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United States
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Examiners' Handbook for Developing Operator Licensing Written Examinations

Division of Licensee Performance
and Quality Evaluation
Office of Nuclear Reactor Regulation

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

February 15, 1990

MEMORANDUM FOR: Recipients of NUREG/BR-0122

FROM: Kenneth E. Perkins, Jr., Chief
Operator Licensing Branch
Division of Licensee Performance
and Quality Evaluation, NRR

SUBJECT: REV. 5 TO NUREG/BR-0122, EXAMINERS' HANDBOOK FOR DEVELOPING OPERATOR LICENSING WRITTEN EXAMINATIONS

Enclosed is a copy of Revision 5 to NUREG/BR-0122, Examiners' Handbook for Developing Operator Licensing Written Examinations. This revision goes into effect 60 days from the date of this memorandum. If I can be of further assistance, please contact me at (301) 492-1031.

Sincerely,

Kenneth E. Perkins, Jr., Chief
Operator Licensing Branch
Division of Licensee Performance
and Quality Evaluation, NRR

ABSTRACT

A procedure is presented for systematically constructing content-valid licensing examinations for nuclear power plant reactor operators (ROs) and senior reactor operators (SROs) at pressurized water reactors and boiling water reactors. This procedure contains explicit guidance for sampling knowledge and abilities (K/As) from companion documents which define important, safety-related, testable K/As for safe power plant operation at the RO and SRO levels. The companion documents, "Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors" (NUREG-1122) and "Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactors" (NUREG-1123), catalog K/As derived from a job-task analysis of the operator's work. Guidance for developing test objectives based on facility learning objectives is also provided. Using the procedures outlined in this handbook, operator licensing examinations having demonstrable content validity can be constructed.

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1 INTRODUCTION

For a test to be considered valid, it must be shown to measure that which it is intended to measure. In the case of the NRC licensing examination, the intent is to measure the candidate's knowledge and ability such that those who are licensed will perform the duties of the RO and SRO to ensure the safe operation of the plant. The general sequence of activities needed to establish the content validity of NRC licensing examinations are outlined below.

1.1 Content Validity and the NRC Licensure Examination Process

The public protection function of licensing examinations is necessary to assure that those who are licensed possess sufficient knowledge and ability to perform the job activities in a safe and effective manner. In order to develop examinations that serve this public protection function, the knowledge and abilities (K/As) selected for testing must be linked to and based upon a description of the most important job duties. This is accomplished through the conduct of job/task analysis (JTA), focusing on the delineation of essential knowledge and abilities.

This approach to the development of content valid licensing examinations is endorsed by the testing industry in the 1985 revision of the Standards for Educational and Psychological Testing published by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education. The standards treat licensing examinations in a separate section in recognition of their importance and uniqueness. Accordingly, those seeking additional technical guidance are encouraged to consult Chapter Eleven of the document for further clarification.

Once the essential knowledge and abilities have been identified through the conduct of the job or task analysis, test specifications must be developed. The test specifications consist of a content outline or sample plan indicating what proportion of items or questions shall deal with each knowledge and ability. The overall outline may also include a) specifications as to the number of items in the examination, b) the time allowed for administration, c) the format for the items or questions, d) rules for selecting knowledge and abilities to be tested based on frequency and importance ratings by subject matter experts, and, where appropriate, e) the statistical properties of test items or questions such as difficulty and discrimination.

It is important to note that the purpose of licensing is not to distinguish among levels of competency or to identify the most qualified, but to make reliable and valid distinctions at the minimum level of competency that the agency has selected in the interests of public protection. This level is usually defined by the licensing agencies in terms of education, experience, and test scores.

This handbook in conjunction with its dual companions, the K/A Catalog and Supplement for Pressurized Water Reactors and the K/A Catalog for Boiling Water Reactors, provides the basis for the development of content valid licensing examinations for reactor operators and senior reactor operators consistent with testing industry standards described above. The examinations developed using this handbook and the appropriate K/A catalog will cover those topics listed under Title 10, Code of Federal Regulations, Part 55.

1.1.1 Selection of Job-Relevant Content

First and foremost, K/As tested in a licensing examination must have been proven to be important and essential to the performance of the job or position being tested. This proof must involve a documented analysis of the job.

For the purposes of validating the content of the NRC licensing examinations, the job/task analysis performed on the licensing operator position by the Institute of Nuclear Power Operations (INPO) served as the initial source of information. The INPO JTA identified more than 28,000 knowledge, skills, and abilities (K/As) and nearly 800 tasks. The extensive number of INPO tasks and K/A statements is due, in part, to the specific purpose of the INPO analysis, which was to provide an information base to be used in developing training programs that would be applicable to all PWR and BWR facilities. Accordingly, many of the individual statements were too specific and/or too elementary for use as the basis for the development of licensing examinations. Perhaps most important, the job content of special interest in license applications is that subset of K/As that are required for the safe operation of the nuclear plant. Although safe performance and efficient performance may have considerable overlap, any K/A that contributes to efficiency but not to safety is an inappropriate focus for the licensing examination.

The initial drafts of the K/A catalogs were reviewed by licensed SROs as well as licensed examiners from the NRC regional offices. These experts reviewed each statement for accuracy and completeness and then rated each statement with respect to its importance to safe operation. Further explanation of the content of the resulting K/A catalogs is provided in Section 2 which follows and in the introduction to each catalog.

1.1.2 Proportional Sampling of K/As

Test items selected for inclusion in the examination should be based on the K/As contained in the appropriate catalog. Testing outside the documented K/As can jeopardize the content validity of the examination. Content validity can also be threatened if important K/As are omitted from the examination. Therefore, the sample of K/As that are tested should cover all the major K/A categories in the catalogs in a fashion that is consistent with their contribution to the public protection function of the examination. Not all categories are equal in this regard. This conclusion is based on the analysis of ratings on importance and testing emphasis collected from licensed SROs, as well as from licensed examiners from the regional offices. Section 2 describes how to develop a test outline that will provide proper documentation and guidance concerning the application of the proportional sampling techniques to ensure accurate content coverage.

1.1.3 Development of Test Objectives

Test objectives provide the specific conditions for testing and the standards of performance for K/As selected for inclusion in the licensing examination. Since facility learning objectives are specific to the job requirements at that site, they should provide an excellent basis for test objectives. Examiners should refer to facility learning objectives (as described in Section 3), to determine the appropriate conditions for testing and the standard of performance expected of fully competent candidates at that plant.

1.1.4 Congruence Between Test Objectives and Test Items

Once the relevant K/As are selected and the testing objectives have been considered, the examiner's next responsibility is to develop test items for the written examination that will meet the testing objectives. The content and format of the test material must be clearly linked to the underlying purposes of the test. This means that, among other things, the test items must be relevant, unambiguous, readable, and at a level of difficulty necessary to assure accurate discrimination at the minimum level of competence selected by the examiner in the interest of public safety.

PLEASE NOTE: The procedures described in Section 2 for using the catalog(s) in constructing the licensing examinations do permit licensing examiners latitude in the selection of the appropriate test item format and in the development of the test. Test construction is not a mechanical process and should never be completely reduced to the blind application of testing principles. Rather, a good test is the result of the implementation of testing principles by a test examiner who is not only knowledgeable of good testing principles but is also knowledgeable of the subject matter, its significance, and the most appropriate training vehicle for the material. Accordingly, the information presented in Section 3 should be useful to examiners in evaluating such factors as the level of knowledge and mode of testing appropriate for items. Section 4 discusses the various item types, lists issues and considerations in using each type, and provides suggestions for writing good test material regardless of the format of the test items.

1.1.5 Test Reliability and Quality Control

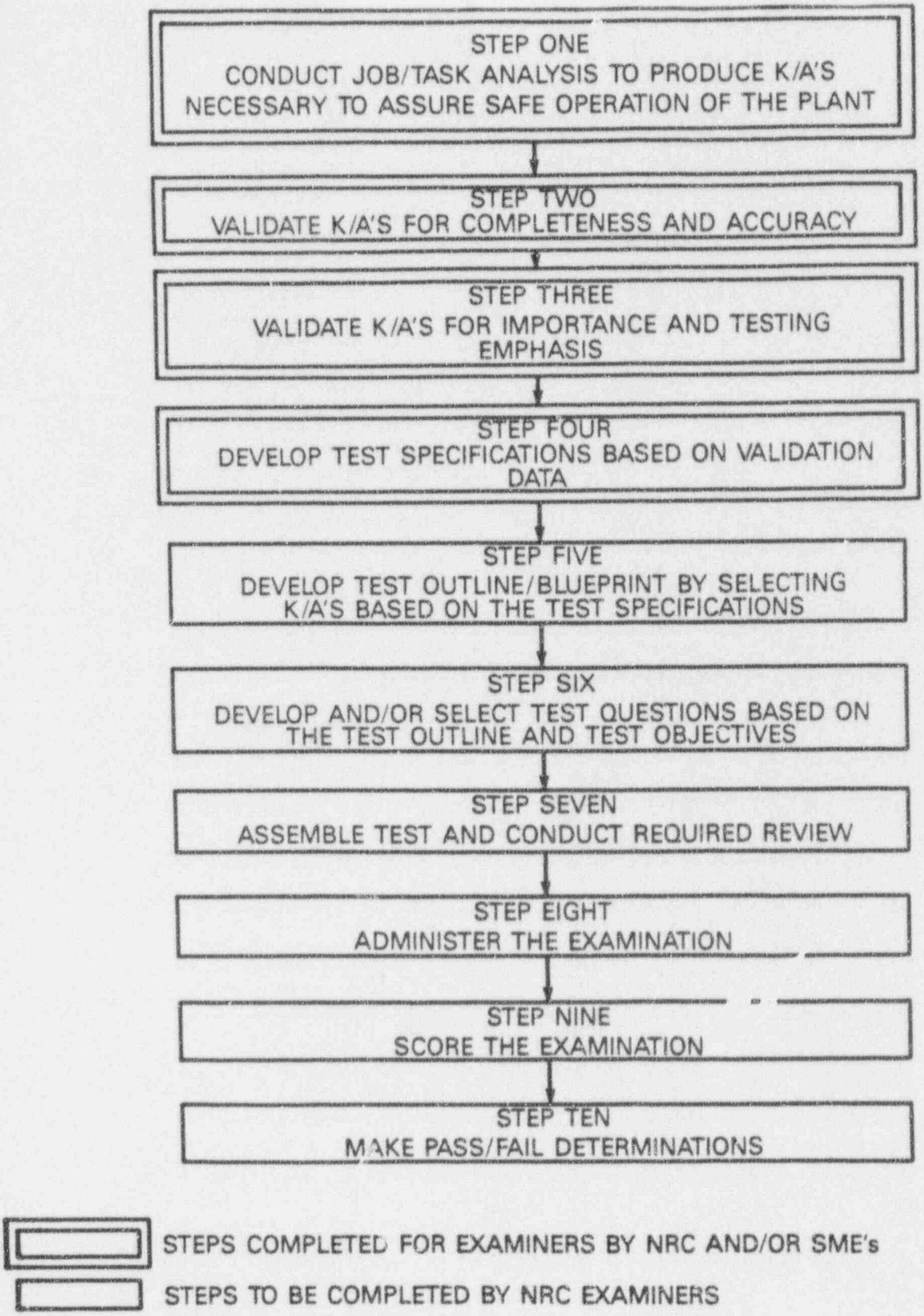
The concept of reliability refers to the making of consistent interpretations of test scores across examinations and candidates and is different from the notion of validity which emphasizes the appropriateness of the content of the NRC licensing examinations.

The higher the reliability of a test, the fewer errors will be made in determining whether candidates have passed or failed the licensing examination. Key points to be remembered in reducing scoring and interpretation errors have to do with quality control. For example, maintaining standardized examination development, administration, and grading procedures will enhance the reliability of the pass/fail decision that is made. A thorough and accurate sampling from the appropriate K/A catalog(s) according to the guidance provided by the test specifications is essential in maintaining consistency from examination-to-examination. In a sense, every section of this handbook addresses some aspect of the quality control issue. Special reference must be made to Section 2 which describes the procedures examiners are to implement to assure that NRC examinations cover the most important K/As in a comprehensive fashion from each test construction effort to the next. Please remember, this section is the most critical with regard to the procedures that need to be followed to assure the development of valid test specifications or outline. Once the test outline has been developed, Sections 3, 4, and 5 will be very useful in constructing test items that are consistent with the test specifications. Finally, Sections 4, 5, and 6 also describe ways of assuring that the candidates will be evaluated in a consistent, job-related manner.

1.1.6 Summary of Steps in Developing Licensing Examinations

The flowchart presented in Figure One illustrates the logical and preferred sequence of activities to be followed in the development of content valid licensing examinations. The purpose of the flowchart is to highlight and overview the test development enterprise and illustrate for examiners exactly where in the sequence their work and skills are critical to completing the process.

FIGURE ONE
STEPS IN DEVELOPING NRC LICENSING EXAMINATIONS



2 USE OF THE K/A CATALOG IN CONSTRUCTING LICENSING EXAMINATIONS

This section describes the structure of the knowledge and ability (K/A) catalogs for pressurized water reactors (PWRs) and boiling water reactors (BWRs) and the development of test outlines that will ensure valid, representative coverage of test content.

Any examination can only include a sample of all the relevant questions that can be asked of an RO or SRO candidate. To make maximum use of testing time and to ensure that the test adequately samples the content that might be covered, a test outline should be developed before writing individual questions or scenarios.

Use of the procedures described in this handbook will provide documentation for each question on the examination and will show how each question fits into the overall plan for the examination. Use of the procedures will also assure that the overall content of the examination samples the content from each section of the catalog in proportion to estimates of the importance of the sections assigned by subject-matter-experts.

The test outline can serve as a record of specific K/As that have been tested at a given facility. Additionally, a test outline can be used to defend the content of a particular examination, should defense become necessary, since the outline can be linked to a job/task analysis and to important K/As.

2.1 Organization of the K/A Catalogs

The structure of the K/A catalog and supplement for PWRs and the structure of the K/A catalog for BWRs are shown schematically in Tables 2.1 and 2.2. Please open the appropriate K/A catalog and refer to it as you read through the rest of this section.

Overall, the content of the PWR catalog and supplement and the BWR catalog are similar, although the location of the information within the catalogs differs. Plant-wide generic responsibilities are delineated in Section 2 and plant systems are delineated in Section 3 of both catalogs. Emergency plant evolutions are delineated in Section 3 of the PWR catalog and Section 4 of the BWR catalog. Components and fundamental theory are located in Sections 5 and 6 of the BWR catalog and in the supplement to the PWR catalog. These locations will be highlighted in the descriptions which follow.

2.1.1 Plant-wide generic knowledge and ability K/As

Plant-wide generic knowledge and ability statements are located in Section 2 of both the PWR and the BWR catalogs. These statements are primarily administrative-type job requirements with broad applicability across all plant systems or emergency (and abnormal) plant evolutions. The importance of these

Table 2.1
Structure of the PWR K/A Catalog and Supplement

PLANT-WIDE GENERIC KNOWLEDGE AND ABILITIES

SAFETY FUNCTIONS

- Plant Systems
  - Task Modes
    - Knowledge Categories
    - Ability Categories
    - System-wide Generics
- Emergency Plant Evolutions
    - Knowledge Categories
    - Ability Categories
    - System-wide Generics

COMPONENTS

THEORY
- Reactor Theory Categories
- Thermodynamics

Table 2.2
Structure of the BWR K/A Catalog

PLANT-WIDE GENERIC KNOWLEDGE AND ABILITIES

SAFETY FUNCTIONS

- Plant Systems
  - Knowledge Categories
  - Ability Categories
  - System-wide Generics

EMERGENCY AND ABNORMAL PLANT EVOLUTIONS

- Emergency Plant Evolutions
- Abnormal Plant Evolutions
  - Knowledge Categories
  - Ability Categories
  - System-wide Generics

COMPONENTS

THEORY
- Reactor Theory Categories
- Thermodynamics Categories

statements is a function of their impact on the overall operation of the entire plant rather than on any specific system. For example, the plant-wide generic knowledge statement, "Knowledge of tagging and clearance procedures," can apply to any plant system.

2.1.2 Catalog differences

Section 3 of the PWR and the BWR catalogs are organized by safety functions. However, the two catalogs display major format differences. The formats of the two catalogs are described separately in the material which follows.

2.1.3 Plant systems and emergency plant evolutions: PWR catalog, Section 3

Major safety functions must be maintained to ensure safe nuclear power plant operation. The eleven safety functions required for a PWR plant are:

Reactivity Control
RCS Inventory Control
RCS Pressure Control
RCS Heat Transport
Secondary System Heat Transport
Containment Integrity
Electrical
Control Air
Instrumentation
Auxiliary Thermal
Indirect Radioactivity Release Control

In the PWR catalog and supplement, the K/As are organized within the 11 safety functions. Each safety function contains both plant systems and emergency evolutions. There are a total of 45 plant systems and 38 emergency evolutions, each with its associated K/As. Every system has an INPO JTA identifying number. Emergency plant evolutions (EPEs) are linked to more than one plant system and are included in the safety functions after the plant systems. The first three digits for emergency evolutions have been designated by the generic system number of "000." However, each EPE also has a unique three digit number that corresponds with those numbers used in the INPO JTA.

Table 2.3 shows the names of each PWR plant system and emergency plant evolution organized within the 11 safety functions. Four plant systems that are included in two safety functions are denoted by an asterisk (*).

Table 2.3
PWR Plant Systems and Emergency Plant Evolutions
by Safety Function

Safety Function I: Reactivity Control Systems and Malfunctions

Plant Systems
- Control rod drive system (CRDS)
- *Chemical and volume control system (CVCS)
- Rod position indication system (RPIS)

Emergency Plant Evolutions
- Continuous rod withdrawal
- Dropped control rod
- Inoperable/stuck control rod
- Reactor trip
- Emergency boration
- Anticipated transient without scram (ATWS)

Safety Function II: RCS Inventory Control Systems and Malfunctions

Plant Systems
- *Reactor coolant system (RCS)
- *Chemical and volume control system
- *Emergency core cooling system (ECCS)
- Pressurizer level control system (PZR LCS)
- Engineered safety features actuation system (ESFAS)

Emergency Plant Evolutions
- Loss of reactor coolant makeup
- Pressurizer level malfunction

Safety Function III: RCS Pressure Control Systems and Malfunctions

Plant Systems
- *Emergency core cooling system
- Pressurizer pressure control system (PZR PCS)

Emergency Plant Evolutions
- Pressurizer vapor space accident
- Small break LOCA
- Large break LOCA
- Pressurizer pressure control system malfunction
- Steam generator tube leak
- Steam generator tube rupture

Safety Function IV: RCS Heat Transport Systems and Malfunctions

Plant Systems
- *Reactor coolant system
- Reactor coolant pump system (RCPS)
- Residual heat removal system (RHRS)
- *Steam generator system (S/GS)

Emergency Plant Evolutions
    Reactor coolant pump malfunctions
    Loss of residual heat removal system
    Inadequate core cooling

Safety Function V: Secondary System Heat Transport Systems and Malfunctions

Plant Systems
    *Steam generator system
    Main and reheat steam system (MRSS)
    Steam dump system (SDS)/turbine bypass control
    Main turbine generator (MT/G) system
    Condenser air removal system (CARS)
    Condensate system
    Main feedwater (MFW) system
    Auxiliary/Emergency feedwater (AFW) system
    Service water system (SWS)
    Emergency Plant Evolutions
        Steam line rupture
        Loss of condenser vacuum
        Loss of main feedwater

Safety Function VI: Containment Integrity Systems and Malfunctions

Plant Systems
    Pressurizer relief tank/quench tank system (PRTS)
    Containment cooling system (CCS)
    Ice condenser system
    Containment spray system (CSS)
    Containment iodine removal system (CIRS)
    Hydrogen recombiner and purge control system (HRPS)
    Containment system
Emergency Plant Evolutions
    Loss of containment integrity

Safety Function VII: Electrical Systems and Malfunctions

Plant Systems
    A.C. electrical distribution system
    D.C. electrical distribution system
    Emergency diesel generator (ED/G) system
Emergency Plant Evolutions
    Loss of offsite and onsite power
    Loss of offsite power
    Loss of vial A.C. electrical instrument bus
    Loss of D.C. power

Safety Function VIII: Control Air Systems and Malfunctions

Plant Systems
    Instrument air system (IAS)
    Station air system (SAS)

Emergency Plant Evolutions
- Loss of instrument air
- Control room evacuation

Safety Function IX: Instrumentation Systems and Malfunctions

Plant Systems
- Reactor protection system (RPS)
- Nuclear instrumentation system (NIS)
- Non-nuclear instrumentation system (NNIS)
- In-core temperature monitor (ITM) system
- Area radiation monitoring (ARM) system
- Process radiation monitoring (PRM) system

Emergency Plant Evolutions
- Loss of source-range nuclear instrumentation
- Loss of intermediate-range instrumentation
- Area radiation monitoring system alarms

Safety Function X: Auxiliary Thermal Systems and Malfunctions

Plant Systems
- Component cooling water system (CCWS)
- Circulating water system

Emergency Plant Evolutions
- Loss of component cooling water
- Loss of nuclear service water

Safety Function XI: Indirect Radioactivity Release Control Systems and Malfunctions

Plant Systems
- Containment purge system (CPS)
- Spent fuel pool cooling system (SFPCS)
- Fuel handling equipment system (FHES)
- Liquid radwaste system (LRS)
- Waste gas disposal system (WGDS)
- Fire protection system (FPS)

Emergency Plant Evolutions
- Fuel handling incident
- Accidental liquid radioactive waste release
- Accidental gaseous-waste release
- Plant fire on site
- High reactor coolant activity

Tasks underlying each system have been combined into between one and five task modes:

Generic (000)
Startup/Shutdown (010)
Normal Operations (020)
Mode Change (030)
What If/Abnormal (050)

The generic task mode is the first mode listed for a particular plant system. The generic K/As are those job requirements which were judged to be applicable to all of the tasks within that system. Most systems in the catalog delineate K/As for just the generic mode.

Below each task mode is a list of INPO JTA tasks (e.g., Deenergize a CRDM). These tasks generally require similar knowledge and abilities. The task lists may provide a context within which to develop operationally oriented questions related to the associated K/As.

The K/As for each plant system are organized into six knowledge categories and four ability categories. Each K/A category has a unique number. Table 2.4 contains the K/A categories for the PWR plant systems.

Fifteen knowledge and abilities have been identified as generic to all systems. They are generally administrative in nature. Unlike the plant-wide generic statements in Section 2 of the PWR Catalog, the system-wide generic statements derive their importance in relation to their impact on the operation of specific systems within the plant. Therefore, the system-wide generic (SG) K/As are repeated at the end of the K/As for each plant system in the PWR Catalog.

Following the plant systems, the related emergency plant evolutions (EPEs) are included in each safety function. Table 2.3 lists the EPEs included within each safety function. There are only three knowledge categories and two ability categories for the EPEs. Table 2.5 contains a list of the K/A categories for the EPEs.

Table 2.4
Knowledge and Ability Categories for PWR Plant Systems

K1 Knowledge of the physical connections and/or cause-effect relationships between the (SYSTEM) and the following systems:

K2 Knowledge of bus power supplies to the following:

K3 Knowledge of the effect that a loss of the (SYSTEM) will have on the following:

K4 Knowledge of (SYSTEM) design feature(s) and/or interlocks which provide for the following:

K5 Knowledge of the following theoretical concepts as they apply to the (SYSTEM):

K6 Knowledge of the applicable performance and design attributes of the following (SYSTEM) components:

A1 Ability to predict and/or monitor changes in parameters (to prevent exceeding design limits) associated with operating the (SYSTEM) controls including:

A2 Ability to (a) predict the impacts of the following malfunctions or operations on the (SYSTEM); and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:

A3 Ability to monitor automatic operation of the (SYSTEM) including:

A4 Ability to manually operate and/or monitor in the control room:

Table 2.5
Knowledge and Ability Categories for
PWR Emergency Plant Evolutions

EK1	Knowledge of the following theoretical concepts as they apply to the emergency task:
EK2	Knowledge of the following components:
EK3	Knowledge of the basis or reasons for the following:
EA1	Ability to operate and monitor the following:
EA2	Ability to determine and interpret:

Twelve knowledge and abilities have been identified as generic to all emergency plant evolutions. The 12 system-wide generic K/As are repeated following each emergency plant evolution in the PWR Catalog as they derive their importance in relation to the specific emergency evolutions.

2.1.4 Plant systems and emergency and abnormal plant evolutions: BWR catalog, Sections 3 and 4

Major safety functions must be maintained to ensure safe nuclear power plant operation. The nine safety functions required for a BWR plant are:

Reactivity Control
Reactor Water Inventory Control
Reactor Pressure Control
Heat Removal from Reactor Core
Containment Integrity
Electrical
Instrumentation
Plant Service Systems
Radioactivity Release

Fifty-four plant systems have been included in Section 3 of the BWR catalog based on their relationship and importance to the safety functions. Table 2.6 contains a list of these plant systems by safety function. Ten plant systems each contributing to two safety functions are denoted by an asterisk (*). Each plant system has a six-digit code number. The first three digits are the same as those used by INPO to identify the related SYSTEM/DUTY area.

Table 2.6
BWR Plant Systems by Safety Function

Safety Function I: Reactivity Control

201001	Control rod drive hydraulic system
201003	Control rod and drive mechanism
201002	Reactor manual control system
202002	Recirculation flow control system
202001	*Recirculation system
201005	*Rod control and information system
211000	Standby liquid control system

Safety Function II: Reactor Water Inventory Control

206000	*High pressure coolant injection system
209002	*High pressure core spray system
209001	*Low pressure core spray system
256000	Reactor condensate system
217000	*Reactor core isolation cooling system
259001	Reactor feedwater system
204000	Reactor water cleanup system
259002	Reactor water level control system
203000	*RHR/LPCI: Injection mode (Plant-specific)

Safety Function III: Reactor Pressure Control

218000	Automatic depressurization system
239001	*Main and reheat steam system
241000	Reactor/turbine pressure regulating system
239002	Relief/safety valves

Safety Function IV: Heat Removal From Reactor Core

206000	*High pressure coolant injection system
209002	*High pressure core spray system
207000	Isolation (emergency) condenser
209001	*Low pressure core spray system
239001	*Main and reheat steam system
245000	Main turbine generator and auxiliary systems
217000	*Reactor core isolation cooling system
202001	*Recirculation system
203000	*RHR/LPCI: Injection mode (Plant-specific)
205000	Shutdown cooling system (RHR shutdown cooling mode)

Table 2.6 (Continued)
BWR Plant Systems by Safety Function

Safety Function V: Containment Integrity

223001 Primary containment system and auxiliaries
223002 Primary containment isolation system/Nuclear steam supply shut-off
290002+ *Reactor vessel internals
219000 RHR/LPCI: Torus/suppression pool cooling mode
226001 RHR/LPCI: Containment spray system mode
230000 RHR/LPCI: Torus/suppression pool spray mode
290001+ Secondary containment

Safety Function VI: Electrical

262001 A.C. electrical distribution
263000 D.C. electrical distribution
264000 Emergency generators (diesel/jet)
262002 Uninterruptable power supply (A.C./D C.)

Safety Function VII: Instrumentation

215005 Average power range monitor/local power range monitor system
215003 Intermediate range monitor system
216000 Nuclear boiler instrumentation
272000 *Radiation monitoring system
212000 Reactor protection system
215002 Rod block monitor system
201005 *Rod control and information system
214000 Rod position information system
201004 Rod sequence control system (Plant specific)
201006 Rod worth minimizer system (RWM) (Plant specific)
215004 Source range monitor (SRM) system
215001 Traversing in-core probe

Safety Function VIII: Plant Service Systems

286000 Fire protection system
234000 Fuel handling equipment

Safety Function IX: Radioactivity Release

239003 MSIV leakage control system
271000 Offgas system
288000 Plant ventilation systems
272000 *Radiation monitoring system
268000 Radwaste
290002+ *Reactor vessel internals
233000 Fuel pool cooling and clean-up
261000 Standby gas treatment system
290003+ Control room heating, ventilating and air conditioning

+This system number does not correspond to an INPO SYSTEM/DUTY area number.

Tasks listed are INPO JTA tasks (e.g., Perform lineups on the system). These tasks generally require similar knowledge and abilities. The task lists may provide a context within which to develop operationally oriented questions related to the associated K/As.

The information listed within each plant system is organized into six knowledge categories and four ability categories. Each K/A category has a unique number. The knowledge and ability categories for the BWR plant systems are listed in Table 2.7.

Table 2.7
Knowledge and Ability Categories for BWR Plant Systems

KI Knowledge of the physical connections and/or cause-effect relationships between (SYSTEM) and the following:

K2 Knowledge of electrical power supplies to the following:

K3 Knowledge of the effect that a loss or malfunction of the (SYSTEM) will have on the following:

K4 Knowledge of (SYSTEM) design feature(s) and/or interlocks which provide for the following:

K5 Knowledge of the operational applications of the following concepts as they apply to (SYSTEM):

K6 Knowledge of the effect that a loss or malfunction of the following will have on the (SYSTEM):

A1 Ability to predict and/or monitor changes in parameters associated with operating the (SYSTEM) including:

A2 Ability to (a) predict the impacts of the following on the (SYSTEM) and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those abnormal conditions or operations:

A3 Ability to monitor automatic operations of the (SYSTEM) including:

A4 Ability to manually operate and/or monitor in the control room:

A set of fifteen knowledge and abilities have been identified as generic to all systems. They are generally administrative in nature. Unlike the plant-wide generic statements in Section 2 of the BWR Catalog, the system-wide generic statements derive their importance in relation to their impact on the operation of specific systems within the plant. The fifteen system-wide generic K/As are repeated at the end of each plant system included in the BWR Catalog.

Section 4 of the BWR Catalog contains 15 emergency plant evolutions and 23 abnormal plant evolutions (E/APEs). The listing of emergency and abnormal plant evolutions was developed to include integrative situations crossing several plant systems and/or safety functions. An emergency plant evolution is any condition, event or symptom which leads to entry into Emergency Procedures Guidelines (EPGs). An abnormal evolution is any degraded condition, event or symptom not directly leading to an EPG entry condition nor related to an operational condition such as power operation, start-up, hot shut down, cold shut down, and refuel. Table 2.8 contains an alphabetical list of the emergency and abnormal plant evolutions included in Section 4 of the BWR Catalog.

Table 2.8
Emergency and Abnormal Plant Evolutions
Delineated in the BWR Catalog

EMERGENCY PLANT EVOLUTIONS

High Containment Temperature (Mark III only)
High Drywell Pressure
High Drywell Temperature
High Off-site Release Rate
High Reactor Pressure
High Secondary Containment Area Radiation Levels
High Secondary Containment Area Temperature
High Suppression Pool Water Level
Low Suppression Pool Water Level
Reactor Low Water Level
Scram Condition Present and Reactor Power Above
APRM Downscale or Unknown
Secondary Containment High Differential Pressure
Secondary Containment High Sump/Area Water Level
Secondary Containment Ventilation High Radiation
Suppression Pool High Water Temperature

ABNORMAL PLANT EVOLUTIONS

Control Room Abandonment
High Containment Temperature (Mark III only)
High Drywell Pressure
High Drywell Temperature
High Off-site Release Rate
High Reactor Pressure
High Reactor Water Level
High Suppression Pool Temperature
Inadvertent Containment Isolation
Inadvertent Reactivity Addition

Table 2.8 (Continued)

Incomplete SCRAM
Loss of CRD Pumps
Loss of Main Condenser Vacuum
Loss of Shutdown Cooling
Low Reactor Water Level
Main Turbine Generator Trip
Partial or Complete Loss of A.C. Power
Partial or Complete Loss of Component Cooling Water
Partial or Complete Loss of D.C. Power
Partial or Complete Loss of Forced Core Flow Circulation
Partial or Complete Loss of Instrument Air
Refueling Accidents
Scram

There are three knowledge categories and two ability categories for the E/APEs. The K/As for the emergency and abnormal plant evolutions are listed in Table 2.9.

Table 2.9
Knowledge and Ability Categories for
BWR Emergency and Abnormal Plant Evolutions

E/AK1 Knowledge of the operational implications of the following concepts as they apply to (EMERGENCY OR ABNORMAL PLANT EVOLUTION):

E/AK2 Knowledge of the interrelations between (EMERGENCY OR ABNORMAL PLANT EVOLUTION) and the following:

E/AK3 Knowledge of the reasons for the following responses as they apply to (EMERGENCY OR ABNORMAL PLANT EVOLUTION):

E/AAI Ability to operate and/or monitor the following as they apply to (EMERGENCY OR ABNORMAL PLANT EVOLUTION):

E/AA2 Ability to determine and/or interpret the following as they apply to (EMERGENCY OR ABNORMAL PLANT EVOLUTION):

Finally, 12 knowledge and abilities have been identified as generic to all emergency and abnormal plant evolutions. The 12 system-wide generic K/As are repeated following each emergency and abnormal plant evolution in the BWR Catalog as they derive their importance in relation to the specific emergency evolutions.

2.1.5 Components

Basic components such as valves and pumps are found in many systems. The following eight categories of components, for which additional K/As are presented, are delineated in Appendix A of the PWR Catalog and Supplement and Section 5 of the BWR Catalog. These additional K/As are more detailed or specific than those appropriate for system listings, yet at the same time they are generic to the component types. Each component has a unique six-digit code number.

- Valves
- Sensors/Detectors
- Controllers and Positioners
- Pumps
- Motors and Generators
- Heat Exchangers and Condensers
- Demineralizers and Ion Exchangers
- Breakers, Relays and Disconnects

2.1.6 Theory

Fundamental theoretical knowledge which underlies safe performance on the job is delineated in Appendix B of the PWR Catalog and Supplement and in Section 6 of the BWR Catalog. Each theory topic has a unique six-digit code number.

Reactor Theory

- Neutrons
- Neutron Life Cycle
- Reactor Kinetics and Neutron Sources
- Reactivity Coefficients
- Control Rods
- Fission Product Poisons
- Fuel Depletion and Burnable Poisons
- Reactor Operational Physics

Thermodynamics

- Thermodynamic Units and Properties
- Basic Energy Concepts
- Steam
- Thermodynamic Processes
- Thermodynamic Cycles
- Fluid Statics
- Heat Transfer and Heat Exchanges
- Thermal Hydraulics
- Core Thermal Limits
- Brittle Fracture and Vessel Thermal Stress

The topic areas listed above in Section 2.1.5 and 2.1.6 are covered by the Generic Fundamentals Exam Section. They are listed here for information only and will not be included in the exam construction discussion.

2.1.7 RO/SRO importance ratings of K/As

Each K/A in the PWR Catalog and Supplement and the BWR Catalog has been rated by subject matter experts as to its importance in terms of safety, including the control of reactor power as well as the prevention and mitigation of accidents. Importance includes the direct and indirect impact of the K/A on safe plant operations in a manner ensuring personnel and public health and safety. K/As were rated for importance to safety, for both RO and SRO positions, using the following scale:

5 = essential
4 = very important
3 = fairly important
2 = limited importance
1 = insignificant importance

The average importance ratings are listed to the right of each K/A in the catalogs. As you will note some importance ratings are flagged with either an asterisk (*) or a question mark (?). Ratings marked with an asterisk indicate that subject matter experts varied considerably with respect to their opinion about the importance of that K/A. An asterisk can also signify that more than 15 percent of the raters indicated that the knowledge or ability is not required for the RO or SRO position at their plant because it is the responsibility of someone else (e.g., SRO vs. RO). A question mark indicates that more than 15 percent of the raters felt that they were not familiar with the knowledge or ability as related to the particular system or design feature. These marks highlight the need for examiners to carefully review plant-specific materials to determine whether or not that knowledge or ability is indeed appropriate for a given facility.

2.1.8 Plant specific data

In the BWR Catalog, some K/A statements apply only to specific BWR plants with applicable design features. These statements appear with a colon (:) and are followed by plant identifying information. For example, if a statement applies to containment, it may refer only to plants with Mark I, or II, or III containment vessels. The statement would then be followed by ": Mark I, or II, or III". Some statements are followed by ": Plant-specific" indicating that they relate to a particular plant or a group of plants regardless of design or containment.

2.1.9 Difference ratings

In the BWR Catalog, a dagger (+) to the left of an individual knowledge or ability statement indicates that more than 20% of the raters indicated that the level of knowledge or ability required by an SRO is different than the level of knowledge or ability required by an RO.

2.2 Developing a Test Outline

This section describes a procedure for selecting K/As from the PWR Catalog and Supplement and the BWR Catalog to develop a test outline. A test outline includes the list of K/As selected as the basis for examination item development, the location of each K/A in the catalog and its importance rating.

The development of a test outline is a vital step in any content-valid testing process. The outline may be considered a sample plan for the actual construction of the items for the examination. The test outline provides:

-- an explicit, documented link between each question or exam topic and one (or more) K/As that have been verified as relevant and important, based on the job/task analysis;

-- assurance that the total array of test questions/topics samples from all relevant job content. Omitting the planning involved in developing a test outline risks an imbalance in test content. Imbalance can occur in two ways First, deficiencies may exist in test content if important topic areas are untested. Second, irrelevancies may exist in test content if topics are included that have minimal or no relationship to the purpose of the exam -- the assessment of K/As that will assure safe and competent operator performance; and

-- consistency in the way exams are developed across administrations, examiners, and regions. This consistency will help reduce biases in exam content due to individual examiner likes and dislikes. It will also help ensure that all licensing decisions are based on candidate performance on the same body of knowledge and ability, even though specific topics covered on individual exams will differ.

The specific procedures to develop a test outline described below are intended to be clear-cut and easy to follow. These procedures are not intended to dictate how many K/As or which K/As should be included in any outline. Rather, this handbook, current guidance including 10 CFR 55 and NUREG - 1021, plant-specific priorities, and the examiner's knowledge of RO/SRO responsibilities in ensuring the safe operation of the plant all contribute to making these decisions.

2.2.1 Using the test outline forms to develop the written exam

The test outline forms, located at the end of this section, include: (1) an Examination Outline Model leading to a sample plan for the overall outline of the written examination; and (2) a Knowledge and Ability (K/A) Record Form. Completion of the K/A Record Form makes it possible to trace specific items in the examination to K/As in the catalog, thereby ensuring that topics included are important and relevant. The Examination Outline Model provides an efficient method to scan the content of the catalog and to ensure well-balanced coverage across the examination items.

Separate sets of test outline forms have been included in this handbook, reflecting the differences in the specific responsibilities of ROs and SROs at PWR and BWR facilities. These differences affect the overall sample plan which serves as the basis for K/A selection and examination item construction. However, the directions for using the sets of forms are the same regardless of job position or plant type.

2.2.2 Specific procedures for developing a test outline or sample plan.

The following procedures presume familiarity with the layout and general content of the catalog. In order to develop a sample plan from which to develop a written licensing examination, review the appropriate Examination Outline Model for the facility type and the job position of the candidate. Then, after reviewing the model, identify and record on the K/A Record Form all of the plant-specific test priorities you may wish to include in the examination. Using the general guidance which has been developed, select K/As from the various sections of the catalog and complete the remainder of the K/A Record Form. Finally, review the balance of coverage for the written examination as indicated by the specific K/As which have been included in the sample plan. These procedures are described in detailed below.

2.2.2.1 **Review the Examination Outline Model**

The Examination Outline Models have been developed to guide the construction of all written licensing examinations. Please refer to the version of the Examination Outline Model corresponding to the exam you are developing. Models for each reactor type and position level are located at the end of this section of the Handbook on pages 2-24, 2-33, 2-42, and 2-51. The exact structure of the model affects the overall composition of the written examination in terms of testing emphasis and K/A content selection.

The Examination Outline Model is a three-tiered structure parallel to the structure of the K/A catalog. In the case of the BWR Catalog, each layer of the model matches a specific section of the catalog. In the case of the PWR Catalog and Supplement, each layer of the model matches either a specific section of the material or readily identifiable content across several sections of the material.

The first tier of the model provides information regarding the selection of K/As related to plant-wide generic responsibilities. (Plant-wide generic statements are located in Section 2 of both the PWR Catalog and Supplement and the BWR Catalog.) Included in the model is the percentage of the total written examination which is to be derived from the array of plant-wide generic statements. For example, approximately 13% of the total point value of the written examination for BWR ROs should be based on the plant-wide generic K/As.

The second tier of the model provides information regarding the selection of K/As related to the plant systems in the facilities. (Plant system K/As are located in Section 3 of both the PWR Catalog and Supplement and the BWR Catalog.) All of the plant systems included in each catalog are listed in one of three groups within the tier. The placement of each plant system into one of the groups reflects the testing emphasis to be given to that system. The content of Group 1 is given greater emphasis than the content of Group 2 and, in turn, Group 2 content is given greater emphasis than Group 3 content. Therefore, a K/A for a Group 1 plant system has a greater likelihood of being included in an examination than a K/A for either a Group 2 or Group 3 plant system.

Two sets of guidelines are provided within the model with regard to the testing of plant system K/As. First, the percentage of the total written examination to be derived from all of the plant systems K/As is indicated. Second, the percentage of the total written examination to be derived from the plant systems within each system group is indicated. For example, approximately 51% of the total written examination for ROs at BWR facilities should be based on K/As delineated within the plant systems section of the catalog. More specifically, however, 28% of the total written examination should be derived from the K/As delineated in connection with the 25 plant systems included in Group 1; 19% in connection with the 22 plant systems included in Group 2; and 4% in connection with the 7 plant systems included in Group 3.

The third tier of the model provides information regarding the selection of K/As related to emergency (and abnormal) plant evolutions in the facilities. (Emergency plant evolutions are delineated in Section 3 of the PWR Catalog and Supplement and emergency and abnormal plant evolutions are delineated in Section 4 of the BWR Catalog.) All of the evolutions included in each catalog are listed in one of the groups included within this tier. As described in connection with the plant systems, placement of an emergency plant evolution into a group reflects the testing emphasis to be given to the K/As associated with the emergency evolution. That is, material in Group 1 has a higher probability of being incorporated in a licensing exam than material in Group 2 or Group 3. Similarly, material in Group 2 has a proportionately greater testing emphasis than material in Group 3.

The third tier of the Examination Outline Model includes two guidelines similar to those in the second tier. First, the overall proportion of the written test to be derived from K/As related to the emergency (and abnormal) plant evolutions is indicated. Second, the percentage of the overall written examination to be derived from the evolutions within each group is indicated. For example, for the RO position in BWR facilities, approximately 36% of the total written licensing examination should be drawn from K/As related to emergency and abnormal plant evolutions. However, 13% of the written exam should be derived from the 11 evolutions in Group 1, 19% percent from the 22 evolutions in Group 2, and 4% from the 5 evolutions included in Group 3.

2.2.2.2 **Identify plant-specific test priorities**

Before selecting K/As to include in the test outline, you should identify any plant-specific, high priority items that you may want to include in the licensing examination. High priority events, systems, problems, or new technology developments are all potential topics for an examination. Items identified as plant-specific test priorities should be based on such considerations as (1) relevant recent licensee event reports (LERs) or other incident reports that reflect operator K/As, (2) system modifications or new procedures that have been implemented at the plant, and/or (3) any other testable areas excluded from other examinations over the past two years. However, your list of high-priority topics need not be too extensive, nor is it necessary to identify high-priority topics for every examination. As you identify a high-priority topic, make a decision about where in the exam it might be tested, and note the topic on the appropriate page of the K/A Record Form. For example, if you decide that one high-priority item you have identified is best tested as part of the emergency (and abnormal) plant evolution section of the exam, write the topic down on that part of K/A Record Form used to record emergency (and abnormal) plant evolution K/As. If you decide that a recent system modification would be best tested as part of the plant systems section of the examination, note the topic on the K/A Record Form for that section of the exam.

Once you have identified all plant-specific priority topics, look through the catalog to locate a K/A that corresponds to each topic. First, locate the appropriate section of the catalog in which you expect to find the topic. Then, review the K/A categories and the individual K/As in that section of the catalog to find the specific one that best represents the topic. If you find two or more K/A statements that represent your topic, select the one that you feel is more specific to your topic or more accurate. Finally, complete the required information on the appropriate part of the K/A Record Form as described below.

2.2.2.3 **Review the general guidance for the selection of K/As**

As you review the catalog to locate K/As for construction of the examination, keep in mind the following general criteria:

Importance

Importance is determined on the basis of the importance ratings listed in the catalog and any plant-specific priorities you have previously identified. You should select K/As from the catalog in accordance with their importance ratings; that is, K/As with the highest average importance ratings should be selected first.

PLEASE NOTE: The average importance rating reflects the judgments of subject matter experts as to the contribution that the K/A makes to the performance of the RO and SRO in a manner assuring the safe operation of the plant and public and personnel health and safety. These ratings can range from a "5" which represents a knowledge or ability essential to the safe operation of the plant and public and personnel health and safety to a "1" indicating a knowledge or ability considered insignificant with regard to assuring the safe operation of the plant and public and personnel health and safety. In making selections, you should use K/As with ratings of at least 2.5. K/As with importance ratings less than 2.5 can be used, but justification for their inclusion must be based on other information beyond that contained in the catalog. That is, K/As with ratings less than 2.5 can be selected provided that their plant specific importance can be documented or that they can be clearly traced to licensee event reports (LERs) and/or other operational data available from the plant. It is also required that the selection and documentation of K/As with ratings less than 2.5 be approved by the Section Leader.

A final point to consider with regard to the importance issue is to review the selected K/As that are marked by either an asterisk or "Plant-specific". The purpose of this review is to assure the importance and applicability of the selected K/As to the plant by making a special effort to check them against the plant reference material.

Differentiation

In addition to being important, a K/A should lead to an examination item which differentiates between competent and less-than-competent candidates. Try to select a high percentage of K/As that will differentiate among candidates in terms of their competence. Additional guidance on developing differentiating items is provided in later sections 3 and 4 of this handbook.

Job level

Different Examination Outline Models have been developed for guiding the selection of K/As for testing ROs and SROs. The models reflect differences in the testing emphasis related to the specific responsibilities of the ROs and the SROs. Each model contains information about the relative percentages of the examination that are to be related to each section of the catalog and more specific information about the breakdown of the selections within each section of the catalog.

If you are developing an examination for a BWR facility, you may find it useful to consider the K/As which are flagged by a dagger (+) because (as was noted previously) these K/As were judged to represent different levels of either knowledge or ability for the RO and the SRO. The examination items developed from these K/As should be different at the RO and the SRO levels.

Operationally oriented

Choose K/As that have an explicit, operationally oriented basis. Even when selecting K/As for the theory sections of your exams, pick K/As that have a direct link to safe and competent operator performance. The task list at the beginning of each system can help you tie individual K/As to operator performance by providing an operational base to the K/As. Review the task lists before you review the K/As which have been delineated for each system.

Selecting K/As for the written exam

When selecting K/As for the written examination, remember that:

-- written examinations are especially useful for testing K/As that are difficult to judge on the basis of behavior alone (e.g., trying to determine certain aspects of candidate knowledge of basic reactor theory from performance on the simulator examination);

-- written examinations are appropriate for testing written abilities and skills (e.g., steam table calculations);

-- written examinations are appropriate for testing factual information.

There are no hard and fast rules regarding the choice of exam mode for specific knowledge or ability categories. In general, knowledge statements can easily be tested on the written examination. However, ability statements may also be tested on the written examination.

2.2.2.4 Select K/As and complete the K/A Record Form

The following guidance is for the selection of specific K/As in each section of the catalog. Refer to the appropriate page of the K/A Record Form corresponding to the examination you are developing as you read these instructions. See the pages following the Examination Outline Models on pages 2-26, 2-36, 2-46, and 2-56, for samples of these K/A Record Forms.)

PLEASE NOTE: When you actually construct an examination, there is no predetermined sequence for completing the pages of the K/A Record Form.

Plant-wide generic K/As

Review the entire list of 33 plant-wide generic K/A statements. Select enough K/As to generate items for the written examination. The percentage of points on the written exam related to this material is indicated on the Examination Outline Model and on the K/A Record Form. In order to complete the K/A Record Form, you have only to check the numbers of the statements you wish to use to generate the actual items. The importance rating of each K/A statement has already been recorded in the appropriate column. If you have identified any plant-specific priorities in this area, be sure to check the most appropriate K/As in order to cover the topics.

Plant systems

Review the names of the plant systems in Groups 1, 2, and 3 as they appear on the K/A Record Form. Turn to the appropriate section of the catalog and select enough K/As for the plant systems in each group to generate items for the written examination. (Later on, you will have to locate plant reference material in order to develop questions from the K/As. Therefore, it may be helpful to select additional K/As to use in case the necessary plant reference material is not available.) The percentage of the written examination to be related to the K/As for the plant systems in each group is indicated on the Examination Outline Model and repeated on the K/A Record Form.

When selecting K/As related to plant systems, select at least one topic from every K/A category. That is, select at least one KI topic, one K2 topic, one K3 topic, etc., and one AI topic, one A2 topic, etc., and one system-generic topic. As the K/As with the highest importance ratings generally fall into the K3, A4, and system-wide generic categories, you may wish to emphasize these categories in any additional sampling required to complete the K/A Record Form. Finally, select K/A topics from many systems. Avoid selecting more than two or three K/A topics from one given system unless they are specifically related to plant specific priorities. If you have identified plant-specific priorities in this area, be sure to select K/As that correspond to the priorities.

To record your K/A selection, fill in the system number, the K/A number, a brief summary statement of the topic, and the importance rating as it appears in the catalog for the job level of the exam you are developing.

Emergency (and abnormal) plant evolutions

Review the names of the emergency (and abnormal) plant evolutions in each group as they appear on the K/A Record Form. Turn to the appropriate section of the catalog and select enough K/As for the evolutions in each group to generate examination items. Because of the difficulty in locating plant reference materials, you may wish to identify extra K/As at this time. The percentage of the written examination to be related to K/As in each group of emergency (and abnormal) plant evolutions is indicated on both the Examination Outline Model and on the K/A Record Form. When selecting K/As related to emergency and abnormal plant evolutions, select at least one topic in every K/A category. That is, select at least one E/A K1, one E/A K2, etc., one E/A AI, etc., and one system-wide generic statement. Generally, the statements in the K2 and the system-wide generic categories have the highest importance ratings. Therefore, you may wish to emphasize the K/As from these categories when selecting additional topics. Finally, select topics from many evolutions. Avoid selecting more than two or three K/As from a specific plant evolution unless they relate to a plant specific priority. Be sure to select K/As to match any plant-specific priorities you may have noted.

To record your K/A selection, complete the E/A plant evolution number. The K/A number, a brief summary statement of the topic, and the importance rating as it appears in the catalog for the job level of the exam you are developing.

2.2.2.5 **Check the K/As for balance of coverage**

As you near completion of the test sample plan, check the adequacy and balance of test content coverage. Consider the coverage outlined across the three separate sections of the K/A Record Form as well as the coverage within each section of the form.

2.2.3 Summary of procedures for developing a test outline or sample plan:

1. Review the appropriate Examination Outline Model for the licensing examination you are developing.

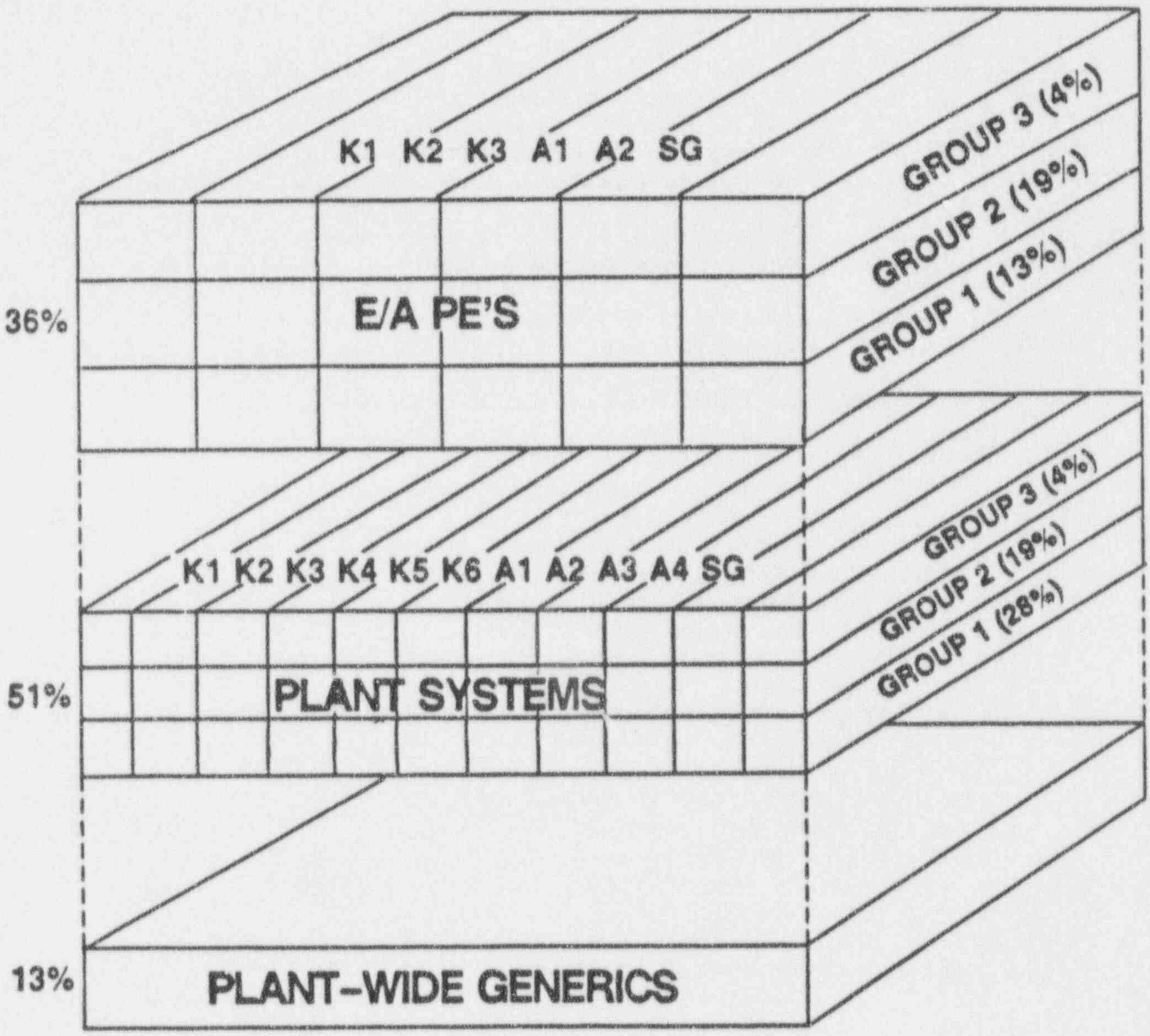
2. Identify plant specific priorities.

3. Review the general guidance for the selection of K/As including information regarding differentiation, job level, operational orientation, and selection of K/As for written examinations.

4. Select the K/As for each of the three tiers of the outline and complete the K/A Record Form.

5. Check the K/As for balance of coverage.

SAMPLE PLAN
BWR – REACTOR OPERATOR



Knowledge and Abilities Record Form
PLANT-WIDE GENERIC RESPONSIBILITIES
BWR - Reactor Operator - 13%

Check if included	294001 K/A #	Statement	Rating
________	K1.01	Knowledge of how to conduct and verify valve lineups.	3.7
________	K1.02	Knowledge of tagging and clearance procedures.	3.9
________	K1.03	Knowledge of 10 CFR 20 and related facility radiation control requirements.	3.3
________	K1.04	Knowledge of facility ALARA program.	3.3
________	K1.05	Knowledge of facility requirements for controlling access to vital/control areas.	3.2
________	K1.06	Knowledge of safety procedures related to rotating equipment.	3.2
________	K1.07	Knowledge of safety procedures related electrical equipment.	3.3
________	K1.08	Knowledge of safety procedures related to high temperature.	3.1
________	K1.09	Knowledge of safety procedures related to high pressure.	3.4
________	K1.10	Knowledge of safety procedures related to caustic solutions.	3.1
________	K1.11	Knowledge of safety procedures related to chlorine.	2.9*
________	K1.12	Knowledge of safety procedures related to noise.	2.7
________	K1.13	Knowledge of safety procedures related to oxygen-deficient environment.	3.2
________	K1.14	Knowledge of safety procedures related to confined spaces.	3.2
________	K1.15	Knowledge of safety procedures related to hydrogen.	3.4
________	K1.16	Knowledge of facility protection requirements, including fire brigade and portable fire-fighting equipment usage.	3.5
________	K1.17	Knowledge of the equipment rotation schedules and the reasoning behind the rotation procedure.	2.3

Check if included	294001 K/A #	Statement	Rating
_______	A1.01	Ability to obtain and verify control procedure copy.	2.9
_______	A1.02	Ability to execute procedural steps.	4.2*
_______	A1.03	Ability to locate and use procedures and station directives related to shift staffing and activities.	2.7
_______	A1.04	Ability to operate the plant phone, paging system, and two-way radio.	3.1*
_______	A1.05	Ability to make accurate, clear, and concise verbal reports.	3.4
_______	A1.06	Ability to maintain accurate, clear and concise logs, records, status boards and reports.	3.4
_______	A1.07	Ability to obtain and interpret station electrical and mechanical drawings.	3.0
_______	A1.08	Ability to obtain and interpret station reference material such as graphs, monographs, and tables which contain system performance data.	3.1
_______	A1.09	Ability to coordinate personnel activities inside the control room.	3.3
_______	A1.10	Ability to coordinate personnel activities outside the control room.	3.6
_______	A1.11	Ability to direct personnel activities inside the control room.	3.3
_______	A1.12	Ability to direct personnel activities outside the control room.	3.5
_______	A1.13	Ability to locate control room switches, controls, and indications, and to determine that they are correctly reflecting the desired plant lineup.	4.5*
_______	A1.14	Ability to maintain primary and secondary plant chemistry within allowable limits.	2.9*

Check if included	294001 K/A #	Statement	Rating
_______	A1.15	Ability to use plant computer to obtain and evaluate parametric information on system and component status.	3
_______	A1.16	Ability to take actions called for in the Facility Emergency Plan, including (if required) supporting or acting as the Emergency Coordinator.	2.9*

Knowledge and Abilities Record Form
PLANT SYSTEMS
BWR - Reactor Operator - 51%

Plant Specific Priorities

System #	K/A #	K/A Topic	Rating

Group I Plant Systems - 28%

201001 Control Rod Drive Hydraulic
201002 Reactor Manual Control
201005 Rod Control and Information
202002 Recirculation Flow Control
203000 RHR/LPCI: Injection Mode
206000 High Presure Coolant Injection
207000 Isolation (Emergency) Condenser
209000 Low Pressure Core Spray
209002 High Pressure Core Spray
211000 Standby Liquid Control
212000 Reactor Protection
215003 Intermediate Range Monitor
215004 Source Range Monitor
215005 Average Power Range Monitor/ Local Power Range Monitor
216000 Nuclear Boiler Instrumentation
217000 Reactor Core Isolation Cooling
218000 Automatic Depressurization
223001 Primary Containment and Auxiliaries
223002 Primary Containment Isolation/ Nuclear Steam Supply Shut-Off
239002 Relief/Safety Valves
241000 Reactor/Turbine Pressure Regul.
259001 Reactor Feedwater
259002 Reactor Water Level Control
261000 Standby Gas Treatment
264000 Emergency Generators

System #	K/A #	K/A Topic	Rating

Group II Plant Systems - 19%

201003 Control Rod and Drive Mechanism
201004 Rod Sequence Control
201006 Rod Worth Minimizer
202001 Recirculation
204000 Reactor Water Cleanup
200500 Shutdown Cooling System (RHR Shutdown Cooling Mode)
214000 Rod Position Information
215002 Rod Block Monitor
219000 RHR/LPCI: Torus/Suppression Pool Cooling Mode
226001 RHR/LPCI: Containment Spray System Mode
230000 RHR/LPCI: Torus/Suppression Pool Spray Mode
239001 Main and Reheat Steam
245000 Main Turbine Generator and Auxiliary
256000 Reactor Condensate
262001 A.C. Electrical Distribution
262002 Uninterruptable Power Supply
263000 D.C. Electrical Distribution (A.C./D.C.)
271000 Offgas
272000 Radiation Monitoring
286000 Fire Protection
290001 Secondary Containment
290003 Control Room HVAC

System #	K/A #	K/A Topic	Rating

Group III Plant System - 4%

215001 Traversing In-Core Probe
233000 Fuel Pool Cooling and Clean-up
234000 Fuel Handling Equipment
239003 MSIV Leakage
268000 Radwaste
288000 Plant Ventilation
290002 Reactor Vessel Internals

System #	K/A #	K/A Topic	Rating

Knowledge and Abilities Record Form
EMERGENCY AND ABNORMAL PLANT EVOLUTIONS
BWR - Reactor Operator - 36%

Plant Specific Priorities

E/A #	K/A #	K/A Topic	Rating

Group I Emergency and Abnormal Plant Evolutions - 13%

295005 Main Turbine Generator Trip
295006 SCRAM
295007 High Reactor Pressure
295009 Low Reactor Water Level
295010 High Drywell Pressure
295014 Inadvertent Reactivity Addition
295015 Incomplete SCRAM
295024 High Drywell Pressure
295025 High Reactor Pressure
295031 Reactor Low Water Level
295037 SCRAM Condition Present and Reactor Power Above APRM Downscale or Unknown

E/A #	K/A #	K/A Topic	Rating

Group II Emergency and Abnormal Plant Evolutions - 19%

295001	Partial or Complete Loss of Forced Core Flow Circulation
295002	Loss of Main Condenser Vacuum
295003	Partial or Complete Loss of AC Power
295004	Partial or Complete Loss of DC Power
295008	High Reactor Water Level
295011	High Containment Temperature (Mark III Containment Only)
295012	High Drywell Temperature
295013	High Suppression Pool Temp.
295016	Control Room Abandonment
295017	High Off-Site Release Rate
295018	Partial or Complete Loss of Component Cooling Water
295019	Partial or Complete Loss of Instrument Air
295020	Inadvertent Containment Isolation
295022	Loss of CRD Pumps
295026	Suppression Pool High Water Temperature
295027	High Containment Temperature (Mark III Containment Only)
295028	High Drywell Temperature
295029	High Suppression Pool Water Level
295030	Low Suppression Pool Water Level
295033	High Secondary Containment Area Radiation Levels
295034	Secondary Containment Ventilation High Ratiation
295038	High Off-Site Release Rate

E/A #	K/A #	K/A Topic	Rating
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____

Group III Emergency and Abnormal Plant Evolutions - 4%

295021	Loss of Shutdown Cooling
295023	Refueling Accidents
295032	High Secondary Containment Area Temperature
295035	Secondary Containment High Differential Pressure
295036	Secondary Containment High Sump/Area Water Level

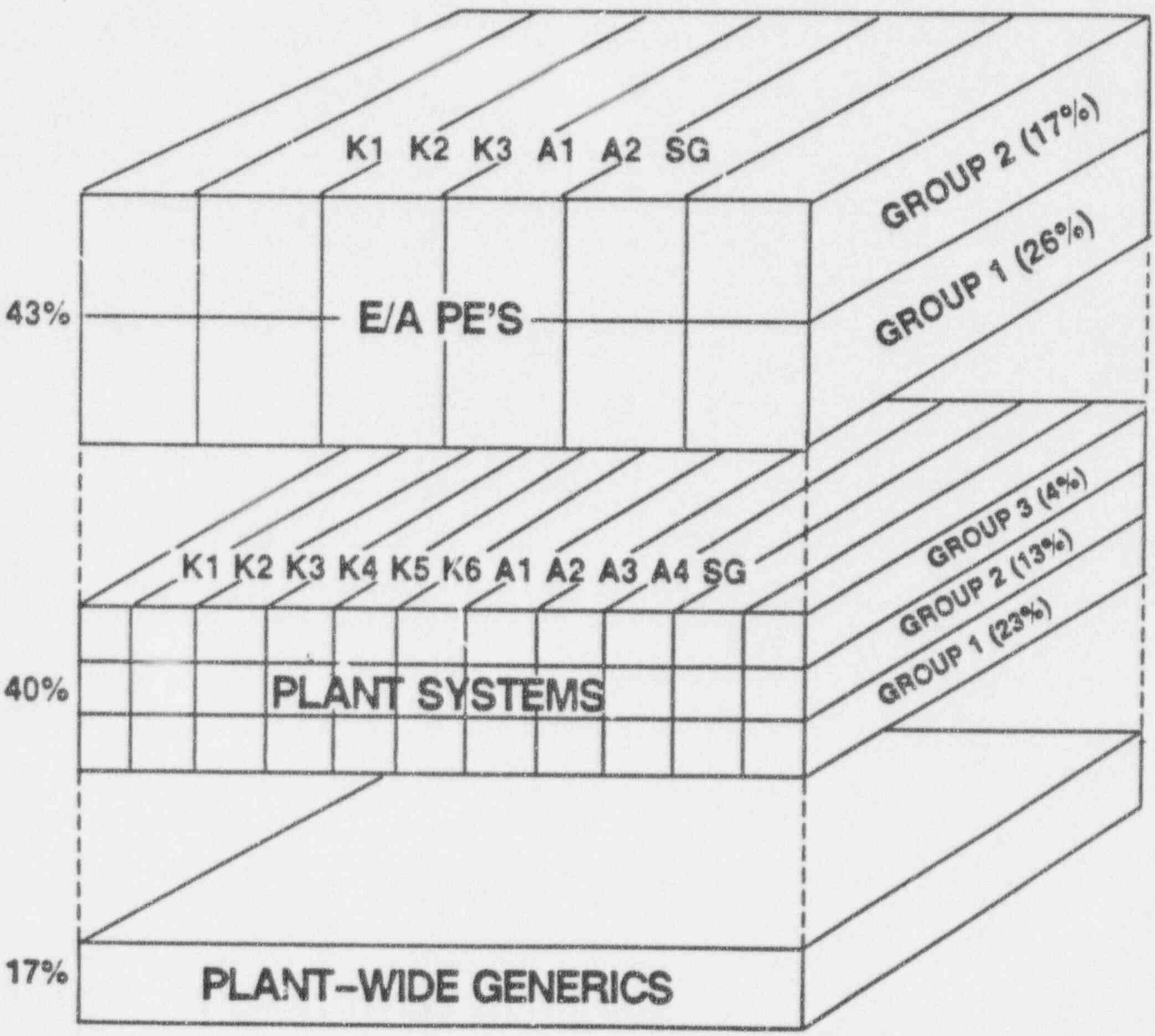
E/A #	K/A #	K/A Topic	Rating
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____
______	_____	______________________________	_____

Knowledge and Abilities Record Form
BWR - Supplemental Item Sheet

Plant Specific Priorities

Comp. #	K/A #	K/A Topic	Rating

SAMPLE PLAN
BWR – SENIOR REACTOR OPERATOR



Knowledge and Abilities Record Form
PLANT-WIDE GENERIC RESPONSIBILITIES
BWR - Senior Reactor Operator - 17%

Check if included	294001 K/A #	Statement	Rating
______	K1.01	Knowledge of how to conduct and verify valve lineups.	3.7
______	K1.02	Knowledge of tagging and clearance procedures.	4.5*
______	K1.03	Knowledge of 10 CFR 20 and related facility radiation control requirements.	3.8
______	K1.04	Knowledge of facility ALARA program.	3.6
______	K1.05	Knowledge of facility requirements for controlling access to vital/control areas.	3.7
______	K1.06	Knowledge of safety procedures related to rotating equipment.	3.4
______	K1.07	Knowledge of safety procedures related electrical equipment.	3.6
______	K1.08	Knowledge of safety procedures related to high temperature.	3.4
______	K1.09	Knowledge of safety procedures related to high pressure.	3.8
______	K1.10	Knowledge of safety procedures related to caustic solutions.	3.4
______	K1.11	Knowledge of safety procedures related to chlorine.	3.3
______	K1.12	Knowledge of safety procedures related to noise.	3.1*
______	K1.13	Knowledge of safety procedures related to oxygen-deficient environment.	3.6
______	K1.14	Knowledge of safety procedures related to confined spaces.	3.4
______	K1.15	Knowledge of safety procedures related to hydrogen.	3.8
______	K1.16	Knowledge of facility protection requirements, including fire brigade and portable fire-fighting equipment usage.	3.8
______	K1.17	Knowledge of the equipment rotation schedules and the reasoning behind the rotation procedure.	2.6

Check if included	294001 K/A#	Statement	Rating
_______	A1.01	Ability to obtain and verify control procedure copy.	3.4
_______	A1.02	Ability to execute procedural steps.	4.2*
_______	A1.03	Ability to locate and use procedures and station directives related to shift staffing and activities.	3.7
_______	A1.04	Ability to operate the plant phone, paging system, and two-way radio.	3.2*
_______	A1.05	Ability to make accurate, clear, and concise verbal reports.	3.8
_______	A1.06	Ability to maintain accurate, clear and concise logs, records, status boards and reports.	3.6
_______	A1.07	Ability to obtain and interpret station electrical and mechanical drawings.	3.7
_______	A1.08	Ability to obtain and interpret station reference material such as graphs, monographs, and tables which contain system performance data.	3.6
_______	A1.09	Ability to coordinate personnel activities inside the control room.	4.2*
_______	A1.10	Ability to coordinate personnel activities outside the control room.	4.2*
_______	A1.11	Ability to direct personnel activities inside the control room.	4.3*
_______	A1.12	Ability to direct personnel activities outside the control room.	4.2
_______	A1.13	Ability to locate control room switches, controls, and indications, and to determine that they are correctly reflecting the desired plant lineup.	4.3*
_______	A1.14	Ability to maintain primary and secondary plant chemistry within allowable limits.	3.4

Check if included	294001 K/A #	Statement	Rating
_______	A1.15	Ability to use plant computer to obtain and evaluate parametric information on system and component status.	3.4
_______	A1.16	Ability to take actions called for in the Facility Emergency Plan, including (if required) supporting or acting as the Emergency Coordinator.	4.7*

Knowledge and Abilities Record Form
PLANT SYSTEMS
BWR - Senior Reactor Operator - 40%

Plant Specific Priorities

System #	K/A #	K/A Topic	Rating

Group I Plant Systems - 23%

201005 Rod Control and Information
202002 Recirculation Flow Control
203000 RHR/LPCI: Injection Mode
206000 High Pressure Coolant Injection
207000 Isolation (Emeregency) Condenser
209000 Low Pressure Core Spray
209002 High Pressure Core Spray
211000 Standby Liquid Control
212000 Reactor Protection
215004 Source Range Monitor
215005 Average Power Range Monitor/ Local Power Range Monitor
216000 Nuclear Boiler Instrumentation
217000 Reactor Core Isolation Cooling
218000 Automatic Depressurization
223001 Primary Containment and Auxiliaries
223002 Primary Containment Isolation/Nuclear Steam Supply Shut-off
226001 RHR/LPCI: Containment Spray System Mode
239002 Relief/Safety Valves
241000 Reactor/Turbine Pressure Regulator
259002 Reactor Water Level Control
261000 Standby Gas Treatment
262001 A.C. Electrical Distribution
264000 Emergency Generators
290001 Secondary Containment

System #	K/A #	K/A Topic	Rating

Plant Systems (Continued)

Group II Plant Systems - 13%

201001 Control Rod Drive Hydraulic
201002 Reactor Manual Control
201004 Rod Sequence Control
201006 Rod Worth Minimizer
202001 Recirculation
204000 Reactor Water Cleanup
205000 Shutdown Cooling
214000 Rod Position Information
215002 Rod Block Monitor
215003 Intermediate Range Monitor
219000 RHR/LPCI: Torus/Suppression Pool Cooling Mode
230000 RHR/LPCI: Torus/Suppression Pool Spray Mode
234000 Fuel Handling Equipment
239003 MSIV Leakage Control
245000 Main Turbine Generator and Auxiliary
259001 Reactor Feedwater
262002 Uninterruptable Power Supply (A.C./D.C.)
263000 D.C. Electrical Distribution
271000 Offgas
272000 Radiation Monitoring
286000 Fire Protection
290003 Control Room HVAC

System #	K/A #	K/A Topic	Rating

Group III Plant System - 4%

201003 Control Rod and Drive Mechanism
215001 Traversing In-Core Probe
233000 Fuel Pool Cooling and Clean-up
239001 Main and Reheat Steam
256000 Reactor Condensate
268000 Radwaste
288000 Plant Ventilation
290002 Reactor Vessel Internals

System #	K/A #	K/A Topic	Rating

Knowledge and Abilities Record Form
EMERGENCY AND ABNORMAL PLANT EVOLUTIONS
BWR - Senior Reactor Operator - 43%

Plant Specific Priorities

E/A #	K/A #	K/A Topic	Rating

Group I Emergency and Abnormal Plant Evolutions - 26%

295003	Partial or Complete Loss of AC Power
295006	SCRAM
295007	High Reactor Pressure
295009	Low Reactor Water Level
295010	High Drywell Pressure
295013	High Suppression Pool Temp.
295014	Inadvertent Reactivity Addition
295015	Incomplete SCRAM
295016	Control Room Abandonment
295017	High Off-Site Release Rate
295023	Refueling Accidents
295024	High Drywell Pressure
295025	High Reactor Pressure
295026	Suppression Pool High Water Temperature
295027	High Containment Temperature
295030	Low Suppression Pool Water Level
295031	Reactor Low Water Level
295037	SCRAM Condition Present and Reactor Power Above APRM Downscale or Unknown
295038	High Off-Site Release Rate

E/A #	K/A #	K/A Topic	Rating

Group II Emergency and Abnormal Plant Evolutions - 17%

295001	Partial or Complete Loss of Forced Core Flow Circulation	295021	Loss of Shutdown Cooling
295002	Loss of Main Condenser Vacuum	295022	Los of CRD Pumps
295004	Partial or Complete Loss of DC Power	295028	High Drywell Temperature
295005	Main Turbine Generator Trip	295029	High Suppression Pool Water Level
295008	High Reactor Water Level	295032	High Secondary Containment Area Temperature
295011	High Containment Temperature	295033	High Secondary Containment Area Radiation Levels
295012	High Drywell Temperature	295034	Secondary Containment Ventilation High Radiation
295018	Partial or Complete Loss of Component Cooling Water	295035	Secondary Containment High Differential Pressure
295019	Partial or Complete Loss of Instrument Air	295036	Secondary Containment High Sump/Area Water Level
295020	Inadvertent Containment Isolation		

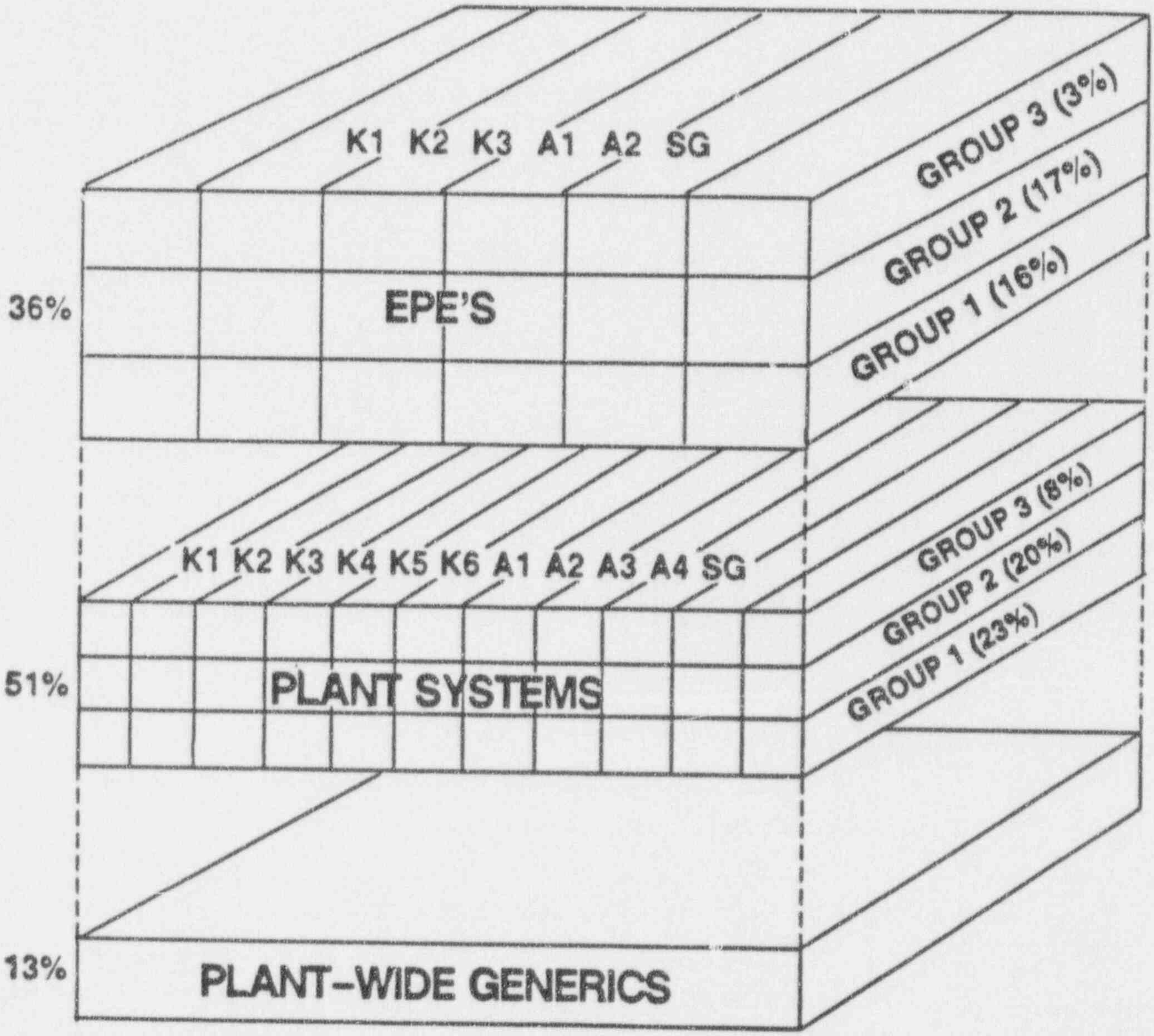
E/A #	K/A #	K/A Topic	Rating

Knowledge and Abilities Record Form
BWR - Supplemental Item Sheet

Plant Specific Priorities

Comp. #	K/A #	K/A Topic	Rating

SAMPLE PLAN
PWR – REACTOR OPERATOR



Check if included	294001 K/A #	Statement	Rating
________	K1.01	Knowledge of how to conduct and verify valve lineups.	3.6
________	K1.02	Knowledge of tagging and clearance procedures.	3.7
________	K1.03	Knowledge of 10 CFR 20 and related facility radiation control requirements.	2.8
________	K1.04	Knowledge of facility ALARA program.	3.3
________	K1.05	Knowledge of facility requirements for controlling access to vital/control areas.	3.1
________	K1.06	Knowledge of safety procedures related to rotating equipment.	3.4
________	K1.07	Knowledge of safety procedures related electrical equipment.	3.6*
________	K1.08	Knowledge of safety procedures related to high temperature.	3.5*
________	K1.09	Knowledge of safety procedures related to high pressure.	3.4
________	K1.10	Knowledge of safety procedures related to caustic solutions.	3.0*
________	K1.11	Knowledge of safety procedures related to chlorine.	3.4*
________	K1.12	Knowledge of safety procedures related to noise.	2.6*
________	K1.13	Knowledge of safety procedures related to oxygen-deficient environment.	3.3*
________	K1.14	Knowledge of safety procedures related to confined spaces.	3.3
________	K1.15	Knowledge of safety procedures related to hydrogen.	3.4
________	K1.16	Knowledge of facility protection requirements, including fire brigade and portable fire-fighting equipment usage.	3.5
________	K1.17	Knowledge of the equipment rotation schedules and the reasoning behind the rotation procedure.	2.1

Knowledge and Abilities Record Form
PLANT-WIDE GENERIC RESPONSIBILITIES
PWR - Reactor Operator (Continued)

Check if included	294001 K/A #	Statement	Rating
______	A1.01	Ability to obtain and verify control procedure copy.	3.3
______	A1.02	Ability to execute procedural steps.	4.1*
______	A1.03	Ability to locate and use procedures and station directives related to shift staffing and activities.	2.5
______	A1.04	Ability to operate the plant phone, paging system, and two-way radio.	3.0
______	A1.05	Ability to make accurate, clear, and concise verbal reports.	3.6
______	A1.06	Ability to maintain accurate, clear and concise logs, records, status boards and reports.	3.4
______	A1.07	Ability to obtain and interpret station electrical and mechanical drawings.	2.5
______	A1.08	Ability to obtain and interpret station reference material such as graphs, monographs, and tables which contain system performance data.	2.6
______	A1.09	Ability to coordinate personnel activities inside the control room.	2.7
______	A1.10	Ability to coordinate personnel activities outside the control room.	2.9
______	A1.11	Ability to direct personnel activities inside the control room.	2.8
______	A1.12	Ability to direct personnel activities outside the control room.	3.1
______	A1.13	Ability to locate control room switches, controls, and indications, and to determine that they are correctly reflecting the desired plant lineup.	4.3*
______	A1.14	Ability to maintain primary and secondary plant chemistry within allowable limits.	2.5*

Check if included	294001 K/A #	Statement	Rating
_______	A1.15	Ability to use plant computer to obtain and evaluate parametric information on system and component status.	3.1
_______	A1.16	Ability to take actions called for in the Facility Emergency Plan, including (if required) supporting or acting as the Emergency Coordinator.	3.1

Knowledge and Abilities Record Form
PLANT SYSTEMS
PWR - Reactor Operator - 51%

Plant Specific Priorities

System #	K/A #	K/A Topic	Rating

Group I Plant Systems - 23%

001 Control Rod Drive System
003 Reactor Coolant Pump System
004 Chemical and Volume Control System
013 Engineered Safety Features Actuation System
015 Nuclear Instrumentation System
017 In-Core Temperature Monitor System
022 Containment Cooling System
025 Ice Condenser System
056 Condensate System
059 Main Feedwater System
061 Auxiliary/Emergency Feedwater System
068 Liquid Radwaste System
071 Waste Gas Disposal System
072 Area Radiation Monitoring System

System #	K/A #	K/A Topic	Rating

Plant Systems (Continued)

Group II Plant Systems - 20%

002 Reactor Coolant System
006 Emergency Core Cooling System
010 Pressurizer Pressure Control System
011 Pressurizer Level Control System
012 Reactor Protection System
014 Rod Position Indication System
016 Non-Nuclear Instrumentation System
026 Containment Spray System
029 Containment Purge System
033 Spent Fuel Pool Cooling System
035 Steam Generator System
039 Main and Reheat Steam System
055 Condenser Air Removal System
062 AC Electrical Distribution System
063 DC Electrical Distribution System
064 Emergency Diesel Generator System
073 Process Radiation Monitoring System
075 Circulating Water System
079 Station Air System
086 Fire Protection System

System #	K/A #	K/A Topic	Rating
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

Group III Plant System - 8%

005 Residual Heat Removal System
007 Pressurizer Relief Tank/Quench Tank System
008 Component Cooling Water System
027 Containment Iodine Removal System
028 Hydrogen Recombiner and Purge Control System
034 Fuel Handling Equipment System
041 Steam Dump System
045 Main Turbine Generator
076 Service Water System
078 Instrument Air System
103 Containment System

System #	K/A #	K/A Topic	Rating
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

Knowledge and Abilities Record Form
EMERGENCY PLANT EVOLUTIONS
PWR - Reactor Operator - 36%

Plant Specific Priorities

E/A #	K/A #	K/A Topic	Rating

Group I Emergency and Abnormal Plant Evolutions - 16%

000005	Inoperable/Stuck Control Rod	000055	Loss of Offsite and Onsite Power
000015	RCP Motor Malfunction	000057	Loss of Vital AC Electrical Instrument Bus
000024	Emergency Boration	000067	Plant Fire of Site
000026	Loss of Component Cooling Water	000068	Control Room Evacuation
000027	Pressurizer Pressure Control System Malfunction	000069	Loss of Containment Integrity
000040	Steam Line Rupture	000074	Inadequate Core Cooling
000051	Loss of Condenser Vacuum	000076	High Reactor Coolant Activity

E/A #	K/A #	K/A Topic	Rating

Emergency Plant Evolutions (Continued)

Group II Emergency and Abnormal Plant Evolutions - 17%

000001 Continuous Rod Withdrawal
000003 Dropped Control Rod
000007 Reactor Trip
000008 Pressurizer Vapor Space Accident
000009 Small Break LOCA
000011 Large Break LOCA
000022 Loss of Reactor Coolant Makeup
000025 Loss of Residual Heat Removal System
000029 Anticipated Transient Without Scram
000032 Loss of Source-Range Nuclear Instrumentation
000033 Loss of Intermediate-Range Instrumentation
000037 Steam Generator Tube Leak
000038 Steam Generator Tube Rupture
000054 Loss of Main Feedwater
000058 Loss of DC Power
000059 Accidental Liquid Radioactive-Waste Release
000060 Accidental Gaseous-Waste Release
000061 Area Radiation Monitoring System Alarms

E/A #	K/A #	K/A Topic	Rating
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

Group III Emergency and Abnormal Plant Evolutions - 3%

000028 Pressurizer Level Malfunction
000036 Fuel Handling Incident
000056 Loss of Offsite Power
000065 Loss of Instrument Air

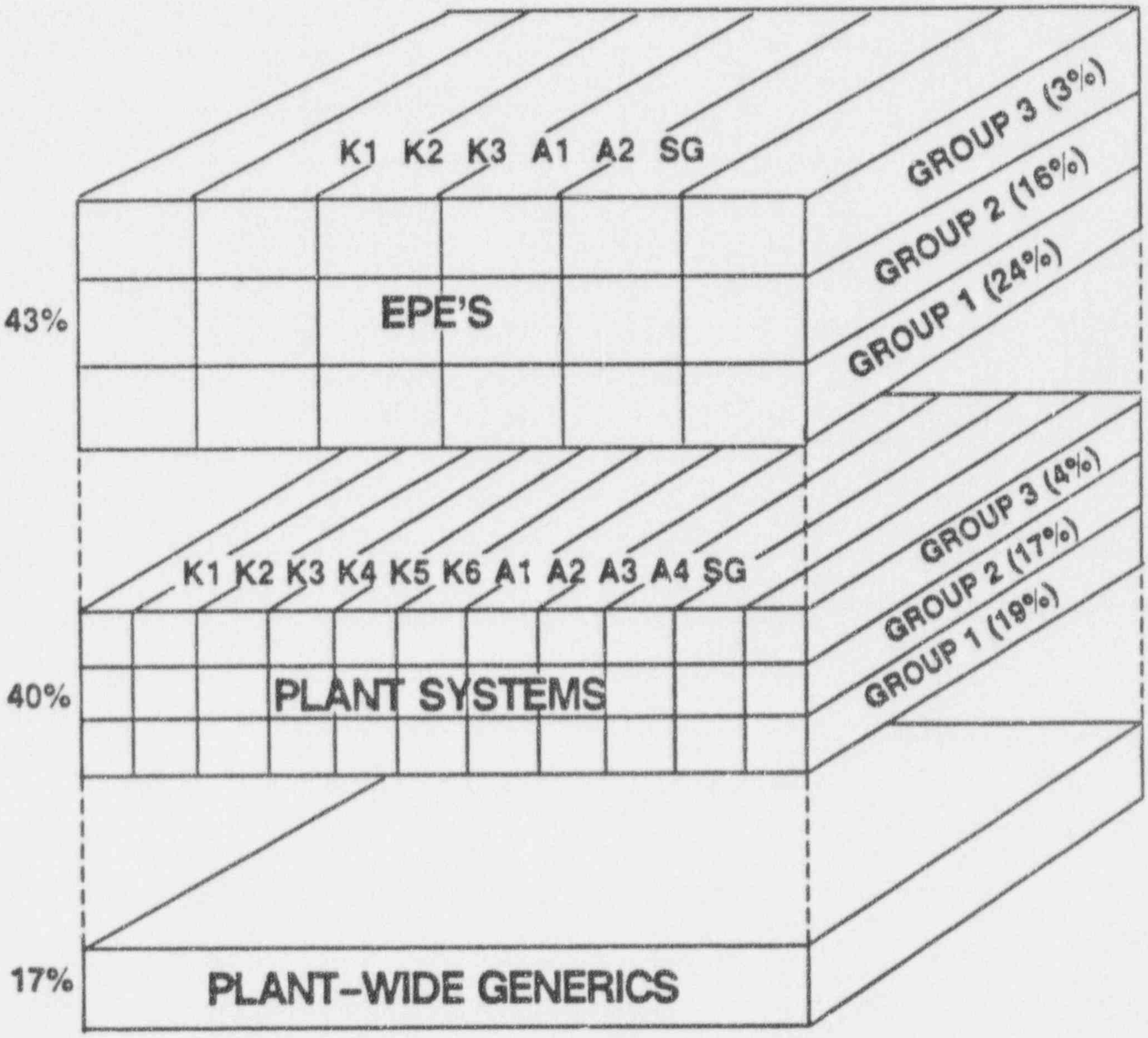
E/A #	K/A #	K/A Topic	Rating
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

Knowledge and Abilities Record Form
PWR - Supplemental Item Sheet

Plant Specific Priorities

Comp. #	K/A #	K/A Topic	Rating

SAMPLE PLAN
PWR – SENIOR REACTOR OPERATOR



Knowledge and Abilities Record Form
PLANT-WIDE GENERIC RESPONSIBILITIES
PWR - Senior Reactor Operator - 17%

Check if included	294001 K/A #	Statement	Rating
________	K1.01	Knowledge of how to conduct and verify valve lineups.	3.7
________	K1.02	Knowledge of tagging and clearance procedures.	4.1
________	K1.03	Knowledge of 10 CFR 20 and related facility radiation control requirements.	3.4
________	K1.04	Knowledge of facility ALARA program.	3.5
________	K1.05	Knowledge of facility requirements for controlling access to vital/control areas.	3.4*
________	K1.06	Knowledge of safety procedures related to rotating equipment.	3.4*
________	K1.07	Knowledge of safety procedures related electrical equipment.	3.7*
________	K1.08	Knowledge of safety procedures related to high temperature.	3.4
________	K1.09	Knowledge of safety procedures related to high pressure.	3.4
________	K1.10	Knowledge of safety procedures related to caustic solutions.	3.3
________	K1.11	Knowledge of safety procedures related to chlorine.	3.5*
________	K1.12	Knowledge of safety procedures related to noise.	2.9
________	K1.13	Knowledge of safety procedures related to oxygen-deficient environment.	3.6
________	K1.14	Knowledge of safety procedures related to confined spaces.	3.6
________	K1.15	Knowledge of safety procedures related to hydrogen.	3.8*
________	K1.16	Knowledge of facility protection requirements, including fire brigade and portable fire-fighting equipment usage.	4.2*
________	K1.17	Knowledge of the equipment rotation schedules and the reasoning behind the rotation procedure.	2.5

Check if included	294001 K/A #	Statement	Rating
______	A1.01	Ability to obtain and verify control procedure copy.	3.4
______	A1.02	Ability to execute procedural steps.	3.9
______	A1.03	Ability to locate and use procedures and station directives related to shift staffing and activities.	3.4
______	A1.04	Ability to operate the plant phone, paging system, and two-way radio.	3.2
______	A1.05	Ability to make accurate, clear, and concise verbal reports.	3.8
______	A1.06	Ability to maintain accurate, clear and concise logs, records, status boards and reports.	3.4
______	A1.07	Ability to obtain and interpret station electrical and mechanical drawings.	3.2
______	A1.08	Ability to obtain and interpret station reference material such as graphs, monographs, and tables which contain system performance data.	3.1
______	A1.09	Ability to coordinate personnel activities inside the control room.	3.9*
______	A1.10	Ability to coordinate personnel activities outside the control room.	3.9*
______	A1.11	Ability to direct personnel activities inside the control room.	4.1*
______	A1.12	Ability to direct personnel activities outside the control room.	4.1*
______	A1.13	Ability to locate control room switches, controls, and indications, and to determine that they are correctly reflecting the desired plant lineup.	4.1
______	A1.14	Ability to maintain primary and secondary plant chemistry within allowable limits.	2.9

Check if included	294001 K/A #	Statement	Rating
_______	A1.15	Ability to use plant computer to obtain and evaluate parametric information on system and component status.	3.4
_______	A1.16	Ability to take actions called for in the Facility Emergency Plan, including (if required) supporting or acting as the Emergency Coordinator.	4.4*

Knowledge and Abilities Record Form
PLANT SYSTEMS
PWR - Senior Reactor Operator - 40%

Plant Specific Priorities

System #	K/A #	K/A Topic	Rating

Group I Plant Systems - 19%

001 Control Rod Drive System
003 Reactor Coolant Pump System
004 Chemical and Volume Control System
013 Engineered Safety Features Actuation System
014 Rod Position Indication System
015 Nuclear Instrumentation System
017 In-Core Temperature Monitor System
022 Containment Cooling System
025 Ice Condenser System
026 Containment Spray System
056 Condensate System
059 Main Feedwater System
061 Auxiliary/Emergency Feedwater System
063 DC Electrical Distribution System
068 Liquid Radwaste System
071 Waste Gas Disposal System
072 Area Radiation Monitoring System

System #	K/A #	K/A Topic	Rating

Plant Systems (Continued)

Group II Plant Systems - 17%

002 Reactor Coolant System
006 Emergency Core Cooling System
010 Pressurizer Pressure Control System
011 Pressurizer Level Control System
012 Reactor Protection System
016 Non-Nuclear Instrumentation System
027 Containment Iodine Removal System
028 Hydrogen Recombiner and Purge Control System
029 Containment Purge System
033 Spent Fuel Pool Cooling System
034 Fuel Handling Equipment System
035 Steam Generator System
039 Main and Reheat Steam System
055 Condenser Air Removal System
062 AC Electrical Distribution System
064 Emergency Diesel Generator System
073 Process Radiation Monitoring System
075 Circulating Water System
079 Station Air System
086 Fire Protection System
103 Containment System

System #	K/A #	K/A Topic	Rating

Group III Plant System - 4%

005 Residual Heat Removal System
007 Pressurizer Relief Tank/Quench Tank System
008 Component Cooling Water System
041 Steam Dump System/Turbine Bypass Control
045 Main Turbine Generator System
076 Service Water System
078 Instrument Air System

System #	K/A #	K/A Topic	Rating

Knowledge and Abilities Record Form
EMERGENCY PLANT EVOLUTIONS
PWR - Senior Reactor Operator - 43%

Plant Specific Priorities

E/A #	K/A #	K/A Topic	Rating

Group I Emergency and Abnormal Plant Evolutions - 24%

000001 Continuous Rod Withdrawal
000003 Dropped Control Rod
000005 Inoperable/Stuck Control Rod
000011 Large Break LOCA
000015 RCP Motor Malfunction
000024 Emergency Boration
000026 Loss of Component Cooling Water
000029 Anticipated Transient Without Scram
000040 Steam Line Rupture
000051 Loss of Condenser Vacuum
000055 Loss of Offsite and Onsite Power
000057 Loss of Vital AC Electrical Instrument Bus
000059 Accidental Liquid Radioactive-Waste Release
000067 Plant Fire On Site
000068 Control Room Evacuation
000069 Loss of Containment Integrity
000074 Inadequate Core Cooling
000076 High Reactor Coolant Activity

E/A #	K/A #	K/A Topic	Rating

Group II Emergency and Abnormal Plant Evolutions - 16%

000007	Reactor Trip
000008	Pressurizer Vapor Space Accident
000009	Small Break LOCA
000022	Loss of Reactor Coolant Makeup
000025	Loss of Residual Heat Removal System
000027	Pressurizer Pressure Control System Malfunction
000032	Loss of Source-Range Nuclear Instrumentation
000033	Loss of Intermediate-Range Instrumentation
000037	Steam Generator Tube Leak
000038	Steam Generator Tube Rupture
000054	Loss of Main Feedwater
000058	Loss of DC Power
000060	Accidental Gaseous-Waste Release
000061	Area Radiation Monitoring System Alarms
000065	Loss of Instrument Air

E/A #	K/A #	K/A Topic	Rating

Group III Emergency and Abnormal Plant Evolutions - 3%

000028	Pressurizer Level Malfunction
000036	Fuel Handling Incident
000056	Loss of Offsite Power

E/A #	K/A #	K/A Topic	Rating

Knowledge and Abilities Record Form
PWR - Supplemental Item Sheet

Plant Specific Priorities

Comp. #	K/A #	K/A Topic	Rating

3 DEVELOPING TESTING OBJECTIVES

The completed test outline or sample plan provides the examiner with a list of K/As upon which to base the test questions. Please remember, however, that many of the K/As in the catalogs, and therefore, in your test sample plan, are stated in general terms. Accordingly, there is some room for interpretation with regard to translating the K/A statement into a test item. Consideration of a testing objective should be helpful in clarifying the relationship or link between the K/A as stated and the actual test item. The testing objective will help you focus the item so that it measures the specific aspect of the K/A statement that you desire to test.

For the purposes of discussion, two K/As have been selected from the PWR Catalog and two K/As have been selected from the BWR Catalog. Consider K5.15 selected from the Control Rod Drive System (CEDS) and K6.07 taken from the Chemical and Volume Control System (CVCS) in the PWR Catalog. These K/As are as follows:

CRDS-K5.15	Knowledge of the following theoretical concepts as they apply to the CRDS: Relationship between RCS and MTC
CVCS-K6.07	Knowledge of the applicable performance and design attributes of the following CVCS components: Reason for venting VCT and pump castings while filling

Alternately, examine K1.08 selected from the Reactor Protection System (RPS) and A2.16 taken from the Radiation Monitoring System (RMS) in the BWR Catalog. These K/As are as follows:

RPS-K1.08	Knowledge of the physical connections and/or cause-effect relationships between RPS and the following: Control rod and drive mechanism
RMS-A2.16	Ability to (a) predict the impacts of the following on the RMS; and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those abnormal conditions and operations: Instrument malfunctions

Although these K/As are clearly stated with respect to their content, they do not provide clear direction regarding how candidates should demonstrate the appropriate knowledge and ability. Properly designed testing objectives will assist the examiner in determining more precisely the aspects of the knowledge or ability to be measured by the test item. The testing objective will also provide a standard against which the examiner and other reviewers can judge the test items to ensure that they are eliciting the specific knowledge and ability intended by the K/A.

PLEASE NOTE: Documentation of the actual test objective is not required. However, it is suggested that testing objectives be informally developed, or alternately, be considered by the examiner using the guidelines provided below, before and during the attempt to translate a K/A into a test item.

3.1 Elements of a Testing Objective

Each testing objective should give consideration to the following elements:

(1) The Performance: A statement of what the candidate should do or exhibit to demonstrate mastery of the objective.

(2) The Conditions: This refers to what the candidate will be given or provided with when asked to demonstrate the performance. Some examples of the conditions element of the testing objective include copies of procedures, graphs, and steam tables.

(3) Standards of Performance: This element refers to the level or degree to which the candidate should perform in order to demonstrate mastery of the objective. Examples of this element of the testing objective would include reference to time limits and the completeness or comprehensiveness of the response that would constitute the correct answer.

It is important that every testing objective include each of the above three elements. However, it is not necessary to state obvious conditions (such as "given paper-and-pencil"), nor is it necessary in many cases to state the standards of performance (such as "answer the question correctly"). However, every testing objective should include a specific statement of the performance; that is, what the candidate must do to demonstrate mastery of the testing objective. The more precise the examiner can be in identifying the performance, the greater assurance there will be that the resulting test question provides the best measure of the selected K/A.

3.2 Sources of Testing Objectives

Plant specific learning objectives are an important source of potential testing objectives. As part of its accreditation effort, each facility is required to develop learning objectives based on the conduct of a job analysis. The INPO accreditation manual states that each facility's training program will include "learning objectives stating the action(s) the trainee must demonstrate, the conditions under which the actions will take place, and the standards of performance the trainee should achieve upon completion of the training activity". In addition to being resource efficient, use of the facility learning objectives can help assure that your testing objectives are appropriate for the specific job requirements at that site. Review the relevant facility learning objectives, and any other supporting instructional materials, such as lesson plans, at the same time as you review other plant reference material for use in examination development and construction is sought.

PLEASE NOTE: Before adopting any facility learning objective as a testing objective, be sure that it meets the standards discussed throughout this Handbook. Facilities are presently in various stages of completing their own job-task analyses, and therefore, their learning objectives may or may not be based on a valid set of job requirements. Furthermore, some learning objectives may be relevant for training, but not for licensing examinations. In attempting to make meaningful distinctions here, it will be useful for you to think of facility learning objectives as covering all of the things that an RO or SRO should know. In a licensing examination, however, only those things that are important in terms of the safe operation of the plant and ensuring personnel and public health and safety should be included. Accordingly, the things tested in a licensing examination represent a sub-set of what is emphasized in training. For example, from the perspective of the utility, it is very useful for the trainee to know all of the things that will make the plant run more efficiently or cost-effectively. However, this type of knowledge will typically be excluded from consideration on the licensing examination because it does not focus squarely on what must be known to protect the public. It is strongly recommended that examiners follow this overall approach in deciding which learning objectives satisfy the public protection function of licensing.

3.3 Selected Examples of Poor and Good Testing Objectives

This section provides several examples of testing objectives in order to clarify some of the issues that have been discussed above.

PLEASE NOTE: These examples are merely representative and illustrative of some of the appropriate and inappropriate ways of stating testing objectives. It is not intended as a definitive treatment of all of the ways of handling testing objectives.

Examples of vague testing objectives are as follows:

--The candidate will know the major parts of the (________).

--The candidate will be aware of the reasons for (________).

--The candidate will show an appreciation for the importance of (__________).

--The candidate will understand why (_______) is so important.

In the first example, the term know is open to interpretation. How will the candidate show he or she knows? By identifying them on a diagram? By recalling parts from memory? By explaining how each part operates? This issue must be clarified in order to improve the testing objective.

In the second example the term aware is also vague. Again, how will the candidate demonstrate that he or she is aware of the reasons? By picking the correct reason or reasons from a list? By explaining the reason or reasons upon request from the examiner? A decision must be made by the examiner as to how the knowledge is to be made operational.

In the third example, the word appreciate is equally unclear. What a candidate must do to exhibit appreciation is open to interpretation by the examiner. Since the testing objective could be interpreted differently by examiners, the statement might lead to different types of examination items from examination-to-examination, thereby contributing to the unreliability of examinations from administration-to-administration. Again, greater specificity is required.

Finally, the term understand in the fourth example needs to be clarified. What must the candidate do to demonstrate understanding? What criteria will be applied by the examiner? Should the candidate merely explain why it is important? Or alternately, should the candidate distinguish among correct and incorrect reasons from a listing of those provided? The examiner will need to consider the most appropriate way of providing this additional clarification.

The following examples illustrate testing objectives that are more precise in description:

--The candidate will differentiate between three types of (__________).

--Without the aid of references, the candidate will define all of the terms found in (__________).

--Given a steam table, the candidate will calculate (__________).

--The candidate will read and correctly interpret (__________) within 100 degrees Centigrade.

These objectives provide a much clearer indication of what the candidate will be expected to do to demonstrate mastery of the objective as an indication of competence in the underlying K/A. Equally important, possible questions that could be constructed to test for these objectives are more apparent than for the earlier examples. It is clear that most of the above testing objectives could be translated into written examination items.

Examiners are encouraged to follow the guidelines on Selecting K/As For The Written Exam presented in Section 2.2.2 on Specific Steps for Developing a Test Outline or Sample Plan.

PLEASE NOTE: The stem categories in the catalogs do not relate to a particular mode of testing. However, the use of the testing objectives is intended to assist in clarifying which testing mode is most appropriate.

3.4 Testing Objectives and Level of Knowledge

In addition to making sure that the testing objectives are relevant, important to job competence, and measurable, the examiner should also pay close attention to the level of knowledge implied in the selection of the testing objective, and therefore, in the actual test question. Level of knowledge refers to the degree and/or type of thinking process that is required by the candidate to meet the objective or answer the question. For ease of description and use, three major levels of knowledge are defined:

--Knowledge Fundamentals

--Comprehension

--Application/Analysis/Problem-Solving

Knowledge, the basic or fundamental level of memory, involves recalling, recognizing, or remembering information such as facts, procedures, rules, principles, or definitions.

Questions at the knowledge level are relatively easy to write. The important decision is determining whether the knowledge is worth remembering in terms of its public protection value. Although some facts or other pieces of information are important to know in their own right, memory-level knowledge often serves only as a means to an end, rather than as an end in itself. That is, candidates need not only know information at the knowledge level, but more importantly, they need to be able to use that information in fulfilling an important job task or responsibility related to assuring the safe operation of the plant. Questions posed at the knowledge level do not necessarily test for the complete understanding of the underlying concepts or issues in comparison to questions at the two other levels of knowledge.

The comprehension level is often considered to represent the lowest level of true understanding. It requires the candidate to interpret, translate, summarize, and/or discuss the implications or logical extensions, or otherwise demonstrate that he or she understands the concept beyond simply recalling a fact or principle.

Questions that require candidates to contrast, differentiate, apply, or illustrate are generally at the comprehension level.

Testing at the comprehension level means, among other things, that the candidate will be required to demonstrate understanding in ways other than simply repeating the information in the same way it is listed in the training and/or reference materials.

The application/analysis/problem-solving level involves the ability to determine or identify the appropriate fact, rule, or principle, and correctly apply it to a novel or "what-if" situation or problem to arrive at a solution or course of action.

Objectives and questions that require the candidate to estimate, analyze, calculate, or evaluate are often at the application level. In many respects objectives and questions at this level are the most consistent with the purpose of the licensing examination which is to make sure that candidates who pass can apply their knowledge and ability to assure the safe operation of the plant.

To illustrate the three levels of knowledge, consider the following testing objectives developed for a K/A appearing in both the PWR or BWR Catalog.

(1) The candidate will state the automatic turbine trip signals.

(2) The candidate will state the actions which occur to close the control and stop valves on a turbine trip signal.

(3) The candidate will analyze the effect of a turbine trip signal on the EHC Load Control Logic Circuitry.

The first objective is at the memory level. It simply requires the candidate to list a response to a condition. The candidate's response to this question will not give the examiner an indication as to whether the candidate can use his or her knowledge to assure the safe operation of the plant.

The second objective is closer to the comprehension level. It requires the candidate to demonstrate his or her knowledge of turbine trip signals as they affect turbine operation. Yet it still will not provide an indication of whether the candidate knows how to analyze the effects of a turbine trip on plant operations.

The third objective is at a more operationally oriented, application level. The candidates must demonstrate his or her knowledge of turbine trips by showing that they understand the implications of a turbine trip on specific subsystems such as turbine control circuitry.

PLEASE NOTE: Your testing objectives should be developed to reflect the highest level of knowledge appropriate for the K/As that have been selected for inclusion in the test outline. However, this does <u>not</u> mean that all objectives must be at the application level. Knowing the meaning of various terms, or being able to list immediate action steps might be at the memory level, but are, none-the-less, appropriate for inclusion on a licensing examination.

The important point is that each level of knowledge makes a different demand on the candidate and provides a somewhat different perspective on the competence of the candidate. Each examiner must consider this issue when considering testing objectives and developing test items to make sure that knowledge is not tested for knowledge's sake, nor is an important K/A tested in such a way that it is far removed from the candidate's use of the K/A in the actual performance of the job. In this regard, it is critical for the examiner to note whether the selected K/A has a dagger (+) to the left of the statement in the BWR Catalog. The daggers indicate that the level of knowledge or ability required by an RO is different than the level required by an SRO. In such cases, different testing objectives and different test items should be developed from the same K/A.

3.5 Summary Guidelines

All examiners are encouraged to use the following guidelines in developing and judging the effectiveness of the testing objectives:

(1) Base the testing objective on K/As from the Catalogs in order to show a clear link between mastery of the objectives and safe and competent performance of the job.

(2) Make sure the testing objective is precise enough that any test items written from it will measure the same competence.

(3) To keep the testing objective precise, avoid the use of vague terms such as "demonstrate knowledge of", "be familiar with", "know", or other terms that do not indicate how the objective will be demonstrated or measured.

(4) Base the testing objective on performance that is intended to differentiate between competent and less competent performance. The examiner should ask the following questions:

--Does being able to meet the objective relate to being a safe RO/SRO?

--Does not meeting the objective provide an indication that the candidate is less than competent?

(5) When the selected K/As have been noted with a dagger (+), examiners should give strong consideration to the development of different testing objectives and different test items at the RO and SRO levels.

4 WRITTEN EXAMINATION ITEMS: CONSTRUCTION AND SCORING

Test questions consist of two components: the content (what is asked) and the style or format (the way it is asked). The K/As in the catalog are intended to ensure that the content of your questions is valid and appropriate. However, the quality of the question depends as much on the way the item is constructed as on the content. Important topics that are tested by ambiguous, awkward, or poorly specified questions cannot be considered valid. Therefore, the selection of valid topics and careful construction of test items are equally important parts of a valid test development process.

The conversion of a K/A or testing objective into a test item is in good part a creative process. Yet there are certain procedures and guidelines that can help in writing your test item and in ensuring that the item will measure the knowledge or ability that it is intended to measure.

4.1 Objective vs. Subjective Test Items

The following sections offer guidance on how to select, construct, and score three different types of written test items: short answer, multiple choice, and matching. Traditionally, questions that require the candidate to supply an answer (e.g., short answer, essay) have been considered "subjective"; questions requiring the candidate to select an answer (e.g., multiple choice, matching) have been considered "objective." The names arose from the scoring of the items. If graders require subject matter expertise to interpret the answers of test takers, then the question has been considered subjective; if the examination can be scored on a machine, it has been considered objective.

All of the guidance in this handbook will deal with objective items. However, the definition of "objective" is different than the traditional one described above. An objective test item is defined here as one in which: (1) there is only one correct answer; and (2) all qualified graders would agree on the amount of credit allowed for any given candidate's answer. All written questions on the licensing examination should meet these conditions. Questions with no single correct answer, or for which the credit given for candidate's answers vary, depending on who graded it or when it was graded, have no place in the written examinations that you develop.

4.2 Source Questions for Test Items

If you are having difficulty translating a K/A or testing objective into a test questions, asking yourself the following questions may help you generate ideas for potential test questions:

(1) What are the common misconceptions about ______?

(2) Why is ________ important to satisfactory job performance?

(3) In what sort of circumstances might it be important to understand ____?

(4) What might the individual do who does not understand _______?

(5) What might be the consequences of a lack of knowledge about ________?

(6) How can the individual demonstrate the knowledge?

These questions may not only help in the development of test questions, but they also may be useful to keep in mind when generating testing objectives.

4.3 Development of Written Test Items:

Guidance on the construction of each item type is provided in the following sections. However, there are basic principles that apply across all item formats:

(1) Ensure that the concept being measured has a direct, important relationship to the ability to perform the job.

Although the importance of relevant K/As and testing objectives was stressed in earlier sections, it is equally important that construction of the question itself clearly reflects the importance of the topic. Word the question so that is has "face validity" as well as underlying content validity. That is, make sure that the question would be considered reasonable to other subject-matter-experts utilizing the same reference materials.

(2) State the question unambiguously and precisely. State the question as concisely as possible, but provide all necessary information.

Often the individuals who develop a question assume that certain stipulations or conditions are inherent in the question when in fact they are not. It is very difficult for the person who authored the question to review it impartially or through the eyes of a new reader. Therefore, it is very important to have others review your questions to ensure that all necessary information is included, and that all extraneous or superfluous information is deleted. You and others should ask yourselves: Will the candidates clearly know what they are expected to do? Do they have all the information they need to work with? Does answering the question depend on certain assumptions that must be stated?

(3) Write the question at the highest level of knowledge reflected in the testing objective.

The advantages of higher level knowledge questions were discussed in Section 3 of the Handbook. As mentioned there, objectives and questions should be written to reflect the level of knowledge that is most appropriate for a specific K/A; however, try to avoid high percentages of knowledge-level questions on your exam. When you have a choice between two levels of knowledge, try to write your question to reflect the higher level.

(4) Make sure that the question matches the testing objective and intent of the K/A.

It is very easy to end up with a question that tests a relatively trivial aspect of an important K/A topic. When reviewing your draft question, ask yourself whether it is likely that someone could answer the question correctly and still not meet the objective or intent of the K/A or perform the responsibilities or tasks for which this K/A is needed.

(5) Cull questions that are unnecessarily difficult or irrelevant.

As discussed in items 1 and 2 above, unintended irrelevances or trivialities can easily end up in well-meant questions. When reviewing your draft question, ask yourself: Could someone do the job safely and effectively without being able to answer the question? If so, is it because the content is inappropriate, because the wording is unclear, or because the level of understanding is too great?

(6) Limit the question to one concept or topic, unless a synthesis of concepts is being tested.

There is a common misconception that testing for multiple K/A topics in one question is a time-efficient way to examine. Questions containing a variety of topics and issues only serve to confuse the candidate about the purpose of the question, and therefore what is expected in terms of a correct response. Each individual question should be reserved for testing one K/A topic, and that topic, as well as the intent of the question, should be clear to both examiner and candidate.

(7) Avoid copying text directly from training or other reference material.

Another common tendency among exam developers is to copy sentences directly from reference material and turn them into test questions. Unfortunately, questions written in this way generally encourage rote memorization. Further, copying from reference material can cause ambiguity or deficiency in questions because the material lifted often draws its meaning (and importance) from its surrounding context. Therefore, important assumptions or stipulations stated elsewhere in the material are often omitted from the test question. Finally, these types of questions can frequently be answered correctly by candidates who do not really understand the concept, but do remember the specific wording on a page of material. Conversely, candidates who understand the topic, but not in the exact way it was written in the material, may miss the question because of unstated assumptions or other missing information.

(8) Avoid "backwards logic" questions--those questions that ask for what should be provided in the question, and provide what should be required in the candidate's response.

In addition to testing on valid topics, it is important to examine on those topics in a way consistent with how the K/A should be remembered and used. Don't test on the topic in a backwards way. For example, consider the following question:

"If it takes 12.5 cubic feet of concrete to build a square loading pad 6 inches thick, what is the length of one side of the pad?"

This question gives the test takers information they should be asked to calculate, while it requires them to provide information that would be supplied in an actual work situation. In constructing your questions, make sure that you include information that candidates would typically have or have access to, and require responses that reflect the decisions, or calculations, or other information they would typically have to supply.

(9) Place the easier questions at the beginning of each section.

Starting each exam section with the easier questions helps candidates gain composure and confidence. However, this is not to say that extremely easy, non-differentiating questions should be included in the exam for the sole sake of relieving candidate tension.

4.4 Selecting the Type of Written Examination Item to Construct

Although each type of written item has its own advantages and disadvantages, it is important to note that the quality of a test question depends more on the quality of the test objective and the consistency between the objective and the test question than on the format of the question. Good multiple choice questions can require high levels of knowledge; poor essay questions can encourage rote learning. The quality of your test questions, regardless of the item type you select, is a function of the importance of the K/As, the appropriateness of the testing objectives, and the clarity and absence of ambiguity in the questions themselves.

Table 4.1 summarizes the best uses, strengths and weaknesses of each of the three item types for written examination items. Use the table to help you select the particular type of item to construct for a given K/A topic. Keep in mind, however, that many K/As can be tested by several types of items and that, overall, at least 75 points of the test items must be of the matching or multiple choice type. This will be discussed in more detail in Section 5.3. The table is intended to provide considerations, not specific rules, for deciding what kind of item to write.

4.5 Constructing Supply-Type Items (Short Answer)

4.5.1 Short-Answer Items

Short-answer items require the candidate to compose a response in contrast to selecting from among a set of alternative responses. A short-answer item may be presented in such a way as to give the candidate complete freedom to express ideas or it may restrict a response to a given content area or answer format. Keep the following guidelines in mind when constructing these open-ended items:

(1) Provide clear, explicit directions/guidelines for answering the question so that the candidate understands what constitutes a fully correct response.

Choose words carefully to ensure that the stipulations and requirements of the question are appropriately conveyed. Words such as "evaluate," "outline," and "explain," can invite lots of detail that is not necessarily relevant.

(2) Avoid extra or superfluous wording/information in the question.

In an attempt to make a question operationally oriented and/or meaningful, there can be a tendency to add more information than required for a fully correct response. The two examples below illustrate this point:

> "The term undermoderated is used to describe one of the major characteristics of a typical PWR core. Discuss the effect that an increase in power would have on the moderator-to-fuel ratio, and what effect that would have on K-eff."

The first sentence of the above question adds nothing but extra reading time.

> "Two isotopes, one with a half life of 10 days and another with a half life of 5 days, sit on opposite trays of a set of scales. Assuming the isotopes have identical atomic weights, and there is 1 Curie of each isotope, which way will the scales tilt (which weighs more) and why?"

The situation in the above question bears little relationship to a situation that an operator would encounter on the job.

(3) Make sure that the answer key response matches (and is limited to) the requirements posed in the question.

"Explain the effect of increasing boron concentration on the MTC." (total point value: 1.5)

Answer key: Increasing the boron concentration in the reactor coolant reduces the magnitude of the negative MTC coefficient (.6 points). When the moderator temperature is increased, the coolant density is decreased. When the coolant density is decreased, the slowing-down effect of the water is decreased and the absorption effect of the B-10 is decreased (.5 points). Decreasing the slowing-down effect reduces k (.1 point). Decreasing the B-10 absorption rate increases K-eff (.1 point); and, the larger the boron concentration, the larger the later effect (.2 points).

In the above example, candidates who fail to discuss how the effect of boron concentration occurs will lose 60% of the point value assigned, yet the question itself did not stipulate that this discussion was required.

"Can a licensed operator who has not been at the facility for a period of six months immediately resume duties in a licensed position?"

Answer key: No, in any case the NRC would have to be notified before the operator resumed duties, and only after certification by an authorized representative of the facility or by a demonstration by the individual that his/her understanding of facility operations and administration are satisfactory.

The above question only asks for a yes or no response, yet the answer key indicates that an explanation of that one-word response is required.

(4) Avoid giving away part or all of the answer by the way the question is worded.

"If the letdown line became obstructed, could boration of the plant be accomplished shortly after a reactor trip to put the plant in cold shutdown? (1 point) If so, how? (1 point)"

Half credit was allotted for answering the first part of the question "yes." However, a test-wise candidate can realize that the answer has to be yes, or else the second part of the question would have read something like "If so, how? If not, why not?"

(5) Avoid writing what could be considered "trick" questions.

Trick questions can occur unintentionally when the answer key does not precisely match the question (see #3 above).

"How doe the SI termination criteria change following a SI reinitiation?"

Answer key: It does not change.

The question above asks for how, not if, the termination criteria change.

(6) For questions requiring computation, specify the degree of precision expected. Try to make the answer turn out to be whole numbers.

4.6 Constructing Select-Type Items (Multiple-Choice, Matching)

Constructing good select-type items have two major advantages. First, the scoring of objective items is considerably more reliable and less time consuming than scoring open-ended response items. Second, since the item requires less time to answer, more items can be used to test K/As. This will provide better content coverage, which will also increase test reliability.

4.6.1 Multiple-Choice Items

Multiple-choice items are the most common and most popular of the select-type items. Although multiple-choice items are not as easy to construct as other forms, they are very versatile, can be used to test for all levels and types of knowledge, and minimize the likelihood of the candidate obtaining the correct answer by guessing. Construct multiple-choice items using the following guidelines:

(1) Use four answer options.

The four distractor multiple choice item is universally acceptable and will be the style required. The five answer option contributes nothing to the question but confusion and any format with fewer than four distractors makes guessing correctly more probable.

(2) Do not use "none of the above" or "all of the above."

"All of the above" questions provide inadvertent clues to the candidate. When the "all of the above" option is the correct response, the candidate need only recognize that two of the options are correct to answer the question correctly. When the "all of the above" option is used as a distractor, the candidate needs only to be able to determine that one option is incorrect in order to eliminate this option. "None of the above" responses should not be used with "best answer" multiple-choice questions, since it may always be defensible as a response.

(3) Don't present a collection of true-false statements as a multiple-choice item.

As discussed earlier, each item should be focused on one K/A topic. A question containing answer options related to many separate issues does not increase the efficiency of the question. On the contrary, questions with multiple topics only confuse the candidate about the meaning and purpose of the question.

The following statements are based on the Unit 1 procedure "Low Condenser Vacuum," 1-AP-14. Which one is a true statement?

a. Purpose: This procedure provides indications of probable causes for and immediate long-term actions to be taken during a complete or partial loss of condenser vacuum.
b. Indication: Increasing exhaust hood temperature.
c. Probable Cause: Low condenser hotwell level.
d. Immediate Operator Action: If condenser pressure decreases below 9.5" Hg abs. and the turbine has not tripped automatically, manually trip the turbine. Trip the reactor if power is greater than 10%.

Another version of this type of question is what has been dubbed by one examiner as the "apples-apples-oranges-bananas" phenomenon, in which two answer options are related to the same topic, but the other two options deal with different topics. Not only does this type of question suffer from the same problems discussed above, but it can clue the candidate that one of the two "apples" is the correct response, which is usually the case.

(4) Define the question, task or problem in the stem of the question.

Include as much necessary information about the problem or situation in the stem, leaving only the solution, action or effect for the answer options.

Poor:

At 50% power:

a. the equilibrium xenon reactivity worth is approximately equal to the equilibrium xenon worth at 100% power.
b. the equilibrium xenon reactivity worth is approximately one-half the equilibrium xenon worth as 100% power.
c. the equilibrium xenon reactivity worth is approximately two-thirds the equilibrium xenon worth at 100% power.
d. the equilibrium xenon reactivity worth is approximately three-fourths the equilibrium xenon worth at 100% power.

Better:

Which of the following approximates the 50% power equilibrium xenon reactivity worth to the 100% power equilibrium xenon reactivity worth:

a. equal to
b. one-half
c. two-thirds
d. three-fourths

(5) When possible, avoid using negatively stated stems. If a negative stem is necessary, highlight the negative word (e.g., not, never, least).

It is very tempting to write negatively stated questions, since they can be constructed by picking three true statements out of the reference material and changing a fourth statement to make it false. However, studies have shown that examinees do not do as well on negatively stated questions, either because they overlook the negative word and/or because negatively stated questions require examinees to pick an answer that is not true or characteristic, which can be somewhat confusing. In addition, these questions tend to emphasize negative learning. For example, consider the following stem of a multiple-choice question:

> During 100% power operation, the feedwater 2A high level dump valve opens inadvertently. The condensate pumps will not do which of the following:

This stem can be made to read positively:

> During 100% power operation, the feedwater 2A high level dump valve opens inadvertently. The condensate pumps will:
>
> a. increase flow to maintain feedwater flow rate.
> b. trip due to a runout condition.
> c. have no response.
> d. trip due to low suction pressure.

There are times when a negatively stated question is unavoidable. However, <u>never</u> use a negatively stated stem with a negatively stated answer option:

Which of the following indications would not be expected and might indicate an instrument failure?

a. The CRD "travel" lamp does not indicate when group 8 rods are in motion.
b. Group 7 out-motion is prevent past 91.4%
c. When you depress the "CRD travel in" lamp test pushbutton, the "CRD travel out" lamp comes on.
d. During a transfer of a group from DC hold to auxiliary, when you select "SEQ-OR," the "SEQ-OR" lamp is on and the "SEQ" lamp goes off.

Notice how confusing answer option A is in combination with the question stem.

(6) Provide sufficient counterbalance in questions with multi-part answers.

Multiple-choice questions can legitimately contain multi-part answer options. However, if the answers contain too many parts and/or too many options for each part, cues indicating the correct answer may be unavoidable. Consider the following example:

> The RCS is in hot standby with no reactor coolant pumps running. If OTSG pressure in decreased, according to the plant

verification procedure, which of the following temperature responses indicates the presence of natural circulation?

a. T-H increases, T-C remains the same.
b. T-H increases, T-C decreases.
c. T-H decreases, T-C decreases.
d. T-H remains the same, T-C decreases.

The candidate could choose the correct answer (C) without knowing about the T-C temperature response in this situation, since "T-H decreases" only occurs in option C.

Notice that two-part answers, with each part containing a two-option response, provides complete counterbalance, since all contingencies can be covered in four responses. For example:

Which of the following is a definition of quadrant power tilt ratio (QPTR)?

a. minimum upper detector output divided by average upper detector output.
b. maximum upper detector output divided by average upper detector output.
c. minimum upper detector output divided by average lower detector output.
d. maximum upper detector output divided by average lower detector output.

A multi-part question which is highly recommended is one in which the two-part answer options consist of a two-level response (e.g., yes/no; off/on) and a reason. For example:

Which of the following best describes the behavior of equilibrium xenon reactivity over core life?

a. it decreases, because of the increased fuel burnup.
b. it decreases, because of the decrease in plutonium-xenon yield.
c. it increases, because of the increase in thermal flux.
d. it increases, because of the decrease in boron concentration.

(7) When possible, include common misconceptions as distractors Since the purpose of the licensing examination is to differentiate between competent and less-than-competent candidates, a good source of questions involves topics in which there are common misconceptions about important K/A topics. For example, the following question was based upon a common misconception about loss of subcooling margin:

During a LOCA with a resultant loss of subcooling margin, why are the reactor coolant pumps (RCPs) secured?

a. to prevent pump damage resulting from operation under two-phase conditions.

b. to prevent core damage resulting from separation upon subsequent loss of RCS flow.
c. to reduce RCS pressure by removing the pressure heat developed by the RCPs.
d. to remove the heat being added to the RCS by the operating RCPs.

(8) Make all answer options homogeneous and highly plausible.

On a loss of condenser circulating water intake canal, the upper surge tank, hotwell, and condensate storage tank will supply sufficient feedwater to allow decay heat removal for approximately:

Poor:	Better:
a. 15 minutes	a. 8 hours
b. 8 hours	b. 24 hours
c. 48 hours	c. 48 hours
d. 3 months	d. 72 hours

Notice how one method of changing the difficulty level of a question is to vary the similarity among answer options. Develop distractors that are similar enough to be chosen by those who do not meet the testing objective, yet different enough so that they do not test trivial issues or distinctions.

(9) If the answer options have a logical sequence, put them in order (as in # 8 above.)

(10) Avoid overlapping answer options.

The SPND uses rhodium which decays with a half-life of 42 seconds. How long will it take for a detector to indicate approximately 95% of an instantaneous power level change?

Poor:	Better:
a. 2-4 minutes	a. 1-2 minutes
b. 4-6 minutes	b. 3-4 minutes
c. 6-8 minutes	c. 5-6 minutes
d. 8-10 minutes	d. 7-8 minutes

(11) Do not include trivial distractors with more important distractors.

In the search for distractors, it is very tempting to include relatively trivial facts along with options focused on more important issues or concepts. For example:

Which of the following is true concerning the turbine?

a. the turbine is rotated at low speed when shut down in order to prevent distortion of the turbine casing.
b. turbine eccentricity is the measure of turbine speed.
c. the turbine blades are cooled by hydrogen gas.

d. tech Specs require at least one turbine overspeed protection system be operable in Mode 2.

Relative to the other options, C could be considered a trivial distractor. Even if included as a wrong answer, the inclusion of relatively unimportant information jeopardizes the content validity of the question.

(12) Check your questions over for "specific determiners," which give clues as to the correct answer.

Specific determiners include:

(a) distractors which do not follow grammatically from the stem.

During 100% normal power operation a single steam flow element to the steam generator feedwater fails high. The steam generator feedwater control system will cause:

a. the feedwater valves to increase steam generation level slightly before returning the level to normal.
b. before returning the level to slightly above normal, the feedwater valves to increase the steam generator significantly.
c. the feedwater valves to increase the steam generator level to the level of a reactor trip.
d. the feedwater valves to increase the steam generator level slightly and maintain the increased level.

Improved Distractors:

a. the feedwater valves to increase steam generator level slightly before returning the level to normal.
b. the feedwater valves to increase the steam generator level significantly before returning the level to slightly above normal.
c. the feedwater valves to increase the steam generator level to the level of a reactor trip.
d. the feedwater valves to increase the steam generator level slightly and maintain the increased level.

(b) options which can be judged correct or incorrect without reading the stem;

(c) equivalent and/or synonymous options, which rule out both options for a candidate who recognizes the equivalence;

(d) an option which includes another option (for example: A) less than 5; B) less than 3...);

(e) implausible distractors;

(f) a correct answer which is longer than the distractors, unless longer options occur as the correct answer with equal frequency;

(g) qualifiers in the correct answer (e.g., probably, ordinarily, etc.) unless they are also used in the distractors;

(h) words such as "never" or "always" which suggest a wrong option;

(i) a correct option that differs from the distractors in favorableness, style, or terminology. For example:

Which of the following action or occurrence is likely to cause water hammer?

a. maintaining the discharge line from an auto starting pump filled with fluid.
b. water collecting in a steamline.
c. pre-warming of steam lines.
d. slowly closing the discharge valve of an operating pump.

In the above question, all options except for B (the correct answer) describe preventive actions. However, option B describes a condition that occurs as a result of negligence or oversight. A test-wise candidate need only know that water hammer is not a desired occurrence to determine the B is the least favorable and therefore correct answer.

(13) Vary the location of the correct answer; avoid a pattern.

Make sure the position of the correct answer is randomized throughout the set of multiple-choice questions. This means that the "A", "B", "C" and "D" options should be correct about an equal number of times but in no specific order.

4.6.2 Matching Items

With matching items, a candidate is required to match each word, sentence, or phrase in one column with a word, sentence, or phrase in another column. The items in the first column are called premises. The answers in the second column are called responses. Consider the following guidelines when constructing matching items.

(1) Give specific directions for each matching item, indicating on exactly what basis the matching is to be done.

(2) State in the directions whether a response can be used only once or more than once.

(3) Only use logically related material in a single matching item.

Nothing should be listed in either column that is not part of the subject in question.

(4) Consider the following possibilities for pairing premises and responses:

Premise	Response
terms or words	definitions
short questions	answers

symbols	proper names
causes	effects
principles	situations in which they apply

(5) For any single matching item, use only one set of premise-response types, e.g., only terms with definitions.

(6) Each response should be a plausible answer for each premise.

Match the alarm (letter) with its appropriate tone (number). Responses (numbers) may be used more than once.

a. fire	1. pulse tone
b. reactor building evacuation	2. wailing siren
c. site evacuation	3. steady tone

(7) Present an unequal number of premises and responses, or allow responses to be used more than once.

This will inhibit the candidate from obtaining clues to a correct answer through a process of elimination.

(8) Arrange the responses in a logical order, such as alphabetical or numerical.

(9) The entire matching item can contain no more than six subpart questions (see Chapter 5, Sections 5.4.1 and 5.4.2, Point Values and General Rules: A matching item may not exceed [3.0] total points and a single subpart of that item shall be [0.5] points.)

(10) Place the entire matching item on one page so the candidate need not flip back and forth between pages.

(11) Before scoring a matching item, list all possible responses you will accept as correct for each premise.

(12) A premise may have only one response, i.e., only one response may occupy an answer space.

Directions to matching items should <u>not</u> require more than one response to a premise; this practice not only fragments scoring and alters the implicit equality of the subitems but also may encourage "shotgunning," the writing in of all responses to a premise in order to receive some partial credit. Partial credit is not given for individual subitems of a matching item when only one response occupies an answer space.

Poor

Match the refueling interlock(s) from Column I that is (are) in effect for the plant conditions listed in Column I. Each interlock in Column II may be used more than once, or not at all.

	Column I	Column II
____	a. The service platform is loaded, not all rods are in, and the mode switch is in "refuel."	1. Rod Block
		2. Stops refuel platform travel towards core
____	b. Frame mounted hoist is fuel loaded, not all rods are in, mode switch is in "refuel", and the refuel platform is near or over the core.	3. Stops fuel grapple operation
		4. Stops operation of the service platform hoist
____	c. The refuel platform is near or over the core when the mode switch is placed in "start-up	5. Frame mounted hoist "LIFT" is deenergized
____	d. The service platform hoist is loaded, not all rods are in, when the mode switch is placed in "start-up"	6. Trolley mounted hoist "LIFT" is deenergized

ANSWER

a. 1, 4 [+0.5]
b. 1, 2, 3, 5, [+0.5] ← INCORRECT
c. 1, 2 [+0.5]
d. 1, 4 [+0.5]

See Chapter 5, Section 5.3.3.5 for further guidance and desirable examples.

Table 4.1
Considerations for Selecting Type of Written
Examination Item to Test K/As

I. MULTIPLE-CHOICE ITEMS

Multiple-Choice items are useful for:

K/A involving recognition of correct answer (vs. recall)
Simple factual K/As or more complex reasoning

Facts to remember when using multiple-choice items:

Can test many K/As with more questions, therefore higher test reliability
Candidates not penalized for poor writing skills
Can test many levels of K/As, knowledge depth
Easy, objective scoring

Wrong answers can help diagnose weaknesses
Difficult to construct
Difficult to generate good "distractor" answer-options
Requires recognition rather than recall

II. MATCHING ITEMS

Matching items are useful for:

Associations, relationships within homogeneous K/A material that is related by concept of objective

Facts to remember when using matching items:

Can test many K/As in a short space and time
Easy, objective scoring
Good test of associative thinking
Candidates are not penalized for poor writing skills

Limited to homogeneous material
Hard to control overlapping items
May encourage memorization

Table 4.1
Considerations for Selecting Type of Written Examination Item to Test K/As
(Cont.)

III. SHORT ANSWER ITEMS

Short Answer items are useful for:

Integration of K/As, systems events effects
Information required to be recalled in a precise form

Facts to remember when using short answer items:

Can test for recall of information (rather than recognition)
Can measure global approach to problems
Relatively easy to write
Answer must be known, cannot guess

Difficult to grade reliably
More susceptible to vagueness in question and misinterpretation
Time-consuming and sometimes difficult to grade
Longer to answer, leading to fewer K/As and a less reliable test

APPENDIX A
EXAM DEVELOPMENT CHECKLISTS

A. Constructing and Scoring Written Examinations

The following checklist presents points that should be incorporated when constructing examination items from the K/As for the written portion of the licensing examination.

1. General Guidance

a. Does the concept being measured have a direct, important relationship to the ability to perform the job?

b. Does the question match the testing objective and intent of the K/A?

c. Is the item clear, concise, and easy to read? Could it be stated more simply and still provide the necessary information? Can it be reworded or split up into more than one question?

d. Does the question provide all necessary information, stipulations, and assumptions needed for a fully correct response?

e. Is the question written at the highest appropriate level of knowledge or ability for the job position of the candidate being tested?

f. Is the question free of unnecessary difficulty or irrelevancy?

g. Is the question limited to one concept or topic?

h. Does the question have face validity?

i. Are key points underlined?

j. Is each question separate and independent of all other questions?

k. Are the less difficult questions at the beginning of each section?

l. Have your questions been reviewed by others?

m. Does your exam contain enough multiple choice, completion and matching to meet the requirements of Section 5.3?

Examiner Standards ES-107 and Attachment 1, "Written License Examination Quality Assurance Checkoff Sheet," contain additional areas for review.

2. Short Answer Questions

a. Is there one, short definitely correct answer for each item?

b. Does the scoring key follow directly from the question?

c. Are clues to the answer avoided?

d. Is the required degree of precision specified?

3. Multiple-Choice Items

a. Does the question have one focused topic, making it something other than a collection of true-false items?

b. Is as much information as possible included in the stem?

c. Is the question or problem defined in the stem?

d. Are tricky or irrelevant questions avoided?

e. Are the answer options homogeneous and highly plausible?

f. Are "none of the above" and "all of the above" avoided?

g. Are there an appropriate number of options for each question?

h. Is each item stated positively, unless the intent is to test knowledge of what not to do?

i. Is the question free of "specific determiners" (e.g., logical or grammatical inconsistencies, incorrect answers which are consistently different, verbal associations between the stem and the answer options)?

j. Are common misconceptions used as distractors?

k. Are the answer options of the items ordered sequentially?

l. Is the question free of trivial distractors?

4. Matching Items

a. Are tricky or irrelevant questions avoided?

b. Is there a clearly correct answer or answers to the item?

c. Are clues to the answer avoided (e.g., grammatical clues, response patterns)?

d. Do the directions clearly tell the candidates the basis on which to make the match and how to indicate their answers?

e. Do the directions tell whether responses can be used more than once?

f. Is each response a plausible answer for each premise?

g. Are there more responses than premises if each response can only be used once?

h. Are there 5-12 total responses required for the item?

i. Are the responses arranged in a logical order and all on one page?

j. Is the item arranged so that the candidate can mark answers easily and so the item can be scored efficiently?

5 NRC STYLE REQUIREMENTS FOR WRITTEN EXAMINATIONS

5.1 Purpose

Examiners currently utilize a wide variety of writing styles and formatting techniques in the generation of written examination items. Because of this expression of individuality, it is difficult to achieve a standardized appearance to our examinations, particularly when more than one examiner is contributing to a single exam, or when examiners try to use questions from the NRC Examination Question Bank (EQB). This manual chapter is designed to achieve a greater degree of consistency in examination development.

This consistency of appearance will also lead to an even more desirable outcome: improved reliability. Reliability is the consistency or dependability of results of the exam. It is, furthermore, the faith and confidence we attribute to the exam, knowing that we are testing examinees in a similar and like manner within and across regions. Specifically, this type of reliability is called interexaminer reliability, and it is enhanced when examiners develop examinations that are similar in overall length, assess knowledge at the use or application level, adhere to NRC item construction guidelines, and adopt the same scoring and grading criteria.

The structure and format guidance contained herein shall be followed by all examiners.

5.2 Exam Structure

Chapter 4 of this "Examiner's Handbook for Developing Operator Licensing Examinations" provides extensive guidance on how to generate an exam that is content valid via usage of the K/A Catalogues, NUREG 1122/23. This handbook should be the basis for identifying the topics on which the examination will focus. Learning objectives, particularly those associated with a facility related job/task analysis, shall be used to the extent practicable in conjunction with the K/A Catalogues to identify exam items and support their validity. By utilizing these two sources of information, test questions will be better able to withstand the close scrutiny they receive and the number of questions that must be deleted or modified due to a lack of association to operator oriented tasks will be minimized.

In addition to exam validity, the structure of the exam is also an important contributor to exam reliability. Easily interpreted, unambiguous questions can be asked repeatedly and should be a positive indicator of an examinee's competence and knowledge level. Therefore, grouping questions together based on topic area is highly desirable. The written examination should consist of many discrete questions, covering a broad range of topics. Because of recent industry or facility events, more than one question about a particular topic may be justified.

5.3 Individual Exam Item Development

As stated, Chapter 4 of this Handbook provides explicit guidance on how to use the various question formats. Before generating an exam, this chapter should be reviewed in order to refresh your memory on the correct methods to be used in construction of exam items. All questions shall be objective in nature; that is, all graders would agree on the answer and the credit allowed for each part of the answer. The intent of the written examination is to perform a broad sampling of the candidate's knowledge level and his ability to apply that knowledge. Therefore, the emphasis should be placed on generating questions which cover a wide spectrum of topics (i.e., a large variety of K/As). High point value essay questions that probe at a particular topic exclusively are not to be utilized. Concentration requirements for the different format types described in this section are given below:

(1) The written examination will be constructed for 100 points.

(2) At least 75 points shall conform to the multiple choice or matching format. The multiple choice format is considered the perfered format

(3) Short answer questions shall not constitute more than 25 points of the exam.

The following will provide information on how to phrase and format the questions.

5.3.1 Multiple Choice Format

The multiple choice format represents a desirable and efficient means for assessing a broad sampling of K/As and for assessing them at a use or application level of knowledge.

5.3.1.1 Set a tab at 5 spaces. This will be utilized to indent the possible choices. Use letters, followed by a period to identify each possible choice and include a blank line between each potential answer: e.g.,

a. fuel Temperature Coefficient
b. moderator Temperature Coefficient
c. void Coefficient
d. power Coefficient

5.3.1.2 Use a singular tense sentence or phrase as the initial part of the stem of the question: e.g.,

Which ONE of the following describes the behavior of the CVCS on a SIAS while at power?

OR

Select the curve on Attachment 1 which indicates how the Xenon concentration will change for the given power history.

5.3.1.3 Use a direct vice an incomplete statement in the stem of the question: e.g., Poor stem

Valve __________ is used to control the temperature of the RCS when on Shutdown Bypass Cooling.

Better stem

Select the valve below which is utilized to control the temperature of the RCS when on Shutdown Bypass Cooling.

5.3.1.4 In designing multiple choice questions that are operationally based and require an application/use scenario, provide the conditions to the candidate in the first part of the question separated by a double space from the body of the question, and blocked to the left column with each condition bulleted.

Given the following conditions:

- Both CFPTs tripped
- CA automatically started
- CA valves reset to control steam generator water level
- CA suction pressure decreases to seven (7) psig

Which ONE of the following describes CA pump response for the given conditions?

a. suction will automatically shift to RN.
b. suction will automatically shift to UST.
c. trip when suction pressure decreases to five (5) psig.
d. trip after a six (6) second time delay.

5.3.2 Multiple Choice Design Models

The movement toward increased objectivity in item development makes the multiple choice format increasingly desirable. The range of possible answers is limited to four and only one option can be correct. Scoring is, therefore, simpler and objective.

Developing a good multiple choice item, written at the use or application level of knowledge, which also adheres to good item construction guidelines, i.e., valid, operationally oriented, plausible distracters presents a challenge to the examiner. To assist and guide you in designing multiple choice items, the following four acceptable models are presented:

Model A

a. correct answer
b. incorrect answer
c. incorrect answer
d. incorrect answer

Model A depicts the traditional multiple choice design format. This model shows one correct single word/phrase answer followed by three incorrect single word/phrases options. Notice that the lengths of all options are similar.

Model B

a. correct answer
b. plausible misconception
c. incorrect answer
d. incorrect answer

Model B is a variation of Model where a plausible misconception is used as an incorrect answer. Notice again that the lengths of all options are similar.

Model C

a. correct answer with correct condition
   (e.g., because, since, when, if, etc.)
b. correct answer with incorrect condition
c. incorrect answer with incorrect condition
d. incorrect answer with incorrect condition

Model C depicts an acceptable multiple choice design that uses conditions with answers. (A condition in a setting, event, cause/effect that may make the answer correct or incorrect.) Notice that Model C shows only one correct answer with its correct condition and that all options are uniform in length.

Model D

a. correct answer
b. incorrect answer
c. correct answer with incorrect condition
d. incorrect answer with incorrect condition

Model D illustrates an acceptable model when it may not be possible to create all options in uniform length. This model shows paired lengths - two long and two short options - which avoids any single option from standing apart (either too long or too short) from the remaining options.

The four models presented are basic. Other models may be developed and used in combination with one another.

5.3.3 Matching Format

Matching items can be used where examiners want to assess ability to draw relationships among a similar set of ideas. While matching items can be objectively scored, care must be taken to insure that associations to be made in each respective column are similar in nature and kind, i.e., conditions and procedures, causes and results, actions and individuals, etc.

The following style format shall be used for developing matching items.

5.3.3.1 A two column format shall be utilized, with the items of interest (premises) blocked to the left in Column A and the possible choices (responses) listed in Column B.

5.3.3.2 Label the columns with a descriptive phrase.

5.3.3.3 Column A premises shall be lettered and the Column B responses shall be numbered as follows:

Column A (ACTION) --------	Column B (INDIVIDUAL) ------------
_____ a. Approves Clearance	1. SS
_____ b. Initiates Clearance	2. CRO
_____ c. Fills Out Clearance	3. Work Supervisor
	4. AO
	5. Individual performing work

Type a 5 space response line for each premise flush left margin.

5.3.3.4 More potential responses shall be available than premises and/or responses may be used more than once.

5.3.3.5 The directions of the question should indicate whether a response may be utilized only once, or if more than one response may apply to each premise in column A: e.g.,

Match the actions in Column A with the correct individual(s) in Column B responsible for ensuring the action takes place. (NOTE: Each response in Column B may be utilized only once, and only a single answer may occupy one answer space.)

OR

Match the actions in Column A with the correct individual(s) in Column B responsible for ensuring the action takes place. (NOTE: The items in Column B may be used once, more than once, or not at all, and only a single answer may occupy one answer space.)

Do not use both of these options simultaneously, however, as it may cause too much confusion. See the following examples that illustrate each of these two variations.

Example:

For the thermodynamic terms below, match the definitions in Column B to the terms in Column A. Write only one correct number to the left of the letter. Items in Column B can only be used once, and only a single answer may occupy one answer space.

Column A (TERMS)	Column B (DEFINITIONS)
_____ a. Pressure Spike	1. Shock caused by sudden decrease of motion in water.
_____ b. Cavitation	2. Water and steam mixture in stream.
_____ c. Two-Phase Flow	3. Caused by lack of steam in a system.
_____ d. Gas Binding	4. Causes pump vibration, low discharge pressure, and no flow.
_____ e. Water Hammer	5. Collapsing of steam pockets which tends to reduce pump output.
	6. Can be caused in solid system water hammer.

Example:

The HPCI control mode of the Feedwater Level Control System alters the setpoints for some of the FCV controllers. For each of the FCV controllers listed in Column 1, SELECT the correct revised setpoints from Column B. Write only one correct number to the left of the letter. The items from Column B may be used once, more than once, or not at all and only a single answer may occupy one answer space.

Column A (CONTROLLER)	Column B (SETPOINTS)
_____ a. FCV-11	1. No change in setpoints.
_____ b. FCF-12	2. Will maintain reactor water level at (+)71 inches or limit flow to 3,800 gpm.
_____ c. FCV-13a	3. Will maintain reactor water level at (+)65 inches or limit flow to 3,800 gpm.
	4. Will maintain reactor water level at (+)56 inches or limit flow to 3,800 gpm.

NOTE: As stated in Chapter 4, Section 4.6.2(12), only a single answer may occupy one answer space.

5.3.4 Short Answer Format

The short answer format can be used for testing recall or analysis depending upon the examiner's intent. Care must be taken in using this item format since objectivity is often difficult to achieve.

The language of the stem must be precise and focused so that it is clear as to what is expected for a correct answer.

The inherent nature of the short answer format lends itself toward "depth of response", typically takes longer to answer, and carries a higher point value. Because of this, the short answer may be more readily used during the operating portion of the exam. Since the objective of the written exam is to assess breadth of knowledge, use of the short answer format here should be used judiciously.

The following style format should be used for developing short answer questions.

5.3.4.1 Be specific in denoting the number of responses that are required for full credit and capitalize the number: e.g.,

> State THREE reasons for isolating the Letdown Heat Exchanger when ....

5.3.4.2 Use "ALL" vice a number to indicate the amount of responses required for full credit if there is doubt as to the number of responses into which the candidate will separate the required answer: e.g.,

The desired response is from a procedure where there are two immediate actions listed as:

1) Isolate letdown and secure charging
2) Immediately reduce turbine load and reactor power.

The two immediate actions could conceivably be broken up into four responses. Asking for ALL the required actions would be the correct way to ask the question.

5.3.4.3 Structure the short answer question so that the desired response is only a few words or phrases. At most, an answer shall be contained in two relatively simple sentences, such that the answer is readily apparent given the structure and content of the question.

The following example depicts the style for a typical short answer question.

> Example:
>
> In Procedure OP-EO.ZZ-101, "RPV Control," step RC/L-9 states "If RPV LEVEL FALLS BELOW - 129" THEN DELAY ADS INITIATION BY RESETTING THE TIMERS." Give THREE (3) reasons WHY this step is necessary.

5.3.4.4 The short answer format <u>may</u> take the form of a multi-part question discussed later. The format guidance for the short answer format is identical to that for the multi-part question as per the following example.

Example:

During a plant shutdown with Reactor Pressure at 65 psig, it is discovered that the Shutdown Cooling System cannot be placed in service and the Recirculation pumps are not available. In accordance with OP-IO.ZZ-004(Q), "Shutdown From Rated Power to Cold Shutdown" a reactor water level of greater than or equal or equal to 80 inches should be maintained.

a. WHY is this level required? (1.0)
b. IDENTIFY the level instrumentation range required to be used to indicate this level. (0.5)
c. WHAT system is utilized to remove decay heat? (0.5)

5.3.5 Drawings/Sketches/Curves

5.3.5.1 Provide the candidate with enough information and material to produce the desired output without making the effort too labor intensive. The question should be explicit in terms of what is required for full credit.

5.3.5.2 Provide the candidate with graph paper, incomplete system or logic drawings or other appropriate frame of reference materials so that you eliminate the effect of an individual's artistic skills in answering the question: e.g.,

Given the incomplete drawing of the Main Electrical Distribution System attached, draw in a dashed line between the appropriate breakers to indicate where ALL mechanical interlocks exist.

5.3.6 Multi-part Questions

Though the intent of the written examination is to investigate the breadth of a candidate's knowledge by testing a wide variety of K/As, situational questions provide a good framework for asking several integrated plant questions or a series of questions about one or several systems/procedures/concepts. This format is very useful when asking a series of questions associated with a recent licensee event or recently installed safety related system.

5.3.6.1 Present pertinent information, such as plant conditions, in tabular form, blocked in the left, and separate from the body of the question by blank lines: e.g.,

The following plant conditions exist:

-Tavg - 579 degrees
-PZR Pressure - 2200 psig
-A S/L Level - 33%
-B S/G Level - 41%

This will enable the examinee to quickly review and refer to the data while determining an answer.

5.3.6.2 Provide the assumptions/conditions in the first part of the question to establish a frame of reference for the individual before presenting the query.

Poor question structure

What are the Tech Spec actions and the procedural requirements if, while at 100% power with one MDAFW pump out of service and the C Channel S/G Level instrument failed LOW, a second MDAFW pump is declared INOPERABLE?

Better question structure

The following pertinent plant conditions exist:

-Mode 1 at 100% power
-B MDAFW pump out of service for 36 hours
-Maintenance reports another 72 hours to repair pump

The A MDAFW pump is now declared INOPERABLE. Using the attached Technical Specifications list what actions, if any, must be taken over the next 24 hours.

5.3.6.3 Distinguish a multi-part question from a multiple choice format by starting each part at the left margin. Each part is to be identified by a letter followed by a period, and the body of the question is to be block indented at the fifth space: e.g.,

a. What will be the effect of this situation on the TDAFW Pump?
b. If the discharge line from the B MDAFW Pump were to rupture, what would prevent the other AFW Pumps from exceeding runout conditions?

5.3.7 Binary/Three Response Examination Items

Questions such as True/False and Increase/Decrease/Remain the Same (as stand-alone distractors) shall not be used since there is an increased probability of getting the right answer, even if the examinee is uninformed of the topic area. Therefore, use of these types of questions is prohibited.

5.3.8 Miscellaneous

5.3.8.1 Ensure that the appropriate noun name or title is included (e.g., CV-1122, Charging Flow Control Valve) when asking a question that utilizes information such as a procedure or valve number.

5.3.8.2 Procedural titles shall be set off through the use of quotation marks (AOP-17, "Response to High Pressurizer Level").

5.3.8.3 The following shall be emphasized by the use of capital letters:

- Annunciators and alarms (e.g., HI FLUX AT SHUTDOWN)
-Number of responses required (e.g., THREE, ALL, etc.)

-Words or phrases defined in Technical Specifications (e.g., INOPERABLE, CHANNEL CHECK, etc.)
-Words or phrases used in the query to describe how a system or component is behaving (e.g., ... the PZR Pressure Channel A failed LOW)

5.3.8.4 Do not use comparative or superlative terms, such as "Best Answer" or "Most Correct Answer" in the stem of a question. These terms suggest that there may be more than one correct answer to the question, which not only compromises the definition of an objective question but also creates the potential for debate on the actual answer.

5.3.8.5 Do not use the word "correct" or "correctly describes" in the stem of a question. Since there is only one correct answer in the options, use of the word "correct" is redundant and unnecessary.

5.3.8.6 Inclusion of point values in the right margin of a question shall be utilized only for multi-part questions since the (NRC) EQB exam generation program will automatically list question point values in the question heading. Point values shall be blocked to the right margin and contained in brackets: e.g.,

a. What TWO conditions must exist for the EDG Sequencer to reinitiate the ESF Loading Sequence if it has TIMED OUT following a loss of off-site power without an SI? (1.0)
b. How long must an operator wait after an EDG Load Sequence is initiated before he can take manual control of EDF components? (0.5)

5.3.8.7 Brackets [ ] shall be utilized instead of parentheses ( ) to set apart information such as point values or extra information. Information contained within parentheses will be ignored by the EQB when uploading questions. The only data that should be in parentheses is that which may vary from plant to plant, such as setpoints.

5.4 Structure of Answers and References

5.4.1 Point Values

Standardization of question and examination point values is required so that consistency and reliability may be achieved. Arguments can be made for varying point values for a given question format based on the importance of the question, the time required to answer the question and the level of analysis needed to determine a response. However, the advantages of having a few simple rules for assignment of point values far outweigh any gains achieved by trying to incorporate a multitude of factors, several of which are extremely difficult to measure and quantify.

Application of the guidelines in the Examiner's Handbook will effectively structure the examination content so that there is appropriate emphasis on areas of greater importance. Additionally, by developing questions that stress application of knowledge and synthesis of information, the rationalizations for varying point values for similarly formatted questions are rendered moot.

5.4.2 General Rules

All point values for any single test item shall have a minimum value of one point [1.0] and a maximum value of three points [3.0].

The lowest value assigned to any part of a single test item shall be half a point [0.5].

5.4.3 Specific Rules

5.4.3.1 Multiple choice questions will be worth one point [1.0].

5.4.3.2 Each response required in a matching question will be worth a half a point [0.5]: Not to exceed [3.0] for a single item.

Answer Key for Question 1.21:

a. 1 [+0.5]
b. 1, 4 [+0.5 ea]
c. 2 [+0.5]

5.4.3.3 Phrases or words that encompass a single concept, action or idea shall be worth half a point [0.5]: e.g.,

Answer Key for Question 2.06:

This failure initiates an SI Signal [+0.5] and will Auto Start the TDEFW Pump [+0.5]

Answer Key for Question 3.28:

Trip the RCPs [+0.5] and isolate Seal Injection [+0.5]

5.4.3.4 Singular data items (i.e, discrete bits of knowledge), such as parameters, valves, switches, setpoints and alarms which are memorization type responses shall be worth half a point [0.5]: e.g.,

Answer Key for Question 3.11:

a. MOV-67, MOV-68, AOV-12 [+0.5 ea]
b. 2250 PSIG [+0.5]
c. LTOP Switch, PORV ACTUATED annunciator [+0.5 ea]

5.4.3.5 When an answer is in a sentence form, insert the assigned point values within the sentence(s) such that it is apparent what credit will be assigned for each segment of the answer. The previous grading rules above shall be applied: e.g., Answer Key for Question 5.15:

So that the design margins to core limits [+0.5] will not be exceeded [+0.5] under both steady state and transient conditions [+0.5]

Answer Key for Question 7.20:

A reactor trip may result [+0.5] at 2350 PSIG [+0.5] or at 105% Reactor Power [+0.5]

Answer Key for Question 3.09:

It prevents voltage drops [+0.5] during EDG Load Sequencing [+0.5]

5.4.3.6 When a system drawing or curve is given and the examinee is asked to identify parts, assign half a point [0.5] to each item correctly identified.

5.4.3.7 Each key element required to be supplied by a candidate, when given an incomplete system/logic drawing or curve shall be assigned half a point [0.5]

5.4.3.8 Calculation problems shall be worth no more than 2.0 points, with values assigned to identifying the proper equation(s) or concept(s) to be applied, methods and use of data, and for mathematical skills displayed in multiples of half a point [0.5]: e.g.,

Question 1.21:

S/G pressure is 964 psig
S/G steam quality is 99%
B S/G PORV fails OPEN

Calculate the percent quality or degrees superheat, as appropriate, for the steam leaving the PORV. Show all work.

Answer Key for Question 1.21:

Isenthalpic process, so enthalpy [h] is the same on both sides of the PORV [+0.5 for recognition of isenthalpic process]

$h|_{986\ psig} = h|_{1000\ psia}$ = 1192 - [1192 - 542] [0.1] = 1185.5

h_f for atmospheric pressure is 1150.5, steam is superheated

form superheated steam tables, Temp = 284 degrees for $h|_{1185}$

284 - 212 = 72 degrees superheat.

[+1.0 for enthalpy and temperature determination processes]

[+0.5 for math/calculation setup]

5.4.3.9 Use brackets to separate information that is included in the answer key to aid the grader, but which is not required for full credit: e.g.,

Answer Key for Question 7.05:

Manually initiate emergency boration [by opening V-112 and V-114] [+0.5] and insert all rods using fast speed [+0.5]

5.4.3.10 Include appropriate facility learning objectives, if available, within the reference section: e.g.,

Reference for Question 1.13:

Lesson Plan CA-1-NRD, LO 3a
K/A [3.2/3.3]

5.4.3.11 If a question is asked that has a K/A value less than 2.5, the reference section shall list the applicable justification, such as facility LER or recent system modification.

5.4.3.12 Until such time as it is done automatically by the EQB, the K/A Importance Factor shall be included in the reference section. (See 5.4.3.10 above.)

5.4.3.13 The total point value of a written examination shall be 100 points. As all questions will be objective in nature and require minimal candidate effort to record the answer, the main source of variance in establishing an exam point value total will be the time required to determine the correct response (due to analysis required, etc.). A well-constructed examination should leave a competent examinee with approximately 15-20 minutes per section for review. Examiner experience will be the deciding factor in determining the final point value of the test.

5.5 Test Compilation/Use of Handouts

The way in which handouts are incorporated into the exam has a bearing on the reliability of the examination. If an examinee has to search for the applicable drawing or curve, it adds to their frustration level and the time consumed in test administration. The format of the exam itself also contributes to the exam's reliability. It takes considerably more time to take an examination that incorporates a multitude of administrative requirements and detracts from the examinee's ability to focus on just the exam questions.

5.5.1 Handouts

5.5.1.1 Include handouts, such as matrices or incomplete system drawings on which the examinee must transcribe his answer, directly behind the page of the applicable question. This will help ensure the integrity of the candidate's package of answers.

5.5.1.2 Include all other handouts, such as reference material, Technical Specification excerpts, etc., within a separate handout package, which shall be page checked with the candidates before exam administration.

5.5.1.3 Use Steam Table Booklets, vice copied pages, whenever possible. This will alleviate problems with reproduction quality or inclusion of incorrect excerpts. The facility shall provide sufficient unmarked copies of the seam tables utilized in the control room. The examination proctors shall ensure that compromise of the exam is not possible by checking that the steam table supplements are clean of any marks.

5.5.2 Exam Layout

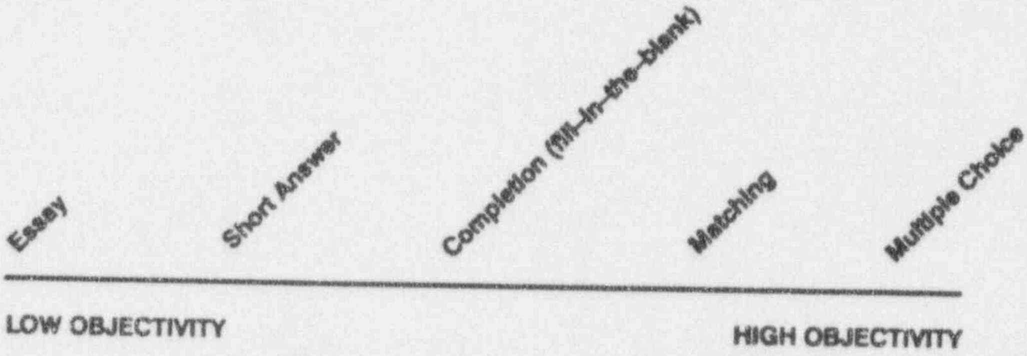
5.5.2.1 Use of single page/single question layout shall be required. This has proven to facilitate both the exam grading and the test taking processes. It minimizes the administrative burden on the candidate, and greatly reduces the chances for an examinee to inadvertently miss answering a question.

A Final Comment On Objectivity

Writing good test items that are technically and psychometrically sound is a skillful and challenging task. Exam writers must mentally juggle and balance technical concepts with an array of item writing principles to create a single "good" item. In addition, the test item must, in the examiner's judgement, be one that reasonably assesses what an RO or SRO ought to know and also be one that assesses knowledge at an application/analysis level to insure that knowledge can be used to predict or solve problems rather than to test knowledge for memory sake alone. The test writing challenge is further complicated by the inherent ambiguities and interpretations of the written language. The test item stem, for example, must be as precise and focused as possible so as to make perfectly clear in the mind of the candidate what the question is asking for.

It is clear to see then, how the written language (clarity or lack of clarity) can affect objectivity. Objectivity can be increased by selecting more objective scoring formats, that is, formats less dependent upon written language and misinterpretations. The Figure 2 below shows the relationship of item formats on the continuum of objectivity.

Figure 2



Of the various item formats, it is obvious that the multiple choice format is the most objective. It is recommended that as many items as possible, if not all, should be in this format.

Finally, the overall written examinations can be highly streamlined if examiners adapt use of a separate answer sheet for the recording of candidate answers. The separate answer sheet affords several key benefits:

1. Directions for recording answers for multiple choice items need only be given once (at the onset of the exam) rather than repeating "circle the answer below" for each item.

2. Examiner scoring can be made easier and more rapid through either the use of an overlay key or an optical scanner.

3. Item analysis can be accomplished more readily through either a single sheet visual profile of responses or through a computerized item analysis via optical scanner.

Please forward any comments, recommendations,
or modifications to:

Program Review and Development Section
Operator Licensing Branch
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
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