BODY OF KNOWLEDGE
CERTIFIED QUALITY INSPECTOR

The last administration of this current Quality Inspector Body of Knowledge will be March 2, 2012.

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 allinclusive 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. TECHNICAL MATHEMATICS (16 Questions)

A. Basic Shop Math
Solve basic shop problems using addition, subtraction, multiplication, division, fractions, decimals, squares, and square roots. Use various methods to obtain significant digits for positive and negative numbers, including truncating, rounding up, and rounding down. (Application)

B. Basic Algebra
Solve or simplify first-degree and single-variable equations. (Application)

C. Basic Geometry
Calculate general parameters such as area, circumference, perimeter, and volume for basic geometric shapes, and calculate complementary and supplementary angles. (Application)

D. Basic Trigonometry
Compute angles and lengths using such trigonometric functions as sine, cosine, tangent, and the Pythagorean theorem. (Application)

E. Measurement Systems
Convert like-units between SI, English, and metric measurement systems (e.g., inch-micro-inch, liter-quart, meter-millimeter). (Application)

F. Measurement Conversions
Use various numbering methods such as scientific notation, decimals, and fractions, and convert values between these methods. (Application)

II. METROLOGY (30 Questions)

A. Common Gages and Measurement Instruments

1. Variable gages
Identify and use variable gages, including micrometers, calipers, thread wires, pitch micrometers, linear scales, etc. (Application)

2. Attribute gages
Identify and use attribute gages, including snap, plug, and thread gages, gage blocks, pins, etc. (Application)

3. Transfer gages
Identify and use transfer gages, including small-hole gages, radius gages, spring calipers, etc. (Application)

4. Measurement scales
Describe and distinguish between dial, digital, and vernier scales. (Comprehension)

B. Special Gages and Applications

1. Electronic gaging
Identify and describe basic tools used with electronics such as oscilloscope, multimeter, pyrometer, etc. (Comprehension)

2. Automatic gaging
Identify and describe basic components of automatic gaging, such as machine vision, ultrasonic, X-ray, laser, etc. (Comprehension)
Note: The use of these components is covered under 3D1.

3. Pneumatic gaging
Identify and describe basic components of pneumatic gaging, including air columns, probes, rings, etc. (Comprehension)

C. Gage Selection, Handling, and Use

1. Factors in gage selection
Select gages according to the feature or characteristic to be measured, the applicable tolerance, the 10:1 rule, etc.; the accuracy, resolution, and capability of the test instrument, and determine whether the type of measurement should be direct, differential, or transfer. (Application)

2. Gage handling, preservation, and storage
Identify and apply various methods of cleaning, handling, and storing gages. (Application)

3. Gage correlation
Identify and apply methods for establishing the correlation between measurement instruments, such as gage-to-gage or manual-toautomated process. (Application)

D. Surface Plate Tools and Techniques

1. Surface plate equipment
Select and use height gages, V-blocks, indicators, etc., to measure various types of products. (Application)

2. Angle measurement instruments
Identify and use tools such as protractors, sine bars, angle blocks, etc.,

in various situations. (Application)

E. Specialized Inspection Equipment

1. Weights, balances, and scales
Define and describe how to use these types of tools. (Application)

2. Measuring finish
Describe and apply profilometers, profile tracers, fingernail comparators, etc. (Application)

3. Measuring shape and profile
Describe and apply various types of comparators, roundness testers, precision spindles, etc. (Application)

4. Optical equipment
Describe and apply optical comparators, optical flats, microscopes, reference specimens, etc. (Application)

5. Digital vision systems
Define and describe how digital cameras, online surface inspection, and other digital systems are used in quality inspection. (Comprehension)

6. Coordinate measuring machine (CMM)
Explain the basic operation of a CMM, including use of the *x, y,* and *z* axes, and the limitations of locating functional datums, target points, and target areas. (Application)

F. Calibration

1. Calibration systems
Describe the principles of calibration, including its basic purpose, methods of establishing and monitoring calibration intervals, records, coding schemes, etc. (Application)

2. Calibration standards
Describe the hierarchy of standards, from working standards through international standards. (Comprehension)

3. Equipment traceability
Describe the requirements for documenting traceability to standards. (Comprehension)

4. Gage calibration environment
Describe the effects that environmental conditions, such as temperature, humidity, vibration, the cleanliness of the gage, etc., can have on the calibration process. (Application)

5. Out-of-calibration effects
Describe the effects that out-of-calibration instruments can have on product acceptance and the actions to take in response to this situation. (Application)

G. Measurement System Analysis

Define and describe various elements, including identifying and measuring bias, stability, accuracy, linearity, etc., and reviewing repeatability and reproducibility (R&R) studies. (Comprehension)

III. INSPECTION AND TEST (30 Questions)

A. Geometric Dimensioning and Tolerancing (GD&T)

1. Blueprints and engineering drawings

Define and interpret various sections of technical drawings, including title, tolerance, and revision blocks, notes, scale, etc. (Application)

2. Terminology and symbols

Define and interpret drawing views, details, etc., for product specifications or other controlling documents, and define and use various terms and symbols from the ASME Y14.5M Standard. (Application)

3. Position and bonus tolerances

Calculate these from various drawings. (Analysis)

4. Part alignment and datum structure

Determine part alignment and setup using the datum structure. (Analysis)

B. Sampling

Define and interpret terms such as acceptable quality level (AQL), random sampling, lot size, acceptance number, sampling plans, inspection type, timeliness, etc. (Application)

B. Inspection Planning and Procedures

1. Inspection planning

Define and distinguish between inspection types such as incoming material, first article (first piece), in-process, final, etc., and identify in what order they should be applied. (Application)

2. Inspection errors

Identify potential inspection errors such as bias, fatigue, flinching, distraction, etc. (Application)

3. Product traceability

Identify methods to trace products and materials such as age control, shelf life, and first-in first-out (FIFO). (Application)

4. Identification of nonconforming material

Describe various methods of identifying nonconforming material such as tagging, labeling, and segregating. (Application)

5. Levels of severity

Determine levels of severity, such as critical, major, and minor

classification of product features and defects. (Application)

6. Reporting of nonconforming material
Describe the reporting of nonconforming material for disposition, such as material review board (MRB), rework, reprocess, scrap, and customer waiver. (Application)

C. Testing Methods

1. Nondestructive testing
Define methods such as X-ray, eddy current, ultrasonic, dye penetrant, and magnetic particle. (Knowledge)

2. Destructive testing
Define methods such as tensile, force testing, and leak testing. (Knowledge)

3. Functionality testing
Define methods such as tension, torque, and compression. (Knowledge)

4. Hardness testing
Classify and apply methods such as Brinell, Rockwell, Durometer, and micro-hardness test. (Application)

5. Verification of software for test equipment
Identify and define basic steps to ensure that the software for test equipment adequately and correctly performs its intended functions by safeguarding, functional checks, comparison of test results, and identification of attributes and parameters. (Knowledge)

IV. QUALITY ASSURANCE (24 Questions)

A. Basic Statistics and Applications

1. Measures of central tendency
Calculate mean, median, and mode. (Application)

2. Measures of dispersion
Calculate range, standard deviation, and variance. (Application)

3. Measures of proportion or percentage
Calculate these measures for various data sets. (Application)

4. Graphical displays
Define, interpret, and distinguish between graphical displays, such as histograms, scatter diagrams, tally sheets, bar charts, etc., and apply them in various situations. (Application)

5. Normal distribution
Define the characteristics of a normal distribution, such as symmetry, bell curve, central tendency, etc. (Comprehension)

B. Statistical Process Control (SPC)

1. Common and special causes

Explain the difference between these causes of variation. Determine whether a process is in or out of statistical control by analyzing data patterns (runs, trends, hugging, etc.), and identify what actions should be taken in response. (Evaluation)

2. Control limits vs. specification limits

Define, describe, and distinguish between these types of limits. (Application)

3. Variables charts

Identify characteristics and uses of $\bar{X}$ – R and $\bar{X}$ – s charts. (Application)

4. Attributes charts

Identify characteristics and uses of p, np, c, and u charts. (Application)

5. Process capability analysis

Define and distinguish between C_p, C_{pk}, P_p, and P_{pk}, and apply them to various data sets. (Application)

C. Quality Improvement

1. Terms and concepts

Define basic quality improvement concepts such as prevention versus detection, the importance of customer satisfaction, the cost of poor quality, total quality management (TQM), etc. (Comprehension)

2. Products vs. processes

Define and distinguish between products and processes. Describe the interrelationships of product design, materials used, manufacturing processes, and final output. Describe how individual steps in a process can affect the final product or the system as a whole. (Comprehension)

3. Quality audits

Define and describe various types of audits, including internal, external, system, product, process, etc., and describe how corrective action requests (CARs) from audits can support quality improvement. (Comprehension)

D. Quality Tools and Techniques

Define and use various problem-solving and continuous improvement tools, including the seven quality control tools, plan-do-check-act (PDCA)/ plan-dostudy-act (PDSA), six sigma DMAIC, root-cause analysis, etc. (Application)

D. Resources

1. Environmental and safety

Define supports such as material safety data sheet (MSDS), personal protective equipment (PPE), etc. (Knowledge)

2. Reference documents
Identify and apply reference materials and documents such as ISO, ANSI, ASTM, and QS standards, and customer requirements as the authority for certain procedures or actions. (Application)

3. Technical reports
Read, interpret, and generate technical reports to diagnose problems and communicate solutions. (Analysis)

4. Employees as resources
Define and describe related concepts, including empowering employees, involving them on projects or improvement teams, etc. Define team roles and responsibilities (facilitator, ground rules, etc.), and describe the four stages of team development: forming, storming, norming, performing. (Comprehension)

Math Note: Approximately 20% of the questions in each CMI 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
Able to read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

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

Analysis
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
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

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.