Certified **Reliability Engineer** CRE

Certified

American Society for Quality ASQ

Get Knowledge Get Noticed Get Certified

Certification

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Introduction to

ASQ Certification Programs

Since 1968, when the first ASQ certification exam was given, more than 85,000 individuals have become certified through ASQ, including many who have attained more than one designation. In addition, an increasing number of companies, some 125 at last count, have formally recognized ASQ's certification as verification of an individual's knowledge of quality theory and techniques. A recent search on www.monster.com, an Internet job listings site, resulted in more than 575 job postings calling for an ASQ certification. These statistics demonstrate the increasing value of ASQ certification as perceived in the marketplace.

It's important to understand that ASQ certification is not a license or registration. It is peer recognition that an individual has demonstrated a proficiency in and comprehension of a particular quality area at a specific point in time. ASQ certification is awarded to those who meet three criteria: Candidates must 1) have a specified level of education and/or experience, 2) provide proof of professionalism, and 3) pass a standardized examination in the certification area.

In today's world, where competition is a fact of life and the need for a work force proficient in the principles and practices of quality is a central concern of many companies, certification is a mark of excellence. It demonstrates that the certified individual has the knowledge to ensure the quality of products and services. Certification is an investment in your career and in the future of your employer.

But for many, the process of becoming certified remains something of a mystery. Frequently questions come up about how the exams are put together, how they are scored, and how best to prepare for taking the test. In this brochure we will attempt to address many of these issues.

ASQ welcomes your interest in becoming certified and hopes that this brochure will aid you in preparing for this important career achievement. Although ASQ membership is not a prerequisite for certification, most of the people who hold one of these designations do belong to the Society. In fact certification ranks as one of the **top benefits** of membership. If you have any questions about becoming a member of ASQ, or if you would like information on any of our other certification programs, call Customer Service at ASQ headquarters, 800-248-1946 (United States, Canada, and Mexico) or 414-272-8575. You can also visit our Web site at www.asq.org.

Developing

The Exam and the Questions

The ASQ certification exams are not created in an ivory tower or by a computer program that randomly generates questions. Their development relies heavily on the efforts of ASQ members. During the course of any given year, approximately 300 volunteers are involved in some phase of exam development, ranging from developing a body of knowledge (BOK), to writing questions, to ensuring the validity of an exam through a variety of review processes. Volunteers travel to ASQ headquarters in Milwaukee for up to three days at a time. During that period, they are expected to put in long, fast-paced days that may keep them occupied for up to 10 hours at a stretch. These are intense sessions with lots of questioning and interaction. In return the volunteers get to sharpen their skills, network with peers, and come away with the knowledge that they have contributed to the development of the quality field.

The ASQ Certification Board has oversight responsibility for the exams, and the board's top priority is to ensure the integrity of the exam development process. Toward that end, the board has mandated that anyone involved in the development of an exam must refrain from having anything to do with helping others prepare for the test, either formally or informally, for a period of two years.

The Many Phases of Exam Development

To ensure that ASQ certification retains its status as a hallmark of excellence, the Certification Board uses continuous improvement processes and formally reexamines each certification program on a five-year cycle to ensure continued relevance.

- **Job Analysis and Survey** *(the foundation for the examinations)*
  Whether a program is new or has been available for many years, the starting point for the exam development process is with a job analysis. This tool is developed as a survey and is used to identify the skills and knowledge areas currently being used in the field to be tested.

- **Advisory Committee** *(identifies job responsibilities and knowledge of field)*
  In order to create an appropriate survey instrument, an advisory committee is appointed by the sponsoring ASQ division. This committee, like all of the subsequent exam development committees, is composed of ASQ members who work in the area to be tested and are already certified. (In the case of brand-new certification exams, ASQ volunteers who are subject matter experts in the field to be tested serve on the committee.) The volunteers for the advisory committee meet for two days, and their primary goals are to identify typical job responsibilities (what people do on the job) and the knowledge required (what people need to know in order to perform their job). The result of this meeting is a questionnaire that asks respondents to rate each item in the survey in terms of criticality ("How important is this task or knowledge?") and frequency ("How often is this task performed or knowledge used?").

- **Member Input** *(who decides what will be in the Body of Knowledge?)*
  Once the survey instrument has been approved by the advisory committee, it is sent to a sample of certified or otherwise qualified ASQ members who either work in the area to be tested (as identified by job title) or supervise employees who perform the tasks identified in the survey. Except for the deliberate job-title selection, the 2,000 plus certified ASQ members who receive the survey are randomly selected across geographic locations and industry types to ensure that no one industry or region skews the results of the survey. The data from the survey are then analyzed and a set of recommended tasks and knowledge areas are presented to the sponsoring division, which approves the results. This same report is then submitted to the Certification Board for final approval.
  So while the sponsoring division and Certification Board *approve* the results of the job analysis, it is really the ASQ members who answer the survey who truly determine what should be in the BOK and, ultimately, what material should be covered in the exam itself.

- **The Body of Knowledge (BOK) Committee** *(how does the content get organized in the BOK?)*
  After the approval process, a BOK committee is formed. This committee includes some members of the advisory committee and other qualified individuals who have subject matter expertise and represent a wide demographic and industry spectrum. The BOK committee meets for two days, and its primary task is to translate the job analysis results into meaningful categories that can be tested. As part of this process, the committee determines how many questions will be asked in each area of the BOK, based on the importance of the topic (as indicated in the job analysis) and the depth of testable material for each subtopic.

- **Question-Writing Committee** *(how do they write questions?)*
  The next step is the actual writing of the exam questions. This task is handled by a group of 25 certified volunteers who attend a two-day question-writing workshop. The volunteers are given extensive training in a variety of exam development issues, including how to avoid writing trick questions and how to develop thought-provoking questions and answers. The processes used in this and other exam-development workshops are driven by internationally recognized standards for the development of assessments.[1] In keeping with those standards, and as a means of ensuring the validity of the exam, each question must be linked to a reference book from the bibliography for that certification. (The bibliography for each exam is listed in the "Reference Materials" section of this brochure.) This "linkage requirement" means that the question-writers must document support for the correct answer, down to the specific page number, in their reference for each question. Once a question-writer or a team has finished writing a complete item, the other members of the team review it for completeness, accuracy, and appropriateness. Only after approval by one or more reviewers at the question-writing session can it be data-entered into the exam bank as a "raw" item.

- **Question Review** *(verification and review)*
  The next stage in the exam development process is to convene another panel of 12 subject matter experts who meet for two days to review those raw questions, verify the references and the BOK classification, and, most important, agree that there is one, and only one, correct answer.

The Many Phases of Exam Development *(continued)*

This additional, intensive process of review, revision, and rework is designed to ensure that all language ambiguities have been eliminated and that the questions have been phrased and presented as clearly as possible. The questions are also reviewed to ensure that they aren't biased in favor of any particular industry. A question can be selected for use in a test only if it has survived these two initial phases of development.

- **Testing the Test** *(the last check before the exam)*
  The next phase in the process is the exam review meeting at which another 12 volunteers are asked to participate, first by actually taking the exam and submitting their comments and answers before coming to the meeting. At the meeting, the group reviews each question for clarity and correctness. By the time an exam makes it through this process, each question on the test has been reviewed and approved by dozens of qualified professionals.

- **Exam Statistics** *(post-exam question verification)*
  Despite the best efforts of all of these individuals, there are questions on the test that do not perform well. These problem items are identified through a statistical analysis that is conducted after each administration of a test. Also, comments from examinees and proctors let us know if they think a question is bad: i.e., is confusing, tricky, or has more than one correct answer. These questions are checked again.

[1] *The Standards for Education and Psychology Testing*

The Grading Process *(how ASQ examinations are graded)*

Just as great care is taken in developing an exam, ASQ goes to great lengths to ensure that the grading process provides an accurate assessment of a candidate's proficiency. ASQ uses procedures that meet the *Standards for Educational and Psychological Testing*, which were developed jointly by the American Educational Research Association (AERA), the American Psychological Association (APA), and the National Council on Measurement in Education (NCME)

- **Cut-Score Process** *(the process to determine the passing score)*
  Since the whole point of taking an ASQ certification exam is to pass it, many questions arise about how the passing grade for any given exam is determined and what adjustments are made to ensure that one version of an exam is no harder, or easier, than any other.

  The passing grade, or cut point, is established through a cut-score study. The methodology used on ASQ exams is called a Modified Angoff and is based on the work of the late William Angoff, a renowned measurement research statistician in Princeton, NJ.

  The cut point for an ASQ exam is established each time a body of knowledge (BOK) is created or revised. For this process, a panel of 12 to 15 subject matter experts, also called judges, is convened. The panel's first task is to set the performance standard for the exam. Through consensus they determine a set of characteristics that they expect of a minimally qualified or "borderline" candidate in relation to the BOK. The distinction regarding borderline candidates is key to understanding the cut-score process, as it ultimately draws a very fine line between candidates who are qualified to be certified and those who are not. The expectations for performance, therefore, need to be clearly stated and agreed to by all of the participants in the study.

  Once that list of characteristics is developed, the subject matter experts use it as a guide to help them rate each question on the test in terms of what proportion of 100 such borderline candidates will get the answer right. For example, the judges may agree that borderline candidates will know a particular topic in the BOK very well when asked a definition question, and therefore they may estimate that 85% to 90% will get it right. But the same candidates will be much more challenged in that topic when required to apply a specific formula to get the correct answer (resulting in estimates of 35% to 45% correct).

The results of this two-day cut-score study are then presented to the Certification Board. Along with the written expectation of performance that the panel developed, the summary of the judges' combined estimate of the difficulty of the exam is presented as the recommended cut point for the exam. Once that raw cut-score point is established by board approval, it is converted to a scaled score (550), which becomes the minimum score necessary to earn certification in that BOK.

- **Scaled Scores** *(how results are reported)*
  Although the raw cut-score is established for a specific number of questions correct for the first exam under a BOK, the scaled score is what is reported to the candidates. This scale score allows adjustments for exam difficulty on subsequent forms of the test, while maintaining a scaled score of 550. This is the minimum standard of performance for all ASQ certification exams.

  The goal of ensuring that two versions of the same exam have the equivalent degree of difficulty is achieved through a process known as common item equating. Here ASQ selects a set of questions from the previous exam and embeds them in the next exam. This set of questions, called equaters, is a kind of mini-exam in that the questions are representative of the previous exam's difficulty level (some easy, some hard, some in the middle) and cover areas of the BOK proportionately. ASQ then develops the rest of the test with different questions, some new and some previously used. This way ASQ can administer almost entirely new tests each time and still maintain the established standard of performance.

  For example, on Test 1, the mean score of the candidates is 111; on Test 2, their mean score is 108. All of which could mean either that Test 1 was a lot easier than Test 2, or that the candidates who took Test 1 were significantly better prepared than the candidates who took Test 2. Before making any adjustments to the cut point based on differences in exam difficulty, more information is needed about the two candidate groups. To gather that information, comparisons are made between the performances of the two groups on the common items (equaters) in the two tests. If the two groups perform equally well on the equaters, then it is safe to conclude that Test 2 is in fact harder than Test 1. Only then is the cut point adjusted to offset the effects of that more difficult exam. Through this method, both tests will fairly assess the candidates' abilities while maintaining a consistent scaled score of 550 to pass.

  Candidates shouldn't worry about whether they will get a hard test or an easy test. If they get a hard test, they won't have to get as many questions right to meet the standard. If they get an easy test, they will have to get more of the easy questions right in order to meet the standard.

Top 10 Myths of Certification

Myth: If an answer is obvious it must be a trick question.

FACT: Just because an answer is obvious to you doesn't mean it is obvious to everyone. Don't let the fact that this is a test question get in the way of your knowledge. Answer it and move on. Don't read more into the question in an effort to make it harder.

Myth: Guessing wrong can hurt your score more than leaving an answer blank.

FACT: There is no penalty for guessing, and you have a 25% chance of getting it right. Although some tests use "formula scoring" methods, ASQ certifications do not. You get one point for each question you answer correctly and zero points for those you get wrong or leave blank.

Myth: The passing score for all ASQ exams is 70%.

FACT: The passing score for each ASQ exam is established as a minimum performance standard during the cut-score process, which is detailed on p. 3.

Myth: Taking a section refresher course or buying ASQ exam prep material is a sure way to pass.

FACT: Section refresher courses and the self-directed products are excellent ways to prepare for the examinations, but using them does not guarantee that you will pass. Refresher courses are meant to renew your knowledge, not to instruct you in areas that aren't familiar to you. Questions from the self-directed products will assist you in becoming familiar with how to answer certain questions, but they are not the same questions that you will see on the exams. Individual study is also a critical element for success.

Myth: If you do poorly on one area of the body of knowledge, you automatically fail the test.

FACT: Your total score on the examination determines whether you pass or fail, not your score on any one portion of the test. Even in the certified quality manager's exam it is possible to pass if you do poorly on the constructed response portion, as long as your overall score is at or above the passing grade.

Myth: ASQ limits the number of people who pass.

FACT: Anyone who meets or exceeds the passing score (cut point) passes the examination. ASQ does not set a passing rate.

Myth: The grading of the constructed response portion of the certified quality manager exam is very subjective.

FACT: The constructed response portion of the exam is designed to test the candidate's ability to respond to real-world situations. The responses are scored by certified quality managers who have been trained in the evaluation techniques used for the scoring process. In addition, all the scorers judge the papers against a standard of performance that is specific to each essay question. That standard is neither arbitrary nor subjective, but is developed on the basis of sound quality practices, as described and prescribed in major textbooks in the field of quality. The essay questions are pretested on a group of certified quality managers, so the development of the question includes a reality check to make sure that the committee's expectation of performance matches actual responses.

Myth: It takes a long time to receive exam results.

FACT: ASQ works very hard to provide exam results as quickly as possible and is very aware that the examinees are anxious to learn whether they have passed or failed. As a direct result of bringing the exam development in house, ASQ has recently reduced the exam turnaround time from eight weeks to two weeks, and to three and one-half weeks for the quality manager results.

There are many steps that have to be completed, verified, and checked prior to sending out the results: The answer sheets are sent back to ASQ headquarters and scanned; statistics must be run and reviewed by the test development staff and appropriate volunteers. The results are then scored, verified, and uploaded to a computer before any result letters can be generated. ASQ is continuously working to reduce this cycle time.

Myth: Test questions are deliberately tricky.

FACT: ASQ goes through an extensive process to ensure that examination questions are as accurate, clear, and concise as possible. (Please see p. 2 of this brochure.)

Myth: I can't learn from my mistakes if I don't get my scored test back.

FACT: Because of its policy to reuse examination questions, ASQ cannot release copies of the examinations. Releasing tests would give the retake applicants an unfair advantage over candidates taking the examinations for the first time. The integrity of the examination process is of paramount importance to ASQ. Besides, it would not support the underlying premise of the certification program for candidates to just study the questions they got wrong, as it would not ensure that they would understand the material any better. It is more appropriate for the retake candidates to use the diagnostic information to identify the areas where they are weak and improve their knowledge in those areas.

Study Guide

We should say at the outset that preparing to take an exam is a personal matter and highly dependent on an individual's personal learning methods. For some, a careful reading of the texts in the reference bibliography will be most helpful, while others may find value in purchasing study guides, taking a local ASQ section refresher course, or forming a study group with other quality professionals. All certification candidates are responsible for their own study and preparation for the examination. No specific set of courses or curriculum of study is required as part of the certification process. Likewise, ASQ makes no representation that completion of any specific course or program of study will significantly enhance a person's chance of passing a certification examination.

Test-Taking Tips

Test-Taking Tips

Test takers are also advised to keep in mind these general pointers about standardized exams:

- Read all of the questions on the first page of the test so you realize that you do know the material. In other words, *relax*.
- Read each question thoroughly. Don't assume you know what's being asked.
- Eliminate implausible answers and move quickly past the obviously wrong choices.
- Keep in mind that an answer may be a correct statement in itself but may not answer the question. Two answers may say exactly the opposite things or may be very similar. Read them again to decide what makes one correct and the other wrong.
- ASQ does not subtract points for incorrect answers. Answer every question. There is no penalty for guessing, and you have a 25% chance of getting it right.
- Go through and answer the questions you know. Then go through and read the ones you're unsure of. Mark those you are still uncomfortable with. You will narrow the field down to just a few questions you will need to spend more time on. These are the questions you might want to use your reference books for.
- Be aware of the time available for the exam and the remaining time as you work through the exam.
- Do not double-bubble your response for a question. If you do, it will be scored as a "blank." For example, you think that both A and C are correct answers. Bubble in only one answer and use the comment sheet supplied with your test to point out why you think both A and C are correct. Your comments will be reviewed before results are reported.

Application Process

Submitting an Application

Complete and submit the application included in this brochure along with supporting documentation for all qualifying work history (resume, job description, Six Sigma Black Belt Affidavit etc.) and the correct fee to ASQ headquarters. You may also apply online at www.asq.org.

Applications must be postmarked or faxed on or before the deadline date. Applications postmarked after the deadline date will be scheduled for the next subsequent exam. If you are applying for certification through your ASQ section or company, you are still responsible for submitting the application by the deadline. You will not be allowed to take an examination unless you have paid all fees. ASQ certification is not restricted to ASQ members. Nonmembers may apply by submitting the nonmember fee. To become a member of ASQ, please complete the membership application included in this brochure. You can mail your membership and certification applications together and pay the member rate for certification. Or, you may call and join over the phone using your credit card—800-248-1946 or 414-272-8575. Applicants should indicate their preferred site on the application form. A list of possible sites begins on p. 15. Each examination is conducted on prescribed dates, as listed on the application.

In submitting an application for certification, applicants agree to uphold the security of the examination itself while complying with the ASQ Code of Ethics (see p. 7). This includes complying with the proctor's instructions and not discussing the content of the examination with anyone except the proctor. Problems with the content or administration of the examination should be reported only to the proctor, who is required to submit a written report. The Code of Ethics, which is binding for all ASQ members and certificate holders, defines the responsibilities and obligations of a quality professional. It is strictly forbidden for either examinees or proctors to make any copies of any questions or answers that appear on an actual examination. If such unauthorized copying is detected, the examinee will be disqualified from the examination and will not be certified by ASQ.

Exam Sites—Domestic and International

Examination sites are hosted by local ASQ sections and by international organizations (please refer to the section list on p. 15 and the list of international organizations on p. 16). You will be asked to designate a preferred examination site on your application form. If at all possible, ASQ will assign you to your preferred location. If this is not possible, ASQ will assign you to the site nearest your preferred location. You will be notified approximately two weeks before the examination date of your assigned testing location. If for some reason you do not receive a seating letter one week before the exam, please call our Customer Service Center to inquire. International notification will be by e-mail, fax, or mail through local exam proctors in your country.

If you live in a country other than the United States, Canada, or Mexico, please check the list of established international organizations on p. 16. If your country is not listed, please contact ASQ headquarters for details.You may be required to provide your own proctor. Proctors may be from professional societies, government agencies, educational institutions, or employers of the applicants.

Refund / Reschedule / Retake Policies

- **Refund:** If you are not approved to sit for a particular certification examination, you may obtain a partial refund of the fee if you write or phone the Certification Department at ASQ headquarters. The $50.00 application fee is not refundable. Once the exam has been held, or you have taken the examination, no refunds will be granted.
- **Absence:** Notification of reschedule or cancellation must be postmarked, faxed, telephoned, or e-mailed six business days prior to the exam or you will forfeit all fees and need to reapply.
- **Reschedule:** You are allowed to reschedule once within a one-year period. If you do not take the exam during that one-year period, you will forfeit all fees and must reapply.
- **Retake:** There is no limit to the number of times you may retake an examination; however, you will be charged a fee each time. You must retake the examination within two years of your last attempt. If you do not retake within this period, you will have to submit a new application with full fees.

What Can and Cannot be Brought into the Exam Site

What You Can Bring into the Exam Site:

- PICTURE IDENTIFICATION IS REQUIRED FOR ADMITTANCE. Your seating letter is only exam site and proctor contact information.
- You will need at least two soft-lead (no. 2) pencils with erasers.
- The multiple-choice portion of the exam is an open-book examination and personally generated materials/notes from training or refresher courses are allowed with the following conditions:
  - Each examinee must make his/her reference materials available to the proctor for review.
  - Calculator Policy: With the introduction of palmtop computers and the increasing sophistication of scientific calculators, ASQ has become increasingly aware of the need to limit the types of calculators that are permitted for use during examinations. Any silent, hand-held, battery-operated calculator **without** an alphabetic keyboard will be permitted. All programmable memory must be cleared before you enter the exam room. If you bring an alphabetic keyboard calculator into the exam room, it will be confiscated by the proctor, and returned after the exam. It is the obligation of ASQ to ensure that everyone is treated equitably. The examination is written so that a simple calculator will be sufficient to perform all calculations.
  - The proctor for the exam site will make the final determination of appropriateness of any electronic device.

What You Cannot Bring into the Exam Site:

- No laptops, palmtop computers, cell phones, headphones, or pagers are allowed.
- You may not share reference materials or calculators.
- Absolutely no collections of questions and answers or weekly refresher course quizzes are permitted. Reference sources that contain such copy are not allowed unless the questions are removed or obscured. Examples of such sources include, but are not limited to, refresher and preparatory primers.

Exam Results

Examination results for pilot exams and exams with updated BOKs are mailed within six weeks. Otherwise, examination results are mailed about two weeks (three and a half weeks for quality manager results) after the examination date (delays may occur with international mail). We recognize that prompt notification of examination results is important and we will make every effort to provide results as soon as possible. Results will not be given over the telephone. Information about certification is never divulged to third parties except at the written request of the person who took the examination. Your examination results are kept in strict confidence.

Notification

Exam Result Notification

If you pass the examination you will receive a letter of congratulations from the Certification Board, and a wallet card and certificate showing your certificate number. Your name will be published in *The Quality Advocate* and your local ASQ section will be notified. If you are certified as a Quality Manager, CQE, CQA, CSQE, CRE, or SSBB, you must participate in the Maintenance of Certification program to keep your certification current. The recertification journal provided with your certificate gives complete details.

ASQ certification is not a license. It is peer recognition of proficiency within the prescribed body of knowledge. In order to avoid misunderstanding, the Certification Board requires that certified persons always refer to ASQ in citing their certification, e.g., “ASQ Certified Reliability Engineer.”

ASQ may withdraw formal recognition and any current ASQ certification for falsification of credentials and/or unethical behavior. Such action may be taken by the Certification Board or, in the case of an ethics action, by the ASQ board of directors or its designee. In such cases, due process will be afforded to the individual against whom the action is directed. A copy of the ASQ Code of Ethics is supplied to all certified persons. By applying for certification, you pledge to uphold this code.

If you don't pass the examination you will receive an analysis of the exam to assist you in further studies.

ASQ Code of Ethics

To uphold and advance the honor and dignity of the profession, and in keeping with high standards of ethical conduct, I acknowledge that I:

Fundamental Principles

I. Will be honest and impartial; will serve with devotion my employer, my clients, and the public.

II. Will strive to increase the competence and prestige of the profession.

III. Will use my knowledge and skill for the advancement of human welfare and in promoting the safety and reliability of products for public use.

IV. Will earnestly endeavor to aid the work of the Society.

Relations With the Public

1.1 Will do whatever I can to promote the reliability and safety of all products that come within my jurisdiction.

1.2 Will endeavor to extend public knowledge of the work of the Society and its members that relates to the public welfare.

1.3 Will be dignified and modest in explaining my work and merit.

1.4 Will preface any public statements that I may issue by clearly indicating on whose behalf they are made.

Relations With Employers and Clients

2.1 Will act in professional matters as a faithful agent or trustee for each employer or client.

2.2 Will inform each client or employer of any business connections, interests, or affiliations that might influence my judgment or impair the equitable character of my services.

2.3 Will indicate to my employer or client the adverse consequences to be expected if my professional judgment is overruled.

2.4 Will not disclose information concerning the business affairs or technical processes of any present or former employer or client without his or her consent.

2.5 Will not accept compensation from more than one party for the same service without the consent of all parties. If employed, I will engage in supplementary employment of consulting practice only with the consent of my employer.

Relations With Peers

3.1 Will take care that credit for the work of others is given to those to whom it is due.

3.2 Will endeavor to aid the professional development and advancement of those in my employ or under my supervision.

3.3 Will not compete unfairly with others; will extend my friendship and confidence to all associates and those with whom I have business relations.

Certified Reliability Engineer Information

Certified Reliability Engineer Requirements:

The Certified Reliability Engineer ...

...is a professional who understands the principles of performance evaluation and prediction to improve product/systems safety, reliability, and maintainability. This body of knowledge (BOK) and applied technologies include, but are not limited to, design review and control; prediction, estimation, and apportionment methodology; failure mode effects and analysis; the planning, operation, and analysis of reliability testing and field failures, including mathematical modeling; understanding human factors in reliability; and the ability to develop and administer reliability information systems for failure analysis, design and performance improvement, and reliability program management over the entire product life cycle.

Minimum Expectations of a Certified Reliability Engineer:

Reliability Management

- Have basic knowledge and skills to understand reliability program requirements, planning, definitions, training, and organizational resources to achieve those requirements within the constraints of life-cycle issues and costs.

Probability and Statistical Tools

- Have an understanding of basic probability and statistical tools to analyze product life cycle. This includes the proper application of probability distributions, Pareto concepts, tolerance and confidence intervals, sample-size determination, and regression analysis.

Modeling and Prediction

- Be able to develop models and predict, analyze, and interpret the reliability system using block diagrams, apportionment, and simulations to compare results with available field data.

Data Collection, Analysis, and Corrective Action

- Collect appropriate data to define, identify, analyze, correct, and prevent potential system failures;
- Be able to implement FRACAS (failure reporting, analysis, and corrective-action system), root cause, and trend analysis.

Reliability Tools in Design and Development

- Be able to establish product reliability requirements; be able to understand and use the reliability tools listed in the BOK;
- Be able to identify and control critical parts, services, and products.

Maintainability and Availability

- Understand the principles of maintainability and availability over the life cycle of the product or system;
- Demonstrate a basic knowledge of testability, human factor, and maintenance activities.

Reliability Testing

- Develop reliability test plans that cover the expected customer use environment and operational conditions;
- Identify appropriate acceleration stresses and methods, analyze and interpret the results of these development tests;
- Understand the cost-effective use of production screening methods.

Product Safety and Liability

- Uphold ASQ code of ethics;
- Use reliability analysis tools and customer feedback to identify and analyze potential safety issues for a product;
- Recommend the appropriate action necessary to resolve safety issues;
- Have a knowledge of applicable regulatory requirements and the implementation of closed-loop corrective/preventive-action systems.

Education and/or Experience Requirements

You must have eight years of on-the-job experience in one or more of the areas of the Certified Reliability Engineer Body of Knowledge. A minimum of three years of this experience must be in a decision-making position. "Decision-making" is defined as the authority to define, execute, or control projects/processes and to be responsible for the outcome. This may or may not include management or supervisory positions. If you are now or were previously certified by ASQ as a Quality Auditor, Quality Engineer, Software Quality Engineer, or Quality Manager, experience used to qualify for certification in these fields applies to certification as a Reliability Engineer, as long as the eight-year minimum requirement is met.

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

- Diploma from a technical or trade school—one year will be waived
- Associate degree—two years waived
- Bachelor's degree—four years waived
- Master's or doctorate—five years waived

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

Proof of Professionalism

Proof of professionalism may be demonstrated in one of three ways:

1. Membership in ASQ, an international affiliate society of ASQ, or another society that is a member of the American Association of Engineering Societies or the Accreditation Board for Engineering and Technology
2. Registration as a Professional Engineer
3. The signatures of two persons—ASQ members, members of an international affiliate society, or members of another recognized professional society—verifying that you are a qualified practitioner of the quality sciences

Examination

Each certification candidate is required to pass a written examination that consists of multiple-choice questions that measure comprehension of the BOK. The Reliability Engineer examination is a four-hour, 150 multiple-choice question examination. It is offered in the English language only.

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 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.

I. Reliability Management (19 Questions)

A. Strategic management

1. Benefits of reliability engineering

   Demonstrate how reliability engineering techniques and methods improve programs, processes, products, and services. (Synthesis)

2. Interrelationship of quality and reliability

   Define and describe quality and reliability and how they relate to each other. (Comprehension)

3. Role of the reliability function in the organization

   Demonstrate how reliability professionals can apply their techniques and interact effectively with marketing, safety and product liability, engineering, manufacturing, logistics, etc. (Analysis)

4. Reliability in product and process development

   Integrate reliability engineering techniques with other development activities (e.g., concurrent engineering). (Synthesis)

5. Failure consequence and liability management

   Use liability and consequence limitation objectives to determine reliability acceptance criteria, and identify development and test methods that verify and validate these criteria. (Application)

6. Life-cycle cost planning

   Determine the impact of failures in terms of service and cost (both tangible and intangible) throughout a product's life cycle. (Analysis)

7. Customer needs assessment

   Describe how various feedback mechanisms (e.g., QFD, prototyping, beta testing) help determine customer needs and specify product and service requirements. (Comprehension)

8. Project management

   Interpret basic project management tools and techniques, such as Gantt chart, PERT chart, critical path, resource planning, etc. (Comprehension)

B. Reliability program management

1. Terminology

   Identify and define basic reliability terms such as MTTF, MTBF, MTTR, availability, failure rate, dependability, maintainability, etc. (Analysis)

2. Elements of a reliability program

   Use customer requirements and other inputs to develop a reliability program including elements such as design for reliability, progress assessment, FRACAS, monitoring and tracking components, customer satisfaction and other feedback, etc. (Evaluation)

3. Product life cycle and costs

   Identify the various life-cycle stages and their relationship to reliability, and analyze various cost-related issues including product maintenance, life expectation, duty cycle, software defect phase containment, etc. (Analysis)

4. Design evaluation

   Plan and implement product and process design evaluations to assess reliability at various life-cycle stages using validation, verification, or other review techniques. (Evaluation)

5. Requirements management

   Describe how requirements management methods are used to help prioritize design and development activities. (Comprehension)

6. Reliability training programs

   Demonstrate the need for training, develop a training plan, and evaluate training effectiveness. (Application)

C. Product safety and liability

1. Roles and responsibilities

   Define and describe the roles and responsibilities of a reliability engineer in terms of safety and product liability. (Application)

2. Ethical issues

   Identify appropriate ethical behaviors for a reliability engineer in various situations. (Evaluation)

3. System safety program

   Identify safety-related issues by analyzing customer feedback, design data, field data, and other information sources. Use risk assessment tools such as hazard analysis, FMEA, FMECA, PRAT, FTA, etc., to identify and prioritize safety concerns, and identify steps to idiot-proofing products and processes to minimize risk exposure. (Analysis)

II. Probability and Statistics for Reliability (25 Questions)

A. Basic concepts

1. Statistical terms

   Define and use basic terms such as population, parameter, statistic, random sample, the central limit theorem, etc., and compute expected values. (Application)

2. Basic probability concepts

   Define and use basic probability concepts such as independence, mutually exclusive, complementary and conditional probability, joint occurrence of events, etc., and compute expected values. (Application)

3. Discrete and continuous probability distributions

   Describe, apply, and distinguish between various distributions (binomial, Poisson, exponential, Weibull, normal, log-normal, etc.) and their functions (cumulative distribution functions (CDFs), probability density functions (PDFs),

hazard functions, etc.). Apply these distributions and functions to related concepts such as the bathtub curve. (Evaluation)

4. Statistical process control (SPC)

   Define various SPC terms and describe how SPC is related to reliability. (Comprehension)

B. Statistical inference

1. Point and interval estimates of parameters

   Define and interpret these estimates. Obtain them using probability plots, maximum likelihood methods, etc. Analyze the efficiency and bias of the estimators. (Evaluation)

2. Statistical interval estimates

   Compute confidence intervals, tolerance intervals, etc., and draw conclusions from the results. (Analysis)

3. Hypothesis testing (parametric and non-parametric)

   Apply hypothesis testing for parameters such as means, variance, and proportions. Apply and interpret significance levels and Type I and Type II errors for accepting/rejecting the null hypothesis. (Analysis)

4. Bayesian technique

   Describe the advantages and limitations of this technique. Define elements including prior, likelihood, and posterior probability distributions, and compute values using the Bayes formula. (Application)

III. Reliability in Design and Development (25 Questions)

A. Reliability design techniques

1. Use factors

   Identify and characterize various use factors (e.g., temperature, humidity, vibration, corrosives, pollutants) and stresses (e.g., severity of service, electrostatic discharge (ESD), radio frequency interference (RFI), throughput) to which a product may be subjected. (Synthesis)

2. Stress-strength analysis

   Apply this technique and interpret the results. (Evaluation)

3. Failure mode effects analysis (FMEA) in design

   Apply the techniques and concepts and evaluate the results of FMEA during the design phase. (Evaluation) [NOTE: Identifying and using this tool for other aspects of reliability are covered in VII.C.1.]

4. Failure mode effects and criticality analysis (FMECA) in design

   Apply the techniques and concepts and evaluate the results of FMECA during the design phase. (Evaluation) [NOTE: Identifying and using this tool for other aspects of reliability are covered in VII.C.2.]

5. Fault tree analysis (FTA) in design

   Apply this technique at the design stage to eliminate or minimize undesired events. (Analysis)

   [NOTE: Identifying and using the symbols and rules of FTA are covered in VII.C.3.]

6. Tolerance and worst-case analyses

   Use various analysis techniques (e.g., root-sum squared, extreme value, statistical tolerancing) to characterize variation that affects reliability. (Evaluation)

7. Robust-design approaches

   Define terms such as independent and dependent variables, factors, levels, responses, treatment, error, replication, etc. Plan and conduct design of experiments (full-factorial, fractional factorial, etc.) or other methods. Analyze the results and use them to achieve robustness. (Evaluation)

8. Human factors reliability

   Describe how human factors influence the use and performance of products and processes. (Comprehension)

9. Design for X (DFX)

   Apply tools and techniques to enhance a product's producibility and serviceability, including design for assembly, service, manufacturability, testability, etc. (Evaluation)

B. Parts and systems management

1. Parts selection

   Apply techniques such as parts standardization, parts reduction, parallel model, software reuse, etc., to improve reliability in products, systems, and processes. (Application)

2. Material selection and control

   Apply probabilistic methods for proper selection of materials. (Application)

3. Derating methods and principles

   Use methods such as S-N diagram, stress-life relationship, etc., to determine the relationship between applied stress and rated value. (Application)

4. Establishing specifications

   Identify various terms related to reliability, maintainability, and serviceability (e.g., MTBF, MTTF, MTBR, MTBUMA, service interval) as they relate to product specifications.

IV. Reliability Modeling and Predictions (23 Questions)

A. Reliability modeling

1. Sources of reliability data

   Identify and describe various types of data (e.g., public, common, in-house data) and their advantages and limitations, and use data from various sources (prototype, development, test, field, etc.) to measure and enhance product reliability. (Analysis)

2. Reliability block diagrams and models

   Describe, select, and use various types of block diagrams and models (e.g., series, parallel, partial redundancy, time-dependent modeling) and analyze them for reliability. (Evaluation)

3. Simulation techniques

   Identify, select, and apply various simulation methods (e.g., Monte Carlo, Markov) and describe their advantages and limitations. (Analysis)

B. Reliability predictions

1. Part count predictions and part stress analysis

   Use parts failure rate data to estimate system- and subsystem-level reliability. (Analysis)

2. Advantages and limitations of reliability predictions

   Demonstrate the advantages and limitations of reliability predictions, how they can be used to maintain or improve reliability, and how they relate

to and can be used with field reliability data. (Application)

3. Reliability prediction methods for repairable and non-repairable devices

   Identify and use appropriate prediction methods for these types of devices and systems. (Application)

4. Reliability apportionment/allocation

   Describe the purpose of reliability apportionment/allocation and its relationship to subsystem requirements, and identify when to use equal apportionment or other techniques. (Analysis)

V. Reliability Testing (23 Questions)

A. Reliability test planning

1. Elements of a reliability test plan

   Determine the appropriate elements and reliability test strategies for various development phases. (Analysis)

2. Types and applications of reliability testing

   Identify and evaluate the appropriateness and limitations of various reliability test strategies within available resource constraints. (Evaluation)

3. Test environment considerations

   Evaluate the application environment (including combinations of stresses) to determine the appropriate reliability test environment. (Evaluation)

B. Development testing

Assess the purpose, advantages, and limitations of each of the following types of tests, and use common models to develop test plans, evaluate risks, and interpret test results. (Evaluation)

1. Accelerated life tests (e.g., single-stress, multiple-stress, sequential stress)
2. Step-stress testing (e.g., HALT)
3. Reliability growth testing (e.g., Duane, AMSAA, TAAF)
4. Software testing (e.g., white-box, fault-injection)

C. Product testing

Assess the purpose, advantages, and limitations of each of the following types of tests, and use common models to develop test plans, evaluate risks, and interpret test results. (Evaluation)

1. Qualification/demonstration testing (e.g., sequential tests, fixed-length tests)
2. Product reliability acceptance testing (PRAT)
3. Stress screening (e.g., ESS, HASS, burn-in tests)
4. Attribute testing (e.g., binomial, hypergeometric)
5. Degradation testing (e.g., Arrhenius)
6. Software testing (e.g., black-box, operational profile)

VI. Maintainability and Availability (17 Questions)

A. Management strategies

1. Maintainability and availability planning

   Develop maintainability and availability plans that support reliability goals and objectives. (Application)

2. Maintenance strategies

   Identify the advantages and limitations of various maintenance strategies (e.g., reliability-centered maintenance (RCM), predictive maintenance, condition-based maintenance), and determine which strategy to use in specific situations. (Analysis)

3. Maintainability apportionment/allocation

   Describe the purpose of maintainability apportionment/allocation and its relationship to system and subsystem requirements, and determine when to modify the maintainability strategy to achieve maintainability goals. (Synthesis)

4. Availability tradeoffs

   Identify various types of availability (e.g., inherent availability, operational availability), and evaluate the reliability/maintainability tradeoffs associated with achieving availability goals. (Evaluation)

B. Analyses

1. Maintenance time distributions

   Determine the applicable distributions (e.g., log-normal, Weibull) for maintenance times. (Analysis)

2. Preventive maintenance (PM) analysis

   Identify the elements of PM analysis (e.g., types of PM tasks, optimum PM intervals, items for which PM is not applicable) and apply them in specific situations. (Analysis)

3. Corrective maintenance analysis

   Identify the elements of corrective maintenance analysis (e.g., fault-isolation time, repair/replace time, skill level, crew hours) and apply them in specific situations. (Analysis)

4. Testability

   Identify testability requirements and use various methods (e.g., built-in tests (BITs), no fault found, retest OK, false-alarm rates, software testability) to achieve reliability goals. (Analysis)

5. Spare parts strategy

   Evaluate the relationship between spare parts requirements and maintainability and availability. (Evaluation)

VII. Data Collection and Use (18 Questions)

A. Data collection

1. Types of data

   Identify, define, classify, and compare various data types (e.g., variables vs. attributes, censored vs. uncensored). (Evaluation)

2. Data sources

   Evaluate the appropriateness of various data sources such as field, in-house, environment, location, test specification, failure modes, failure mechanisms, time at failure, etc. (Evaluation)

3. Collection methods

   Identify elements of data collection methods such as surveys, automated tests, automated monitoring and reporting, etc. (Application)

4. Data management

   Identify the requirements for an organization-wide product-failure database, including which user groups (e.g., production, research, field service, supplier relations, purchasing, business management/accounting) will use the database and how the information interests and needs of those groups can conflict. Identify and distinguish between the level of detail each user group requires,

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and explain how reporting formats, coding schemes, and other structural components of the database system can influence the usefulness of the data over time and throughout the organization. (Evaluation)

B. Data use

1. Data summarization

   Analyze, evaluate, and summarize data using techniques such as trend analysis, Weibull, graphic representation, etc., based on data types, sources, and required output. (Evaluation)

2. Preventive and corrective action

   Select and use various root cause and data (failure) analysis tools to determine degradation or failure causes, and identify various preventive or corrective actions to take in specific situations. (Evaluation)

3. Measures of effectiveness

   Select and use various data analysis tools to evaluate the effectiveness of preventive and corrective actions. (Synthesis)

C. Data and failure analysis tools

1. Failure mode and effects analysis (FMEA)

   Identify the components and steps used to develop a FMEA, and use this tool to analyze problems found in various situations. (Evaluation)

2. Failure mode, effects, and criticality analysis (FMECA)

   Distinguish this analysis tool from FMEA, and use it to evaluate the likelihood of certain effects and their criticality (including identifying and applying various levels of severity) in specific situations. (Evaluation)

3. Fault tree analysis (FTA) and Success tree analysis (STA)

   Identify and use the event and logic symbols and rules of these tools to determine the root cause of product failures or the steps necessary to ensure product success. (Evaluation)

4. Failure reporting, analysis, and corrective action system (FRACAS)

   Identify the elements necessary for a FRACAS to be effective. (Application)

NOTE: Approximately 20% of the CRE exam will require candidates to perform mathematical functions.

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.) Remember or recognize terminology, definitions, facts, ideas, materials, patterns, sequences, methodologies, principles, etc.

Comprehension Level

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

Application Level

Apply ideas, procedures, methods, formulas, principles, theories, etc., in job-related situations.

Analysis

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

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

Make judgments regarding the value of proposed ideas, solutions, methodologies, etc., by using appropriate criteria or standards to estimate accuracy, effectiveness, economic benefits, etc.

Study Guide

1. Which of the following is best defined as the practice of using parallel components and subsystems?
   a. Maintainability
   b. Reliability
   c. Optimization
   d. Redundancy

2. Balancing a reliability requirement against other design parameters, such as performance, cost, or schedule, and then analyzing the consequences of placing special emphasis on one of these factors is called
   a. reliability allocation
   b. reliability predictions
   c. trade-off decisions
   d. system modeling

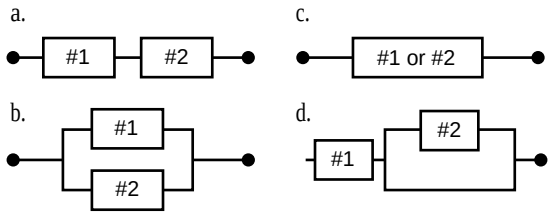
3. Software reliability planning includes all of the following EXCEPT
   a. selecting models for data analysis and prediction
   b. modeling acquisition of computer software systems
   c. trade-offs of general purpose programs vs. commercially available programs
   d. trade-offs involving cost, schedule, and failure intensity of software products

4. The lifetime of a mechanical lifter is normally distributed with a mean of 100 hours and a standard deviation of 3 hours. What is the reliability of the lifter at 106 hours?
   a. 0.0228
   b. 0.0570
   c. 0.9430
   d. 0.9772

5. In an analysis of variance, which of the following distributions is the basis for determining whether the variance estimates are all from the same population?
   a. Chi square
   b. Student's t
   c. Normal
   d. F

6. A full factorial design of experiments has four factors. The first factor has two levels, the second factor has three levels, the third factor has two levels, and the final factor has four levels. How many runs are required for this analysis?
   a. 16
   b. 48
   c. 192
   d. 256

7. In a certain application, two identical transducers are used to measure the vacuum in a system. The system is considered to have failed if either of the vacuums read by the transducers varies from the standard by more than 10 mm Hg. Which of the following is the correct reliability logic block diagram for the transducer assembly?



8. Assuming perfect switching and perfect starting, which of the following systems has the longest mean life if each system consists of n units with identical reliability?
   a. A series system
   b. A parallel system
   c. A k out of n system
   d. A cold standby system

Questions 9-11 refer to the following situation:

A high incidence of failures has developed during aircraft acceptance testing over the last several months.. The identified failure is that an instrument panel light has malfunctioned on six of the last 10 aircraft tested. This problem needs to be investigated and a Failure Reporting and Corrective-Action System (FRACAS) needs to be completed without stopping aircraft production.

9. The first step of the investigation should be to
   a. collect additional data on similar events over the last two years
   b. conduct failure analysis to determine the failure mode and mechanism
   c. conduct surveillance testing on suspect components
   d. establish a cross-functional team to brainstorm on the cause and effect

10. If the cause of the failure is determined to be a faulty subassembly manufactured only by a single supplier, and this situation is threatening to shut down aircraft production, the next step should be to
    a. visit the supplier to assist in determining the root cause of the problem
    b. initiate a supplier corrective action and return all of the unsorted inventory
    c. issue a Government and Industry Data Exchange Program (GIDEP) alert
    d. update the inspection instruction and retrain receiving inspection

11. If a corrective-action notice was sent to the supplier of a faulty subassembly and the supplier's response states that the root cause is simply an operation error, the next step should be to
    a. accept the response and close the FRACAS
    b. visit the supplier to develop a better understanding of the root cause
    c. issue a Government and Industry Data Exchange Program (GIDEP) alert
    d. begin looking for a new supplier

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12. Which of the following is an appropriate use for experimental design?
    a. Establishing product requirements
    b. Developing a fault-tree analysis
    c. Ensuring the robust design of a product
    d. Analyzing customer complaint reports

13. Which of the following is NOT considered good practice in reliability design?
    a. Using proven parts
    b. Using series design
    c. Using failure mode and effects analysis (FMEA)
    d. Simplifying item configuration

14. According to Taguchi, robustly designed experiments should employ all of the following techniques EXCEPT
    a. inner and outer arrays
    b. signal-to-noise ratios
    c. linear graphs
    d. fold-over capabilities

15. Which of the following measures can be used to find a quick approximation of the availability of a system?
    a. Mean time to failure (MTTF) and mean time to repair (MTTR)
    b. Failure rate and failure mode
    c. Mission time and failure rate
    d. Downtime and time to repair

16. The investment in automated test equipment is often justified under which of the following circumstances?
    a. Numerous tests must be performed.
    b. Repair times must be short.
    c. Conformance records are required.
    d. Traceable records are required.

Study Guide *(continued)*

17. For a company operating multiple units of production equipment, the observed failure rate is 42 x 10^-6 failures per operating hour and the preventive maintenance rate is 320 x 10^-6 actions per hour. What is the mean time between corrective and preventive maintenance (MTBM)?
    a. 2,688.2 hr
    b. 2,762.4 hr
    c. 2,840.9 hr
    d. 26,935.0 hr

18. All of the following are purposes of a production reliability assurance test (PRAT) EXCEPT
    a. detect significant shifts between the as-built reliability requirements and the as-designed reliability requirements
    b. assess performance against reliability requirements
    c. assess actual product reliability against reliability requirements
    d. minimize the need for specific process controls

19. The primary aim of sequential-life testing is to determine
    a. the probability density function of failures
    b. the mean time between failures (MTBF)
    c. whether a lot meets the reliability goal
    d. whether the stress-level variation is significant

20. A small sample from a product population is subjected to multiple levels of elevated stress. Which of the following could be used to model the life of the product?
    a. Poisson process
    b. Pascal expansion
    c. Pareto rule
    d. Inverse power law

21. Which of the following are important elements in the concept of consumer risk?
    I. Frequency
    II. Schedule
    III. Damage
    a. I and II only
    b. I and III only
    c. II and III only
    d. I, II, and III

22. Which of the following tools is used to analyze the safety of a system?
    a. Fault-tree analysis
    b. Failure reporting and corrective-action system
    c. Reliability allocation
    d. Environmental stress screening

23. System-safety analytical techniques included all EXCEPT
    a. hazards analyses
    b. fault-tree analyses
    c. logic diagram analyses
    d. design readiness reviews

24. A component fails on the average of once every four years with 75% of the failures observed to occur during stormy weather. If there are 12 hours of stormy weather to every 240 hours of good weather, what are the failure rates for stormy and good weather, respectively?
    a. λ (stormy) = 3.939, λ (good) = 0.0656 failures/yr
    b. λ (stormy) = 4.202, λ (good) = 0.0525 failures/yr
    c. λ (stormy) = 6.594, λ (good) = 0.0458 failures/yr
    d. λ (stormy) = 20.16, λ (good) = 0.0403 failures/yr

25. A go/no-go device is tested until it fails. If X is the number of tests to first failure with no wear out present, and the probability of success on each test is 0.99, then the probability that X is greater than five is
    a. 0.9310
    b. 0.9410
    c. 0.9510
    d. 0.9610

26. The best way to set an overall reliability goal is to
    a. write a specification calling for a product to have high reliability and incorporate it into a contract
    b. put down specific numerical requirements for reliability, statements of operating environments, and a definition of successful product performance
    c. insist that the goal be expressed in terms of mean-time-between-failures for all components and assemblies
    d. indicate who would be at fault if the desired reliability is not obtained during the warranty

27. Weibull analysis is a way to analyze field data or interval test data. The limits of the use of this technique include having a good estimate for the
    a. MTBF
    b. expected life
    c. shape parameter
    d. average quality of the production lots

28. A system consists of four parallel units each having a reliability of 0.80. The system can still complete its mission with only two units functioning. If the failure rate is constant and failures are independent then the system reliability will be
    a. 0.4096
    b. 0.5376
    c. 0.8192
    d. 0.9728

29. Given a reliability growth test in progress having accumulated four failures during 5000 test hours. Assume a growth rate of 0.3, what is the expected MTBF at 25,000 hours?
    a. 1250 hrs
    b. 1895 hrs
    c. 2026 hrs
    d. 3856 hrs

30. A Weibull distribution has been found to describe the reliability distribution with characteristic life = 12,000 hours, and shape parameter ß = 2.2. If these are good parameters, at what time will reliability decrease to .85?
    a. 2204 hrs
    b. 3503 hrs
    c. 4838 hrs
    d. 5254 hrs

Answers:

1. d	7. a	13. b	19. c	25. c
2. c	8. d	14. d	20. d	26. b
3. b	9. b	15. a	21. b	27. c
4. a	10. a	16. a	22. a	28. d
5. d	11. b	17. b	23. d	29. c
6. b	12. c	18. d	24. a	30. d

Reference Materials

These books cover significant parts of the BOK. The ASQ Certification Board does not endorse any one particular reference source.

I. Reliability Management

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