of available examination questions. Unapproved items may be discarded or flagged to be returned to the next Item Writing Committee for rework. Item Review meetings are held after each Item Writing session.

Examination Selection. Prior to administering each examination, The Chauncey Group selects questions for the examination from the question pool. The mix of questions is based on the distribution of questions over the Body of Knowledge as defined in the Test Specification.



Examination Review. This committee consists of 10–12 experienced practitioners in the discipline of the certification. This group reviews the examination's accuracy, consistency, and validity. Each member must take the exam and answer each question as well as noting any concerns and comments. In the committee meeting, the group goes through the examination question by question. This group can change the wording of the question, change the wording of the answers, or replace the question with another one from the pool that tests the same area of knowledge.

7.3.5 E. Initial Examination Development

The following two steps are executed only for the first examination:

Pilot Examination. When a new certification is created, a Pilot Examination is administered. Typically, 20–25 pilot sites will be selected from the list of ASQ Sections who have volunteered to sponsor the pilot. These examinations are graded and statistically evaluated. However, the Cut Score Committee will meet and determine the passing grade prior to completion of the grading cycle.

Determine Cut Score. This committee consists of 10–12 experienced practitioners in the discipline of the certification. This group meets to recommend a written standard of minimum competency for the certification based on the Body of Knowledge and a recommended minimum passing score for the examination.

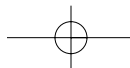
7.3.6 F. Examination Administration

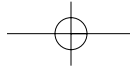
Typically, certification examinations are administered twice a year. ASQ certification staff are responsible for the administration of the examination. They screen potential candidates based on the certification requirements. Local ASQ Sections provide sites and proctors for the examination.

Determine Passing Score. The Chauncey Group scores the examination and runs statistical validation checks on each examination question. Statistically questionable items are reviewed. The Cut Score is statistically adjusted for each subsequent examination based on its difficulty. In this way, the same passing standard is maintained for each exam. Based on the established passing score, individuals who passed the examination are awarded certification. Individuals who do not meet the minimum passing score are given a report that indicates areas of the examination where they did well and areas where they need improvement.

7.3.7 G. Sustaining the Examination

The ASQ Certified Software Quality Engineer bibliography (see Section 7.6, ASQ Certified Software Quality Engineer Bibliography) is updated occasionally to





reflect new publications that provide information about topics in the Body of Knowledge.

The Job Analysis Process is repeated approximately every five years to ensure that the certification continues to reflect the state of the practice in the discipline. As a result, the content of the Body of Knowledge could change.

7.4 How Should You Prepare for the Exam?

An “Application for Certification as a Software Quality Engineer” must be completed and mailed approximately two months before the date of the examination. The fee for taking the exam is as follows:

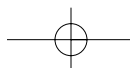
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|---------------------------------------|----------|
| 1. ASQ Member — North America | \$ 90.00 |
| 2. ASQ Member — outside North America | \$120.00 |
| 3. Nonmember — North America | \$195.00 |
| 4. Nonmember — outside North America | \$225.00 |

The best approach to prepare for the examination is to review the Certified Software Quality Engineer Body of Knowledge and identify specific topics on which to focus your studies. Then review the bibliography provided for each topic in the Body of Knowledge and identify key references that should be used for study. Begin your preparation well in advance because of the extensive breadth and depth of the topics. Waiting until the last minute will only bring on frustration and confusion. As the examination date gets closer, make sure your reference materials are organized so you can locate information quickly.

Refresher courses are also available to help you prepare for the examination. These courses are not sponsored nor endorsed by ASQ. Attending a refresher course does not ensure that you will pass the examination. Also, be aware that a refresher course may not be covering the exact topics on the examination. Anyone offering a refresher course cannot participate in the question writing nor the examination review so they do not have any “inside” information as to the specific content. The majority of each examination is new, so past questions do not reflect future questions on any given version of the examination. Refresher courses may be helpful to motivate early study and review, but be aware that they do not replace individual preparation.

7.4.1 What Reference Materials Can Be Used During the Exam?

The Certified Software Quality Engineer examination is open-book and your personal notes from preparation and materials from refresher courses are allowed. However, material containing sample questions and answers are not allowed. Any reference materials taken into the examination room must be made available to the



proctor for review. Reference materials cannot replace having an understanding of the material. The average time to answer each question is 1 1/2 minutes (four hours for 160 questions); therefore, there will not be time to dig through reference material for many answers.

Calculators may be used during the examination, but laptop computers are not allowed.

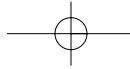
7.5 What Is In the Body of Knowledge?

The following is a high-level outline of the topics that constitute the Body of Knowledge for Software Quality Engineering.^{4, 5} Note: the number in parentheses following the title of each major topic (see I–VIII below) represents the number of questions for that section of the exam, totaling 160, and does not represent the number of items listed below; these items represent areas from which questions may be taken.

- I. GENERAL KNOWLEDGE, CONDUCT, AND ETHICS (24 questions)
 - A. Standards
 - 1. Domestic and international standards and specifications (e.g., ISO 9000, IEEE, Human Factors and Ergonomics Society, graphical user interface guidelines)
 - 2. Software quality and process initiatives, ventures, and consortia (e.g., SEI, SPICE, bootstrap, ESPIRIT)
 - B. Quality Philosophies and Principles
 - 1. Benefits of software quality
 - 2. Quality philosophies (e.g., Juran, Deming, Crosby)
 - 3. Prevention vs. detection philosophies
 - 4. Software Total Quality Management principles and applications
 - 5. Organization and process benchmarking (i.e., identifying, analyzing, and modeling best practices)
 - C. Organizational and Interpersonal Techniques
 - 1. Verbal communication and presentation
 - 2. Written communication
 - 3. Effective listening
 - 4. Interviewing
 - 5. Facilitation (e.g., team management, customer-supplier relationships)
 - 6. Principles of team leadership and facilitation

4. ASQ CSQE Certification Brochure, Item B0110.

5. CSQE Certification Chair, Linda Westfall.



7.5 What Is in the Body of Knowledge?

183

7. Meeting management
 8. Conflict resolution
 9. Organization and implementation of various types of quality teams
- D. Problem-Solving Tools and Processes
1. Root cause analysis
 2. Tools (e.g., affinity diagram, tree diagram, matrix diagram, interrelationship digraph, prioritization matrix, activity network diagram)
 3. Risk management (e.g., project, product, process)
 4. Problem-solving processes
- E. Professional Conduct and Ethics
1. ASQ Code of Ethics
 2. Conflict of interest issues for a software quality engineer
 3. Ethical issues involving software product licensing
 4. Legal issues involving software product liability and safety (e.g., negligence, customer notification, recall, regulations)

II. SOFTWARE QUALITY MANAGEMENT (16 questions)

- A. Planning
1. Product and project software quality goals and objectives
 2. Customer requirements for quality
 3. Quality and customer support activities
 4. Issues related to software security, safety, and hazard analysis
- B. Tracking
1. Scope and objectives of quality information systems
 2. Categories of quality data and their uses
 3. Problem reporting and corrective action procedures (e.g., software defects, process nonconformances)
 4. Techniques for implementing information systems to track quality-related data
 5. Records and data collection, storage, maintenance, and retention
- C. Organizational and Professional Software Quality Training
1. Quality training subject areas (e.g., inspection, testing, configuration management, project management)
 2. Available training resources, materials, and providers
 3. Professional societies, technical associations, and organizations for software quality engineers

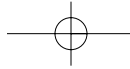
III. SOFTWARE PROCESSES (24 questions)

- A. Development and Maintenance Methods
1. Software development procedures

2. Life cycle or process models (e.g., waterfall, spiral, rapid prototyping)
 3. Defect prevention, detection, and removal methods
 4. Requirement analysis and specification methods (e.g., data flow diagram, entity-relationship diagram)
 5. Requirements elicitation methods and techniques (e.g., quality function deployment, joint application development, context-free questioning, needs analysis, focus groups)
 6. Software design methods (e.g., structured analyses and design, Jackson design methods, Warnier-Orr methods, object-oriented)
 7. Issues related to reuse, reengineering, and reverse engineering
 8. Maintenance processes (e.g., reengineering, reverse engineering, change management, retirement)
- B. Process and Technology Change Management
1. Software process and technology change management theory and methods
 2. Process maturity model
 3. Software process assessment and evaluation techniques
 4. Software process modeling (e.g., entry and exit criteria, task definition, feedback loops)
 5. Software environments (e.g., development methodologies, tools, data, infrastructure)
 6. Barriers to the implementation or success of quality improvement efforts and quality systems

IV. SOFTWARE PROJECT MANAGEMENT (16 questions)

- A. Planning
1. Project planning factors (e.g., quality, costs, resources, deliverables, schedules)
 2. Project planning methods and tools (e.g., work breakdown structures, documentation, forecasting, estimation)
 3. Goal-setting and deployment methodologies
 4. Maintenance types (e.g., corrective, adaptive, perfective)
 5. Software maintenance and adaptability program planning
 6. Supplier management methodologies
- B. Tracking
1. Phase transitioning control techniques (e.g., reviews and audits, Gantt charts, PERT, budgets)
 2. Methods of collecting cost of quality data
 3. Cost of quality categories (e.g., prevention, appraisal, internal failure, external failure)
 4. Cost, progress, and deliverable tracking (e.g., status reports, life cycle phase reports)



7.5 What Is in the Body of Knowledge?

185

C. Implementation

1. Project management tools (e.g., planning, tracking, cost estimating, reporting)
2. Methods of reporting cost of quality data
3. Tradeoffs involved in product release decisions (e.g., cost, quality, schedule, customer, test sufficiency, stability)

**V. SOFTWARE METRICS, MEASUREMENT, AND ANALYTICAL METHODS
(24 questions)****A. Measurement Theory**

1. Goal, question, metric paradigm for selecting metrics
2. Basic measurement theory and techniques
3. Definitions of metrics and measures
4. Designing measures
5. Psychology of metrics (e.g., how metrics affect people and how people affect metrics)

B. Analytical Techniques

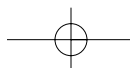
1. Issues involving data integrity, completeness, accuracy, and timeliness
2. Basic statistical concepts and graphical techniques for analysis and presentation of software data (e.g., distributions, confidence intervals, statistical inference)
3. Quality analysis tools (Pareto chart, flowcharts, control charts, check sheets, scatter diagrams, histograms)
4. Sampling theory and techniques as applied to audits, testing, and product acceptance

C. Software Measurement

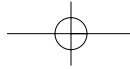
1. Prediction techniques of future maintainability
2. Applications of measurements to process, product, and resources
3. Commonly used metrics (e.g., complexity, reliability, defect density, phase containment, size)
4. Software quality attributes (e.g., reliability, maintainability, usability, testability)
5. Defect detection effectiveness (e.g., cost, yield, escapes, customer impact)

**VI. SOFTWARE INSPECTION, TESTING, VERIFICATION, AND VALIDATION
(24 questions)****A. Inspection**

1. Inspection types (e.g., peer reviews, inspections, walk-throughs)
2. Inspection process (e.g., objectives, criteria, techniques and methods, participant roles)



3. Inspection data collection, reports, and summaries
 4. Methods for reviewing inspection efforts (e.g., technical accomplishments, resource utilization, future planning)
- B. Testing
1. Types of tests (e.g., functional, performance, usability, stress, regression, real-time response)
 2. Test levels (e.g., unit, integration, system field)
 3. Test strategies (e.g., top down, bottom up, automated testing, I/O first, beta testing, black box, white box)
 4. Test design (e.g., test cases, fault insertion and error handling, equivalence class partitioning, usage scenarios, customer defect reports)
 5. Test coverage of code (e.g., branch-to-branch, path, individual predicate, data)
 6. Test coverage of specifications (e.g., functions, states, data and time domains, localization, internationalization)
 7. Test environments (e.g., tools and methodologies, test libraries, drivers/stubs, equipment compatibility test laboratories)
 8. Test documentation (e.g., test plans, logs, test designs, defect recording, test reports)
 9. Test management (e.g., scheduling, freezing, resources, dependencies, analysis of test results)
 10. Methods for reviewing testing efforts (e.g., technical accomplishments, resource utilization, future planning, risk management)
 11. Methods for testing supplier components and products
 12. Methods for testing the accuracy of customer deliverables including user documentation, marketing and training materials
 13. Traceability mechanisms (e.g., system verification diagrams)
- C. Verification and Validation (V&V)
1. V & V planning procedures
 2. Methods for reviewing V & V program (e.g., technical accomplishments, resource utilization, future planning, risk management, impact analysis of proposed changes)
 3. Methods for evaluating software life cycle products and processes (e.g., physical traces, documentation, source code, plans, test and audit results) to determine if user needs and project objectives are satisfied
 4. Methods for performing requirements traceability (e.g., requirements to design, design to code)
 5. Methods for evaluating requirements for correctness, consistency, completeness, and testability
 6. Methods for evaluating interfaces with hardware, user, operator, and other software applications



7.5 What Is in the Body of Knowledge?

187

7. Methods for evaluating test plans (e.g., system, acceptance, validation) to determine if software satisfies software and system objectives
8. Methods for evaluating the severity of anomalies in software operation
9. Methods for assessing all proposed modifications, enhancements, or additions to determine the effect each change will have on the system
10. Methods for determining which V & V tasks should be iterated based upon proposed modifications and enhancements

VII. SOFTWARE AUDITS (16 questions)**A. Audit Types**

1. Performing internal audits (e.g., quality system, product, process, project, customer)
2. Performing external audits (e.g., supplier qualifications, certification of supplier systems, auditing testing done by independent agencies)
3. Functional and physical configuration audits

B. Audit Methodology

1. Purpose, objectives, frequency, and criteria of the overall audit program and individual software audits
2. Procedures, tools, and issues related to conducting audits in specific areas (e.g., software development, project management, configuration management)
3. Audit steps (planning, preparation, execution, reporting, corrective action, verification, follow-up)
4. Audit process (e.g., objectives, criteria, techniques and methods, participant roles)

C. Audit Planning

1. Audit team member responsibilities
2. Management (auditee and auditor) responsibilities concerning audits
3. Hosting external audits
4. Audit program development and administration
5. Auditing requirements (e.g., industry and government standards)

VIII. SOFTWARE CONFIGURATION MANAGEMENT (16 questions)**A. Planning and Configuration Identification**

1. Technical and managerial factors that guide software product partitioning into configuration items and components
2. Release process issues (e.g., supporting multiple versions, feature vs. corrective releases, hardware and software dependencies)
3. Liberty control procedures
4. Configuration identification methods (e.g., schemes, reidentification, naming conventions, versions and serialization, baselines)

5. Configuration management tools
- B. Configuration Control, Status Accounting, and Reporting
 1. Documentation control (e.g., issuing, approval, storage, retrieval, revision)
 2. Patching issues (e.g., testing, traceability, source updating)
 3. Tradeoffs between cost, cycle time, and integrity of software product and rigor and formality of change control process
 4. Source and object code control procedures
 5. Software configuration/change control board processes
 6. Techniques for assessing impacts of proposed software changes

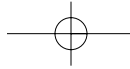
7.5.1 Sample Questions

The following examples are intended to provide a general overview of question types that appear on the CSQE certification examination.

1. Which of the following reviews are required in order to ensure proper tracking of software between phases of a project?
 - I. Product feasibility
 - II. Software requirements
 - III. Software design
 - IV. Acceptance test
 - a. I and II only
 - b. II and III only
 - c. I, II, and III only
 - d. II, III, and IV only

2. What happens to the relative cost of fixing software errors from the requirements phase through the test phase?
 - a. It decreases linearly
 - b. It remains fairly constant
 - c. It increases linearly
 - d. It increases exponentially

Answer: d



7.5 What Is in the Body of Knowledge?**189**

3. When an audit team concludes that a finding demonstrates a breakdown of the quality management system, the finding should be documented as:
- a minor nonconformance
 - a major nonconformance
 - a deficiency
 - an observation

Answer: b

4. According to Crosby, it is less costly to:
- let the customer find the defects
 - detect defects than to prevent them
 - prevent defects than to detect them
 - ignore minor defects

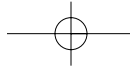
Answer: c

5. Which of the following is LEAST likely to be used during software maintenance?
- Software project management plan
 - Customer support hot line
 - Software problem reports
 - Change control board

Answer: a

6. An effective software development environment consists of tools that:
- are freestanding and free from access by other tools
 - have different user interfaces for each tool depending on the development phase supported by each tool
 - allow maximum flexibility while maintaining security and traceability
 - are integrated, linked to other tools, and have common user interfaces

Answer: d



7. A software firm has just signed a contract to deliver an inventory tracking/online transaction system for use by 500 entry clerks. The client has demanded a schedule of rigorous checkpoints but the requirements for the project are poorly defined. Which of the following would be most suitable as a development model?
- Spiral
 - Top-Down
 - Rapid Prototyping
 - Waterfall

Answer: c

8. Which of the following is NOT an accepted code inspection technique?
- Domain analysis
 - Item-by-item paraphrasing
 - Mental code execution
 - Consistency analysis

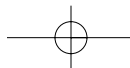
Answer: a

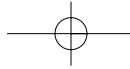
9. The defect density for a computer program is best defined as the:
- ratio of failure reports received per unit of time
 - ratio of discovered errors per size of code
 - number of modifications made per size of code
 - number of failures reported against the code

Answer: b

10. When a company evaluates its own performance, it is conducting what type of audit?
- First-party
 - Second-party
 - Third-party
 - Extrinsic

Answer: a





11. The primary task of the Change Control Board (CCB) is to:
- define change procedures
 - approve or disapprove changes to software products
 - evaluate cost and schedule impact of changes
 - authorize personnel to implement change

Answer: b

12. A module includes a control flow loop that can be executed 0 or more times. The test that is most likely to reveal loop initialization defects executes the loop body:
- 0 times
 - 1 time
 - 2 times
 - 3 times

Answer: b

7.6 ASQ Certified Software Quality Engineer Bibliography

7.6.1 I. General Knowledge, Conduct, and Ethics

Standards

ANSI/ASQ Q91-94

ISO 9000-3 Guidelines

TICKIT Guidelines

The Team Handbook (Scholtes; Joiner Assoc.) ISBN 0-9622264-0-8

Quality Planning & Analysis (Juran & Gryna; McGraw-Hill) ISBN 0-07-033183-9

Software Quality Engineering (Deutsch & Willis; Prentice Hall) ISBN 0-13-823204-0

Software Quality Manual (Boyer; Globe Engineering Documents) ISBN 0-91-270286-9

7.6.2 II. Software Quality Management

Out of the Crisis (Deming; Quality Press) ISBN 0-911379-01-0

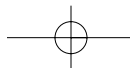
Metrics and Models in Software Quality Engineering (Kan; Addison-Wesley)

ISBN 0-201-63339-6

Managerial Breakthrough (Juran; McGraw-Hill) ISBN 0-07-034037-4

Assessment and Control of Software Risks (Jones; Prentice Hall) ISBN 0-13-741406-4

Handbook of Software Quality Assurance (Schulmeyer & McManus; Van Nostrand Reinhold) ISBN 0-442-00796-5



Software Quality Concepts & Plans (Dunn; Prentice Hall) ISBN 0-13-820283-4

7.6.3 III. Software Processes

Managing the Software Process (Humphrey; Addison-Wesley) ISBN 0-201-18095-2

A Manager's Guide to Software Engineering (Pressman; McGraw-Hill)

ISBN 0-07-050820-8

Software Engineering, A Practitioner's Approach (Pressman; McGraw-Hill)

ISBN 0-07-050783-X

ACM Communications (May 1995, vol. 38 #5)

7.6.4 IV. Software Project Management

Metrics and Models in Software Quality Engineering (Kan; Addison-Wesley)

ISBN 0-201-63339-6

Software Engineering Productivity Handbook (Keyes; Windcrest/McGraw-Hill)

ISBN 0-07-911366-4

Software Engineering Concepts (Fairley; McGraw-Hill) ISBN 0-07-019902-7

Software Engineering, A Practitioner's Approach (Pressman; McGraw-Hill)

ISBN 0-07-050783-X

7.6.5 V. Software Metrics, Measurement, and Analytical Methods

Metrics and Models in Software Quality Engineering (Kan; Addison-Wesley)

ISBN 0-201-63339-6

IEEE Guide for the Use of IEEE Standard Dictionary of Measures to Produce Reliable Software (IEEE)

Software Engineering, A Practitioner's Approach (Pressman; McGraw-Hill)

ISBN 0-07-050783-X

Software Quality Concepts and Plans (Dunn; Prentice Hall) ISBN 0-13-820283-4

Handbook of Software Quality Assurance (McManus; Van Nostrand Reinhold)

ISBN 0-442-00796-5

7.6.6 VI. Software Inspection, Testing, Verification, and Validation

Testing Computer Software (Kaner, Falk, Nguyen; Van Nostrand Reinhold)

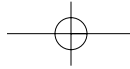
ISBN 0-442-01361-2

The Art of Software Testing (Myers; John Wiley & Sons) ISBN 0-471-04328-1

Software System Testing and Quality Assurance (Beizer; Van Nostrand Reinhold)

ISBN 0-442-21306-9

Managing the Software Process (Humphrey; Addison-Wesley) ISBN 0-201-18095-2



7.6.7 VII. Software Audits

Quality Audits for Improved Performance (Arter; Quality Press) ISBN 0-87389-263-1
Software Quality Assurance and Evaluation (Dobbins; Quality Press)

ISBN 0-87389-059-0

Standards

1028-1988: Standard for Software Reviews and Audits (IEEE)

Guide to Software Quality Management System Construction & Certification
(TICKIT) ISBN 0-9519309-0-7

Guidelines for Auditing Quality Systems (ANSI)

7.6.8 VIII. Software Configuration Management

Software Configuration Management (Babich; Addison-Wesley) ISBN 0-201-10161-0
A Manager's Guide to Software Engineering (Pressman; McGraw-Hill)

ISBN 0-07-050820-8

Standards:

#1042-1987: Guide to Software Configuration Management (IEEE)

#828-1990: Standard for Software Configuration Management Plans (IEEE)

Managing the Software Process (Humphrey; Addison-Wesley)

ISBN 0-201-18095-2

Software Configuration Management: An Overview (Osborne; National
Computer Systems Lab) NIST Special Publication 500-161

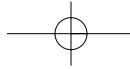
7.7 Recertification

ASQ has a Maintenance of Certification program that requires recertification every three years, beginning from the date you were originally certified. It is necessary to accumulate 18 recertification units during the three-year period. Recertification units are earned by participating in activities in the field in which you are certified that maintain your expertise. These activities include professional employment, continuing education, attending conferences and workshops, teaching, or publishing articles or papers.

If you are unable to accumulate 18 recertification units, it will be necessary to pass the examination again in order to be a Certified Software Quality Engineer.

Since the Body of Knowledge and bibliography for Software Quality Engineering can change over time, always contact ASQ for the latest information.

For questions about the ASQ Certification program, call the Certification Department at ASQ headquarters, 800-248-1946 (United States, Canada, and Mexico) or 414-272-8575.



References

1. ASQ Web Page <http://www.asq.org>.
2. Kleiman, Carol, "Certified is the magic word in qualifying computer specialists." In: *Chicago Tribune*, February 9, 1997.
3. King, Julia, "Are there big benefits in certification?" In: *Info Canada*, June 1996.
4. ASQ Certified Software Quality Engineer Certification brochure, Item B0110.
5. Author's Note: Special thanks to Linda Westfall, CSQE Certification Chair, for contributing certification exam development information contained in this chapter.

