CHAPTER 1

THE CERTIFIED QUALITY ENGINEER EXAM

“Where shall I begin your majesty?”

The White Rabbit

“Begin at the beginning, and go on till you come to the end, then stop.”

The King of Hearts

THE CERTIFIED QUALITY ENGINEER EXAM

1.0 THE EXAM

The first ASQ certified quality engineer (CQE) examination was given in 1968 to recognize those individuals that demonstrated proficiency within a body of knowledge in the quality sciences. The program has become a marketplace requirement for quality professionals. Local ASQ sections and foreign international organizations conduct the examinations twice a year, in early June and early December. You will be asked to designate a preferred examination location on your application form. Membership in the ASQ is not a requirement for certification.

To qualify for the examination, you must have eight years of experience in one or more areas of the CQE body of knowledge. At least three years must be in a decision-making technical, professional, or management position. If you have completed a degree, part of the eight-year experience requirement may be waived.

If you are now or were previously certified by ASQ as a Quality Auditor, Reliability Engineer, Software Quality Engineer, or Quality Manager, experience used to qualify for certification in these fields applies to certification as a Quality Engineer.

- Diploma from technical or trade school - one year waived
- Associate degree - two years waived
- Bachelors degree - four years waived
- Masters or doctorate - five years waived

All CQE's must participate in the Maintenance of Certification program. Under this program you will have to recertify every three years by accumulating 18 recertification units or by successfully completing the certification examination.

A brochure containing additional information and an application form may be obtained from the ASQ (1-800-248-1946). The body of knowledge for certification is affected by new technologies and new versions of the examination are used at each offering.

The purpose of QReview is to help you prepare for this important milestone in your career. Suggestions are welcome and will be considered for future issues. Please email suggestions or comments to qreview@cqeweb.com.

2.0 SUGGESTIONS FOR STUDY

2.1 Reference Material

- All exams are open book and all questions have multiple choice answers. Each CQE candidate is to bring his or her own materials. No sharing of reference materials is allowed.

- Open book means that textbooks, tables, calculators, and review course material are allowed. A collection of personally generated materials or notes from training or refresher courses may be used. Laptop computers are not allowed. A dictionary is recommended.

- Previously published examinations or any collection of questions and answers that approximate an examination are not permitted. The questions, problems and answers in QReview are separated from the basic material to comply with this requirement.

2.2 Preparing For the Exam

- Start studying immediately. Review all course notes and work out as many extra problems as time allows.

- Plan a reading program and allocate time to read all course material plus your own references.

- Group study is encouraged. Clarification of course homework problems and certain quality topics may be enhanced by group discussions.

2.3 Taking the Exam

- Bring only familiar material to the exam, otherwise, you may waste valuable time searching (Mark key pages and tables).

- Answer as many questions as you can (preferably all of them). You are graded on the percent of the total questions answered correctly.

- Allow about two minutes per question. If you find yourself stuck on a question, go to the next one and come back to it when you are finished.

- Read the questions and problems very carefully. Some of the questions may be worded to bypass casual glances.

- If you are in doubt as to the correct answer, eliminate the obvious wrong answers first, then guess.

2.4 What If You Do Not Pass

- Plan to retake the examination. You can do it in six months.

- There is no stigma to not passing. The mere fact that you prepared for and took the exam has enhanced your own knowledge and skill in the quality profession.

3.0 CQE EXAMINATION CONTENT ✧

The following information is reprinted from the ASQ CQE examination brochure.

The examination will consist of 160 multiple choice questions over a five-hour time limit. The Body of Knowledge consists of six main areas:

I. Management and Leadership In Quality Engineering (19 Questions)

II. Quality Systems Development, Implementation, and Verification (19 Questions)

III. Planning, Controlling, and Assuring Product and Process Quality (33 Questions)

IV. Reliability and Risk Management (11 Questions)

V. Problem Solving and Quality Improvement (25 Questions)

VI. Quantitative Methods (53 Questions)

The CQE examination is offered in the English language only.

The following is an outline of the topics that constitute the Body of Knowledge for Quality Engineering.

I. **MANAGEMENT AND LEADERSHIP IN QUALITY ENGINEERING (19 Questions)**

A. Professional Conduct and ASQ Code of Ethics

B. Management systems for improving quality (e.g., policy deployment, benchmarking, goal setting, planning and scheduling, project management, quality information systems)

C. Leadership principles and techniques (e.g., leading quality initiatives, team development, team building, team organization)

D. Facilitation principles and techniques, (e.g., roles and responsibilities, conflict resolution)

E. Training (e.g., needs analysis, program development, material construction, determining effectiveness)

F. Cost of quality (e.g., concepts, data collection, and reporting)

G. Quality philosophies and approaches (e.g., Juran, Deming, Taguchi, Ishikawa)
   1. Benefits of quality
   2. History of quality
   3. Definitions of quality

H. Customer relations, expectations, needs, and satisfaction (e.g., QFD, customer satisfaction surveys)

I. Supplier relations and management methodologies (e.g., qualification, certification, evaluation, ratings, performance improvement)

II. QUALITY SYSTEMS DEVELOPMENT, IMPLEMENTATION, AND VERIFICATION (19 Questions)

A. Elements of a quality system

B. Documentation systems (e.g., configuration management, document control)

C. Domestic and/or international standards and/or specifications

D. Quality audits
   1. Types and purpose of quality (e.g., product, process, system, registration, certification, 1st party, 2nd party, 3rd party, management, compliance)
   2. Roles and responsibilities of individuals involved in the audit process (e.g., audit team, client, auditee)
   3. Quality Audit Planning, Preparation, and Execution
   4. Audit reporting and follow-up (e.g., need for corrective action and verification)

III. PLANNING, CONTROLLING, AND ASSURING PRODUCT AND PROCESS QUALITY (33 Questions)

A. Preproduction or pre-service planning process
   1. Classification of quality characteristics
   2. Design inputs and design review
   3. Validation and qualification methods
   4. Interpretation of technical drawings and specifications
   5. Determining product and process control methods

B. Material Control
   1. Material identification, status, and traceability
   2. Sample integrity (e.g., avoiding contamination or misidentification)
   3. Material segregation
   4. Material Review Board (MRB)

C. Acceptance Sampling
   1. General concepts (e.g., lot-by-lot protection, average quality protection, producers and consumers risk, operating characteristics [OC] curves)
   2. Definitions (AQL, LTPD, AOQ, AOQL)
   3. Standards (ANSI/ASQC Z1.4, ANSI/ASQC Z1.9)
   4. Acceptance sampling plans (single, double, multiple, sequential, continuous)

D. Measurement Systems
   1. Terms and definitions (e.g., precision, accuracy, metrology)
   2. Destructive and nondestructive measurement and test methods
   3. Selection of measurement tools, gages, and instruments

4. Measurement system analysis (e.g., repeatability and reproducibility, measurement correlation, capability, bias, linearity)
5. Metrology (traceability to standard, measurement error, calibration systems, control of standards and integrity)

IV. **RELIABILITY AND RISK MANAGEMENT (11 Questions)**

A. Terms and definitions (e.g., MTTF, MTBF, MTTR, availability, failure rate)

B. Reliability life characteristic concepts (e.g., bathtub model)

C. Design of systems for reliability (redundancy, series, parallel)

D. Reliability and maintainability
   1. Prediction
   2. Prevention
   3. Maintenance Scheduling

E. Reliability failure analysis and reporting

F. Reliability / Safety / Hazard Assessment Tools
   1. Failure mode and effects analysis (FMEA)
   2. Failure mode and effects criticality analysis (FMECA)
   3. Fault-tree analysis (FTA)

V. **PROBLEM SOLVING AND QUALITY IMPROVEMENT (25 Questions)**

A. Approaches (e.g., Kaizen, CI, PDSA)

B. Management and planning tools (affinity diagrams, tree diagrams, process decision program charts, matrix diagrams, interrelationship digraphs, prioritization matrices, and activity network diagrams)

C. Quality tools (Pareto charts, cause and effect diagrams, flowcharts, control charts, check sheets, scatter diagrams, and histograms)

D. Corrective action (problem identification, correction, recurrence control, effectiveness assessment)

E. Preventive action (e.g., error proofing, opportunities for improvement, robust design)

F. Overcoming barriers to quality improvement

VI. QUANTITATIVE METHODS (53 Questions)

A. Concepts of Probability and Statistics
   1. Terms (e.g., population, parameter, statistic, random sample, expected value)
   2. Drawing valid statistical conclusions (e.g., enumerative and analytical studies, assumptions and robustness)
   3. Central limit theorem and sampling distribution of the mean
   4. Basic probability concepts (e.g., independence, mutually exclusive, multiplication rules, complementary probability, joint occurrence of events)

B. Collecting and Summarizing Data
   1. Types of data (continuous vs. discrete; variables vs. attributes)
   2. Measurement scales (nominal, ordinal, interval, ratio)
   3. Methods for collecting data (e.g., check sheets, coding data, automatic gaging)
   4. Techniques for assuring data accuracy and integrity
   5. Descriptive statistics (measures of central tendency, measures of variation, frequency distribution, cumulative frequency distribution)
   6. Graphical Methods
      a. Depicting relationships (e.g., stem-and-leaf plots, box-and-whisker plots, run charts, scatter diagrams)
      b. Depicting distributions (e.g., histogram, normal probability plot, Weibull plot)

C. Properties and Applications of Probability Distributions
   1. Discrete distributions (binomial, Poisson, hypergeometric, multinomial)
   2. Continuous distributions (uniform, normal, bivariate normal, exponential, log normal, Weibull, Chi-square, Student's t, F-distribution)

D. Statistical Decision-Making
   1. Point and interval estimation (efficiency and bias of estimators, standard error, tolerance intervals, confidence intervals)
   2. Hypothesis testing
      a. Tests for means, variances, and proportions
      b. Significance level, power, type I and type II errors
      c. Statistical versus practical significance
   3. Paired comparison
   4. Goodness-of-fit tests
   5. Analysis of Variance (ANOVA)
   6. Contingency tables

E. Measuring and Modeling Relationships Between Variables
   1. Simple and multiple least-squares linear regression (e.g., calculate and use the regression model for estimation and inference, interpret regression statistics)

2. Simple linear correlation (e.g., calculate and interpret the correlation coefficient, perform hypothesis, test and calculate confidence interval for the correlation coefficient)

F. Designing Experiments
   1. Terminology (e.g., independent and dependent variables, factors and levels, response, treatment, error, replication)
   2. Planning and organizing experiments (e.g., objective, choice of factors and responses, defining measurement methods, choice of design)
   3. Design principles (power and sample size, balance, replication, order, efficiency, randomization and blocking, interaction, confounding)
   4. Design and analysis of one-factor experiments (e.g., completely randomized, randomized block)
   5. Design and analysis of full factorial experiments
   6. Design and analysis of two-level fractional factorial experiments
   7. Taguchi robustness concepts

G. Statistical Process Control (SPC)
   1. Objectives and benefits
   2. Selection of variable
   3. Rational subgrouping
   4. Selection and application of control charts (x-bar & r, x-bar & s, individual and moving range, moving average and moving range, median, p, np, c, u)
   5. Analysis of control charts (common vs. special causes of variation and rules for determining statistical control)
   6. Pre-control
   7. Short-run SPC

H. Analyzing Process Capability
   1. Designing and conducting process capability studies
   2. Calculating process performance vs. specification
   3. Process capability indices (C_p, C_{pk}, C_{pm}, CR)
   4. Process performance indices (P_p, P_{pk})