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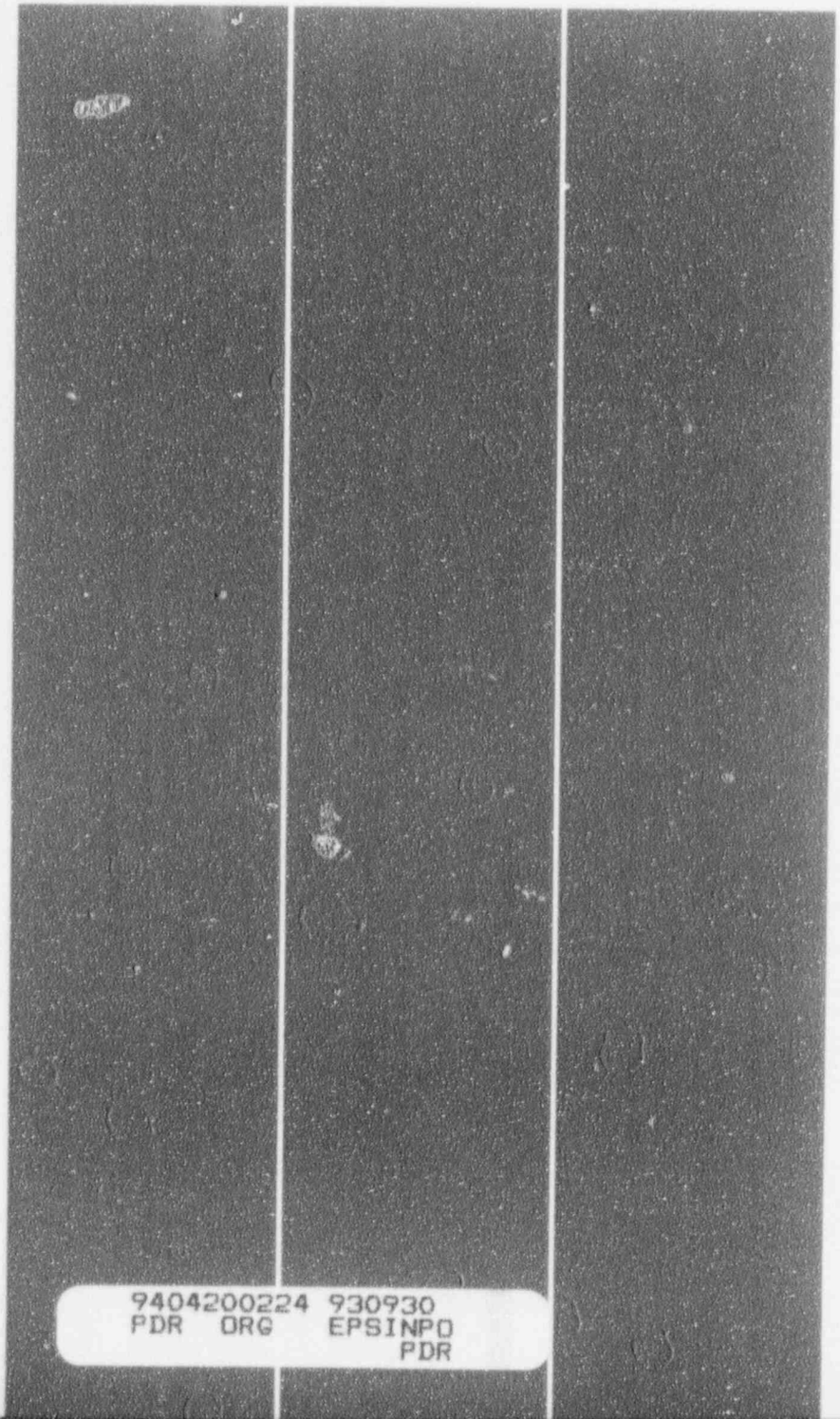

The Principles of Training System Development Manual, Addendum I: Test Item Development

NATIONAL ACADEMY FOR NUCLEAR TRAINING

PRINCIPLES OF
TRAINING SYSTEM DEVELOPMENT
ADDENDUM I
TEST ITEM DEVELOPMENT

September 1993
ACAD 88-002

NATIONAL ACADEMY FOR NUCLEAR TRAINING

Plant Area: Training and Qualification

Key Words: Evaluations, Testing, Test Items

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INTRODUCTION

The methodology used in developing test items varies significantly in the nuclear power industry. To ensure quality examinations, test items should be developed systematically. Test item development is discussed in the design section of the TSD manual, *Principles of Training System Development* (INPO 85-006). This addendum is intended to supplement the TSD manual by providing more detailed guidance on the development of test items.

This addendum is limited in scope; it addresses the development of written examination test items. However, many of the concepts also apply to oral examinations, both in the classroom and on the job. A subsequent addendum will address the broader area of test design and test development. This addendum is intended to be used as guidance for the classroom and laboratory instructor or curriculum developer responsible for the construction of individual test items.

This document focuses on written test items. These test items have been categorized as short answer, multiple-choice, or essay. Each item type is described, examples are provided, and a procedure for development is recommended. The appendixes provide example rules for writing test items, a test item development form, and additional examples of the various test item types.

DISCUSSION

Knowledge and skills required for acceptable job performance must be identified prior to test item development. Specific, measurable, and appropriate learning objectives must be developed. Learning objectives must be grouped, sequenced, and assigned to appropriate training settings. When these steps are complete, test and test item development can proceed.

Three steps must be performed when developing test items: The test item type must be determined, the number of test items to be developed must be determined, and the test items must be developed from learning objectives. After development, test items may be placed in a test bank and used later to construct entry-level tests, pretests, progress tests, and post-tests for the training program.

Selection of test item type is guided by the action verb of the learning objective. Skill verbs suggest performance testing while knowledge verbs suggest one or more of the written formats. For example, "start up" and "shut down" are skill verbs that suggest a performance test, whereas "recall," "identify," and "list" are verbs more appropriately addressed by the completion and short-answer formats. Verbs such as "discriminate" and "select" may be tested using a multiple-choice format. Learning objectives that require the trainee to classify or relate are most easily tested by using the matching format. Higher order verbs such as "synthesize" and "evaluate" may be tested using an essay format.

After the test item type is selected, the number of test items to be developed should be established. Some of the factors that significantly affect the number of test items to be developed are the number and type of examinations on which the questions will be used, the ease with which questions can be created, and how frequently a test item can be reused. The initial number of items selected for development may range from one to several items per objective.

Test items should be derived from the learning objectives and should reflect the action and intent of the objective. Development of test items is a critical task because the best stated objectives become meaningless if the test items do not require the trainee to demonstrate attainment of those objectives. A well-constructed test item has several characteristics and requires the trainee to recall, assess, and apply what he knows.

- First, test items should be clear, grammatically correct, and free of clues to the correct answer. They should be written at a reading level appropriate for the trainees.
- Second, it is imperative that the test items be *valid* and *reliable*. For a test item to meet the validity and reliability criteria, it should measure exactly what it purports to measure and should consistently measure a trainee's knowledge of a topic.
- Finally, a test item must be worded so that it discriminates between those who know what is being asked and those who do not. The art of writing an examination test item requires knowledge of the subject and knowledge of how the subject is taught at the learning level for which the test item is intended. Moreover, the developer of the test item must be familiar with what trainees should not have learned. That is, he should be able to construct each test item in a way that trainees who have misinformation or misconceptions will be differentiated from those with correct knowledge.

The following information on test item development is provided to enhance the ability of test item developers to write valid, reliable test items. Refer to Appendix C for additional test item examples.

A. Short-answer Test Items

Short-answer test items require trainees to supply the correct answer as a word or short phrase in response to a question, an incomplete statement, or an incomplete table or diagram. This type of test item is useful in testing knowledge, comprehension, and simple application. The "guess-factor" is reduced from that of a multiple-choice test item because the chance of successfully guessing the answer is greatly diminished. Due to varying trainee responses, the person grading the test item needs a definitive answer key and an understanding of the subject matter.

There are three common styles of short-answer test items: completion, fill-in-the-blank, and table/diagram completion. In each case, the trainee must supply the correct answer. Because the originator of a short-answer test item often has clear ideas about expected answers, it is essential that a model answer, acceptable alternatives, and the associated grading criteria be written at the same time as the test item.

1. Examples of short-answer test items

Completion:

How many protons and electrons does the element hydrogen contain?

Fill in the blank:

In a pressurized water reactor, fuel pellets of _____ are clad in _____; the primary coolant is _____ _____.

Table/Diagram Completion:

Complete the blanks in the following table, indicating thermocouple type and material.

Type	Material
K	
	Alumel –
	Iron +
	Constantan –
T	
	Constantan –
	Chromel +
	Constantan –
R or S	
	Plantinum-Rhodium +

2. Detailed writing procedure

As with all types of test items, more consistent results are attainable if certain guidelines and rules are followed when the test items are produced. All short-answer test items should have clear instructions that tell the trainee how the test item should be answered. Test items should be phrased so that a single correct response is given.

Successful test item writing can be achieved with preparation and practice. While experienced writers develop their own more comprehensive techniques, the beginner may choose to follow a simple, systematic method such as the following:

- Referring to the instructional objectives, select a topic for which to develop a test item.
- Determine the level of learning required to satisfy the learning objective (remembering that the higher levels, i.e., analysis, synthesis, and evaluation, are difficult to assess using short-answer test items). Higher level objectives may be more easily addressed using other test item formats.
- Using terms that trainees should know, (1) write a short-answer test item and provide the correct answer, or (2) write a fill-in-the-blank statement with the blanks filled in, or (3) compile a table of associated facts indicating which facts are the answers, or (4) draw a labeled diagram and indicate which labels should be identified.
- Write a brief but comprehensive set of directions, particularly for table/diagram completion test items, so trainees are not in doubt as to how the test item should be answered.
- If the test item has sub-parts, establish the percentage value that each sub-part will have. This value does not need to be the same for all sub-parts. Percentage values should be proportional to the importance of the sub-part being tested.
- Check the test item against the rules for short-answer test items (see Appendix B).
- Write the test item on a form such as that shown in Appendix A.
- Have another curriculum development person review the test item for content accuracy, format, and readability.

B. Multiple-choice Test Items

Multiple-choice test items require trainees to select the best answer from a series of choices. They are very useful for testing knowledge, comprehension, and application of knowledge and theory. Since the answer is provided, the subjective aspect of scoring is eliminated. Furthermore, scoring can be conducted by mechanical means. But because the answers are provided, it is difficult, though not impossible, to develop test items which can effectively test higher level cognitive abilities.

1. Styles of multiple-choice test items

Multiple choice test items comprise the principal form of structured response-type test items. By definition, multiple choice includes alternate-choice (true/false, yes/no, right/wrong) and matching, since both vary only in the number of alternatives available.

The most common multiple-choice form, as seen below, consists of a stem and the choices, which include the correct answer and several distracters:

The atoms of a chemical element all have the same	STEM
(a) **atomic number . . Correct choice**	C
	H
(b) **relative atomic mass . . Distracter**	O
	I
(c) **number of neutrons in the nucleus . . Distracter**	C
	E
(d) **number of neucleons in the nucleus . . Distracter**	S

There are various ways of producing and selecting distracters. The test item developer can independently or in discussion with colleagues determine possible distracters. An effective method is to develop a simple test item or a fill-in-the-blank statement. (For example: "What do all the atoms of a chemical element have in common?") Then, give this test item to a group of trainees. From their responses possible distracters will emerge that are usually more effective than those devised by the test item developer, particularly since the distracters also identify trainee learning errors.

The selection of distracters should be based on the required depth of trainee understanding. As shown in Example 1 below, one set of distracters may be appropriate when only a general understanding of a subject is required, while a different set of distracters is needed when an in-depth understanding is required.

Having determined the approximate format of the test item, the test item developer must then clearly organize the details. There are definite rules to be followed (Appendix B), but in essence they include the following:

- The stem must be clear, concise, and in such a form that the knowledgeable trainee knows the correct answer without scanning the choices.
- The choices should make grammatical sense when read with the stem.

2. Examples of multiple-choice test items

Example 1: A Four-option Multiple-choice Test Item
A multiple-choice test item with the same correct answer (key) can be written in several ways depending on the breadth of knowledge being assessed. The following example shows three variations of a multiple-choice item. The correct answer in each is "rad," but the distracters have been chosen with different objectives in mind.

Variation 1

In health physics, the unit of absorbed dose is:

(a) volt (b) rad (c) calorie (d) newton

This set of choices covers such a wide range that discrimination would be extremely easy for those with only a vague understanding of health physics.

Variation 2

In health physics, the unit of absorbed dose is:

(a) rad (b) rem (c) kerma (d) disintegration/sec

This set of choices covers such a narrow band of knowledge that only those who have a good understanding of health physics would choose the correct answer.

Variation 3

In health physics, the unit of absorbed dose is:

(a) counts/sec (b) rad (c) half-life (d) rem

This set of choices covers two bands of knowledge—counts/sec and half life would be immediately dismissed by those with some understanding of health physics, leaving the choice between (b) and (d) (i.e., one choice from two, not four, distracters)

Example 2: A Matching Test Item
Subatomic particles have certain properties. Match the names of the following particles with their properties by writing the letter representing the particle next to its properties.

Particles		Properties
A Alpha	E Neutron	_____ 1. Very small mass, one negative charge
B Electron	F Positron	_____ 2. Very small mass, one positive charge
C Meson	G Proton	_____ 3. Mass 1 unit, no charge
D Neutrino		_____ 4. Mass 1 unit, one positive charge
		_____ 5. Mass 4 units, two positive charges

3. Detailed writing procedure

The following method may be used to develop alternate choice, multiple-choice, and matching items:

- Using learning objectives, select a topic from which to develop a test item.
- Determine the level of learning you expect in response to a test item on this topic (e.g., comprehension or application).
- For multiple-choice test items, write a draft test item and correct answer. Then develop plausible distracters by choosing trainees' incorrect responses, or create the distracters yourself by imagining plausible answers from a trainee who had misunderstood the topic under examination. It may be useful to include a diagram, periodic table, etc., as part of the test item—this is known as stimulus material.
- For multiple-choice test items, rewrite the test item using plausible answers as distracters and the correct answer as the key. Experiment with drafting the stem both as a question and as an incomplete statement. Then refine the test item by reducing the choices (key and distracters) to a common form and a similar length.
- For matching test items, develop multiple stems or premises and appropriate multiple alternatives.
- Eliminate superfluous words from the stem, especially where these might direct the trainee too easily to the correct answer. Be consistent in the use of language and technical terms. The correct technical term appearing in only one choice will usually direct the trainee to the correct answer.
- For multiple-choice or matching, arrange the premises and alternatives in a definite order, such as quantitative order, descending order, logical order, etc.
- If partial credit is possible, establish how it will be assigned (e.g., a five-item matching item might have 20 percent credit for each correct match).
- Check the test item against the rules for writing multiple-choice test items (see Appendix B).
- Write the test item on a form such as that shown in Appendix A.
- Have another test item developer review the test item for content accuracy, format, and readability.

C. Essay-type Test Items

Test items that are called essay-type include those requiring a calculation, a graph, a description, an argument, an estimate, a sketch, or a combination of these. The trainee has to determine the answer and select the means of communication. Test items of this type can test the whole range of abilities, but they usually are considered most suitable for application, analysis, synthesis, and evaluation. The test item and the associated grading criteria must be prepared concurrently. The person grading the test item must be knowledgeable in the subject matter.

There are two major styles of essay-type test items: structured and unstructured. In each case, trainees must supply the correct answer; however, the unstructured questions require a greater amount of analysis and composition than are required by structured test items.

1. Examples of essay-type test items

It is possible to express the same test item as either a structured or unstructured test item. Two extremes are shown here:

- .uctured Essay-type Test Item

A pressurized water reactor at full power has the following conditions:

- **Core flow** **100%**
- **T_{avg}** **588°F**
- **Core ΔT** **60°F**
- **Steam Generator ΔT (T_{avg}—T_{steam})** **44°F**

The reactor is operating at steady state power with four loops operating. One reactor coolant pump trips, resulting in three loop operation. The rod control system is in automatic. The reactor has not tripped.

A. Sketch graphs of RCS mass flow, reactor power, core ΔT, and steam generator pressure versus time if no operator action is taken. (Use the same time axis for all graphs.)

(4 points)

B. Calculate the final reactor power, T_{avg}, core ΔT, and steam generator ΔT.

(4 points)

This test item gives the trainee clear guidelines on what is expected. This is termed a structured test item and requires little personal initiative, but a clear requirement exists to apply knowledge gained from theoretical and practical experience in the course.

- Unstructured Essay-type Test Item

A pressurized water reactor is operating at 100 percent steady state power. One reactor coolant pump trips resulting in three- loop operation. Explain what happens if the reactor does not trip and no operator action is taken. State any assumptions you make.

(8 points)

This test item requires the trainee to interpret the word "explain." He must decide what the important issues are, what assumptions to make (possibly based on parameters taken from his own experience), and then communicate the issues and assumptions by whatever means he thinks are appropriate. Some trainees may use graphs and a short explanation; others may use only an explanation. Each answer will be unique. This test item requires the trainee to express his understanding of the topic clearly.

For assessment purposes, most test item developers prefer to write structured essay-type test items. Unstructured essay-type test items are most appropriate in learning exercises in which feedback and additional clarification can be provided if necessary (e.g., oral examination, on-the-job training, walk-through, etc.).

2. **Detailed writing procedure**

The layout of the test item and the clarity of the wording are crucial for the trainee to understand what is required. Test items that can be answered by a single word should be avoided. Generally the words "how" and "why" are the best, followed by "what" and "when," although the latter two can more easily lead to single word or very short answers.

Trainees find particular difficulty with interpretation of words such as "discuss," "compare," and "explain." The level of the answer expected is important in determining whether a more specific statement is useful.

The beginning test item developer should follow a systematic method such as the following:

- Allow adequate time for developing the test item, model answer, and grading criteria. Essay-type test items usually require several revisions during the development process.
- Referring to the lesson objectives, select a topic from which the test item is structured.
- From the lesson objective, determine the level of learning expected in response to a test item on this topic.
- Define the problem explicitly. An essay-type test item is of no use if the trainee cannot comprehend the test item. It must be open to only one interpretation so all trainees address the same topic.
- Limit the problem. The scope of the content area should not be too large. Remember that trainees will take longer to answer the test item than the developer will.
- If additional guidance for a particular test item is necessary beyond that shown in the general instructions, make a clear and concise statement.
- Do not provide alternative choices within a test item or alternative test items; all trainees should be given the same questions.

- Develop the test item grading criteria. Identify the key responses expected from the trainee. Identify each necessary response (e.g., by underlining key words, phrases, or steps, or by circling important parts of graphs or diagrams). Determine the percentage value to be allocated for each test item subpart (based on their relative importance).
- Check the test item against the grading criteria.
  - Does the test item clearly request what is considered important in the grading criteria?
  - Is the time necessary to answer the test item proportional to the importance of the test item? Critical objectives justify more time if required.
  - Do trivial details (e.g., an extended calculation) take too much time to address?
  - How could the test item and/or the grading criteria be revised to be more consistent?
- Ensure that the sequence of requirements is in a logical order.
- Ensure that all the data (stimulus material) needed by the trainee is provided.
- Check the test item against the rules for writing essay-type test items (see Appendix B).
- Write the test item on a form such as that shown in Appendix A.
- Have another test item developer review the test item for accuracy, format, and readability.

3. Scoring essay-type test items

A major difficulty in the use of essay-type test items is the inability to maintain consistent scoring. The model answer must clearly identify the key points of each test item. The grading criteria must be followed closely to ensure consistency of scoring. Effective grading criteria eliminate bias toward trainees whose answers appear plausible, have neat handwriting, or are known to the instructor by removing subjectivity and promoting objectivity.

During scoring, it is easy to drift from the established grading criteria. It is, therefore, necessary to check each answer against the model answer and grading criteria for every test. It is also advisable for the same person to score one test item across all tests before scoring the next test item. This increases the consistency of the scoring process.

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APPENDIX A

SAMPLE TEST ITEM DEVELOPMENT FORM

_____
Test Item Reference Number

TEST ITEM DEVELOPMENT FORM

Developed by: _____ Date: _____

Reviewed by (SME): _____ Date: _____

_____ _____

Reviewed by (IT): _____ Date: _____

_____ _____

Approved by: _____ Date: _____

Test Item Type:

____ Short answer

____ Multiple choice

____ Essay

____ Other

Purpose of test item (i.e., objectives tested, areas covered, content tested):

Reference to course material (which lecture/lesson plan, what references, page numbers):

Test item statement (provide complete test item with point values):

Test item response (model answer and grading criteria, including partial credit):

Alternate acceptable answers:

APPENDIX B

EXAMPLE RULES FOR WRITING TEST ITEMS

EXAMPLE RULES FOR WRITING SHORT-ANSWER TEST ITEMS

Problems in developing short-answer test items have been considered in the formation of the following rules. In general, these rules apply equally to the completion style of test item, fill-in-the-blank, or table/diagram completion, although it will be obvious that some rules are specific to one style of short-answer test item.

1. Ask only for important, relevant information.
2. Make the sentence structure as simple as possible so the test item is clear to all trainees.
3. State and qualify the test item unmistakably so a single response is correct.
4. Limit the space allocated for each answer to encourage a single word or short phrase.
5. Ensure that the point value for each test item or part of a test item is shown on the test paper.
6. For fill-in-the-blank items, arrange the blanks to be of equal but adequate length.
7. For fill-in-the-blank items, do not make sentences unrecognizable by leaving too many blanks.
8. For fill-in-the-blank items, do not omit words that are interdependent.
9. For a completion table, do not have more than six items in one column.
10. For a completion diagram, include only necessary features and ensure that components are clearly referenced.
11. Compose a detailed model answer, identifying important statements, steps, or parts, and allocate points for each item subpart.

EXAMPLE RULES FOR WRITING MULTIPLE-CHOICE TEST ITEMS

Frequent problems in developing multiple-choice test items have been considered in the formation of the following rules.

1. Ask only for important, relevant information.

2. If the stem is in the form of an incomplete sentence, each choice must complete the sentence using correct grammar.

3. Avoid negative stems for the following reasons: (a) they may lead to double negatives, (b) they are unnecessarily difficult to interpret, and (c) it is more important to test what something is than what it is not.

4. Avoid statements open to more than one interpretation.

5. Put all common phrases into the stem.

6. The stem should include a verb and should be constructed in such a way that the correct response is immediately suggested; thus, reference to the choices is mere confirmation.

7. Ensure that the use of singulars or plurals in the stem, such as "are," "is," "they," "its," does not lead to the correct answer by linking the stem to a singular choice while the distracters are plural.

8. Provide choices that are all plausible. The distracters should be logical and, in most cases, based on known likely errors. For example, in quantitative problems, anticipate likely errors in the interpretation of a formula or in arithmetical steps.

9. Ensure all choices are plausible in construction; for example, if three of the four options are the names of elements, do not include the name of a reactor as the fourth option.

10. Ensure that only one statement is correct or clearly the best of the choices.

11. Keep all choices as short as possible to reduce reading and make it easier to consider all options simultaneously. The style should be simple and direct.

12. Avoid any one choice being noticeably longer or shorter than the others.

13. If there is a logical order for the choices, arrange them in that order (i.e., increasing or decreasing order of magnitude, alphabetical order, etc.).

14. Avoid technical terms in the distracters that are unlikely to be known to trainees. Never include nonsense words or terms.

15. Avoid irrelevant clues that would guide trainees to the right answer for trivial reasons.

16. Avoid grouping choices in opposite pairs.

17. Avoid overlapping choices.

18. Avoid synonymous distracters.

19. The choice "none of the above" or "all of the above," while at times a useful device, should be used sparingly and only very rarely as a correct answer.

20. Do not create a pattern in the sequence of answers for easier scoring; trainees can often detect these patterns.

EXAMPLE RULES FOR WRITING ESSAY-TYPE TEST ITEMS

Frequent problems in developing essay-type test items have been considered in the formation of the following rules.

1. Ask only for important, relevant information.
2. Use short sentences.
3. Avoid ambiguity.
4. Avoid test items that can be answered by a single word or a short phrase.
5. Avoid negative statements in test items; they may lead to double negatives, which are difficult to interpret.
6. Use the words "discuss," "explain," or "compare" only when aiming deliberately at higher cognitive levels (e.g., as in the last part of a structured test item).
7. State clearly whether exact answers or estimates (or precise figures or sketches) are required.
8. Ensure that the point value for each test item or part of a test item is stated.
9. Collect all data together, and display it clearly.
10. Give clear guidance (e.g., "state any formula used and show work in calculating your answer").
11. Compose a detailed model answer, identifying important statements, steps, or parts, and allocate points accordingly.
12. State the anticipated answering time for the test item.

APPENDIX C

TEST ITEM EXAMPLES

SHORT-ANSWER TEST ITEM EXAMPLES

Unsatisfactory:

1. Select the words from the list provided to complete the simplified descriptions. Place the letter corresponding to each answer in the blanks. Each correct response is worth two (2) points.

   a. The _____ critical power ratio (MCPR) is the smallest CPR that exists in the core.

   b. Rod density is the number of control rod notches _____ as a fraction of the total number of control rod notches. One hundred percent rod density is achieved when all rods are _____.

   c. The _____ fraction of limiting power density is the _____ value of FLPD that exists in the core.

   Word List

   1. Maximum
   2. Minimum
   3. Smallest
   4. Largest
   5. Inserted
   6. Withdrawn

   Answer:

   a. 2
   b. 5, 5
   c. 1, 4

   Comment:

   - Since the alternatives are provided, this is actually a matching test item.
   - Completion items should not be used if the intent is to test complex knowledge.
   - The answer choices are identified by numbers not letters (does not match instructions).
   - The word list includes synonymous distracters (e.g., maximum versus largest, smallest versus minimum).
   - The acronym MCPR identifies the correct answer as beginning with "M".

Satisfactory:

1. Define the following terms:

   a. Minimum critical power ratio (MCPR)
   b. Rod density
   c. Maximum fraction limiting power density (MFLPD)

Answer:

a. MCPR is the smallest critical power ratio that exists in the core.
b. Rod density is the number of control rod notches inserted as a fraction of the total number of notches.
c. MFLPD is the largest value of fraction limiting power density that exists in the core.

Unsatisfactory:
(4 points)

1. Procedure HNP-2-1909, "Inability to Shutdown with Control Rods," states that

   ". . . if at any time, either condition ___b(1)___ or ___b(2)___ exists, and either ___(a.1)___ or ___(a.2)___, and if it is obvious that the reactor cannot be shut down and, in the judgment of the shift supervisor, (or in his absence, a licensed operator), a hazard exists to the environs, personnel or the plant, use the standby liquid control system per HNP-2-1400 . . ."

   a. List conditions (a.1) and (a.2).
   b. List conditions b(1) and b(2).

Answer:

a. 1. RPV level cannot be maintained (1.5)
   2. Suppression pool water temperature cannot be maintained below 110 degrees Fahrenheit (1.5)

b) 1. Five (5) or more adjacent control rods not inserted below the 06 position (0.5)
   2. Thirty (30) or more total control rods not inserted below the 06 position (0.5)

Comment:

- Response blanks should occur at or near the end of a question after sufficient information has been provided to establish exactly what the problem is and what frame of reference should be used to arrive at the solution.
- Response blank labels are unnecessarily complicated b(1), b(2), (a.1), (a.2), vs. 1, 2, 3, and 4.
- If blanks are used, they should either be of sufficient size to write in the answers, or a separate location should be provided for the answers.
- There is no apparent reason for assigning different values to the four responses, and the trainee will not be aware of the differential weighting.

Satisfactory:
(4 points)

1. Procedure AOP-2-1909, "Inability to Shutdown with Control Rods," states that when certain conditions are present, the shift supervisor is required to use the standby liquid control system to shut down the reactor.

   List the four conditions identified in Procedure AOP-2-1909 that must be considered by the shift supervisor in determining the need to shut down the reactor using the standby liquid control system.

   Answer:

   1. Five (5) or more adjacent control rods are not inserted past the 06 position.
   2. Thirty (30) or more total control rods are not inserted past the 06 position.
   3. Reactor pressure vessel level cannot be maintained.
   4. Suppression pool water temperature cannot be maintained below 110 degrees Fahrenheit.

MATCHING TEST ITEM EXAMPLES

Unsatisfactory:

1. In the containment air return system, both fans are actuated upon a _____ actuation signal but are delayed starting for _____ minutes. They continuously draw air from the dome of the containment vessel and from the following pocketed spaces _____, _____, _____, and _____.

A. 1 hour
B. Instrument room
C. HPZ
D. Accumulator spaces
E. One minute
F. Lower containment compartment
G. 10 minutes
H. Containment high-high pressure
I. Cable penetration area
J. S/G enclosures
K. Pressurizer enclosure
L. Upper containment compartment

Answer:

1. H, G, B, D, J, and K

Comment:

- Directions are implied but not given.
- Abbreviations are used when complete terms should be specified. (HPZ, S/G)
- Distracters are not logically grouped, i.e., by signal, time, and spaces.
- Answers are not appropriate for blanks (i.e., *10 minutes* minutes).
- Number of points available has not been stated.
- Blanks are not same size.
- Avoid specific determiners before blanks, like a or an.

Satisfactory:
(6 points)

1. Select the answers needed to complete each sentence. Write the letter of each answer in the blank provided.

In the containment air return system, both fans are actuated upon the ___B___ actuation signal but are delayed starting for ___D___ minutes. They continuously draw air from the dome of the containment vessel and from the following pocketed spaces ___F___, ___G___, ___J___, and ___K___.

A. High pressurizer pressure
B. Containment high-high pressure
C. Two
D. 10
E. 60
F. Instrument room
G. Accumulator spaces
H. Lower containment compartment
I. Cable penetration area
J. Steam generator enclosures
K. Pressurizer enclosure
L. Upper containment

MULTIPLE-CHOICE TEST ITEM EXAMPLES

Unsatisfactory:

1. During a cold S/U, after a long refueling outage, with power level below the point of adding heat, you are asked to hold the reactor power level steady for several hours while surveillances are being conducted. During this period of time you may be doing any of the following to hold power constant. Pick the best answers.

   a. withdrawing rods slowly
   b. inserting rods slowly
   c. diluting boron slowly
   d. borating slowly
   e. holding rods and boron at a constant level

   Explain your answer.

   Answer: a and b

   Comment:

   - The stem suggests more than one response.
   - There should be one clear best or correct response.
   - An essay test item is mixed with a multiple-choice test item.
   - The conditions in the stem are not precise; confusion exists as to the best answers.
   - Acronyms such as S/U should be avoided.
   - Available points are not stated.

Satisfactory:

After a long refueling outage, a reactor startup is performed, and criticality is achieved in the source range.

(2 points)

1. How would you hold reactor power level constant (in the source range) for eight hours while surveillances are conducted?

   a. adjust rods
   b. adjust boron concentration
   c. adjust reactor coolant system temperature
   d. no adjustments required

   Answer: a

(2 points)

2. Why are reactivity adjustments required to hold reactor power level constant (in the source range)?

   a. to compensate for doppler feedback
   b. to compensate for the condition that K_{eff} cannot be exactly one
   c. to compensate for power coefficients
   d. no adjustments required, the inherent power coefficients will maintain the reactor at constant power

   Answer: b

ESSAY TEST ITEM EXAMPLES

Unsatisfactory:
(3.5 points)

1. For each of the reactor protective system trips listed below, state the sensed parameter, the limiting safety system setting, and what each trip protects against. Only the LSSS that would apply at 100 percent power is required.

   a. High power level (1.0)
   b. Low reactor coolant flow (1.0)
   c. Steam generator differential pressure (1.0)
   d. Containment high pressure (Sensed parameter is NOT required) (0.5)

Answer:

a. neutron flux (thermal backup) is sensed (0.3)
   LSSS @ 100 percent is 107 percent of rated power (0.2)
   Prevents clad damage due to reactivity excursions too rapid to be detected by pressure/temperature trips (0.5)

b. RCS differential pressure across each SG is sensed (0.3)
   LSSS @ 100 percent is 95 percent of max flow (0.2)
   Protects against DNB (0.5)

c. Secondary differential pressure across each SG is sensed (0.3)
   LSSS @ 100 percent is 135 psid (0.2)
   Protects the core against DNB (0.5)

d. LSSS @ 100 percent is 5 psig (0.1)
   Assures reactor is tripped whenever SI initiates (0.4)

Reference: FCS TS 1.3, p. 1-7 to 1-10

Comment:

- The developer has assigned different values to responses (i.e., state the sensed parameter, limiting safety system setting, and what each trip protects against).
- Abbreviations are used instead of complete wording.

Satisfactory:

1. Assume the reactor is at 100 percent power. For each of the following reactor protective system trips, state (a) the sensed parameter, (b) the limiting safety system setting (LSSS), and (c) the protection provided.

   1. High power level trip (3 points)
   2. Low reactor coolant flow trip (3 points)
   3. Steam generator differential pressure trip (3 points)

   Answer:

   1. a. neutron flux (thermal backup) is sensed.
      b. LSSS @ 100 percent is 107 percent of rated power.
      c. Prevents clad damage due to reactivity excursions too rapid to be detected by pressure/temperature trips.
   2. a. Reactor coolant system (RCS) differential pressure across each steam generator (SG) is sensed.
      b. LSSS @ 100 percent is 95 percent of max flow.
      c. Protects the core against departure from nucleate boiling (DNB).
   3. a. Secondary differential pressure across each SG is sensed.
      b. LSSS @ 100 percent is 135 psid.
      c. Protects against departure from nucleate boiling (DNB) and high linear heat rate.

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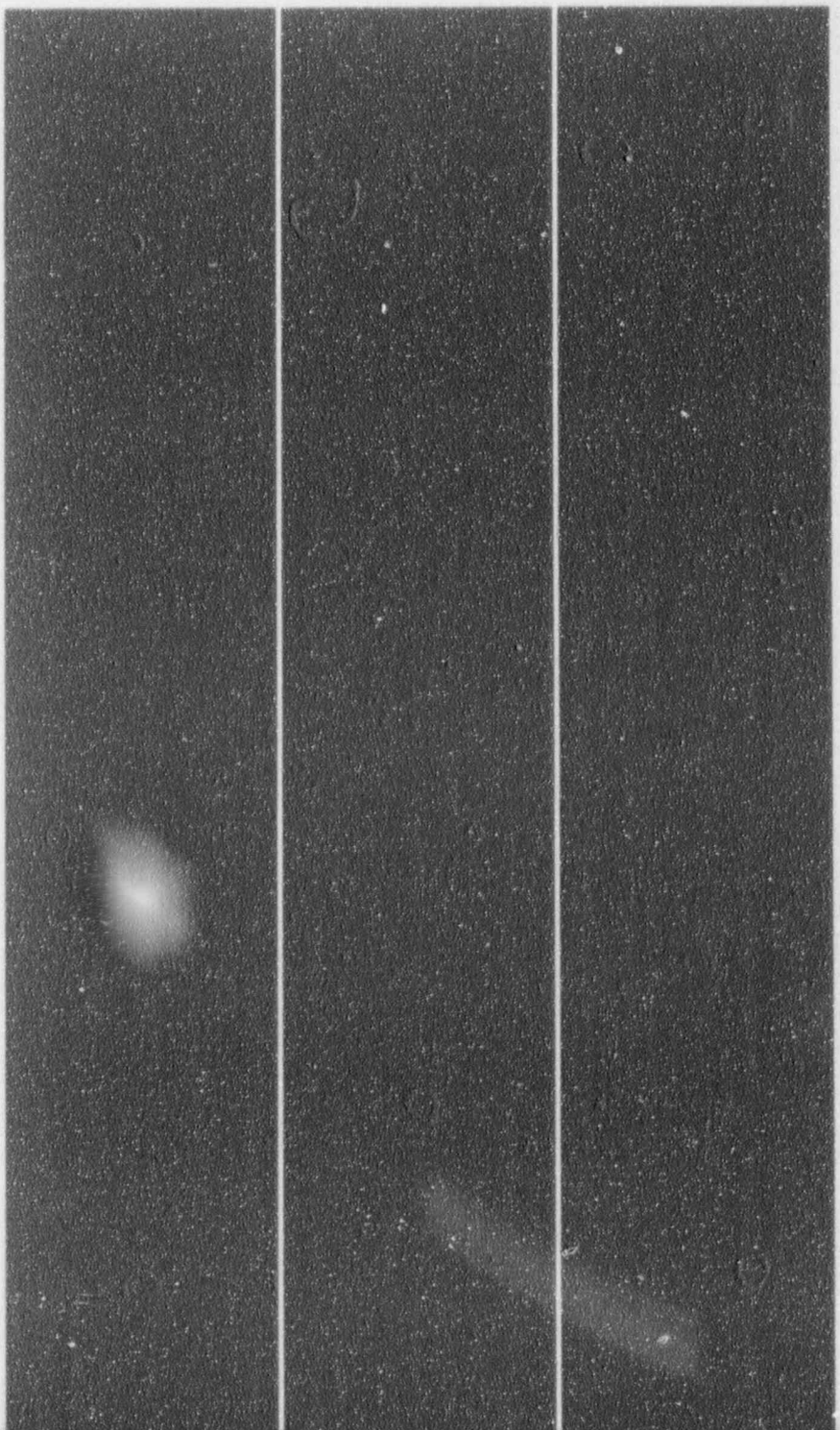

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April 19, 1994

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Records and Archives Services Section
Information and Records Management Branch
Office of Information Resources Management

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