AMERICAN SOCIETY FOR QUALITY
CERTIFIED QUALITY ENGINEER (CQE)
BODY OF KNOWLEDGE

The topics in this Body of Knowledge include additional detail in the form of subtext explanations and the cognitive level at which the questions will be written. This information will provide useful guidance for both the Exam Development Committee and the candidate p to take the exam. The subtext is not intended to limit the subject matter or be all-inclusive of what might be covered in an exam. It is mea clarify the type of content to be included in the exam. The descriptor in parentheses at the end of each entry refers to the maximum cogn level at which the topic will be tested. A more complete description of cognitive levels is provided at the end of this document.

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

A. Professional Conduct and ASQ Code of Ethics

Identify appropriate behaviors for situations requiring ethical decisions. (Evaluation)

B. Management Systems for Improving Quality

Define, select and apply elements such as policy deployment, benchmarking, goal setting, planning and scheduling, project management, quality information systems, etc. (Analysis)

C. Leadership Principles and Techniques

Describe and apply principles and techniques for developing, building, and organizing teams, and leading quality initiatives. (Application)

D. Facilitation Principles and Techniques

Describe facilitator roles and responsibilities in the team environment. Define and apply brainstorming, nominal group techniq (NGT), conflict resolution, etc. (Application)

E. Training

Identify training needs, describe elements of training programs and material development, and apply methods for determining effectiveness. (Application)

F. Cost of Quality

Describe and apply cost of quality concepts, including quality cost categories, data collection, reporting, etc. Evaluate cost of and interpret results. (Evaluation)

G. Quality Philosophies and Approaches (e.g., Juran, Deming, Taguchi, Ishikawa)

1. Benefits of quality

Describe the advantages of managing for quality and using quality techniques, both in theory and in practice. (Comprehe

2. History of quality

Describe how and why modern quality has evolved, with emphasis on the forces, significant events, and leading contribu have shaped quality practices.
NOTE: Specific dates will **not** be addressed. (Comprehension)

3. Definitions of quality

Differentiate between various definitions of quality such as fitness-for-use, the Taguchi loss function etc. (Comprehensic

H. Customer Relations, Expectations, Needs, and Satisfaction

Define, apply and analyze the results of customer relation measures such as quality function deployment (QFD), customer sat surveys, etc. (Analysis)

I. Supplier Relations and Management Methodologies

Define, select and apply methodologies such as qualification, certification, evaluation, ratings, performance improvement, etc. (Analysis)

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

A. Elements of a Quality System

Identify and integrate the common elements such as design control, process control, quality costs, auditing, test procedures, ((Synthesis)

B. Documentation Systems

Identify, define and apply the elements of a documentation system such as configuration management, document control, etc. (Application)

C. Domestic and International Standards and Specifications

Identify the content and applicability of ASQ and ISO quality standards. NOTE: Industry-specific standards will **not** be includ (Comprehension)

D. Quality Audits

1. Types and purpose of quality audits

Identify and apply the concepts and techniques of various types of quality audits such as product, process, system, regis certification, management, compliance, 1st, 2nd, 3rd-party, etc. (Application)

2. Roles and responsibilities of individuals involved in the audit process

Identify and define roles and responsibilities for audit participants such as audit team, client, auditee, etc. (Comprehensio

3. Quality audit planning, preparation, and execution

Identify, describe and apply the steps of planning, preparation, and execution of a quality audit. (Application)

4. Audit reporting and follow up

Identify, describe and apply the steps of audit reporting and follow-up, including the need for and verification of audit co action, etc. (Application)

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

A. Processes for Planning Product and Service Development

1. Classification of quality characteristics

Identify, define and classify quality characteristics, including seriousness classification of defects. (Application)

2. Design inputs and design review

Identify sources of design input such as customer needs, regulatory requirements, etc. Identify and apply common eleme the design review process, including roles and responsibilities of participants. (Application)

3. Validation and qualification methods

Identify and describe how validation and qualification methods are used for process, product, and service designs. (Appl

4. Interpretation of technical drawings and specifications

Interpret basic technical drawings including characteristics such as views, title blocks, dimensioning, tolerancing, GD&T symbols, etc. Interpret specification requirements in relation to product and process characteristics. (Application)

5. Determining product and process control methods

Identify and apply methods such as job instructions, process control points, etc. (Application)

B. Material Control

1. Material identification, status, and traceability

Describe and apply these methods. NOTE: Product recall procedures will **not** be included. (Application)

2. Sample integrity

Describe the importance of establishing and maintaining sample integrity and select the appropriate techniques for avoid contamination, misidentification, etc. (Application)

3. Material segregation

Describe the importance of and apply methods for material segregation. (Application)

4. Material Review Board (MRB)

Describe the purpose and function of an MRB, including appropriate disposition decisions. (Analysis)

C. Acceptance Sampling

1. General concepts

Use, interpret and apply lot-by-lot protection, average quality protection, producer's and consumer's risk, operating chara (OC) curves, attributes and variables sampling plans, etc. (Application)

2. Definitions of AQL, LTPD, AOQ, AOQL

Interpret and describe these terms. (Comprehension)

3. ANSI/ASQC Z1.4, ANSI/ASQC Z1.9 Standards

Use, interpret and apply these standards. (Analysis)

4. Acceptance sampling plans

Use, interpret and apply single, double, multiple, sequential, and continuous sampling, including Dodge-Romig. (Analysi

D. Measurement Systems

1. Terms and definitions

Interpret and describe precision, accuracy, metrology, etc. (Comprehension)

2. Destructive and non-destructive measurement and test methods

Distinguish between these methods and apply them appropriately. (Analysis)

3. Selection of measurement tools, gages, and instruments

Select and describe appropriate uses of inspection tools such as gage blocks, calipers, micrometers, optical comparators, (Application)

4. Measurement system analysis

Calculate, analyze, and interpret repeatability and reproducibility, measurement correlation, capability, bias, linearity, etc., including both conventional and control chart methods. (Analysis)

5. Metrology

Interpret, describe and evaluate traceability to calibration standards, measurement error, calibration systems, control and of standards and measurement devices. (Evaluation)

IV. Reliability and Risk Management (11 Questions)

A. Terms and Definitions

Identify and define basic reliability measures and terms such as MTTF, MTBF, MTTR, availability, failure rate, etc. (Compreh

B. Reliability Life Characteristic Concepts

Identify and interpret elements of reliability life characteristics of the bathtub curve. (Comprehension)

C. Design of Systems for Reliability

Compute and evaluate reliability for redundant, series, and parallel systems. (Evaluation)

D. Reliability and Maintainability

1. Prediction

Compute, classify and apply reliability and maintainability characteristics
such as, MTTF, MTBF, MTTR, availability, failure rate, etc. (Application)

2. Prevention

Identify and apply methods to maintain and improve process and product reliability. (Application)

3. Maintenance scheduling

Identify, classify and describe methods of predictive and preventive maintenance. (Application)

E. Reliability Failure Analysis and Reporting

Analyze reliability failure information and evaluate possible actions to improve or correct performance. (Evaluation)

F. Reliability / Safety / Hazard Assessment Tools

1. Failure mode and effects analysis (FMEA)

Define, construct and interpret FMEAs. (Application)

2. Failure mode and effects criticality analysis (FMECA)

Define, construct and interpret FMECAs. (Application)

3. Fault-tree analysis (FTA)

Define, construct and interpret FTAs. (Application)

V. Problem Solving and Quality Improvement (25 Questions)

A. Approaches

Describe and classify the implementation steps of quality improvement models such as Kaizen, PDSA, continuous improveme (Application)

B. Management and Planning Tools

Select, construct, apply and interpret affinity diagrams, tree diagrams, process decision program charts, matrix diagrams, interrelationship digraphs, prioritization matrices, and activity network diagrams. (Analysis)

C. Quality Tools

Select, construct, apply and interpret flow charts, Pareto charts, and cause and effect diagrams. Select, apply and interpret, co charts, check sheets, scatter diagrams, and histograms. [NOTE: The **mechanics** of these tools are covered in section VI as foll *control charts* (VI.G.4 & 5), *check sheets* (VI.B.3), *scatter diagrams* (VI.B.6.a.), *histograms* (VI.B.6.b.)] (Analysis)

D. Corrective Action

Identify elements of the corrective action process including problem identification, root cause analysis, correction, recurrence and verification of effectiveness, and determine root causes and appropriate corrective actions. (Analysis)

E. Preventive Action

Describe and apply preventive action concepts and techniques such as error proofing, poka-yoke, robust design, etc., and an effectiveness of their implementation. (Analysis)

F. Overcoming Barriers to Quality Improvement

Identify barriers and their causes, evaluate their impact, and describe methods for overcoming them. (Evaluation)

VI. Quantitative Methods (53 Questions)

A. Concepts of Probability and Statistics

1. Terms

Describe population, parameter, statistic, random sample, expected value, etc., and compute expected value. (Application)

2. Drawing valid statistical conclusions

Distinguish between enumerative and analytical studies and evaluate the validity of conclusions based on statistical ass and the robustness of the technique used. (Evaluation)

3. Central limit theorem and sampling distribution of the mean

Define and apply these concepts. (Application)

4. Basic probability concepts

Describe and apply concepts such as independence, mutually exclusive, multiplication rules, complementary probability, occurrence of events, etc. NOTE: Bayes' Theorem will **not** be included. (Application)

B. Collecting and Summarizing Data

1. Types of data

Identify, define, classify and compare continuous (variables) and discrete (attributes) data. (Application)

2. Measurement scales

Define and apply nominal, ordinal, interval, and ratio measurement scales. (Application)

3. Methods for collecting data

Define and apply methods for collecting data such as check sheets, coding data, automatic gaging, etc. (Application)

4. Techniques for assuring data accuracy and integrity

Define and apply techniques for assuring data accuracy and integrity such as random sampling, stratified sampling, samp homogeneity, etc. NOTE: *Sample integrity* is covered in III.B.2, not here. (Application)

5. Descriptive statistics

Define, compute and interpret measures of dispersion and central tendency, and construct and interpret frequency distrib and cumulative frequency distributions. NOTE: Geometric and harmonic means will **not** be included. (Synthesis)

6. Graphical methods

a. Depicting relationships

Construct, apply and interpret diagrams and charts such as stem-and-leaf plots, box-and-whisker plots, run charts, sc diagrams, etc. (Analysis)

b. Depicting distributions

Construct, apply and interpret diagrams such as histograms, normal probability plots, Weibull plots, etc. (Analysis)

C. Properties and Applications of Probability Distributions

1. Discrete distributions

Describe and apply binomial, Poisson, hypergeometric, and multinomial distributions. (Analysis)

2. Continuous distributions

Describe and apply uniform, normal, bivariate normal, exponential, lognormal, Weibull, Chi-square, Student's t, and *F* distributions. (Analysis)

D. Statistical Decision-Making

1. Point and interval estimation

Define and interpret the efficiency and bias of estimators. Compute, draw conclusions from and interpret statistics such a standard error, tolerance intervals, and confidence intervals. (Analysis)

2. Hypothesis testing (NOTE: Non-parametric tests will not be included.)

a. Tests for means, variances, and proportions

Apply parametric hypothesis tests for means, variances and proportions, and interpret the results. (Analysis)

b. Significance level, power, type I and type II errors

Apply and interpret these concepts as they apply to statistical tests. (Analysis)

c. Statistical versus practical significance

Define and distinguish between statistical and practical significance. (Evaluation)

3. Paired comparison tests

Define, determine applicability and apply paired comparison parametric hypothesis tests, and interpret the results. (Analy

4. Goodness-of-fit tests

Define, determine applicability and apply Chi-square tests, and interpret the results. (Analysis)

5. Analysis of variance (ANOVA)

Define, determine applicability, and apply analysis of variance, and interpret the results. (Analysis)

6. Contingency tables

Define, determine applicability and construct a contingency table, and use it to determine statistical significance. (Analys

E. Measuring and Modeling Relationships Between Variables

1. Simple and multiple least-squares linear regression

Calculate the regression equation. Apply and interpret hypothesis tests for regression statistics. Use the regression m estimation and prediction, and analyze the uncertainty in the estimate. NOTE: Models that are non-linear in their param not be included. (Evaluation)

2. Simple linear correlation

Calculate and interpret the correlation coefficient and its confidence interval. Apply and interpret a hypothesis test correlation coefficient. NOTE: Serial correlation will **not** be included. (Analysis)

3. Basic time-series analysis

Apply basic time-series analyses such as moving average. Interpret time-series graphs to identify trends, seasonal and variation, etc. (Analysis)

F. Designing Experiments

NOTE: Mixture designs, data transformations, nested designs and response surface methods will **not** be included.

1. Terminology

Define terms such as independent and dependent variables, factors and levels, response, treatment, error, and replication. (Knowledge)

2. Planning and organizing experiments

Describe and apply the basic elements of experiment planning and organizing, including determining the experiment objec selecting factors, responses, and measurement methods, choosing the appropriate design, etc. (Evaluation)

3. Design principles

Define and apply the principles of power and sample size, balance, replication, order, efficiency, randomization and blocki interaction, and confounding. (Application)

4. Design and analysis of one-factor experiments

Construct one-factor experiments such as completely randomized, randomized block, and Latin square designs, and apply computational and graphical methods to analyze and evaluate the significance of results. (Evaluation)

5. Design and analysis of full-factorial experiments

Construct full-factorial designs and apply computational and graphical methods to analyze and evaluate the significance results. (Evaluation)

6. Design and analysis of two-level fractional factorial experiments

Construct two-level fractional factorial designs (including Taguchi designs) and apply computational and graphical meth analyze and evaluate the significance of results. NOTE: Higher-order and mixed-level designs will **not** be included. (Evalua

7. Taguchi robustness concepts

Identify and describe Taguchi robustness concepts and techniques such as signal-to-noise ratio, controllable and uncont factors, and robustness to external sources of variability. (Comprehension)

G. Statistical Process Control (SPC)

1. Objectives and benefits

Identify and describe objectives and benefits of SPC such as assessing process performance, distinguishing special from common causes, etc. (Comprehension)

2. Selection of variable

Identify and select characteristics for monitoring by control chart. (Application)

3. Rational subgrouping

Define and apply the principle of rational subgrouping. (Application)

4. Selection and application of control charts

Identify, select, construct and apply the following control charts: $\overline{X}$ and *R*, $\overline{X}$ and *s*, individual and moving range (ImR), average and moving range (MamR), median, p, np, c, and u charts. (Synthesis)

5. Analysis of control charts

Interpret control charts and distinguish between common and special causes using rules for determining statistical contro (Evaluation)

6. PRE-control

Define and describe PRE-control and perform PRE-control calculations and analysis. (Analysis)

7. Short-run SPC

Identify, define and apply short-run SPC methods and techniques. (Analysis)

H. Analyzing Process Capability

1. Designing and conducting process capability studies

Identify, describe and apply the elements of designing and conducting process capability studies, including identifying characteristics, specifications, and/or tolerances, developing sampling plans, establishing statistical control, etc. (Evaluat

2. Calculating process performance versus specification

Distinguish between natural process limits and specification limits and calculate process performance metrics such as per defective. (Analysis)

3. Process capability indices

Define, select, and calculate C_p, C_{pk}, C_{pm}, and CR and assess process capability. (Evaluation)

4. Process performance indices

Define, select, and calculate P_p and P_{pk} and assess process performance. (Evaluation)

Six Levels of Cognition
based on Bloom's Taxonomy (1956)

In addition to ***content*** specifics, the subtext detail also indicates the intended ***complexity level*** of the test questions for that topic. The
are based on "Levels of Cognition" (from Bloom's Taxonomy, 1956) and are presented below in rank order, from least complex to most c

Knowledge Level
(Also commonly referred to as recognition, recall, or rote knowledge.) Being able to remember or recognize terminology, definitions, fac
materials, patterns, sequences, methodologies, principles, etc.

Comprehension Level
Be able to read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

Application Level
Be able to apply ideas, procedures, methods, formulas, principles, theories, etc., in job-related situations

Analysis
Be able to break down information into its constituent parts and recognize the parts' relationship to one another and how they are orga
identify sublevel factors or salient data from a complex scenario

Synthesis
Be able to put parts or elements together in such a way as to show a pattern or structure not clearly there before; identify which data or
information from a complex set is appropriate to examine further or from which supported conclusions can be drawn

Evaluation
Be able to make judgments regarding the value of proposed ideas, solutions, methodologies, etc., by using appropriate criteria or stand
estimate accuracy, effectiveness, economic benefits, etc.