BODY OF KNOWLEDGE
CERTIFIED QUALITY TECHNICIAN

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 preparing 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 meant to 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 cognitive level at which the topic will be tested. A complete description of cognitive levels is provided at the end of this document.

I. QUALITY CONCEPTS AND TOOLS [20 QUESTIONS]

A. Quality Concepts

1. Customers and suppliers

   Define internal and external customers, identify their expectations, and determine their satisfaction levels; define internal and external suppliers and key elements of relations with them. (Comprehension)

2. Quality principles for products and processes

   Identify basic quality principles related to products (such as features, fitness-for-use, freedom from defects, etc.) and processes (such as monitoring, measuring, continuous improvement, etc.). (Comprehension)

3. Quality standards, requirements, and specifications

   Define and distinguish between quality standards, requirements, and specifications. (Comprehension)

4. Cost of quality (COQ)

   Describe the four classic cost of quality (COQ) categories and their uses. (Comprehension)

   NOTE: Specific distinctions between prevention, appraisal, internal and external failure costs will **not** be covered.

5. Six sigma

   Identify key components of six sigma such as belt levels, tools, types of projects, processes used, etc. (Knowledge)

6. Continuous improvement techniques

   Define and apply the principles of various continuous improvement techniques including the PDCA cycle, lean manufacturing, brainstorming, benchmarking, etc., to solve various quality problems. (Application)

B. Quality Tools

Select, construct, apply, and interpret the seven quality tools: cause and effect diagrams, flow charts (process maps), check sheets, Pareto diagrams, scatter diagrams, control charts, and histograms. (Synthesis)

C. Team Functions

1. Meeting management

   Define, describe, and apply various meeting management techniques such as creating and following an agenda, recording and distributing minutes, establishing ground rules and protocols, etc. (Application)

2. Team development

   Define, describe, and train team members in the basic elements of team-building, including the importance of diversity and team member participation, how to use creative-thinking tools like brainstorming, and use various tools to achieve consensus, etc. (Application)

3. Team stages

   Describe the evolutionary stages of teams: forming, storming, norming, and performing. (Application)

4. Globalization

   Define and describe the impact globalization has on team-related issues such as developing and participating on virtual teams, using electronic communications to support distant collaboration, etc. (Comprehension)

II. STATISTICAL TECHNIQUES [21 QUESTIONS]

A. General Concepts

1. Terminology

   Identify and differentiate between statistical terms such as population, sample, parameter, statistic, statistical process control, statistical quality control, etc. (Comprehension)

2. Frequency distributions

   Define and compute normal, Poisson, and binomial frequency distributions. (Application)

3. Design of experiments (DOE)

   Define and recognize the basic elements of DOE, including terms such as blocking, randomization, etc. (Knowledge)

4. Reliability

   Define concepts such as mean time to failure (MTTF), mean time between failures (MTBF), and mean time between maintenance actions (MTBMA), and recognize failure models such as bathtub curve, prediction, growth, etc. (Knowledge)

B. Calculations

1. Measures of central tendency

   Define, compute, and interpret mean, median, and mode. (Application)

2. Measures of dispersion

   Define, compute, and interpret standard deviation, range, and variance. (Application)

3. Statistical inference

   Determine, calculate, and apply confidence levels in various situations. (Analysis)

4. Confidence limits

   Determine, calculate, and apply confidence limits in various situations. (Application)

5. Probability

   Calculate probability using the basic concepts of combinations, permutations, and area under the normal curve. (Application)

6. Student's t

   Describe how and why t tests are used. (Comprehension)

7. Analysis of variance (ANOVA)

   Define and determine the applicability of ANOVAs. (Comprehension)

C. Control Charts

1. Techniques and applications

   Select control charts that are appropriate for monitoring or analyzing a process and explain their construction and use. (Application)

2. Control limits vs. specification limits

   Identify and describe the different uses of control limits and specification limits. (Comprehension)

3. Variables charts

   Identify, select, construct, and interpret variables charts such as $\overline{X} - R$, $\overline{X} - s$, etc. (Analysis)

4. Attributes charts

   Identify, select, construct, and interpret attributes charts such as p, np, c, u, etc. (Analysis)

5. Rational subgroups

   Define and describe the principles of rational subgroups. (Comprehension)

6. Process capability measures

   Define the prerequisites for capability, and calculate and interpret C_p, C_{pk}, and capability ratio (CR) in various situations. (Analysis)

7. Machine capability measures

   Determine machine capability in various situations, and describe its contribution to process capability. (Application)

8. PRE-control chart

   Describe the concept of PRE-control and construct and interpret PRE-control charts. (Application)

9. Common and special cause variation

   Interpret various control chart patterns (runs, hugging, trends, etc.) and use rules for determining statistical control to distinguish between common cause and special cause variation. (Analysis)

10. Data plotting

    Identify the advantages and limitations of using this method to analyze data visually instead of numerically. (Comprehension)

III. METROLOGY AND CALIBRATION [19 QUESTIONS]

A. Measurement and Test Equipment (M&TE)

Describe, select, and use the following types of tools, and evaluate their measurement results to determine conformance to specifications. (Evaluation)

1. Hand tools (e.g., calipers, micrometers, linear scales)
2. Gages (e.g., pins, thread, custom gages)
3. Optical tools (e.g., comparators, profiles, microscopes)
4. Coordinate measuring machines (CMM)
5. Electronic measuring equipment (e.g., digital displays, output)
6. Weights, balances, and scales
7. Hardness testing equipment (e.g., Brinell, Rockwell)
8. Surface plate methods and equipment
9. Surface analyzers (e.g., optical flats, roughness testers)
10. Force measurement tools (e.g., torque wrenches, tensiometers)
11. Angle measurement tools (e.g., protractors, sine bars, angle blocks)
12. Color measurement tools (e.g., spectrophotometer, color guides, light boxes)
13. Gage maintenance, handling, and storage

B. Calibration

1. Measurement and test equipment (M&TE) identification and inventory

   Describe methodologies for M&TE identification, control, and traceability to specific standards. (Application)

2. Gage repeatability and reproducibility (R&R) studies

   Describe the purpose and use of gage R&R studies. (Application)

   NOTE: The components of gage R&R are covered in area IV.B.3.

3. Calibration intervals

   Use M&TE usage history and gage R&R data to establish calibration intervals. (Application)

4. Calibration error

   Identify the causes of calibration error (i.e., environmental influences) and its effect on processes and products. (Comprehension)

5. Customer-supplied M&TE

   Describe and apply requirements for validation and control of customer-supplied equipment. (Application)

IV. INSPECTION AND TEST [21 QUESTIONS]

A. Blueprint Reading and Interpretation

1. Blueprint symbols and components

Interpret drawings and apply requirements in various test and inspection activities. (Analysis)

2. Geometric dimensioning and tolerancing (GD&T) terminology

   Define and use GD&T terms covered in the ASME Y14.5M standard. (Application)

3. Classification of product or component characteristics

   Define and distinguish between product defect characteristics and their classifications in terms of critical, major, minor, etc. (Analysis)

B. Inspection Concepts

1. Types of measurements

   Define and distinguish between direct, differential, and transfer measurements. (Comprehension)

2. Gage selection

   Determine which measurement instrument to use in various situations based on considerations such as the characteristic to be measured, the 10:1 rule, the required accuracy level, uncertainty, etc. (Analysis)

3. Gage R&R

   Define and distinguish between accuracy, precision, repeatability, reproducibility, etc., as used in measurement. (Analysis)

   NOTE: Gage R&R studies are covered in area III.B.2.

4. Rounding rules

   Determine when truncation and rounding rules apply to both positive and negative numbers. (Application)

5. Conversion of measurements

   Convert between metric and English units. (Application)

6. Inspection points

   Define, distinguish between, and determine which inspection point functions (such as receiving, in-process, final, source, first-article, etc.) should be used at different stages of inspection and test. (Analysis)

7. Inspection error

   Identify various types of inspection error including parallax, fatigue, flinching, distraction, etc. (Comprehension)

8. Measurement scales

   Read and interpret measurements obtained from analog, digital, and vernier scales. (Application)

9. Product traceability

   Describe the requirements for preserving the identity of a product and its origins. (Comprehension)

10. Certificates of compliance (COC) and analysis (COA)

    Define and distinguish between these two types of certificates. (Comprehension)

C. Inspection Techniques and Processes

1. Nondestructive testing (NDT) techniques

Identify various NDT techniques (X-ray, eddy current, ultrasonic, dye penetrant, electromagnetic, magnetic particle) for specific applications. (Comprehension)

2. Destructive testing techniques

Identify various destructive tests (tensile, fatigue, flammability) for specific applications. (Comprehension)

3. Other testing techniques

Identify characteristics of testing techniques such as those used for electrical measurement (DC, AC, resistance, capacitance, etc.), chemical analysis (pH, conductivity, chromatography, etc.), physical/mechanical measurement (pressure tests, vacuum, flow, etc.), and software testing/verification (safeguarding, functional checks, comparison of test results, identification of attributes and parameters, etc.). (Knowledge)

D. Sampling

1. Characteristics

Identify and define sampling characteristics such as operating characteristic (OC) curve, lot size, sample size, acceptance number, switching rules, etc. (Comprehension)

2. Sampling types

Define and distinguish between fixed sampling, 100% inspection, attributes and variables sampling, etc. (Comprehension)

3. Selecting samples from lots

Determine sample size (e.g., AQL), selection method, and accept/reject criteria (e.g., zero-defect sampling) in various situations. (Application)

V. QUALITY AUDITS [9 QUESTIONS]

A. Audit types

Define basic audit types such as internal, external, system, product, process, etc. (Comprehension)

B. Audit Components

Describe and apply various elements of the audit process, including audit preparation, performance, record keeping, closure, and verification. (Application)

C. Tools and techniques

Define and apply various auditing tools such as checklists, record/document review, forward- and backward-tracing, etc., and identify and use interview techniques appropriate to various situations. (Application)

VI. PREVENTIVE AND CORRECTIVE ACTION [10 QUESTIONS]

A. Preventive action

Identify and apply various preventive methods including both design and process failure mode and effects analysis (DFMEA and PFMEA), mistake-proofing, etc., for products and processes. (Application)

B. Corrective action

1. Elements of corrective action

   Describe various steps to ensure corrective action, including interim action, permanent action, verification, etc. (Comprehension)

2. Failure analysis and root cause analysis

   Describe how and when these analyses are conducted. (Comprehension)

C. Nonconforming material

1. Identifying and segregating

   Determine whether products or material meet conformance requirements, and use various methods to label and segregate nonconforming materials. (Application)

2. Material review process

   Describe various elements of this process, including the function of the material review board (MRB), the steps in determining fitness-for-use and product disposition, etc. (Comprehension)

Math Note: Approximately 20% of the questions in each CQT exam will require calculation.

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. These levels are based on "Levels of Cognition" (from Bloom's Taxonomy, 1956) and are presented below in rank order, from least complex to most complex.

Knowledge Level
(Also commonly referred to as recognition, recall, or rote knowledge.) Being able to remember or recognize terminology, definitions, facts, ideas, 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 organized; 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 standards to estimate accuracy, effectiveness, economic benefits, etc.