

# WE GET COMPLAINTS REGULARLY SUCH AS, “I PASSED THE NARTE EXAM FOR ENGINEERING CERTIFICATION. EVERYTHING HAS BEEN SUBMITTED EXCEPT THOSE PESKY 10 QUESTIONS”-

“Is there any way that this requirement can be deferred, substituted or eliminated?” Or, “I believe it is redundant to submit questions just to determine if one has been working in the field and if one has been involved. Having submitted all my references and having passed the exam—what else do they really need?” and even, “I have taken exams for the FCC, FAA and other organizations and received certification without submitting questions to a question pool.”

Well, no one ever said that becoming NARTE certified would be easy.

The 10 questions requirement is tough. It is tough because it demands technical competence, creativity and good writing skills. Furthermore, this requirement demands that the applicant strive to reverse his or her problem solving skills - that is, pose a hypothetical problem to an identified solution. This demanding component of the NARTE application process evolved as a multi-faceted evaluation tool. The quality of the questions that an applicant submits reveals to the review committee:

- How much technical competence is held by the applicant (content of the questions).
- His or her writing skills (so necessary for the Engineering disciplines).
- His or her documentation capability, through the references cited and problems solved.

The other important aspect of question submission is the ability of NARTE to accumulate questions for future examinations. From the questions submitted, we select certain ones for further development. This ensures that NARTE examinations will keep pace with current work practices and technology.

Additionally, sometimes we discover the change in reference because of the new questions. And often, just the different approach taken to address a particular subject, adds value to the testing process. Certainly, many questions submitted are closely related to other, valid questions in the question pool, and are rejected for inclusion. But consistently we find questions that improve the testing process.

## Writing Multiple Choice Test Items

Our objective is to set out some conventional wisdom for the construction of multiple-choice questions. The comments that follow are applicable mainly to multiple-choice tests covering fairly broad topic areas.

Before proceeding, it will be useful to establish terms for discussing multiple-choice items. The “stem” is the introductory question or incomplete statement at the beginning of each item, which is followed by the options. The “options” consist of the

answer—the correct option—and “distractors,” the incorrect but (we hope) tempting options.

## Writing Stems

As a rule, one is concerned with writing stems that are clear and concise, answers that are unequivocal and chosen by the candidates who do best on the test, and distractors that are plausible competitors of the answer as evidenced by the frequency with which they are chosen. In developing good multiple-choice items, two tasks need to be considered: writing stems, writing options.

We will first describe some basic rules for the construction of multiple-choice stems, because they are typically, though not necessarily, written before the options.

1. Before writing the stem, identify the one point to be tested by that item. In general, the stem should not pose more than one problem, although the solution to that problem may require more than one step.

2. Construct the stem to be either an incomplete statement or a direct question, avoiding stereotyped phraseology, as rote responses are usually based on verbal stereotypes. For example, the following stems (with answers in parentheses) illustrate undesirable phraseology:

Q: What is the biological theory of recapitulation?

A: (Ontogeny repeats phylogeny)

Q: Who was the chief spokesman for the American System?

A: (Henry Clay)

Correctly answering these questions depends less on knowledge than on recognizing familiar phraseology.

3. Avoid including nonfunctional words that do not contribute to the basis for choosing among the options. An introductory statement is often included to enhance the appropriateness or significance of an item but does not affect the meaning of the problem in the item.

Generally, such superfluous phrases should be excluded. For example, consider:

The American flag has three colors. One of them is:

(1) Red (2) Green (3) Black

*versus*

One of the colors of the American flag is:

(1) Red (2) Green (3) Black

In particular, irrelevant material should not be used to make the answer less obvious. This tends to place too much importance on reading comprehension as a determiner of the correct option.

4. Include as much information in the stem and as little in the options as possible. For example, if the point of an item is to associate a term with its definition, the preferred format would be

# HOW TO WRITE THEM

20

YEARS OF EXCELLENCE



to present the definition in the stem and several terms as options rather than to present the term in the stem and several definitions as options.

5. Restrict the use of negatives in the stem. Negatives in the stem usually require that the answer be a false statement. Because students are likely in the habit of searching for true statements, this may introduce an unwanted bias.

6. Avoid irrelevant clues to the correct option. Grammatical construction, for example, may lead students to reject options that are grammatically incorrect as the stem is stated. Perhaps more common and subtle, though, is the problem of common elements in the stem and in the answer. Consider the following item:

What led to the formation of the States' Rights Party?

- a. The level of federal taxation
- b. The demand of states for the right to make their own laws
- c. The industrialization of the South
- d. The corruption of federal legislators on the issue of state taxation

One does not need to know U.S. history in order to be attracted to the answer, b.

Other rules that we might list are generally commonsensical, including recommendations for independent and important items and prohibitions against complex, imprecise wording.

### Writing Options

After constructing the item stem, next comes perhaps the more difficult task—to generate options. The rules listed below are not likely to simplify this task as much as they are intended to guide creative efforts.

1. Be satisfied with three or four well-constructed options. Generally, the minimal improvement from a hard-to-come-by fifth option is not worth the effort to construct it. Indeed, all else the same, a test of 10 items each with four options is a better test than a test with nine items of five options each.

2. Construct distractors that are comparable in length, complexity and grammatical form as the answer, avoiding the use of such words as “always,” “never,” and “all.” Adherence to this rule avoids some of the more common sources of biased cueing. For example, we sometimes find ourselves increasing the length and specificity of the answer (relative to distractors) in order to ensure its truthfulness. This, however, becomes an easy-to-spot clue for the test-wise student. Related to this issue is the question of whether or not test writers should take advantage of these types of cues to construct more tempting distractors. Surely not! The number of students choosing a distractor should depend only on deficits in the content area which the item targets and should not depend on cue biases or reading comprehension differences in “favor” of the distractor.

3. Options that read “none of the above,” “both a. and e. above,” “all of the above,” etc., should be avoided when the candidates have been instructed to choose “the best answer,” which implies that the options vary in degree of correctness. On the other hand, “none of the above” is acceptable if the question is factual and is probably desirable if computation yields the answer. “All of the above” is never desirable, as one recognized distractor eliminates it and two recognized answers identify it.

4. After the options are written, vary the location of the answer on as random a basis as possible. A convenient method is

to flip two (or three) coins at a time where each possible Head-Tail combination is associated with a particular location for the answer. Furthermore, if the test writer is conscientious enough to randomize the answer locations, students should be informed that the locations are randomized. (Test-wise students know that for some instructors the first option is rarely the answer.)

5. If possible, have a colleague with expertise in the content area of the exam review the items for possible ambiguities, redundancies or other structural difficulties.

*The above excerpt was adapted with permission from “Testing Memo 4: Constructing Multiple-Choice Tests—Part I”, Office of Measurement and Research Services, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060*

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### Items Particular to 10 Questions For NARTE

For NARTE-specific submissions:

- The sample questions provided should be representative of industry practice as you understand it. The questions can address areas of your specialty practice.

- References are given for many questions to assist the student with self-study. Note that all references must be in the public domain. (No classified or proprietary references can be used.)

- Solution times need to be indicated for each question. The times are estimates by both the question originator and the Exam Committee.

Sample question categories are available in the “Rules of Procedure Handbook” for each discipline.

### Multiple Choice Question Guidelines

The following is a set of guidelines for structuring answers to multiple-choice questions correctly:

- Some questions have answers with two parts. This technique is often used to convert true-false questions into questions with four or five answers.

- Some questions have answers that are all correct. The only answer for which credit will be given is “All of the above.” The important point is that some questions require the applicant to study all answers.

- Some questions have two correct answers. If such a question is used, credit will be given for either correct answer unless answer e) is “Both a) and d)”, for example, in which case credit will be given only for answer e). Questions of this type require the applicant to study all answers.

- Some questions have very good wrong answers. Wrong answers may correspond to anticipated mistakes on the part of the examinee. Some wrong answers correspond to mistakes and misinterpretations made by the question originator or by the review committee in working out the question. Including good wrong answers for questions with numerical answers is also one of the goals of the Exam Committee.

So now you have it. Go to the Rules of Procedure Handbook for your discipline and select the technological categories with which you are most comfortable and begin the writing process. You will find that it is just not that hard, so . . .

**Enjoy the challenge! Ω**



# Summary of Tips For Preparing 10 Multiple Choice Questions as Part of the NARTE Certification Application Procedure

- Questions should be geared toward the certification type for which you are applying. Identify the question as applicable to Engineer, Technician or Both.
- Questions should be challenging, yet answerable by a knowledgeable practitioner.
- Questions which relate to real-life work situations or problems are desirable.
- Construct the question or statement “stem” by identifying **one** point to be tested.
- Avoid including irrelevant or superfluous information in the question “stem.”
- Avoid the use of negatives in the question “stem.”
- Provide at least 4 and no more than 5 possible answers. NO True/False questions.
- Avoid answers that read “always”, “never”, “none of the above” or “all of the above”.
- Provide the exam category of the question and the time required to answer the question.
- Provide reference documents used for the question, however, do not copy questions directly from a reference.
- Review your questions for possible ambiguities, redundancies or other structural difficulties.

## Documenting Evidence of On-going Professional Experience During the NARTE Certification Renewal Process

*As standard procedure, NARTE asks those who are renewing their NARTE Certification to confirm that they are still practicing. Sometimes the information provided is quite interesting and the member is encouraged to write about their discipline for potential publication in the NARTE News. The following is such a reply:*

I wish to thank you for recognition of the accomplishments that I have provided for this year’s NARTE Certification renewal. I have been impressed that NARTE has requested evidence of ongoing experience in the Electromagnetics discipline as a condition for sustaining membership.

My range of contribution has been in the area of Electromagnetic Vulnerability (EMV) for most of the 25 years that I have been with Rockwell, or Rockwell Collins Navigation/Communications divisions. This area has often seemed to be on the fringe of typical NARTE proceedings, however, common threads are never difficult to find when the task is to protect antenna ports, clock interfaces, high speed data, etc., from sporadic energy.

EMV has undergone noticeable change in past decades. At one time, it almost universally meant the threat of damage to electronic components. Now, it is common for both hardware and software (processing) functions to carry similar weighting in EMV design plans.

An example of this has been in the direction taken by the Radio Technical Commission for Aeronautics (RTCA) in the DO-160 certification test requirements for aircraft. A much heavier emphasis is being placed on certification methods where loss of critical stored or transmitted information may result.

I serve on the SAE-AE2 Committee for Lightning Protection. We provide technical input to sections 22 and 23 of the

DO-160 certification document. These sections pertain to indirect and direct lightning effects, respectively. At the last meeting of the RTCA, Multiple Stroke and Multiple Burst lightning test waveforms were introduced for review to section 22 through the committee proceedings. These waveforms appear in natural lightning, extending the threat of an encounter beyond that of device burnout and into the area of critical functional upset. Therefore, it is an important effort to expand the scope of certification under this threat.

Other areas of EMV include Nuclear Effects, High Intensity Radiated Fields (HIRF) including EW, and ESD. I have worked to provide ongoing design guidance for these environments in my years with the company.

It is difficult to go into any significant depth for these areas in a short communication, however, it may be significant to say that as semiconductor and software technologies progress, each of these areas present challenges that only time will disclose. There are no current sets of rules, such as shielding, transient suppressor application, or data protocol that will conquer EMV on all fronts. It is an area where we constantly look to innovation and creativity in order to maintain a secure, robust, and competitive stance.

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**20**  
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