

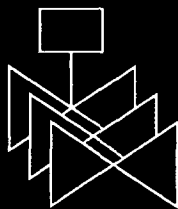
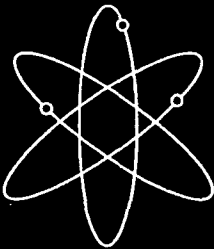
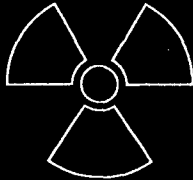
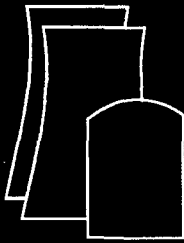
NUREG-1123  
Rev. 2, Supp. 1

# Knowledge and Abilities Catalog for Nuclear Power Plant Operators

## Boiling Water Reactors

**Draft Report for Comment**

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



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NUREG-1123  
Rev. 2, Supp. 1

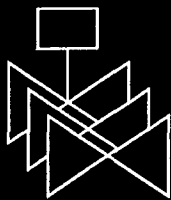
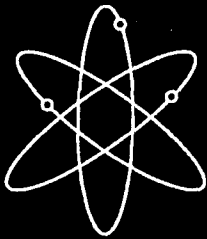
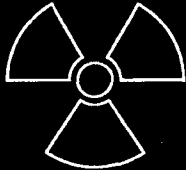
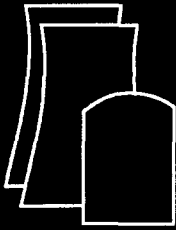
# **Knowledge and Abilities Catalog for Nuclear Power Plant Operators**

## **Boiling Water Reactors**

### **Draft Report for Comment**

Manuscript Completed: April 2007  
Date Published: May 2007

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



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## ABSTRACT

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactors (BWRs) (NUREG-1123, 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 BWR Catalog along with the Operator Licensing Examination Standards for Power Reactors (NUREG-1021, Rev. 8 9, Supplement 1) will sample the topics listed under Title 10, Code of Federal Regulations, Part 55 (10 CFR 55).

The BWR Catalog contains approximately 7,000 knowledge and ability (K/A) statements for ROs and SROs at BWRs. The catalog is organized into six major sections: Organization of the Catalog, Generic Knowledge and Ability Statements, Plant Systems grouped by Safety Functions, Emergency and Abnormal Plant Evolutions, Components and Theory.

Revision 1 to the BWR 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 with approximately one hundred new K/As. Component Cooling Water and Instrument Air Systems were added to the Systems Section. Finally, High Containment Hydrogen Concentration and Plant Fire On Site evolutions were added to the Emergency and Abnormal Plant Evolutions section.

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 7 K/As that had been omitted in Rev. 1.
2. correction of typographical errors.
3. addition of importance value modifiers that had been omitted in Rev. 1.

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), 700000, "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.

**Draft Supplement 1 to Revision 2 of NUREG-1123  
Record of Changes**

Instructions: Remove the existing NUREG-1123, 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-blank                     | iii-iv / replace Section 2, add one additional APE (700000), and add Record of Changes  |
| Table of Contents                            | v-viii                        | v-viii / add Supplement 1, page number changes, add new APE (700000) for Generator Voltage and Electric Grid Disturbances to Section 4.2                                      |
| Summary of Significant Changes               | xi-xii<br><br>xv              | xi-xii / describe the replacement of Section 2<br><br>xv / discuss the study basis to reassess job safety and importance values   |
| Organization of Catalog                      | 1-1 to 1-6<br><br>1-9 to 1-12 | 1-1 to 1-6 / amend to conform with Revision 9 of NUREG-1021 and Section 2 changes<br><br>1-9 to 1-12 / add new APE (700000) Generator Voltage and Electric Grid Disturbances  |
| 2.0 Generic Knowledges and Abilities         | 2-1 to 2-15                   | 2-1 to 2-18 / revise Section 2  |
| 4.2 Generic Abnormal Plant Evolutions (APEs) | 4.2-1<br><br>4.2-43 and blank | 4.2-1 add new APE (700000) for Generator Voltage and Electric Grid Disturbances<br><br>4.2-43 to 4.2-45 / add new APE 700000 Generator Voltage and Electric Grid Disturbances |

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## 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 are 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 BWR CATALOG

#### 1.1 The 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 Knowledge and Abilities linked to 10 CFR 55

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, requires 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) examination specifications 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 An updated catalog organization was implemented.**

**1. ORGANIZATION OF BWR CATALOG**

1. Added 10 CFR information

**2 Generic Knowledge and Abilities**

1. Combined old plant-wide and system generic K/As in one section.
2. Eliminated duplicate generic K/As.
3. Organized the section into 4 topic areas.
4. Added about 100 new generic K/As.

**3 Plant Systems**

1. Moved System Generic K/As to new generic section
2. Added Instrument Air System
3. Added Component Cooling Water System

**4 Emergency & Abnormal Plant Evolution Section**

1. Moved Generic K/As to Section 2
2. Added High Containment Hydrogen Concentration
3. Added Plant Fire On Site

**5 Components**

No change

**6 Theory Section**

No change

4.4 Emergency and Abnormal Evolution K/As were linked to 10 CFR 55 item numbers at the stem statement level.

## 5 COMPONENTS

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

## 6 THEORY

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

## 7 REVISION 2 CHANGES

7.1 Approximately 7 K/As that had been omitted in Rev. 1 were added.

7.2 Typographical errors were corrected.

7.3 Importance value modifiers that had been omitted in Rev. 1 were added. Corrections and additions are identified by "redline" marking in the margins.

## 8 CHANGES IN SUPPLEMENT 1 TO REVISION 2

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 700000, "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.

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# 1 ORGANIZATION OF THE CATALOG

## 1.1 INTRODUCTION

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactors (BWR) NUREG-1123, 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

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**

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 ~~should~~ includes ~~at least 25 questions based on the higher license level K/As from the 7 items listed under 10 CFR 55.43(b), and No more than 75 questions percent (75%) of the SRO K/As may be derived from the 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) Safely 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 BWR CATALOG**

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

## **1 ORGANIZATION OF THE BWR 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 (56) WITHIN 9 SAFETY FUNCTIONS**

Knowledge Categories (K1 - K6)  
Ability Categories (A1 - A4)

### **4 EMERGENCY & ABNORMAL PLANT EVOLUTIONS (41)**

Knowledge Categories (E/A K1 - E/A K3)  
Ability Categories (E/A A1 - E/A - A2)

### **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 or temporary modification procedures.

The generic K/As for "Equipment Control " are used to evaluate the administrative requirements 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 use. The emergency plan K/As may be 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 BWR nuclear power plant operation. The safety functions groups are:

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

Fifty six (56) plant systems have been included in the BWR Catalog based on their relationship and importance to safety functions. Table 1 contains a list of these plant systems, arranged within safety function. It should be noted that some plant systems contribute to more than one safety function.

Each plant system has a 6-digit code number. The words "Plant Specific" following the system title, indicates that the knowledge or ability does not apply to all plants.

See Section 3 of the BWR catalog for the delineation of K/As for the plant systems.

**Table 1**  
**Plant Systems by Safety Functions**

---

#### **Safety Function 1: Reactivity Control**

|        |                                    |
|--------|------------------------------------|
| 201001 | Control Rod Drive Hydraulic System |
| 201003 | Control Rod and Drive Mechanism    |
| 201002 | Reactor Manual Control System      |

## 1.9.2 Knowledge and Ability Stem Statements for Plant Systems

The information delineated within each plant system is organized into 6 different types of knowledge and 4 different types of ability. If there are no knowledge or ability statements following a stem statement there is no applicable K/A.

The applicable 10 CFR 55.41 / 43 / and 45 item numbers are included with each stem statement. In most cases the K/As associated with the stem statements can be used for both the written examination and the operating test. See Table 2 below:

**Table 2**  
**Knowledge and Ability Stem Statements for Plant Systems**

- K1. Knowledge of the physical connections and/or cause-effect relationships between (SYSTEM) and the following:  
(CFR: 41.2 to 41.9 / 45.7 to 45.8)
- K2. Knowledge of electrical power supplies to the following:  
(CFR: 41.7)
- K3. Knowledge of the effect that a loss or malfunction of the (SYSTEM) will have on the following:  
(CFR: 41.7 / 45.4)
- K4. Knowledge of (SYSTEM) design feature(s) and or interlock(s) which provide for the following:  
(CFR: 41.7)
- K5. Knowledge of the operational implications of the following concepts as they apply to the (SYSTEM):  
(CFR: 41.5 / 45.3)
- K6. Knowledge of the effect that a loss or malfunction of the following will have on the (SYSTEM):  
(CFR: 41.7 / 45.7)
- A1. Ability to predict and/or monitor changes in parameters associated with operating the (SYSTEM) controls including:  
(CFR: 41.5 / 45.5)
- 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 operation:  
(CFR: 41.5 / 45.6)

- A3. Ability to monitor automatic operations of the (SYSTEM) including:  
(CFR: 41.7 / 45.7)
- A4. Ability to manually operate and/or monitor in the control room:  
(CFR: 41.7 / 45.5 to 45.8)

**1.10 EMERGENCY & ABNORMAL PLANT EVOLUTIONS**

Section 4 of the BWR catalog contains emergency plant evolutions (EPEs) and abnormal plant evolutions (APEs). An emergency plant evolution is any condition, event or symptom which leads to entry into the plant-specific emergency operating procedures (EOPs). An abnormal plant evolution is any degraded condition, event or symptom not directly leading to an EOP entry condition, but, nonetheless, adversely affecting a safety function. The listing of EPEs and APEs was developed to include those integrative situations crossing several plant systems and/or safety functions.

The emergency plant evolution strategies described in Revision 4 to the Boiling Water Reactor Owners Group Emergency Procedures Guidelines, cover five broad areas:

- 1) Reactor Pressure Vessel Control
- 2) Reactor Pressure Vessel Control With SCRAM Condition Present and Reactor Power Above APRM Downscale or Unknown.
- 3) Primary Containment Control
- 4) Secondary Containment Control
- 5) Radioactivity Release Control.

If the operator controls the five broad areas of emergency plant evolutions listed above, the plant safety functions will be safely maintained. Table 3, below, contains a numerical list of the 16 emergency plant evolutions and the 25 abnormal plant evolutions covered by this catalog.

**Table 3  
Emergency and Abnormal Plant Evolutions**

**EPEs**

|        |  |
|--------|--|
| 295024 | High Drywell Pressure                                    |
| 295025 | High Reactor Pressure                                    |
| 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                         |
| 295031 | Reactor Low Water Level                                  |
| 295032 | High Secondary Containment Area Temperature              |

295033 High Secondary Containment Area Radiation Levels  
 295034 Secondary Containment Ventilation High Radiation  
 295035 Secondary Containment High Differential Pressure  
 295036 Secondary Containment High Sump / Area Water Level  
 295037 SCRAM Condition Present and Reactor Power Above APRM Downscale  
 or unknown  
 295038 High Off-Site Release Rate  
 500000 High Containment Hydrogen Concentration.

### APEs

295001 Partial or Complete Loss of Forced Core Flow Circulation  
 295002 Loss of Main Condenser Vacuum  
 295003 Partial or Complete Loss of A.C. Power  
 295004 Partial or Complete Loss of D.C. Power  
 295005 Main Turbine Trip  
 295006 SCRAM  
 295007 High Reactor Pressure  
 295008 High Reactor Water Level  
 295009 Low Reactor Water Level  
 295010 High Drywell Pressure  
 295011 High Containment Temperature (Mark III Containment Only)  
 295012 High Drywell Temperature  
 295013 High Suppression Pool Water Temperature  
 295014 Inadvertent Reactivity Addition  
 295015 Incomplete SCRAM  
 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  
 295021 Loss of Shutdown Cooling  
 295022 Loss of Control Rod Drive Pumps  
 295023 Refueling Accidents  
 600000 Plant Fire On Site  
 700000 Generator Voltage and Electric Grid Disturbances

### 1.10.1 Knowledge and Ability Stem Statements for Emergency and Abnormal Plant Evolutions

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

The applicable 10 CFR 55.41, 43, and 45 item numbers are included with each stem statement. In most cases the K/As associated with the stem statements can be used for both

the written and operating examinations. See Table 4, below:

**Table 4**  
**Knowledge and Ability Stem Statements for**  
**Emergency and Abnormal Plant Evolutions**

- E/AK1 Knowledge of the operational applications of the following concepts as they apply to the (EMERGENCY OR ABNORMAL PLANT EVOLUTION):  
(CFR: 41.8 to 41.10)
- E/AK2 Knowledge of the interrelations between (EMERGENCY OR ABNORMAL PLANT EVOLUTION) and the following:  
(CFR: 41.7 / 45.8)
- E/AK3 Knowledge of the reasons for the following responses as they apply to (EMERGENCY OR ABNORMAL PLANT EVOLUTION):  
(CFR: 41.5 / 45.6)
- E/AA1 Ability to operate and / or monitor the following as they apply to (EMERGENCY AND ABNORMAL PLANT EVOLUTION):  
(CFR: 41.7 / 45.6)
- E/AA2 Ability to determine and interpret the following as they apply to (EMERGENCY AND ABNORMAL PLANT EVOLUTION):  
(CFR: 41.10 / 43.5 / 45.13)

### 1.11 COMPONENTS

Basic components such as valves and pumps are found in many systems. NUREG-1021, section ES-205, "General Fundamentals Examination," lists 8 categories of components. The following eight (8) categories of components, for which additional knowledge statements are necessary are listed below and delineated in Section 5 of the BWR catalog.

The component knowledge statements are more detailed than those provided in the system listing, yet at the same time they are generic to the component types. Each component has a unique six (6) digit code number and 10 CFR 55.41 (b) item number. See Table 5, below.

**Table 5**  
**Components**

- |        |   |
|--------|---|
| 291001 | Valves (CFR: 41.3)                      |
| 291002 | Sensors and Detectors ( CFR: 41.7)      |
| 291003 | Controllers and positioners (CFR: 41.7) |
| 291004 | Pumps(CFR: 41.3)                        |



## 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 indicator.**

(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 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)

Note: The issue of setpoints and automatic safety features is not specifically covered in the systems sections.

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.**

(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**

| 4.2           | Abnormal Plant Evolutions                                | page          |
|---------------|--|---------------|
| 295001        | Partial or Complete Loss of Forced Core Flow Circulation | 4.2-3         |
| 295002        | Loss of Main Condenser Vacuum                            | 4.2-5         |
| 295003        | Partial or Complete Loss of A.C. Power                   | 4.2-7         |
| 295004        | Partial or Complete Loss of D.C. Power                   | 4.2-9         |
| 295005        | Main Turbine Trip  | 4.2-10        |
| 295006        | SCRAM  | 4.2-12        |
| 295007        | High Reactor Pressure                                    | 4.2-14        |
| 295008        | High Reactor Water Level                                 | 4.2-16        |
| 295009        | Low Reactor Water Level                                  | 4.2-18        |
| 295010        | High Drywell Pressure                                    | 4.2-19        |
| 295011        | High Containment Temperature (Mark III Containment Only) | 4.2-21        |
| 295012        | High Drywell Temperature                                 | 4.2-22        |
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| 295014        | Inadvertent Reactivity Addition                          | 4.2-24        |
| 295015        | Incomplete SCRAM   | 4.2-26        |
| 295016        | Control Room Abandonment                                 | 4.2-28        |
| 295017        | High Off-Site Release Rate                               | 4.2-29        |
| 295018        | Partial or Complete Loss of Component Cooling Water      | 4.2-31        |
| 295019        | Partial or Complete Loss of Instrument Air               | 4.2-33        |
| 295020        | Inadvertent Containment Isolation                        | 4.2-35        |
| 295021        | Loss of Shutdown Cooling                                 | 4.2-37        |
| 295022        | Loss of Control Rod Drive Pumps                          | 4.2-39        |
| 295023        | Refueling Accidents                                      | 4.2-40        |
| 600000        | Plant Fire On Site                                       | 4.2-42        |
| <u>700000</u> | <u>Generator Voltage and Electric Grid Disturbances</u>  | <u>4.2-44</u> |

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**APE: 600000 Plant Fire On Site**

| K/A NO.    | ABILITY   | IMPORTANCE | RO  | SRO |
|------------|---|------------|-----|-----|
| <b>AA1</b> | <b>Ability to operate and / or monitor the following as they apply to PLANT FIRE ON SITE:</b> |            |     |     |
| AA1.01     | Respirator air pack   | 3.0        | 3.0 | 2.9 |
| AA1.02     | Re-installation of fire detector  | 1.8        | 1.8 | 1.9 |
| AA1.03     | Bypass of fire zone detector  | 1.8        | 1.8 | 2.2 |
| AA1.04     | Bypass of heat detector   | 1.9        | 1.9 | 2.2 |
| AA1.05     | Plant and control room ventilation systems  | 3.0        | 3.0 | 3.1 |
| AA1.06     | Fire alarm  | 3.0        | 3.0 | 3.0 |
| AA1.07     | Fire alarm reset panel  | 2.3        | 2.3 | 2.4 |
| AA1.08     | Fire fighting equipment used on each class of fire  | 2.6        | 2.6 | 2.9 |
| AA1.09     | Plant fire zone panel (including detector location)   | 2.5        | 2.5 | 2.7 |
| <b>AA2</b> | <b>Ability to determine and interpret the following as they apply to PLANT FIRE ON SITE:</b>  |            |     |     |
| AA2.01     | Gas treatment system  | 2.2        | 2.2 | 2.3 |
| AA2.02     | Damper position   | 2.8        | 2.8 | 2.9 |
| AA2.03     | Fire alarm  | 2.8        | 2.8 | 3.2 |
| AA2.04     | The fire's extent of potential operational damage to plant equipment                          | 2.8        | 2.8 | 3.1 |
| AA2.05     | Ventilation alignment necessary to secure affected area                                       | 2.9        | 2.9 | 3.0 |
| AA2.06     | Need for pressurizing control room (recirculating mode)                                       | 2.5        | 2.5 | 2.8 |
| AA2.07     | Whether malfunction is due to common-mode electrical failures                                 | 2.6        | 2.6 | 3.0 |
| AA2.08     | Limits of affected area   |            |     |     |
| AA2.09     | That a failed fire alarm detector exists  | 2.4        | 2.4 | 2.8 |
| AA2.10     | Time limit of long-term-breathing air system for control room                                 | 2.9        | 2.9 | 3.1 |
| AA2.11     | Time limit for use of respirators   | 2.9        | 2.9 | 3.0 |
| AA2.12     | Location of vital equipment within fire zone  | 3.1        | 3.1 | 3.5 |
| AA2.13     | Need for emergency plant shutdown   | 3.2        | 3.2 | 3.8 |
| AA2.14     | Equipment that will be affected by fire suppression activities in each zone                   | 3.0        | 3.0 | 3.6 |
| AA2.15     | Requirements for establishing a fire watch  | 2.3        | 2.3 | 3.5 |
| AA2.16     | Vital equipment and control systems to be maintained and operated during a fire               | 3.0        | 3.0 | 3.5 |
| AA2.17     | Systems that may be affected by the fire  | 3.1        | 3.1 | 3.6 |

APE:

**700000 Generator Voltage and Electric Grid Disturbances**

|             |  | IMPORTANCE |    |     |
|-------------|--|------------|----|-----|
| K/A NO.     | KNOWLEDGE  |            | RO | SRO |
| <b>AK1.</b> | <b>Knowledge of the operational implications of the following concepts as they apply to GENERATOR VOLTAGE AND ELECTRIC GRID DISTURBANCES:</b><br>(CFR: 41.4, 41.5, 41.7, 41.10 / 45.8) |            |    |     |
| AK1.01      | Definition of terms: volts, watts, amps, VARs, power factor  | 3.3        |    | 3.5 |
| AK1.02      | Over-excitation  | 3.3        |    | 3.4 |
| AK1.03      | Under-excitation   | 3.3        |    | 3.4 |
| <b>AK2.</b> | <b>Knowledge of the interrelations between GENERATOR VOLTAGE AND ELECTRIC GRID DISTURBANCES and the following:</b><br>(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 |
| <b>AK3.</b> | <b>Knowledge of the reasons for the following responses as they apply to GENERATOR VOLTAGE AND ELECTRIC GRID DISTURBANCES:</b><br>(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**

|             |   |     |  |     |
|-------------|---|-----|--|-----|
| <b>AA1.</b> | <b>Ability to operate and/or monitor the following as they apply to GENERATOR VOLTAGE AND ELECTRIC GRID DISTURBANCES:</b><br>(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: 70000 Generator Voltage and Electric Grid Disturbances**

| K/A NO. | ABILITY  | IMPORTANCE | RO  | SRO |
|---------|--|------------|-----|-----|
| AA2.    | <b>Ability to determine and/or interpret the following as they apply to GENERATOR VOLTAGE AND ELECTRIC GRID DISTURBANCES:</b><br>(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 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 |     |

**BIBLIOGRAPHIC DATA SHEET**

(See instructions on the reverse)

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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 BWR 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.

Draft Supplement 1 to Revision 2 of NUREG-1123 proposes to reword and reorganize Section 2, "Generic Knowledge and Abilities," and add a new K/A topic to Section 4, "Emergency/Abnormal Plant Evolutions," to address generator voltage and electric grid disturbances. Other proposed changes are minor and typographic in nature.

The NRC seeks comments on Draft Supplement 1 to Revision 2 of NUREG-1123. Comments must be provided within 60 days from the date of publication. Comments received after 60 days will be considered if practicable to do so, but only those comments received on or before the due date can be assured for consideration.

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

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