

CERTIFIED CALIBRATION TECHNICIAN (CCT) BODY OF KNOWLEDGE MAP 2017

The Certified Calibration Technician (CCT) body of knowledge (BOK) has been updated to ensure that the most current state of practice is being tested in the examination. If you would like more information on how a BOK is updated, see a description of the process on <http://asq.org/cert/faq/create-body-of-knowledge>.

Part of the updating process is to conduct a job analysis survey to determine whether the topics in the 2010 BOK are still relevant to the job role of calibration technicians and to identify any new topics that have emerged since that BOK was developed. The results of the CCT job analysis survey showed that nearly all of the topics that were in the 2010 BOK are still relevant to the job roles of calibrations technicians in 2010. One new topic was added to the 2017 BOK, and is indicated in the following table.

The 2017 Certified Calibration Technician Body of Knowledge (CCT BOK) will be introduced at the December 1, 2017, administration. Both BOKs will be available online until January 1, 2018, at which time the 2010 BOK will be removed.

General comments about ASQ Body of Knowledge updates

When the Body of Knowledge (BOK) is updated for an ASQ exam, the majority of the material covered in the BOK remains the same. There are very few programs that change dramatically over a 5-7 year period. One of the points that we make to all of the exam development committees is that ASQ Certification Exams need to reflect “the state of practice” not “the state of the art” – this helps to keep the programs grounded in what people currently do, rather than being driven by the latest hot-topic improvement idea or trend. Typically, the biggest change in any updated BOK is in how the content is organized. When a new BOK is announced and posted on the ASQ website, we also include a “BOK Map” that highlights the changes between the two bodies of knowledge: old and new. The BOK map also clearly identifies any new content that has been added to the exam, as well as any content that has been removed from the exam.

With regard to exam preparation materials, you should be able to use any of the reference books that are currently listed on the bibliography for the exam program. These are the source materials that the exam development committees use to write questions and verify answers.

Specific comments about the 2017 CCT Body of Knowledge updates

There were minimal changes made to the content when updating the CCT BOK. The 2010 subtopic IV.D.9 Graphs and plots was combined with IV.D.4 Linear interpolation and extrapolation to create IV.D.4 Tables, graphs, and plots in the 2017 CCT BOK.

One new subtopic, V.F.4 Pre and Post Calibration Condition was added to the BOK and no topics were removed.

In addition to those updates, there were 11 increases in cognitive level as well as 2 decreases in cognitive level associated with particular topics. The total number of questions allocated to topics has been modified for I. General Metrology, II. Measurement Systems, III. Calibration Systems, and IV. Measurement Uncertainty and Applied Math.

Table 1 starting on page 3 presents the 2017 CCT BOK, maps the topics to the 2010 BOK, and details the modifications that have been made.

Table 1. 2017 CCT BOK mapped to the 2010 CCT BOK

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
	I. General Metrology [30 test questions]	Decrease in questions by 5
I.A	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)	
I.B	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)	
I.C	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)	
I.D	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 <u>not</u> be tested.	Increase in level of cognition
I.E	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)	
I.F	F. Traceability standards and hierarchy Identify various aspects of traceability, including traceability through commercial laboratories, national laboratories, and international metrology organizations. (Apply)	Increase in level of cognition
I.G	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)	Increase in level of cognition
I.H	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)	Increase in level of cognition

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
	II. Measurement Systems [26 test questions]	Increase in questions by 4
II.A	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)	
II.B	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.	
II.C	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)	
II.D	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)	
II.E	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)	
II.F	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 test questions]	Decrease in questions by 3
III.A	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)	Increase in level of cognition

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
III.B	B. Standardization and adjustment methods Utilize methods such as 1) spanning, 2) nulling, 3) zeroing, 4) linearization, etc., to adjust and standardize IM&TE, as well as analyze the outcomes. (Analyze)	
III.C	C. Industry practices and regulations	
III.C.1	1. Industry practices Identify various sources of industry-accepted metrology and calibration practices, including published resources, manufacturer recommendations, national standards, and international standards. (Understand)	
III.C.2	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)	
III.D	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)	Decrease in level of cognition
III.E	E. Calibration processes for IM&TE	
III.E.1	1. Process flow Describe the basic flow of IM&TE through the calibration process. (Understand)	
III.E.2	2. Logistical information Explain IM&TE logistical information such as equipment identification, ownership, service history, and process tracking systems. (Understand)	
III.E.3	3. Roles and responsibilities Identify roles and responsibilities of calibration staff members, including laboratory manager, technical manager, scheduler, quality manager, and technician. (Understand)	
III.E.4	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)	
III.F	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)	Increase in level of cognition

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
III.G	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)	
III.H	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 test questions]		Increase in questions by 4
IV.A	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)	Increase in level of cognition
IV.B	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)	
IV.C	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)	Decrease in level of cognition
IV.D	D. Technical and applied mathematics	
IV.D.1	1. Scientific and engineering notation Express a floating point number in scientific and engineering notation. (Apply)	
IV.D.2	2. English/Metric conversions Convert various units of measurement between English/US Customary Units and metric units, including length, area, volume, capacity, and mass. (Apply)	
IV.D.3	3. Ratios Express various terms such as percentage, parts per million (ppm), and decibels (dB). (Apply)	

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
IV.D.4	4. Tables, graphs, and plots a. Interpret tables and graphs to determine intermediate and extrapolated values. (Analyze)	Increase in level of cognition
IV.D.9	b. Interpret graphs and plots that illustrate the aspects of slope, intercept, and linearity of data sets. (Analyze)	Increase in level of cognition
IV.D.5	5. Rounding, truncation, and significant figures Round and truncate a given number to a specified number of digits. (Apply)	
IV.D.6	6. Order of mathematical operations Identify the correct order for performing mathematical operations and solve equations that contain multiple operations. (Apply)	
IV.D.7	7. Algebraic equations Use basic algebra to solve for the unknown. (Apply)	
IV.D.8	8. Angular conversions Convert various angular units such as degrees, minutes, seconds, grads, and radians. (Apply)	
V. Quality Systems and Standards [15 test questions]		No change in number of questions
V.A	A. Quality management systems	
V.A.1	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)	
V.A.2	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)	
V.B	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)	
V.C	C. Quality audits Define and describe the following elements of quality audits. (Understand)	

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
V.C.1	1. Types of audits such as internal, external, product, and process.	
V.C.2	2. Roles and responsibilities of auditor, auditee, and client.	
V.C.3	3. Audit components including but not limited to audit plan, audit purpose, and audit standard.	
V.C.4	4. Auditing tools such as checklist, and final report.	
V.D	D. Corrective action for nonconformances	
V.D.1	1. Nonconformance identification Determine conformance status and apply various methods of identifying and segregating nonconforming IM&TE. (Evaluate)	
V.D.2	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)	
V.E	E. Professional conduct and ethics Demonstrate appropriate behaviors that are aligned with the ASQ Code of Ethics, for various situations. (Apply)	
V.F	F. Occupational safety requirements	
V.F.1	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)	Increase in level of cognition
V.F.2	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)	New heading
V.F.3	3. Housekeeping Apply housekeeping methods in the calibration environment including, maintenance, 6S, IM&TE and cleaning. (Apply)	Increase in level of cognition

2010 BOK	2017 BOK Details	New Elements in 2017 BOK
	4. Pre and Post Calibration Condition Identify operational set-up prior to calibration and return to safe and operational set-up upon completion. (Apply)	This is new to the BOK
V.G	G. Quality standards and guides Explain the benefits and importance of the following documents and organizations in relation to calibration. (Understand)	
V.G.1	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).	The called out standards and guides have changed
V.G.2	2. Accreditation boards, such as those recognized by ILAC (International Laboratory Accreditation Cooperation).	The called out bodies have been removed.