NUREG-1122
Rev. 2, Supp. 1

Knowledge and Abilities Catalog for Nuclear Power Plant Operators

Pressurized Water Reactors

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

NUREG-1122
Rev. 2, Supp. 1

Knowledge and Abilities Catalog for Nuclear Power Plant Operators

Pressurized Water Reactors

Final Report

Manuscript Completed: September 2007
Date Published: October 2007

Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at NRC's Public Electronic Reading Room at http://www.nrc.gov/reading-rm.html. Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

1. The Superintendent of Documents
   U.S. Government Printing Office
   Mail Stop SSOP
   Washington, DC 20402–0001
   Internet: bookstore.gpo.gov
   Telephone: 202-512-1800
   Fax: 202-512-2250
2. The National Technical Information Service
   Springfield, VA 22161–0002
   www.ntis.gov
   1–800–553–6847 or, locally, 703–605–6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: U.S. Nuclear Regulatory Commission
Office of Administration
Mail, Distribution and Messenger Team
Washington, DC 20555-0001
E-mail: DISTRIBUTION@nrc.gov
Facsimile: 301–415–2289

Some publications in the NUREG series that are posted at NRC's Web site address http://www.nrc.gov/reading-rm/doc-collections/nuregs are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852–2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute
11 West 42nd Street
New York, NY 10036–8002
www.ansi.org
212–642–4900

Legally binding regulatory requirements are stated only in laws; NRC regulations; licenses, including technical specifications; or orders, not in NUREG-series publications. The views expressed in contractor-prepared publications in this series are not necessarily those of the NRC.

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG–XXXX) or agency contractors (NUREG/CR–XXXX), (2) proceedings of conferences (NUREG/CP–XXXX), (3) reports resulting from international agreements (NUREG/IA–XXXX), (4) brochures (NUREG/BR–XXXX), and (5) compilations of legal decisions and orders of the Commission and Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of NRC's regulations (NUREG–0750).

Supplement 1 to Revision 2 of NUREG-1122
Record of Changes

Instructions: Remove the existing NUREG-1122, Revision 2, pages and insert replacement pages as noted below (corrections and clarifications have been made as indicated).

Section	Remove Page(s)	Replacement Page(s) / Correction Summary
Cover page	Cover page	Cover page / add Supp.1
Abstract	iii and blank	iii-iv / describe Supplement 1 changes in Abstract, add Paperwork Reduction Act page
Table of Contents	v-viii	v-viii / add Supplement 1, page number changes, add new APE (077) for Generator Voltage and Electric Grid Disturbances to Section 4.2
Summary of Significant Changes	xi-xii xvii-xviii	xi-xii / describe the replacement of Section 2 xvii-xviii / discuss the study basis to reassess job safety and importance values
Organization of Catalog	1-1 to 1-6 1-11 and 1-12	1-1 to 1-6 / amend to conform with Revision 9 of NUREG-1021 and Section 2 changes 1-11 and 1-12 / add new APE (077) for Generator Voltage and Electric Grid Disturbances
2.0 Generic Knowledges and Abilities	2-1 to 2-16	2-1 to 2-18 / revise Section 2
4.2 Generic Abnormal Plant Evolutions (APEs)	4.2-1 to 4.2-2 4.2-11 to 4.2-14 4.2-59 and blank	4.2-1 to 4.2-2/ add new APE (077) for Generator Voltage and Electric Grid Disturbances 4.2-11 to 4.2-14/ correct typographical error, delete the word "pump" from loss of reactor coolant makeup K/A category statements 4.2-59 to blank / add new APE (077) for Generator Voltage and Electric Grid Disturbances

ABSTRACT

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized-Water Reactors (PWRs) (NUREG-1122, Revision 2, Supplement 1) provides the basis for the development of content-valid licensing examinations for reactor operators (ROs) and senior reactor operators (SROs). The examinations developed using the PWR Catalog along with the Operator Licensing Examination Standards for Power Reactors (NUREG-1021, Rev. 9, Supplement 1) will sample the topics listed under Title 10, Code of Federal Regulations, Part 55 (10 CFR 55).

The PWR Catalog contains approximately 5,100 knowledge and ability (K/A) statements for ROs and SROs at PWRs. The catalog is organized into six major sections: Catalog Organization, Generic Knowledge and Ability Statements, Plant Systems, Emergency and Abnormal Plant Evolutions, Components and Theory.

Revision 1 to the PWR Catalog modified the form and content of the original catalog. The K/As were linked to their applicable 10 CFR 55 item numbers. SRO level K/As were identified by 10 CFR 55.43 item numbers. The plant-wide generic and system generic K/As were combined in one section. Systems were organized into nine safety functions and the emergency and abnormal evolutions were reorganized and expanded.

Revision 2 incorporated corrections to the Rev. 1 catalog that were identified during a pilot testing program associated with revision of 10 CFR 55 and implementation of NUREG-1021, Interim Rev. 8, "Operator Licensing Examination Standards for Power Reactors." Corrections to the catalog included:

1. addition of K/As that had been omitted in Rev. 1 (approximately 70).
2. deletion of duplicate K/As (approximately 15).
3. correction of importance values of consolidated K/As to reflect highest previously assigned values (approximately 75).
4. correction of typographical errors.
5. addition of importance value modifiers that had been omitted in Rev. 1 (approximately 225).

Revision 2, Supplement 1, includes the following changes:

1. total replacement of Section 2, "Generic Knowledges and Abilities."
2. inclusion of one additional Abnormal Plant Evolution (APE), 077, "Generator Voltage and Electric Grid Disturbances," in Section 4.2, "Generic Abnormal Plant Evolutions."

Corrections and additions are identified by "redline" marking in the margins.

PAPERWORK REDUCTION ACT STATEMENT

This NUREG contains information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget, approval number 3150-0018.

Public Protection Notification

The NRC may neither conduct nor sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB approval number.

TABLE OF CONTENTS

	page
ABSTRACT	iii
SUMMARY OF SIGNIFICANT CHANGES	xi
1 ORGANIZATION OF THE CATALOG	
1.1 Introduction	1-1
1.2 Part 55 of Title 10 of the Code of Federal Regulations	1-1
1.3 RO Written Examination Items	1-1
1.4 SRO Written Examination Items	1-3
1.5 RO and SRO Operating Test Items	1-3
1.6 Senior Operators Limited to Fuel Handling	1-4
1.7 Organization of the PWR Catalog	1-5
1.8 Generic Knowledge And Abilities	1-5
1.9 Plant Systems	1-6
1.10 Emergency And Abnormal Plant Evolutions	1-10
1.11 Components	1-13
1.12 Theory	1-14
1.13 Importance Ratings	1-15
1.14 Acronyms And Terms	1-16
2 GENERIC KNOWLEDGES AND ABILITIES	
2.1 Conduct of Operations	2-1
2.2 Equipment Control	2-6
2.3 Radiation Control	2-11
2.4 Emergency Procedures / Plan	2-13
3 PLANT SYSTEMS	
3.1 Safety Function 1: Reactivity Control	**3.1-1**
Control Rod Drive System	3.1-2
Chemical and Volume Control System	3.1-11
Rod Position Indication System	3.1-21

Table of Contents (Continued)

	page
3.2 Safety Function 2: Reactor Coolant System Inventory Control	**3.2-1**
Reactor Coolant System	3.2-2
Chemical and Volume Control System	3.2-6
Emergency Core Cooling System	3.2-16
Pressurizer Level Control System	3.2-21
Engineered Safety Features Actuation System	3.2-24
3.3 Safety Function 3: Reactor Pressure Control	**3.3-1**
Emergency Core Cooling System	3.3-2
Pressurizer Pressure Control System	3.3-6
3.4 Safety Function 4: Heat Removal From Reactor Core	**3.4-1**
PRIMARY SYSTEM	
Reactor Coolant System	3.4-2
Reactor Coolant Pump System	3.4-6
Residual Heat Removal System	3.4-10
Steam Generator System	3.4-14
SECONDARY SYSTEM	
Main and Reheat Steam System	3.4-19
Steam Dump System and Turbine Bypass Control	3.4-23
Main Turbine Generator System	3.4-26
Condenser Air Removal System	3.4-33
Condensate System	3.4-36
Main Feedwater System	3.4-41
Auxiliary / Emergency Feedwater System	3.4-45
Service Water System	3.4-48
3. 5 Safety Function 5: Containment Integrity	**3.5-1**
Pressurizer Relief Tank / Quench Tank System	3.5-2
Containment Cooling System	3.5-5
Ice Condenser System	3.5-8
Containment Spray System	3.5-10
Containment Iodine Removal System	3.5-14
Hydrogen Recombiner and Purge Control System	3.5-16
Containment System	3.5-18
3. 6 Safety Function 6: Electrical	**3.6-1**
A.C. Electrical Distribution	3.6-2
D.C. Electrical Distribution	3.6-6
Emergency Diesel Generators	3.6-8

Table of Contents (Continued)

	page
3.7 Safety Function 7: Instrumentation	**3.7-1**
Reactor Protection System	3.7-2
Nuclear Instrumentation System	3.7-5
Non-Nuclear Instrumentation System	3.7-9
In-Core Temperature Monitor System	3.7-11
Area Radiation Monitoring System	3.7-13
Process Radiation Monitoring System	3.7-15
3.8 Safety Function 8: Plant Service Systems	**3.8-1**
Component Cooling Water System	3.8-2
Containment Purge System	3.8-6
Spent Fuel Pool Cooling System	3.8-9
Fuel Handling Equipment System	3.8-12
Circulating Water System	3.8-14
Instrument Air System	3.8-19
Station Air System	3.8-21
Fire Protection System	3.8-23
3.9 Safety Function 9: Radioactivity Release	**3.9-1**
Liquid Radwaste System	3.9-2
Waste Gas Disposal System	3.9-5

4 EMERGENCY AND ABNORMAL PLANT EVOLUTIONS

4.1 Generic Emergency Plant Evolutions	**4.1-1**
Reactor Trip	4.1-2
Small Break LOCA	4.1-4
Large Break LOCA	4.1-7
Anticipated Transient Without Scram (ATWS)	4.1-9
Steam Generator Tube Rupture	4.1-11
Station Blackout	4.1-14
Inadequate Core Cooling	4.1-16
4.2 Generic Abnormal Plant Evolutions	**4.2-1**
Continuous Rod Withdrawal	4.2-2
Dropped Control Rod	4.2-4
Inoperable/Stuck Control Rod	4.2-6
Pressurizer Vapor Space Accident	4.2-8
Reactor Coolant Pump Malfunctions	4.2-10
Reactor Coolant Pump Malfunctions (Loss of RC Flow)	4.2-10
Loss of Reactor Coolant Makeup	4.2-12

Table of Contents (Continued)

	page
Emergency Boration	4.2-14
Loss of Residual Heat Removal System	4.2-16
Loss of Component Cooling Water	4.2-18
Pressurizer Pressure Control System Malfunction	4.2-20
Pressurizer Level Control Malfunction	4.2-22
Loss of Source Range Nuclear Instrumentation	4.2-24
Loss of Intermediate Range Nuclear Instrumentation	4.2-26
Fuel Handling Incidents	4.2-28
Steam Generator Tube Leak	4.2-29
Steam Line Rupture	4.2-31
Loss of Condenser Vacuum	4.2-33
Loss of Main Feedwater	4.2-35
Loss of Off-Site Power	4.2-37
Loss of Vital AC Electrical Instrument Bus	4.2-41
Loss of DC Power	4.2-43
Accidental Liquid Radwaste Release	4.2-44
Accidental Gaseous Radwaste Release	4.2-46
Area Radiation Monitoring (ARM) System Alarms	4.2-48
Loss of Nuclear Service Water	4.2-49
Loss of Instrument Air	4.2-50
Plant Fire on Site	4.2-52
Control Room Evacuation	4.2-54
Loss of Containment Integrity	4.2-57
High Reactor Coolant Activity	4.2-58
Generator Voltage and Electric Grid Disturbances	4.2-60
4.3 Babcock and Wilcox EPEs and APEs	4.3-1
Vital System Status Verification	4.3-1
Inadequate Subcooling Margin	4.3-4
Inadequate Heat Transfer	4.3-7
Excessive Heat Transfer	4.3-9
LOCA Cooldown	4.3-12
Natural Circulation Cooldown	4.3-15
Post-Trip Stabilization	4.3-18
EOP Rules	4.3-21
EOP Enclosures	4.3-24
Plant Runback	4.3-26
Loss of NNI-X	4.3-28
Loss of NNI-Y	4.3-30
Turbine Trip	4.3-32
Emergency Diesel Actuation	4.3-34
Shutdown Outside Control Room	4.3-36
Flooding	4.3-38
Refueling Canal Level Decrease	4.3-40

SUMMARY OF SIGNIFICANT CHANGES

The changes described in paragraphs 1 through 6, below, were incorporated in Revision 1 of the catalog in August, 1995. Paragraph 7 describes changes that were incorporated with Revision 2 of the catalog. Paragraph 8 describes Supplement 1 to Revision 2, which includes a replacement of Section 2, "Generic Knowledges and Abilities," and a new abnormal plant evolution (APE).

1 ORGANIZATION OF THE CATALOG CHANGES

1.1 10 CFR 55 items listed

The content of the written examinations and operating licensing tests is dictated by Sections 55.41, 55.43, and 55.45 of Title 10 of the Code of Federal Regulations (10 CFR). The thirty four (34) items listed in 10 CFR 55 are listed in the catalog to reduce the need for cross referencing.

1.2 Stem statements linked to 10 CFR 55 items

The linkage of K/As to the 10 CFR 55.41, 43 and 45 requirements was done to help ensure that the examinations include a representative sample from among the applicable items. Throughout the catalog, 10 CFR 55 section references are shown in parentheses following the appropriate K/A statement, such as (CFR: 41.x / 43.x / 45.x).

1.3 Senior Reactor Operator (SRO) K/As identified

NUREG-1021, Rev. 8, "Operator Licensing Examination Standards for Power Reactors," Section ES-401, required at least 25% of the site-specific written examination for SROs to evaluate K/As required for the higher license level. The original catalogs did not explicitly identify the K/As that represented the higher license level. Differences in RO and SRO importance ratings were sometimes used, but, the rating differences were not linked to the 10 CFR 55.43 SRO items. In this catalog revision, SRO license level K/As were linked to the items associated with the 10 CFR 55.43 SRO items. This is intended to remove subjectivity from selection of higher license level K/As.

1.4 Senior Reactor Operator Limited to Fuel Handling (LSRO) discussion added

NUREG-1021, Rev. 8, Section 701 referred to the K/A catalog. In an effort to assure consistency between the Examination Standards and the catalog, a brief discussion of the use of the catalog for LSRO examinations was included.

1.5 New catalog organization was implemented.

1 ORGANIZATION OF THE CATALOG

2 GENERIC KNOWLEDGE AND ABILITIES (120, Rev. 2, Supp. 1)
- Conduct of Operations K/As
- Equipment Control K/As

Radiation Control K/As
Emergency Procedures / Plan K/As

3 PLANT SYSTEMS (45)
Knowledge Categories (K1 - K6)
Ability Categories (A1 - A4)

4 EMERGENCY AND ABNORMAL PLANT EVOLUTIONS

Generic EPEs (7) and APEs (32)
Babcock and Wilcox EPEs and APEs (17)
Combustion Engineering EPEs and APEs (7)
Westinghouse EPEs and APEs (16)
Knowledge Categories (EK/AK 1 - EK/ AK3)
Ability Categories (EA/AA 1 - EA/AA 2)

5 COMPONENTS
Component Knowledge Categories (8)

6 THEORY
Reactor Theory Knowledge Categories (8)
Thermodynamics Knowledge Categories (10)

1.6 Revised knowledge and ability stem statements for plant systems.

The knowledge and ability stem statements (categories) for plant systems were revised for consistency with the BWR catalog. This involved revising three knowledge stem statements as shown below. The changes are underlined.

K3. Knowledge of the effect that a loss <u>or malfunction</u> of the (SYSTEM) will have on the following:
(CFR 41.7 / 45.6)

K5. Knowledge of the <u>operational implications</u> of the following concepts as they apply to the (SYSTEM):
(CFR 41.5 / 45.7)

K6 Knowledge of the <u>effect of a loss or malfunction of the</u> following will have on the (SYSTEM):
(CFR 41.7 / 45.7)

1.7 Revised knowledge and ability stem statements for emergency plant evolutions.

The knowledge and ability stem statements (categories) for emergency plant evolutions were revised for consistency with the BWR catalog. This involved revising all five (5) knowledge stem statements as shown below. The changes are underlined.

EK1. Knowledge of the operational implications following concepts as they apply to the (EMERGENCY PLANT EVOLUTION)
(CFR 41.8 / 41.10 / 45.3)

EK2. Knowledge of the interrelations between (EMERGENCY PLANT EVOLUTION) and the following:
(CFR 41.7 / 45.7)

EK3. Knowledge of the reasons for the following responses as they apply to (EMERGENCY PLANT EVOLUTION):
(CFR 41.5 / 41.10 / 45.6 . 45.13)

EA1. Ability to operate and / or monitor the following as they apply to (EMERGENCY PLANT EVOLUTION):
(CFR 41.7 / 45.6)

EA2. Ability to determine and interpret the following as they apply to (EMERGENCY PLANT EVOLUTION):
(CFR 43.5 / 45.13)

3.4 Consolidated multi-mode plant system K/As.

This change was made for several reasons. First, only ten (10) of the forty five (45) plant systems were organized in more than one mode. This created inconsistency in the way the tasks and K/As associated with the plant system were presented within the catalog. This also resulted in K/A duplication (e.g. 28 duplicate K/As in ECCS).

As result of this change, duplicate K/As were eliminated and the remaining K/As were organized into one section per system. The systems affected by this change are listed below:

1. Control Rod Drive System
2. Chemical and Volume Control System
3. Reactor Coolant System
4. Emergency Core Cooling System
5. Main Turbine Generator System
6. Condensate System
7. Containment Spray System
8. Emergency Diesel Generator
9. Component Cooling Water System
10. Circulating Water System.

4 EMERGENCY (EPE) AND ABNORMAL PLANT EVOLUTIONS (APE) CHANGES

4.1 The original EPEs were organized into generic EPEs and APEs.

The original EPEs represented a mix of EPEs and APEs. In the context of the K/A catalog an EPE is any condition, event or symptom which leads to entry into

emergency operating procedures (EOPs). An APE is any degraded condition, event or symptom not leading directly to an EOP entry condition nor related to an operational condition as: power operation, hot shutdown, start-up, shutdown and refueling.

4.2 All EPEs and APEs were consolidated in new Section 4.

The original PWR catalog listed 7 EPEs and 31 APEs in the individual safety function sections. This method of organizing the EPEs and APEs did not accommodate integrative situations crossing several plant systems and or safety functions. The consolidated organization in Section 4 is designed to accommodated integrative evolutions.

4.3 Vendor specific EPEs and APEs were added to Section 4.

The original EPEs did not address the EPE and APE differences imposed by vendor specific technologies and procedures. As a result, 40 new vendor specific APEs and APEs were added.

5 COMPONENTS CHANGES

5.1 Component K/As were linked to 10 CFR 55 item numbers.

6 THEORY CHANGES

6.1 Reactor Theory and Thermodynamics theory K/As were linked to 10 CFR 55 item numbers.

7 REVISION 2 CHANGES

7.1 Approximately 70 K/As that had been omitted in Rev. 1 were added.
7.2 Approximately 15 duplicate K/As were deleted.
7.3 Approximately 75 corrections were made to the importance values of consolidated K/As to reflect highest previously assigned values.
7.4 Typographical errors were corrected.
7.5 Importance value modifiers that had been omitted in Rev. 1 were added.

8 REVISION 2, SUPPLEMENT 1, CHANGES

8.1 Regarding replacement of Section 2, the Pressurized Water Reactor Owners Group, with the endorsement of the U.S. Nuclear Regulatory Commission (NRC), first initiated a study to reassess the job relevance and importance-to-safety ratings of 129 K/As in Section 2 of NUREG-1122. The study was subsequently expanded to include the Boiling Water Reactor Owners Group to reassess its counterpart Section 2 of NUREG-1123.

8.2 Regarding the additional APE 077, "Generator Voltage and Electric Grid Disturbances," the NRC requested that additional K/As related to degraded voltage be incorporated and validated during the study's second phase to address lessons learned from a major blackout in August 2003.

Corrections and additions are identified by "redline" marking.

1 ORGANIZATION OF THE CATALOG

1.1 INTRODUCTION

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors (PWR) NUREG-1122, Revision 2, Supplement 1, provides the basis for development of content-valid written and operating licensing examinations for reactor operators (ROs) and senior reactor operators (SROs). The Catalog is designed to ensure equitable and consistent examinations.

1.2 PART 55 OF TITLE 10 OF THE CODE OF FEDERAL REGULATIONS

The catalog is used in conjunction with NUREG-1021, Revision 9, Supplement 1, "Operator Licensing Examination Standards for Power Reactors." NUREG-1021 provides policy and guidance and establishes the procedures and practices for examining licensees and applicants for RO and SRO licenses pursuant to Part 55 of Title 10 of the Code of Federal Regulations (10 CFR 55). All knowledge and abilities (K/As) in this catalog are directly linked by item number to 10 CFR 55.

1.3 RO WRITTEN EXAMINATION ITEMS

The items for RO written examinations are specified in 10 CFR 55.41(b). The RO written examination questions should be generated from a representative sample of K/As derived from among the 10 CFR 55.41(b) items listed below:

(1) Fundamentals of reactor theory, including fission process, neutron multiplication, source effects, control rod effects, criticality indications, reactivity coefficients, and poison effects.

(2) General design features of the core, including core structure, fuel elements, control rods, core instrumentation, and coolant flow.

(3) Mechanical components and design features of reactor primary system.

(4) Secondary coolant and auxiliary systems that affect the facility.

(5) Facility operating characteristics during steady state and transient conditions, including coolant chemistry, causes and effects of temperature, pressure and reactivity changes, effects of load changes, and operating limitations and reasons for these operating characteristics.

(6) Design, components, and function of reactivity control mechanisms and instrumentation.

(7) Design, components, and function of control and safety systems, including instrumentation, signals, interlocks, failure modes, and automatic and manual features.

(8) Components, capacity, and functions of emergency systems.

(9) Shielding, isolation, and containment design features, including access limitations.

(10) Administrative, normal, abnormal, and emergency operating procedures for the facility.

(11) Purpose and operation of radiation monitoring systems, including alarms and survey equipment.

(12) Radiological safety principles and procedures.

(13) Procedures and equipment available for handling and disposal of radioactive materials and effluents.

(14) Principals of heat transfer, thermodynamics and fluid mechanics.

The RO written examination is administered in two sections, a generic fundamentals examination (GFE) section and a site-specific examination. The GFE covers those knowledge items that do not vary significantly among reactors of the same type (refer to NUREG-1021, ES-205). The GFE covers components, reactor theory, and thermodynamics knowledge.

The component knowledge items are derived from 10 CFR 55.41(b) items 3 and 7. Reactor theory knowledge items are derived from 10 CFR 55.41(b)1.
Thermodynamic knowledge items are derived from 10 CFR 55.41(b)14.

The site-specific RO written examination covers K/As that vary among reactors of the same type. The guidance for preparation of RO written examination is presented in NUREG-1021, ES-401. The RO examination includes a balanced mix of generic K/As, plant systems K/As, and emergency/abnormal evolution K/As. The K/As associated with the RO site-specific written examinations are derived from 10 CFR 55.41(b) items 2 through 13.

1.4 SRO WRITTEN EXAMINATION ITEMS

The items for SRO written examinations are presented in 10 CFR 55.43(b). The guidance for preparation of the SRO written examination is presented in NUREG-1021, ES-401. The examination for SROs includes 25 questions based on the higher license level K/As from the 7 items listed under 10 CFR 55.43(b), and 75 questions derived from 10 CFR 55.41(b) RO K/As. The 7 SRO items listed under 10 CFR 55.43(b) include:

(1) Conditions and limitations in the facility license.

(2) Facility operating limitations in the technical specifications and their bases.

(3) Facility licensee procedures required to obtain authority for design and operating changes in the facility.

(4) Radiation hazards that may arise during normal and abnormal situations, including maintenance activities and various contamination conditions.

(5) Assessment of facility conditions and selection of appropriate procedures during normal, abnormal, and emergency situations.

(6) Procedures and limitations involved in initial core loading, alterations in core configuration, control rod programming, and determination of various internal and external effects on core reactivity.

(7) Fuel handling facilities and procedures.

1.5 RO AND SRO OPERATING TEST ITEMS

The items for operating tests for ROs and SROs are presented in 10 CFR 55.45(a). The guidance for preparation of the operating tests is presented in NUREG-1021, ES-301. The operating test should include a representative selection of K/As derived from 13 items listed in 10 CFR 55.45(a). The 13 items listed in 10 CFR 55.45(a) are:

(1) Perform pre-startup procedures for the facility, including operating of those controls associated with plant equipment that could affect reactivity.

(2) Manipulate the console controls as required to operate the facility between shutdown and designated power levels.

(3) Identify annunciators and condition-indicating signals and perform appropriate remedial actions where appropriate.

(4) Identify the instrumentation systems and the significance of facility instrument readings.

(5) Observe and safely control the operating behavior characteristics of the facility.

(6) Perform control manipulations required to obtain desired operating results during normal, abnormal, and emergency situations.

(7) Safely operate the facility's heat removal systems, including primary coolant, emergency coolant, and decay heat removal systems, and identify the relations of proper operation of these systems to the operation of the facility.

(8) Safety operate the facility's auxiliary and emergency systems, including operation of those controls associated with plant equipment that could affect reactivity or the release of radioactive materials to the environment

(9) Demonstrate or describe the use and function of the facility's radiation monitoring systems, including fixed radiation monitors and alarms, portable survey instruments, and personnel monitoring equipment.

(10) Demonstrate a knowledge of significant radiation hazards, including permissible levels in excess of those authorized, and ability to perform other procedures to reduce excessive levels of radiation and to guard against personnel exposure.

(11) Demonstrate knowledge of the emergency plan for the facility, including, as appropriate, the operator's or senior operator's responsibility to decide when the plan should be executed and the duties under the plan assigned.

(12) Demonstrate the knowledge and ability as appropriate to the assigned position to assume the responsibilities associated with the safe operation of the facility.

(13) Demonstrate the applicant's ability to function within the control room team as appropriate to the assigned position, in such a way that the facility licensee's procedures are adhered to and that the limitations in its license and amendments are not violated.

1.6 SENIOR OPERATORS LIMITED TO FUEL HANDLING

The specifications for examinations for Senior Operators Limited to Fuel Handling (LSRO) are provided in Examination Standard, NUREG 1021, Section ES-701. The LSRO examination process includes both a written examination and an operating test. This examination and test include, but are not limited to, items associated with 10 CFR 55.43(b) items 5 through 7, and 10 CFR 55.45(a) items 5 and 6.

1.7 ORGANIZATION OF THE PWR CATALOG

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors is organized into 6 major sections. K/As are grouped according to the major section to which they pertain. This organization is shown schematically below.

1 ORGANIZATION OF THE CATALOG

2 GENERIC KNOWLEDGE AND ABILITIES (120)
- Conduct of Operations K/As
- Equipment Control K/As
- Radiation Control K/As
- Emergency Procedures / Plan K/As

3 PLANT SYSTEMS (45)
- Knowledge Categories (K1 - K6)
- Ability Categories (A1 - A4)

4 EMERGENCY AND ABNORMAL PLANT EVOLUTIONS

- Generic EPEs (7) and APEs (32)
- Babcock and Wilcox EPEs and APEs (17)
- Combustion Engineering EPEs and APEs (7)
- Westinghouse EPEs and APEs (16)
- Knowledge Categories (EK/AK 1 - EK/ AK3)
- Ability Categories (EA/AA 1 - EA/AA 2)

5 COMPONENTS
- Component Knowledge Categories (8)

6 THEORY
- Reactor Theory Knowledge Categories (8)
- Thermodynamics Knowledge Categories (10)

1.8 GENERIC KNOWLEDGE AND ABILITIES

Generic knowledge and abilities are generally administrative knowledges and abilities with broad application across systems and operations. They are listed in Section 2 of the catalog. The four (4) categories of generic K/As are listed below:

1) Conduct of Operations K/As
2) Equipment Control K/As
3) Radiation Control K/As
4) Emergency Procedures / Plan K/As

The generic K/As for "Conduct of Operations" are used to evaluate the applicant's knowledge of the daily operation of the facility. The types of information covered under this category may include, for example, shift turnover, operator responsibilities, and procedure usage.

The generic K/As for "Equipment Control " are used to evaluate the administrative activities associated with the management and control of plant systems and equipment. Examples of the types of information evaluated under this topic include maintenance and temporary modifications of systems.

The generic K/As for "Radiation Control" are used to evaluate the applicant's knowledge and abilities with respect to radiation hazards and protection (personnel and public). Examples of the types of information that should be evaluated under this topic are knowledge of significant radiation hazards or radiation work permits.

The generic K/As for "Emergency Procedures / Plan" are used to evaluate the applicant's general knowledge of emergency operations. The K/As are designed to evaluate knowledge of the emergency procedures network and its use. The emergency plan K/As are used to evaluate the applicant's knowledge of the plan, including, as appropriate, the RO's or SRO's responsibility to decide whether it should be executed and the duties assigned under the plan.

1.9 PLANT SYSTEMS

1.9.1 Plant System Organization by Safety Function

Nine (9) major safety functions must be maintained to ensure safe PWR nuclear power plant operation. The safety function groups are:

1) Reactivity Control
2) Reactor Coolant System Inventory Control
3) Reactor Pressure Control
4) Heat Removal From Reactor Core
5) Containment Integrity
6) Electrical
7) Instrumentation
8) Plant Service Systems
9) Radioactivity Release.

Forty five (45) plant systems have been included in the PWR Catalog based on their relationship and importance to 9 safety functions. Table 1 contains a list of these plant systems, arranged within safety function. It should be noted that 3 plant systems (Reactor Coolant System, Chemical and Volume Control System, and Emergency Core Cooling System) each contribute to 2 safety functions. Also, because the emergency plant evolutions are linked to more than one system, they have been listed separately

011 Large Break LOCA
029 Anticipated Transient Without Scram (ATWS)
038 Steam Generator Tube Rupture
055 Station Blackout
074 Inadequate Core Cooling

Generic Abnormal Plant Evolutions (APEs)

001 Continuous Rod Withdrawal
003 Dropped Control Rod
005 Inoperable/Stuck Control Rod
008 Pressurizer Vapor Space Accident
015 Reactor Coolant Pump Malfunctions
017 Reactor Coolant Pump Malfunctions (Loss of RC Flow)
022 Loss of Reactor Coolant Makeup
024 Emergency Boration
025 Loss of Residual Heat Removal System
026 Loss of Component Cooling Water
027 Pressurizer Pressure Control System Malfunction
028 Pressurizer Level Control Malfunction
032 Loss of Source Range Nuclear Instrumentation
033 Loss of Intermediate Range Nuclear Instrumentation
036 Fuel Handling Incidents
037 Steam Generator Tube Leak
040 Steam Line Rupture
051 Loss of Condenser Vacuum
054 Loss of Main Feedwater
056 Loss of Off-Site Power
057 Loss of Vital AC Electrical Instrument Bus
058 Loss of DC Power
059 Accidental Liquid Radwaste Release
060 Accidental Gaseous Radwaste Release
061 Area Radiation Monitoring (ARM) System Alarms
062 Loss of Nuclear Service Water
065 Loss of Instrument Air
067 Plant Fire on Site
068 Control Room Evacuation
069 Loss of Containment Integrity
076 High Reactor Coolant Activity
077 Generator Voltage and Electric Grid Disturbances

Babcock and Wilcox EPEs /APEs

E02 Vital System Status Verification
E03 Inadequate Subcooling Margin
E04 Inadequate Heat Transfer
E05 Excessive Heat Transfer

E08 LOCA Cooldown
E09 Natural Circulation Operations
E10 Post-Trip Stabilization
E13 EOP Rules
E14 EOP Enclosures
A01 Plant Runback
A02 Loss of NNI-X
A03 Loss of NNI-Y
A04 Turbine Trip
A05 Emergency Diesel Actuation
A06 Shutdown Outside Control Room
A07 Flooding
A08 Refueling Canal Level Decrease

Combustion Engineering Emergency and Abnormal Plant Evolutions
E02 Reactor Trip Recovery
E05 Excess Steam Demand
E06 Loss of Feedwater
E09 Functional Recovery
A11 RCS Overcooling
A13 Natural Circulation Operations
A16 Excess RCS Leakage

Westinghouse Emergency and Abnormal Plant Evolutions
E02 SI Termination
E03 LOCA Cooldown and Depressurization
E04 LOCA Outside Containment
E05 Loss of Secondary Heat Sink
E06 Degraded Core Cooling
E07 Saturated Core Cooling
E08 Pressurized Thermal Shock
E09 Natural Circulation Operations
E10 Natural Circulation with Steam Void in Vessel with/without RVLIS
E11 Loss of Emergency Coolant Recirculation
E12 Uncontrolled Depressurization of all Steam Generators
E13 Steam Generator Overpressure
E14 High Containment Pressure
E15 Containment Flooding
E16 High Containment Radiation

1.10.2 K/A Stem Statements for EPEs and APEs

The information delineated within each emergency plant evolution is organized into 3 different types of knowledge and 2 different types of ability. If there are no knowledge or ability statements following a stem statement there is no applicable K/A.

2.0 GENERIC KNOWLEDGES AND ABILITIES

2.0.1 Technical Requirements Manual (TRM) - For the purpose of this catalog, K/As that reference Technical Specifications (TS) may include the Technical Requirements Manual, where applicable.

2.0.2 K/A Clarifying Examples - K/As that include the words "such as" list suggested topical areas as examples and are not intended to be all inclusive.

2.1 Conduct of Operations

2.1.1 **Knowledge of conduct of operations requirements.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.8 SRO 4.2

2.1.2 **Knowledge of operator responsibilities during all modes of plant operation.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 4.1 SRO 4.4

2.1.3 **Knowledge of shift or short-term relief turnover practices.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.7 SRO 3.9

2.1.4 **Knowledge of individual licensed operator responsibilities related to shift staffing, such as medical requirements, "no-solo" operation, maintenance of active license status, 10CFR55, etc.**
(CFR: 41.10 / 43.2)
IMPORTANCE RO 3.3 SRO 3.8

2.1.5 **Ability to use procedures related to shift staffing, such as minimum crew complement, overtime limitations, etc.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 2.9* SRO 3.9

2.1.6 **Ability to manage the control room crew during plant transients.**
(CFR: 41.10 / 43.5 / 45.12 / 45.13)
IMPORTANCE RO 3.8* SRO 4.8

2.1.7 **Ability to evaluate plant performance and make operational judgments based on operating characteristics, reactor behavior, and instrument interpretation.**
(CFR: 41.5 / 43.5 / 45.12 / 45.13)
IMPORTANCE RO 4.4 SRO 4.7

2.1 Conduct of Operations (continued)

2.1.8 **Ability to coordinate personnel activities outside the control room.**
(CFR: 41.10 / 45.5 / 45.12 / 45.13)
IMPORTANCE RO 3.4 SRO 4.1

2.1.9 **Ability to direct personnel activities inside the control room.**
(CFR: 41.10 / 45.5 / 45.12 / 45.13)
IMPORTANCE RO 2.9* SRO 4.5

2.1.10 **Moved to 2.2.38**

2.1.11 **Moved to 2.2.39**

2.1.12 **Moved to 2.2.40**

2.1.13 **Knowledge of facility requirements for controlling vital/controlled access.**
(CFR: 41.10 / 43.5 / 45.9 / 45.10)
IMPORTANCE RO 2.5 SRO 3.2

2.1.14 **Knowledge of criteria or conditions that require plant-wide announcements, such as pump starts, reactor trips, mode changes, etc.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.1 SRO 3.1

2.1.15 **Knowledge of administrative requirements for temporary management directives, such as standing orders, night orders, Operations memos, etc.**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 2.7 SRO 3.4

2.1.16 **Deleted**

2.1.17 **Ability to make accurate, clear, and concise verbal reports.**
(CFR: 41.10 / 45.12 / 45.13)
IMPORTANCE RO 3.9 SRO 4.0

2.1.18 **Ability to make accurate, clear, and concise logs, records, status boards, and reports.**
(CFR: 41.10 / 45.12 / 45.13)
IMPORTANCE RO 3.6 SRO 3.8

2.1.19 **Ability to use plant computers to evaluate system or component status.**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 3.9 SRO 3.8

2.1 Conduct of Operations (continued)

2.1.20 **Ability to interpret and execute procedure steps.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 4.6 SRO 4.6

2.1.21 **Ability to verify the controlled procedure copy.**
(CFR: 41.10 / 45.10 / 45.13)
IMPORTANCE RO 3.5* SRO 3.6*

2.1.22 **Revised and moved to 2.2.35**

2.1.23 **Ability to perform specific system and integrated plant procedures during all modes of plant operation.**
(CFR: 41.10 / 43.5 / 45.2 / 45.6)
IMPORTANCE RO 4.3 SRO 4.4

2.1.24 **Moved to 2.2.41**

2.1.25 **Ability to interpret reference materials, such as graphs, curves, tables, etc.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.9 SRO 4.2

2.1.26 **Knowledge of industrial safety procedures (such as rotating equipment, electrical, high temperature, high pressure, caustic, chlorine, oxygen and hydrogen).**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 3.4 SRO 3.6

2.1.27 **Knowledge of system purpose and/or function.**
(CFR: 41.7)
IMPORTANCE RO 3.9 SRO 4.0

2.1.28 **Knowledge of the purpose and function of major system components and controls.**
(CFR: 41.7)
IMPORTANCE RO 4.1 SRO 4.1

2.1.29 **Knowledge of how to conduct system lineups, such as valves, breakers, switches, etc.**
(CFR: 41.10 / 45.1 / 45.12)
IMPORTANCE RO 4.1 SRO 4.0

2.1 Conduct of Operations (continued)

2.1.30 **Ability to locate and operate components, including local controls.**
(CFR: 41.7 / 45.7)
IMPORTANCE RO 4.4 SRO 4.0

2.1.31 **Ability to locate control room switches, controls, and indications, and to determine that they correctly reflect the desired plant lineup.**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 4.6 SRO 4.3

2.1.32 **Ability to explain and apply system limits and precautions.**
(CFR: 41.10 / 43.2 / 45.12)
IMPORTANCE RO 3.8 SRO 4.0

2.1.33 **Moved to 2.2.42**

2.1.34 **Knowledge of primary and secondary plant chemistry limits.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 2.7 SRO 3.5

2.1.35 **Knowledge of the fuel-handling responsibilities of SROs.**
(CFR: 41.10 / 43.7)
IMPORTANCE RO 2.2 SRO 3.9

2.1.36 **Knowledge of procedures and limitations involved in core alterations.**
(CFR: 41.10 / 43.6 / 45.7)
IMPORTANCE RO 3.0 SRO 4.1

2.1.37 **Knowledge of procedures, guidelines, or limitations associated with reactivity management.**
(CFR: 41.1 / 43.6 / 45.6)
IMPORTANCE RO 4.3 SRO 4.6

2.1.38 **Knowledge of the station's requirements for verbal communications when implementing procedures.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.7* SRO 3.8

2.1.39 **Knowledge of conservative decision making practices.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.6 SRO 4.3

2.1.40 **Knowledge of refueling administrative requirements.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 2.8 SRO 3.9

2.1 Conduct of Operations (continued)

2.1.41 **Knowledge of the refueling process.**
(CFR: 41.2 / 41.10 / 43.6 / 45.13)
IMPORTANCE RO 2.8 SRO 3.7

2.1.42 **Knowledge of new and spent fuel movement procedures.**
(CFR: 41.10 / 43.7 / 45.13)
IMPORTANCE RO 2.5 SRO 3.4

2.1.43 **Ability to use procedures to determine the effects on reactivity of plant changes, such as reactor coolant system temperature, secondary plant, fuel depletion, etc.**
(CFR: 41.10 / 43.6 / 45.6)
IMPORTANCE RO 4.1 SRO 4.3

2.1.44 **Knowledge of RO duties in the control room during fuel handling, such as responding to alarms from the fuel handling area, communication with the fuel storage facility, systems operated from the control room in support of fueling operations, and supporting instrumentation.**
(CFR: 41.10 / 43.7 / 45.12)
IMPORTANCE RO 3.9 SRO 3.8

2.1.45 **Ability to identify and interpret diverse indications to validate the response of another indication.**
(CFR: 41.7 / 43.5 / 45.4)
IMPORTANCE RO 4.3 SRO 4.3

2.2 Equipment Control

2.2.1 **Ability to perform pre-startup procedures for the facility, including operating those controls associated with plant equipment that could affect reactivity.**
(CFR: 41.5 / 41.10 / 43.5 / 43.6 / 45.1)
IMPORTANCE RO 4.5 SRO 4.4

2.2.2 **Ability to manipulate the console controls as required to operate the facility between shutdown and designated power levels.**
(CFR: 41.6 / 41.7 / 45.2)
IMPORTANCE RO 4.6 SRO 4.1

2.2.3 (multi-unit license) **Knowledge of the design, procedural, and operational differences between units.**
(CFR: 41.5 / 41.6 / 41.7 / 41.10 / 45.12)
IMPORTANCE RO 3.8 SRO 3.9

2.2.4 (multi-unit license) **Ability to explain the variations in control board/control room layouts, systems, instrumentation, and procedural actions between units at a facility.**
(CFR: 41.6 / 41.7 / 41.10 / 45.1 / 45.13)
IMPORTANCE RO 3.6 SRO 3.6

2.2.5 **Knowledge of the process for making design or operating changes to the facility.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 2.2 SRO 3.2

2.2.6 **Knowledge of the process for making changes to procedures.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 3.0 SRO 3.6

2.2.7 **Knowledge of the process for conducting special or infrequent tests.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 2.9 SRO 3.6

2.2.8 **Deleted**

2.2.9 **Deleted**

2.2.10 **Deleted**

2.2 Equipment Control (continued)

2.2.11 **Knowledge of the process for controlling temporary design changes.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 2.3 SRO 3.3

2.2.12 **Knowledge of surveillance procedures.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.7 SRO 4.1

2.2.13 **Knowledge of tagging and clearance procedures.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 4.1 SRO 4.3

2.2.14 **Knowledge of the process for controlling equipment configuration or status.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 3.9 SRO 4.3

2.2.15 **Ability to determine the expected plant configuration using design and configuration control documentation, such as drawings, line-ups, tag-outs, etc.**
(CFR: 41.10 / 43.3 / 45.13)
IMPORTANCE RO 3.9 SRO 4.3

2.2.16 **Deleted**

2.2.17 **Knowledge of the process for managing maintenance activities during power operations, such as risk assessments, work prioritization, and coordination with the transmission system operator.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 2.6 SRO 3.8

2.2.18 **Knowledge of the process for managing maintenance activities during shutdown operations, such as risk assessments, work prioritization, etc.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 2.6 SRO 3.9

2.2.19 **Knowledge of maintenance work order requirements.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 2.3 SRO 3.4

2.2 Equipment Control (continued)

2.2.20 **Knowledge of the process for managing troubleshooting activities.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 2.6 SRO 3.8

2.2.21 **Knowledge of pre- and post-maintenance operability requirements.**
(CFR: 41.10 / 43.2)
IMPORTANCE RO 2.9 SRO 4.1

2.2.22 **Knowledge of limiting conditions for operations and safety limits.**
(CFR: 41.5 / 43.2 / 45.2)
IMPORTANCE RO 4.0 SRO 4.7

2.2.23 **Ability to track Technical Specification limiting conditions for operations.**
(CFR: 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.1 SRO 4.6

2.2.24 **Moved to 2.2.36**

2.2.25 **Knowledge of the bases in Technical Specifications for limiting conditions for operations and safety limits.**
(CFR: 41.5 / 41.7 / 43.2)
IMPORTANCE RO 3.2 SRO 4.2

2.2.26 **Moved to 2.1.40**

2.2.27 **Moved to 2.1.41**

2.2.28 **Moved to 2.1.42**

2.2.29 **Moved to 2.1.35**

2.2.30 **Moved to 2.1.44**

2.2.31 **Revised and moved to 2.1.36**

2.2.32 **Deleted**

2.2.33 **Deleted**

2.2.34 **Revised and moved to 2.1.43**

2.2 Equipment Control (continued)

2.2.35 **Ability to determine Technical Specification Mode of Operation.**
(CFR: 41.7 / 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.6 SRO 4.5

2.2.36 **Ability to analyze the effect of maintenance activities, such as degraded power sources, on the status of limiting conditions for operations.**
(CFR: 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.1 SRO 4.2

2.2.37 **Ability to determine operability and/or availability of safety related equipment.**
(CFR: 41.7 / 43.5 / 45.12)
IMPORTANCE RO 3.6 SRO 4.6

2.2.38 **Knowledge of conditions and limitations in the facility license.**
(CFR: 41.7 / 41.10 / 43.1 / 45.13)
IMPORTANCE RO 3.6 SRO 4.5

2.2.39 **Knowledge of less than or equal to one hour Technical Specification action statements for systems.**
(CFR: 41.7 / 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.9 SRO 4.5

2.2.40 **Ability to apply Technical Specifications for a system.**
(CFR: 41.10 / 43.2 / 43.5 / 45.3)
IMPORTANCE RO 3.4 SRO 4.7

2.2.41 **Ability to obtain and interpret station electrical and mechanical drawings.**
(CFR: 41.10 / 45.12 / 45.13)
IMPORTANCE RO 3.5 SRO 3.9

2.2.42 **Ability to recognize system parameters that are entry-level conditions for Technical Specifications.**
(CFR: 41.7 / 41.10 / 43.2 / 43.3 / 45.3)
IMPORTANCE RO 3.9 SRO 4.6

2.2.43 **Knowledge of the process used to track inoperable alarms.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.0 SRO 3.3

2.2 Equipment Control (continued)

2.2.44 **Ability to interpret control room indications to verify the status and operation of a system, and understand how operator actions and directives affect plant and system conditions.**

(CFR: 41.5 / 43.5 / 45.12)

IMPORTANCE RO 4.2 SRO 4.4

2.3 Radiation Control

2.3.1 **Deleted**

2.3.2 **Deleted**

2.3.3 **Deleted**

2.3.4 **Knowledge of radiation exposure limits under normal or emergency conditions.**
(CFR: 41.12 / 43.4 / 45.10)
IMPORTANCE RO 3.2 SRO 3.7

2.3.5 **Ability to use radiation monitoring systems, such as fixed radiation monitors and alarms, portable survey instruments, personnel monitoring equipment, etc.**
(CFR: 41.11 / 41.12 / 43.4 / 45.9)
IMPORTANCE RO 2.9 SRO 2.9

2.3.6 **Ability to approve release permits.**
(CFR: 41.13 / 43.4 / 45.10)
IMPORTANCE RO 2.0 SRO 3.8

2.3.7 **Ability to comply with radiation work permit requirements during normal or abnormal conditions.**
(CFR: 41.12 / 45.10)
IMPORTANCE RO 3.5 SRO 3.6

2.3.8 **Deleted**

2.3.9 **Deleted**

2.3.10 **Deleted**

2.3.11 **Ability to control radiation releases.**
(CFR: 41.11 / 43.4 / 45.10)
IMPORTANCE RO 3.8 SRO 4.3

2.3.12 **Knowledge of radiological safety principles pertaining to licensed operator duties, such as containment entry requirements, fuel handling responsibilities, access to locked high-radiation areas, aligning filters, etc.**
(CFR: 41.12 / 45.9 / 45.10)
IMPORTANCE RO 3.2 SRO 3.7

2.3 Radiation Control (continued)

2.3.13 **Knowledge of radiological safety procedures pertaining to licensed operator duties, such as response to radiation monitor alarms, containment entry requirements, fuel handling responsibilities, access to locked high-radiation areas, aligning filters, etc.**
(CFR: 41.12 / 43.4 / 45.9 / 45.10)
IMPORTANCE RO 3.4 SRO 3.8

2.3.14 **Knowledge of radiation or contamination hazards that may arise during normal, abnormal, or emergency conditions or activities.**
(CFR: 41.12 / 43.4 / 45.10)
IMPORTANCE RO 3.4 SRO 3.8

2.3.15 **Knowledge of radiation monitoring systems, such as fixed radiation monitors and alarms, portable survey instruments, personnel monitoring equipment, etc.**
(CFR: 41.12 / 43.4 / 45.9)
IMPORTANCE RO 2.9 SRO 3.1

2.4 Emergency Procedures / Plan

2.4.1 **Knowledge of EOP entry conditions and immediate action steps.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 4.6 SRO 4.8

2.4.2 **Knowledge of system set points, interlocks and automatic actions associated with EOP entry conditions.**
(CFR: 41.7 / 45.7 / 45.8)
IMPORTANCE RO 4.5 SRO 4.6

2.4.3 **Ability to identify post-accident instrumentation.**
(CFR: 41.6 / 45.4)
IMPORTANCE RO 3.7 SRO 3.9

2.4.4 **Ability to recognize abnormal indications for system operating parameters that are entry-level conditions for emergency and abnormal operating procedures.**
(CFR: 41.10 / 43.2 / 45.6)
IMPORTANCE RO 4.5 SRO 4.7

2.4.5 **Knowledge of the organization of the operating procedures network for normal, abnormal, and emergency evolutions.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.7 SRO 4.3

2.4.6 **Knowledge of EOP mitigation strategies.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.7 SRO 4.7

2.4.7 **Deleted**

2.4.8 **Knowledge of how abnormal operating procedures are used in conjunction with EOPs.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.8 SRO 4.5

2.4.9 **Knowledge of low power/shutdown implications in accident (e.g., loss of coolant accident or loss of residual heat removal) mitigation strategies.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.8 SRO 4.2

2.4 Emergency Procedures / Plan (continued)

2.4.10 **Deleted**

2.4.11 **Knowledge of abnormal condition procedures.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 4.0 SRO 4.2

2.4.12 **Knowledge of general operating crew responsibilities during emergency operations.**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 4.0 SRO 4.3

2.4.13 **Knowledge of crew roles and responsibilities during EOP usage.**
(CFR: 41.10 / 45.12)
IMPORTANCE RO 4.0 SRO 4.6

2.4.14 **Knowledge of general guidelines for EOP usage.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.8 SRO 4.5

2.4.15 **Revised and moved to 2.1.38**

2.4.16 **Knowledge of EOP implementation hierarchy and coordination with other support procedures or guidelines such as, operating procedures, abnormal operating procedures, and severe accident management guidelines.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.5 SRO 4.4

2.4.17 **Knowledge of EOP terms and definitions.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.9 SRO 4.3

2.4.18 **Knowledge of the specific bases for EOPs.**
(CFR: 41.10 / 43.1 / 45.13)
IMPORTANCE RO 3.3 SRO 4.0

2.4.19 **Knowledge of EOP layout, symbols, and icons.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.4 SRO 4.1

2.4.20 **Knowledge of the operational implications of EOP warnings, cautions, and notes.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.8 SRO 4.3

2.4 Emergency Procedures / Plan (continued)

2.4.21 **Knowledge of the parameters and logic used to assess the status of safety functions, such as reactivity control, core cooling and heat removal, reactor coolant system integrity, containment conditions, radioactivity release control, etc.**
(CFR: 41.7 / 43.5 / 45.12)
IMPORTANCE RO 4.0 SRO 4.6

2.4.22 **Knowledge of the bases for prioritizing safety functions during abnormal/emergency operations.**
(CFR: 41.7 / 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.6 SRO 4.4

2.4.23 **Knowledge of the bases for prioritizing emergency procedure implementation during emergency operations.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.4 SRO 4.4

2.4.24 **Deleted**

2.4.25 **Knowledge of fire protection procedures.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.3 SRO 3.7

2.4.26 **Knowledge of facility protection requirements, including fire brigade and portable fire fighting equipment usage.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.1 SRO 3.6

2.4.27 **Knowledge of "fire in the plant" procedures.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.4 SRO 3.9

2.4.28 **Knowledge of procedures relating to a security event (non-safeguards information).**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.2 SRO 4.1

2.4.29 **Knowledge of the emergency plan.**
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 3.1 SRO 4.4

2.4 Emergency Procedures / Plan (continued)

2.4.30 **Knowledge of events related to system operation/status that must be reported to internal organizations or external agencies, such as the State, the NRC, or the transmission system operator.**
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 2.7 SRO 4.1

2.4.31 **Knowledge of annunciator alarms, indications, or response procedures.**
(CFR: 41.10 / 45.3)
IMPORTANCE RO 4.2 SRO 4.1

2.4.32 **Knowledge of operator response to loss of all annunciators.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.6 SRO 4.0

2.4.33 **Moved to 2.2.43**

2.4.34 **Knowledge of RO tasks performed outside the main control room during an emergency and the resultant operational effects.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 4.2 SRO 4.1

2.4.35 **Knowledge of local auxiliary operator tasks during an emergency and the resultant operational effects.**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.8 SRO 4.0

2.4.36 **Deleted**

2.4.37 **Knowledge of the lines of authority during implementation of the emergency plan.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.0 SRO 4.1

2.4.38 **Ability to take actions called for in the facility emergency plan, including supporting or acting as emergency coordinator if required.**
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 2.4 SRO 4.4

2.4.39 **Knowledge of RO responsibilities in emergency plan implementation.**
(CFR: 41.10 / 45.11)
IMPORTANCE RO 3.9 SRO 3.8

2.4 Emergency Procedures / Plan (continued)

2.4.40 **Knowledge of SRO responsibilities in emergency plan implementation.**
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 2.7 SRO 4.5

2.4.41 **Knowledge of the emergency action level thresholds and classifications.**
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 2.9 SRO 4.6

2.4.42 **Knowledge of emergency response facilities.**
(CFR: 41.10 / 45.11)
IMPORTANCE RO 2.6 SRO 3.8

2.4.43 **Knowledge of emergency communications systems and techniques.**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.2 SRO 3.8

2.4.44 **Knowledge of emergency plan protective action recommendations.**
(CFR: 41.10 / 41.12 / 43.5 / 45.11)
IMPORTANCE RO 2.4 SRO 4.4

2.4.45 **Ability to prioritize and interpret the significance of each annunciator or alarm.**
(CFR: 41.10 / 43.5 / 45.3 / 45.12)
IMPORTANCE RO 4.1 SRO 4.3

2.4.46 **Ability to verify that the alarms are consistent with the plant conditions.**
(CFR: 41.10 / 43.5 / 45.3 / 45.12)
IMPORTANCE RO 4.2 SRO 4.2

2.4.47 **Ability to diagnose and recognize trends in an accurate and timely manner utilizing the appropriate control room reference material.**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 4.2 SRO 4.2

2.4.48 **Revised and moved to 2.2.44**

2.4.49 **Ability to perform without reference to procedures those actions that require immediate operation of system components and controls.**
(CFR: 41.10 / 43.2 / 45.6)
IMPORTANCE RO 4.6 SRO 4.4

2.4 Emergency Procedures / Plan (continued)

2.4.50 **Ability to verify system alarm setpoints and operate controls identified in the alarm response manual.**
(CFR: 41.10 / 43.5 / 45.3)
IMPORTANCE RO 4.2 SRO 4.0

Generic Abnormal Plant Evolutions

		page
001	Continuous Rod Withdrawal	4.2-2
003	Dropped Control Rod	4.2-4
005	Inoperable/Stuck Control Rod	4.2-6
008	Pressurizer Vapor Space Accident	4.2-8
015	Reactor Coolant Pump Malfunctions	4.2-10
017	Reactor Coolant Pump Malfunctions (Loss of RC Flow)	4.2-10
022	Loss of Reactor Coolant Makeup	4.2-12
024	Emergency Boration	4.2-14
025	Loss of Residual Heat Removal System	4.2-16
026	Loss of Component Cooling Water	4.2-18
027	Pressurizer Pressure Control Malfunction	4.2-20
028	Pressurizer Level Control Malfunction	4.2-22
032	Loss of Source Range Nuclear Instrumentation	4.2-24
033	Loss of Intermediate Range Nuclear Instrumentation	4.2-26
036	Fuel Handling Incidents	4.2-28
037	Steam Generator Tube Leak	4.2-29
040	Steam Line Rupture	4.2-31
051	Loss of Condenser Vacuum	4.2-33
054	Loss of Main Feedwater	4.2-35
056	Loss of Off-Site Power	4.2-37
057	Loss of Vital AC Instrument Bus	4.2-41
058	Loss of DC Power	4.2-43
059	Accidental Liquid Radwaste Release	4.2-44
060	Accidental Gaseous Radwaste Release	4.2-46
061	Area Radiation Monitoring (ARM) System Alarms	4.2-48
062	Loss of Nuclear Service Water	4.2-49
065	Loss of Instrument Air	4.2-50
067	Plant Fire on Site	4.2-52
068	Control Room Evacuation	4.2-54
069	Loss of Containment Integrity	4.2-57
076	High Reactor Coolant Activity	4.2-58
077	Generator Voltage and Electric Grid Disturbances	4.2-60

APE: 001 Continuous Rod Withdrawal

K/A NO.	KNOWLEDGE	IMPORTANCE RO	IMPORTANCE SRO
AK1.	**Knowledge of the operational implications of the following concepts as they apply to Continuous Rod Withdrawal: (CFR 41.8 / 41.10 / 45.3)**		
AK1.01	Prompt criticality	3.4*	3.7
AK1.02	SUR	3.6	3.9
AK1.03	Relationship of reactivity and reactor power to rod movement	3.9	4.0
AK1.04	Effect of continuous rod withdrawal on insertion limits and SDM	3.7	3.9
AK1.05	Effects of turbine-reactor power mismatch on rod control	3.5	3.8
AK1.06	Relationship of reactivity and reactor power to rod movement	4.0	4.2
AK1.07	Effects of power level and control position on flux	3.5	3.8
AK1.08	Control rod motion on S/G pressure	2.9	3.2
AK1.09	Reason for use of pulse/analog converter (determination of actual rod positions)	2.1*	2.6
AK1.10	Definition of T-ave., T-ref., °F, linear scale, % megawatts, reactor power, Kg/fe, pcm, $\Delta k/k$, rate, % of level	2.4	2.6
AK1.11	Definitions of core quadrant power tilt	2.8	3.3
AK1.12	Long-range effects of core quadrant power tilt	2.8	3.8
AK1.13	Units of measure for power range indication	2.4	2.9
AK1.14	Interaction of ICS control stations as well as purpose, function, and modes of operation of ICS	3.4*	3.7
AK1.15	Theory of operation of rod drive motors	1.7	2.0
AK1.16	Definition and application of power defect	3.0	3.4
AK1.17	MTC	3.4	3.7
AK1.18	Fuel temperature coefficient	3.4	3.8
AK1.19	Voids coefficient	2.6	2.8
AK1.20	Differential rod worth	3.1	3.3
AK1.21	Integral rod worth	2.9	3.2
AK1.22	Delta flux (ΔI)	3.2	3.6
AK1.23	Calculation of power defect: algebraic sum of moderator temperature and fuel temperature defects	2.6	2.9
AK2.	**Knowledge of the interrelations between the Continuous Rod Withdrawal and the following: (CFR 41.7 / 45.7)**		
AK2.01	Rod bank step counters	2.9	3.2
AK2.02	Controllers and positioners	2.4	2.5
AK2.03	Sensors and detectors	2.3	2.6
AK2.04	Breakers, relays, disconnects, and control room switches	2.4	2.6
AK2.05	Rod motion lights	2.9*	3.1

APE: 015/017 Reactor Coolant Pump (RCP) Malfunctions

AA1.02	RCP oil reservoir level and alarm indicators	2.8	2.7
AA1.03	Reactor trip alarms, switches, and indicators	3.7*	3.8
AA1.04	RCP ventilation cooling fan run indicators	2.5	2.5
AA1.05	RCS flow	3.8	3.8
AA1.06	CCWS	3.1	2.9
AA1.07	RCP seal water injection subsystem	3.5	3.4
AA1.08	S/G LCS	3.0*	2.9
AA1.09	RCS temperature detection subsystem	3.1	3.2
AA1.10	RCP ammeter and trip alarm	2.7	2.6
AA1.11	RCP on/off and run indicators	2.5	2.4
AA1.12	Reactor coolant loop flow meters	2.8*	3.1
AA1.13	Reactor power level indicators	3.4*	3.4*
AA1.14	Power range remote flux meter	2.9*	3.0*
AA1.15	High-power/low-flow reactor trip block status lights	3.5*	3.6*
AA1.16	Low-power reactor trip block status lights	3.2*	3.5*
AA1.17	Station auxiliary transformer volt-amp meters	2.2*	2.2
AA1.18	Station auxiliary power supply breakers and indicators	2.3*	2.4
AA1.19	Power transfer confirm lamp	2.9*	3.0*
AA1.20	RCP bearing temperature indicators	2.7	2.7
AA1.21	Development of natural circulation flow	4.4	4.5
AA1.22	RCP seal failure/malfunction	4.0	4.2
AA1.23	RCP vibration	3.1	3.2

AA2. Ability to determine and interpret the following as they apply to the Reactor Coolant Pump Malfunctions (Loss of RC Flow): (CFR 43.5 / 45.13)

AA2.01	Cause of RCP failure	3.0	3.5*
AA2.02	Abnormalities in RCP air vent flow paths and/or oil cooling system	2.8	3.0
AA2.03	Temperature differential across the RCP oil cooler	2.2	2.2
AA2.04	Temperature differential across the RCP air cooler	1.9	2.1
AA2.05	Relationship between RCP ammeter readings and RCS average temperature	1.9	2.2
AA2.06	Relationship between cooling air flow and oil reservoir temperature/level for RCP	1.8	2.3
AA2.07	Calculation of expected values of flow in the loop with RCP secured	2.1	2.9
AA2.08	When to secure RCPs on high bearing temperature	3.4	3.5
AA2.09	When to secure RCPs on high stator temperatures	3.4	3.5
AA2.10	When to secure RCPs on loss of cooling or seal injection	3.7	3.7
AA2.11	When to jog RCPs during ICC	3.4*	3.8*

APE: 022 Loss of Reactor Coolant Makeup

K/A NO.	KNOWLEDGE	IMPORTANCE RO	IMPORTANCE SRO
AK1.	**Knowledge of the operational implications of the following concepts as they apply to Loss of Reactor Coolant Makeup: (CFR 41.8 / 41.10 / 45.3)**		
AK1.01	Consequences of thermal shock to RCP seals	2.8	3.2*
AK1.02	Relationship of charging flow to pressure differential between charging and RCS	2.7	3.1
AK1.03	Relationship between charging flow and PZR level	3.0	3.4
AK1.04	Reason for changing from manual to automatic control of charging flow valve controller	2.9	3.0
AK2.	**Knowledge of the interrelations between the Loss of Reactor Coolant Makeup and the following: (CFR 41.7 / 45.7)**		
AK2.01	Valves	2.4	2.4
AK2.02	Sensors and detectors	1.9	2.1
AK2.03	Controllers and positioners	2.2	2.3
AK2.04	Pumps	2.3	2.3
AK2.05	Motors	2.1	2.1
AK2.06	Heat exchangers and condensers	1.9	2.1
AK3.	**Knowledge of the reasons for the following responses as they apply to the Loss of Reactor Coolant Makeup: (CFR 41.5, 41.10 / 45.6 / 45.13)**		
AK3.01	Adjustment of RCP seal backpressure regulator valve to obtain normal flow	2.7	3.1
AK3.02	Actions contained in SOPs and EOPs for RCPs, loss of makeup, loss of charging, and abnormal charging	3.5	3.8
AK3.03	Performance of lineup to establish excess letdown after determining need	3.1*	3.3*
AK3.04	Isolating letdown	3.2	3.4
AK3.05	Need to avoid plant transients	3.2	3.4
AK3.06	RCP thermal barrier cooling	3.2	3.3
AK3.07	Isolating charging	3.0*	3.2

APE: **022 Loss of Reactor Coolant Makeup**

ABILITY

AA1. **Ability to operate and / or monitor the following as they apply to the Loss of Reactor Coolant Makeup: (CFR 41.7 / 45.5 / 45.6)**

AA1.01	CVCS letdown and charging	3.4	3.3
AA1.02	CVCS charging low flow alarm, sensor, and indicator	3.0	2.9
AA1.03	PZR level trend	3.2	3.2
AA1.04	Speed demand controller and running indicators (positive displacement pump)	3.3	3.2*
AA1.05	RCP seal back pressure regulator valves and flow indicators	2.9*	2.8*
AA1.06	CVCS charging pump ammeters and running indicators	2.9	2.7
AA1.07	Excess letdown containment isolation valve switches and indicators	2.8*	2.7*
AA1.08	VCT level	3.4	3.3
AA1.09	RCP seal flows, temperatures, pressures, and vibrations	3.2	3.3

AA2. **Ability to determine and interpret the following as they apply to the Loss of Reactor Coolant Makeup: (CFR 43.5/ 45.13)**

AA2.01	Whether charging line leak exists	3.2	3.8
AA2.02	Charging pump problems	3.2	3.7
AA2.03	Failures of flow control valve or controller	3.1	3.6
AA2.04	How long PZR level can be maintained within limits	2.9	3.8

APE: 024 Emergency Boration

K/A NO.	KNOWLEDGE	IMPORTANCE RO	IMPORTANCE SRO
AK1.	**Knowledge of the operational implications of the following concepts as they apply to Emergency Boration: (CFR 41.8 / 41.10 / 45.3)**		
AK1.01	Relationship between boron addition and change in T-ave	3.4	3.8
AK1.02	Relationship between boron addition and reactor power	3.6	3.9
AK1.03	Calculation of boration time from volumetric boron addition and addition rate	2.4	2.9
AK1.04	Low temperature limits for born concentration	2.8	3.6
AK2.	**Knowledge of the interrelations between Emergency Boration and the following: (CFR 41.7 / 45.7)**		
AK2.01	Valves	2.7	2.7
AK2.02	Sensors and detectors	2.1	2.2
AK2.03	Controllers and positioners	2.6	2.5
AK2.04	Pumps	2.6	2.5
AK2.05	Motors	2.1	2.1
AK2.06	Breakers, relays, and disconnects	2.0	2.1
AK3.	**Knowledge of the reasons for the following responses as they apply to Emergency Boration: (CFR 41.5, 41.10 / 45.6 / 45.13)**		
AK3.01	When emergency boration is required	4.1	4.4
AK3.02	Actions contained in EOP for emergency boration	4.2	4.4
	ABILITY		
AA1.	**Ability to operate and / or monitor the following as they apply to Emergency Boration: (CFR 41.7 / 45.5 / 45.6)**		
AA1.01	Use of spent fuel pool as backup to BWST	2.7*	3.4*
AA1.02	Boric acid pump	3.7	3.5
AA1.03	Boric acid controller	3.5	3.3
AA1.04	Manual boration valve	3.6*	3.7
AA1.05	Performance of letdown system during emergency boration	3.1	3.2

APE: **076 High Reactor Coolant Activity**

ABILITY

AA1. **Ability to operate and / or monitor the following as they apply to the High Reactor Coolant Activity: (CFR 41.7 / 45.5 / 45.6)**

AA1.01	Interlocks associated with orifice isolation valve	2.4	2.2
AA1.02	CCWS standby pump and outlet valves	2.1	2.0
AA1.03	CVCS letdown flow rate and temperature	2.3*	2.1
AA1.04	Failed fuel-monitoring equipment	3.2	3.4

AA2. **Ability to determine and interpret the following as they apply to the High Reactor Coolant Activity: (CFR: 43.5 / 45.13)**

AA2.01	Location or process point that is causing an alarm	2.7	3.2
AA2.02	Corrective actions required for high fission product activity in RCS	2.8	3.4
AA2.03	RCS radioactivity level meter	2.5	3.0
AA2.04	Process effluent radiation chart recorder	2.6	3.0
AA2.05	CVCS letdown flow rate indication	2.2	2.5
AA2.06	Response of PZR LCS to changes in the letdown flow rate	2.2	2.5
AA2.07	When demineralizer resin needs to be replaced	2.4	2.7*

APE: 077 Generator Voltage and Electric Grid Disturbances

K/A NO.	KNOWLEDGE	IMPORTANCE RO	IMPORTANCE SRO
AK1.	**Knowledge of the operational implications of the following concepts as they apply to Generator Voltage and Electric Grid Disturbances: (CFR: 41.4, 41.5, 41.7, 41.10 / 45.8)**		
AA1.01	Definition of terms: volts, watts, amps, VARs, power factor	3.3	3.5
AK1.02	Over-excitation	3.3	3.4
AA1.03	Under-excitation	3.3	3.4
AK2.	**Knowledge of the interrelations between Generator Voltage and Electric Grid Disturbances and the following: (CFR: 41.4, 41.5, 41.7, 41.10 / 45.8)**		
AK2.01	Motors	3.1	3.2
AK2.02	Breakers, relays	3.1	3.3
AK2.03	Sensors, detectors, indicators	3.0	3.1
AK2.04	Controllers, positioners	3.0	3.0
AK2.05	Pumps	3.1	3.2
AK2.06	Reactor power	3.9	4.0
AK2.07	Turbine / generator control	3.6	3.7
AK3.	**Knowledge of the reasons for the following responses as they apply to Generator Voltage and Electric Grid Disturbances: (CFR: 41.4, 41.5, 41.7, 41.10 / 45.8)**		
AK3.01	Reactor and turbine trip criteria	3.9	4.2
AK3.02	Actions contained in abnormal operating procedure for voltage and grid disturbances	3.6	3.9
	ABILITY		
AA1.	**Ability to operate and/or monitor the following as they apply to Generator Voltage and Electric Grid Disturbances: (CFR: 41.5 and 41.10 / 45.5, 45.7, and 45.8)**		
AA1.01	Grid frequency and voltage	3.6	3.7
AA1.02	Turbine / generator controls	3.8	3.7
AA1.03	Voltage regulator controls	3.8	3.7
AA1.04	Reactor controls	4.1	4.1
AA1.05	Engineered safety features	3.9	4.0

APE: 077 Generator Voltage and Electric Grid Disturbances

AA2. Ability to determine and interpret the following as they apply to Generator Voltage and Electric Grid Disturbances: (CFR: 41.5 and 43.5 / 45.5, 45.7, and 45.8)

AA2.01	Operating point on the generator capability curve	3.5	3.6
AA2.02	Voltage outside the generator capability curve	3.5	3.6
AA2.03	Generator current outside the capability curve	3.5	3.6
AA2.04	VARs outside the capability curve	3.6	3.6
AA2.05	Operational status of offsite circuit	3.2	3.8
AA2.06	Generator frequency limitations	3.4	3.5
AA2.07	Operational status of engineered safety features	3.6	4.0
AA2.08	Criteria to trip the turbine or reactor	4.3	4.4
AA2.09	Operational status of emergency diesel generators	3.9	4.3
AA2.10	Generator overheating and the required actions	3.6	3.8

NRC FORM 335
(9-2004)
NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1122, Revision 2, Supplement 1

2. TITLE AND SUBTITLE

Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors

3. DATE REPORT PUBLISHED

MONTH	YEAR
October	2007

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

D. Muller

6. TYPE OF REPORT

Technical

7. PERIOD COVERED *(Inclusive Dates)*

8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as above

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

This document provides the basis for development of content-valid licensing examinations for reactor operators and senior reactor operators. The examinations developed using this document will cover those topics listed under 10 CFR 55, "Operators' Licenses." The PWR catalog contains approximately 7,000 knowledge and ability (K/A) statements for reactor operators and senior reactor operators. Each K/A statement has been rated for its importance to safety.

Supplement 1 to Revision 2 of NUREG-1122 reworded and reorganized Section 2, "Generic Knowledge and Abilities," added a new K/A topic to Section 4, "Emergency/Abnormal Plant Evolutions," to address generator voltage and electric grid disturbances, and corrected other minor typographical errors.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

operator licensing
examinations
reactor operator
senior reactor operator
training
task analysis
pressurized water reactors

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)

unclassified

(This Report)

unclassified

15. NUMBER OF PAGES

16. PRICE

PRINTED ON RECYCLED PAPER

Printed
on recycled
paper

Federal Recycling Program