

Society of Maintenance and Reliability Professionals
Certifying Organization (SMRPCO)

Exam Item (Question) Development Rules and Guidelines

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SMRPCO Exam Item (Question) Development Rules & Guidelines

Preface

The certification exam for Maintenance and Reliability developed and administered by the Society for Maintenance and Reliability Certifying Organization has gained a strong reputation for fairness characterized by comments (received from candidates upon completion of the exam but before their receipt of results) such as:

- “Good broad questions in all five areas;”
- “Well organized, tough test”
- “Excellent; reflects ‘real world’ concerns and job concerns”
- “Extraordinarily complete”
- “Challenging, as our profession should be”
- “Learned more about what to learn about”

As the examination was administered to candidate from an increasing number of nations, in two languages as this is written and more to come, the need for questions suitable for use internationally became obvious. Even in the original language (English) in which questions are developed and validated different words, phrases, meanings and spellings need to be accommodated. As a result near the end of the question validation process, we conduct a “international English” review using CMRP’s from the United Kingdom and Australia to screen questions and recommend changes or additions to accommodate their use in most if not all countries of the world where English is the primary language.

The principles reflected in CMRP exam questions must be those generally accepted internationally. Questions that address subjects unique to a specific region or address regulations or laws of a specific country or region (such as North America, Europe or Asia) are not acceptable for use on SMRP exams. Subject areas that constitute the Body of Knowledge upon which the current CMRP exams are based are addressed in detail on the Society for Maintenance and Reliability Reference Guide for Certification in Maintenance and Reliability Profession (SMRPCO Reference Guide) which is available as described in the next paragraph.

Likewise, the sources used for exam questions need to be available internationally for candidates to study. For this reason, textbooks and other resources used as references should generally be those that carry an International Standard Book Number (ISBN). All books listed in the SMRPCO Reference Guide, which is posted for free download on the SMRP.org web site and is available in hard copy for sale from SMRP, carry ISBN’s. Books from this list are available for purchase through many booksellers worldwide.

In addition the “Recommended Reading” page of the smrp.org website links to a current listing of resources addressing Maintenance and Reliability (M & R) principles. These are arranged per the “5 Pillars of the M & R Profession” and

may be purchased through the same Internet Link. As SMRP Standards become available, these too should be considered as resources from which CMRP question may be developed. Other sources for standards (such as those from the Organization for International Standards (ISO) or the Society for Automotive and Aerospace Engineering (SAE)) if available and widely recognized may be used as resources from which questions are developed. Care must be exercised, however, when using standards which are subject to periodic review and may no longer be supported by the issuing organization. **References to information on most Internet web sites available at the time a question is written are not considered as permanent as resources with ISBN's or recognized standards designations and thus are not acceptable.** In addition, while conference papers, professional journals and magazine articles may seem like tempting sources for exam questions, their limited availability to most CMRP candidates worldwide makes it less fair than use of the resources mention above.

Material contained on the remainder of pages 4 and through page 7 of these "Rules and Guidelines for Development of Certification Questions" is summarized from the views of Dr. Larry Allen Early Ph. D. (a long term advisor to SMRP and SMRPCO on Exam development) and George C. Wheeler on the preferred use of multiple choice questions in certification examinations. It has been adapted from their book entitled A Guide for Developing NDT Certification Examinations ©2005, ISBN-10: 57117-152-5 and an earlier text with the same title by Mr. Wheeler The material is used with the authors' permission. In the earlier book, Mr. Wheeler wrote:

".... the predominant opinion of most professionals in the field of personnel achievement measurements is that for written tests, multiple choice questions provide the most objective and reliable results. Well-phrased multiple-choice questions can be designed to evaluate knowledge, communication skills, judgment, mathematical ability, and analytical reasoning. They are objective, easy to administer, and can be easily graded by mechanical or electronic means. Because of these advantages, multiple choice questions are easy to evaluate statistically."

Transfer of Intellectual Property Rights and Copy Rights

On advice of legal counsel, in order to assure SMRPCO has complete authority to use the items submitted to it on exams it has been determined that it is prudent that transfer of all intellectual property and copy rights be obtained to the stem, correct answer and distractors voluntarily submitted in support of its certification examination programs. The submittal form contains the following statement to this effect:

Note: By submitting this form the Authtor(s) voluntarily transfer, assign and grant all intellectual property and copy rights for elements of the item (Stem, Correct Answer and Distractors) to the Society for Maintenance and Reliability Professionals to use, revise and apply as required in pursuit of its certification examination program(s).

Terminology

Multiple choice questions are referred to as “items” rather than questions because they consist of both the questions and a number of possible answers. An “item” consists of a “stem” and the “responses”. The stem is the first portion, or the true question portion. The responses are the possible answers from which the examination candidate must make a choice.

Types of Multiple Choice Items

1. Items relating to definition of terms.
2. Items relating to purpose.
3. Items relating to cause.
4. Items relating to effects.
5. Items relating to associations or relationships
6. Items relating to the identification of error
7. Items relating to the recognition of error
8. Items relating to evaluation
9. Items relating to differences
10. Items relating to similarities
11. Items relating to arrangement
12. Items relating to incomplete arrangements
13. Items relating to common principles
14. Items relating to controversial subjects
15. Items requiring identification of the most general or most inclusive answer
16. Items requiring identification of misfits

Rules for Developing Items

1. The test item must be expressed as clearly as possible.
2. The test item should concern knowledge or deal with a problem that most experts in the field would agree is important to good performance in that field. Don't include trivial or unimportant items that would make the exam trivial or reduce its credibility.
3. Test items should cover knowledge or problems specific to the field (i.e., don't include items that can be answered by exercise of intelligence or general knowledge).
4. Test items should be independent of each other. Do not have items where the content of one item provides the answer to another item, or depends on the answer to another item.
5. Avoid negative questions and never use double negatives.
6. Avoid items about inconsequential details.
7. Avoid questions that can be answered correctly simply by finding a correct statement or value in reference data.
8. Avoid changing units of measure within an item.
9. Items requiring calculations should contain all of the information required to solve the problem, or needed information should be included in reference data supplied with the exam.

10. New or controversial material can be used as the basis for items, but the material or ideas should be stated as part of the item or included in reference data supplied with the exam.
11. It is desirable to use charts, graphs, nomograms, and tables in reference data supplied with the exam, but they must be clear, legible and complete. It is NOT desirable to limit such material to just that which is referred to or needed in the exam. It should be presented in the same way as it would be encountered in actual practice.

Rules for Developing Stems

1. It is important for the problem or question to be stated as clearly and specifically as possible.
2. The stem must have a definite correct answer that is unlikely to be challenged by competent practitioners
3. Items requiring knowledge or facts are less desirable than those that call for understanding and application of facts and principles to typical job problems.
4. The inclusion of irrelevant material in the stem is a way to make the problem more realistic.
5. The stem should include as much of the item as possible.
6. In most cases it is preferable to state the question or problem positively rather than negatively.
7. The stem should contain all the qualifying information needed to allow selection of the correct response, or that information must be available in reference material to which the examinee has access.
8. Be very cautious about constructing a stem by simply extracting part of a statement from a text or reference book.

Rules for Developing Responses

The two most commonly used response types are the “one right answer” and the “best answer”. For the “one right answer” type, the correct response must be totally correct and all other responses must be totally incorrect. For the “best answer” type, it must be carefully written and reviewed to avoid ambiguities that would destroy its values. This type can be very discriminating, and can be good for distinguishing between strong and weak candidates.

1. There should only be one correct response or one that is clearly the most correct.
2. All distracters (wrong responses) should be plausible. The wrong responses should appear reasonable to the less competent examinee, and at least one of them should seem to be a better response than the correct one.
3. All distracters should be appropriate to the stem.
4. Distracters should distract or confuse the weak examinee, but should NOT confuse the competent examinee.
5. The correct answer should not systematically appear in one or two locations within the list of responses. Random scrambling is needed, and can be done with the computer examination programs once we are into the beta-testing

phase. For the alpha phase, we can organize this manually to achieve randomness.

6. Avoid using similar words or phrases in the stem and the correct response unless the same words or phrases are used in the distracters as well.
7. Avoid the use of phrases such as “always,” “never,” “all,” “none,” and phrases such as “without doubt.” Responses that include these are almost always wrong, it is difficult to word a correct response with such firm words.
8. As a corollary to (7), words such as “usually,” “generally,” “sometimes,” and “often,” when used only in correct responses tip off the answer. Word that weaken or modify should be used in all distracters as well as the correct answer, if they are used at all.
9. The relative length of responses should not depend on whether or not they are correct. Keep all choices of similar length.
10. All responses should be grammatically correct with regard to the stem of the item. Exam writers have a tendency to ensure the correct response is grammatically correct and often fail to ensure the distracters are grammatically correct.
11. It is preferable to keep the responses reasonably short.
12. Limit the use of phrases such as “all of the above” and “none of the above.” It does not add a lot of value and reduces the number of incorrect responses that the examinee has to discriminate. It also interferes with using software to randomize exam response locations.

Checklist for Reviewing Items

1. Does the item present a significant problem or deal with important, useful knowledge in the field of maintenance and reliability work process leadership?
2. Is the item clear and unambiguous?
3. Is the item independent of all other item in the examination question bank?
4. Is the item appropriately difficult?
5. Does the item measure what it is intended to measure?
6. Is the item stated positively? If not, is a negative stem appropriate?
7. If the stem is stated negatively, have the negative words been emphasized (to reduce ambiguity)?
8. Are all the responses, both the correct answer and the distracters, grammatically consistent with the stem?
9. Are the distracters plausible to those who do not know the material?
10. Are all the responses of approximately equal length and complexity?
11. Are you sure that neither the stem nor any of the responses gives away the answer?
12. Is there one and only one correct answer to the item?
13. Do the responses avoid overlapping or including each other?

Capitalization and Punctuation

1. The first letter of the first word of each item should be capitalized.

2. Whenever the stem of an item is a question, the stem should end with a question mark and the first letter of the first word of each response should be capitalized.
3. Whenever the stem of an item is an incomplete statement, the first letter of the first word of each response should NOT be capitalized unless it would be capitalized regardless of its position in the statement.
4. The first letter of all proper names and abbreviations of proper names should be capitalized.
5. It is desirable to place a period after each response unless the form of the response makes a question mark more appropriate.

Question Item Template - Instructions for Use
To develop an exam item (Question consisting of Stem, Correct Answer and three (3) Distractors) print out or electronically “copy” the template provided on the following page and:

1. Identify a Body of Knowledge “subject area” upon which you would like to write questions. Circle or type parentheses around the “subject area” you’ve selected (Business Management, Manufacturing Process, Equipment Reliability People Skill or Work Management) on the template form.
2. Identify relevant source material (e.g., text or standard) selected per guidelines on pages 3 and 4 of this document, “SMRPCO Exam Item (Question) Development Rules and Guidelines,” and enter title, author, publisher, ISBN or standard number of the source as a “ Source Reference” in the template.
3. Excerpt or paraphrase from the source reference a brief “statement of fact” relevant to the question(s) you contemplate writing and enter what you’ve excerpted or paraphrased in the “statement of fact” section of the template. Enter the chapter or section and page number(s) where you got the “statement of fact” in the “Source Reference” section of the template.
4. Outline on a separate piece of paper one or more stem(s) of items that cover the critical concept(s) of the “statement of fact” and meet the guidelines for developing stems on page 5 of this document
5. For each possible item, one per template page, formulate the item stem, correct answer and distractors following the guidelines of this document on pages 5, 6 and 7. Enter each in the designated place for them on the template page(s).
6. Use the “Checklist for Reviewing Items” on page 7 of this document to determine if the question(s) you have formulated meet the criteria contained in the checklist
7. When you are satisfied with all parts of the item you have written, fill out the remainder of the form (name, phone number, e-mail, organization, reason for submission (except those entries “for SMRPCO use only)
8. Submit the completed template page per instructions at the top of the page or pass the document to a member of the SMRPCO Exam Development Team, Board of Directors or SMRPCO Staff Member or other associate who will do it for you.

SMRPCO Exam Item (Question) Development Template

Upon completion (by word processing or by legible hand writing) send to:

Terry Harris 656 Ridgeway Drive Sidney Ohio 45365
e-mail:tkharris10@hotmail.com

Author(s) Name(s)

Phone/FAX:

Organization(s):

E-mail address:

Submitted for : (circle or enter parentheses around one of the following)

2006 Rewards Program

Certification

Other _____

Date created:

Statement of Fact:

Source Reference: (Author(s), title, chapter, page(s), publisher, ISBN No..)

Question Stem:

Correct Answer

Distractor #1

Distractor #2

Distractor #3

SMRPCO Reference Guide (Body of Knowledge) Subject Area **(Circle or Enter Parentheses around One)** Business Management Manufacturing Process Equipment Reliability People Skills Work Management

Note: By submitting this form the Authtor(s) voluntarily transfer, assign and grant all intellectual property and copy rights for elements of the item (Stem, Correct Answer and Distractors) to the Society for Maintenance and Reliability Professionals to use, revise and apply as required in pursuit of its certification examination program(s).

Revision dates & notes: (for SMRPCO use only)

Date Accepted as Candidate Question (for SMRPCO Use Only) _____

Examiner ID#(For SMRPCO use only) _____

SMRPCO Exam Item (Question) Development Template (Example filled out –)

Upon completion (by word processing or by legible hand writing) send to:
Terry Harris 656 Ridgeway Drive Sidney Ohio 45365 e-mail:tkharris10@hotmail.com

Author(s) Name(s) Dr. Rupey Sawhney / Tom Byerley / Larry Cote **Phone/FAX:** 905 548 4307/4574

Organization(s): Univ Tenn (Saehney, Byerly) Dofasco (Cote) **E-mail address:** larry_cote@dofasco.ca

Submitted for : (circle or enter parentheses around one of the following)

Rewards Program

Certification

(Other_Volunteer)

Date created: December 20, 2002

Statement of Fact: There are different inventory models that M&R professionals should be aware of and apply to the management of spares. The objective of any inventory control system for maintenance materials is to be able to better balance the cost of inventory with the risk of stocking out. The reference establishes that in order to provide this balance and properly control inventory of all items, it is a recommended to classify maintenance store items into one of three categories:

- 1) Items representing 10-15% of all items, but 70-85% of the total investment in inventory.
- 2) Items representing 20-30% of all items, but about 25% of the total investment.
- 3) Items representing 60-70% of all items, but only about 10% of the total investment.

The classical inventory models are best applied to controlling the first type of items, i.e., those representing 10-15% of all items, but 70-85% of the total investment in inventory. Tests concepts of maintenance inventory control, classic inventory management models, balancing the risk of stock-out versus the cost of inventory

Source Reference: (Author(s), title, chapter, page(s), publisher, ISBN No..)

Niebel, Benjamin W.; Engineering Maintenance Management, 2nd. Edition, Chapter 6, pp. 663-669 McGraw-Hill, NY, 1996, ISBN 98978-09

Question Stem: To properly balance the cost of inventory with the risk of stocking out, it is advisable to

Correct Answer : control stores items representing 10-15% of all items, but 70-85% of the total investment in inventory.

Distractor #1: control stores items representing 20-30% of all items, but about 25% of the total investment in inventory.

Distractor #2: control stores items representing 60-70% of all items, but about 10% of the total investment in inventory.

Distractor #3: control stores items representing 80-95% of all items, but 70-85% of the total investment in inventory.

SMRPCO Reference Guide (Body of Knowledge) Subject Area **(Circle or Enter Parentheses around One)** Business Management Manufacturing Process Equipment Reliability People Skills (Work Management)

Note: By submitting this form the Author(s) voluntarily transfer, assign and grant all intellectual property and copy rights for elements of the item (Stem, Correct Answer and Distractors) to the Society for Maintenance and Reliability Professionals to use, revise and apply as required in pursuit of its certification examination program(s).

Revision dates & notes:(for SMRPCO use only) 01/10/03 - question items reworked to drop vocabulary and nomenclature specific to the reference in the interest of a more general-purpose question.

Date Accepted as Candidate Question (for SMRPCO Use Only) 1/10/03

Examiner ID#(For SMRPCO use only) TBD

Person Responsible (by Title) for Maintaining and Revising This Document:

Exam Director

Revision History

Version 1.0 drafted December, 2002

Version 1.0 updated to V1.1 and approved as per Exam team meeting 01/10/03 in Knoxville, TN.

Version 2.0 drafted January 2006 to:

- Reflect experience gained in first three years of exam administration, especially as the Exam Items had to be adjusted to accommodate use on an international scale in multiple languages
- Narrow the choice of reference sources to those that are generally available internationally and to provide guidance that reflects the need for exam items that serve a broader international base of candidates from that community
- Update the fundamental reference from which rules and guidelines for developing Exam Item are drawn and to strengthen the authorization for a multiple page excerpt from that reference.
- Reflect changes to the SMRP Web Site that affect current SMRPCO goals and objectives
- Reflect the existence of the SMRP BoK Committee formed in late 2005.
- Remove process tables and diagrams to a separate document in order to provide for easier download for anyone desiring to contribute exam Items for recertification credit or participate in the SMRPCO Rewards Program for Exam Item authors This required that the title of the original document be changed to remove the word “process” from it). Exam Item contributors don’t need this information and might be put off contributing anything if the “rules, guidelines (and process)” document is perceived to be too long.
- Change the Exam Item (Question) Template for submission of Candidate Items to reflect current and projected needs of the Exam Development Team, Exam Director and Exam Administrator (ICI) and Administrative Assistant.
- Provide more detailed instructions for completing the Exam Item (Question) Template

Version 2.1 – 11 November 2006 Header & footer info added IAW SMRPCO Procedure for Writing and Controlling Procedures, Process Guides, Checklists and Related Documents. Format left as is since content of body did not change and is perfectly useable, even though it does not follow the procedure mentioned above.

Version 2.2 - 9 January 2007 Name, Office and e-mail addresses changed to that for new Exam Director

Version 2.3 – 30 April 2007 – Added section entitled “Transfer of Intellectual and Copy Rights” to body of the test and a note to that effect to the forms for submittal of items. Also, changed submittal instructions to update them.

Version 2.4 - 19 May 2007 – Corrected e-mail address for Exam Director on pages 9 & 10 and made some formatting changes to allow for more efficient revisions in future.