CCT

CERTIFIED CALIBRATION TECHNICIAN

Quality excellence to enhance your career and boost your organization's bottom line

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ASQ

Excellence Through Quality™

Certification from ASQ is considered a mark of quality excellence in many industries. It helps you advance your career, and boosts your organization's bottom line through your mastery of quality skills. Becoming certified as a Calibration Technician confirms your commitment to quality and the positive impact it will have on your organization.

Examination

Each certification candidate is required to pass an examination that consists of multiple-choice questions that measure comprehension of the body of knowledge.

Certified Calibration Technician

The Certified Calibration Technician (CCT) is a professional who tests, calibrates, maintains, and repairs electrical, mechanical, electromechanical, analytical, and electronic measuring, recording, and indicating instruments and equipment for conformance to established standards.

CCT

Computer Delivered - The CCT examination is a one-part, multiple choice 135-question exam and is offered in English only. 125 questions are scored and 10 are unscored. Total appointment time is four-and-a-half hours, exam time is 4 hours and 18 minutes.

Paper and Pencil – The CCT examination is a one-part, 125-question, four-hour exam and is offered in English only.

For comprehensive exam information on the Calibration Technician certification, visit **asq.org/cert**.

Work Experience

You must have five years of on-the-job experience in one or more of the areas of the Certified Calibration Technician Body of Knowledge.

If you have completed a degree* from a college, university, technical or trade school with accreditation accepted by ASQ, part of the five-year experience requirement will be waived, as follows (only one of these waivers may be claimed):

- Diploma from a technical, military, or trade school—two years waived
- Associate's degree—two years waived
- Bachelor's degree—two years waived
- Master's or doctorate—two years waived

*Degrees or diplomas from educational institutions outside the United States must be equivalent to degrees from U.S. educational institutions.

Certified Calibration Technician (CCT)

Topics in this body of knowledge (BoK) 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 more complete description of cognitive levels is provided at the end of this document.

Note Regarding IM&TE (inspection, measurement, and test equipment)
The Test Specification Committee that created this BoK recognizes that different industries and branches of the military use various descriptors and abbreviations to refer to the units being calibrated. To avoid confusion, the committee decided to use the term IM&TE as the most globally descriptive term. This term will be used in both the BoK and the CCT exam itself.

I. General Metrology (30 questions)

A. Base SI Units

Describe and define the seven base units: 1) meter, 2) kilogram, 3) second, 4) ampere, 5) kelvin, 6) candela, and 7) mole.

NOTE: The application of these units is covered in I.B., I.C., and I.E. (Understand)

B. Derived SI Units

Define, calculate, and convert various derived units, including 1) degree, 2) ohm, 3) pascal, 4) newton, 5) joule, 6) coulomb, and 7) hertz. (Apply)

C. SI Multipliers and Conversions

Define various multipliers, including kilo, deci, centi, milli, and calculate converted values such as mega to kilo, and micro to milli. (Apply)

D. Fundamental Constants

Identify the fundamental constants of 1) velocity or speed of light in a vacuum (c), 2) gravitational constant (g), and 3) universal gas constant (R), as well as their standard symbols and common applications. (Understand)

NOTE: The values of these constants and the formulas for calculating them will not be tested.

E. Common Measurements

Describe and apply IM&TE in measuring 1) temperature, 2) humidity, 3) pressure, 4) torque, 5) force, 6) mass, 7) voltage/current/resistance, 8) time/frequency, and 9) linear displacement. (Evaluate)

F. Traceability Standards and Hierarchy

Identify various aspects of traceability, including traceability through commercial laboratories, national laboratories, and international metrology organizations. (Apply)

G. Measurement Standards

Define and distinguish between various types of standards, including 1) primary, 2) reference, 3) working, 4) intrinsic, 5) derived, 6) consensus, and 7) transfer, and identify when to use them in various situations. (Analyze)

H. Substitution of Standards

Assess when and how calibration standards can be substituted based on 1) measurement requirements, 2) equipment availability, 3) equipment specifications, etc. (Evaluate)

II. Measurement Systems (26 questions)

A. Measurement Methods

Describe and employ various measurement methods, including 1) direct, 2) indirect, 3) ratio, 4) transfer, 5) differential, and 6) substitution by unit under test (UUT). (Evaluate)

B. Measurement Characteristics

Define and distinguish various measurement characteristics as they are used for basic measurements, such as 1) variability, 2) sensitivity, 3) repeatability, 4) reproducibility, 5) bias, 6) linearity, 7) stability, and 8) measurand. (Understand)

NOTE: The use of these characteristics in uncertainty measurements is covered in IV.

C. Measurement Data Considerations

Identify and analyze various aspects of measurement data, including but not limited to 1) format, 2) readability, 3) resolution, 4) suitability for use, and 5) confidentiality. (Analyze)

D. IM&TE Specification Terms and Characteristics

Demonstrate knowledge of common specification descriptions, including percent of full scale (FS), percent of range, percent of reading, and number of counts. Describe and distinguish between characteristics of specifications, including tolerance and specifications, baseline modifiers and qualifiers, output, scale, and floor terms. (Analyze)

E. Error Sources

Identify and correct error sources that can affect measurement results, including 1) drift, 2) bias, 3) operator error, and 4) environment. (Evaluate)

F. Measurement Assurance Program (MAP)

Explain basic MAP concepts, including 1) interlaboratory comparisons and testing schemes, 2) proficiency tests, and 3) gage R&R studies. (Understand)

III. Calibration Systems (30 questions)

A. Calibration Procedures

Identify and apply common elements of calibration procedures such as 1) required equipment, 2) revisions, 3) equipment listing, 4) environmental considerations and restraints, and 5) common procedures. (Apply)

B. Standardization and Adjustment Methods

Utilize methods such as 1) spanning, 2) nulling, 3) zeroing, and 4) linearization, to adjust and standardize IM&TE, as well as analyze the outcomes. (Analyze)

C. Industry Practices and Regulations

1. **Industry practices**
   Identify various sources of industry-accepted metrology and calibration practices, including published resources, manufacturer recommendations, national standards, and international standards. (Understand)

2. **Regulations, mandates, and guidance**
   Define and distinguish between government regulations, traceability, and other legally mandated metrology requirements such as national or international guidance, and identify which rules or conventions take precedence in various situations. (Apply)

D. Environmental Control

Recognize various environmental parameters for 1) humidity, 2) dust levels, 3) electrostatic discharge (ESD), 4) temperature, 5) vibration, etc., and explain their influence on calibration activities. (Apply)

E. Calibration Processes for IM&TE

1. **Process flow**
   Describe the basic flow of IM&TE through the calibration process. (Understand)

2. **Logistical information**
   Explain IM&TE logistical information such as equipment identification, ownership, service history, and process tracking systems. (Understand)

3. **Roles and responsibilities**
   Identify roles and responsibilities of calibration staff members, including laboratory manager, technical manager, scheduler, quality manager, and technician. (Understand)

4. **Scheduling**
   Determine IM&TE scheduling considerations, such as planned calibration intervals, material or equipment requests, steps in the notification process, overdue lists, and staff workloads, and analyze their impact. (Analyze)

F. Validation Processes

Determine issues related to validating manual and automated calibration systems, and identify unique validation considerations for software or firmware that is part of IM&TE or calibration processes. (Apply)

G. Records Management

Define and describe document control in terms of maintaining the integrity and confidentiality of various calibration records, including but not limited to audit results, staff training, uncertainty budgets, and customer data, in both electronic and paper formats. (Apply)

H. Official Reports

Describe and distinguish various types of formal results reporting, including calibration certificates, calibration labels, nonconformance calibration reports, and test reports. (Apply)

IV. Measurement Uncertainty and Applied Math (24 questions)

A. Uncertainty Terminology

Define and explain basic terms such as 1) guardbanding, 2) test uncertainty ratio (TUR), 3) test accuracy ratio (TAR), 4) bias, 5) error, 6) percent of tolerance, and 7) gage R&R. (Apply)

B. Uncertainty Budget Components

Define and identify various type A and type B uncertainty components, including 1) environment, 2) human factors, 3) methods, 4) unit under test, 5) reference standards, 6) materials, and 7) the key elements and steps of developing an uncertainty budget. (Apply)

C. Uncertainty Determination and Reporting

Define various methods to determine and report measurement uncertainty, including 1) combined and expanded uncertainty, 2) weighted factors, 3) explanatory graphics, 4) coverage factors, 5) confidence levels, 6) effective degrees of freedom, and 7) uncertainty calculation elements including mean, standard deviation, root sum square (RSS), and variance. (Apply)

D. Technical and Applied Mathematics

1. **Scientific and engineering notation**

   Express a floating point number in scientific and engineering notation. (Apply)

2. **English/Metric conversions**

   Convert various units of measurement between English/U.S. customary units and metric units, including length, area, volume, capacity, and mass. (Apply)

3. **Ratios**

   Express various terms such as percentage, parts per million (ppm), and decibels (dB). (Apply)

4. **Tables, graphs, and plots**

   a. Interpret tables and graphs to determine intermediate and extrapolated values. (Analyze)

   b. Interpret graphs and plots that illustrate the aspects of slope, intercept, and linearity of data sets. (Analyze)

5. **Rounding, truncation, and significant figures**

   Round and truncate a given number to a specified number of digits. (Apply)

6. **Order of mathematical operations**

   Identify the correct order for performing mathematical operations and solve equations that contain multiple operations. (Apply)

7. **Algebraic equations**

   Use basic algebra to solve for the unknown. (Apply)

8. **Angular conversions**

   Convert various angular units such as degrees, minutes, seconds, grads, and radians. (Apply)

V. Quality Systems and Standards (15 questions)

A. Quality Management Systems

1. **System components**
   Define and distinguish between various components of a quality system, such as management and customer focus, employee training and development, and continuous process improvement. (Apply)

2. **Strategic and tactical processes**
   Identify various methods used to develop, improve, and review quality systems, including but not limited to mission and goals, planning and deployment, and cross-functional teams. (Understand)

B. Quality Control Tools

Select and apply the seven basic quality tools: 1) flowcharts/process maps, 2) check sheets, 3) Pareto diagrams, 4) cause and effect diagrams, 5) scatter diagrams, 6) control charts, and 7) histograms. (Analyze)

C. Quality Audits

Define and describe the following elements of quality audits. (Understand)

1. **Types of audits such as internal, external, product, and process.**
2. **Roles and responsibilities of auditor, auditee, and client.**
3. **Audit components including but not limited to audit plan, audit purpose, and audit standard.**
4. **Auditing tools such as checklist, and final report.**

D. Corrective Action for Nonconformances

1. **Nonconformance identification**
   Determine conformance status and apply various methods of identifying and segregating nonconforming IM&TE. (Evaluate)

2. **Impact assessment**
   Apply various tools for evidence (e.g., reverse traceability, customer notification, product recall, calibration standard evaluation, root cause analysis) in response to out-of-tolerance conditions for IM&TE. (Apply)

E. Professional Conduct and Ethics

Demonstrate appropriate behaviors that are aligned with the ASQ Code of Ethics for various situations. (Apply)

F. Occupational Safety Requirements

1. **Hazards and safety equipment**
   Assess potential hazards in the work environment, such as improper ventilation, soldering fumes, and suboptimal workplace lighting, as well as identify appropriate personal protective equipment (PPE) for various situations. (Apply)

2. **Occupational health and safety**
   Identify and interpret various elements of occupational health and safety including safety data sheet terms (SDS—formerly known as MSDS), material labeling requirements, and workplace safety. (Understand)

3. **Housekeeping**
   Apply housekeeping methods in the calibration environment including, maintenance, 6S, IM&TE, and cleaning. (Apply)

4. **Pre- and Post-Calibration Condition**
   Identify operational setup prior to calibration and return to safe and operational setup upon completion. (Apply)

G. Quality Standards and Guides

Explain the benefits and importance of the following documents and organizations in relation to calibration. (Understand)

1. **Quality standards and guides such as ISO/IEC 17025-2005, ANSI/NCSL Z540.3-2006, ISO 9001-2015, GUM (JCGM 100:2008), and VIM (JCGM 200:2012).**
2. **Accreditation boards, such as those recognized by ILAC (International Laboratory Accreditation Cooperation).**

LEVELS OF COGNITION

Based on Bloom's Taxonomy—Revised (2001)

In addition to **content** specifics, the subtext for each topic in this BoK 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—Revised, 2001) and are presented below in rank order, from least complex to most complex.

REMEMBER | Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.

UNDERSTAND | Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

APPLY | Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.

ANALYZE | Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario.

EVALUATE | Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards.

CREATE | Put parts or elements together in such a way as to reveal 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.

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