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NUREG-2103

Knowledge and Abilities Catalog for Nuclear Power Plant Operators

Pressurized Water Reactors Westinghouse AP1000

Final Report

Office of Nuclear Reactor Regulation

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Errata

NUREG-2103, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized Water Reactors,” published January 2021

On Page 3-18, knowledge and ability (K/A) statements K6.20 (letdown heat exchanger, importance rating 3.1) and K6.21 (purification stop valves, importance rating 3.2) for Safety Function 2, Chemical and Volume Control System, were inadvertently deleted. Section K6 for Safety Function 2, Chemical and Volume Control System, should read as follows:

K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the chemical and volume control system components:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	3.2
K 6.02	Component cooling water system	3.1
K 6.03	Diverse actuation system	3.7
K 6.04	Demineralized water transfer and storage system	2.5
K 6.05	Engineered safeguards actuation system	4.0
K 6.06	Special process heat tracing system	2.0
K 6.07	Nuclear instrumentation system	3.0
K 6.08	Plant gas system	2.3
K 6.09	Pressurizer level control system	3.5
K 6.10	Reactor coolant system	3.6
K 6.11	Hot-leg level during midloop	3.8
K 6.12	Normal residual heat removal system	3.2
K 6.13	Spent fuel pool cooling system	3.0
K 6.14	Liquid radwaste system	2.3
K 6.15	Chemical and volume control system makeup pump	3.2
K 6.16	Mixed bed demineralizer	2.6
K 6.17	Reactor coolant filter	2.4
K 6.18	Makeup filter	2.5
K 6.19	Reactor makeup control system	3.5
K 6.20	Letdown heat exchanger	3.1
K 6.21	Purification stop valves	3.2
K 6.22	Makeup line containment isolation valves	3.6

On Page 4-125, the K/A statement numbers under AK3, “Knowledge of the reasons for the following actions as they apply to a degraded grid,” for abnormal plant evolution A-348 Degraded Grid, are numbered incorrectly, and should read as follows:

AK 3	**Knowledge of the reasons for the following actions as they apply to a degraded grid:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Reactor trip	2.9
AK 3.02	Turbine trip	2.3
AK 3.03	M bank manual operation	2.5
AK 3.04	Main generator voltage control	2.1

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Pressurized Water Reactors
Westinghouse AP 1000

Final Report

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Prepared by:
R. Pelton
J. Kellum
M. Scheetz
L. Nist

Office of Nuclear Reactor Regulation

ABSTRACT

The Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized-Water Reactors (NUREG-2103) provides the basis for the development of content-valid licensing examinations for reactor operators and senior reactor operators. The examinations developed using this catalog, along with the Operator Licensing Examination Standards for Power Reactors (NUREG-1021), will sample the topics listed under Title 10 of the Code of Federal Regulations (10 CFR) Part 55, “Operators’ Licenses.”

The catalog is organized into six major sections: Organization of the Catalog, Generic Knowledge and Abilities, Plant Systems (grouped by safety functions), Emergency and Abnormal Plant Evolutions, Components, and Theory.

This Knowledge and Abilities Catalog was developed specifically to address the passive nature of the Westinghouse AP1000 design.

This NUREG is considered a rule as defined in the Congressional Review Act (5 U.S.C. 801-808). However, the Office of Management and Budget has not found it to be a major rule as defined in the Congressional Review Act.

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TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ΔT	differential temperature
ΔP	differential pressure
ac	alternating current
ADS	automatic depressurization system
AOP	abnormal operating procedure
ATWS	anticipated transient without scram
CAS	compressed and instrument air systems
CCS	component cooling water system
CDS	condensate system
CFR	*Code of Federal Regulations*
CMS	condenser air removal system
CNS	containment system
CVS	chemical and volume control system
CWS	circulating water system
DAS	diverse actuation system
dc	direct current
DNB	departure from nucleate boiling
DNBR	departure from nucleate boiling ratio
DRCS	digital rod control system
ECP	estimated critical position
ECS	main AC power system
EDS	non-Class 1E DC and UPS system
EOL	end of life
EOP	emergency operating procedure
ESAS	engineered safeguards actuation system
F	Fahrenheit
$F^N_{\Delta H}$	nuclear enthalpy rise hot channel factor
FHS	fuel handling system
FPS	fire protection system
FWS	main and startup feedwater system
gpm	gallon(s) per minute
HCS	generator hydrogen and CO_2 systems

HPA	high-pressure air
HVAC	heating, ventilation, and air conditioning
IDS	Class 1E DC and UPS system
IIS	incore instrument system
K/A	knowledge and ability
K-eff	subcritical multiplication factor (K-effective)
kV	kilovolt(s)
kw/ft	kilowatt(s) per foot (Z)
LCO	limiting condition for operation
LSRO	senior operators limited to fuel handling
MFCV	main feedwater control valve
MFIV	main feedwater isolation valve
M-G	motor generator
MSIV	main steam isolation valve
MSR	moisture separator/reheater
MSS	main steam system
MTC	moderator temperature coefficient
MTS	main turbine system
N/A	not applicable
NIS	nuclear instrumentation system
OE	operating experience
OPΔT	over-pressure differential temperature
OTΔT	over-temperature differential temperature
PCS	passive containment cooling system
PLCS	pressurizer level control system
PLS	plant control system
PMS	protection and safety monitoring system
PPCS	pressurizer pressure control system
PRA	probabilistic risk assessment
PRHR	passive residual heat removal
psig	pounds per square inch gauge
PWR	pressurized-water reactor
PXS	passive core cooling system
RCP	reactor coolant pump
RCS	reactor coolant system

RMS	radiation monitoring system
RNS	normal residual heat removal system
RO	reactor operator
RPIS	rod position indication system
RTS	reactor trip system
SDCS	steam dump control system
SF	safety function
SFS	spent fuel pool cooling system
SG PORV	steam generator power-operated relief valve
SGS	steam generator system
SRO	senior reactor operator
SUR	startup rate
SWS	service water system
Tavg	average temperature
Tref	reference temperature
UPS	uninterruptible power supply
V	volt(s)
VCS	containment recirculation cooling system
VES	main control room emergency habitability system
VFS	containment air filtration system
VLS	containment hydrogen control system
VTS	turbine building ventilation system
VWS	central chilled water system
WGS	gaseous radwaste system
WLS	liquid radwaste system
ZBS	transmission switchyard and offsite power system
ZOS	onsite standby power system

1 ORGANIZATION OF THE CATALOG

1.1 Introduction

NUREG-2103, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000,” provides the basis for the development of content-valid licensing examinations for reactor operators (ROs) and senior reactor operators (SROs). The catalog is designed to ensure equitable and consistent examinations.

1.2 Title 10 of the Code of Federal Regulations, Part 55

This catalog is used in conjunction with NUREG-1021, "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 Title 10 of the *Code of Federal Regulations* (10 CFR) Part 55, “Operators’ Licenses.” All knowledge and abilities (K/As) in this catalog are directly linked by item number to 10 CFR Part 55.

1.3 Reactor Operator Written Examination Items

NUREG-1021 presents the guidance for the preparation of the RO written examination, while 10 CFR 55.41(b) presents the specific items for RO written examinations.

1.4 Senior Reactor Operator Written Examination Items

NUREG-1021 presents the guidance for the preparation of the SRO written examination. In addition to the RO items specified in 10 CFR 55.41(b), 10 CFR 55.43(b) lists additional items for SRO written examinations.

1.5 Reactor Operator and Senior Reactor Operator Operating Test Items

The U.S. Nuclear Regulatory Commission (NRC) provides the items for operating tests for ROs and SROs in 10 CFR 55.45(a). NUREG 1021 presents the guidance for the preparation of operating tests. The operating test should include a representative selection of K/As derived from those items listed in 10 CFR 55.45(a).

1.6 Senior Operators Limited to Fuel Handling

NUREG-1021 provides the guidance for examinations for senior reactor operators limited to fuel handling (LSRO). The LSRO examination process includes both a written examination and an operating test. These examinations and tests 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 Catalog

This catalog is organized into six major sections. K/As are grouped according to the major section to which they pertain.

The following scheme shows the organization.

1.0 ORGANIZATION OF THE CATALOG

2.0 GENERIC KNOWLEDGE AND ABILITIES
Conduct of Operations K/As
Equipment Control K/As
Radiation Control K/As
Emergency Procedures/Plan K/As

3.0 PLANT SYSTEMS
Knowledge Categories (K1–K6)
Ability Categories (A1–A4)

4.0 EMERGENCY AND ABNORMAL PLANT EVOLUTIONS
Knowledge Categories (EK/AK 1–EK/AK3)
Ability Categories (EA/AA 1–EA/AA 2)

5.0 COMPONENTS
Component Knowledge Categories

6.0 THEORY
Reactor Theory Knowledge Categories
Thermodynamics Knowledge Categories

1.8 Generic Knowledge and Abilities

Generic K/As are generally administrative K/As with broad application across systems and operations. They are listed in Section 2 of the catalog. The following are the four categories of generic K/As:

2.1 Conduct of Operations K/As
2.2 Equipment Control K/As
2.3 Radiation Control K/As
2.4 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. Examples of the types of information evaluated under this category include shift turnover, operator responsibilities, and procedure usage.

The generic K/As for “Equipment Control” are used to evaluate the administrative issues associated with the management and control of plant systems and equipment. Examples of the types of information evaluated under this category 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 evaluated under this category include 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 emergency procedures K/As are designed to evaluate knowledge of the use of emergency procedures. 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 the plan should be executed and the duties assigned under the plan.

1.9 Plant Systems

1.9.1 Plant System Organization by Safety Function

Nine major safety functions must be maintained to ensure safe nuclear power plant operation. The safety function groups are the following:

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

Plant systems have been included in this catalog based on their relationship and importance to the nine safety functions. These plant systems, arranged by safety function, are listed below. Three plant systems (reactor coolant system, chemical and volume control system, and passive core cooling system) each contribute to several safety functions.

Safety Function 1: Reactivity Control

SF1 CVS	Chemical and Volume Control System
SF1 DRCS	Digital Rod Control System
SF1 RPIS	Rod Position Indication System

Safety Function 2: Reactor Coolant System Inventory Control

SF2 CVS	Chemical and Volume Control System
SF2 ESAS	Engineered Safeguards Actuation System
SF2 PLCS	Pressurizer Level Control System
SF2 PXS	Passive Core Cooling System
SF2 RCS	Reactor Coolant System

Safety Function 3: Reactor Pressure Control

SF3 ADS	Automatic Depressurization System
SF3 PPCS	Pressurizer Pressure Control System

Safety Function 4: Heat Removal from Reactor Core
Primary Systems

SF4P PRHR	Passive Residual Heat Removal
SF4P RCP	Reactor Coolant Pump System
SF4P RCS	Reactor Coolant System
SF4P RNS	Normal Residual Heat Removal System
SF4P SGS	Steam Generator System

Secondary Systems

SF4S CDS	Condensate System
SF4S CMS	Condenser Air Removal System
SF4S FWS	Main and Startup Feedwater System
SF4S MSS	Main Steam System
SF4S MTS	Main Turbine and Main Turbine Control Systems
SF4S SDCS	Steam Dump Control System
SF4S SWS	Service Water System

Safety Function 5: Containment Integrity

SF5 CNS	Containment System
SF5 PCS	Passive Containment Cooling System
SF5 VLS	Containment Hydrogen Control System

Safety Function 6: Electrical

SF6 ECS	AC Electrical Distribution
SF6 IDS	Class 1E and Non-Class 1E DC and UPS Systems
SF6 ZOS	Onsite Standby Power System

Safety Function 7: Instrumentation

SF7 DAS	Diverse Actuation System
SF7 IIS	Incore Instrumentation System
SF7 NIS	Nuclear Instrumentation System
SF7 RMS	Radiation Monitoring System
SF7 RTS	Reactor Trip System

Safety Function 8: Plant Service Systems

SF8 CAS	Compressed Air System
SF8 CCS	Component Cooling Water System
SF8 CWS	Circulating Water System
SF8 FHS	Fuel Handling System
SF8 FPS	Fire Protection System
SF8 SFS	Spent Fuel Pool Cooling System
SF8 VES	Main Control Room HVAC
SF8 VFS	Containment Air Filtration System

Safety Function 9: Radioactivity Release

SF9 WGS	Gaseous Radwaste System
SF9 WLS	Liquid Radwaste System

1.9.2 Plant System Knowledge and Ability Stem Statements

The information delineated within each plant system is organized into six different types of knowledge and four different types of ability. If there are no knowledge or ability statements following a stem statement, there is no applicable K/A, and these are marked N/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. Stem statements and bases are listed below:

Knowledge Stem Statements

K 1 Knowledge of the physical or control/protection logic relationship between the [system] and the following systems:
(CFR: 41.2 to 41.9 / 45.7 to 45.8)

Basis - Contains the systems that have a connection to system XXS. The selected systems listed have either a plant protection/control logic relationship or physical piping relationship to system XXS. The list of supporting and dependent systems can be found in the System Specification Document Section 8.0, "Interfacing Systems Requirements," and Appendix A, "Interface Lists." The electrical systems were not included in K1 because they are addressed in K2. The plant control system was not included in K1. All systems are controlled through the plant control system, and the specific controls and interlocks are covered in K4. The relationship to the protection and safety monitoring system is found in K1 as either the reactor trip system (RTS) (Limiting Condition for Operation (LCO) 3.3.1), engineered safety features actuation system (LCO 3.3.2), or post accident monitoring system (LCO 3.3.3).

K 2 Knowledge of bus or division power supplies to the following:
(CFR: 41.7)

Basis - Lists the power supplies to system components for which knowledge of power supplies is testable. The intent is to limit the required knowledge to the Class 1E direct current (dc) and uninterruptible power supply (UPS) system (IDS) division and/or main alternating current (ac) power system (ECS) standby diesel generator backed bus providing power to the component.

K 3 Knowledge of the effect that a loss or malfunction of the [system] will have on the following systems or system parameters:
(CFR: 41.7 / 45.6)

Basis - Lists the systems included in K1 that are directly affected by a loss of system XXS.

K 4 Knowledge of [system] design feature(s) and/or interlock(s) that provide for the following:
(CFR: 41.7)

Basis - Contains the plant protection/control design features and interlocks.

K 5 Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the [system]:
(CFR: 41.7 / 45.7)

Basis - Contains theoretical concepts related to the operation of the system.

K 6 Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the [system]:
(CFR: 41.7 / 45.5 to 45.8)

Basis - Lists the systems included in K1 that will have an effect on system XXS if the listed system is lost. It also lists the components of system XXS whose failure can affect the operation of the XXS.

Ability Stem Statements

A 1 Ability to predict and/or monitor changes in parameters associated with operation of the [system], including the following:
(CFR: 41.5 / 45.5)

Basis - Lists the parameters monitored to verify proper operation of the system.

A 2 Ability to (a) predict the impacts of the following system/component malfunctions or operations on the [system] and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

Basis - Lists the ability to predict and mitigate the consequences of selected items from K6.

A 3 Ability to monitor automatic operation of the [system], including the following:
(CFR: 41.7 / 45.5 / 45.13)

Basis - Contains the automatic features of the XXS identified in K4 that can be monitored from the control room.

A 4 Ability to manually operate and monitor in the control room:
(CFR: 41.7 / 45.5 to 45.8)

Basis - Contains the features of the XXS listed in A3 that can also be manually performed, as well as the features of the XXS system that can only be manually performed and monitoring parameters. A4 includes system monitoring associated with the listed manual actions

1.10 Emergency and Abnormal Plant Evolutions

1.10.1 Emergency Plant Evolutions and Abnormal Plant Evolutions

Section 4 of this catalog contains the AP1000 specific emergency and abnormal plant evolutions. An emergency plant evolution (EPE) is any condition, event, or symptom that leads to entry into the plant-specific emergency operating procedures. An abnormal plant evolution

(APE) is any degraded condition, event, or symptom that does not directly lead to an EOP entry condition but, nonetheless, adversely affects a safety function.

The emergency plant and abnormal plant evolutions each have a unique evolution designator. The emergency plant evolutions and abnormal plant evolutions covered by this catalog are listed below.

Emergency Plant Evolutions

E-0	Reactor Trip or Safeguards Actuation
ES-0.1	Reactor Trip Response
ES-0.2	Natural Circulation Cooldown
E-1	Loss of Reactor or Secondary Coolant Accident
ES-1.1	Passive Safety System Termination
ES-1.2	Post-Loss-of-Coolant Accident Cooldown and Depressurization
ES-1.3	ADS Stage 1–3 Actuation Response
ES-1.4	ADS Stage 4 Actuation Response
ECA-1.1	Loss-of-Coolant Accident Outside Containment
E-2	Faulted Steam Generator Isolation
E-3	Steam Generator Tube Rupture
FR-S.1[1]	Response to Nuclear Power Generation—ATWS
FR-C.1	Response to Inadequate Core Cooling
FR-C.2	Response to Degraded Core Cooling
FR-C.3	Response to Saturated Core Cooling
FR-H.1	Response to Loss of Heat Sink
FR-H.2	Response to Steam Generator Overpressure
FR-I.1	Response to High Pressurizer Level
FR-I.2	Response to Low Pressurizer Level
FR-I.3	Response to Voids in the Reactor Vessel
FR-P.1	Response to Imminent Pressurized Thermal Shock Condition
FR-Z.1	Response to High Containment Pressure
FR-Z.2	Response to Containment Flooding
FR-Z.3	Response to High Containment Radiation
FR-Z.4	Response to Low Containment Pressure
SDP-1	Response to Loss of RCS Inventory during Shutdown
SDP-2	Response to Loss of Normal Residual Heat Removal System during Shutdown
SDP-4	Response to Rising Nuclear Flux during Shutdown
SDP-5	Response to RCS Cold Overpressure during Shutdown
SDP-6	Response to Unexpected RCS Temperature Changes during Shutdown

Abnormal Plant Evolutions

A-301	Rapid Power Reduction
A-302	Emergency Boration
A-304	Steam Generator Tube Leak
A-306	Evacuation of Control Room
A-307	DAS Operation at Local Cabinets
A-308	Loss of Control Room Air Conditioning

[1] FR-S.2 and FR-P.2 have one K/A in addition to those identified under FR-S.1 and FR-P.1. That K/A is included with K/As FR-S.1 and FR-P.1.

A-311	Rod Control System Malfunctions
A-313	Uncontrolled Cooldown
A-314	Fuel Handling Incidents
A-317	Loss of Component Cooling Water
A-318	Condensate System Malfunctions
A-320	Loss of Circulating Water
A-321	Malfunction of Data Display and Processing System
A-323	Loss of 6.9-Kilovolt, 4,160-Volt, or 480-Volt Bus Power
A-326	Feedwater System Malfunctions
A-327	Startup Feedwater System Malfunctions
A-328	Malfunction of Feedwater Heaters and Extraction Steam
A-329	Loss of Instrument Air
A-331	Loss of Plant DC Power or AC Instrument Power
A-332	Turbine Trip Without Reactor Trip
A-333	Main Turbine Malfunctions
A-336	Malfunction of Protection and Safety Monitoring System
A-337	Passive Residual Heat Removal Heat Exchanger Leak
A-340	Reactor Coolant Leak
A-342	Reactor Coolant Pump Malfunctions
A-343	Loss of Normal Residual Heat Removal
A-345	Loss of Service Water
A-348	Degraded Grid

1.10.2 Knowledge and Ability Stem Statements for Emergency Operating Evolutions and Abnormal Operating Evolutions

The information delineated within each EPE or APE is organized into three types of knowledge and two different types of ability. If there are no knowledge or ability statements following a stem statement, then there is no applicable K/A; these are marked N/A.

The applicable 10 CFR 55.41 / 43 / 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. The stem statements are listed below:

<u>Knowledge Stem Statements</u>

EK 1 Knowledge of the relationship between a(n) [event] and the following systems or components:
(CFR: 41.8 / 41.10 / 45.3)

Basis - Lists the systems required to be monitored and/or operated in response to the emergency/abnormal plant evolution.

EK 2 Knowledge of the operational implications or cause and effect relationships of the following as they apply to a(n) [event]:
(CFR: 41.5 / 41.7 / 45.7 / 45.8)

Basis - Lists the operationally based theoretical concepts applicable to the emergency/abnormal plant evolution. These items typically came from the procedure bases, probabilistic risk assessment (PRA), operating experience (OE), procedure notes and cautions, and system design bases.

EK 3 Knowledge of the reasons for the following actions as they apply to a(n) [event]:
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

Basis - Lists the actions taken for the emergency/abnormal plant evolution and the bases.

Ability Stem Statements

EA 1 Ability to operate and/or monitor the following as they apply to a(n) [event]:
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

Basis - Lists the system and/or components required to be monitored and/or operated in response to the emergency/abnormal plant evolution.

EA 2 Ability to evaluate the following parameters and/or conditions as they apply to a(n) [event]:
(CFR: 41.7 / 43.5 / 45.6)

Basis - Lists the parameters and/or conditions that are monitored for an emergency/abnormal plant evolution.

1.11 Components

Basic components such as valves and pumps are found in many systems. NUREG-1021 lists eight categories of components. The eight categories of components for which additional knowledge statements are necessary are listed below and delineated in Section 5 of this 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-digit code number identified in NUREG-1021 and a 10 CFR 55.41(b) item number.

191001 Valves (CFR: 41.3)
191002 Sensors and Detectors (CFR: 41.7)
191003 Controllers and Positioners (CFR: 41.7)
191004 Pumps (CFR: 41.3)
191005 Motors and Generators (CFR: 41.7)
191006 Heat Exchangers and Condensers (CFR: 41.4)
191007 Demineralizers and Ion Exchangers (CFR: 41.3)
191008 Breakers, Relays, and Disconnects (CFR: 41.7)

1.12 Theory

NUREG-1021 lists theory items. Section 6 of the PWR catalog delineates the general fundamental knowledge that underlies safe performance on the job. These theory topics represent general fundamental concepts related to plant operation. Each theory topic has a unique six-digit code number, and the applicable 10 CFR 55.41(b) item number is provided.

Reactor Theory (CFR: 41.1)

192001	Neutrons
192002	Neutron Life Cycle
192003	Reactor Kinetics and Neutron Sources
192004	Reactivity Coefficients
192005	Control Rods
192006	Fission Product Poisons
192007	Fuel Depletion and Burnable Poisons
192008	Reactor Operational Physics

Thermodynamics Theory (CFR: 41.14)

193001	Thermodynamic Units and Properties
193002	Basic Energy Concepts
193003	Steam
193004	Thermodynamic Process
193005	Thermodynamic Cycles
193006	Fluid Statics and Dynamics
193007	Heat Transfer
193008	Thermal Hydraulics
193009	Core Thermal Limits
193010	Brittle Fracture and Vessel Thermal Stress

1.13 Importance Ratings

Importance, in this context, considers direct and indirect impacts of the K/A on safe plant operation in a manner ensuring personnel and public health and safety. Importance ratings of the K/As are given next to each K/A in the catalog. These ratings reflect average ratings of respondents. The rating scale is presented below.

Rating	Importance for Safe Operation
5	Essential
4	Very important
3	Fairly important
2	Of limited importance
1	Insignificant importance

A rating below 2.5 represents a statement of limited or insignificant importance for the safe operation of a plant. Such statements are generally considered as inappropriate content for U.S. Nuclear Regulatory Commission (NRC) licensing examinations. (See below for qualifications of importance ratings related to variability of the ratings and plant-specific data.)

1.14 Rules of Use

To ensure consistency in applying this catalog, the following terms are interpreted as follows:

- “Parameters” include any characteristic of a system/component that is measured.

- "Actuation" includes actuation logic, signals, blocks, bypasses, permissives, interlocks, and resets.

1.15 General Guidance

The following strategies and principles are utilized in this catalog:

- The use of setpoints is minimized. Values included are specific to titles or procedures. If a value included in the catalog changes, the statement is still testable if it meets the intent of the statement.

- K/A statement overlap in multiple sections is minimized. K/As are assigned to the most appropriate section.

- All importance ratings are single-column format except A2 and generic K/As and fuel handling.

2 GENERIC KNOWLEDGES AND ABILITIES

2.0.1 For the purpose of this catalog, K/As that reference 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 / 43.10 / 45.13)
IMPORTANCE RO 3.8 SRO 4.2

2.1.2 Knowledge of operator responsibilities during any mode of plant operation
(CFR: 41.10 / 43.1 / 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, and maintenance of active license status, 10 CFR part 55
(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 or overtime limitations (reference potential)
(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 (SRO only)
(CFR: 43.5 / 45.12 / 45.13)
IMPORTANCE RO N/A 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

2.1.8 Ability to coordinate personnel activities outside the control room
(CFR: 41.10 / 43.1 / 45.5 / 45.12 / 45.13)
IMPORTANCE RO 3.4 SRO 4.1

2.1.9 Ability to direct licensed personnel activities inside the control room (SRO only)
(CFR: 43.1 / 45.5 / 45.12 / 45.13)
IMPORTANCE RO N/A 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 Deleted

2.1.14 Knowledge of criteria or conditions that require plantwide announcements, such as pump starts, reactor trips, and mode changes
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.1 SRO 3.1

2.1.15 Knowledge of administrative requirements for temporary management direction, such as standing orders, night orders, or operations memoranda
(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 available indications to evaluate system or component status
(CFR: 41.10 / 45.12)
IMPORTANCE RO 3.9 SRO 3.8

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 that a copy of a controlled procedure is the proper revision
(CFR: 41.10 / 45.10 / 45.13)
IMPORTANCE RO 3.5 SRO 3.6

2.1.22 Moved to 2.2.35

2.1.23 Ability to perform general and/or normal operating procedures during any plant condition
(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, and tables (reference potential)
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.9 SRO 4.2

2.1.26 Deleted

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, or switches
(CFR: 41.10 / 45.1 / 45.12)
IMPORTANCE RO 4.1 SRO 4.0

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 whether 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 precautions, limitations, notes, or cautions
(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 reactor coolant system or balance-of-plant chemistry controls, including parameters measured and reasons for the control
(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 (SRO only)
(CFR: 43.7)
IMPORTANCE RO N/A 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 / 41.5 / 41.10 / 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 / 43.6 / 45.13)
IMPORTANCE RO 2.8 SRO 3.9

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 (SRO only)
(CFR: 43.7 / 45.13)
IMPORTANCE RO N/A SRO 3.4

2.1.43 Ability to use an online power distribution monitoring system and/or procedures to determine the effects on reactivity of plant changes, such as RCS temperature, secondary plant, or fuel depletion
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, communicating with fuel-handling personnel, operating systems from the control room to support fueling operations, or supporting instrumentation
(CFR: 41.10 / 43.7 / 45.12)
IMPORTANCE RO 3.9 SRO N/A

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

2.1.46 Ability to use integrated control systems to operate plant systems or components
(CFR: 41.10 / 45.12 / 45.13)
IMPORTANCE RO 4.0 SRO 3.3

2.1.47 Ability to direct nonlicensed personnel activities inside the control room
(CFR: 41.10 / 43.5 / 45.5 / 45.12 / 45.13)
IMPORTANCE RO 3.2 SRO 3.2

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/or 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 room layouts, systems, instrumentation, and/or 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, such as 10 CFR 50.59, "Changes, Tests and Experiments," screening and evaluation processes, administrative processes for temporary modifications, disabling annunciators, or installation of temporary equipment
(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 infrequently performed tests or evolutions
(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
2.2.11 Deleted

2.2.12 Knowledge of surveillance procedures
(CFR: 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.7 SRO 4.1

2.2.13 Knowledge of tagging and clearance procedures
(CFR: 41.10 / 43.1 / 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, lineups, or tagouts (reference potential)
(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 and work prioritization
(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

2.2.20 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 TS limiting conditions for operation
(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 TS for limiting conditions for operation and safety limits (SRO only)
(CFR: 43.2)
IMPORTANCE RO N/A 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 Moved to 2.1.36
2.2.32 Deleted
2.2.33 Deleted
2.2.34 Moved to 2.1.43

2.2.35 Ability to determine TS for 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 operation
(CFR: 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.1 SRO 4.2

2.2.37 Ability to determine operability or availability of safety-related equipment (SRO Only)
(CFR: 43.2 / 43.5 / 45.12)
IMPORTANCE RO N/A 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 1 hour TS action statements (does not include action statements of 1 hour or less that follow the expiration of a completion time for a TS condition for which an action statement has already been entered)
(CFR: 41.7 / 41.10 / 43.2 / 45.13)
IMPORTANCE RO 3.9 SRO 4.5

2.2.40 Ability to apply TS with action statements of less than or equal to 1 hour
(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 (reference potential)
(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 TS
(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

2.2.44 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

2.2.45 Ability to determine and/or interpret TS with action statements of greater than 1 hour (SRO only)
(CFR: 43.2 / 43.5 / 45.3)
IMPORTANCE RO N/A SRO 4.7

2.3 Radiation Control

2.3.1 Deleted
2.3.2 Deleted
2.3.3 Deleted
2.3.4 Deleted

2.3.5 Ability to use RMSs, such as fixed radiation monitors and alarms or personnel monitoring equipment
(CFR: 41.11 / 41.12 / 43.4 / 45.9)
IMPORTANCE RO 2.9 SRO 2.9

2.3.6 Ability to approve liquid or gaseous release permits
(CFR: 41.13 / 43.4 / 45.10)
IMPORTANCE RO 2.0 SRO 3.8

2.3.7 Deleted
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 and 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, or alignment of filters
(CFR: 41.12 / 43.4 / 45.9 / 45.10)
IMPORTANCE RO 3.2 SRO 3.7

2.3.13 Deleted

2.3.14 Knowledge of radiation or contamination hazards that may arise during normal, abnormal, or emergency conditions or activities, such as analysis and interpretation of radiation and activity readings as they pertain to administrative, normal, abnormal, and emergency procedures or to analysis and interpretation of coolant activity, including comparison to emergency plan or regulatory limits (SRO Only)
(CFR: 43.4 / 45.10)
IMPORTANCE RO N/A SRO 3.8

2.3.15 Deleted

2.4 Emergency Procedures/Emergency Plan

2.4.1 Deleted

2.4.2 Knowledge of system setpoints, interlocks, and automatic actions associated with emergency and abnormal operating procedure 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 emergency and abnormal operating procedures major action categories
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.7 SRO 4.7

2.4.7 Deleted
2.4.8 Deleted
2.4.9 Deleted
2.4.10 Deleted
2.4.11 Deleted

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

2.4.13 Deleted

2.4.14 Knowledge of general guidelines for emergency and abnormal operating procedures usage
(CFR: 41.10 / 43.1 / 45.13)
IMPORTANCE RO 3.8 SRO 4.5

2.4.15 Moved to 2.1.38

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

2.4.17 **Knowledge of emergency and abnormal operating procedures terms and definitions**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.9 SRO 4.3

2.4.18 **Knowledge of the specific bases for emergency and abnormal operating procedures**
(CFR: 41.10 / 43.1 / 45.13)
IMPORTANCE RO 3.3 SRO 4.0

2.4.19 **Knowledge of emergency and abnormal operating procedures 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 emergency and abnormal operating procedures warnings, cautions, and notes**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.8 SRO 4.3

2.4.21 **Knowledge of the parameters and logic used to assess the status of emergency operating procedures critical safety functions or shutdown critical safety functions**
(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 and 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 operating procedures Implementation**
(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 firefighting equipment usage**
(CFR: 41.10 / 43.5 / 45.12)
IMPORTANCE RO 3.1 SRO 3.6

2.4.27 **Deleted**

2.4.28 **Knowledge of procedures relating to a security event (ensure the test item includes no safeguards information)**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 3.2 SRO 4.1

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

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 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 responsibilities outside the main control room during an emergency**
(CFR: 41.10 / 43.5 / 45.13)
IMPORTANCE RO 4.2 SRO N/A

2.4.35 **Knowledge of nonlicensed operator responsibilities during an emergency**
(CFR: 41.10 / 43.1 / 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 implementing procedures**
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.0 SRO 4.1

2.4.38 Ability to take actions required by the facility emergency plan implementing procedures, including supporting or acting as emergency coordinator
(CFR: 41.10 / 43.5 / 45.11)
IMPORTANCE RO 2.4 SRO 4.4

2.4.39 Knowledge of RO responsibilities in emergency plan implementing procedures
(CFR: 41.10 / 45.11)
IMPORTANCE RO 3.9 SRO N/A

2.4.40 Knowledge of SRO responsibilities in emergency plan implementing procedures (SRO only)
(CFR: 43.5 / 45.11)
IMPORTANCE RO N/A SRO 4.5

2.4.41 Knowledge of the emergency action level thresholds and classifications (SRO only)
(CFR: 43.5 / 45.11)
IMPORTANCE RO N/A 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 / 43.5 / 45.13)
IMPORTANCE RO 3.2 SRO 3.8

2.4.44 Knowledge of emergency plan implementing procedures protective action recommendations (SRO only)
(CFR: 41.10 / 41.12 / 43.5 / 45.11)
IMPORTANCE RO N/A 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 using the appropriate control room reference material (reference potential)
(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

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

2.4.51 Knowledge of emergency operating procedure exit conditions (e.g., emergency condition no longer exists, or severe accident guideline entry is required)
(CFR: 41.10 / 43.5 /45.13)
IMPORTANCE RO 3.0 SRO 4.0

2.4.52 Knowledge of the lines of authority during implementation of the emergency plan, emergency plan implementing procedures, emergency operating procedures, or severe accident guidelines
(CFR: 41.10 / 45.13)
IMPORTANCE RO 3.0 SRO 4.0

3 PLANT SYSTEMS

3.1 Safety Function 1: Reactivity Control

3.1.1 SF1 CVS Chemical and Volume Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the chemical and volume control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	3.0
K 1.02	Component cooling water system	2.9
K 1.03	Diverse actuation system	3.6
K 1.04	Demineralized water transfer and storage system	2.6
K 1.05	Engineered safeguards actuation system	4.0
K 1.06	Special process heat tracing system	1.9
K 1.07	Nuclear instrumentation system	3.0
K 1.08	Postaccident monitoring system	3.0
K 1.09	Plant gas system	2.3
K 1.10	Pressurizer level control system	3.6
K 1.11	Plant sampling system	1.9
K 1.12	Passive core cooling system	3.6
K 1.13	Reactor coolant system	3.7
K 1.14	Normal residual heat removal system	3.3
K 1.15	Spent fuel pool cooling system	3.0
K 1.16	Radiologically controlled area ventilation system	2.2
K 1.17	Liquid radwaste system	2.1
K 1.18	Radioactive waste drain system	2.0
K 1.19	Wastewater system	1.8
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Chemical and volume control system makeup pumps	3.2
K 2.02	Boric acid tank heaters	2.0
K 2.03	Purification stop valves	3.1
K 2.04	Containment isolation valves	3.7
K 3	**Knowledge of the effect that a loss or malfunction of the chemical and volume control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Component cooling water system	2.6
K 3.02	Reactor coolant system	3.8
K 3.03	Pressurizer level control system	3.8
K 3.04	Passive core cooling system	3.6

K 3.05	Reactor coolant system	3.7
K 3.06	Hot-leg level during midloop	3.7
K 3.07	Normal residual heat removal system	3.2
K 3.08	Radiologically controlled area ventilation system	2.1
K 3.09	Liquid radwaste system	2.1

K 4 **Knowledge of chemical and volume control system design feature(s) and/or interlock(s) that provide for the following:**
(CFR: 41.7)

K 4.01	Containment penetration isolation	4.0
K 4.02	Boron dilution block actuation	3.8
K 4.03	Chemical and volume control system makeup isolation actuation	3.7
K 4.04	Chemical and volume control system letdown isolation actuation	3.8
K 4.05	Auxiliary spray and purification line isolation actuation	3.5
K 4.06	Preservation of reactor coolant system pressure boundary	4.1
K 4.07	Isolation of excessive makeup	3.5
K 4.08	Chemical and volume control system letdown isolation actuation (hot-leg level low-1)	3.7
K 4.09	Reactor coolant system inventory control	3.8
K 4.10	Reactor coolant system boration and/or dilution	3.7
K 4.11	Pressurizer auxiliary spray supply	3.1
K 4.12	Reactor coolant purification	2.7
K 4.13	Chemical control	2.8
K 4.14	Oxygen control	2.5
K 4.15	Filling and pressure testing the reactor coolant system	2.1
K 4.16	Borated makeup to auxiliary equipment	2.4
K 4.17	Reactor coolant system degassing	2.6
K 4.18	Chemical and volume control system makeup pumps suction header control valve interlocks	3.0
K 4.19	Demineralized water supply isolation valve interlocks	3.0
K 4.20	Purification loop temperature control	2.6
K 4.21	Purification stop valve interlocks	3.0
K 4.22	Pressurizer auxiliary spray valve interlocks	3.1
K 4.23	Letdown line isolation valve—orifice side interlocks	3.4
K 4.24	Makeup line containment isolation valve interlocks	3.7
K 4.25	Letdown line outside containment isolation valve interlocks	3.5
K 4.26	Letdown line inside containment isolation valve interlocks	3.8
K 4.27	Chemical and volume control system makeup flow control valve interlocks	3.2
K 4.28	Chemical and volume control system makeup pump interlocks	3.1
K 4.29	Reactor makeup control system borate mode	3.5
K 4.30	Reactor makeup control system dilute mode	3.0
K 4.31	Reactor makeup control system blend mode	3.1
K 4.32	Reactor makeup control system auto makeup mode	3.2
K 4.33	Reactor coolant system pressure control during solid plant operation	3.5

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the chemical and volume control system:** (CFR: 41.7 / 45.7)	
K 5.01	Thermal shock of reactor coolant system penetrations	3.6
K 5.02	Demineralizer depletion	2.6
K 5.03	Reactor coolant pump configuration and speed effect on purification loop flow	2.8
K 5.04	Borating fresh demineralizer bed before placing in service (OE related)	3.2
K 5.05	Temperature effects on demineralizer beds (OE related)	3.0
K 5.06	Temperature effects on boron solubility (OE related)	3.0
K 5.07	Reactor coolant system corrosion, activity, and isotopic control (i.e., hydrogen concentration, oxygen concentration, zinc concentration, and pH control)	2.9
K 5.08	Reactor coolant system pH outside of acceptability range	2.8
K 5.09	Reactor coolant system pressure control during solid plant operation	3.5

K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the chemical and volume control system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	3.2
K 6.02	Component cooling water system	3.1
K 6.03	Diverse actuation system	3.7
K 6.04	Demineralized water transfer and storage system	2.5
K 6.05	Engineered safeguards actuation system	4.0
K 6.06	Special process heat tracing system	2.0
K 6.07	Nuclear instrumentation system	3.0
K 6.08	Plant gas system	2.3
K 6.09	Pressurizer level control system	3.5
K 6.10	Reactor coolant system	3.6
K 6.11	Hot-leg level during midloop	3.8
K 6.12	Normal residual heat removal system	3.2
K 6.13	Spent fuel pool cooling system	3.0
K 6.14	Liquid radwaste system	2.3
K 6.15	Chemical and volume control system makeup pump	3.2
K 6.16	Mixed bed demineralizer	2.6
K 6.17	Reactor coolant filter	2.4
K 6.18	Makeup filter	2.5
K 6.19	Reactor makeup control system	3.5
K 6.20	Letdown heat exchanger	3.1
K 6.21	Purification stop valves	3.2
K 6.22	Makeup line containment isolation valves	3.6

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the chemical and volume control system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Purification flow rate	2.7
A 1.02	Boration flow rate	3.4
A 1.03	Dilution flow rate	3.1
A 1.04	Chemical and volume control system makeup pump flow rate (one pump)	2.9
A 1.05	Chemical and volume control system makeup pump flow rate (two pumps)	3.0
A 1.06	Letdown water temperatures	2.9
A 1.07	Maximum demineralizer and filter temperatures	2.9
A 1.08	Effluent temperature to liquid radwaste system	2.3
A 1.09	Effluent flow rate to liquid radwaste system	2.4
A 1.10	Boric acid storage tank boric acid concentration	3.3
A 1.11	Placing cation demineralizer bed in service (OE related)	2.8
A 1.12	Control rod position	3.7
A 1.13	Reactor power	4.0
A 1.14	Pressurizer auxiliary spray	3.2
A 1.15	Reactor coolant system temperature	3.6
A 1.16	Reactor coolant system pressure during solid plant operations	3.7
A 1.17	Pressurizer pressure	3.4
A 1.18	Pressurizer temperature	3.1
A 1.19	Pressurizer level	3.5
A 1.20	Pressurizer spray line temperature	3.0
A 1.21	Total gallons and time required to achieve desired boron concentration	3.2

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the chemical and volume control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13 / 45.13)

		RO	**SRO**
A 2.01	Compressed air system	3.4	3.1
A 2.02	Component cooling water system	3.0	2.9
A 2.03	Diverse actuation system	4.0	3.7
A 2.04	Demineralized water transfer and storage system	3.0	2.7
A 2.05	Engineered safeguards actuation system	3.8	3.9
A 2.06	Special process heat tracing system	2.2	1.9
A 2.07	Nuclear instrumentation system	3.4	2.9
A 2.08	Pressurizer level control system	3.6	3.5
A 2.09	Plant gas system	2.4	2.2
A 2.10	Reactor coolant system	3.8	3.6
A 2.11	Normal residual heat removal system	3.8	3.1
A 2.12	Spent fuel pool cooling system	3.0	2.7
A 2.13	Liquid radwaste system	2.6	2.2

A 2.14	Chemical and volume control system makeup pump	3.4	3.1
A 2.15	Mixed bed demineralizer	2.2	2.6
A 2.16	Reactor coolant filter	2.4	2.4
A 2.17	Makeup filter	2.8	2.4
A 2.18	Reactor makeup control system	3.6	3.4
A 2.19	Letdown heat exchanger	3.0	2.9
A 2.20	Inadvertent boration or dilution	3.8	4.0
A 2.21	Containment isolation actuation	4.0	4.1
A 2.22	Boron dilution block actuation	3.8	3.9
A 2.23	Chemical and volume control system makeup isolation actuation	3.6	3.6
A 2.24	Chemical and volume control system letdown isolation actuation	3.6	3.7
A 2.25	Auxiliary spray and purification line isolation actuation	3.6	3.3
A 2.26	High reactor coolant system activity	3.4	3.6
A 2.27	Accumulator boron concentration out of specification	3.8	3.4
A 2.28	Core makeup tank boron concentration out of specification	3.4	3.4
A 2.29	In-containment refueling water storage tank boron concentration out of specification	4.0	3.7
A 2.30	Spent fuel pool cooling system boron concentration out of specification	3.8	3.3
A 2.31	End-of-life (EOL) boron reduction using mixed bed deborating demineralizer	2.4	2.9

A 3 **Ability to monitor automatic operation of the chemical and volume control system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Reactor coolant system boration	3.6
A 3.02	Reactor coolant system dilution	3.7
A 3.03	Reactor coolant system makeup	3.4
A 3.04	Chemical and volume control system purification	2.9
A 3.05	Chemical and volume control system letdown	3.1
A 3.06	Reactor coolant system pressure control during solid plant operation	3.8
A 3.07	Containment isolation actuation	4.1
A 3.08	Boron dilution block actuation	3.8
A 3.09	Chemical and volume control system makeup isolation actuation	3.8
A 3.10	Chemical and volume control system letdown isolation actuation	3.8
A 3.11	Auxiliary spray and purification line isolation actuation	3.3

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Reactor coolant system boration (including reactivity effects)	3.9
A 4.02	Reactor coolant system dilution (including reactivity effects)	4.0
A 4.03	EOL boron reduction using mixed bed deborating demineralizer (including reactivity effects)	3.2
A 4.04	Reactor coolant system makeup	3.5
A 4.05	Chemical and volume control system purification	3.0
A 4.06	Chemical and volume control system letdown	3.4
A 4.07	Reactor coolant system pressure control during solid plant operation	3.8
A 4.08	Reactor coolant system pressure control using auxiliary spray	3.4
A 4.09	Containment isolation actuation	4.0

A 4.10	Boron dilution block actuation	3.8
A 4.11	Chemical and volume control system makeup isolation actuation	3.8
A 4.12	Auxiliary spray and purification line isolation actuation	3.6
A 4.13	Chemical and volume control system letdown isolation actuation	3.8
A 4.14	Fill/makeup to the accumulators	3.2
A 4.15	Fill/makeup to the core makeup tank	3.2
A 4.16	Fill/makeup to the in-containment refueling water storage tank	3.5
A 4.17	Fill/makeup to the spent fuel pool cooling system	3.1
A 4.18	Maintain proper reactor coolant system hydrogen/oxygen concentration	2.9
A 4.19	Maintain proper reactor coolant system zinc concentration	2.8

3.1.2 SF1 DRCS Digital Rod Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the digital rod control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Main and startup feedwater system	2.3
K 1.02	Diverse actuation system	3.5
K 1.03	Main turbine system	2.8
K 1.04	Nuclear instrumentation system	3.5
K 1.05	Online power distribution monitoring system	3.5
K 1.06	Pressurizer level control system	2.7
K 1.07	Pressurizer pressure control system	2.5
K 1.08	Reactor coolant system	3.3
K 1.09	Rod position indication system	3.6
K 1.10	Reactor trip system	4.0
K 1.11	Reactor system	3.2
K 1.12	Steam dump control system	3.3
K 1.13	Main turbine control and diagnostics system	2.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Control rod drive mechanism motor-generator (M-G) set motor	3.1
K 2.02	Control rod drive mechanism	3.1
K 2.03	Reactor trip breaker control power	3.8
K 2.04	Logic cabinet control power	3.1
K 2.05	Power cabinet control power	3.1
K 2.06	Integrated head package cooling fans	2.5
K 2.07	DC hold bus	2.9
K 3	**Knowledge of the effect that a loss or malfunction of the digital rod control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Reactor coolant system	3.5
K 3.02	Rod position indication system	3.7
K 3.03	Reactor trip system	3.9
K 3.04	Reactor system	3.2
K 3.05	Steam dump control system	3.5
K 3.06	Main turbine control and diagnostics system	2.8
K 4	**Knowledge of digital rod control system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Group demand position indication	3.6

K 4.02	Digital rod position indication	3.7
K 4.03	High-power rod control mode	3.6
K 4.04	Low-power rod control mode	3.6
K 4.05	Rod speed and direction determination	3.7
K 4.06	Load regulation mode	3.0
K 4.07	Axial offset control	3.7
K 4.08	Automatic rod motion	3.9
K 4.09	Manual rod motion	3.8
K 4.10	Bank select rod motion	3.5
K 4.11	Rapid power reduction logic—rod control system	3.9
K 4.12	Control bank sequence and overlap	3.8
K 4.13	Control rod insertion limits	4.0
K 4.14	Control rod withdrawal limits	3.8
K 4.15	C-1, High Intermediate-Range Flux, Auto and Manual Rod Withdrawal Block	3.8
K 4.16	C-2, High Power Range Flux, Auto and Manual Rod Withdrawal Block	3.8
K 4.17	C-3, Low OTΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.8
K 4.18	C-4, Low OPΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.8
K 4.19	C-5, Low Turbine Power, Rod Block	3.7
K 4.20	C-11, M Bank Rod Out Limit, M Bank Auto Rod Withdrawal Block	3.8
K 4.21	C-15, Axial Offset Bank Insertion Limit, Axial Offset Bank Insertion Block	3.7
K 4.22	C-17, M Bank Rod Insertion Limit, Axial Offset Bank Withdrawal Block	3.6
K 4.23	C-18, M Bank Rod Withdrawal Limit, Axial Offset Bank Insertion Block	3.6
K 4.24	P-3, Reactor Trip Breaker Open	4.1
K 4.25	P-4, Reactor Trip	4.2
K 4.26	P-17, Negative Nuclear Power Rate	4.0
K 4.27	Automatic withdrawal permissive—M banks	3.8
K 4.28	Automatic and manual withdrawal permissive—M banks	3.8
K 4.29	Automatic and manual withdrawal permissive—axial offset bank	3.7
K 4.30	Automatic withdrawal permissive—axial offset bank	3.7
K 4.31	Automatic insertion permissive—axial offset bank	3.7
K 4.32	Dropped or misaligned control rod recovery (OE related)	4.0
K 4.33	Control rod exchange	3.7
K 4.34	Control rod motion inhibit	3.6
K 4.35	Reactor trip	4.5
K 4.36	Reactor trip breaker operability testing	3.7
K 4.37	Rod control startup reset	3.2
K 4.38	Rod control alarm reset	3.1
K 4.39	Sequencing of gripper and lift coil energization during control rod motion	2.9

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the digital rod control system:** (CFR: 41.7 / 45.7)	
K 5.01	Control rod position change effect on shutdown margin	4.0
K 5.02	Reactor coolant system boron change effect on shutdown margin	4.0
K 5.03	Dropped or misaligned control rod effect on core poisons (OE related)	3.7
K 5.04	Dropped or misaligned control rod recovery effect on core poisons (OE related)	3.7
K 5.05	Control rod position and core poison redistribution effect on axial flux difference	3.6
K 5.06	Axial flux difference response to reactor power maneuvers	3.9
K 5.07	Core poison redistribution effect on quadrant power tilt ratio	3.7
K 5.08	Control rod position change effect on integral control rod worth	3.2
K 5.09	Control rod position change effect on differential control rod worth	3.3
K 5.10	Control rod bank positions not within the control rod insertion limits of the core operating limits report	4.2
K 5.11	Moderator temperature coefficient (MTC) not within limits of the core operating limits report	4.0
K 5.12	Positive MTC effect on reactor control	4.1
K 5.13	Negative MTC effect on reactor control	4.0
K 5.14	Performing a reactor startup within 24 hours after a trip from power	3.5
K 5.15	Power mismatch circuit effect on control rod motion	3.5
K 5.16	Control rod exchange	3.7
K 5.17	Inadequate shutdown margin before withdrawing shutdown banks	4.2
K 5.18	Axial offset bank movement effect on reactor power	3.7
K 5.19	Erroneous estimated critical position	4.0
K 5.20	Failure to maintain power margin	3.7
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the digital rod control system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Main and startup feedwater system	3.0
K 6.02	Main turbine system	3.0
K 6.03	Nuclear instrumentation system	3.7
K 6.04	Online power distribution monitoring system	3.8
K 6.05	Pressurizer level control system	3.0
K 6.06	Pressurizer pressure control system	3.0
K 6.07	Reactor coolant system	3.3
K 6.08	Rod position indication system	3.7
K 6.09	Reactor trip system	4.0
K 6.10	Reactor system	3.3
K 6.11	Steam dump control system	3.3
K 6.12	Main turbine control and diagnostics system	2.9
K 6.13	Control rod exchange	3.5

K 6.14	Dropped control rod (OE related)	3.8	
K 6.15	Misaligned control rod (OE related)	3.8	
K 6.16	Inoperable control rod	3.9	
K 6.17	Logic cabinet nonurgent alarm	3.1	
K 6.18	Logic cabinet urgent alarm	3.5	
K 6.19	Power cabinet nonurgent alarm	3.1	
K 6.20	Power cabinet urgent alarm	3.5	
K 6.21	Digital rod position indication failure	3.5	
K 6.22	Group demand position indication failure	3.5	
K 6.23	Control rod drive mechanism failure	3.7	
K 6.24	Integrated head package cooling fan failure	2.7	
K 6.25	Control rod drive mechanism M-G set	3.1	
K 6.26	Reactor trip breaker failure	4.1	
K 6.27	Loss of all AC power	3.7	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the digital rod control system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Nuclear instrumentation system indicated power and startup rate	4.0	
A 1.02	Calculated reactor power	3.9	
A 1.03	Reactor coolant system ΔT	3.7	
A 1.04	Reactor coolant system T_{avg}	3.9	
A 1.05	Reactor coolant system T_{ref}	3.7	
A 1.06	Axial flux difference	3.8	
A 1.07	Axial power margin	3.5	
A 1.08	Group demand position indication	3.6	
A 1.09	Digital rod position indication	3.8	
A 1.10	Quadrant power tilt ratio	3.7	
A 1.11	Control rod insertion and withdrawal limits	3.9	
A 1.12	Control bank sequence and overlap	3.9	
A 1.13	Group demand positions	3.6	
A 1.14	Digital rod position indication rod positions	3.7	
A 1.15	Control rod operability	4.0	
A 1.16	Peak kilowatts per foot (kw/ft) (Z)	3.4	
A 1.17	Nuclear enthalpy rise hot channel factor ($F^N_{\Delta H}$)	3.4	
A 1.18	Departure from nucleate boiling ratio	3.5	
A 1.19	Shutdown margin	3.9	
A 1.20	Main turbine load	3.2	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the digital rod control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Main and startup feedwater system	2.4	3.1
A 2.02	Main turbine system	2.9	3.2

A 2.03	Nuclear instrumentation system	3.4	3.6
A 2.04	Online power distribution monitoring system	3.6	3.8
A 2.05	Pressurizer level control system	2.4	3.3
A 2.06	Pressurizer pressure control system	2.6	3.2
A 2.07	Reactor coolant system	3.1	3.4
A 2.08	Rod position indication system	3.4	3.9
A 2.09	Reactor trip system	4.1	4.1
A 2.10	Reactor system	2.9	3.2
A 2.11	Steam dump control system	3.4	3.4
A 2.12	Main turbine control and diagnostics system	3.0	3.0
A 2.13	Dropped control rod (OE related)	3.6	4.1
A 2.14	Misaligned control rod (OE related)	3.6	4.1
A 2.15	Inoperable control rod	3.8	4.1
A 2.16	Logic cabinet failure	2.9	3.6
A 2.17	Power cabinet failure	2.9	3.6
A 2.18	Digital rod position indication failure	2.9	3.8
A 2.19	Group demand position indication failure	3.0	3.8
A 2.20	Control rod drive mechanism failure	3.3	3.7
A 2.21	Integrated head package cooling fan failure	2.6	2.7
A 2.22	Control rod drive mechanism M-G set	2.8	3.3
A 2.23	Reactor trip breaker failure	4.1	4.3
A 2.24	Control rod exchange	3.0	3.9

A 3 **Ability to monitor automatic operation of the digital rod control system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Group demand position indication	3.6
A 3.02	Digital rod position indication	3.7
A 3.03	High-power rod control mode	3.8
A 3.04	Low-power rod control mode	3.8
A 3.05	Control rod speed and direction determination	3.9
A 3.06	Load regulation mode	3.4
A 3.07	Axial offset control mode	3.7
A 3.08	Automatic control rod motion	3.9
A 3.09	Rapid power reduction logic—rod control system	4.0
A 3.10	Control bank sequence and overlap	4.0
A 3.11	Control rod insertion limits	4.1
A 3.12	Control rod withdrawal limits	3.9
A 3.13	C-1, High Intermediate-Range Flux, Auto and Manual Rod Withdrawal Block	3.6
A 3.14	C-2, High Power Range Flux, Auto and Manual Rod Withdrawal Block	3.6
A 3.15	C-3, Low OTΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.7
A 3.16	C-4, Low OPΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.7
A 3.17	C-5, Low Turbine Power, Rod Block	3.5
A 3.18	C-11, M Bank Rod Out Limit, M Bank Auto Rod Withdrawal Block	3.6

A 3.19	C-15, Axial Offset Bank Insertion Limit, Axial Offset Bank Insertion Block	3.6
A 3.20	C-17, M Bank Rod Insertion Limit, Axial Offset Bank Withdrawal Block	3.6
A 3.21	C-18, M Bank Rod Withdrawal Limit, Axial Offset Bank Insertion Block	3.6
A 3.22	P-3, Reactor Trip Breaker Open	4.2
A 3.23	P-4, Reactor Trip	4.4
A 3.24	P-17, Negative Nuclear Power Rate	4.0
A 3.25	Automatic withdrawal permissive—M banks	3.6
A 3.26	Automatic and manual withdrawal permissive—M banks	3.6
A 3.27	Automatic and manual withdrawal permissive—axial offset bank	3.6
A 3.28	Automatic withdrawal permissive—axial offset bank	3.6
A 3.29	Automatic insertion permissive—axial offset bank	3.5
A 3.30	Control rod motion inhibit	3.6
A 3.31	Reactor trip	4.5
A 3.32	Control rod exchange	3.7

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Group demand position indication	3.6
A 4.02	Digital rod position indication	3.7
A 4.03	High-power rod control mode	3.7
A 4.04	Low-power rod control mode	3.7
A 4.05	Load regulation mode	3.4
A 4.06	Axial offset control	3.7
A 4.07	Manual rod motion	3.9
A 4.08	Bank select rod motion	3.8
A 4.09	Dropped or misaligned control rod recovery (OE related)	4.0
A 4.10	Control rod exchange	3.8
A 4.11	Reactor trip	4.7
A 4.12	Reactor trip breaker operability testing	3.7
A 4.13	Integrated head package cooling fans	2.7

3.1.3 SF1 RPIS Rod Position Indication System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the rod position indication system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Digital rod control system	3.5
K 1.02	Online power distribution monitoring system	3.3
K 1.03	Reactor coolant system	3.0
K 1.04	Reactor system	3.2
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Digital rod position indication data cabinets	2.8
K 2.02	Digital rod position indication logic cabinets	2.8
K 2.03	Digital rod position indication coils	2.8
K 3	**Knowledge of the effect that a loss or malfunction of the rod position indication system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Group demand position indication	3.3
K 3.02	Digital rod position indication	3.4
K 3.03	Online power distribution monitoring system	3.5
K 3.04	Rod insertion limit monitor	3.4
K 3.05	Rod deviation monitor	3.5
K 3.06	Automatic withdrawal permissive—M banks	3.5
K 3.07	Automatic and manual withdrawal permissive—M banks	3.5
K 3.08	Automatic and manual withdrawal permissive—axial offset bank	3.5
K 3.09	Automatic withdrawal permissive—axial offset bank	3.5
K 3.10	Automatic insertion permissive—axial offset bank	3.5
K 4	**Knowledge of rod position indication system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Group demand position indication	3.3
K 4.02	Digital rod position indication	3.4
K 4.03	Online power distribution monitoring system	3.4
K 4.04	Rod insertion limit monitor	3.5
K 4.05	Rod deviation monitor	3.4
K 4.06	Rod at bottom indication	3.3
K 4.07	Digital rod position indication operation with one failed data channel	3.3
K 4.08	C-11, M Bank Rod Out Limit, M Bank Auto Rod Withdrawal Block	3.5

K 4.09	C-15, Axial Offset Bank Insertion Limit, Axial Offset Bank Insertion Block	3.5
K 4.10	C-17, M Bank Rod Insertion Limit, Axial Offset Bank Withdrawal Block	3.5
K 4.11	C-18, M Bank Rod Withdrawal Limit, Axial Offset Bank Insertion Block	3.5

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the rod position indication system:**
(CFR: 41.7 / 45.7)

K 5.01	Misaligned/dropped control rod effect on digital rod position indication and group demand position indication	3.7

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the rod position indication system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Digital rod control system	3.5
K 6.02	Reactor coolant system	3.0
K 6.03	Reactor system	3.1
K 6.04	Digital rod position indication data cabinet	3.4
K 6.05	Digital rod position indication logic cabinet	3.4
K 6.06	Digital rod position indication coil	3.4
K 6.07	Group demand position indication	3.4

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the rod position indication system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Digital rod position indication	3.4
A 1.02	Rod at bottom	3.4
A 1.03	Group demand position indication	3.4

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the rod position indication system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13 / 45.13)

		RO	**SRO**
A 2.01	Dropped control rod	3.9	4.1
A 2.02	Misaligned control rod	3.9	4.0
A 2.03	Inoperable control rod	3.7	4.1
A 2.04	Digital rod position indication nonurgent alarm	2.6	2.8
A 2.05	Digital rod position indication urgent alarm	3.0	3.5
A 2.06	Digital rod position indication accuracy at Data A + B	2.7	3.2
A 2.07	Digital rod position indication accuracy at Data A only	2.7	3.2

A 2.08	Digital rod position indication accuracy at Data B only	2.7	3.2
A 2.09	Failed digital rod position indication data cabinet	3.0	3.4
A 2.10	Failed digital rod position indication logic cabinet	3.1	3.4
A 2.11	Failed digital rod position indication coil	3.0	3.2
A 2.12	Failed group demand position indication	3.0	3.2
A 2.13	Reactor trip	4.0	3.9
A 2.14	Loss of AC power	3.4	3.6
A 2.15	Loss of power to control rod position monitor	3.0	3.5

A 3 Ability to monitor automatic operation of the rod position indication system, including the following:
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Digital rod position indication accuracy	3.3

A 4 Ability to manually operate and monitor in the control room:
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Digital rod position indication accuracy mode selector	2.9
A 4.02	Rod control startup reset switch	3.1
A 4.03	Group demand position indication	3.0

3.2 Safety Function 2: Reactor Coolant System Inventory Control

3.2.1 SF2 CVS Chemical and Volume Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the chemical and volume control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	3.0
K 1.02	Component cooling water system	2.9
K 1.03	Diverse actuation system	3.6
K 1.04	Demineralized water transfer and storage system	2.6
K 1.05	Engineered safeguards actuation system	4.0
K 1.06	Special process heat tracing system	1.9
K 1.07	Nuclear instrumentation system	3.0
K 1.08	Postaccident monitoring system	3.0
K 1.09	Plant gas system	2.3
K 1.10	Pressurizer level control system	3.6
K 1.11	Plant sampling system	1.9
K 1.12	Passive core cooling system	3.6
K 1.13	Reactor coolant system	3.7
K 1.14	Normal residual heat removal system	3.3
K 1.15	Spent fuel pool cooling system	3.0
K 1.16	Radiologically controlled area ventilation system	2.2
K 1.17	Liquid radwaste system	2.1
K 1.18	Radioactive waste drain system	2.0
K 1.19	Waste water system	1.8
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Chemical and volume control system makeup pumps	3.2
K 2.02	Boric acid tank heaters	2.0
K 2.03	Purification stop valves	3.1
K 2.04	Containment isolation valves	3.7
K 3	**Knowledge of the effect that a loss or malfunction of the chemical and volume control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Component cooling water system	2.6
K 3.02	Reactor coolant system	3.8
K 3.03	Pressurizer level control system	3.8
K 3.04	Passive core cooling system	3.6
K 3.05	Reactor coolant system	3.7
K 3.06	Hot-leg level during midloop	3.7
K 3.07	Normal residual heat removal system	3.2

K 3.08	Radiologically controlled area ventilation system	2.1
K 3.09	Liquid radwaste system	2.1

K 4 **Knowledge of chemical and volume control system design feature(s) and/or interlock(s) that provide for the following:**
(CFR: 41.7)

K 4.01	Containment penetration isolation	4.0
K 4.02	Boron dilution block actuation	3.8
K 4.03	Chemical and volume control system makeup isolation actuation	3.7
K 4.04	Chemical and volume control system letdown isolation actuation	3.8
K 4.05	Auxiliary spray and purification line isolation actuation	3.5
K 4.06	Preservation of reactor coolant system pressure boundary	4.1
K 4.07	Isolation of excessive makeup	3.5
K 4.08	Chemical and volume control system letdown isolation (hot-leg level low-1)	3.7
K 4.09	Reactor coolant system inventory control	3.8
K 4.10	Reactor coolant system boration and/or dilution	3.7
K 4.11	Pressurizer auxiliary spray supply	3.1
K 4.12	Reactor coolant purification	2.7
K 4.13	Chemical control	2.8
K 4.14	Oxygen control	2.5
K 4.15	Filling and pressure testing the reactor coolant system	2.1
K 4.16	Borated makeup to auxiliary equipment	2.4
K 4.17	Reactor coolant system degassing	2.6
K 4.18	Chemical and volume control system makeup pump suction header control valve interlocks	3.0
K 4.19	Demineralized water supply isolation valve interlocks	3.0
K 4.20	Purification loop temperature control	2.6
K 4.21	Purification stop valve interlocks	3.0
K 4.22	Pressurizer auxiliary spray valve interlocks	3.1
K 4.23	Letdown line isolation valve—orifice side interlocks	3.4
K 4.24	Makeup line containment isolation valve interlocks	3.7
K 4.25	Letdown line outside containment isolation valve interlocks	3.5
K 4.26	Letdown line inside containment isolation valve interlocks	3.8
K 4.27	Chemical and volume control system makeup flow control valve interlocks	3.2
K 4.28	Chemical and volume control system makeup pump interlocks	3.1
K 4.29	Reactor makeup control system borate mode	3.5
K 4.30	Reactor makeup control system dilute mode	3.0
K 4.31	Reactor makeup control system blend mode	3.1
K 4.32	Reactor makeup control system auto makeup mode	3.2
K 4.33	Reactor coolant system pressure control during solid plant operation	3.5

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the chemical and volume control system:**
(CFR: 41.7 / 45.7)

K 5.01	Thermal shock of reactor coolant system penetrations	3.6

K 5.02	Demineralizer depletion	2.6
K 5.03	Reactor coolant pump configuration and speed effect on purification loop flow	2.8
K 5.04	Borating fresh demineralizer bed before placing in service (OE related)	3.2
K 5.05	Temperature effects on demineralizer beds (OE related)	3.0
K 5.06	Temperature effects on boron solubility (OE related)	3.0
K 5.07	Reactor coolant system corrosion, activity, and isotopic control (i.e., hydrogen concentration, oxygen concentration, zinc concentration, and pH control)	2.9
K 5.08	Reactor coolant system pH outside of acceptability range	2.8
K 5.09	Reactor coolant system pressure control during solid plant operation	3.5

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the chemical and volume control system components:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Compressed air system	3.2
K 6.02	Component cooling water system	3.1
K 6.03	Diverse actuation system	3.7
K 6.04	Demineralized water transfer and storage system	2.5
K 6.05	Engineered safeguards actuation system	4.0
K 6.06	Special process heat tracing system	2.0
K 6.07	Nuclear instrumentation system	3.0
K 6.08	Plant gas system	2.3
K 6.09	Pressurizer level control system	3.5
K 6.10	Reactor coolant system	3.6
K 6.11	Hot-leg level during midloop	3.8
K 6.12	Normal residual heat removal system	3.2
K 6.13	Spent fuel pool cooling system	3.0
K 6.14	Liquid radwaste system	2.3
K 6.15	Chemical and volume control system makeup pump	3.2
K 6.16	Mixed bed demineralizer	2.6
K 6.17	Reactor coolant filter	2.4
K 6.18	Makeup filter	2.5
K 6.19	Reactor makeup control system	3.5
K 6.22	Makeup line containment isolation valves	3.6

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the chemical and volume control system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Purification flow rate	2.7
A 1.02	Boration flow rate	3.4
A 1.03	Dilution flow rate	3.1
A 1.04	Chemical and volume control system makeup pump flow rate (one pump)	2.9

A 1.05	Chemical and volume control system makeup pump flow rate (two pumps)	3.0
A 1.06	Letdown water temperatures	2.9
A 1.07	Maximum demineralizer and filter temperatures	2.9
A 1.08	Effluent temperature to liquid radwaste system	2.3
A 1.09	Effluent flow rate to liquid radwaste system	2.4
A 1.10	Boric acid storage tank boric acid concentration	3.3
A 1.11	Placing cation demineralizer bed in service (OE related)	2.8
A 1.12	Control rod position	3.7
A 1.13	Reactor power	4.0
A 1.14	Pressurizer auxiliary spray	3.2
A 1.15	Reactor coolant system temperature	3.6
A 1.16	Reactor coolant system pressure during solid plant operations	3.7
A 1.17	Pressurizer pressure	3.4
A 1.18	Pressurizer temperature	3.1
A 1.19	Pressurizer level	3.5
A 1.20	Pressurizer normal spray line temperature	3.0
A 1.21	Total gallons and time required to achieve desired boron concentration	3.2

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the chemical and volume control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Compressed air system	3.4	3.1
A 2.02	Component cooling water system	3.0	2.9
A 2.03	Diverse actuation system	4.0	3.7
A 2.04	Demineralized water transfer and storage system	3.0	2.7
A 2.05	Engineered safeguards actuation system	3.8	3.9
A 2.06	Special process heat tracing system	2.2	1.9
A 2.07	Nuclear instrumentation system	3.4	2.9
A 2.08	Pressurizer level control system	3.6	3.5
A 2.09	Plant gas system	2.4	2.2
A 2.10	Reactor coolant system	3.8	3.6
A 2.11	Normal residual heat removal system	3.8	3.1
A 2.12	Spent fuel pool cooling system	3.0	2.7
A 2.13	Liquid radwaste system	2.6	2.2
A 2.14	Chemical and volume control system makeup pump	3.4	3.1
A 2.15	Mixed bed demineralizer	2.2	2.6
A 2.16	Reactor coolant filter	2.4	2.4
A 2.17	Makeup filter	2.8	2.4
A 2.18	Reactor makeup control system	3.6	3.4
A 2.19	Letdown heat exchanger	3.0	2.9
A 2.20	Inadvertent boration and/or dilution	3.8	4.0
A 2.21	Containment isolation actuation	4.0	4.1
A 2.22	Boron dilution block actuation	3.8	3.9
A 2.23	Chemical and volume control system makeup isolation actuation	3.6	3.6

A 2.24	Chemical and volume control system letdown isolation actuation	3.6	3.7
A 2.25	Auxiliary spray and purification line isolation actuation	3.6	3.3
A 2.26	High reactor coolant system activity	3.4	3.6
A 2.27	Accumulator boron concentration out of specification	3.8	3.4
A 2.28	Core makeup tank boron concentration out of specification	3.4	3.4
A 2.29	In-containment refueling water storage tank boron concentration out of specification	4.0	3.7
A 2.30	Spent fuel pool cooling system boron concentration out of specification	3.8	3.3
A 2.31	EOL boron reduction using mixed bed deborating demineralizer	2.4	2.9

A 3 **Ability to monitor automatic operation of the chemical and volume control system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Reactor coolant system boration	3.6
A 3.02	Reactor coolant system dilution	3.7
A 3.03	Reactor coolant system makeup	3.4
A 3.04	Chemical and volume control system purification	2.9
A 3.05	Chemical and volume control system letdown	3.1
A 3.06	Reactor coolant system pressure control during solid plant operation	3.8
A 3.07	Containment isolation actuation	4.1
A 3.08	Boron dilution block actuation	3.8
A 3.09	Chemical and volume control system makeup isolation actuation	3.8
A 3.10	Chemical and volume control system letdown isolation actuation	3.8
A 3.11	Auxiliary spray and purification line isolation actuation	3.3

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Reactor coolant system boration (including reactivity effects)	3.9
A 4.02	Reactor coolant system dilution (including reactivity effects)	4.0
A 4.03	EOL boron reduction using mixed bed deborating demineralizer (including reactivity effects)	3.2
A 4.04	Reactor coolant system makeup	3.5
A 4.05	Chemical and volume control system purification	3.0
A 4.06	Chemical and volume control system letdown	3.4
A 4.07	Reactor coolant system pressure control during solid plant operation	3.8
A 4.08	Reactor coolant system pressure control using auxiliary spray	3.4
A 4.09	Containment isolation actuation	4.0
A 4.10	Boron dilution block actuation	3.8
A 4.11	Chemical and volume control system makeup isolation actuation	3.8
A 4.12	Auxiliary spray and purification line isolation actuation	3.6
A 4.13	Chemical and volume control system letdown isolation actuation	3.8
A 4.14	Fill/makeup to the accumulators	3.2
A 4.15	Fill/makeup to the core makeup tank	3.2
A 4.16	Fill/makeup to the in-containment refueling water storage tank	3.5
A 4.17	Fill/makeup to the spent fuel pool cooling system	3.1
A 4.18	Maintain proper reactor coolant system hydrogen/oxygen concentration	2.9
A 4.19	Maintain proper reactor coolant system zinc concentration	2.8

3.2.2 SF2 ESAS Engineered Safeguards Action System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the engineered safeguards actuation system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Automatic depressurization system	4.3
K 1.02	Steam generator blowdown system	3.3
K 1.03	Compressed air system	2.9
K 1.04	Component cooling water system	3.0
K 1.05	Containment system	3.5
K 1.06	Chemical and volume control system	3.4
K 1.07	Digital rod control system	3.4
K 1.08	Diverse actuation system	3.8
K 1.09	Fuel handling system	2.7
K 1.10	Fire protection system	2.6
K 1.11	Main and startup feedwater system	3.3
K 1.12	Main steam system	3.4
K 1.13	Main turbine system	2.8
K 1.14	Nuclear instrumentation system	3.6
K 1.15	Passive containment cooling system	3.9
K 1.16	Plant control system	3.2
K 1.17	Pressurizer level control system	3.3
K 1.18	Pressurizer pressure control system	3.4
K 1.19	Primary sampling system	2.7
K 1.20	Passive core cooling system	4.1
K 1.21	Reactor coolant system	3.7
K 1.22	Reactor coolant pump	3.4
K 1.23	Normal residual heat removal system	3.4
K 1.24	Reactor trip system	4.0
K 1.25	Remote shutdown workstation	3.4
K 1.26	Reactor system	3.0
K 1.27	Steam dump control system	3.0
K 1.28	Spent fuel pool cooling system	2.7
K 1.29	Steam generator system	3.3
K 1.30	Main turbine control and diagnostics system	3.0
K 1.31	Main control room emergency habitability system	3.9
K 1.32	Containment air filtration system	3.2
K 1.33	Central chilled water system	2.7
K 1.34	Gaseous radwaste system	2.4
K 1.35	Liquid radwaste system	2.5
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Engineered safeguards actuation system instrumentation	3.8

K 3	**Knowledge of the effect that a loss or malfunction of the engineered safeguards actuation system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Automatic depressurization system	4.3
K 3.02	Steam generator blowdown system	3.2
K 3.03	Compressed air system	2.7
K 3.04	Component cooling water system	3.1
K 3.05	Containment system	3.4
K 3.06	Chemical and volume control system	3.0
K 3.07	Digital rod control system	3.2
K 3.08	Diverse actuation system	3.8
K 3.09	Fuel handling system	2.5
K 3.10	Fire protection system	2.6
K 3.11	Main and startup feedwater system	3.3
K 3.12	Main steam system	3.3
K 3.13	Main turbine system	2.8
K 3.14	Nuclear instrumentation system	3.1
K 3.15	Passive containment cooling system	3.9
K 3.16	Plant control system	3.0
K 3.17	Pressurizer level control system	3.1
K 3.18	Pressurizer pressure control system	3.1
K 3.19	Primary sampling system	2.5
K 3.20	Passive core cooling system	4.0
K 3.21	Reactor coolant system	3.6
K 3.22	Reactor coolant pump	3.3
K 3.23	Normal residual heat removal system	3.1
K 3.24	Reactor trip system	3.9
K 3.25	Remote shutdown workstation	3.0
K 3.26	Reactor system	3.0
K 3.27	Steam dump control system	3.1
K 3.28	Spent fuel pool cooling system	2.7
K 3.29	Steam generator system	3.2
K 3.30	Main turbine control and diagnostics system	2.9
K 3.31	Main control room emergency habitability system	3.7
K 3.32	Containment air filtration system	3.2
K 3.33	Central chilled water system	2.6
K 3.34	Gaseous radwaste system	2.3
K 3.35	Liquid radwaste system	2.5
K 4	**Knowledge of engineered safeguards actuation system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Safeguards actuation	4.4
K 4.02	Core makeup tank actuation	4.4
K 4.03	Containment isolation actuation	4.3
K 4.04	Steamline isolation actuation	4.1
K 4.05	Turbine trip actuation	3.8

K 4.06	Main feedwater control valve isolation actuation	3.9
K 4.07	Main feedwater pump trip and valve isolation actuation	3.9
K 4.08	Startup feedwater isolation actuation	3.9
K 4.09	Automatic depressurization system Stage 1, 2, and 3 actuation	4.4
K 4.10	Automatic depressurization system Stage 4 actuation	4.5
K 4.11	Reactor coolant pump trip actuation	3.9
K 4.12	Passive containment cooling system actuation	4.1
K 4.13	Passive residual heat removal heat exchanger actuation	4.1
K 4.14	Steam generator blowdown system isolation actuation	3.6
K 4.15	Boron dilution block actuation	3.7
K 4.16	Chemical and volume control system makeup isolation actuation	3.7
K 4.17	Normal residual heat removal system isolation actuation	3.8
K 4.18	P-3, Reactor Trip Breaker Open	3.9
K 4.19	P-4, Reactor Trip	3.9
K 4.20	P-6, Intermediate-Range Neutron Flux	3.6
K 4.21	P-11, Pressurizer Pressure Below 1,970 pounds per square inch gauge (psig)	3.7
K 4.22	P-12, Pressurizer Level	3.7
K 4.23	P-19, Reactor Coolant System Pressure less than 700 psig	3.6
K 4.24	Containment air filtration system isolation actuation	3.5
K 4.25	Main control room isolation and air supply initiation actuation	4.0
K 4.26	Auxiliary spray and purification line isolation actuation	3.4
K 4.27	In-containment refueling water storage tank injection line valve actuation	4.1
K 4.28	In-containment refueling water storage tank containment Recirculation valve actuation	4.1
K 4.29	Refueling cavity isolation actuation	3.6
K 4.30	Pressurizer heater trip actuation	3.2
K 4.31	Chemical and volume control system letdown isolation actuation	3.5
K 4.32	Steam generator power-operated relief valve (SG PORV) and block valve isolation actuation	3.5
K 4.33	Reactor trip actuation	4.1
K 4.34	Interdivisional communication	3.4
K 4.35	Coincidence, separation, and/or redundancy	3.5
K 4.36	Containment vacuum relief actuation	2.6

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the engineered safeguards actuation system:**
(CFR: 41.7 / 45.7)

K 5.01	Reactor trip actuation	4.0
K 5.02	Anticipated transient without scram	4.2
K 5.03	Anticipated transient without scram coincident with turbine trip failure	4.2
K 5.04	Loss of feedwater anticipated transient without scram	4.2
K 5.05	Placing a channel in bypass	3.5

K 5.06	Placing a channel in trip	3.4
K 5.07	Engineered safeguards actuation system signal with one division in test	3.5
K 5.08	Partial trip	3.5
K 5.09	Loss-of-coolant accident	4.2
K 5.10	Steam generator tube leak	3.8
K 5.11	Steam generator tube rupture	4.2
K 5.12	Main steamline break	4.1
K 5.13	Feed water line break	4.1
K 5.14	Loss of heat sink	4.2
K 5.15	Inadequate core cooling	4.2
K 5.16	Inadvertent engineered safeguards actuation system actuation	4.0

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the engineered safeguards actuation system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Reactor trip system	4.0
K 6.02	Safeguards actuation	4.2
K 6.03	Core makeup tank actuation	4.2
K 6.04	Containment isolation actuation	3.9
K 6.05	Steamline isolation actuation	3.8
K 6.06	Turbine trip actuation	3.7
K 6.07	Main feedwater control valve isolation actuation	3.8
K 6.08	Main feedwater pump trip and valve isolation actuation	3.7
K 6.09	Startup feedwater isolation actuation	3.7
K 6.10	Automatic depressurization system Stage 1, 2, and 3 actuation	4.3
K 6.11	Automatic depressurization system Stage 4 actuation	4.3
K 6.12	Reactor coolant pump trip actuation	3.7
K 6.13	Passive containment cooling system actuation	4.1
K 6.14	Passive residual heat removal heat exchanger actuation	4.2
K 6.15	Steam generator blowdown system isolation actuation	3.4
K 6.16	Boron dilution block actuation	3.5
K 6.17	Chemical and volume control system makeup isolation actuation	3.5
K 6.18	Normal residual heat removal system isolation actuation	3.5
K 6.19	P-3, Reactor Trip Breaker Open	3.9
K 6.20	P-4, Reactor Trip	3.9
K 6.21	P-6, Intermediate-Range Neutron Flux	3.6
K 6.22	P-11, Pressurizer Pressure Below 1,970 psig	3.6
K 6.23	P-12, Pressurizer Level	3.6
K 6.24	P-19, Reactor Coolant System Pressure less than 700 psig	3.6
K 6.25	Containment air filtration system isolation actuation	3.4
K 6.26	Main control room isolation and air supply initiation actuation	3.7
K 6.27	Auxiliary spray and purification line isolation actuation	3.3
K 6.28	In-containment refueling water storage tank injection line valve actuation	4.0
K 6.29	In-containment refueling water storage tank containment Recirculation valve actuation	4.0
K 6.30	Refueling cavity isolation actuation	3.5

K 6.31	Pressurizer heater trip actuation	3.0	
K 6.32	Chemical and volume control system letdown isolation actuation	3.4	
K 6.33	SG PORV and block valve isolation actuation	3.4	
K 6.34	Reactor trip actuation	3.8	
K 6.35	Interdivisional communication	3.3	
K 6.36	Bistable processor logic	3.0	
K 6.37	Local coincidence logic	3.1	
K 6.38	Integrated logic processor	3.0	
K 6.39	Component interface module	2.9	
K 6.40	Containment vacuum relief actuation	2.5	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the engineered safeguards actuation system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Reactor power	3.8	
A 1.02	Pressurizer pressure	3.8	
A 1.03	Reactor coolant system temperature	3.7	
A 1.04	Pressurizer level	3.7	
A 1.05	Steam generator level	3.6	
A 1.06	Steam generator pressure	3.6	
A 1.07	Control rod positions	3.6	
A 1.08	Reactor trip breaker status	3.9	
A 1.09	Reactor power	3.9	
A 1.10	Startup rate	3.5	
A 1.11	Shutdown margin	3.6	
A 1.12	Containment pressure, temperature, water level, radiation, and/or humidity	3.6	
A 1.13	Hot-leg level	3.4	
A 1.14	In-containment refueling water storage tank level	3.9	
A 1.15	Core makeup tank level	3.9	
A 1.16	Control room air supply radiation	3.6	
A 1.17	Startup feedwater flow	3.3	
A 1.18	Spent fuel pool level	3.1	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the engineered safeguards actuation system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Safeguards actuation	4.3	4.2
A 2.02	Core makeup tank actuation	4.3	4.1
A 2.03	Containment isolation actuation	4.2	4.0
A 2.04	Steamline isolation actuation	3.8	3.9
A 2.05	Turbine trip actuation	3.7	3.8
A 2.06	Main feedwater control valve isolation actuation	3.5	3.7
A 2.07	Main feedwater pump trip and valve isolation actuation	3.7	3.7
A 2.08	Startup feedwater isolation actuation	3.5	3.6

A 2.09	Automatic depressurization system Stage 1, 2, and 3 actuation	4.5	4.2
A 2.10	Automatic depressurization system Stage 4 actuation	4.5	4.2
A 2.11	Reactor coolant pump trip actuation	3.3	3.6
A 2.12	Passive containment cooling system actuation	4.2	4.1
A 2.13	Passive residual heat removal heat exchanger actuation	4.2	4.1
A 2.14	Steam generator blowdown system isolation actuation	3.2	3.4
A 2.15	Boron dilution block actuation	3.5	3.5
A 2.16	Chemical and volume control system makeup isolation actuation	3.5	3.4
A 2.17	Normal residual heat removal system isolation actuation	3.5	3.6
A 2.18	P-3, Reactor Trip Breaker Open	4.0	3.8
A 2.19	P-4, Reactor Trip	4.0	3.8
A 2.20	P-6, Intermediate-Range Neutron Flux	3.8	3.6
A 2.21	P-11, Pressurizer Pressure Below 1,970 psig	3.8	3.5
A 2.22	P-12, Pressurizer Level	3.7	3.5
A 2.23	P-19, Reactor Coolant System Pressure less than 700 psig	3.8	3.4
A 2.24	Turbine island chemical feed isolation actuation	2.7	2.6
A 2.25	Main control room isolation and air supply initiation actuation	3.7	3.7
A 2.26	Auxiliary spray and purification line isolation actuation	3.7	3.1
A 2.27	In-containment refueling water storage tank injection line valve actuation	4.2	3.9
A 2.28	In-containment refueling water storage tank containment Recirculation valve actuation	4.3	3.9
A 2.29	Refueling cavity isolation actuation	3.5	3.3
A 2.30	Pressurizer heater trip actuation	2.8	2.9
A 2.31	Chemical and volume control system letdown isolation actuation	3.5	3.3
A 2.32	SG PORV and block valve isolation actuation	3.5	3.3
A 2.33	Reactor trip actuation	3.8	3.9
A 2.34	Loss-of-coolant accident	4.3	4.2
A 2.35	Steam generator tube leak	4.0	4.0
A 2.36	Steam generator tube rupture	4.3	4.2
A 2.37	Main steamline break	4.2	4.2
A 2.38	Feed water line break	4.2	4.2
A 2.39	Loss of heat sink	4.3	4.2
A 2.40	Inadequate core cooling	4.3	4.2
A 2.41	Loss of divisional power	3.8	3.6

A 3 **Ability to monitor automatic operation of the engineered safeguards actuation system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Safeguards actuation	4.4
A 3.02	Core makeup tank actuation	4.3
A 3.03	Containment isolation actuation	4.2
A 3.04	Steamline isolation actuation	4.1
A 3.05	Turbine trip actuation	4.0
A 3.06	Main feedwater control valve isolation actuation	3.9
A 3.07	Main feedwater pump trip and valve isolation actuation	3.9
A 3.08	Startup feedwater isolation actuation	3.9
A 3.09	Automatic depressurization system Stage 1, 2, and 3 actuation	4.4
A 3.10	Automatic depressurization system Stage 4 actuation	4.4

A 3.11	Reactor coolant pump trip actuation	4.0
A 3.12	Passive containment cooling system actuation	4.3
A 3.13	Passive residual heat removal heat exchanger actuation	4.3
A 3.14	Steam generator blowdown system isolation actuation	3.5
A 3.15	Boron dilution block actuation	3.7
A 3.16	Chemical and volume control system makeup isolation actuation	3.5
A 3.17	Normal residual heat removal system isolation actuation	3.6
A 3.18	P-3, Reactor Trip Breaker Open	3.9
A 3.19	P-4, Reactor Trip	4.0
A 3.20	P-6, Intermediate-Range Neutron Flux	3.7
A 3.21	P-11, Pressurizer Pressure Below 1,970 psig	3.7
A 3.22	P-12, Pressurizer Level	3.6
A 3.23	P-19, Reactor Coolant System Pressure less than 700 psig	3.6
A 3.24	Turbine island chemical feed isolation actuation	2.7
A 3.25	Main control room isolation and air supply initiation actuation	4.0
A 3.26	Auxiliary spray and purification line isolation actuation	3.4
A 3.27	In-containment refueling water storage tank injection line valve actuation	4.1
A 3.28	In-containment refueling water storage tank containment recirculation valve actuation	4.2
A 3.29	Refueling cavity isolation actuation	3.6
A 3.30	Pressurizer heater trip actuation	3.0
A 3.31	Chemical and volume control system letdown isolation actuation	3.5
A 3.32	SG PORV and block valve isolation actuation	3.5
A 3.33	Reactor trip actuation	4.1

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Core makeup tank actuation	4.3
A 4.02	Containment isolation actuation	4.2
A 4.03	Steamline isolation actuation	4.1
A 4.04	Turbine trip actuation	4.1
A 4.05	Main feedwater control valve isolation actuation	4.1
A 4.06	Main feedwater pump trip and valve isolation actuation	4.0
A 4.07	Startup feedwater isolation actuation	3.9
A 4.08	Automatic depressurization system Stage 1, 2, and 3 actuation	4.5
A 4.09	Automatic depressurization system Stage 4 actuation	4.5
A 4.10	Reactor coolant pump trip actuation	4.0
A 4.11	Passive containment cooling system actuation	4.4
A 4.12	Passive residual heat removal heat exchanger actuation	4.4
A 4.13	Steam generator blowdown system isolation actuation	3.4
A 4.14	Boron dilution block actuation	3.8
A 4.15	Chemical and volume control system makeup isolation actuation	3.6
A 4.16	Normal residual heat removal system isolation actuation	3.8
A 4.17	Turbine island chemical feed isolation actuation	2.9
A 4.18	Main control room isolation and air supply initiation actuation	4.0
A 4.19	Auxiliary spray and purification line isolation actuation	3.4
A 4.20	In-containment refueling water storage tank injection line valve actuation	4.2

A 4.21	In-containment refueling water storage tank containment recirculation valve actuation	4.3
A 4.22	Refueling cavity isolation actuation	3.6
A 4.23	Pressurizer heater trip actuation	3.2
A 4.24	Chemical and volume control system letdown isolation actuation	3.6
A 4.25	SG PORV and block valve isolation actuation	3.7
A 4.26	Reactor trip actuation	4.2

3.2.3 SF2 PLCS Pressurizer Level Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the pressurizer level control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Engineered safeguards actuation system	3.4
K 1.02	Chemical and volume control system	3.2
K 1.03	Postaccident monitoring system	2.9
K 1.04	Passive core cooling system	3.1
K 1.05	Pressurizer pressure control system	3.1
K 1.06	Reactor coolant system	3.3
K 1.07	Reactor trip system	3.5
K 1.08	Main turbine control and diagnostic system	2.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Chemical and volume control system makeup pumps	2.8
K 2.02	Pressurizer heaters	2.7
K 2.03	Pressurizer level channels	3.0
K 3	**Knowledge of the effect that a loss or malfunction of the pressurizer level control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Engineered safeguards actuation system	3.7
K 3.02	Chemical and volume control system	3.2
K 3.03	Postaccident monitoring system	3.1
K 3.04	Passive core cooling system	3.3
K 3.05	Pressurizer pressure control system	3.1
K 3.06	Reactor coolant system	3.5
K 4	**Knowledge of pressurizer level control system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Pressurizer level program	3.1
K 4.02	Coolant density compensation	2.7
K 4.03	Letdown isolation valve control	3.2
K 4.04	Makeup pump control	3.0
K 4.05	Load regulation mode	2.7
K 4.06	Solid plant operation	3.1
K 4.07	Remote shutdown workstation operations	2.5
K 4.08	Sizing of pressurizer for insurge and outsurge	2.4

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the pressurizer level control system:** (CFR: 41.7 / 45.7)		
K 5.01	Reactor trip actuation	3.7	
K 5.02	Turbine runback/load rejection	3.4	
K 5.03	Voiding in reactor head	3.7	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the pressurizer level control system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Engineered safeguards actuation system	3.5	
K 6.02	Chemical and volume control system	3.2	
K 6.03	Postaccident monitoring system	2.7	
K 6.04	Passive core cooling system	3.0	
K 6.05	Pressurizer pressure control system	3.2	
K 6.06	Reactor coolant system	3.3	
K 6.07	Pressurizer level control	3.3	
K 6.08	Loss-of-coolant accident	3.7	
K 6.09	Pressurizer outside program band	3.0	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the pressurizer level control system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Pressurizer level	3.5	
A 1.02	Reactor coolant system T_{avg}	3.2	
A 1.03	Reactor coolant system leakrate	3.3	
A 1.04	Reactor coolant system inventory balance	3.3	
A 1.05	Pressurizer liquid temperature	2.9	
A 1.06	Pressurizer surge line temperatures	2.9	
A 1.07	Reactor power	3.3	
A 1.08	Code safety tailpipe temperature	3.1	
A 1.09	Turbine load	2.9	
A 1.10	Makeup flow	3.0	
A 1.11	Letdown flow	3.0	
A 1.12	Pressurizer pressure	3.1	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the pressurizer level control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Engineered safeguards actuation system	3.3	3.6
A 2.02	Chemical and volume control system	3.2	3.1
A 2.03	Postaccident monitoring system	2.5	2.8

A 2.04	Passive core cooling system	3.0	3.3
A 2.05	Pressurizer pressure control system	3.2	3.2
A 2.06	Reactor coolant system	3.2	3.4
A 2.07	Pressurizer level controller	3.0	3.4
A 2.08	Loss-of-coolant accident	3.8	3.7
A 2.09	Load regulation mode	2.7	2.7
A 2.10	Remote shutdown workstation operations	2.3	2.6
A 2.11	Loss of pressurizer level	3.2	3.6
A 2.12	Loss of pressurizer level temperature compensation	2.7	2.8

A 3 **Ability to monitor automatic operation of the pressurizer level control system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Letdown operation	3.1
A 3.02	Makeup to reactor coolant system	3.2
A 3.03	Solid plant operations	3.3
A 3.04	Pressurizer heaters	3.0

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Letdown operation	3.4
A 4.02	Makeup to reactor coolant system	3.4
A 4.03	Solid plant operations	3.4

3.2.4 SF2 PXS Passive Core Cooling System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the passive core cooling system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	3.1
K 1.02	Chemical and volume control system	2.9
K 1.03	Diverse actuation system	4.3
K 1.04	Engineered safeguards actuation system	4.2
K 1.05	Postaccident monitoring system	3.3
K 1.06	Plant gas system	2.4
K 1.07	Plant sampling system	2.2
K 1.08	Reactor coolant system	4.2
K 1.09	Passive residual heat removal system heat exchanger	3.7
K 1.10	Normal residual heat removal system	3.6
K 1.11	Reactor trip system	3.7
K 1.12	Spent fuel pool cooling system	2.8
K 1.13	Liquid radwaste system	1.9
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Core makeup tank inlet isolation valves	3.6
K 2.02	Accumulator discharge isolation valves	3.4
K 2.03	Containment recirculation block valves	3.6
K 2.04	Containment recirculation isolation valves	3.6
K 2.05	In-containment refueling water storage tank line A/B isolation valves	3.6
K 2.06	In-containment refueling water storage tank injection isolation valves	3.6
K 3	**Knowledge of the effect that a loss or malfunction of the passive core cooling system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Reactor coolant system	4.3
K 3.02	Normal residual heat removal system	3.2
K 3.03	Spent fuel pool cooling system	2.4
K 4	**Knowledge of passive core cooling system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Emergency core decay heat removal	4.5
K 4.02	Containment sump pH control	3.4
K 4.03	Postaccident containment flooding	3.8
K 4.04	Reactor coolant system cooldown	3.6
K 4.05	Noncondensable gas detection	3.3

K 4.06	Sequence of core makeup tank, accumulator, and in-containment refueling water storage tank injection during a loss-of-coolant accident	4.3
K 4.07	Core makeup tank actuation	4.4
K 4.08	In-containment refueling water storage tank containment injection line valve actuation	4.3
K 4.09	In-containment refueling water storage tank containment Recirculation valve actuation	4.2
K 4.10	Containment penetration isolation	3.9

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the passive core cooling system:**
(CFR: 41.7 / 45.7)

K 5.01	In-containment refueling water storage tank heatup by reactor coolant system leak	3.4
K 5.02	Small loss-of-coolant accident (saturated in-containment refueling water storage tank)	3.8
K 5.03	Failure of reactor coolant pump to trip	4.3
K 5.04	Noncondensable gas buildup in system	3.8
K 5.05	Postaccident containment pH control	3.4
K 5.06	Core makeup tank water recirculation mode	3.9
K 5.07	Core makeup tank steam drain-down mode	3.8
K 5.08	Core makeup tank temperatures and core makeup tank injection flow relationship	3.7

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the passive core cooling system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Automatic depressurization system	4.6
K 6.02	Compressed air system	3.0
K 6.03	Normal residual heat removal system	3.3
K 6.04	Spent fuel pool cooling system	2.7
K 6.05	In-containment refueling water storage tank actuation	4.1
K 6.06	In-containment refueling water storage tank	4.3
K 6.07	In-containment refueling water storage tank line A/B isolation valve	4.0
K 6.08	In-containment refueling water storage tank injection isolation valves	4.1
K 6.09	In-containment refueling water storage tank injection check valve	3.7
K 6.10	Containment recirculation isolation valve	3.8
K 6.11	In-containment refueling water storage tank gutter isolation valve	3.6
K 6.12	Containment recirculation check valve	3.3
K 6.13	In-containment refueling water storage tank screens	3.7
K 6.14	Core makeup tank actuation	4.6
K 6.15	Core makeup tank inlet isolation valve	3.9
K 6.16	Core makeup tank discharge isolation valve	4.2
K 6.17	Core makeup tank discharge check valve	3.8
K 6.18	Passive residual heat removal heat exchanger actuation	4.4

K 6.19	Passive residual heat removal system heat exchanger tube leak	4.1	
K 6.20	Accumulator discharge isolation valve	3.7	
K 6.21	Accumulator discharge check valve	3.3	
K 6.22	Direct vessel injection line	4.1	
K 6.23	Core makeup tank discharge line	4.1	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the passive core cooling system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Accumulator level	3.8	
A 1.02	Accumulator pressure	3.8	
A 1.03	Accumulator boron concentration	3.6	
A 1.04	In-containment refueling water storage tank level	3.9	
A 1.05	In-containment refueling water storage tank temperature	3.8	
A 1.06	In-containment refueling water storage tank boron concentration	3.6	
A 1.07	Core makeup tank inlet, top, mid, and bottom temperatures	3.4	
A 1.08	Core makeup tank boron concentration	3.5	
A 1.09	Core makeup tank level	4.0	
A 1.10	Core makeup tank high-point level	3.7	
A 1.11	Direct vessel injection line cold and hot temperatures	3.5	
A 1.12	Passive residual heat removal system heat exchanger pressure	3.5	
A 1.13	Passive residual heat removal system heat exchanger inlet high-point temperature	3.5	
A 1.14	Passive residual heat removal system heat exchanger temperature	3.6	
A 1.15	Passive residual heat removal system heat exchanger flow	3.8	
A 1.16	Passive residual heat removal system heat exchanger high-point level	3.5	
A 1.17	Containment floodup level	3.8	
A 1.18	Containment radiation	3.5	
A 1.19	Reactor coolant system level	3.9	
A 1.20	Reactor coolant system pressure	3.8	
A 1.21	Reactor coolant system temperature	3.9	
A 1.22	Core exit thermocouples	3.9	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the passive core cooling system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Automatic depressurization system	4.3	4.6
A 2.02	Compressed air system	2.8	3.0
A 2.03	Normal residual heat removal system	3.0	3.4
A 2.04	Spent fuel pool cooling system	2.5	3.1
A 2.05	In-containment refueling water storage tank actuation	4.2	4.5
A 2.06	In-containment refueling water storage tank parameters out of spec	3.3	3.9
A 2.07	In-containment refueling water storage tank line A/B isolation valve	3.5	4.0
A 2.08	In-containment refueling water storage tank injection isolation valves	3.2	4.1

A 2.09	In-containment refueling water storage tank injection check valve	3.0	3.6
A 2.10	Containment recirculation isolation valve	3.2	3.9
A 2.11	In-containment refueling water storage tank gutter isolation valve	3.3	3.8
A 2.12	Containment recirculation check valve	3.3	3.3
A 2.13	Core makeup tank actuation	4.2	4.8
A 2.14	Core makeup tank parameters out of spec	3.5	4.1
A 2.15	Core makeup tank inlet isolation valve	3.2	4.0
A 2.16	Core makeup tank discharge isolation valve	3.8	4.3
A 2.17	Core makeup tank discharge check valve	3.2	3.5
A 2.18	Accumulator discharge isolation valve	3.3	4.2
A 2.19	Accumulator discharge check valve	3.2	3.3
A 2.20	Accumulator parameters out of spec	3.5	4.0
A 2.22	Direct vessel injection line break	4.2	4.6
A 2.23	Core makeup tank discharge line break	4.5	4.5
A 2.24	Noncondensable gas buildup	3.5	3.7
A 2.25	Battery charger undervoltage	3.5	4.1

A 3 **Ability to monitor automatic operation of the passive core cooling system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Safeguards actuation	4.7
A 3.02	Core makeup tank actuation	4.6
A 3.03	Containment isolation actuation	4.3
A 3.04	Turbine trip	3.7
A 3.05	Main feedwater pump trip and valve isolation actuation	3.7
A 3.06	Automatic depressurization system Stage 1, 2, and 3 actuation	4.7
A 3.07	Automatic depressurization system Stage 4 actuation	4.8
A 3.08	Reactor coolant pump trip actuation	4.3
A 3.09	Passive residual heat removal heat exchanger actuation	4.6
A 3.10	Steam generator blowdown isolation actuation	3.2
A 3.11	Chemical and volume control system makeup isolation actuation	3.3
A 3.12	Normal residual heat removal system isolation actuation	3.5
A 3.13	Containment air filtration system isolation actuation	3.3
A 3.14	In-Containment refueling water storage tank injection line valve actuation	4.3
A 3.15	In-containment refueling water storage tank containment recirculation valve actuation	4.3
A 3.16	Pressurizer heater trip actuation	2.9
A 3.17	Reactor trip actuation	4.4

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Safeguards actuation	4.7
A 4.02	Core makeup tank actuation	4.6
A 4.03	Containment isolation actuation	4.4
A 4.04	Turbine trip	4.2
A 4.05	Main feedwater pump trip and valve isolation actuation	4.0
A 4.06	Automatic depressurization system Stage 1, 2, and 3 actuation	4.6

A 4.07	Automatic depressurization system Stage 4 actuation	4.6
A 4.08	Reactor coolant pump trip actuation	4.3
A 4.09	Steam generator blowdown isolation actuation	3.4
A 4.10	Chemical and volume control system makeup isolation actuation	3.4
A 4.11	Normal residual heat removal system isolation actuation	3.6
A 4.12	Containment air filtration system isolation actuation	3.4
A 4.13	In-containment refueling water storage tank injection line valve actuation	4.3
A 4.14	In-containment refueling water storage tank containment Recirculation valve actuation	4.3
A 4.15	Pressurizer heater trip actuation	3.1
A 4.16	Reactor trip actuation	4.4

3.2.5 SF2 RCS Reactor Coolant System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the reactor coolant system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Automatic depressurization system	4.5
K 1.02	Compressed air system	2.9
K 1.03	Component cooling water system	3.1
K 1.04	Containment system	3.4
K 1.05	Chemical and volume control system	3.6
K 1.06	Diverse actuation system	4.2
K 1.07	Digital rod control system	3.6
K 1.08	Engineered safeguards actuation system	4.4
K 1.09	Incore instrumentation system	3.5
K 1.10	Main steam system	3.4
K 1.11	Nuclear instrumentation system	3.7
K 1.12	Postaccident monitoring system	3.6
K 1.13	Primary sampling system	2.4
K 1.14	Passive core cooling system	4.3
K 1.15	Pressurizer level control system	3.5
K 1.16	Pressurizer pressure control system	3.6
K 1.17	Reactor coolant pumps	3.7
K 1.18	Normal residual heat removal system	3.6
K 1.19	Rod position indication system	3.4
K 1.20	Reactor trip system	4.2
K 1.21	Reactor system	3.8
K 1.22	Steam generator system	3.9
K 1.23	Spent fuel pool cooling system	2.8
K 1.24	Special monitoring system	2.5
K 1.25	Containment recirculation cooling system	2.8
K 1.26	Containment air filtration system	2.7
K 1.27	Liquid radwaste system	2.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Reactor vessel head vent valves	3.2
K 2.02	Reactor coolant system wide-range pressure channels	2.9
K 2.03	Reactor coolant system loop flow channels	3.0
K 2.04	Reactor coolant system cold-leg wide-range temperature channels	2.9
K 2.05	Reactor coolant system hot-leg wide-range temperatures channels	2.9
K 2.06	Reactor coolant system cold-leg narrow-range temperatures channels	3.0
K 2.07	Reactor coolant system hot-leg narrow-range temperatures channels	3.0
K 2.08	Hot-leg level instrumentation channels	3.2

K 3	**Knowledge of the effect that a loss or malfunction of the reactor coolant system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Automatic depressurization system	4.2
K 3.02	Compressed air system	2.5
K 3.03	Component cooling water system	2.6
K 3.04	Containment system	3.7
K 3.05	Chemical and volume control system	3.3
K 3.06	Digital rod control system	3.4
K 3.07	Engineered safeguards actuation system	4.3
K 3.08	Postaccident monitoring system	3.7
K 3.09	Primary sampling system	2.5
K 3.10	Passive core cooling system	4.4
K 3.11	Pressurizer level control system (OE related)	3.4
K 3.12	Pressurizer pressure control system	3.4
K 3.13	Reactor coolant pump	3.8
K 3.14	Radiation monitoring system	3.2
K 3.15	Normal residual heat removal system	3.5
K 3.16	Reactor trip system	4.0
K 3.17	Reactor system	3.6
K 3.18	Steam generator system	3.5
K 3.19	Containment recirculation cooling system	3.2
K 3.20	Containment air filtration system	3.0
K 3.21	Liquid radwaste system	2.4
K 3.22	Reactor fuel	4.3
K 4	**Knowledge of reactor coolant system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Reactor coolant pressure boundary	4.2
K 4.02	Core cooling	4.3
K 4.03	Reactivity control	4.4
K 4.04	Process monitoring	3.4
K 4.05	Emergency letdown	3.4
K 4.06	Reactor coolant system venting	3.4
K 4.07	Reactor coolant system temperature control	3.7
K 4.08	Pressurizer heater control	3.6
K 4.09	Pressurizer normal spray control (OE related)	3.7
K 4.10	Pressurizer level control	3.7
K 4.11	Safety valve discharge drain header isolation	3.6
K 4.12	Overpressure protection	4.4
K 4.13	Reactor coolant system vacuum refill	3.0
K 4.14	Reactor coolant system level control	3.5
K 4.15	Filling and draining of reactor coolant system, refueling cavity, and refueling canal	3.0
K 4.16	Reactor coolant system leak detection	4.0
K 4.17	Solid plant operation	3.9
K 4.18	Pressurizer cooldown	3.3

K 4.19	Establishing a pressurizer bubble	3.3
K 4.20	Reduced inventory operation	4.0

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the reactor coolant system:**
(CFR: 41.7 / 45.7)

K 5.01	Pressurizer normal spray transients	3.5
K 5.02	Direct vessel injection nozzle transients	3.4
K 5.03	Steam generator passive residual heat removal system heat exchanger nozzle transients	3.3
K 5.04	Passive residual heat removal system heat exchanger nozzle transients	3.3
K 5.05	Chemical and volume control system nozzle transients	3.2
K 5.06	Leak before break	3.5
K 5.07	Pressurizer cooldown	3.4
K 5.08	Solid plant operation	3.8
K 5.09	Reactor coolant pump trip (OE related)	3.8
K 5.10	Reactor coolant pump start	3.5
K 5.11	Hard bubble in pressurizer	3.4
K 5.12	Mid-loop operation	4.0
K 5.13	Changes in core cooling between normal operations and a loss-of-coolant accident	4.2
K 5.14	Changes in core cooling between normal operations and a steam generator tube rupture (OE related)	4.2
K 5.15	Changes in core cooling between normal operations and faulted team generator	4.1
K 5.16	Changes in core cooling between normal operations and loss of heat sink event	4.4
K 5.17	Loss of forced circulation	4.1
K 5.18	Natural circulation reactor coolant system and steam generator indications	4.1
K 5.19	Downcomer voiding effects on nuclear instrumentation system	3.9
K 5.20	Cold-leg opening with no reactor coolant system vent path	3.7
K 5.21	Inadequate reactor coolant system venting during reactor coolant system draindown	3.6
K 5.22	Effects of a leaking pressurizer safety	3.8
K 5.23	Vacuum refill	3.1
K 5.24	Operating with pressurizer level outside the normal operating band	3.5
K 5.25	Effects of reactor power changes on T_{hot}, T_{cold}, T_{avg}, and ΔT	4.0
K 5.26	Changing pressurizer temperature and the effect on pressurizer pressure	3.6
K 5.27	Changing reactor coolant system temperature and the effect on pressurizer pressure and level	3.6
K 5.28	Changing reactor coolant system temperature and effect on noncondensable gases	3.1
K 5.29	Changing reactor coolant system pressure and effect on noncondensable gases	3.3
K 5.30	Boration and/or dilution effect on shutdown margin	4.0
K 5.31	Xenon and samarium effect on shutdown margin	3.9

K 5.32	Boration and/or dilution effect on MTC	3.8
K 5.33	Failure to recognize the need for reactor coolant system depressurization during a small loss-of-coolant accident or loss of high-pressure heat removal system (PRA related)	4.4
K 5.34	Failure to recognize the need for reactor coolant system depressurization during a shutdown condition with failure of core makeup tank and the normal residual heat removal system (PRA related)	4.4
K 5.35	Failure to recognize the need and failure to initiate gravity injection via normal residual heat removal system hot-leg connection during shutdown events (PRA related)	4.3

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the reactor coolant system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Automatic depressurization system	4.6
K 6.02	Compressed air system	2.9
K 6.03	Component cooling water system	3.1
K 6.04	Chemical and volume control system	3.3
K 6.05	Diverse actuation system	4.1
K 6.06	Digital rod control system	3.5
K 6.07	Engineered safeguards actuation system	4.4
K 6.08	Incore instrumentation system	3.3
K 6.09	Main steam system (OE related)	3.6
K 6.10	Passive core cooling system	4.5
K 6.11	Pressurizer level control system	3.6
K 6.12	Pressurizer pressure control system	3.7
K 6.13	Reactor coolant pump	3.7
K 6.14	Reactor trip system	4.3
K 6.15	Reactor system	3.6
K 6.16	Steam generator system	3.7
K 6.17	Containment recirculation cooling system	3.0
K 6.18	Liquid radwaste system	2.3
K 6.19	Pressurizer code safety valve	4.0
K 6.20	Reactor fuel failure	4.2
K 6.21	Reactor coolant system hot-leg level indication	3.5
K 6.22	Reactor coolant system head vent valve	3.5

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the reactor coolant system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Pressurizer pressure	4.1
A 1.02	Reactor coolant system wide-range pressure	3.8
A 1.03	Reactor coolant system loop flow	3.7
A 1.04	Reactor coolant system cold-leg wide-range temperatures	3.6
A 1.05	Reactor coolant system hot-leg wide-range temperatures	3.6
A 1.06	Core exit thermocouples	4.0
A 1.07	Reactor coolant system cold-leg narrow-range temperatures	3.5

A 1.08	Reactor coolant system hot-leg narrow-range temperatures	3.6
A 1.09	Reactor coolant system loop T_{avg}	3.7
A 1.10	Auctioneered reactor coolant system loop T_{avg}	3.5
A 1.11	Reactor coolant system loop ΔT	3.6
A 1.12	Auctioneered reactor coolant system loop ΔT	3.5
A 1.13	Reactor coolant system T_{ref}	3.6
A 1.14	Diverse hot-leg temperature	3.5
A 1.15	Reactor vessel head vent line temperature	3.0
A 1.16	Passive residual heat removal system return line temperature	3.8
A 1.17	Reactor coolant system automatic depressurization system discharge temperature	3.9
A 1.18	Safety valve discharge temperatures	3.9
A 1.19	Pressurizer temperature	3.3
A 1.20	Pressurizer normal spray line temperatures	3.2
A 1.21	Pressurizer surge line temperatures	3.2
A 1.22	Pressurizer level reference leg temperature	2.8
A 1.23	Pressurizer level	3.8
A 1.24	Diverse pressurizer level	3.4
A 1.25	Cold calibrated pressurizer level	3.0
A 1.26	Reactor coolant system hot-leg level	3.5
A 1.27	Nuclear instrumentation system	3.9
A 1.28	Steam generator pressure	3.5
A 1.29	Reactor coolant system subcooling (OE related)	4.2
A 1.30	In-containment refueling water storage tank level, reactor coolant system level, and reactor cavity level relationships during outage	3.6

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the reactor coolant system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Automatic depressurization system	4.3	4.6
A 2.02	Compressed air system	2.8	2.7
A 2.03	Component cooling water system	3.0	3.1
A 2.04	Chemical and volume control system	3.3	3.6
A 2.05	Diverse actuation system	3.9	4.3
A 2.06	Digital rod control system	3.6	3.6
A 2.07	Engineered safeguards actuation system	4.1	4.5
A 2.08	Incore instrumentation system	3.1	3.3
A 2.09	Main steam system (OE related)	3.1	3.7
A 2.10	Passive core cooling system	4.0	4.6
A 2.11	Pressurizer level control system	3.6	3.8
A 2.12	Pressurizer pressure control system	3.6	3.8
A 2.13	Reactor coolant pump	3.8	3.7
A 2.14	Reactor trip system	4.5	4.5
A 2.15	Reactor system	3.5	4.1
A 2.16	Steam generator system	3.4	4.0
A 2.17	Containment recirculation cooling system	2.5	3.3

A 2.18	Liquid radwaste system	1.9	2.4
A 2.19	Pressurizer safety valve	4.0	4.3
A 2.20	Reactor fuel failure	4.3	4.4
A 2.21	Reactor coolant system level indication	3.5	3.8
A 2.22	Failure of a pressurizer normal spray valve	3.4	4.0
A 2.23	Failure of pressurizer heaters	3.0	3.6
A 2.24	Reactor coolant system pressure boundary valve leakage	3.9	4.1
A 2.25	Water solid operation	3.8	3.8
A 2.26	Reactor coolant pump trip (OE related)	3.8	3.9
A 2.27	Loss-of-coolant accident	4.3	4.6
A 2.28	Faulted steam generator	4.3	4.6
A 2.29	Steam generator tube rupture (OE related)	4.4	4.6
A 2.30	Loss of heat sink	4.4	4.6
A 2.31	Reactor vessel flange leakage	3.6	3.7

A 3 **Ability to monitor automatic operation of the reactor coolant system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Pressurizer pressure control and protection functions	4.1
A 3.02	Pressurizer level control and protection functions	4.1
A 3.03	Reactor coolant system T_{avg} control and protection functions	4.0
A 3.04	Reactor coolant system ΔT control and protection functions	4.0
A 3.05	Reactor coolant system hot-leg level control and protection functions	4.0
A 3.06	Core makeup tank actuation	4.5
A 3.07	Passive residual heat removal heat exchanger actuation	4.6
A 3.08	Automatic depressurization system actuation	4.6
A 3.09	Pressurizer safety valve actuation	4.5
A 3.10	Solid plant operation	4.0

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Pressurizer pressure	3.9
A 4.02	Pressurizer level	3.9
A 4.03	Reactor coolant system T_{avg}	3.9
A 4.04	Reactor coolant system ΔT	3.8
A 4.05	Reactor coolant system flow	3.7
A 4.06	Reactor power	4.5
A 4.07	Steam generator level	4.0
A 4.08	Steam generator pressure	3.8
A 4.09	Reactor coolant system hot-leg level	3.8
A 4.10	Core makeup tank actuation	4.6
A 4.11	Passive residual heat removal heat exchanger actuation	4.6
A 4.12	Automatic depressurization system actuation	4.7
A 4.13	Pressurizer safety valve actuation	4.2
A 4.14	Head vent system	3.6
A 4.15	Drain reactor coolant system to midloop	3.7
A 4.16	Fill and cool the pressurizer to solid plant	3.5
A 4.17	Establish a pressurizer bubble	3.3

A 4.18	Reactor coolant system vacuum refill	3.1
A 4.19	Plant startup	4.0
A 4.20	Normal operation	3.9
A 4.21	Plant shutdown	3.8
A 4.22	Reduced inventory operations	4.0
A 4.23	Reactor coolant system heatup	3.4
A 4.24	Reactor coolant system cooldown	3.5
A 4.25	Refueling	3.4
A 4.26	Solid plant operation	3.8
A 4.26	Pressurizer cooldown	3.3
A 4.27	Establishing a pressurizer bubble	3.3

3.3 Safety Function 3: Reactor Pressure Control

3.3.1 SF3 ADS Automatic Depressurization System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the automatic depressurization system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Diverse actuation system	4.0
K 1.02	Engineered safeguards actuation system	4.2
K 1.03	Postaccident monitoring system	2.8
K 1.04	Passive core cooling system	3.8
K 1.05	Reactor coolant system	4.1
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Automatic depressurization system Stage 1 valves	3.5
K 2.02	Automatic depressurization system Stage 1 isolation valves	3.5
K 2.03	Automatic depressurization system Stage 2 valves	3.5
K 2.04	Automatic depressurization system Stage 2 isolation valves	3.5
K 2.05	Automatic depressurization system Stage 3 valves	3.5
K 2.06	Automatic depressurization system Stage 3 isolation valves	3.5
K 2.07	Automatic depressurization system Stage 4 valves	3.6
K 2.08	Automatic depressurization system Stage 4 isolation valves	3.6
K 3	**Knowledge of the effect that a loss or malfunction of the automatic depressurization system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Engineered safeguards actuation system	4.0
K 3.02	Passive core cooling system	4.2
K 3.03	Reactor fuel	4.4
K 3.04	Reactor cooling system	4.3
K 4	**Knowledge of automatic depressurization system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Automatic depressurization system actuation	4.5
K 4.02	Manual operation of the automatic depressurization system	4.4
K 4.03	Automatic depressurization system valve discharge drain header isolation	3.4
K 4.04	Automatic depressurization system valve isolation	3.9

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the automatic depressurization system:** (CFR: 41.7 / 45.7)	
K 5.01	Effects of leaking automatic depressurization system valve	3.4
K 5.02	Failure to recognize the need for reactor cooling system depressurization during a small loss-of-coolant accident or loss of high-pressure heat removal system (PRA related)	4.3
K 5.03	Failure to recognize the need for reactor cooling system depressurization during a shutdown condition with failure of the core makeup tank and the normal residual heat removal system (PRA related)	4.2
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the automatic depressurization system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Diverse actuation system	4.2
K 6.02	Engineered safeguards actuation system	4.2
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the automatic depressurization system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Reactor cooling system wide-range pressure	4.0
A 1.02	Reactor cooling system automatic depressurization system discharge temperature	3.6
A 1.03	Reactor cooling system hot-leg level	3.9
A 1.04	Class 1E battery charger voltage	3.7

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the automatic depressurization system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Diverse actuation system	4.0	3.9
A 2.02	Engineered safeguards actuation system	4.1	4.2
A 2.03	Passive core cooling system	4.0	3.8
A 2.04	Loss-of-coolant accident	4.3	4.2
A 2.05	Reactor cooling system hot-leg level	3.9	3.9
A 2.06	Extended undervoltage to Class 1E battery chargers	4.0	3.9

A 3	**Ability to monitor automatic operation of the automatic depressurization system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Automatic depressurization system actuation	4.4
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Reactor cooling system hot-leg level	3.9
A 4.02	Automatic depressurization system actuation	4.5
A 4.03	Core makeup tank level	4.0
A 4.04	Reactor cooling system pressure	4.1
A 4.05	Class 1E battery charger voltage	3.9

3.3.2 SF3 PPCS Pressurizer Pressure Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the pressurizer pressure control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Engineered safeguards actuation system	3.9
K 1.02	Chemical and volume control system	2.9
K 1.03	Main turbine system	2.1
K 1.04	Nuclear instrumentation system	2.7
K 1.05	Postaccident monitoring system	3.3
K 1.06	Passive core cooling system	3.2
K 1.07	Pressurizer level control system	3.1
K 1.08	Reactor coolant system	3.3
K 1.09	Reactor trip system	4.0
K 1.10	Main turbine control and diagnostics system	2.2
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Pressurizer normal spray valves	2.5
K 2.02	Pressurizer normal spray block valves	3.0
K 2.03	Pressurizer heaters	2.8
K 2.04	Pressurizer pressure channels	3.1
K 3	**Knowledge of the effect that a loss or malfunction of the pressurizer pressure control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Engineered safeguards actuation system	4.1
K 3.02	Main turbine system	2.2
K 3.03	Nuclear instrumentation system	2.5
K 3.04	Postaccident monitoring system	3.4
K 3.05	Passive core cooling system	3.6
K 3.06	Pressurizer level control system	2.9
K 3.07	Reactor coolant system	3.7
K 3.08	Reactor trip system	4.0
K 4	**Knowledge of pressurizer pressure control system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Pressurizer heater and normal spray valve operation	3.5
K 4.02	Anticipatory pressurizer spray	3.3
K 4.03	Anticipatory pressurizer spray interlock	3.3
K 4.04	Pressurizer water level interlock	3.2
K 4.05	Pressurizer heater interlock	3.3

K 4.06	Load regulation mode	2.9
K 4.07	Remote shutdown workstation operations	3.2
K 4.08	Bypass spray	2.8

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the pressurizer pressure control system:**
(CFR: 41.7 / 45.7)

K 5.01	Leaking pressurizer normal spray valve	3.3
K 5.02	Insurge/outsurge effect on pressure and temperature	3.1
K 5.03	Difference between pressurizer pressure and reactor coolant system pressure	2.8
K 5.04	Hard pressurizer bubble	3.0
K 5.05	Reactor coolant pump speed effect on pressurizer normal spray flow	3.1
K 5.06	Changing pressurizer pressure effect on OTΔT setpoints	3.6
K 5.07	Effects of leaking pressurizer safety valve	3.6
K 5.08	Reactor trip	3.9
K 5.09	Turbine runback/load rejection	3.4
K 5.10	Differences between reactor coolant system and pressurizer boron concentrations	3.2

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the pressurizer pressure control system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Engineered safeguards actuation system	3.5
K 6.02	Main turbine system	2.6
K 6.03	Nuclear instrumentation system	2.5
K 6.04	Passive core cooling system	3.1
K 6.05	Pressurizer level control system	3.0
K 6.06	Reactor coolant system	3.3
K 6.07	Reactor trip system	3.5
K 6.08	Main turbine control and diagnostics system	2.6
K 6.09	Pressurizer pressure instrument	3.6
K 6.10	Loss-of-coolant accident	3.9
K 6.11	Pressurizer code safety failure	3.9
K 6.12	Pressurizer normal spray valve	3.6
K 6.13	Pressurizer heaters	3.3

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the pressurizer pressure control system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Pressurizer pressure	3.8
A 1.02	Reactor coolant system pressure	3.7
A 1.03	Pressurizer liquid temperature	3.0

A 1.04	Pressurizer vapor temperature	3.0	
A 1.05	Pressurizer surge line temperatures	3.1	
A 1.06	Pressurizer normal spray line temperatures	2.9	
A 1.07	Pressurizer/spray line ΔT	3.3	
A 1.08	Pressurizer level	3.3	
A 1.09	Reactor coolant system temperature	3.1	
A 1.10	Reactor coolant system leakrate	3.3	
A 1.11	Reactor power	3.1	
A 1.12	Code safety tailpipe temperature	3.6	
A 1.13	Turbine load	2.9	
A 1.14	Makeup flow	3.0	
A 1.15	Letdown flow	3.0	
A 1.16	Pressurizer and reactor coolant system boron concentration	3.3	
A 1.17	Spray flow	3.2	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the pressurizer pressure control System and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Engineered safeguards actuation system	3.5	3.6
A 2.02	Main turbine system	2.8	2.7
A 2.03	Nuclear instrumentation system	2.8	2.6
A 2.04	Passive core cooling system	3.2	3.4
A 2.05	Pressurizer level control system	3.2	3.2
A 2.06	Reactor coolant system	3.2	3.3
A 2.07	Reactor trip system	3.2	3.6
A 2.08	Pressurizer pressure instrument failure	3.2	3.4
A 2.09	Loss-of-coolant accident	3.5	4.0
A 2.10	Pressurizer code safety failure	3.8	4.1
A 2.11	Load regulation mode	2.8	2.8
A 2.12	Remote shutdown workstation operations	2.8	3.1
A 2.13	Pressurizer normal spray valve failure	3.5	3.6
A 2.14	Pressurizer heaters failure	3.3	3.4

A 3 **Ability to monitor automatic operation of the pressurizer pressure control system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Pressurizer normal spray valve operation	3.6
A 3.02	Pressurizer heater operation	3.4

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Pressurizer normal spray valve operation	3.7
A 4.02	Pressurizer heater operation	3.5

3.4 Safety Function 4: Heat Removal from Reactor Core

3.4.1 SF4P PRHR Passive Residual Heat Removal System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the passive residual heat removal system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Automatic depressurization system	3.5
K 1.02	Compressed air system	2.9
K 1.03	Diverse actuation system	3.8
K 1.04	Engineering safeguards actuation system	4.0
K 1.05	Postaccident monitoring system	2.9
K 1.06	Passive core cooling system	3.8
K 1.07	Reactor coolant system	3.9
K 1.08	Steam generator system	3.0
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Passive residual heat removal system heat exchanger inlet isolation valves	3.2
K 3	**Knowledge of the effect that a loss or malfunction of the passive residual heat removal system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Reactor coolant system	4.1
K 4	**Knowledge of passive residual heat removal system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Emergency core decay heat removal	4.3
K 4.02	Reactor coolant system cooldown	3.8
K 4.03	Noncondensable gas detection	3.2
K 4.04	Passive residual heat removal system actuation	4.2
K 4.05	Passive residual heat removal system flow control	3.6

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the passive residual heat removal system:** (CFR: 41.7 / 45.7)		
K 5.01	Passive residual heat removal system heat exchanger leakage at power	3.6	
K 5.02	Inadvertent passive residual heat removal system actuation at power	4.1	
K 5.03	Noncondensable gas buildup in system	3.2	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the passive residual heat removal system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Compressed air system	3.0	
K 6.02	Passive residual heat removal system actuation	4.1	
K 6.03	Passive residual heat removal system heat exchanger	3.7	
K 6.04	Passive residual heat removal system heat exchanger inlet isolation	3.6	
K 6.05	Passive residual heat removal system control valve	3.4	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the passive residual heat removal system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Passive residual heat removal system heat exchanger pressure	3.2	
A 1.02	Passive residual heat removal system heat exchanger inlet high-point temperature	3.4	
A 1.03	Passive residual heat removal system heat exchanger temperature	3.5	
A 1.04	Passive residual heat removal system heat exchanger flow	3.6	
A 1.05	Passive residual heat removal system heat exchanger high-point level	3.4	
A 1.06	Reactor coolant system level	3.5	
A 1.07	Reactor coolant system pressure	3.5	
A 1.08	Reactor coolant system temperature	3.4	
A 1.09	Core exit thermocouples	3.6	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the passive residual heat removal system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Compressed air system	3.3	2.8
A 2.02	Passive residual heat removal system actuation	4.0	4.2
A 2.03	Passive residual heat removal system heat exchanger	3.7	4.1

A 2.04	Passive residual heat removal system heat exchanger inlet isolation	3.7	3.9
A 2.05	Passive residual heat removal system control valve	3.7	3.8

A 3 **Ability to monitor automatic operation of the passive residual heat removal system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Passive residual heat removal system actuation	4.2	

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Passive residual heat removal system actuation	4.2	
A 4.02	Passive residual heat removal system flow control valves	3.8	

3.4.2 SF4P RCP Reactor Coolant Pump System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the reactor coolant pump system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Component cooling water system	2.6
K 1.02	Diverse actuation system	3.1
K 1.03	Engineered safeguards actuation system	3.3
K 1.04	Reactor coolant system	3.1
K 1.05	Special monitoring system	2.4
K 1.06	Steam generator system	2.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Reactor coolant pumps	2.3
K 3	**Knowledge of the effect that a loss or malfunction of the reactor coolant pump system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Reactor coolant system (OE related)	3.3
K 3.02	Special monitoring system	2.1
K 3.03	Steam generator system	2.7
K 4	**Knowledge of reactor coolant pump system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Reactor coolant pump speed control	2.8
K 4.02	Reactor coolant pump trip actuation due to safeguards actuation	3.7
K 4.03	Reactor coolant pump trip actuation due to automatic depressurization system Stage 1, 2, and 3 actuation	3.8
K 4.04	Reactor coolant pump trip actuation due to reactor coolant pump bearing water high temperature	3.0
K 4.05	Reactor coolant pump trip actuation due to core makeup tank actuation	3.6
K 4.06	Reactor coolant pump trip actuation due to low pressurizer water level	3.2
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the reactor coolant pump system:** (CFR: 41.7 / 45.7)	
K 5.01	Changing reactor coolant pump speed on chemical and volume control system letdown flow	2.3

K 5.02	Changing reactor coolant pump speed on pressurizer normal spray flow	2.7	
K 5.03	Reactor coolant pump operation effect on passive residual heat removal system heat exchanger operation	3.1	
K 5.04	Reactor coolant pump start effect on reactivity/boron (OE related)	3.2	
K 5.05	Starting a reactor coolant pump when all reactor coolant pumps are stopped, reactor coolant system temperature is above 200 degrees Fahrenheit (F), and pressurizer level is greater than 92 percent	3.0	
K 5.06	Running two reactor coolant pumps in the same loop at low reactor coolant system pressure during a reactor coolant system cooldown (OE related)	2.5	

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the reactor coolant pump system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Component cooling water system	2.9	
K 6.02	Reactor coolant pump trip actuation due to engineered safeguards actuation	3.6	
K 6.03	Reactor coolant pump trip for reasons other than engineered safeguards actuation	3.0	
K 6.04	High reactor coolant pump vibration or bearing temperatures	2.6	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the reactor coolant pump system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Reactor coolant pump speed	2.7	
A 1.02	Reactor coolant pump bearing temperatures, motor current, and/or vibration	2.7	
A 1.03	Reactor coolant system flow	3.3	
A 1.04	Pressurizer normal spray flow	2.9	
A 1.05	Chemical and volume control system letdown flow	2.4	
A 1.06	Passive residual heat removal system heat exchanger flow	3.1	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the reactor coolant pump system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Loss of component cooling water	2.3	2.9
A 2.02	Reactor coolant pump trip actuation due to engineered safeguards actuation	3.3	3.4
A 2.03	Reactor coolant pump trip for reasons other than engineered safeguards actuation	2.2	2.8

A 3	**Ability to monitor automatic operation of the reactor coolant pump system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Reactor coolant pump trip actuation due to engineered safeguards actuation	3.6
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Reactor coolant pump start and speed control	2.9
A 4.02	Reactor coolant pump shutdown	2.9

3.4.3 SF4P RCS Reactor Coolant System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the reactor coolant system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Automatic depressurization system	4.5
K 1.02	Compressed air system	2.9
K 1.03	Component cooling water system	3.1
K 1.04	Containment system	3.4
K 1.05	Chemical and volume control system	3.6
K 1.06	Diverse actuation system	4.2
K 1.07	Digital rod control system	3.6
K 1.08	Engineered safeguards actuation system	4.4
K 1.09	Incore instrumentation system	3.5
K 1.10	Main steam system	3.4
K 1.11	Nuclear instrumentation system	3.7
K 1.12	Postaccident monitoring system	3.6
K 1.13	Primary sampling system	2.4
K 1.14	Passive core cooling system	4.3
K 1.15	Pressurizer level control system	3.5
K 1.16	Pressurizer pressure control system	3.6
K 1.17	Reactor coolant pumps	3.7
K 1.18	Normal residual heat removal system	3.6
K 1.19	Rod position indication system	3.4
K 1.20	Reactor trip system	4.2
K 1.21	Reactor system	3.8
K 1.22	Steam generator system	3.9
K 1.23	Spent fuel pool cooling system	2.8
K 1.24	Special monitoring system	2.5
K 1.25	Containment recirculation cooling system	2.8
K 1.26	Containment air filtration system	2.7
K 1.27	Liquid radwaste system	2.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Reactor vessel head vent valves	3.2
K 2.02	Reactor coolant system wide-range pressure channels	2.9
K 2.03	Reactor coolant system loop flow channels	3.0
K 2.04	Reactor coolant system cold-leg wide-range temperature channels	2.9
K 2.05	Reactor coolant system hot-leg wide-range temperatures channels	2.9
K 2.06	Reactor coolant system cold-leg narrow-range temperatures channels	3.0
K 2.07	Reactor coolant system hot-leg narrow-range temperatures channels	3.0
K 2.08	Hot-leg level instrumentation channels	3.2

K 3	**Knowledge of the effect that a loss or malfunction of the reactor coolant system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Automatic depressurization system	4.2
K 3.02	Compressed air system	2.5
K 3.03	Component cooling water system	2.6
K 3.04	Containment system	3.7
K 3.05	Chemical and volume control system	3.3
K 3.06	Digital rod control system	3.4
K 3.07	Engineered safeguards actuation system	4.3
K 3.08	Postaccident monitoring system	3.7
K 3.09	Primary sampling system	2.5
K 3.10	Passive core cooling system	4.4
K 3.11	Pressurizer level control system (OE related)	3.4
K 3.12	Pressurizer pressure control system	3.4
K 3.13	Reactor coolant pump	3.8
K 3.14	Radiation monitoring system	3.2
K 3.15	Normal residual heat removal system	3.5
K 3.16	Reactor trip system	4.0
K 3.17	Reactor system	3.6
K 3.18	Steam generator system	3.5
K 3.19	Containment recirculation cooling system	3.2
K 3.20	Containment air filtration system	3.0
K 3.21	Liquid radwaste system	2.4
K 3.22	Reactor fuel	4.3
K 4	**Knowledge of reactor coolant system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Reactor coolant pressure boundary	4.2
K 4.02	Core cooling	4.3
K 4.03	Reactivity control	4.4
K 4.04	Process monitoring	3.4
K 4.05	Emergency letdown	3.4
K 4.06	Reactor coolant system venting	3.4
K 4.07	Reactor coolant system temperature control	3.7
K 4.08	Pressurizer heater control	3.6
K 4.09	Pressurizer normal spray control (OE related)	3.7
K 4.10	Pressurizer level control	3.7
K 4.11	Safety valve discharge drain header isolation	3.6
K 4.12	Overpressure protection	4.4
K 4.13	Reactor coolant system vacuum refill	3.0
K 4.14	Reactor coolant system level control	3.5
K 4.15	Filling and draining of reactor coolant system, refueling cavity, and refueling canal	3.0
K 4.16	Reactor coolant system leak detection	4.0
K 4.17	Solid plant operation	3.9
K 4.18	Pressurizer cooldown	3.3

K 4.19	Establishing a pressurizer bubble	3.3
K 4.20	Reduced inventory operation	4.0

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the reactor coolant system:**
(CFR: 41.7 / 45.7)

K 5.01	Pressurizer spray transients	3.5
K 5.02	Direct vessel injection nozzle transients	3.4
K 5.03	Steam generator passive residual heat removal system heat exchanger nozzle transients	3.3
K 5.04	Passive residual heat removal system heat exchanger nozzle transients	3.3
K 5.05	Chemical and volume control system nozzle transients	3.2
K 5.06	Leak before break	3.5
K 5.07	Pressurizer cooldown	3.4
K 5.08	Solid plant operation	3.8
K 5.09	Reactor coolant pump trip (OE related)	3.8
K 5.10	Reactor coolant pump start	3.5
K 5.11	Hard bubble in pressurizer	3.4
K 5.12	Midloop operation	4.0
K 5.13	Changes in core cooling between normal operations and a loss-of-coolant accident	4.2
K 5.14	Changes in core cooling between normal operations and a steam generator tube rupture (OE related)	4.2
K 5.15	Changes in core cooling between normal operations and faulted steam generator	4.1
K 5.16	Changes in core cooling between normal operations and loss of heat sink event	4.4
K 5.17	Loss of forced circulation	4.1
K 5.18	Natural circulation reactor coolant system and steam generator indications	4.1
K 5.19	Downcomer voiding effects on nuclear instrumentation system	3.9
K 5.20	Cold-leg opening with no reactor coolant system vent path	3.7
K 5.21	Inadequate reactor coolant system venting during reactor coolant system draindown	3.6
K 5.22	Effects of leaking pressurizer safety valve	3.8
K 5.23	Vacuum refill	3.1
K 5.24	Operating with pressurizer level outside the normal operating band	3.5
K 5.25	Effects of reactor power changes on T_{hot}, T_{cold}, T_{avg}, and ΔT	4.0
K 5.26	Changing pressurizer temperature and the effect on pressurizer pressure	3.6
K 5.27	Changing reactor coolant system temperature and the effect on pressurizer pressure and level	3.6
K 5.28	Changing reactor coolant system temperature and effect on noncondensable gases	3.1
K 5.29	Changing reactor coolant system pressure and effect on noncondensable gases	3.3
K 5.30	Boration and/or dilution effect on shutdown margin	4.0
K 5.31	Xenon and Samarium effect on shutdown margin	3.9

K 5.32	Boration and/or dilution effect on MTC	3.8
K 5.33	Failure to recognize the need for reactor coolant system depressurization during a small loss-of-coolant accident or loss of high-pressure heat removal system (PRA related)	4.4
K 5.34	Failure to recognize the need for reactor coolant system depressurization during a shutdown condition with failure of core makeup tank and the normal residual heat removal system (PRA related)	4.4
K 5.35	Failure to recognize the need and failure to initiate gravity injection via normal residual heat removal system hot-leg connection during shutdown events (PRA related)	4.3

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the reactor coolant system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Automatic depressurization system	4.6
K 6.02	Compressed air system	2.9
K 6.03	Component cooling water system	3.1
K 6.04	Chemical and volume control system	3.3
K 6.05	Diverse actuation system	4.1
K 6.06	Digital rod control system	3.5
K 6.07	Engineered safeguards actuation system	4.4
K 6.08	Incore instrumentation system	3.3
K 6.09	Main steam system (OE related)	3.6
K 6.10	Passive core cooling system	4.5
K 6.11	Pressurizer level control system	3.6
K 6.12	Pressurizer pressure control system	3.7
K 6.13	Reactor coolant pump	3.7
K 6.14	Reactor trip system	4.3
K 6.15	Reactor system	3.6
K 6.16	Steam generator system	3.7
K 6.17	Containment recirculation cooling system	3.0
K 6.18	Liquid radwaste system	2.3
K 6.19	Pressurizer code safety valve	4.0
K 6.20	Reactor fuel failure	4.2
K 6.21	Reactor coolant system hot-leg level indication	3.5
K 6.22	Reactor coolant system head vent valve	3.5

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the reactor coolant system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Pressurizer pressure	4.1
A 1.02	Reactor coolant system wide-range pressure	3.8
A 1.03	Reactor coolant system loop flow	3.7
A 1.04	Reactor coolant system cold-leg wide-range temperatures	3.6
A 1.05	Reactor coolant system hot-leg wide-range temperatures	3.6
A 1.06	Core exit thermocouples	4.0
A 1.07	Reactor coolant system cold-leg narrow-range temperatures	3.5

A 1.08	Reactor coolant system hot-leg narrow-range temperatures	3.6	
A 1.09	Reactor coolant system loop T_{avg}	3.7	
A 1.10	Auctioneered reactor coolant system loop T_{avg}	3.5	
A 1.11	Reactor coolant system loop ΔT	3.6	
A 1.12	Auctioneered reactor coolant system loop ΔT	3.5	
A 1.13	Reactor coolant system T_{ref}	3.6	
A 1.14	Diverse hot-leg temperature	3.5	
A 1.15	Reactor vessel head vent line temperature	3.0	
A 1.16	Passive residual heat removal system heat exchanger return line temperature	3.8	
A 1.17	Automatic depressurization system discharge temperature	3.9	
A 1.18	Safety valve discharge temperatures	3.9	
A 1.19	Pressurizer temperature	3.3	
A 1.20	Pressurizer spray line temperatures	3.2	
A 1.21	Pressurizer surge line temperatures	3.2	
A 1.22	Pressurizer level reference leg temperature	2.8	
A 1.23	Pressurizer level	3.8	
A 1.24	Diverse pressurizer level	3.4	
A 1.25	Cold calibrated pressurizer level	3.0	
A 1.26	Reactor coolant system hot-leg level	3.5	
A 1.27	Nuclear instrumentation system	3.9	
A 1.28	Steam generator pressure	3.5	
A 1.29	Reactor coolant system subcooling (OE related)	4.2	
A 1.30	In-containment refueling water storage tank level, reactor coolant system level, and reactor cavity level relationships during outage	3.6	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the reactor coolant system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Automatic depressurization system	4.3	4.6
A 2.02	Compressed air system	2.8	2.7
A 2.03	Component cooling water system	3.0	3.1
A 2.04	Chemical and volume control system	3.3	3.6
A 2.05	Diverse actuation system	3.9	4.3
A 2.06	Digital rod control system	3.6	3.6
A 2.07	Engineered safeguards actuation system	4.1	4.5
A 2.08	Incore instrumentation system	3.1	3.3
A 2.09	Main steam system (OE related)	3.1	3.7
A 2.10	Passive core cooling system	4.0	4.6
A 2.11	Pressurizer level control system	3.6	3.8
A 2.12	Pressurizer pressure control system	3.6	3.8
A 2.13	Reactor coolant pump	3.8	3.7
A 2.14	Reactor trip system (OE related)	4.5	4.5
A 2.15	Reactor system	3.5	4.1
A 2.16	Steam generator system	3.4	4.0
A 2.17	Containment recirculation cooling system	2.5	3.3
A 2.18	Liquid radwaste system	1.9	2.4

A 2.19	Pressurizer safety valve	4.0	4.3
A 2.20	Reactor fuel failure	4.3	4.4
A 2.21	Reactor coolant system level indication	3.5	3.8
A 2.22	Failure of a pressurizer normal spray valve	3.4	4.0
A 2.23	Failure of pressurizer heaters	3.0	3.6
A 2.24	Reactor coolant system pressure boundary valve leakage	3.9	4.1
A 2.25	Water solid operation	3.8	3.8
A 2.26	Reactor coolant pump trip (OE related)	3.8	3.9
A 2.27	Loss-of-coolant accident	4.3	4.6
A 2.28	Faulted steam generator	4.3	4.6
A 2.29	Steam generator tube rupture (OE related)	4.4	4.6
A 2.30	Loss of heat sink	4.4	4.6
A 2.31	Reactor vessel flange leakage	3.6	3.7

A 3 **Ability to monitor automatic operation of the reactor coolant system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Pressurizer pressure control and protection functions	4.1
A 3.02	Pressurizer level control and protection functions	4.1
A 3.03	Reactor coolant system T_{avg} control and protection functions	4.0
A 3.04	Reactor coolant system ΔT control and protection functions	4.0
A 3.05	Reactor coolant system hot-leg level control and protection functions	4.0
A 3.06	Core makeup tank actuation	4.5
A 3.07	Passive residual heat removal heat exchanger actuation	4.6
A 3.08	Automatic depressurization system actuation	4.6
A 3.09	Pressurizer safety valve actuation	4.5
A 3.10	Solid plant operation	4.0

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Pressurizer pressure	3.9
A 4.02	Pressurizer level	3.9
A 4.03	Reactor coolant system T_{avg}	3.9
A 4.04	Reactor coolant system ΔT	3.8
A 4.05	Reactor coolant system flow	3.7
A 4.06	Reactor power	4.5
A 4.07	Steam generator level	4.0
A 4.08	Steam generator pressure	3.8
A 4.09	Reactor coolant system hot-leg level	3.8
A 4.10	Core makeup tank actuation	4.6
A 4.11	Passive residual heat removal heat exchanger actuation	4.6
A 4.12	Automatic depressurization system actuation	4.7
A 4.13	Pressurizer safety valve actuation	4.2
A 4.14	Head vent system	3.6
A 4.15	Drain reactor coolant system to midloop	3.7
A 4.16	Fill and cool the pressurizer to solid plant	3.5
A 4.17	Establish a pressurizer bubble	3.3
A 4.18	Reactor coolant system vacuum refill	3.1

A 4.19	Plant startup	4.0
A 4.20	Normal operation	3.9
A 4.21	Plant shutdown	3.8
A 4.22	Reduced inventory operations	4.0
A 4.23	Reactor coolant system heatup	3.4
A 4.24	Reactor coolant system cooldown	3.5
A 4.25	Refueling	3.4
A 4.26	Solid plant operation	3.8
A 4.26	Pressurizer cooldown	3.3
A 4.27	Establishing a pressurizer bubble	3.3

3.4.4 SF4P RNS Normal Residual Heat Removal System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the normal residual heat removal system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	3.1
K 1.02	Component cooling water system	3.5
K 1.03	Chemical and volume control system	3.1
K 1.04	Engineered safeguards actuation system	3.9
K 1.05	Postaccident monitoring system	3.0
K 1.06	Passive core cooling system	3.8
K 1.07	Reactor coolant system	3.8
K 1.08	Spent fuel pool cooling system	3.3
K 1.09	Radiologically controlled area ventilation system	2.4
K 1.10	Liquid radwaste system	2.1
K 1.11	Main generation system	2.6
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Normal residual heat removal system pumps	3.2
K 2.02	Containment isolation valves	3.6
K 2.03	Reactor coolant system isolation valves	3.7
K 2.04	In-containment refueling water storage tank isolation valves	3.6
K 2.05	Spent fuel pool cooling system cask loading pit isolation valve	2.6
K 3	**Knowledge of the effect that a loss or malfunction of the normal residual heat removal system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Chemical and volume control system	2.8
K 3.02	Passive core cooling system	3.6
K 3.03	Reactor coolant system	3.8
K 3.04	Spent fuel pool cooling system	2.8
K 3.05	Radiologically controlled area ventilation system	2.0
K 3.06	Liquid radwaste system	1.9
K 4	**Knowledge of normal residual heat removal system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	In-containment refueling water storage tank isolation	3.7
K 4.02	Containment penetration isolation	4.1
K 4.03	Reactor coolant system isolation	4.1
K 4.04	Low-temperature overpressure protection	4.0
K 4.05	Post-loss-of-coolant accident containment makeup	3.6

K 4.06	Postaccident reactor coolant system makeup	3.7
K 4.07	In-containment refueling water storage tank cooling	3.8
K 4.08	Containment recirculation	3.6
K 4.09	Reactor coolant system heat removal during refueling	3.5
K 4.10	Reactor coolant system draindown during refueling	3.3
K 4.11	Shutdown reactor coolant system purification	2.6
K 4.12	Normal reactor coolant system cooldown	3.4
K 4.13	Postaccident reactor coolant system heat removal	3.7
K 4.14	Spent fuel pool cooling	3.1
K 4.15	Minimum flow protection	2.8
K 4.16	Reactor coolant system loop suction valve interlocks for overpressure protection	3.9

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the normal residual heat removal system:**
(CFR: 41.7 / 45.7)

K 5.01	Normal residual heat removal system startup for shutdown cooling (OE related)	2.9
K 5.02	Aligning normal residual heat removal system from reactor coolant system shutdown cooling mode to postaccident makeup mode (OE related)	3.6
K 5.03	Plant response to reactor coolant system temperature change during solid plant operation	3.9
K 5.04	Reactor coolant system vacuum refill	2.8
K 5.05	Low-temperature overpressure protection event	3.9
K 5.06	Normal residual heat removal system suction vortexing during reduced reactor coolant system inventory (OE related)	3.7
K 5.07	Draindown flow rate restrictions with reactor internals installed	3.3
K 5.08	Using normal residual heat removal system to delay core makeup tank discharge and automatic depressurization system stage actuation	4.1
K 5.09	Two normal residual heat removal system trains aligned for spent fuel pool cooling	2.9

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the normal residual heat removal system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Compressed air system	3.1
K 6.02	Component cooling water system	3.5
K 6.03	Main generation system	2.6
K 6.04	Pump flow rate instrument	2.7
K 6.05	Normal residual heat removal system pump	3.3
K 6.06	normal residual heat removal system heat exchanger	3.4
K 6.07	Containment isolation valves	3.9
K 6.08	Reactor coolant system isolation valves	4.1
K 6.09	In-containment refueling water storage tank isolation valve	3.6

K 6.10	Spent fuel pool cooling system cask loading pit isolation valve	2.8

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the normal residual heat removal system controls, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Reactor coolant system cold-leg wide-range temperature	3.3
A 1.02	Reactor coolant system hot-leg wide-range temperature	3.2
A 1.03	Reactor coolant system heatup and cooldown rates	3.6
A 1.04	Reactor coolant system wide-range pressure	3.4
A 1.05	Reactor coolant system hot-leg level	3.7
A 1.06	Pressurizer level	3.4
A 1.07	Core exit thermocouples	3.5
A 1.08	Normal residual heat removal system heatup and cooldown rates	3.2
A 1.09	Normal residual heat removal system flow	3.3
A 1.10	Normal residual heat removal system pump amps	2.8
A 1.11	Component cooling water system flow	3.2
A 1.12	Component cooling water system temperature	3.0
A 1.13	Reactor coolant system level during shutdown cooling	3.9
A 1.14	Normal residual heat removal system pressure during shutdown cooling	3.5
A 1.15	Chemical and volume control system flow during shutdown reactor coolant system purification	2.5
A 1.16	Spent fuel pool temperature	2.7

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the normal residual heat removal system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Compressed air system	3.0	3.3
A 2.02	Component cooling water system	3.5	3.6
A 2.03	Main generation system	2.5	2.7
A 2.04	Midloop level instrumentation	3.5	4.0
A 2.05	Pump flow rate instrument	2.7	3.1
A 2.06	Normal residual heat removal system pump (OE related)	3.5	3.4
A 2.07	Normal residual heat removal system heat exchanger (OE related)	3.5	3.2
A 2.08	Containment isolation valves	3.3	3.9
A 2.09	Reactor coolant system isolation valves	3.7	4.1
A 2.10	In-containment refueling water storage tank isolation valve	3.2	3.7
A 2.11	Spent fuel pool cooling system cask loading pit isolation valve	2.3	2.7

A 3 **Ability to monitor automatic operation of the normal residual heat removal system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Reactor coolant system temperature during shutdown cooling	3.4

A 3.02	Reactor coolant system heatup and cooldown rate during shutdown cooling	3.5
A 3.03	Normal residual heat removal system pump start	3.2
A 3.04	Normal residual heat removal system isolation actuation	3.7
A 3.05	Low-temperature overpressure protection actuation	4.3

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Reactor coolant system temperature during shutdown cooling	3.6
A 4.02	Reactor coolant system heatup and cooldown rate during shutdown cooling	3.7
A 4.03	Normal residual heat removal system heatup and cooldown rates	3.2
A 4.04	Normal residual heat removal system flow during shutdown cooling	3.4
A 4.05	Normal residual heat removal system isolation actuation	3.8
A 4.06	Containment isolation	4.1
A 4.07	Post-loss-of-coolant accident containment makeup	3.5
A 4.08	Postaccident reactor coolant system makeup	3.7
A 4.09	In-containment refueling water storage tank cooling	3.6
A 4.10	Containment recirculation	3.8
A 4.11	Postaccident reactor coolant system heat removal	3.8

3.4.5 SF4P SGS Steam Generator System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the steam generator system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Steam generator blowdown system	3.3
K 1.02	Compressed air system	2.7
K 1.03	Chemical and volume control system	2.1
K 1.04	Diverse actuation system	3.5
K 1.05	Engineered safeguards actuation system	4.0
K 1.06	Main and startup feedwater system	3.4
K 1.07	Main steam system	3.5
K 1.08	Main turbine system	3.0
K 1.09	Postaccident monitoring system	3.3
K 1.10	Plant gas system	2.0
K 1.11	Passive core cooling system	3.4
K 1.12	Reactor coolant system	3.4
K 1.13	Radiation monitoring system	3.4
K 1.14	Reactor trip system	3.3
K 1.15	Secondary sampling system	2.3
K 1.16	Steam dump control system	3.2
K 1.17	Special monitoring system	2.5
K 1.18	Turbine island vent, drain, and relief valve system	2.0
K 1.19	Annex/auxiliary building nonradioactive ventilation system	1.8
K 1.20	Waste water system	1.9
K 1.21	Transmission switchyard and offsite power system	2.0
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	SG PORV control power	2.7
K 2.02	SG PORV block valves	3.1
K 2.03	Main steam isolation valve control power	2.8
K 2.04	MSIV hydraulic pump	2.8
K 2.05	MSIV bypass valve control power	2.6
K 2.06	Main feedwater isolation valve control power	2.8
K 2.07	Main feedwater isolation valve hydraulic pump	2.7
K 2.08	Main feedwater control valve control power	2.5
K 2.09	Startup feedwater isolation valves	2.9
K 2.10	Startup feedwater control valve control power	2.6
K 2.11	Steam generator blowdown isolation valves	2.9
K 3	**Knowledge of the effect that a loss or malfunction of the steam generator system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Steam generator blowdown system	3.0

K 3.02	Main and startup feedwater system	3.3
K 3.03	Main steam system	3.5
K 3.04	Main turbine system	2.7
K 3.05	Passive core cooling system	3.6
K 3.06	Reactor coolant system	3.8
K 3.07	Radiation monitoring system	3.3
K 3.08	Turbine Island vent, drain, and relief valve system	1.9
K 3.09	Annex/auxiliary building nonradioactive ventilation system	1.8
K 3.10	Waste water system	1.6

K 4 **Knowledge of steam generator system design feature(s) and/or interlock(s) that provide for the following:**
(CFR: 41.7)

K 4.01	Containment isolation	3.9
K 4.02	Steamline isolation	4.1
K 4.03	Feedwater isolation	4.1
K 4.04	Secondary-side overpressure protection	3.6
K 4.05	Steam flow measurement	3.0
K 4.06	Steam pressure measurement	3.2
K 4.07	Steam generator level measurement	3.3
K 4.08	Provide signals to diverse actuation system	3.7
K 4.09	Decay heat removal	3.4
K 4.10	Blowdown to steam generator blowdown system	2.8
K 4.11	Main steamline warming	2.5
K 4.12	Main steamline drainage	2.4
K 4.13	Steamline sampling	2.1

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the steam generator system:**
(CFR: 41.7 / 45.7)

K 5.01	Steam generator tube leak detection	4.0
K 5.02	Steam generator level shrink and swell	3.1
K 5.03	Plant response to a steamline break	4.1
K 5.04	Plant response to a feedwater line break	4.1
K 5.05	Steam generator system response to a loss-of-coolant accident	3.9
K 5.06	Natural circulation	4.0
K 5.07	Feedwater flow changes on reactor coolant system natural circulation flow rate	3.5
K 5.08	Feedwater flow changes on reactor power	3.3
K 5.09	Feedwater flow changes on reactor coolant system pressure	3.1
K 5.10	Feedwater flow changes on reactor coolant system temperature	3.4
K 5.11	Feedwater flow changes on pressurizer level	3.1
K 5.12	Feedwater flow changes on steam generator level	3.3
K 5.13	Feedwater flow changes on steam generator pressure	3.1
K 5.14	Chemistry and corrosion control	2.6
K 5.15	Failure to diagnose a faulted steam generator	4.3
K 5.16	Failure to diagnose a steam generator tube rupture event (PRA related)	4.4

K 5.17	Failure to close the MSIV to isolate the faulted steam generator, given a steam generator tube rupture event (PRA related)	4.4

K 6 Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the steam generator system:
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Steam generator blowdown system	2.8
K 6.02	Compressed air system	2.8
K 6.03	Diverse actuation system	3.4
K 6.04	Engineered safeguards actuation system	4.0
K 6.05	Main and startup feedwater system	3.4
K 6.06	Main steam system	3.3
K 6.07	Main turbine system	2.9
K 6.08	Plant gas system	2.0
K 6.09	Reactor coolant system	3.3
K 6.10	Reactor trip system	3.7
K 6.11	Steam dump control system	3.3
K 6.12	Annex/auxiliary building nonradioactive ventilation system	1.9
K 6.13	Transmission switchyard and offsite power system	2.1
K 6.14	Containment isolation	3.7
K 6.15	Step load changes	3.1
K 6.16	Main and startup feedwater system line break	4.3
K 6.17	Main steam system line break	4.3
K 6.18	Inadvertent opening/failure to close of an SG PORV or main steam safety valve	4.2
K 6.19	Steam generator tube rupture	4.3
K 6.20	Loss of forced reactor coolant system flow	3.6
K 6.21	Reactor coolant pump shaft seizure	3.6
K 6.22	Inadvertent passive residual heat removal system heat exchanger operation	3.6
K 6.23	Loss of one feedwater pump	3.0
K 6.24	Feedwater heater out of service	2.8
K 6.25	Excessive feedwater flow	3.2
K 6.26	Loss of normal feedwater flow	3.3
K 6.27	Startup feedwater control valve failure	3.0
K 6.28	Turbine trip	3.4
K 6.29	SG PORV failure	3.8
K 6.30	MSIV failure	3.9

A 1 Ability to predict and/or monitor changes in parameters associated with operation of the steam generator system, including the following:
(CFR: 41.7 / 45.5)

A 1.01	Reactor coolant system natural circulation flow rate	3.4
A 1.02	Pressurizer level	3.1
A 1.03	Reactor power	3.5
A 1.04	Reactor coolant system pressure	3.2
A 1.05	Reactor coolant system temperature	3.4
A 1.06	Steam generator level	3.5

A 1.07	Steam generator pressure	3.5	
A 1.08	Feedwater flow	3.4	
A 1.09	Steam flow	3.4	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the steam generator system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Steam generator blowdown system	3.0	2.7
A 2.02	Compressed air system	3.0	2.6
A 2.03	Diverse actuation system	3.5	3.5
A 2.04	Engineered safeguards actuation system	3.8	4.0
A 2.05	Main and startup feedwater system	3.5	3.6
A 2.06	Main steam system	3.3	3.6
A 2.07	Main turbine system	3.0	3.0
A 2.08	Plant gas system	2.3	2.0
A 2.09	Reactor coolant system	3.5	3.6
A 2.10	Reactor trip system	3.5	3.8
A 2.11	Steam dump control system	3.7	3.7
A 2.12	Annex/auxiliary building nonradioactive ventilation system	2.2	1.6
A 2.13	Transmission switchyard and offsite power system	2.7	1.7
A 2.14	Containment isolation	3.3	3.9
A 2.15	Step load changes	3.2	3.1
A 2.16	Main and startup feedwater system line break	4.2	4.3
A 2.17	Main steam system line break	4.2	4.3
A 2.18	Inadvertent opening/failure to close of an SG PORV or main steam safety valve	4.2	4.1
A 2.19	Steam generator tube rupture	4.3	4.4
A 2.20	Loss of forced reactor coolant system flow	3.8	3.6
A 2.21	Reactor coolant pump trip	3.7	3.6
A 2.22	Inadvertent passive residual heat removal system heat exchanger operation	3.8	3.7
A 2.23	Loss of one feedwater pump	3.0	3.1
A 2.24	Feedwater heater out of service	3.0	2.8
A 2.25	Excessive feedwater flow	3.3	3.3
A 2.26	Loss of normal feedwater flow	3.3	3.5
A 2.27	Startup feedwater control valve failure	3.2	3.1
A 2.28	Turbine trip	3.5	3.3
A 2.29	Steam generator system response to a loss-of-coolant accident	4.2	4.0

A 3 **Ability to monitor automatic operation of the steam generator system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Safeguards actuation	4.2
A 3.02	Steamline isolation actuation	4.2
A 3.03	Turbine trip	3.8
A 3.04	Main feedwater control valve isolation	3.7

A 3.05	Main feedwater pump trip and valve isolation actuation	3.5
A 3.06	Startup feedwater isolation actuation	3.9
A 3.07	Passive residual heat removal heat exchanger actuation	4.0
A 3.08	Steam generator blowdown isolation actuation	3.7
A 3.09	Chemical and volume control system makeup isolation actuation	3.3
A 3.10	SG PORV and block valve isolation actuation	3.9
A 3.11	SG PORV operation and control	3.5
A 3.12	Steam generator narrow-range water level low reactor trip	4.1
A 3.13	Steam generator narrow-range water level high reactor trip	4.0

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Steamline isolation actuation	4.4
A 4.02	Main feedwater control valve isolation	4.0
A 4.03	Main feedwater pump trip and valve isolation actuation	3.7
A 4.04	Startup feedwater isolation actuation	4.0
A 4.05	Steam generator blowdown isolation actuation	3.8
A 4.06	SG PORV and block valve isolation actuation	4.1
A 4.07	SG PORV operation and control	3.7
A 4.08	Main steamline warming and pressurization	2.8

3.4.6 SF4S CDS Condensate System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the condensate system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Auxiliary steam system	2.1
K 1.02	Steam generator blowdown system	2.3
K 1.03	Compressed air system	2.4
K 1.04	Component cooling water system	2.3
K 1.05	Condenser tube cleaning system	1.8
K 1.06	Turbine island chemical feed system	1.8
K 1.07	Condenser air removal system	2.5
K 1.08	Condensate polishing system	2.1
K 1.09	Circulating water system	2.3
K 1.10	Demineralized water transfer and storage system	2.1
K 1.11	Main and startup feedwater system	2.8
K 1.12	Gland seal system	2.3
K 1.13	Heater drain system	2.4
K 1.14	Main steam system	2.5
K 1.15	Main turbine system	2.3
K 1.16	Steam dump control system	2.7
K 1.17	Secondary sampling system	1.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Condensate pumps	2.3
K 2.02	Condensate pump discharge valves	2.0
K 2.03	First- and second-stage feedwater heater inlet and outlet isolation valves	1.8
K 2.04	First- and second-stage feedwater heater bypass valve	1.7
K 3	**Knowledge of the effect that a loss or malfunction of the condensate system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Steam generator blowdown system	2.4
K 3.02	Turbine island chemical feed system	1.7
K 3.03	Condensate polishing system	2.2
K 3.04	Main and startup feedwater system	2.8
K 3.05	Gland seal system	2.3
K 3.06	Heater drain system	2.3
K 3.07	Main steam system	2.5
K 3.08	Main turbine system	2.3

K 4	**Knowledge of condensate system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Condenser hotwell level control	2.5
K 4.02	Deaerator storage tank level control	2.5
K 4.03	Hotwell recirculation	1.9
K 4.04	Deaerator storage tank recirculation	2.0
K 4.05	Long cycle recirculation	2.0
K 4.06	Low-pressure feedwater heating	2.3
K 4.07	Feedwater heater automatic isolation and bypass	2.6
K 4.08	Condensate polisher automatic isolation and bypass	2.4
K 4.09	Removing heat from the gland seal system condenser	2.1
K 4.10	Removing heat from the steam generator blowdown system heat exchanger	2.2
K 4.11	Condensate pump auto start	2.7
K 4.12	Condensate pump manual start	2.6
K 4.13	C-9, Condenser Available	3.0
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the condensate system:** (CFR: 41.7 / 45.7)	
K 5.01	Reactor response to loss of feedwater heating	3.1
K 5.02	Reactor response to returning feedwater heating to service	3.0
K 5.03	Plant response to a loss of feedwater flow	3.4
K 5.04	Water hammer prevention	2.8
K 5.05	Condenser tube leaks	2.6
K 5.06	Steam generator tube leak	3.4
K 5.07	Chemistry control	2.4
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the condensate system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Auxiliary steam system	2.0
K 6.02	Steam generator blowdown system	2.2
K 6.03	Compressed air system	2.4
K 6.04	Condenser tube cleaning system	1.8
K 6.05	Turbine island chemical feed system	1.7
K 6.06	Condenser air removal system	2.5
K 6.07	Condensate polishing system	2.3
K 6.08	Circulating water system	2.5
K 6.09	Demineralized water transfer and storage system	2.1
K 6.10	Main and startup feedwater system	2.8
K 6.11	Gland seal system	2.1
K 6.12	Heater drain system	2.3
K 6.13	Main steam system	2.5
K 6.14	Main turbine system	2.5
K 6.15	Steam dump control system	2.7

K 6.16	Condensate pump failure	2.6	
K 6.17	Feedwater heater isolation and bypass	2.5	
K 6.18	Diversion of heater drains to the condenser	2.3	
K 6.19	Abnormal hotwell level	2.5	
K 6.20	Abnormal deaerator storage tank level	2.5	
K 6.21	Loss of condenser vacuum	2.4	
K 6.22	Abnormal condensate pump discharge header pressure	2.3	
K 6.23	High condensate outlet temperature from steam generator blowdown system heat exchanger	2.3	
K 6.24	Low condensate flow	2.5	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the condensate system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Deaerator storage tank level	2.6
A 1.02	Hotwell level	2.6
A 1.03	Gland seal system steam condenser pressure	2.1
A 1.04	Feedwater temperatures	2.3
A 1.05	Deaerator storage tank recirculation	1.9
A 1.06	Long cycle recirculation	2.1
A 1.07	Condensate pump amps	2.2
A 1.08	Condensate pump discharge pressure	2.4

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the condensate system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Steam generator blowdown system	2.3	2.2
A 2.02	Compressed air system	3.0	2.4
A 2.03	Turbine island chemical feed system	1.7	1.8
A 2.04	Condenser air removal system	2.8	2.4
A 2.05	Condensate polishing system	2.7	2.1
A 2.06	Circulating water system	2.5	1.4
A 2.07	Demineralized water transfer and storage system	2.5	2.1
A 2.08	Main and startup feedwater system	2.8	2.8
A 2.09	Gland seal system	2.5	2.1
A 2.10	Heater drain system	2.7	2.3
A 2.11	Main steam system	2.7	2.4
A 2.12	Main turbine system	2.5	2.6
A 2.13	Steam dump control system	2.7	2.7
A 2.14	Condensate pump failure	3.0	2.4
A 2.15	Feedwater heater isolation and bypass	3.0	2.4
A 2.16	Diversion of heater drains to the condenser	2.7	2.4
A 2.17	Abnormal hotwell level	3.0	2.2
A 2.18	Abnormal deaerator storage tank level	2.8	2.3
A 2.19	Loss of condenser vacuum	2.8	2.4
A 2.20	Abnormal condensate pump discharge header pressure	2.8	2.1

A 2.21	High condensate outlet temperature from steam generator blowdown system heat exchanger	2.7	2.2
A 2.22	Low condensate flow	2.7	2.3

A 3 **Ability to monitor automatic operation of the condensate system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Condensate pump start	2.7
A 3.02	Hotwell recirculation control	2.3
A 3.03	Hotwell level control	2.6
A 3.04	Deaerator storage tank level control	2.7

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Hotwell recirculation	2.1
A 4.02	Deaerator storage tank recirculation	2.1
A 4.03	Long cycle recirculation	1.9
A 4.04	Condensate pumps	2.8
A 4.05	Deaerator storage tank level control	2.7
A 4.06	Hotwell level control	2.5
A 4.07	Feedwater heater isolation and bypass	2.3
A 4.08	Condensate polisher flow control and bypass valves	2.2

3.4.7 SF4S CMS Condenser Air Removal System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the condenser air removal system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.0
K 1.02	Condensate system	2.6
K 1.03	Circulating water system	2.3
K 1.04	Demineralized water transfer and storage system	1.6
K 1.05	Gland seal system	2.3
K 1.06	Radiation monitoring system	3.3
K 1.07	Turbine island vent, drain, and relief valve system	1.7
K 1.08	Main turbine control and diagnostics system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Condenser vacuum pumps	2.1
K 2.02	Seal water pumps	2.0
K 3	**Knowledge of the effect that a loss or malfunction of the condenser air removal system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Condensate system	2.4
K 3.02	C-9, Condenser Available	3.4
K 3.03	Main turbine availability	2.9
K 4	**Knowledge of condenser air removal system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Vacuum pump start	2.3
K 4.02	Vacuum pump inlet valve opening	2.2
K 4.03	Vacuum pump seal water	2.0
K 4.04	Effluent monitoring and local grab sample	2.8
K 4.05	C-9, Condenser Available	3.2
K 4.06	Main turbine trip	3.2
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the condenser air removal system:** (CFR: 41.7 / 45.7)	
K 5.01	Steam generator tube leak	3.8
K 5.02	Loss of condenser vacuum	3.3
K 5.03	Condensate and feedwater oxygen levels	2.6

K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the condenser air removal system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	2.1
K 6.02	Condensate system	2.4
K 6.03	Circulating water system	2.3
K 6.04	Demineralized water transfer and storage system	1.9
K 6.05	Turbine island vent, drain, and relief valve system	1.7
K 6.06	Vacuum pump trip	2.7
K 6.07	Loss of vacuum pump seal water or seal water cooling	2.4
K 6.08	Condenser vacuum breakers	2.6

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the condenser air removal system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Main condenser vacuum	3.1
A 1.02	Radiation in the turbine island vent, drain, and relief valve system	3.3
A 1.03	C-9, Condenser Available	3.4

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the condenser air removal system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Vacuum pump trip	2.3	2.8
A 2.02	Loss of vacuum pump seal water or seal water cooling	2.3	2.4
A 2.03	Loss of condenser vacuum	3.0	3.2
A 2.04	Loss of gland seal system	2.3	2.5
A 2.05	Loss of circulating water system	2.7	2.5
A 2.06	Condenser vacuum breaker	2.3	2.5
A 2.07	Loss of demineralized water transfer and storage system	2.0	2.1
A 2.08	Loss of compressed air system	2.4	2.2

A 3	**Ability to monitor automatic operation of the condenser air removal system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Vacuum pump start	2.4

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Vacuum pump start	2.3
A 4.02	Condenser vacuum breaker	2.3

3.4.8 SF4S FWS Main and Startup Feedwater System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the main and startup feedwater system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Auxiliary steam system	1.7
K 1.02	Steam generator blowdown system	2.2
K 1.03	Compressed air system	2.6
K 1.04	Condensate system	2.9
K 1.05	Demineralized water transfer and storage system	2.2
K 1.06	Engineered safeguards actuation system	3.6
K 1.07	Fire protection system	1.9
K 1.08	Heater drain system	2.4
K 1.09	Main steam system	2.7
K 1.10	Main turbine system	2.4
K 1.11	Postaccident monitoring system	2.9
K 1.12	Steam generator system	3.2
K 1.13	Secondary sampling system	1.9
K 1.14	Turbine building closed cooling water system	1.9
K 1.15	Transmission switchyard and offsite power system	2.0
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Booster/main feedwater pumps	2.6
K 2.02	Booster/main feedwater pump discharge isolation valves	2.3
K 2.03	Startup feedwater pumps	2.9
K 2.04	Startup feedwater isolation valves	2.8
K 2.05	Startup feedwater control valve control power	2.7
K 2.06	Main feedwater isolation valve control power	2.7
K 2.07	Main feedwater isolation valve hydraulic pump	2.6
K 2.08	Main feedwater control valve control power	2.5
K 3	**Knowledge of the effect that a loss or malfunction of the main and startup feedwater system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Auxiliary steam system	1.6
K 3.02	Condensate system	2.5
K 3.03	Engineered safeguards actuation system	3.7
K 3.04	Heater drain system	2.0
K 3.05	Main steam system	2.6
K 3.06	Main turbine system	2.4
K 3.07	Reactor coolant system	3.5
K 3.08	Steam generator system	3.4

K 4	**Knowledge of main and startup feedwater system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Trip of the booster/main feedwater pumps	3.1
K 4.02	Trip of the startup feedwater pumps	3.1
K 4.03	Decay heat removal	3.7
K 4.04	Feedwater heating	2.5
K 4.05	Long cycle recirculation	2.0
K 4.06	Feedwater flow measurement	2.9
K 4.07	Steam generator water level control in the low-power mode (OE related)	3.3
K 4.08	Steam generator water level control in the high-power mode	3.4
K 4.09	Feedwater flowpath selection	2.6
K 4.10	Reactor trip override	3.4
K 4.11	Startup feedwater pump auto start	3.1
K 4.12	Trip of booster/main feedwater pumps runback	3.3
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the main and startup feedwater system:** (CFR: 41.7 / 45.7)	
K 5.01	Feedwater flow changes on reactor coolant system natural circulation flow rate	3.5
K 5.02	Feedwater flow changes on reactor power	3.8
K 5.03	Feedwater flow changes on reactor coolant system pressure	3.2
K 5.04	Feedwater flow changes on reactor coolant system temperature	3.5
K 5.05	Feedwater flow changes on pressurizer level	2.9
K 5.06	Feedwater flow changes on steam generator level	3.5
K 5.07	Feedwater flow changes on steam generator pressure	3.2
K 5.08	Water hammer	3.4
K 5.09	Effect opening booster/main feedwater pump minimum flow has on feedwater flow to the steam generator	2.9
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the main and startup feedwater system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Auxiliary steam system	1.7
K 6.02	Compressed air system	2.8
K 6.03	Condensate system	2.9
K 6.04	Engineered safeguards actuation system	3.6
K 6.05	Heater drain system	2.5
K 6.06	Main steam system	2.9
K 6.07	Main turbine system	2.8
K 6.08	Steam generator system	3.3
K 6.09	Turbine building closed cooling water system	2.1
K 6.10	Transmission switchyard and offsite power system	2.4

K 6.11	Turbine impulse pressure instrument	2.7
K 6.12	Main feedwater flow instrument	3.0
K 6.13	Steam flow instrument	2.9
K 6.14	Main feedwater temperature instrument	2.4
K 6.15	Wide-range steam generator level instrument	2.9
K 6.16	Narrow-range steam generator level instrument	3.0
K 6.17	Steam pressure instrument	2.9
K 6.18	Main feedwater flow instrument	2.8
K 6.19	Startup feedwater flow instrument	2.8
K 6.20	Trip of one booster/main feedwater pump train at full power	3.2
K 6.21	Loss of offsite power concurrent with main generator trip	3.4
K 6.22	Reactor trip at full power	3.6
K 6.23	Turbine trip at full power without reactor trip	3.7
K 6.24	Main feedwater pump low lube oil supply pressure	2.5
K 6.25	Startup feedwater pump high discharge temperature	2.5
K 6.26	Feedwater heaters out of service	2.5

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the main and startup feedwater system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Reactor coolant system natural circulation flow rate	3.3
A 1.02	Reactor power	3.7
A 1.03	Reactor coolant system pressure	3.2
A 1.04	Reactor coolant system temperature	3.5
A 1.05	Pressurizer level	3.0
A 1.06	Steam generator level	3.5
A 1.07	Steam generator pressure	3.3
A 1.08	Booster/main feedwater pump suction pressure	3.1
A 1.09	Main feedwater pump discharge pressure	2.9
A 1.10	Main feedwater header pressure	3.0
A 1.11	Main steam pressure	3.1
A 1.12	Main feedwater flow	3.3
A 1.13	Startup feedwater pump high discharge temperature	2.6
A 1.14	Startup feedwater pump high discharge pressure	2.6
A 1.15	Startup feedwater flow	3.3

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the main and startup feedwater system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Auxiliary steam system	1.7	1.7
A 2.02	Compressed air system	3.0	2.8
A 2.03	Condensate system	2.7	3.0
A 2.04	Engineered safeguards actuation system	3.7	3.7
A 2.05	Heater drain system	2.3	2.7

A 2.06	Main steam system	2.6	2.9
A 2.07	Main turbine system	2.4	2.8
A 2.08	Steam generator system	3.0	3.4
A 2.09	Turbine building closed cooling water system	2.1	2.2
A 2.10	Transmission switchyard and offsite power system	2.6	2.3
A 2.11	Turbine impulse pressure	2.9	2.8
A 2.12	Main feedwater flow	3.1	3.2
A 2.13	Steam flow	3.0	3.0
A 2.14	Main feedwater temperature	2.3	2.8
A 2.15	Steam generator wide-range level	3.1	3.1
A 2.16	Steam generator narrow-range level	3.1	3.2
A 2.17	Steam pressure	3.1	3.0
A 2.18	Main feedwater flow	3.3	3.1
A 2.19	Startup feedwater flow	3.1	3.2
A 2.20	Startup feedwater temperature	2.4	2.4
A 2.21	Trip of one booster/main feedwater pump train at full power	3.3	3.4
A 2.22	Trip of all booster/main feedwater pump trains at full power	3.4	3.5
A 2.23	Loss of offsite power concurrent with main generator trip	3.4	3.5
A 2.24	Reactor trip from full power	3.4	3.5
A 2.25	Turbine trip at full power without reactor trip	3.6	3.6
A 2.26	Main feedwater pump low lube oil supply pressure	3.7	2.5
A 2.27	Startup feedwater pump high discharge temperature	2.6	2.4
A 2.28	Main feedwater pump high lube oil supply temperature	2.3	2.4
A 2.29	Booster or main feedwater pump high bearing oil temperature	2.1	2.3
A 2.30	Booster/main feedwater pump motor or gear high bearing temperature	2.3	2.2
A 2.31	Booster/main feedwater pump motor high stator temperature	2.4	2.2
A 2.32	Main feedwater pump low flow	2.6	2.7
A 2.33	Startup feedwater pump low and high flow	2.6	3.1
A 2.34	Booster/main feedwater pump/motor/gear high radial vibration	2.3	2.2
A 2.35	Booster/main feedwater pump or gear high axial vibration	2.3	2.2
A 2.36	Feedwater heaters out of service	2.4	2.8

A 3 **Ability to monitor automatic operation of the main and startup feedwater system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Main feedwater control valve	3.4
A 3.02	Booster/main feedwater pump trip	3.3
A 3.03	Startup feedwater control valve	3.3
A 3.04	Startup feedwater from startup feedwater pumps	3.2
A 3.05	Main feedwater pump minimum flow control valves	2.7

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Booster/main feedwater pump operation	3.2
A 4.02	Startup feedwater pumps	3.4
A 4.03	Long cycle recirculation valve	2.2
A 4.04	Main feedwater pump minimum flow control valves	2.2
A 4.05	Main feedwater control valve	3.3
A 4.06	Startup feedwater control valve	3.4

3.4.9 SF4S MSS Main Steam System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the main steam system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Auxiliary steam system	2.0
K 1.02	Compressed air system	2.4
K 1.03	Condensate system	2.2
K 1.04	Engineered safeguards actuation system	3.2
K 1.05	Gland seal system	2.0
K 1.06	Heater drain system	2.0
K 1.07	Main turbine system	2.5
K 1.08	Postaccident monitoring system	2.4
K 1.09	Plant gas systems	1.8
K 1.10	Steam dump control system	3.0
K 1.11	Steam generator system	3.0
K 1.12	Secondary sampling system	1.9
K 1.13	Turbine island vent, drain, and relief valve system	1.8
K 1.14	Turbine building ventilation system	1.7
K 1.15	Hot water heating system	1.5
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Moisture separator/reheater second-stage reheating steam main isolation valve control power	1.9
K 2.02	Extraction steam power-operated shutoff valves	1.8
K 2.03	Main turbine stop valve control power	2.2
K 2.04	Main steam system to auxiliary steam supply header isolation valve	1.8
K 3	**Knowledge of the effect that a loss or malfunction of the main steam system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Auxiliary steam system	2.0
K 3.02	Condensate system	2.3
K 3.03	Gland seal system	2.1
K 3.04	Heater drain system	2.1
K 3.05	Main turbine system	2.5
K 3.06	Steam dump control system	3.0
K 3.07	Steam generator system	3.0
K 3.08	Secondary sampling system	1.7
K 3.09	Turbine island vent, drain, and relief valve system	1.8
K 3.10	Turbine building ventilation system	1.7
K 3.11	Hot water heating system	1.5

K 4	**Knowledge of main steam system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Steamline isolation	3.7
K 4.02	Moisture separation and reheat	2.1
K 4.03	Extraction steam	2.0
K 4.04	Turbine protection	3.0
K 4.05	Main steamline drains	1.9
K 4.06	Auxiliary and gland seal system steam supply	2.0
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the main steam system:** (CFR: 41.7 / 45.7)	
K 5.01	Changing steam flow effect on reactor coolant system natural circulation flow rate	3.4
K 5.02	Changing steam flow effect on pressurizer level	2.9
K 5.03	Changing steam flow effect on reactor power	3.7
K 5.04	Changing steam flow effect on reactor coolant system pressure	3.1
K 5.05	Changing steam flow effect on reactor coolant system temperature	3.4
K 5.06	Changing steam flow effect on steam generator level	3.1
K 5.07	Changing steam flow effect on steam generator pressure	3.0
K 5.08	Changing second-stage reheating steam flow effect on main turbine system	2.2
K 5.09	Water hammer	3.0
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the main steam system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Auxiliary steam system	2.0
K 6.02	Compressed air system	2.5
K 6.03	Condensate system	2.3
K 6.04	Engineered safeguards actuation system	3.2
K 6.05	Heater drain system	2.1
K 6.06	Main turbine system	2.7
K 6.07	Steam dump control system	3.0
K 6.08	Steam generator system	3.0
K 6.09	Turbine island vent, drain, and relief valve system	1.8
K 6.10	Turbine building ventilation system	1.7
K 6.11	100-percent load rejection	3.4
K 6.12	Turbine trip	3.4
K 6.13	Reactor trip from 100-percent power	3.5
K 6.14	Power transients involving less than 100-percent load reduction	3.2
K 6.15	High and low auxiliary steam system/gland seal system supply pressure	2.0
K 6.16	Feedwater heater high-2 level	2.3
K 6.17	Moisture separator/reheater second-stage reheat steam valve failure	2.3

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the main steam system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Hot reheat steam temperatures	2.0	
A 1.02	Low-pressure turbine temperatures	2.0	
A 1.03	Reheating steam temperatures	2.0	
A 1.04	Reheating steam pressure	2.1	
A 1.05	Main steam system temperature	2.0	
A 1.06	Main steam system pressure	2.7	
A 1.07	Reactor coolant system temperature	3.0	
A 1.08	Auxiliary steam system pressure	2.0	
A 1.09	Gland seal system pressure	2.0	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the main steam system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Auxiliary steam system	2.0	1.9
A 2.02	Compressed air system	2.7	2.4
A 2.03	Condensate system	2.3	2.4
A 2.04	Engineered safeguards actuation system	3.1	3.3
A 2.05	Heater drain system	2.1	2.3
A 2.06	Main turbine system	2.7	2.7
A 2.07	Steam dump control system	3.1	3.0
A 2.08	Steam generator system	3.0	2.9
A 2.09	Turbine island vent, drain, and relief valve system	1.9	1.8
A 2.10	Turbine building ventilation system	1.9	1.6
A 2.11	100-percent load rejection	3.3	3.3
A 2.12	Turbine trip	3.3	3.3
A 2.13	Reactor trip from 100-percent power	3.3	3.4
A 2.14	Power transients involving less than 100-percent load reduction	3.3	3.1
A 2.15	High and low auxiliary steam system/gland seal system supply pressure	1.9	1.9
A 2.16	Feedwater heater high-2 level	2.0	2.3
A 2.17	Moisture separator/reheater second-stage reheat steam valve failure	2.1	2.2
A 2.18	Moisture separator/reheater shell relief valve failure	2.0	2.2
A 3	**Ability to monitor automatic operation of the main steam system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Moisture separator/reheater second-stage reheat steam flow	2.0	
A 3.02	Pressure control valves for auxiliary steam system/gland seal system supply	2.0	
A 3.03	Extraction steam power-operated shutoff valves	2.0	
A 3.04	Automatic low-point drain valves	1.8	

A 3.05	Steamline isolation actuation	3.5

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Warming and pressurizing main steam system	2.2
A 4.02	Moisture separator/reheater second-stage reheat supply steam flow	2.0
A 4.03	Moisture separator/reheater second-stage reheat steam air-operated isolation valves	1.9
A 4.04	Pressure control valves for auxiliary steam system/gland seal system supply	2.0
A 4.05	Extraction steam power-operated shutoff valves	2.0
A 4.06	Automatic low-point drain valves	1.8
A 4.07	Steamline isolation	3.6

3.4.10 SF4S MTS Main Turbine and Main Turbine Control Systems

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the main turbine and main turbine control systems and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Condensate system	2.4
K 1.02	Diverse actuation system	3.1
K 1.03	Digital rod control system	2.6
K 1.04	Engineered safeguards actuation system	3.3
K 1.05	Main and startup feedwater system	2.6
K 1.06	Heater drain system	2.2
K 1.07	Main turbine and generator lube oil system	2.2
K 1.08	Main steam system	2.6
K 1.09	Nuclear instrumentation system	2.3
K 1.10	Postaccident monitoring system	2.1
K 1.11	Reactor coolant system	2.3
K 1.12	Reactor trip system (OE related)	3.4
K 1.13	Steam dump control system	2.9
K 1.14	Main generation system	2.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Main turbine control and diagnostics system	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the main turbine and main turbine control systems will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Condensate system	2.2
K 3.02	Digital rod control system	2.4
K 3.03	Engineered safeguards actuation system	3.0
K 3.04	Main and startup feedwater system	2.4
K 3.05	Heater drain system	2.1
K 3.06	Main turbine and generator lube oil system	2.0
K 3.07	Main steam system	2.5
K 3.08	Nuclear instrumentation system	2.2
K 3.09	Reactor coolant system (OE related)	2.5
K 3.10	Reactor trip system	3.2
K 3.11	Steam dump control system	2.8
K 3.12	Main generation system	2.4

K 4	**Knowledge of main turbine and main turbine control systems design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	C-3, Low OTΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.1
K 4.02	C-4, Low OPΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.1
K 4.03	C-5, Low Turbine Power, Rod Block	3.1
K 4.04	C-7, Steam Dump Control System Load Reject Arming Signal	3.1
K 4.05	C-16, Low T_{avg} Turbine Stop Loading	3.1
K 4.06	C-20, Feedwater Pump Trip Turbine Runback	3.1
K 4.07	Isolation of steam to the main turbine, reheat steam, and/or extraction steam due to a turbine trip	3.2
K 4.08	Turbine trip	3.5
K 4.09	Turbine overspeed protection	3.3
K 4.10	Normal load control mode or load regulation mode	2.7
K 4.11	T_{ref} signal generation	3.1
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the main turbine and main turbine control systems:** (CFR: 41.7 / 45.7)	
K 5.01	Operating turbine at critical speeds	2.7
K 5.02	Turbine trip	3.3
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the main turbine and main turbine control systems:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Condensate system	2.5
K 6.02	Engineered safeguards actuation system	3.1
K 6.03	Main and startup feedwater system	2.7
K 6.04	Heater drain system	2.3
K 6.05	Main turbine and generator lube oil system	2.2
K 6.06	Main steam system	2.5
K 6.07	Reactor trip system	3.3
K 6.08	Main generation system	2.6
K 6.09	C-3, Low OTΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.1
K 6.10	C-4, Low OPΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	3.1
K 6.11	C-5, Low Turbine Power, Rod Block	3.0
K 6.12	C-7, Steam Dump Control System Load Reject Arming Signal	2.9
K 6.13	C-16, Low T_{avg} Turbine Stop Loading	2.9
K 6.14	C-20, Feedwater Pump Trip Turbine Runback	2.8
K 6.15	Isolation of steam to the main turbine, reheat steam, and/or extraction steam	3.1

K 6.16	High turbine vibration	2.6	
K 6.17	Turbine trip	3.3	
K 6.18	Turbine overspeed	3.0	
K 6.19	Load regulation mode	2.4	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the main turbine and main turbine control systems, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Reactor coolant system T_{avg} and/or pressure	3.2
A 1.02	Reactor power	3.4
A 1.03	Margin to OTΔT reactor trip	3.2
A 1.04	Margin to OPΔT reactor trip	3.2
A 1.05	Turbine first-stage pressure/power	3.0
A 1.06	Reactor coolant system parameters	2.9
A 1.07	Generator load	2.6
A 1.08	Steam generator pressure	2.8

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the main turbine and main turbine control systems and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	C-3, Low OTΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	2.6	2.9
A 2.02	C-4, Low OPΔT Margin, Auto and Manual Rod Withdrawal Block and Turbine Runback	2.6	2.9
A 2.03	C-5, Low Turbine Power, Rod Block	2.6	2.9
A 2.04	C-7, Steam Dump Control System Load Reject Arming Signal	2.4	3.0
A 2.05	C-16, Low T_{avg} Turbine Stop Loading	2.4	2.9
A 2.06	C-20, Feedwater Pump Trip Turbine Runback	2.6	2.9
A 2.07	Isolation of main steam, reheat steam, and/or extraction steam	2.6	3.0
A 2.08	Turbine vibration	2.2	2.4
A 2.09	Turbine trip	2.6	3.3
A 2.10	Turbine overspeed	2.2	2.7
A 2.11	Normal load control mode or load regulation mode	2.2	2.4
A 2.12	Power load imbalance	2.0	2.3

A 3 **Ability to monitor automatic operation of the main turbine and main turbine control systems, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Turbine trip (OE related)	3.6
A 3.02	Turbine runback	3.3
A 3.03	Turbine overspeed protection actuation	3.2
A 3.04	Load regulation mode	2.6

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Turbine trip (OE related)	3.6

3.4.11 SF4S SDCS Steam Dump Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the steam dump control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.7
K 1.02	Condensate system	2.3
K 1.03	Engineered safeguards actuation system	3.4
K 1.04	Main steam system	3.0
K 1.05	Postaccident monitoring system	2.5
K 1.06	Reactor coolant system	2.5
K 1.07	Reactor trip system	3.0
K 1.08	Steam generator system	2.8
K 1.09	Main turbine control and diagnostics system	2.5
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Turbine bypass control valve control power	2.2
K 3	**Knowledge of the effect that a loss or malfunction of the steam dump control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Condensate system	2.0
K 3.02	Main steam system	2.7
K 3.03	Reactor coolant system	3.1
K 3.04	Steam generator system	3.0
K 3.05	Main turbine control and diagnostics system	2.3
K 3.06	Reactor power	3.4
K 4	**Knowledge of steam dump control system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Load rejection control in T_{avg} mode	2.9
K 4.02	Plant trip control in T_{avg} mode	3.1
K 4.03	Header pressure control in steam pressure mode	3.0
K 4.04	Cooldown control in steam pressure mode	2.9
K 4.05	Manual control in steam pressure mode	3.0
K 4.06	Steam pressure mode arming signal	2.9
K 4.07	P-4, Steam Dump Control System Plant Trip Arming signal	3.1
K 4.08	C-7, Steam Dump Control System Load Reject Arming signal	2.9
K 4.09	C-9, Condenser Available	3.0
K 4.10	Steam generator wide-range low level block actuation	2.9
K 4.11	Reactor coolant system lo T_{avg} block actuation	3.0
K 4.12	Steam dump bank trip open actuation	2.9

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the steam dump control system:** (CFR: 41.7 / 45.7)	
K 5.01	Changing steam flow effect on reactor coolant system natural circulation flow rate	3.3
K 5.02	Changing steam flow effect on pressurizer level	2.9
K 5.03	Changing steam flow effect on reactor power	3.5
K 5.04	Changing steam flow effect on control rod position	3.0
K 5.05	Changing steam flow effect on reactor coolant system pressure	3.0
K 5.06	Changing steam flow effect on reactor coolant system temperature and/or cooldown rate	3.5
K 5.07	Changing steam flow effect on steam generator level	3.0
K 5.08	Changing steam flow effect on steam generator pressure	3.1
K 5.09	Effect of turbine bypass flow on condenser vacuum	2.7
K 5.10	Effect of turbine bypass flow on main turbine vibration	2.1

K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the steam dump control system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	2.7
K 6.02	Condensate system	2.5
K 6.03	Main steam system	2.8
K 6.04	Reactor coolant system	2.7
K 6.05	Reactor trip system	3.1
K 6.06	Steam generator system	2.9
K 6.07	Main turbine control and diagnostics system	2.6
K 6.08	Main steam header pressure	3.0
K 6.09	Reactor coolant system T_{avg}	3.1
K 6.10	Turbine impulse pressure	3.1
K 6.11	Primary controller failure	2.9
K 6.12	Controller transfer failure	2.9
K 6.13	Reactor trip breaker	3.3
K 6.14	P-4, Steam Dump Control System Plant Trip Arming signal	3.3
K 6.15	C-7, Steam Dump Control System Load Reject Arming signal	3.1
K 6.16	C-9, Condenser Available	3.2
K 6.17	Steam generator wide-range lo level block	3.0
K 6.18	Reactor coolant system lo T_{avg} block	3.3
K 6.19	Steam dump bank trip open actuation	2.9
K 6.20	Turbine bypass control valve failure	3.0
K 6.21	Loss of power	2.7
K 6.22	Turbine bypass control valve downstream high temperature	2.2

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the steam dump control system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Reactor coolant system natural circulation flow rate	3.1
A 1.02	Pressurizer level	3.0
A 1.03	Reactor power	3.6
A 1.04	Reactor coolant system pressure	3.1
A 1.05	Reactor coolant system temperature and/or cooldown rate	3.5
A 1.06	Steam generator level	3.0
A 1.07	Steam flow	3.0
A 1.08	Main steam system header pressure	3.0
A 1.09	Feedwater flow	2.5
A 1.10	Condenser vacuum	2.7

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the steam dump control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Compressed air system	3.0	2.7
A 2.02	Condensate system	2.3	2.3
A 2.03	Main steam system	2.6	2.8
A 2.04	Reactor coolant system	2.9	2.8
A 2.05	Reactor trip system	3.1	3.2
A 2.06	Steam generator system	2.7	2.9
A 2.07	Main turbine control and diagnostics system	2.4	2.5
A 2.08	Main steam header pressure	2.7	2.9
A 2.09	Reactor coolant system T_{avg}	3.3	3.2
A 2.10	Turbine impulse pressure	3.0	3.1
A 2.11	Primary controller failure	2.9	2.8
A 2.12	Controller transfer failure	2.9	2.8
A 2.13	Reactor trip breaker	3.0	3.2
A 2.14	P-4, Steam Dump Control System Plant Trip Arming signal	3.3	3.3
A 2.15	C-7, Steam Dump Control System Load Reject Arming signal	3.3	3.2
A 2.16	C-9, Condenser Available	3.0	3.1
A 2.17	Steam generator wide-range lo level block	3.1	3.0
A 2.18	Reactor coolant system lo T_{avg} block	3.1	3.1
A 2.19	Steam dump bank trip open actuation	2.7	2.8
A 2.20	Turbine bypass control valve failure	3.0	3.0
A 2.21	Loss of power	2.7	2.7
A 2.22	Turbine bypass control valve downstream high temperature	2.4	2.1

A 3	**Ability to monitor automatic operation of the steam dump control system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Steam pressure mode	3.1

A 3.02	Load rejection control in T_{avg} mode	3.1
A 3.03	Plant trip control in T_{avg} mode	3.3
A 3.04	Steam dump arming	3.2
A 3.05	Steam dump blocking	3.3
A 3.06	Steamline isolation actuation	3.6

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Transfer between steam pressure control mode and T_{avg} control mode	3.1
A 4.02	Transfer between primary and backup steam dump controllers	2.9
A 4.03	Initiate an automatic reactor coolant system cooldown or heatup	2.9
A 4.04	Manual temperature control in steam pressure mode	3.2
A 4.05	Manual reactor power control in steam pressure mode	3.1

3.4.12 SF4S SWS Service Water System

K/A NO.	KNOWLEDGE	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the service water system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.8
K 1.02	Component cooling water system	3.4
K 1.03	Circulating water system	2.7
K 1.04	Special process heat tracing system	2.2
K 1.05	Fire protection system	2.6
K 1.06	Radiation monitoring system	3.0
K 1.07	Raw water system	2.4
K 1.08	Waste water system	2.2
K 1.09	Transmission switchyard and offsite power system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Service water system pumps	3.1
K 2.02	Service water system pump discharge valves	2.9
K 2.03	Service water system cooling tower inlet control valves	2.7
K 2.04	Service water system cooling tower fans	2.7
K 2.05	Service water system strainers	2.3
K 3	**Knowledge of the effect that a loss or malfunction of the service water system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Component cooling water system	3.6
K 3.02	Raw water system	2.4
K 4	**Knowledge of service water system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Service water system pump start	3.2
K 4.02	Service water system strainer backwash	2.4
K 4.03	Service water system blowdown	2.3
K 4.04	Service water system water temperature control	2.8
K 4.05	Service water system freeze protection	2.4
K 4.06	Service water system tower makeup	2.7
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the service water system:** (CFR: 41.7 / 45.7)	
K 5.01	Water hammer	3.3
K 5.02	Pump run out	3.3

K 5.03	Radiation alarms on service water system	3.4

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the service water system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Compressed air system	2.8
K 6.02	Circulating water system	2.4
K 6.03	Special process heat tracing system	2.3
K 6.04	Fire protection system	2.6
K 6.05	Radiation monitoring system	3.0
K 6.06	Raw water system	2.4
K 6.07	Waste water system	2.0
K 6.08	Transmission switchyard and offsite power system	2.5
K 6.09	Service water system pumps	3.3
K 6.10	Service water system pump discharge valves	3.2
K 6.11	Service water system cooling tower inlet control valves	3.0
K 6.12	Service water system cooling tower fans	2.9
K 6.13	Service water system strainer	2.6
K 6.14	Service water system strainer backwash feature	2.5
K 6.15	Service water system tower makeup valve	2.8
K 6.16	Component cooling water system heat exchanger	3.3
K 6.17	Service water system pump discharge pressure instrument	2.5
K 6.18	Service water system water hot return temperature instrument	2.4
K 6.19	Service water system blowdown flow instrument	2.3
K 6.20	Service water system cooling tower basin level instrument	2.5
K 6.21	Service water pump high or low discharge pressure	2.9
K 6.22	Automatic strainer high-high differential pressure	2.6
K 6.23	Service water system cold water supply high or low temperature	2.5
K 6.24	Component cooling water system heat exchanger high outlet temperature	3.0
K 6.25	Service water pump high or low flow	3.0
K 6.26	Cooling tower basin high or low level	2.7

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the service water system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Service water system pressure	2.9
A 1.02	Service water system cold water supply temperature	2.4
A 1.03	Service water system hot water return temperature	2.6
A 1.04	Service water system cooling tower basin level	2.7
A 1.05	Component cooling water system heat exchanger outlet temperature	3.1

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the service water system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Compressed air system	3.0	2.7
A 2.02	Circulating water system	2.2	2.6
A 2.03	Special process heat tracing system	2.1	2.1
A 2.04	Fire protection system	2.8	2.4
A 2.05	Radiation monitoring system	3.0	3.2
A 2.06	Raw water system	2.3	2.6
A 2.07	Waste water system	1.9	2.2
A 2.08	Transmission switchyard and offsite power system	2.9	2.5
A 2.09	Service water system pumps	3.3	3.4
A 2.10	Service water system pump discharge valves	3.2	3.1
A 2.11	Service water system cooling tower inlet control valves	2.8	3.0
A 2.12	Service water system cooling tower fans	2.8	3.1
A 2.13	Service water system strainer	2.4	2.6
A 2.14	Service water system strainer backwash feature	2.2	2.4
A 2.15	Service water system tower makeup valve	2.7	2.7
A 2.16	Component cooling water system heat exchanger tube failure	3.3	3.6
A 2.17	Service water system pump discharge pressure instrument	2.4	2.7
A 2.18	Service water system water hot return temperature instrument	2.3	2.6
A 2.19	Service water system blowdown flow instrument	2.2	2.4
A 2.20	Service water system cooling tower basin level instrument	2.4	2.6
A 2.21	Service water pump high or low discharge pressure	2.9	3.0
A 2.22	Automatic strainer high-high differential pressure (OE related)	2.7	2.8
A 2.23	Service water system cold water supply high or low temperature	2.2	2.7
A 2.24	Component cooling water system heat exchanger high outlet temperature	2.9	3.1
A 2.25	Service water pump high or low flow (OE related)	2.9	3.0
A 2.26	Cooling tower basin high or low level	2.8	2.9
A 2.27	Service water system high radiation	3.1	3.6

A 3 **Ability to monitor automatic operation of the Service Water System, including:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Service water system pump and discharge valve operation	3.0
A 3.02	Service water system strainer backwash	2.4
A 3.03	Service water system blowdown	2.4
A 3.04	Service water system tower inlet control valve	2.8
A 3.05	Service water system tower fans	2.9
A 3.06	Service water system cooling tower makeup	2.7

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Service water system pump and discharge valve	3.2
A 4.02	Service water system strainer backwash	2.3
A 4.03	Service water system blowdown	2.2
A 4.04	Service water system tower inlet control valve	2.7
A 4.05	Service water system tower fans	2.7
A 4.06	Service water system cooling tower makeup	2.6

3.5 Safety Function 5: Containment Integrity

3.5.1 SF5 CNS Containment System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the containment system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Steam generator blowdown system	2.9
K 1.02	Compressed air system	3.1
K 1.03	Component cooling water system	3.0
K 1.04	Chemical and volume control system	3.1
K 1.05	Diverse actuation system	3.5
K 1.06	Demineralized water transfer and storage system	2.9
K 1.07	Main AC power system	2.6
K 1.08	Non-Class 1E DC and UPS system	2.5
K 1.09	Engineered safeguards actuation system	3.6
K 1.10	Fuel handling system	3.0
K 1.11	Fire protection system	3.0
K 1.12	Class 1E DC and UPS system	2.9
K 1.13	Postaccident monitoring system	2.8
K 1.14	Passive containment cooling system	3.8
K 1.15	Protection and safety monitoring system	3.6
K 1.16	Plant sampling system	2.8
K 1.17	Passive core cooling system	3.2
K 1.18	Normal residual heat removal system	3.2
K 1.19	Spent fuel pool cooling system	3.1
K 1.20	Steam generator system	3.3
K 1.21	Containment recirculation cooling system	3.0
K 1.22	Containment air filtration system	2.9
K 1.23	Containment hydrogen control system	3.0
K 1.24	Containment leak rate test system	2.5
K 1.25	Central chilled water system	2.8
K 1.26	Liquid radwaste system	2.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Containment equipment hatch closure hoists	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the containment system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Containment integrity	4.0
K 3.02	Containment closure	3.8

K 4	**Knowledge of containment system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	4.0
K 4.02	Containment air filtration system isolation	3.4
K 4.03	Normal residual heat removal system containment isolation	3.7
K 4.04	Refueling cavity isolation	3.4
K 4.05	Containment closure	3.4
K 4.06	Personnel access	2.9
K 4.07	Containment evacuation	3.3
K 4.08	Containment vacuum relief actuation	2.6
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the containment system:** (CFR: 41.7 / 45.7)	
K 5.01	Passive residual heat removal system heat exchanger operation	3.6
K 5.02	Automatic depressurization system operation	4.1
K 5.03	Hydrogen detonation inside containment	3.9
K 5.04	Loss-of-coolant accident	4.3
K 5.05	Main steamline break inside containment	4.3
K 5.06	Loss of containment integrity	4.1
K 5.07	Loss of containment closure capability	3.8
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the containment system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Containment isolation	4.1
K 6.02	Containment air filtration system isolation	3.3
K 6.03	Normal residual heat removal system containment isolation	3.6
K 6.04	Refueling cavity isolation	3.4
K 6.05	Containment closure	3.4
K 6.06	Containment isolation valve failure	3.6
K 6.07	Containment mechanical penetration failure	3.4
K 6.08	Containment electrical penetration failure	3.3
K 6.09	Containment airlock seal failure	3.4
K 6.10	Containment equipment hatch closure hoist failure	2.8
K 6.11	Containment vacuum relief actuation	2.6
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the containment system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Containment pressure	4.1
A 1.02	Containment temperature	3.6
A 1.03	Containment radiation	3.6
A 1.04	Containment water level	3.9

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the containment system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Containment isolation	4.0	3.9
A 2.02	Containment air filtration system isolation	3.5	3.4
A 2.03	Normal residual heat removal system containment isolation	3.7	3.6
A 2.04	Refueling cavity isolation	3.5	3.5
A 2.05	Containment closure	3.3	3.5
A 2.06	Containment entry in modes 1, 2, 3, or 4	2.7	3.6
A 2.07	Containment entry in modes 5, 6, or defueled	2.7	2.9
A 2.08	Containment vacuum relief actuation	2.1	3.0
A 3	**Ability to monitor automatic operation of the containment system, including:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Containment isolation	4.1	
A 3.02	Containment air filtration system isolation	3.6	
A 3.03	Normal residual heat removal system containment isolation	3.6	
A 3.04	Refueling cavity isolation	3.5	
A 3.05	Containment vacuum relief actuation	2.6	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Containment isolation	4.2	
A 4.02	Containment air filtration system isolation	3.6	
A 4.03	Normal residual heat removal system containment isolation	3.7	
A 4.04	Refueling cavity isolation	3.6	
A 4.05	Containment closure	3.4	
A 4.06	Containment vacuum relief actuation	2.5	

3.5.2 SF5 PCS Passive Containment Cooling System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the passive containment cooling system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.6
K 1.02	Containment system	3.3
K 1.03	Diverse actuation system	3.2
K 1.04	Storm drain system	1.9
K 1.05	Demineralized water transfer and storage system	2.3
K 1.06	Special process heat tracing system	1.9
K 1.07	Engineered safeguards actuation system	3.7
K 1.08	Fire protection system	2.7
K 1.09	Postaccident monitoring system	2.7
K 1.10	Spent fuel pool cooling system	2.6
K 1.11	Nuclear island nonradioactive ventilation system	2.2
K 1.12	Containment recirculation cooling system	2.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Passive containment cooling water storage tank outlet air-operated isolation valves control power	2.7
K 2.02	Passive containment cooling water storage tank outlet motor-operated isolation valves	3.1
K 2.03	Passive containment cooling water storage tank recirculation heater	2.1
K 2.04	Passive containment cooling water storage tank recirculation pump	2.1
K 2.05	Passive containment cooling ancillary water storage tank heater	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the passive containment cooling system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Containment system	3.8
K 3.02	Storm drain system	1.7
K 3.03	Demineralized water transfer and storage system	2.0
K 3.04	Fire protection system	2.1
K 3.05	Spent fuel pool cooling system	2.6
K 3.06	Containment recirculation cooling system	2.4
K 4	**Knowledge of passive containment cooling system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment vessel heat removal	3.9
K 4.02	Process monitoring	2.8

K 4.03	Spent fuel pit inventory makeup	3.0
K 4.04	Fire protection water supply	2.8
K 4.05	Recirculation of contents of the passive containment cooling water storage tank and passive containment cooling ancillary water storage tank	3.1
K 4.06	Passive containment cooling system Actuation	4.1

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the passive containment cooling system:**
(CFR: 41.7 / 45.7)

K 5.01	Heat transfer via conduction	2.7
K 5.02	Heat transfer via convection	2.7
K 5.03	Heat transfer via radiation	2.5
K 5.04	Heat transfer via water evaporation	2.7

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the passive containment cooling system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Compressed air system	3.3
K 6.02	Containment system	3.4
K 6.03	Diverse actuation system	3.6
K 6.04	Demineralized water transfer and storage system	2.6
K 6.05	Special process heat tracing system	2.3
K 6.06	Engineered safeguards actuation system	3.9
K 6.07	Fire protection system	2.7
K 6.08	Spent fuel pool cooling system	2.9
K 6.09	Nuclear island nonradioactive ventilation system	2.2
K 6.10	Containment recirculation cooling system	2.6
K 6.11	Reactor trip with loss of all AC power	3.3
K 6.12	Automatic depressurization system actuation	3.8
K 6.13	Loss-of-coolant accident	4.1
K 6.14	Main steamline break	3.9
K 6.15	Inadvertent passive containment cooling system actuation	3.5
K 6.16	Passive containment cooling water storage tank abnormal levels	3.1
K 6.17	Passive containment cooling ancillary water storage tank abnormal levels	2.8
K 6.18	Passive containment cooling water storage tank abnormal temperature	3.0
K 6.19	Passive containment cooling ancillary water storage tank abnormal temperature	2.8
K 6.20	Passive containment cooling water storage tank abnormal recirculation flow rate	2.7
K 6.21	Valve room abnormal temperature	2.3
K 6.22	Abnormal isolation valve leakage	2.7
K 6.23	Passive containment cooling water storage tank discharge path blockage	3.8

K 6.24	Water storage tank auxiliary line freezing	2.9	
K 6.25	Weir blockage	3.1	
K 6.26	Annulus drain blockage	3.1	
K 6.27	Passive containment cooling water storage tank makeup line Blockage		

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the passive containment cooling system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Containment pressure	3.9	
A 1.02	Containment temperature	3.9	
A 1.03	Passive containment cooling system water delivery flow	2.6	
A 1.04	Passive containment cooling water storage tank wide range water level	2.9	

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the passive containment cooling system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Compressed air system	3.3	3.1
A 2.02	Containment system	3.5	3.9
A 2.03	Diverse actuation system	3.0	3.9
A 2.04	Demineralized water transfer and storage system	2.5	2.6
A 2.05	Special process heat tracing system	2.3	2.1
A 2.06	Engineered safeguards actuation system	3.8	3.7
A 2.07	Fire protection system	2.8	2.9
A 2.08	Spent fuel pool cooling system	2.8	2.9
A 2.09	Nuclear island nonradioactive ventilation system	2.3	2.7
A 2.10	Containment recirculation cooling system	2.0	3.4
A 2.11	Reactor trip with loss of all AC power	3.3	3.7
A 2.12	Automatic depressurization system actuation	3.8	4.0
A 2.13	Loss-of-coolant accident	3.8	4.1
A 2.14	Main steamline break	3.8	4.0
A 2.15	Inadvertent passive containment cooling system actuation	3.3	3.9
A 2.16	Passive containment cooling water storage tank abnormal levels	2.8	3.4
A 2.17	Passive containment cooling ancillary water storage tank abnormal levels	2.5	3.1
A 2.18	Passive containment cooling water storage tank abnormal temperature	3.0	2.9
A 2.19	Passive containment cooling ancillary water storage tank abnormal temperature	2.8	2.7
A 2.20	Passive containment cooling water storage tank abnormal recirculation flow rate	2.8	3.0
A 2.21	Valve room abnormal temperature	2.8	2.4
A 2.22	Abnormal isolation valve leakage	2.8	2.7
A 2.23	Passive containment cooling water storage tank discharge path blockage	3.5	3.7

A 2.24	Water storage tank auxiliary line freezing	2.8	3.0
A 2.25	Weir blockage	3.0	3.0
A 2.26	Annulus drain blockage	3.0	3.3
A 2.27	Passive containment cooling water storage tank makeup line blockage	2.8	3.3

A 3 **Ability to monitor automatic operation of the passive containment cooling system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Passive containment cooling system actuation	4.2
A 3.02	Containment isolation	4.1

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Passive containment cooling system actuation	4.3
A 4.02	Makeup to passive containment cooling water storage tank from passive containment cooling ancillary water storage tank	3.0
A 4.03	Makeup to passive containment cooling water storage tank from demineralized water transfer and storage system	2.7
A 4.04	Makeup to passive containment cooling water storage tank from fire protection system	2.8
A 4.05	Passive containment cooling ancillary water storage tank flow to water distribution bucket	3.1
A 4.06	Passive containment cooling water storage tank flow to spent fuel pool cooling system	3.2

3.5.3 SF5 VLS Containment Hydrogen Control System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the containment hydrogen control system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Containment system	3.3
K 1.02	Diverse actuation system	3.3
K 1.03	Incore instrumentation system	2.4
K 1.04	Primary sampling system	2.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Containment hydrogen igniters	3.1
K 2.02	Containment hydrogen monitors	3.1
K 3	**Knowledge of the effect that a loss or malfunction of the containment hydrogen control system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Containment hydrogen concentration	3.7
K 4	**Knowledge of containment hydrogen control system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment hydrogen concentration monitoring	3.5
K 4.02	Passive containment hydrogen concentration control	3.6
K 4.03	Containment hydrogen concentration control using containment hydrogen igniters	3.9
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the containment hydrogen control system:** (CFR: 41.7 / 45.7)	
K 5.01	Explosive hydrogen concentration (OE related)	4.0
K 5.02	Flammable hydrogen concentration (OE related)	3.8
K 5.03	Sources of hydrogen into the containment atmosphere (OE related)	3.4
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the containment hydrogen control system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Containment hydrogen monitor failure	3.5
K 6.02	Passive autocatalytic recombiner failure	3.4
K 6.03	Containment hydrogen igniter failure	3.2

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the containment hydrogen control system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Core exit temperature	3.8	
A 1.02	Containment hydrogen concentration	3.8	
A 1.03	Containment temperature	3.1	
A 1.04	Containment pressure	3.5	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the containment hydrogen control system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Containment hydrogen monitor failure	3.3	3.5
A 2.02	Passive autocatalytic recombiner failure	3.4	3.5
A 2.03	Containment hydrogen igniter failure	3.1	3.5
A 2.04	Loss-of-coolant accident	3.9	4.2
A 3	**Ability to monitor automatic operation of the containment hydrogen control system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	N/A		
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Containment hydrogen monitor	3.6	
A 4.02	Containment hydrogen igniter	3.6	

3.6 Safety Function 6: Electrical

3.6.1 SF6 ECS AC Electrical Distribution Systems

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the AC electrical distribution systems and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Standby diesel and auxiliary boiler fuel oil system	3.0
K 1.02	Non-Class 1E DC and UPS system	3.3
K 1.03	Grounding and lightning protection system	2.2
K 1.04	Engineered safeguards actuation system	3.8
K 1.05	Fire protection system	3.0
K 1.06	Class 1E DC and UPS system	3.9
K 1.07	Postaccident monitoring system	3.2
K 1.08	Remote shutdown workstation	3.4
K 1.09	Nuclear island nonradioactive ventilation system	2.5
K 1.10	Turbine building ventilation system	2.1
K 1.11	Annex/auxiliary building nonradioactive ventilation system	2.1
K 1.12	Main generation system	3.1
K 1.13	Transmission switchyard and offsite power system	3.2
K 1.14	Onsite standby power system	3.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Major bus or motor control center power supplies (6.9 kilovolts (kV), 4.16 kV, 480 volts (V))	3.2
K 2.02	Major bus or motor control center loads (6.9 kV, 4.16 kV, 480 V)	3.2
K 2.03	Breaker control power (6.9 kV, 4.16 kV, 480 V)	2.9
K 2.04	Ancillary diesel generator starting battery charger	2.9
K 3	**Knowledge of the effect that a loss or malfunction of the AC electrical distribution systems will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Standby diesel and auxiliary boiler fuel oil system	3.0
K 3.02	Non-Class 1E DC and UPS system	3.0
K 3.03	Engineered safeguards actuation system	3.9
K 3.04	Class 1E DC and UPS system	4.0
K 3.05	Main generation system	2.9
K 3.06	Transmission switchyard and offsite power system	3.1
K 3.07	Onsite standby power system	3.6
K 3.08	Major bus or motor control center loads (6.9 kV, 4.16 kV, 480 V)	3.3

K 4	**Knowledge of AC electrical distribution systems design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Load shedding	3.4
K 4.02	Backfeeding buses from the grid	3.2
K 4.03	Protective relaying and/or bus lockout due to a fault	3.3
K 4.04	Automatic or manual transfer of buses between multiple power sources	3.2
K 4.05	Paralleling the onsite standby diesel generators with the grid	3.1
K 4.06	Supplying bus power from the onsite standby diesel generators during loss of offsite power	3.6
K 4.07	Supplying bus power from the ancillary diesel generator during loss of offsite power	3.5
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the AC electrical distribution systems:** (CFR: 41.7 / 45.7)	
K 5.01	Fault on a bus load	3.3
K 5.02	Fault on a bus	3.3
K 5.03	Fault on a reserve auxiliary transformer	3.2
K 5.04	Fault on a unit auxiliary transformer	3.3
K 5.05	Fault on a main stepup transformer	3.2
K 5.06	Loss of all AC power	4.1
K 5.07	Operating above or below the current or voltage operating limits	3.3
K 5.08	Energizing a faulted or grounded bus or motor control center	3.4
K 5.09	Paralleling out of phase	3.6
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the AC electrical distribution systems:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Standby diesel and auxiliary boiler fuel oil system	3.0
K 6.02	Non-Class 1E DC and UPS system	3.0
K 6.03	Fire protection system	2.9
K 6.04	Class 1E DC and UPS system	3.8
K 6.05	Nuclear island nonradioactive ventilation system	2.4
K 6.06	Turbine building ventilation system	2.2
K 6.07	Annex/auxiliary building nonradioactive ventilation system	2.2
K 6.08	Main generation system	3.1
K 6.09	Transmission switchyard and offsite power system	3.2
K 6.10	Onsite standby power system	3.3
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the AC electrical distribution systems, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Bus, motor control center, and/or load electrical operating parameters	2.9
A 1.02	Ancillary diesel generator electrical operating parameters	3.0

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the AC electrical distribution systems and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Loss of circuit breaker control power	2.7	3.2
A 2.02	Loss of offsite power	3.7	4.1
A 2.03	Fault on a bus load or motor control center load	3.1	3.3
A 2.04	Fault on a bus or motor control center or transformer	3.1	3.4
A 3	**Ability to monitor automatic operation of the AC electrical distribution systems, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Bus transfer from unit auxiliary transformer to reserve auxiliary transformer	3.2	
A 3.02	Tripping of loads, buses, or transformers due to protective relaying	3.3	
A 3.03	Start and loading of standby diesel generator	3.6	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Bus transfer from reserve auxiliary transformer to unit auxiliary transformer	3.2	
A 4.02	Paralleling the grid with the onsite standby diesel generator	3.2	
A 4.03	Paralleling the onsite standby diesel generator with the grid	3.2	
A 4.04	Energizing a bus	3.4	
A 4.05	Energizing a reserve auxiliary transformer	3.3	
A 4.06	Restoring the plant electrical system after a loss of offsite power	3.7	

3.6.2 SF6 IDS Class 1E and Non-Class 1E DC and UPS Systems

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the Class 1E and Non-Class 1E DC and UPS Systems and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Main AC power system	3.2
K 1.02	Grounding and lightning protection system	2.2
K 1.03	Engineered safeguards actuation system	4.0
K 1.04	Postaccident monitoring system	3.4
K 1.05	Nuclear island nonradioactive ventilation system	2.4
K 1.06	Annex/auxiliary building nonradioactive ventilation system	2.2
K 1.07	Onsite standby power system	3.2
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Major Class 1E DC and UPS system loads	3.6
K 2.02	Nuclear island nonradioactive ventilation system equipment	2.0
K 2.03	Class 1E battery chargers	3.5
K 2.04	Class 1E instrument bus inverters (OE related)	3.7
K 2.05	Class 1E regulated transformers	3.3
K 2.06	Major non-Class 1E DC and UPS system loads	2.8
K 2.07	Annex/auxiliary building nonradioactive ventilation system equipment	2.0
K 2.08	Non-Class 1E battery chargers	2.4
K 2.09	Non-Class 1E instrument bus inverters (OE related)	2.5
K 2.10	Non-Class 1E regulated transformers	2.4
K 3	**Knowledge of the effect that a loss or malfunction of the Class 1E and Non-Class 1E DC and UPS systems will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Main AC power system (OE related)	3.1
K 3.02	Engineered safeguards actuation system (OE related)	4.0
K 3.03	Non-Class 1E DC and UPS system loads (OE related)	2.8
K 3.04	Class 1E DC and UPS system loads (OE related)	3.7
K 3.05	Postaccident monitoring system (OE related)	3.3
K 3.06	Nuclear island nonradioactive ventilation system (OE related)	2.4
K 3.07	Annex/auxiliary building nonradioactive ventilation system (OE related)	2.2
K 3.08	Onsite standby power system (OE related)	3.1
K 3.09	Class 1E battery chargers (OE related)	3.5
K 3.10	Class 1E instrument bus inverters (OE related)	3.6
K 3.11	Non-Class 1E battery chargers (OE related)	2.4
K 3.12	Non-Class 1E instrument bus inverters (OE related)	2.5

K 4	**Knowledge of Class 1E and Non-Class 1E DC and UPS system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Monitoring battery health	3.0
K 4.02	Placing spare battery in service	2.8
K 4.03	Placing spare battery charger in service	2.8
K 4.04	Maintaining an instrument bus energized with its inverter removed from service	3.3
K 4.05	Automatic depressurization system actuation	4.1
K 4.06	System ground detection	2.6
K 4.07	Class 1E DC division separation	3.3
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the Class 1E and Non-Class 1E DC and UPS systems:** (CFR: 41.7 / 45.7)	
K 5.01	Extended undervoltage on Class 1E battery chargers	3.8
K 5.02	Loss of one or more Class 1E instrument buses	3.7
K 5.03	Removing a battery cell from service	2.2
K 5.04	System ground	2.6
K 5.05	Loss of nuclear island nonradioactive ventilation system	2.5
K 5.06	Loss of annex/auxiliary building nonradioactive ventilation system	2.3
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the Class 1E and Non-Class 1E DC and UPS systems:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Nuclear island nonradioactive ventilation system	2.3
K 6.02	Class 1E battery charger failure	3.5
K 6.03	Class 1E battery failure	3.9
K 6.04	Class 1E inverter failure (OE related)	3.8
K 6.05	Loss of Class 1E battery bus	4.0
K 6.06	Loss of offsite power	3.3
K 6.07	Loss of all AC power	3.9
K 6.08	Annex/auxiliary building nonradioactive ventilation system	2.3
K 6.09	Non-Class 1E battery charger failure	2.4
K 6.10	Non-Class 1E battery failure	2.5
K 6.11	Non-Class 1E inverter failure (OE related)	2.5
K 6.12	Loss of non-Class 1E battery bus	2.6
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the Class 1E and Non-Class 1E DC and UPS systems, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Battery voltage and/or current	3.0
A 1.02	Battery bus voltage and/or current	3.0
A 1.03	Battery charger voltage and/or current	2.9
A 1.04	Instrument bus current and/or voltage	3.0

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the Class 1E and Non-Class 1E DC and UPS systems and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Main AC power system	3.0	3.3
A 2.02	Grounding and lightning protection system	2.3	2.4
A 2.03	Nuclear island nonradioactive ventilation system	2.3	2.3
A 2.04	Class 1E battery charger failure	3.3	3.6
A 2.05	Class 1E battery failure	3.7	3.9
A 2.06	Class 1E Inverter failure (OE related)	3.7	3.8
A 2.07	Loss of Class 1E battery bus	3.7	3.9
A 2.08	Loss of offsite power	3.4	3.4
A 2.09	Loss of all AC power	3.7	3.9
A 2.10	Annex/auxiliary building nonradioactive ventilation system	2.3	2.4
A 2.11	Non-Class 1E battery charger failure	2.1	2.6
A 2.12	Non-Class 1E battery failure	2.3	2.7
A 2.13	Non-Class 1E inverter failure (OE related)	2.3	2.7
A 2.14	Loss of non-Class 1E battery bus	2.3	2.7
A 3	**Ability to monitor automatic operation of the Class 1E and Non-Class 1E DC and UPS systems, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Inverter input transfer between battery and regulated transformer (OE related)	3.0	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	N/A		

3.6.3 SF6 ZOS Onsite Standby Power System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the onsite standby power system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Standby diesel and auxiliary boiler fuel oil system	2.9
K 1.02	Main AC power system	3.1
K 1.03	Non-Class 1E DC and UPS system	2.9
K 1.04	Fire protection system	2.6
K 1.05	Plant control system	2.8
K 1.06	Diesel generator building heating and ventilation system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Onsite standby power system control power	2.8
K 2.02	Starting air compressor	2.6
K 2.03	Prelubrication oil pump	2.2
K 2.04	Backup prelubrication oil pump	2.1
K 2.05	Keep warm lube oil heater	2.2
K 2.06	Jacket water heater	2.1
K 2.07	Jacket water heater pump	2.1
K 2.08	Jacket water radiator fan	2.2
K 2.09	Diesel fuel oil pump (standby diesel and auxiliary boiler fuel oil system)	2.5
K 2.10	Diesel fuel oil electric heater (standby diesel and auxiliary boiler fuel oil system)	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the onsite standby power system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Standby diesel and auxiliary boiler fuel oil system	2.6
K 3.02	Main AC power system	3.1
K 3.03	Non-Class 1E DC and UPS system	2.7
K 3.04	Fire protection system	2.5
K 3.05	Diesel generator building heating and ventilation system	2.2
K 3.06	Load sequencing	3.1
K 4	**Knowledge of onsite standby power system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Engine prelube and keep warm	2.4
K 4.02	Diesel engine starting	3.0
K 4.03	Combustion air supply	2.6
K 4.04	Fuel oil supply	2.6

K 4.05	Exhaust gas elimination	2.3
K 4.06	Engine cooling	2.6
K 4.07	Engine lubrication	2.6
K 4.08	Engine speed/load control	2.8
K 4.09	Diesel engine protection	3.0
K 4.10	Generator loading	2.9
K 4.11	Generator voltage control	2.8
K 4.12	Generator protection	3.0
K 4.13	Automatic load sequencing (operating or shutdown mode)	3.1

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the onsite standby power system:**
(CFR: 41.7 / 45.7)

K 5.01	Loss of offsite AC power	3.4
K 5.02	Operating while overloaded or underloaded	3.4
K 5.03	Number of diesel starts from the available volume of starting air	3.2

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the onsite standby power system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Standby diesel and auxiliary boiler fuel oil system	2.9
K 6.02	Main AC power system	3.2
K 6.03	Non-Class 1E DC and UPS system	2.9
K 6.04	Fire protection system	2.5
K 6.05	Plant control system	2.9
K 6.06	Diesel generator building heating and ventilation system	2.4
K 6.07	Diesel engine fuel oil system failure	3.0
K 6.08	Starting air system failure	3.0
K 6.09	Prelubrication oil system failure	2.7
K 6.10	Lubrication oil system failure	3.0
K 6.11	Jacket water keep warm system failure	2.7
K 6.12	Jacket water cooling system failure	3.0
K 6.13	Combustion air supply system failure	2.9
K 6.14	Engine speed/load control system failure	3.1
K 6.15	Generator loading system failure	3.1
K 6.16	Generator voltage control failure	3.1

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the onsite standby power system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Diesel engine operating parameters	2.8
A 1.02	Generator operating parameters	2.9
A 1.03	Fuel oil storage and/or day tank levels and/or temperatures	2.6

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the onsite standby power system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Standby diesel and auxiliary boiler fuel oil system	2.8	2.9
A 2.02	Main AC power system	3.3	3.1
A 2.03	Non-Class 1E DC and UPS system	2.6	2.9
A 2.04	Fire protection system	2.6	2.5
A 2.05	Plant control system	2.9	3.0
A 2.06	Diesel generator building heating and ventilation system	2.4	2.4
A 2.07	Starting air system failure	2.8	3.1
A 2.08	Prelubrication oil system failure	2.5	2.7
A 2.09	Lubrication oil system failure	2.6	3.0
A 2.10	Jacket water keep warm system failure	2.5	2.8
A 2.11	Jacket water cooling system failure	2.6	3.0
A 2.12	Combustion air supply system failure	2.5	2.8
A 2.13	Engine speed/load control system failure	2.9	3.2
A 2.14	Generator loading system failure	2.9	3.2
A 2.15	Generator voltage control failure	2.8	3.2
A 2.16	Loss of offsite AC power	3.1	3.4
A 2.17	Parallel operation of onsite standby diesel generator	2.9	3.1
A 2.18	Automatic/manual loading	3.0	3.4
A 3	**Ability to monitor automatic operation of the onsite standby power system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Standby diesel generator starting and loading	3.2	
A 3.02	Standby diesel generator day tank level control	2.8	
A 3.03	Frequency and voltage control during parallel operation	3.0	
A 3.04	Load sequencing	3.2	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Standby diesel generator starting and loading	3.3	
A 4.02	Standby diesel generator unloading and shutdown	3.0	
A 4.03	Adjusting exciter voltage	2.9	
A 4.04	Synchronizing the standby diesel to the grid	3.2	
A 4.05	Synchronizing the grid to the standby diesel generator	3.2	

3.7 Safety Function 7: Instrumentation

3.7.1 SF7 DAS Diverse Action System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the diverse actuation system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Chemical and volume control system	2.4
K 1.02	Digital rod control system	3.0
K 1.03	Incore instrument system	2.9
K 1.04	Passive containment cooling system	3.3
K 1.05	Passive core cooling system	3.3
K 1.06	Reactor coolant system	3.1
K 1.07	Reactor coolant pump	2.9
K 1.08	Steam generator system	3.0
K 1.09	Main turbine control and diagnostics system	3.0
K 1.10	Containment recirculation cooling system	2.6
K 1.11	Containment air filtration system	2.7
K 1.12	Containment hydrogen control system	2.8
K 1.13	Liquid radwaste system	2.4
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Diverse actuation system	3.1
K 3	**Knowledge of the effect that a loss or malfunction of the diverse actuation system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Digital rod control system	3.0
K 3.02	Incore instrument system	2.6
K 3.03	Passive containment cooling system	3.3
K 3.04	Passive core cooling system	3.3
K 3.05	Reactor coolant system	3.0
K 3.06	Reactor coolant pump	3.0
K 3.07	Steam generator system	2.9
K 3.08	Main turbine control and diagnostics system	2.9
K 3.09	Containment recirculation cooling system	2.4
K 3.10	Containment air filtration system	2.5
K 3.11	Containment hydrogen control system	2.8
K 3.12	Liquid radwaste system	2.2
K 3.13	Reactor trip system	3.4

K 4	**Knowledge of diverse actuation system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Reactor and turbine trip actuations	3.7
K 4.02	Core makeup tank actuation and reactor coolant pump trip actuation	3.6
K 4.03	Passive residual heat removal heat exchanger actuation and in-containment refueling water storage tank gutter isolation	3.6
K 4.04	Containment isolation actuation	3.6
K 4.05	Passive containment cooling system actuation	3.7
K 4.06	Hydrogen igniter control	3.1
K 4.07	Automatic depressurization system Stage 1 actuation	3.8
K 4.08	Automatic depressurization system Stage 2 actuation	3.8
K 4.09	Automatic depressurization system Stage 3 actuation	3.8
K 4.10	Automatic depressurization system Stage 4 actuation	3.8
K 4.11	In-containment refueling water storage tank injection line valve actuation	3.7
K 4.12	Containment recirculation	3.6
K 4.13	In-containment refueling water storage tank drain to containment	3.4
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the diverse actuation system:** (CFR: 41.7 / 45.7)	
K 5.01	Failure of protection and safety monitoring system	3.8
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the diverse actuation system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Reactor coolant system	3.4
K 6.02	Steam generator system	3.2
K 6.03	Containment recirculation cooling system	2.9
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the diverse actuation system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Reactor coolant system hot-leg temperature	3.3
A 1.02	Pressurizer level	3.4
A 1.03	Steam generator wide-range water level	3.4
A 1.04	Containment temperature	3.1
A 1.05	Core exit thermocouples	3.5
A 1.06	Control rod drive M-G set output voltage	3.2

A 2 Ability to (a) predict the impacts of the following system/component malfunctions or operations on the diverse actuation system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Anticipated transient without scram (OE related)	3.9	3.8
A 2.02	Reactor and turbine trip	3.3	3.5
A 2.03	Core makeup tank actuation and reactor coolant pump trip actuation	3.4	3.4
A 2.04	Passive residual heat removal actuation and in-containment refueling water storage tank gutter isolation	3.3	3.4
A 2.05	Containment isolation	3.4	3.3
A 2.06	Passive containment cooling system actuation	3.1	3.5
A 2.07	Hydrogen igniter control	2.9	3.0
A 2.08	Automatic depressurization system Stage 1 actuation	3.4	3.5
A 2.09	Automatic depressurization system Stage 2 actuation	2.3	3.5
A 2.10	Automatic depressurization system Stage 3 actuation	3.4	3.5
A 2.11	Automatic depressurization system Stage 4 actuation	3.6	3.5
A 2.12	In-containment refueling water storage tank injection line valve actuation	3.1	3.5
A 2.13	Containment recirculation	3.1	3.3
A 2.14	In-containment refueling water storage tank drain to containment	3.1	3.1

A 3 Ability to monitor automatic operation of the diverse actuation system, including the following:
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Reactor and turbine trip (OE related)	3.6
A 3.02	Core makeup tank actuation and reactor coolant pump trip actuation	3.5
A 3.03	Passive residual heat removal actuation and in-containment refueling water storage tank gutter isolation	3.5
A 3.04	Containment isolation and passive containment cooling system actuation	3.5

A 4 Ability to manually operate and monitor in the control room:
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Reactor and turbine trip (OE related)	4.1
A 4.02	Core makeup tank actuation and reactor coolant pump trip actuation	4.1
A 4.03	Passive residual heat removal actuation and in-containment refueling water storage tank gutter isolation	4.1
A 4.04	Containment isolation	4.0
A 4.05	Passive containment cooling system actuation	4.0
A 4.06	Hydrogen igniter control	3.4
A 4.07	Automatic depressurization system Stage 1 actuation	4.1
A 4.08	Automatic depressurization system Stage 2 actuation	4.1

A 4.09	Automatic depressurization system Stage 3 actuation	4.1
A 4.10	Automatic depressurization system Stage 4 actuation	4.2
A 4.11	In-containment refueling water storage tank injection line valve actuation	4.0
A 4.12	Containment recirculation	3.8
A 4.13	In-containment refueling water storage tank drain to containment	3.7

3.7.2 SF7 IIS Incore Instrumentation System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the incore instrumentation system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Diverse actuation system	2.9
K 1.02	Data display and processing system	2.6
K 1.03	Fuel handling system	1.9
K 1.04	Postaccident monitoring system	3.0
K 1.05	Protection and safety monitoring system	3.4
K 1.06	Reactor system	3.1
K 1.07	Special monitoring system	2.5
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Diverse actuation system	3.3
K 2.02	Incore instrumentation system	2.8
K 2.03	Qualified data processing system	3.0
K 2.04	Data display and processing system	2.5
K 3	**Knowledge of the effect that a loss or malfunction of the incore instrumentation system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Diverse actuation system	3.3
K 3.02	Data display and processing system	2.6
K 3.03	Postaccident monitoring system	3.3
K 3.04	Protection and safety monitoring system	3.6
K 3.05	Reactor system	2.9
K 3.06	Special monitoring system	2.4
K 4	**Knowledge of incore instrumentation system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Postaccident monitoring	3.5
K 4.02	Core power distribution monitoring	3.5
K 4.03	Predictive capability for power maneuvers	3.0
K 4.04	Refueling operations	2.4
K 4.05	Incore instrument thimble assembly replacement	1.9
K 4.06	Core exit thermocouple operability range	3.1

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the incore instrumentation system:** (CFR: 41.7 / 45.7)		
K 5.01	Failed core exit thermocouple	3.1	
K 5.02	Failed self-powered detector	2.9	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the incore instrumentation system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Data display and processing system	2.7	
K 6.02	Fuel handling system	2.0	
K 6.03	Postaccident monitoring system	3.1	
K 6.04	Protection and safety monitoring system	3.2	
K 6.05	Reactor system	2.6	
K 6.06	Special monitoring system	2.3	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the incore instrumentation system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Core exit temperatures	3.8	
A 1.02	Peak kw/ft (Z)	3.0	
A 1.03	Nuclear enthalpy rise hot channel factor ($F^N_{\Delta H}$)	3.0	
A 1.04	Departure from nucleate boiling ratio (OE related)	3.2	
A 1.05	Shutdown margin (OE related)	3.4	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the incore instrumentation system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Loss of core exit thermocouples	3.7	3.2
A 2.02	Loss of self-powered detector	3.0	2.9
A 2.03	Loss of online power distribution monitoring system	3.5	3.4
A 2.04	Core damage	4.0	3.9
A 3	**Ability to monitor automatic operation of the incore instrumentation system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	N/A		
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	N/A		

3.7.3 SF7 NIS Nuclear Instrumentation System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the nuclear instrumentation system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Chemical and volume control system	2.8
K 1.02	Digital rod control system	3.3
K 1.03	Engineered safeguards actuation system	3.9
K 1.04	Online power distribution monitoring system	3.1
K 1.05	Postaccident monitoring system	3.4
K 1.06	Reactor coolant system	3.0
K 1.07	Reactor trip system	4.0
K 1.08	Remote shutdown workstation	3.5
K 1.09	Special monitoring system	2.6
K 1.10	Main turbine control and diagnostics system	2.8
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Nuclear instrumentation system	3.4
K 3	**Knowledge of the effect that a loss or malfunction of the nuclear instrumentation system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Chemical and volume control system	2.8
K 3.02	Digital rod control system	3.5
K 3.03	Engineered safeguards actuation system	3.9
K 3.04	Postaccident monitoring system	3.3
K 3.05	Reactor coolant system	3.0
K 3.06	Reactor trip system	4.0
K 3.07	Main turbine control and diagnostics system	3.0
K 4	**Knowledge of nuclear instrumentation system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	P-6, Intermediate-Range Neutron Flux	3.7
K 4.02	P-10, Power Range Neutron Flux	3.7
K 4.03	P-17, Negative Flux Rate Alert	3.5
K 4.04	C-1, High Flux Intermediate Range	3.2
K 4.05	C-2, High Flux Power Range	3.2
K 4.06	C-3, Low OTΔT Margin	3.1
K 4.07	C-4, Low OPΔT Margin	3.1
K 4.08	Source range neutron flux high reactor trip	4.0
K 4.09	Intermediate-range neutron flux high reactor trip	4.0
K 4.10	Power range high neutron flux low setpoint reactor trip	4.0

K 4.11	Power range high neutron flux high setpoint reactor trip	4.1
K 4.12	Power range positive flux rate high reactor trip	4.1
K 4.13	OTΔT reactor trip	4.1
K 4.14	OPΔT reactor trip	4.1
K 4.15	Boron dilution block actuation	3.5
K 4.16	Chemical and volume control system makeup isolation actuation	3.4
K 4.17	Startup rate calculation	3.2
K 4.18	Axial flux difference calculation	3.3
K 4.19	Quadrant power tilt ratio calculation	3.3
K 4.20	Plant load regulation mode	2.8
K 4.21	Power range nuclear instrumentation cold-leg temperature compensation	3.0
K 4.22	Power range nuclear Instrumentation calibration based on calorimetric	3.2
K 4.23	Audible indication of neutron flux in containment and in the control room (OE related)	3.4

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the nuclear instrumentation system:**
(CFR: 41.7 / 45.7)

K 5.01	Nuclear instrumentation system response to reactor core voiding	3.4
K 5.02	Downcomer density changes effect on neutron leakage	3.2

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the nuclear instrumentation system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Chemical and volume control system	2.7
K 6.02	Digital rod control system	3.2
K 6.03	Engineered safeguards actuation system	3.6
K 6.04	Reactor coolant system	3.1
K 6.05	Reactor trip system	3.7
K 6.06	Main turbine control and diagnostics system	2.8
K 6.07	Source range nuclear instrumentation failure	3.4
K 6.08	Intermediate-range nuclear instrumentation failure	3.4
K 6.09	Power range nuclear Instrumentation failure	3.5
K 6.10	T_{cold} failure	3.0
K 6.11	Power supply failure	3.3
K 6.12	Xenon oscillations	3.3

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the nuclear instrumentation system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01 N/A

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the nuclear instrumentation system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Chemical and volume control system	3.3	2.8
A 2.02	Digital rod control system	3.3	3.1
A 2.03	Engineered safeguards actuation system	3.7	3.7
A 2.04	Reactor coolant system	3.3	3.3
A 2.05	Reactor trip system	3.7	3.7
A 2.06	Main turbine control and diagnostics system	3.3	2.9
A 2.07	Source range nuclear instrumentation detector failure (OE related)	3.5	3.3
A 2.08	Intermediate-range nuclear instrumentation detector failure (OE related)	3.5	3.5
A 2.09	Power range nuclear Instrumentation detector failure (OE related)	3.5	3.6
A 2.10	T_{cold} failure	3.0	3.3
A 2.11	Power supply failure	3.2	3.3
A 2.12	Xenon oscillations	3.3	3.4
A 3	**Ability to monitor automatic operation of the nuclear instrumentation system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	P-6, Intermediate-Range Neutron Flux	3.7	
A 3.02	P-10, Power Range Neutron Flux	3.8	
A 3.03	P-17, Negative Flux Rate Alert	3.6	
A 3.04	C-1, High Flux Intermediate Range	3.3	
A 3.05	C-2, High Flux Power Range	3.3	
A 3.06	C-3, Low OTΔT Margin	3.3	
A 3.07	C-4, Low OPΔT Margin	3.3	
A 3.08	Source range neutron flux high reactor trip	4.1	
A 3.09	Intermediate-range neutron flux high reactor trip	4.1	
A 3.10	Power range high neutron flux low setpoint reactor trip	4.1	
A 3.11	Power range high neutron flux high setpoint reactor trip	4.1	
A 3.12	Power range positive flux rate high reactor trip	4.1	
A 3.13	Boron dilution block actuation	3.6	
A 3.14	Chemical and volume control system makeup isolation actuation	3.5	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Block source range neutron flux high reactor trip	3.7	
A 4.02	Block intermediate-range neutron flux high reactor trip	3.7	
A 4.03	Block power range high neutron flux low setpoint reactor trip	3.7	

3.7.4 SF7 RMS Radiation Monitoring System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the radiation monitoring system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Steam generator blowdown system	3.2
K 1.02	Component cooling water system	3.0
K 1.03	Chemical and volume control system	3.0
K 1.04	Engineered safeguards actuation system	3.4
K 1.05	Operation and control centers	2.9
K 1.06	Postaccident monitoring system	3.1
K 1.07	Plant control system	3.0
K 1.08	Primary sampling system	2.8
K 1.09	Passive core cooling system	2.7
K 1.10	Normal residual heat removal system	2.9
K 1.11	Steam generator system	3.1
K 1.12	Service water system	2.5
K 1.13	Turbine island vent, drain, and relief valve system	2.4
K 1.14	Radiologically controlled area ventilation system	3.2
K 1.15	Nuclear island nonradioactive ventilation system	2.5
K 1.16	Main control room emergency habitability system	3.3
K 1.17	Containment air filtration system	3.1
K 1.18	Health physics and hot machine shop heating, ventilation, and air conditioning (HVAC) system	2.3
K 1.19	Radwaste building HVAC system	2.7
K 1.20	Gaseous radwaste system	3.2
K 1.21	Liquid radwaste system	3.3
K 1.22	Solid radwaste system	2.8
K 1.23	Waste water system	2.6
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Radiation monitors that provide engineered safeguards actuation system actuations	3.1
K 2.02	Postaccident monitoring system radiation monitors	2.9
K 2.03	Containment atmosphere monitor	2.9
K 2.04	Non-Class 1E radiation monitors	1.9
K 3	**Knowledge of the effect that a loss or malfunction of the radiation monitoring system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Steam generator blowdown system	3.1
K 3.02	Engineered safeguards actuation system	3.6
K 3.03	Postaccident monitoring system	3.2
K 3.04	Primary sampling system	2.7

K 3.05	Radiologically controlled area ventilation system	3.2
K 3.06	Nuclear island nonradioactive ventilation system	2.6
K 3.07	Main control room emergency habitability system	3.3
K 3.08	Gaseous radwaste system	3.1
K 3.09	Liquid radwaste system	3.2
K 3.10	Waste water system	2.7

K 4 **Knowledge of radiation monitoring system design feature(s) and/or interlock(s) that provide for the following:**
(CFR: 41.7)

K 4.01	Steam generator blowdown system isolation actuation	3.4
K 4.02	Main control room isolation and air supply initiation actuation	3.6
K 4.03	Containment air filtration system isolation actuation	3.5
K 4.04	Gaseous radwaste system or liquid radwaste system release isolation	3.4
K 4.05	Primary sampling system liquid sample isolation	2.8
K 4.06	Detection of reactor coolant system leakage into containment	3.7
K 4.07	Steam generator tube leak detection	3.8
K 4.08	Plant effluent monitoring	3.4
K 4.09	Fuel handling area HVAC isolation	3.4
K 4.09	Normal residual heat removal system isolation actuation	3.2
K 4.10	Chemical and volume control system isolation	3.2

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the radiation monitoring system:**
(CFR: 41.7 / 45.7)

K 5.01	Steam generator tube leak effect on secondary system radiation monitors	3.8
K 5.02	Reactor coolant system leakage into containment effect on radiation levels	3.6
K 5.03	Reactor coolant system leakage outside containment effect on radiation levels	3.7
K 5.04	Radiation monitor failure on fuel handling operations	3.3

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the radiation monitoring system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Reactor coolant system leakage into containment	3.8
K 6.02	Reactor coolant system leakage outside containment	3.8
K 6.03	Steam generator tube leak	3.8
K 6.04	Excessive activity in liquid radwaste system or gaseous radwaste system effluent during a release	3.5
K 6.05	High radiation detected in the main control room air supply duct	3.8
K 6.06	Loss of power to radiation monitor	3.1
K 6.07	Loss of sample pump	2.8
K 6.08	Loss of radiation detector	3.0
K 6.09	High-radiation setpoint exceeded	3.6

K 6.10	Intermediate-radiation setpoint exceeded	3.0	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the radiation monitoring system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01 N/A

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the radiation monitoring system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	Steam generator tube leak	4.0	3.9
A 2.02	Reactor coolant system leakage into containment	3.8	3.8
A 2.03	Reactor coolant system leakage outside containment	3.9	3.9
A 2.04	Plant effluent radiation levels exceed intermediate- or high-level setpoints	3.4	3.6
A 2.05	Activity detected in plant process systems	3.5	3.2

A 3 **Ability to monitor automatic operation of the radiation monitoring system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Changes in system alignment	3.0	

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01 N/A

3.7.5 SF7 RTS Reactor Trip System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the reactor trip system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Chemical and volume control system	3.0
K 1.02	Digital rod control system	3.7
K 1.03	Engineered safeguards actuation system	4.3
K 1.04	Main and startup feedwater system	3.0
K 1.05	Main steam system	3.0
K 1.06	Nuclear instrumentation system	3.9
K 1.07	Pressurizer level control system	3.3
K 1.08	Plant control system	3.3
K 1.09	Pressurizer pressure control system	3.4
K 1.10	Passive core cooling system	3.2
K 1.11	Reactor coolant system	3.5
K 1.12	Reactor coolant pump	3.5
K 1.13	Rod position indication system	2.9
K 1.14	Remote shutdown workstation	3.3
K 1.15	Steam dump control system	3.1
K 1.16	Steam generator system	3.5
K 1.17	Main turbine control and diagnostics system	3.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Reactor trip breaker control power (OE related)	3.6
K 2.02	Reactor trip system instrumentation	3.6
K 2.03	Protection and safety monitoring system division	3.7
K 3	**Knowledge of the effect that a loss or malfunction of the reactor trip system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Digital rod control system	3.5
K 3.02	Engineered safeguards actuation system	4.1
K 3.03	Nuclear instrumentation system	3.5
K 3.04	Pressurizer level control system	3.0
K 3.05	Pressurizer pressure control system	3.1
K 3.06	Passive core cooling system	3.5
K 3.07	Reactor coolant system	3.4
K 3.08	Reactor coolant pump	3.3
K 3.09	Steam dump control system	3.1
K 3.10	Main turbine control and diagnostics system	3.0
K 3.11	Main feedwater control valve isolation actuation	3.0
K 3.12	Main feedwater pump trip and valve isolation actuation	3.0
K 3.13	Boron dilution block actuation	3.5

K 3.14	P-3, Reactor Trip Breaker Open	3.9
K 3.15	P-4, Reactor Trip	4.0

K 4 **Knowledge of reactor trip system design feature(s) and/or interlock(s) that provide for the following:**
(CFR: 41.7)

K 4.01	Power range neutron flux reactor trip	4.2
K 4.02	Power range neutron flux high positive rate reactor trip	4.2
K 4.03	Intermediate-range neutron flux reactor trip	4.1
K 4.04	Source range neutron flux high reactor trip	4.1
K 4.05	OTΔT reactor trip	4.2
K 4.06	OPΔT reactor trip	4.2
K 4.07	Pressurizer pressure reactor trip	4.2
K 4.08	Pressurizer water level high-3 reactor trip	4.2
K 4.09	Reactor coolant flow—low reactor trip	4.2
K 4.10	Reactor coolant pump bearing water temperature—high reactor trip	4.2
K 4.11	Reactor coolant pump speed—low reactor trip	4.2
K 4.12	Steam generator narrow-range water level—low reactor trip	4.2
K 4.13	Steam generator narrow-range water level—high-2 reactor trip	4.2
K 4.14	Automatic safeguards actuation reactor trip	4.2
K 4.15	Manual safeguards actuation reactor trip	4.2
K 4.16	Automatic automatic depressurization system actuation reactor trip	4.2
K 4.17	Manual automatic depressurization system actuation reactor trip	4.2
K 4.18	Automatic core makeup tank actuation reactor trip	4.2
K 4.19	Manual core makeup tank actuation reactor trip	4.2
K 4.20	Manual reactor trip	4.2
K 4.21	Manual reactor trip from remote shutdown workstation	4.0
K 4.22	P-3, Reactor Trip Breaker Open	4.0
K 4.23	P-4, Reactor Trip	4.1
K 4.24	P-6, Intermediate-Range Neutron Flux	3.9
K 4.25	P-10, Power Range Neutron Flux	3.9
K 4.26	P-11, Pressurizer Pressure Below 1,970 psig	3.9
K 4.27	Reactor trip breaker undervoltage and shunt trip	3.9
K 4.28	First out annunciator	3.1
K 4.29	Placing a channel in bypass	3.2
K 4.30	Placing a channel in trip	3.2
K 4.31	Placing a division in test	3.2
K 4.32	Coincidence, separation, and/or redundancy	3.2

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the reactor trip system:**
(CFR: 41.7 / 45.7)

K 5.01	Reactor trip	4.2
K 5.02	Anticipated transient without scram (OE related)	4.2
K 5.03	Anticipated transient without scram coincident with turbine trip failure	4.3
K 5.04	Loss of feedwater anticipated transient without scram	4.3
K 5.05	Placing a channel in bypass	3.2

K 5.06	Placing a channel in trip	3.2
K 5.07	Reactor trip signal during reactor trip breaker testing	3.6
K 5.08	Reactor trip signal with one division in test	3.5
K 5.09	Partial trip	3.5

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the reactor trip system:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Digital rod control system	3.6
K 6.02	Engineered safeguards actuation system	4.1
K 6.03	Pressurizer level control system	3.4
K 6.04	Pressurizer pressure control system	3.4
K 6.05	Steam dump control system	3.2
K 6.06	Reactor coolant system	3.5
K 6.07	Main turbine control and diagnostics system	3.3
K 6.08	P-6, Intermediate-Range Neutron Flux	3.6
K 6.09	P-10, Power Range Neutron Flux	3.7
K 6.10	P-11, Pressurizer Pressure Below 1,970 psig	3.6
K 6.11	Bistable processor logic	3.0
K 6.12	Local coincidence logic	3.0
K 6.13	Integrated logic processor	3.0
K 6.14	Component interface module	3.0
K 6.15	Reactor trip breaker	3.8
K 6.16	Undervoltage trip coil	3.5
K 6.17	Shunt trip coil	3.5

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the reactor trip system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	OTΔT setpoints	3.6
A 1.02	OPΔT setpoints	3.6
A 1.03	Reactor power (OE related)	4.0
A 1.04	Pressurizer pressure	3.9
A 1.05	Reactor coolant system temperature	3.8
A 1.06	Pressurizer level	3.8
A 1.07	Steam generator level	3.7
A 1.08	Steam generator pressure	3.7
A 1.09	Control rod positions (OE related)	4.0
A 1.10	Reactor trip breaker status (OE related)	4.0
A 1.11	Reactor power (OE related)	4.0
A 1.12	Startup rate	3.6
A 1.13	Shutdown margin	3.5

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the reactor trip system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Plant heatup	3.0	3.1
A 2.02	Reactor startup to full power	3.3	3.5
A 2.03	Reactor shutdown	3.2	3.4
A 2.04	Plant cooldown	3.0	3.3
A 2.05	Digital rod control system	3.3	3.4
A 2.06	Engineered safeguards actuation system	3.5	3.9
A 2.07	Diverse actuation system	3.7	3.7
A 2.08	Pressurizer level control system	3.3	3.4
A 2.09	Pressurizer pressure control system	3.3	3.5
A 2.10	Steam dump control system	3.0	3.3
A 2.11	Reactor coolant system	3.0	3.3
A 2.12	Main turbine control and diagnostics system	3.0	3.1
A 2.13	P-6, Intermediate-Range Neutron Flux	3.7	3.5
A 2.14	P-10, Power Range Neutron Flux	3.7	3.5
A 2.15	P-11, Pressurizer Pressure Below 1,970 psig	3.5	3.4
A 2.16	Bistable processor logic	2.8	3.1
A 2.17	Local coincidence logic	2.8	3.0
A 2.18	Integrated logic processor	2.8	3.0
A 2.19	Component interface module	2.8	3.9
A 2.20	Reactor trip breaker	3.7	3.6
A 2.21	Undervoltage trip coil	3.2	3.4
A 2.22	Shunt trip coil	3.2	3.4
A 2.23	Failure of reactor trip system signal to trip the reactor (OE related)	4.5	4.2
A 2.24	Loss of control power	3.7	3.5
A 3	**Ability to monitor automatic operation of the reactor trip system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Power range neutron flux reactor trip	4.1	
A 3.02	Power range neutron flux high positive rate reactor trip	4.1	
A 3.03	Intermediate-range neutron flux reactor trip	4.0	
A 3.04	Source range neutron flux high Reactor trip	4.0	
A 3.05	OTΔT reactor trip	4.1	
A 3.06	OPΔT reactor trip	4.1	
A 3.07	Pressurizer pressure reactor trip	4.1	
A 3.08	Pressurizer water level high-3 reactor trip	4.1	
A 3.09	Reactor coolant flow—low reactor trip	4.1	
A 3.10	Reactor coolant pump bearing water temperature—high reactor trip	4.1	
A 3.11	Reactor coolant pump speed—low reactor trip	4.1	
A 3.12	Steam generator narrow-range water level—low reactor trip	4.1	
A 3.13	Steam generator narrow-range water level—high-2 reactor trip	4.1	

A 3.14	Safeguards actuation from protection and safety monitoring system reactor trip	4.2
A 3.15	Manual safeguards actuation reactor trip	4.1
A 3.16	Automatic depressurization system actuation from protection and safety monitoring system reactor trip	4.2
A 3.17	Manual automatic depressurization system actuation reactor trip	4.1
A 3.18	Core makeup tank actuation from protection and safety monitoring system reactor trip	4.2
A 3.19	P-3, Reactor Trip Breaker Open (OE-related)	4.0
A 3.20	P-4, Reactor Trip (OE-related)	4.1
A 3.21	P-6, Intermediate-Range Neutron Flux	3.8
A 3.22	P-10, Power Range Neutron Flux	3.9
A 3.23	P-11, Pressurizer Pressure Below 1,970 psig	3.9
A 3.24	Reactor trip breaker undervoltage and shunt trip	3.6

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Manual core makeup tank actuation reactor trip	4.1
A 4.02	Manual reactor trip	4.3
A 4.03	Manual reactor trip from remote shutdown workstation	4.1
A 4.04	Divisional blocks and/or resets	3.5
A 4.05	Bistable, bypasses, trips, and/or resets	3.5

3.8 Safety Function 8: Plant Service Systems

3.8.1 SF8 CAS Compressed Air System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the compressed air system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Steam generator blowdown system	2.1
K 1.02	Component cooling water system	2.2
K 1.03	Condensate system	2.1
K 1.04	Condenser air removal system	2.0
K 1.05	Condensate polishing system	1.9
K 1.06	Chemical and volume control system	2.3
K 1.07	Circulating water system	2.0
K 1.08	Engineered safeguards actuation system	3.0
K 1.09	Fuel handling system	2.2
K 1.10	Fire protection system	2.1
K 1.11	Main and startup feedwater system	2.2
K 1.12	Generator hydrogen and carbon dioxide system	1.9
K 1.13	Heater drain system	1.8
K 1.14	Main turbine and generator lube oil system	1.7
K 1.15	Main steam system	2.1
K 1.16	Postaccident monitoring system	1.9
K 1.17	Passive containment cooling system	2.5
K 1.18	Plant gas system	1.1
K 1.19	Passive core cooling system	2.9
K 1.20	Reactor coolant system	2.7
K 1.21	Steam generator system	2.5
K 1.22	Service water system	2.1
K 1.23	Radiologically controlled area ventilation system	2.2
K 1.24	Main control room emergency habitability system	2.5
K 1.25	Containment air filtration system	1.9
K 1.26	Health physics and hot machine shop HVAC system	1.7
K 1.27	Radwaste building HVAC system	1.7
K 1.28	Turbine building ventilation system	1.7
K 1.29	Central chilled water system	1.8
K 1.30	Annex/auxiliary building nonradioactive ventilation system	1.6
K 1.31	Hot water heating system	1.6
K 1.32	Gaseous radwaste system	1.9
K 1.33	Liquid radwaste system	1.8
K 1.34	Radioactive waste drain system	1.7
K 1.35	Main generation system	1.8
K 1.36	Transmission switchyard and offsite power system	1.7

K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Instrument air compressor package	2.4
K 2.02	Instrument air dryer package	2.1
K 2.03	Service air compressor package	1.9
K 2.04	Service air dryer package	1.7
K 2.05	High-pressure air compressor and filter package	1.9
K 3	**Knowledge of the effect that a loss or malfunction of the compressed air system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Steam generator blowdown system (OE related)	2.4
K 3.02	Component cooling water system (OE related)	2.7
K 3.03	Condensate system (OE related)	2.3
K 3.04	Condenser air removal system (OE related)	2.2
K 3.05	Condensate polishing system (OE related)	2.1
K 3.06	Chemical and volume control system (OE related)	2.8
K 3.07	Circulating water system (OE related)	2.0
K 3.08	Fuel handling system (OE related)	2.1
K 3.09	Fire protection system (OE related)	2.3
K 3.10	Main and startup feedwater system (OE related)	2.7
K 3.11	Generator hydrogen and carbon dioxide system (OE related)	2.1
K 3.12	Heater drain system (OE related)	2.1
K 3.13	Main turbine and generator lube oil system (OE related)	2.0
K 3.14	Main steam system (OE related)	2.6
K 3.15	Passive containment cooling system (OE related)	2.8
K 3.16	Plant gas system (OE related)	2.2
K 3.17	Passive core cooling system (OE related)	3.1
K 3.18	Reactor coolant system (OE related)	2.7
K 3.19	Steam generator system (OE related)	2.5
K 3.20	Service water system (OE related)	2.5
K 3.21	Radiologically controlled area ventilation system (OE related)	2.1
K 3.22	Main control room emergency habitability system (OE related)	2.5
K 3.23	Containment air filtration system (OE related)	2.3
K 3.24	Health physics and hot machine shop HVAC system (OE related)	1.8
K 3.25	Radwaste building HVAC system (OE related)	1.9
K 3.26	Turbine building ventilation system (OE related)	1.7
K 3.27	Central chilled water system (OE related)	1.9
K 3.28	Annex/auxiliary building nonradioactive ventilation system (OE related)	1.7
K 3.29	Hot water heating system (OE related)	1.6
K 3.30	Gaseous radwaste system (OE related)	1.9
K 3.31	Liquid radwaste system (OE related)	1.9
K 3.32	Radioactive waste drain system (OE related)	1.7
K 3.33	Main generation system (OE related)	1.9

K 4	**Knowledge of compressed air system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	3.7
K 4.02	Supplying instrument air from service air	2.7
K 4.03	Instrument air compressor auto start	2.7
K 4.04	Service air compressor auto start	2.0
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the compressed air system:** (CFR: 41.7 / 45.7)	
K 5.01	Loss of instrument air	3.5
K 5.02	Loss of service air	2.3
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the compressed air system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Component cooling water system	2.6
K 6.02	Transmission switchyard and offsite power system	2.1
K 6.03	Instrument air compressor package	2.7
K 6.04	Instrument air dryer package	2.3
K 6.05	Instrument air high dew point	2.0
K 6.06	Loss of instrument air supply pressure	2.7
K 6.07	Instrument air total flow high	2.1
K 6.08	Instrument air to containment flow high	2.2
K 6.09	Service air compressor package	1.7
K 6.10	Service air dryer package	1.6
K 6.11	Service air high dew point	1.5
K 6.12	Loss of service air supply pressure	1.9
K 6.13	High-pressure air compressor and filter package	2.1
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the compressed air system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Instrument air compressor package parameters	2.6
A 1.02	Instrument air dryer package parameters	2.3
A 1.03	Instrument air supply pressure	2.9
A 1.04	Service air supply pressure	1.9
A 1.05	Instrument air total flow	2.1
A 1.06	Instrument air to containment flow	2.2
A 1.07	Instrument air dew point	1.9

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the compressed air system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Component cooling water system	3.0	2.7
A 2.02	Transmission switchyard and offsite power system	2.7	1.9
A 2.03	Instrument air compressor package	2.8	2.7
A 2.04	Instrument air dryer package	2.5	2.2
A 2.05	Instrument air high dew point	2.2	2.1
A 2.06	Loss of instrument air supply pressure	3.0	2.7
A 2.07	Instrument air total flow high	2.3	2.1
A 2.08	Instrument air to containment flow high	2.3	2.2
A 2.09	Service air compressor package	1.8	1.8
A 2.10	Service air dryer package	1.7	1.8
A 2.11	Service air high dew point	1.7	1.7
A 2.12	Loss of service air supply pressure	2.0	1.8
A 2.13	High-pressure air compressor and filter package	2.5	1.9
A 2.14	Containment isolation	3.5	3.4
A 3	**Ability to monitor automatic operation of the compressed air system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Instrument air system	3.1	
A 3.02	Service air system	2.1	
A 3.03	Containment isolation	3.9	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Instrument air system	3.1	
A 4.02	Service air system	2.2	
A 4.03	Containment isolation	4.0	

3.8.2 SF8 CCS Component Cooling Water System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the component cooling water system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.4
K 1.02	Condensate system	2.2
K 1.03	Chemical and volume control system	2.8
K 1.04	Demineralized water transfer and storage system	2.3
K 1.05	Engineered safeguards actuation system	3.6
K 1.06	Fire protection system	2.4
K 1.07	Postaccident monitoring system	2.8
K 1.08	Primary sampling system	2.0
K 1.09	Reactor coolant pump	3.2
K 1.10	Radiation monitoring system	2.8
K 1.11	Normal residual heat removal system	3.4
K 1.12	Spent fuel pool cooling system	3.2
K 1.13	Service water system	2.9
K 1.14	Central chilled water system	2.3
K 1.15	Liquid radwaste system	2.1
K 1.16	Transmission switchyard and offsite power system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Component cooling water system pump	2.9
K 2.02	Containment isolation valves	3.2
K 2.03	Reactor coolant pump cooling line isolation valves	2.9
K 3	**Knowledge of the effect that a loss or malfunction of the component cooling water system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Compressed air system	2.5
K 3.02	Condensate system	2.2
K 3.03	Chemical and volume control system	2.9
K 3.04	Primary sampling system	2.0
K 3.05	Reactor coolant pump	3.2
K 3.06	Radiation monitoring system	2.6
K 3.07	Normal residual heat removal system	3.3
K 3.08	Spent fuel pool cooling system	3.2
K 3.09	Central chilled water system	2.3
K 3.10	Liquid radwaste system	2.0
K 3.11	Reactor coolant pump variable frequency drive	3.1

K 4	**Knowledge of component cooling water system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	3.7
K 4.02	Normal reactor coolant system cooldown	3.0
K 4.03	Refueling reactor coolant system heat removal	3.2
K 4.04	Reactor coolant system heat removal during reduced reactor coolant system inventory	3.7
K 4.05	Chemical and volume control system makeup pump protection	3.0
K 4.06	Spent fuel pool cooling	3.1
K 4.07	In-containment refueling water storage tank cooling	3.2
K 4.08	Postaccident reactor coolant system heat removal	3.5
K 4.09	Component cooling water system pump auto start	3.0
K 4.10	Component cooling water system pump trip on low component cooling water system surge tank level	2.9
K 4.11	Component cooling water system surge tank level control	2.7
K 4.12	Component cooling water system protection due to reactor coolant system in-leakage from reactor coolant pump	3.3
K 4.13	Component cooling water system protection due to reactor coolant system in-leakage from chemical and volume control system	3.1
K 4.14	Reactor coolant system shutdown cooling during a total loss of component cooling water system	3.5
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the component cooling water system:** (CFR: 41.7 / 45.7)	
K 5.01	Water hammer	2.7
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the component cooling water system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	2.7
K 6.02	Demineralized water transfer and storage system	2.3
K 6.03	Central chilled water system	2.2
K 6.04	Service water system	3.0
K 6.05	Transmission switchyard and offsite power system	2.6
K 6.06	Component cooling water system pump discharge pressure instrument	2.6
K 6.07	Component cooling water system pump outlet flow instrument	2.5
K 6.08	Reactor coolant pump cooling water flow instrument	2.8
K 6.09	Chemical and volume control system letdown heat exchanger cooling water flow instrument	2.6
K 6.10	Component cooling water system surge tank level instrument	2.7
K 6.11	Component cooling water system flow instrument failure	2.5
K 6.12	Component cooling water system surge tank level instrument failure	2.8
K 6.13	Loss of component cooling water system pump	3.1

K 6.14	Component cooling water system heat exchanger tube leak	3.0
K 6.15	Loss of cooling to normal residual heat removal system pump	3.2
K 6.16	Loss of cooling to normal residual heat removal system heat exchanger	3.3
K 6.17	Normal residual heat removal system heat exchanger tube leak	3.1
K 6.18	Loss of cooling to spent fuel pool cooling system heat exchanger	3.2
K 6.19	Spent fuel pool cooling system heat exchanger tube leak	3.0
K 6.20	Loss of cooling to chemical and volume control system makeup pump minimum flow heat exchanger	2.9
K 6.21	Loss of cooling to chemical and volume control system letdown heat exchanger	2.9
K 6.22	Chemical and volume control system letdown heat exchanger tube leak	3.0
K 6.23	Loss of cooling to reactor coolant drain tank heat exchanger	2.6
K 6.24	Reactor coolant drain tank heat exchanger tube leak	2.6
K 6.25	Loss of cooling to condensate pump motor	2.3
K 6.26	Loss of cooling to reactor coolant pump	3.4
K 6.27	Loss of cooling to reactor coolant pump variable frequency drive	3.2
K 6.28	Reactor coolant pump external heat exchanger tube leak	3.2
K 6.29	Loss of cooling to central chilled water system chillers	2.4

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the component cooling water system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Component cooling water system surge tank level	2.8
A 1.02	Component cooling water system flow	2.7
A 1.03	Component cooling water system temperature	2.6

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the component cooling water system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Compressed air system	2.7	2.8
A 2.02	Demineralized water transfer and storage system	2.0	2.4
A 2.03	Central chilled water system	2.3	2.2
A 2.04	Service water system	3.3	2.9
A 2.05	Transmission switchyard and offsite power system	2.6	2.5
A 2.06	Component cooling water system pump outlet flow instrument	2.6	2.6
A 2.07	Reactor coolant pump cooling water flow instrument	2.9	2.8
A 2.08	Chemical and volume control system letdown heat exchanger cooling water flow instrument	2.6	2.5
A 2.09	Component cooling water system surge tank level instrument	3.0	2.8
A 2.10	Component cooling water system flow instrument failure	2.7	2.6
A 2.11	Component cooling water system surge tank level instrument failure	3.0	2.8
A 2.12	Loss of component cooling water system pump	3.3	3.2
A 2.13	Component cooling water system heat exchanger tube leak	3.1	2.8

A 2.14	Loss of cooling to normal residual heat removal system pump	3.3	3.2
A 2.15	Loss of cooling to normal residual heat removal system heat exchangers	3.3	3.2
A 2.16	Normal residual heat removal system heat exchanger tube leak	3.4	3.1
A 2.17	Loss of cooling to spent fuel pool cooling system heat exchanger	3.3	3.2
A 2.18	Spent fuel pool cooling system heat exchanger tube leak	3.4	2.9
A 2.19	Loss of cooling to chemical and volume control system makeup pump minimum flow heat exchanger	3.0	2.9
A 2.20	Loss of cooling to chemical and volume control system letdown heat exchanger	2.9	2.9
A 2.21	Chemical and volume control system letdown heat exchanger tube leak	3.3	2.9
A 2.22	Loss of cooling to reactor coolant drain tank heat exchanger	2.7	2.7
A 2.23	Reactor coolant drain tank heat exchanger tube leak	2.7	2.7
A 2.24	Loss of cooling to condensate pump motor	2.3	2.5
A 2.25	Loss of cooling to reactor coolant pump	3.1	3.4
A 2.26	Loss of cooling to reactor coolant pump variable frequency drive	3.0	3.3
A 2.27	Reactor coolant pump external heat exchanger tube leak	3.3	3.2
A 2.28	Loss of cooling to central chilled water system chillers	2.3	2.4

A 3 **Ability to monitor automatic operation of the component cooling water system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Component cooling water system pump start	3.0
A 3.02	Component cooling water system pump trip	3.1
A 3.03	Component cooling water system surge tank makeup	2.5
A 3.04	Reactor coolant pump isolation	3.3
A 3.05	Reactor coolant pump variable frequency drive cooling flow	3.0
A 3.06	Containment isolation	3.7

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Component cooling water system pump start	2.9
A 4.02	Component cooling water system pump trip	3.0
A 4.03	Component cooling water system surge tank makeup	2.6
A 4.04	Reactor coolant pump isolation	3.3
A 4.05	Containment isolation	3.8
A 4.06	Component cooling water system dual train operation	2.8

3.8.3 SF8 CWS Circulating Water System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the circulating water system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.0
K 1.02	Condensate system	2.6
K 1.03	Condenser tube cleaning system	2.0
K 1.04	Condenser air removal system	2.4
K 1.05	Condensate polishing system	1.9
K 1.06	Raw water system	2.0
K 1.07	Service water system	2.4
K 1.08	Turbine building closed cooling water system	2.3
K 1.09	Waste water system	1.7
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Circulating water pumps	2.1
K 2.02	Circulating water pump discharge valves	1.8
K 2.03	Turbine plant cooling tower bypass valve	1.6
K 2.04	Condenser waterbox isolation valves	1.7
K 3	**Knowledge of the effect that a loss or malfunction of the circulating water system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Condensate system	2.5
K 3.02	Condenser tube cleaning system	1.7
K 3.03	Condenser air removal system	2.3
K 3.04	Condensate polishing system	1.7
K 3.05	Raw water system	1.6
K 3.06	Service water system	2.4
K 3.07	Turbine building closed cooling water system	2.2
K 3.08	Waste water system	1.6
K 3.09	C-9, Condenser Available	2.9
K 4	**Knowledge of circulating water system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	C-9, Condenser Available	3.1
K 4.02	Freeze protection	2.1
K 4.03	Pump start or stop	2.4

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the circulating water system:** (CFR: 41.7 / 45.7)		
K 5.01	Isolation of a condenser waterbox at power	2.5	
K 5.02	Condenser tube leak	2.7	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the circulating water system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Compressed air system	2.2	
K 6.02	Condensate system	2.4	
K 6.03	Condenser tube cleaning system	1.9	
K 6.04	Raw water system	1.9	
K 6.05	Service water system	2.4	
K 6.06	Turbine building closed cooling water system	2.2	
K 6.07	Waste water system	1.7	
K 6.08	Circulation water pump trip	2.8	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the circulating water system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Main condenser vacuum	3.1	
A 1.02	C-9, Condenser Available	3.4	
A 1.03	Circulation water temperature	2.4	
A 1.04	Circulation water pump motor current	2.1	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the circulating water system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Loss of condenser vacuum	3.7	3.3
A 2.02	High or low circulation water temperature	2.7	2.4
A 2.03	Cooling tower basin level and makeup flow	2.8	2.3
A 2.04	Circulation water pump trip (OE related)	3.0	2.6
A 2.05	Condenser tube leak	3.0	2.8

A 3	**Ability to monitor automatic operation of the circulating water system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	C-9, Condenser Available	3.2
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Circulation water pump start or stop	2.9

3.8.4 SF8 FHS Fuel Handling System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
K 1	**Knowledge of the physical or control/protection logic relationship between the fuel handling system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)		
		RO	**SRO**
K 1.01	Compressed air system	2.3	2.1
K 1.02	Containment system	3.3	3.3
K 1.03	Demineralized water transfer and storage system	1.9	2.1
K 1.04	Nuclear instrumentation system	3.0	2.6
K 1.05	Reactor coolant system	2.7	2.7
K 1.06	Reactor system	2.7	2.7
K 1.07	Spent fuel pool cooling system	3.3	3.0
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)		
		RO	**SRO**
K 2.01	Refueling machine	N/A	2.1
K 2.02	Fuel handling machine	N/A	2.1
K 2.03	New fuel jib crane	N/A	1.7
K 2.04	New fuel elevator	N/A	1.8
K 2.05	Fuel transfer system	N/A	2.0
K 3	**Knowledge of the effect that a loss or malfunction of the fuel handling system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)		
		RO	**SRO**
K 3.01	Reactor system	2.0	2.5
K 3.02	Spent fuel pool cooling system	2.4	2.7
K 4	**Knowledge of fuel handling system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)		
		RO	**SRO**
K 4.01	Fuel movement	2.5	3.1
K 4.02	Fuel storage	N/A	2.9
K 4.03	Reactor vessel head and/or internals handling	N/A	2.7
K 4.04	Containment integrity	3.3	3.3
K 4.05	Protection from dropping a fuel assembly	N/A	3.5
K 4.06	Hoist overload and/or underload protection	N/A	2.9

K 5 **Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the fuel handling system:**
(CFR: 41.7 / 45.7)

		RO	SRO
K 5.01	HVAC effects on containment pressure, fuel handling building pressure, refueling cavity, and/or spent fuel pool level	2.6	2.6
K 5.02	Nuclear instrumentation system response to core offload/reload	3.4	3.3
K 5.03	Area radiation monitors response to fuel handling event	3.3	3.6
K 5.04	Containment closure requirements	3.3	3.7
K 5.05	Loss of spent fuel pool and/or reactor cavity level	3.7	3.7
K 5.06	Loss of containment air filtration system	2.7	3.0
K 5.07	Low spent fuel pool and/or refueling cavity boron concentration	3.1	3.3

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the fuel handling system:**
(CFR: 41.7 / 45.5 to 45.8

		RO	SRO
K 6.01	Compressed air system	2.7	2.3
K 6.02	Containment system	2.7	2.8
K 6.03	Demineralized water transfer and storage system	1.6	1.9
K 6.04	Nuclear instrumentation system	3.3	3.0
K 6.05	Reactor coolant system	2.4	2.8
K 6.06	Containment air filtration system	2.3	2.5
K 6.07	Bridge, trolley, and/or hoist encoder failure	N/A	2.5
K 6.08	Load cell failure	N/A	2.7
K 6.09	Mechanically bound fuel assembly	N/A	3.1

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the fuel handling system, including the following:**
(CFR: 41.7 / 45.5)

		RO	SRO
A 1.01	Refueling machine mast load and/or speed	N/A	2.7
A 1.02	Refueling machine position, speed, and/or direction	N/A	2.7
A 1.03	Fuel handling machine hoist load and/or speed	N/A	2.7
A 1.04	Fuel handling machine position, speed, and/or direction	N/A	2.7
A 1.05	Fuel transfer system position, speed, and/or direction	N/A	2.5
A 1.06	Fuel transfer system load	N/A	2.4

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the fuel handling system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Compressed air system	2.4	2.5
A 2.02	Containment system	2.9	2.9

A 2.03	Demineralized water transfer and storage system	1.7	2.0
A 2.04	Nuclear instrumentation system	3.4	3.2
A 2.05	Reactor coolant system	2.7	2.8
A 2.06	Transfer car stuck in transfer tube	N/A	2.7
A 2.07	Fuel assembly gripper mast stuck in refueling machine mast	N/A	2.7
A 2.08	Fuel assembly gripper mast stuck in fuel handling machine mast	N/A	2.6
A 2.09	Emergency operation of bridge and trolley	N/A	3.0
A 2.10	Fuel assembly or rod cluster control assembly stuck on gripper	N/A	2.9
A 2.11	Refueling machine mast overload or underload	N/A	3.0
A 2.12	Fuel handling machine hoist overload or underload	N/A	3.0
A 2.13	Loss of reactor cavity level	3.4	3.7
A 2.14	Loss of normal residual heat removal system	3.3	3.2
A 2.15	High area radiation in the containment or fuel handling buildings	3.4	3.8
A 2.16	Dropped or damaged fuel assembly	3.7	3.9

A 3 **Ability to monitor automatic operation of the fuel handling system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

		RO	SRO
A 3.01	N/A		

A 4 **Ability to manually operate and monitor at the equipment location:**
(CFR: 41.7 / 45.5 to 45.8)

		RO	SRO
A 4.01	Refueling machine bridge and/or trolley motion	N/A	2.3
A 4.02	Refueling machine hoist operation	N/A	2.2
A 4.03	Fuel transfer system operation	N/A	2.2
A 4.04	Fuel handling machine hoist operation	N/A	2.1
A 4.05	Fuel elevator operation	N/A	2.0

3.8.5 SF8 FPS Fire Protection System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the fire protection system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.3
K 1.02	Component cooling water system	2.2
K 1.03	Containment system	2.7
K 1.04	Special process heat tracing system	1.4
K 1.05	Passive containment cooling system	2.7
K 1.06	Raw water system	2.0
K 1.07	Radiologically controlled area ventilation system	2.0
K 1.08	Nuclear island nonradioactive ventilation system	1.6
K 1.09	Containment air filtration system	2.0
K 1.10	Health physics and hot machine shop HVAC system	1.5
K 1.11	Radwaste building HVAC system	1.6
K 1.12	Annex/auxiliary building nonradioactive ventilation system	1.6
K 1.13	Diesel generator building heating and ventilation system	1.7
K 1.14	Gaseous radwaste system	1.6
K 1.15	Liquid radwaste system	1.7
K 1.16	Solid radwaste system	1.5
K 1.17	Onsite standby power system	2.1
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Fire jockey pump	2.2
K 2.02	Motor-driven fire pump	2.6
K 3	**Knowledge of the effect that a loss or malfunction of the fire protection system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Component cooling water system	2.0
K 3.02	Containment system	2.5
K 3.03	Passive containment cooling system	2.6
K 3.04	Raw water system	1.7
K 3.05	Nuclear island nonradioactive ventilation system	1.6
K 3.06	Containment air filtration system	1.9
K 3.07	Health physics and hot machine shop HVAC system	1.5
K 3.08	Radwaste building HVAC system	1.5
K 3.09	Annex/auxiliary building nonradioactive ventilation system	1.5
K 3.10	Diesel generator building heating and ventilation system	1.8
K 3.11	Gaseous radwaste system	1.5
K 3.12	Liquid radwaste system	1.6
K 3.13	Solid radwaste system	1.5
K 3.14	Onsite standby power system	2.1

K 4	**Knowledge of fire protection system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	3.4
K 4.02	Fire suppression	2.9
K 4.03	Fire detection and alarm	2.9
K 4.04	Cooling water for the normal residual heat removal heat exchanger	2.9
K 4.05	Alternate source of makeup for the passive containment cooling system storage tank	3.1
K 4.06	Spent fuel pool makeup and spray	2.9
K 4.07	Containment spray	2.7
K 4.08	Seismic qualified fire suppression	2.6
K 4.09	Fire pump automatic start	2.7
K 4.10	Makeup to the fire water storage tanks	2.3
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the fire protection system:** (CFR: 41.7 / 45.7)	
K 5.01	N/A	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the fire protection system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	2.4
K 6.02	Special process heat tracing system	1.4
K 6.03	Passive containment cooling system	2.5
K 6.04	Raw water system	1.9
K 6.05	Radiologically controlled area ventilation system	1.7
K 6.06	Nuclear island nonradioactive ventilation system	1.5
K 6.07	Fire jockey pump failure	2.3
K 6.08	Motor-driven fire pump failure	2.8
K 6.09	Diesel-driven fire pump failure	3.0
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the fire protection system, including the following:** (CFR: 41.7 / 45.5)	
A 1.01	Fire suppression system pressure	2.7
A 1.02	Fire water tank temperature	1.9
A 1.03	Fire water tank level	2.7

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the fire protection system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	N/A		
A 3	**Ability to monitor automatic operation of the fire protection system, including the following:** (CFR: 41.7 / 45.5 / 45.13)		
A 3.01	Motor-driven fire pump start	3.0	
A 3.02	Diesel-driven fire pump start	3.0	
A 3.03	Fire suppression system actuation	3.3	
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)		
A 4.01	Motor-driven fire pump start	3.0	
A 4.02	Diesel-driven fire pump start	3.0	

3.8.6 SF8 SFS Spent Fuel Pool Cooling System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the spent fuel pool cooling system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Component cooling water system	3.1
K 1.02	Containment system	3.1
K 1.03	Chemical and volume control system	2.7
K 1.04	Demineralized water transfer and storage system	2.4
K 1.05	Engineered safeguards actuation system	3.2
K 1.06	Fuel handling system	2.5
K 1.07	Fire protection system	2.4
K 1.08	Postaccident monitoring system	2.5
K 1.09	Passive containment cooling system	3.0
K 1.10	Passive core cooling system	3.1
K 1.11	Reactor coolant system	2.8
K 1.12	Normal residual heat removal system	3.0
K 1.13	Radiologically controlled area ventilation system	2.5
K 1.14	Liquid radwaste system	2.2
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Spent fuel pool cooling pump suction line containment isolation valves	2.6
K 2.02	Spent fuel pool cooling system discharge line containment Isolation valves	2.6
K 2.03	Spent fuel pool cooling pumps	2.4
K 3	**Knowledge of the effect that a loss or malfunction of the spent fuel pool cooling system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Component cooling water system	2.4
K 3.02	Containment system	3.0
K 3.03	Chemical and volume control system	2.3
K 3.04	Fuel handling system	2.6
K 3.05	Fire protection system	2.0
K 3.06	Passive containment cooling system	2.6
K 3.07	Passive core cooling system	2.9
K 3.08	Radiation monitoring system	2.9
K 3.09	Normal residual heat removal system	2.7
K 3.10	Radiologically controlled area ventilation system	2.7
K 3.11	Liquid radwaste system	2.2
K 3.12	Spent fuel temperatures	3.0

K 4	**Knowledge of spent fuel pool cooling system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Safety-related makeup to the spent fuel pool cooling system	3.4
K 4.02	Containment isolation	3.6
K 4.03	Prevent flooding of the refueling cavity during containment flooding	3.0
K 4.04	Maintain refueling cavity level during refueling operations	3.0
K 4.05	Maintain spent fuel pool water level above the top of the spent fuel racks	3.5
K 4.06	Provide drain path from the refueling cavity to containment during nonrefueling plant operations	2.6
K 4.07	Remove the decay heat from the spent and irradiated fuel stored in the spent fuel pool	3.5
K 4.08	Terminate boiling and reduce the spent fuel pool temperatures to normal after loss of normal spent fuel pool cooling	3.4
K 4.09	Remove the decay heat from the fuel in the reactor vessel and/or refueling cavity during a loss of normal residual heat removal system with the cavity flooded	3.1
K 4.10	Clarify the spent fuel pool water	2.3
K 4.11	Transfer water between the in-containment refueling water storage tank and the refueling cavity, the fuel transfer canal, the cask loading pit, and the cask washdown pit	2.7
K 4.12	In-containment refueling water storage tank cooling and purification	2.9
K 4.13	Drain the refueling cavity during an accident	3.1
K 4.14	Adequate shutdown margin	3.5
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the spent fuel pool cooling system:** (CFR: 41.7 / 45.7)	
K 5.01	ΔP between containment and fuel handling buildings	2.8
K 5.02	Improper loading of fuel in the spent fuel racks effect on K_{eff}	3.2
K 5.03	Spent fuel pool level on area dose rates	3.0
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the spent fuel pool cooling system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Component cooling water system	3.1
K 6.02	Containment system	3.0
K 6.03	Demineralized water transfer and storage system	2.2
K 6.04	Engineered safeguards actuation system	3.4
K 6.05	Fire protection system	2.3
K 6.06	Passive containment cooling system	2.7
K 6.07	Passive core cooling system	2.7
K 6.08	Normal residual heat removal system	2.8
K 6.09	Radiologically controlled area ventilation system	2.7
K 6.10	Liquid radwaste system	2.1
K 6.11	Loss of offsite power	2.9

K 6.12	Station blackout	3.0	
K 6.13	Loss of spent fuel pool cooling	3.3	
K 6.14	Leakage from the spent fuel pool	3.2	

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the spent fuel pool cooling system, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Spent fuel pool cooling pump discharge flow	2.4
A 1.02	Spent fuel pool cooling purification loop flow	2.2
A 1.03	Spent fuel pool level	3.2
A 1.04	Spent fuel pool temperature	3.1
A 1.05	Cask washdown pit level	2.2
A 1.06	Cask loading pit level	2.2
A 1.07	Fuel handling building area radiation levels	3.1

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the spent fuel pool cooling system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	SRO
A 2.01	Component cooling water system	3.2	3.3
A 2.02	Containment system	3.0	3.1
A 2.03	Demineralized water transfer and storage system	2.0	2.3
A 2.04	Engineered safeguards actuation system	3.5	3.3
A 2.05	Fire protection system	2.3	2.4
A 2.06	Passive containment cooling system	2.3	3.2
A 2.07	Passive core cooling system	2.7	3.0
A 2.08	Normal residual heat removal system	2.5	3.1
A 2.09	Radiologically controlled area ventilation system	2.0	2.7
A 2.10	Liquid radwaste system	1.8	2.2
A 2.11	Loss of offsite power	3.0	3.0
A 2.12	Station blackout	3.0	3.1
A 2.13	Loss of spent fuel pool cooling	3.3	3.4
A 2.14	Leakage from the spent fuel pool	3.3	3.3
A 2.15	Loss of shutdown margin	3.0	3.5
A 2.16	Abnormal spent fuel pool level	3.2	3.1

A 3 **Ability to monitor automatic operation of the spent fuel pool cooling system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Containment isolation	3.6
A 3.02	Refueling cavity isolation actuation	3.4

A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Spent fuel pool cooling by the normal residual heat removal system	3.1
A 4.02	Makeup to spent fuel pool cooling system	3.0
A 4.03	Spent fuel pool cooling pump	2.9
A 4.04	Containment isolation	3.6

3.8.7 SF8 VES Main Control Room HVAC

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical connections between the main control room HVAC systems and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.6
K 1.02	Demineralized water transfer and storage system	1.9
K 1.03	Engineered safeguards actuation system	3.7
K 1.04	Radiation monitoring system	3.3
K 1.05	Radiologically controlled area ventilation system	2.5
K 1.06	Nuclear island nonradioactive ventilation system	2.7
K 1.07	Main control room emergency habitability system	3.6
K 1.08	Central chilled water system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	N/A	
K 3	**Knowledge of the effect that a loss or malfunction of the main control room HVAC systems will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Control room habitability	3.6
K 4	**Knowledge of main control room HVAC system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Main control room isolation and air supply initiation actuation	3.6
K 4.02	Main control room supply air radiation monitoring	3.4
K 4.03	Main control room outside air intake smoke detection and/or main control room smoke purge	2.9
K 4.04	Maintaining positive pressure in the main control room	2.9
K 4.05	Maintaining main control room temperature and/or humidity limits	2.6
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the main control room HVAC systems:** (CFR: 41.7 / 45.7)	
K 5.01	High or high-high radiation in the main control room air supply duct	3.6
K 5.02	Smoke detected in main control room outside air intake	3.2
K 5.03	Loss of normal main control room HVAC	2.8
K 5.04	Loss of offsite power effect on normal main control room HVAC	2.5
K 5.05	Loss of all AC power on the main control room emergency habitability system	3.1

K 5.06	Fire detected in main control room or control support area	3.4
K 5.07	Loss of main control room ΔP	2.7
K 5.08	Main control room temperature outside the normal band	2.5
K 5.09	Main control room access restrictions during an event	3.1

K 6 **Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the main control room HVAC systems:**
(CFR: 41.7 / 45.5 to 45.8)

K 6.01	Compressed air system	2.6
K 6.02	Demineralized water transfer and storage system	2.0
K 6.03	Engineered safeguards actuation system	3.4
K 6.04	Radiation monitoring system	3.2
K 6.05	Radiologically controlled area ventilation system	2.5
K 6.06	Nuclear island nonradioactive ventilation system	2.8
K 6.07	Main control room emergency habitability system	3.4
K 6.08	Central chilled water system	2.4

A 1 **Ability to predict and/or monitor changes in parameters associated with operation of the main control room HVAC systems, including the following:**
(CFR: 41.7 / 45.5)

A 1.01	Main control room ΔP	2.5
A 1.02	Main control room air temperature	2.5
A 1.03	Main control room air supply duct radiation	2.9
A 1.04	Main control room emergency habitability system emergency air storage tank pressure	3.4

A 2 **Ability to (a) predict the impacts of the following system/component malfunctions or operations on the main control room HVAC systems and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:**
(CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)

		RO	**SRO**
A 2.01	High radiation in the main control room air supply duct	3.2	3.7
A 2.02	Smoke detected in main control room outside air intake	2.8	2.9
A 2.03	Loss of normal main control room HVAC	2.0	2.8
A 2.04	Loss of offsite power effect on normal main control room HVAC	1.8	2.3
A 2.05	Loss of all AC power on the main control room emergency habitability system	3.0	2.9
A 2.06	Fire detected in main control room or control support area	3.0	3.0
A 2.07	Loss of main control room ΔP	2.2	2.3
A 2.08	Main control room temperature outside the normal band	2.2	2.3

A 3	**Ability to monitor automatic operation of the main control room HVAC systems, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Main control room Isolation and air supply initiation actuation	3.5
A 3.02	Response to high or high-high radiation in the main control room air supply duct	3.4
A 3.03	Response to smoke detected in main control room outside air Intake	3.0
A 3.04	Response to loss of normal main control room HVAC	2.5
A 3.05	Loss of offsite power effect on normal main control room HVAC	2.4
A 3.06	Loss of all AC power on the main control room emergency habitability system	3.0
A 3.07	Fire detected in main control room or control support area	3.1
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Main control room isolation and air supply initiation actuation	3.6
A 4.02	Place main control room normal HVAC in service	2.5
A 4.03	Align main control room normal HVAC in the smoke purge mode	2.7

3.8.8 SF8 VFS Containment Air Filtration System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the containment air filtration system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.4
K 1.02	Diverse actuation system	3.2
K 1.03	Engineered safeguards actuation system	3.5
K 1.04	Fire protection system	2.3
K 1.05	Postaccident monitoring system	2.7
K 1.06	Radiation monitoring system	3.1
K 1.07	Radiologically controlled area ventilation system	3.1
K 1.08	Containment recirculation cooling system	2.6
K 1.09	Central chilled water system	2.3
K 1.10	Hot water heating system	2.0
K 1.11	Gaseous radwaste system	2.5
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Containment supply fans	2.1
K 2.02	Containment exhaust fans	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the containment air filtration system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Fire protection system	2.0
K 3.02	Radiation monitoring system	2.8
K 3.03	Radiologically controlled area ventilation system	3.0
K 3.04	Gaseous radwaste system	2.3
K 3.05	Containment exhaust fan flow	2.4
K 3.06	Containment supply fan flow	2.4
K 3.07	Containment isolation	3.4
K 3.08	Radiological control	3.1
K 3.09	Monitor plant vent effluent	3.2
K 3.10	Containment pressure	2.9
K 3.11	Containment humidity	2.5
K 3.12	Containment temperature	2.7
K 3.13	Pressure in the fuel handling area and the radiologically controlled areas of the auxiliary and annex building	2.6

K 4	**Knowledge of containment air filtration system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	3.7
K 4.02	Radiological control	3.2
K 4.03	Monitor plant vent effluent	3.1
K 4.04	Maintain the fuel handling area and the radiologically controlled areas of the Auxiliary and annex building at a slight negative pressure	2.8
K 4.05	Containment pressure control during normal operation	2.8
K 4.06	Containment humidity control during normal operation	2.5
K 4.07	Containment temperature control during normal operation	2.6
K 4.08	Containment vacuum relief actuation	2.4
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the containment air filtration system:** (CFR: 41.7 / 45.7)	
K 5.01	N/A	
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the containment air filtration system:** (CFR: 41.7 / 45.5 to 45.8)	
K 6.01	Compressed air system	2.5
K 6.02	Engineered safeguards actuation system	3.4
K 6.03	Fire protection system	2.3
K 6.04	Radiation monitoring system	3.3
K 6.05	Radiologically controlled area ventilation system	2.9
K 6.06	Containment recirculation cooling system	2.6
K 6.07	Central chilled water system	2.2
K 6.08	Hot water heating system	1.8
K 6.09	Transmission switchyard and offsite power system	2.2
K 6.10	Loss-of-coolant accident	3.7
K 6.11	Fuel handling area exhaust air high radiation	3.1
K 6.12	Auxiliary building area exhaust air high radiation	3.1
K 6.13	Annex/auxiliary building exhaust air high radiation	3.1
K 6.14	Containment purge exhaust air high radiation	3.2
K 6.15	Plant vent exhaust air high radiation	3.1
K 6.16	High ambient air pressure differentials	2.5
K 6.17	Containment air filtration system charcoal absorber fire	3.1
K 6.18	Abnormal reactor coolant system leakage inside containment	3.4
K 6.19	Air filter high pressure differential	2.5
K 6.20	Fan low airflow	2.4
K 6.21	Supply air low temperature	2.1
K 6.22	Exhaust air temperature	2.2
K 6.23	Charcoal absorber humidity	2.2
K 6.24	Inadvertent passive containment cooling system actuation	2.6

A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the containment air filtration system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Secondary building ambient pressure differential	2.5	
A 1.02	Containment supply air temperature	2.4	
A 1.03	Charcoal absorber temperature	2.4	
A 1.04	Containment exhaust fan flow	2.2	
A 1.05	Containment supply fan flow	2.3	
A 1.06	Exhaust air relative humidity	2.2	
A 1.07	Containment supply air smoke	2.5	

A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the containment air filtration system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Compressed air system	2.3	2.6
A 2.02	Engineered safeguards actuation system	3.5	3.6
A 2.03	Fire protection system	2.2	2.3
A 2.04	Radiation monitoring system	3.2	3.1
A 2.05	Radiologically controlled area ventilation system	3.2	3.1
A 2.06	Containment recirculation cooling system	2.5	2.6
A 2.07	Central chilled water system	2.3	2.3
A 2.08	Hot water heating system	1.7	1.8
A 2.09	Transmission switchyard and offsite power system	2.7	2.5
A 2.10	Loss-of-coolant accident	3.8	3.9
A 2.11	Fuel handling area exhaust air high radiation	3.2	3.3
A 2.12	Auxiliary building area exhaust air high radiation	3.2	3.3
A 2.13	Annex/auxiliary building exhaust air high radiation	3.2	3.3
A 2.14	Containment purge exhaust air high radiation	3.2	3.5
A 2.15	Plant vent exhaust air high radiation	3.2	3.3
A 2.16	High ambient air pressure differentials	2.3	2.7
A 2.17	Containment air filtration system charcoal absorber fire	3.3	3.1
A 2.18	Abnormal reactor coolant system leakage inside containment	3.3	3.4
A 2.19	Air filter high pressure differential	2.2	2.5
A 2.20	Fan low airflow	2.2	2.3
A 2.21	Supply air low temperature	2.3	2.2
A 2.22	Exhaust air temperature	2.2	2.1
A 2.23	Charcoal absorber humidity	2.3	2.3
A 2.24	Inadvertent passive containment cooling system actuation	3.0	2.9

A 3	**Ability to monitor automatic operation of the containment air filtration system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Auto fan operation	2.5
A 3.02	Containment air filtration system isolation actuation	3.6
A 3.03	Containment vacuum relief actuation	2.4
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Containment isolation	3.8
A 4.02	Auto fan operation	2.5
A 4.03	Secondary building ambient pressure differential	2.4
A 4.04	Containment supply air temperature	2.3
A 4.05	Charcoal absorber temperature	2.4
A 4.06	Containment exhaust fan flow	2.3
A 4.07	Containment supply fan flow	2.3
A 4.08	Exhaust air relative humidity	2.2
A 4.09	Containment supply air smoke	2.6

3.9 Safety Function 9: Radioactivity Release

3.9.1 SF9 WGS Gaseous Radwaste System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the gaseous radwaste system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.4
K 1.02	Plant gas systems	2.6
K 1.03	Radiation monitoring system	3.3
K 1.04	Inputs from ventilation systems (such as radiologically controlled area ventilation system, containment air filtration system, health physics and hot machine shop HVAC system, radwaste building HVAC system)	3.1
K 1.05	Central chilled water system	2.3
K 1.06	Liquid radwaste system	2.6
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	N/A	
K 3	**Knowledge of the effect that a loss or malfunction of the gaseous radwaste system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Plant gas systems	2.6
K 3.02	Radiation monitoring system	3.0
K 3.03	Liquid radwaste system	2.7
K 4	**Knowledge of gaseous radwaste system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Gaseous radwaste system release isolation	3.5
K 4.02	Nitrogen purging operations	2.4
K 4.03	Prevention of hydrogen ignition	3.1
K 4.04	Activated carbon bed moisture protection	2.5
K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the gaseous radwaste system:** (CFR: 41.7 / 45.7)	
K 5.01	Fuel defects	3.3
K 5.02	Hydrogen/oxygen concentrations within flammability limits	3.3
K 5.03	Charcoal absorption efficiency	2.3

K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the gaseous radwaste system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Compressed air system	2.5	
K 6.02	Plant gas systems	2.8	
K 6.03	Radiation monitoring system	3.3	
K 6.04	Inputs from ventilation systems (such as radiologically controlled area ventilation system, containment air filtration system, health physics and hot machine shop HVAC system, radwaste building HVAC system)	3.0	
K 6.05	Central chilled water system	2.3	
K 6.06	Liquid radwaste system	2.7	
K 6.07	Activated carbon bed fire	3.0	
K 6.08	Loss of hydrogen concentration monitor	3.0	
K 6.09	Loss of oxygen concentration monitor	2.9	
K 6.10	Wetted activated carbon bed	2.5	
K 6.11	Loss of sample pump function	2.5	
K 6.12	Activated carbon bed vessel failure	2.8	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the gaseous radwaste system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Gaseous radwaste system pressure and input flow rates	2.4	
A 1.02	Carbon bed and/or vault temperatures	2.5	
A 1.03	Gas cooler outlet dew point	2.2	
A 1.04	Hydrogen/oxygen concentrations	3.0	
A 1.05	Gaseous radwaste system discharge radiation and/or flow rate	3.3	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the gaseous radwaste system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Compressed air system	2.4	2.5
A 2.02	Plant gas systems	2.1	2.6
A 2.03	Radiation monitoring system	3.1	3.3
A 2.04	Inputs from ventilation systems (such as radiologically controlled area ventilation system, containment air filtration system, health physics and hot machine shop HVAC system, radwaste building HVAC system)	2.6	2.9
A 2.05	Central chilled water system	2.1	2.4
A 2.06	Liquid radwaste system	2.1	2.7
A 2.07	Activated carbon bed fire	3.0	3.0
A 2.08	Loss of hydrogen concentration monitor	3.0	3.0
A 2.09	Loss of oxygen concentration monitor	3.0	3.0
A 2.10	Wetted activated carbon bed	2.4	2.6

A 2.11	Loss of sample pump	2.1	2.4
A 2.12	Activated carbon bed vessel failure	2.9	2.9

A 3 **Ability to monitor automatic operation of the gaseous radwaste system, including the following:**
(CFR: 41.7 / 45.5 / 45.13)

A 3.01	Nitrogen purge	2.5
A 3.02	Gaseous radwaste system discharge isolation	3.5

A 4 **Ability to manually operate and monitor in the control room:**
(CFR: 41.7 / 45.5 to 45.8)

A 4.01	Place gaseous radwaste system in service	2.6
A 4.02	Nitrogen purge	2.5
A 4.03	Recover from automatic gaseous radwaste system release isolation	2.8

3.9.2 SF9 WLS Liquid Radwaste System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
K 1	**Knowledge of the physical or control/protection logic relationship between the liquid radwaste system and the following systems:** (CFR: 41.2 to 41.9 / 45.7 to 45.8)	
K 1.01	Compressed air system	2.3
K 1.02	Chemical and volume control system	2.8
K 1.03	Diverse actuation system	2.9
K 1.04	Engineered safeguards actuation system	3.3
K 1.05	Postaccident monitoring system	2.9
K 1.06	Gaseous radwaste system	2.6
K 1.07	Dilution flow sources (such as circulation water or raw water)	2.6
K 1.08	Waste holdup tank inputs (such as containment sump, auxiliary building sump, or steam generator blowdown)	2.7
K 1.09	Chemical waste system	2.3
K 2	**Knowledge of bus or division power supplies to the following:** (CFR: 41.7)	
K 2.01	Reactor coolant drain tank pump	2.0
K 2.02	Containment sump pump	2.1
K 3	**Knowledge of the effect that a loss or malfunction of the liquid radwaste system will have on the following systems or system parameters:** (CFR: 41.7 / 45.6)	
K 3.01	Chemical and volume control system	2.8
K 3.02	Reactor coolant drain tank	2.7
K 3.03	Waste holdup tank inputs (such as containment sump, auxiliary building sump, or steam generator blowdown)	2.5
K 3.04	Chemical waste system	2.2
K 3.05	Reactor coolant pressure boundary leak detection	3.3
K 4	**Knowledge of liquid radwaste system design feature(s) and/or interlock(s) that provide for the following:** (CFR: 41.7)	
K 4.01	Containment isolation	3.6
K 4.02	Reactor coolant pressure boundary leak detection	3.5
K 4.03	Chemical and volume control system letdown/reactor coolant drain tank influent priority	2.9
K 4.04	Degasifier inlet isolation due to degasifier column hi-3 level	2.4

K 5	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the liquid radwaste system:** (CFR: 41.7 / 45.7)		
K 5.01	N/A		
K 6	**Knowledge of the effect of the following plant conditions, system malfunctions, or component malfunctions on the liquid radwaste system:** (CFR: 41.7 / 45.5 to 45.8)		
K 6.01	Compressed air system	2.4	
K 6.02	Engineered safeguards actuation system	3.3	
K 6.03	Radiation monitoring system	3.2	
K 6.04	Gaseous radwaste system	2.8	
K 6.05	Transmission switchyard and offsite power system	2.3	
K 6.06	Dilution flow sources (such as circulation water or raw water)	2.5	
K 6.07	Waste holdup tank inputs (such as containment sump, auxiliary building sump, or steam generator blowdown)	2.6	
K 6.08	Chemical waste system	2.3	
K 6.09	Degasifier column level control	2.1	
A 1	**Ability to predict and/or monitor changes in parameters associated with operation of the liquid radwaste system, including the following:** (CFR: 41.7 / 45.5)		
A 1.01	Reactor coolant drain tank parameters	2.6	
A 1.02	Effluent holdup tank, waste holdup tank, or waste monitor tank parameters	2.4	
A 1.03	Reactor coolant system inventory balance	3.2	
A 1.04	Containment radiation, pressure, temperature, and/or humidity monitors	3.1	
A 2	**Ability to (a) predict the impacts of the following system/component malfunctions or operations on the liquid radwaste system and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations:** (CFR: 41.5 / 43.5 / 45.3 / 45.5 / 45.13)		
		RO	**SRO**
A 2.01	Compressed air system	2.5	2.5
A 2.02	Chemical and volume control system	2.9	2.9
A 2.03	Engineered safeguards actuation system	3.4	3.3
A 2.04	Reactor coolant drain tank	2.9	2.7
A 2.05	Radiation monitoring system	3.1	3.2
A 2.06	Gaseous radwaste system	2.9	2.8
A 2.07	Transmission switchyard and offsite power system	2.5	2.3
A 2.08	Degasifier column level hi-3	2.4	2.3
A 2.09	Failure of automatic liquid radwaste system release isolation	3.4	3.4
A 2.10	Inadequate dilution flow	2.9	3.0

A 3	**Ability to monitor automatic operation of the liquid radwaste system, including the following:** (CFR: 41.7 / 45.5 / 45.13)	
A 3.01	Reactor coolant drain tank level control	2.6
A 3.02	Containment sump or auxiliary building sump level control	2.7
A 3.03	Liquid radwaste system release isolation	3.3
A 3.04	Align effluent holdup tank, waste holdup tank, or waste monitor tank for service	2.3
A 4	**Ability to manually operate and monitor in the control room:** (CFR: 41.7 / 45.5 to 45.8)	
A 4.01	Containment sump or auxiliary building sump level control	2.6
A 4.02	Reactor coolant drain tank level and/or temperature control	2.6
A 4.03	Align effluent holdup tank, waste holdup tank, waste monitor tank, or chemical waste tank for service	2.2
A 4.04	Process a effluent holdup tank, waste holdup tank, waste monitor tank, or chemical waste tank	2.3
A 4.05	Containment isolation	3.7
A 4.06	Align monitor tank for liquid radwaste system release	2.7
A 4.07	Recover from automatic liquid radwaste system release isolation	2.6

4 EMERGENCY AND ABNORMAL PLANT EVOLUTIONS

4.1 Emergency Plant Evolutions

4.1.1 E-0 Reactor Trip or Safeguards Actuation

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a reactor trip or safeguards actuation and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.3
EK 1.02	Steam generator blowdown system	2.4
EK 1.03	Compressed and instrument air systems	2.3
EK 1.04	Component cooling water system	2.5
EK 1.05	Condensate system	2.1
EK 1.06	Chemical and volume control system	2.8
EK 1.07	Diverse actuation system	3.6
EK 1.08	Digital rod control system	2.6
EK 1.09	Main AC power system	2.5
EK 1.10	Engineered safeguards actuation system	4.2
EK 1.11	Main and startup feedwater system	2.7
EK 1.12	Main steam system	2.7
EK 1.13	Main turbine system	2.1
EK 1.14	Passive containment cooling system	3.9
EK 1.15	Pressurizer level control system	2.9
EK 1.16	Pressurizer pressure control system	2.8
EK 1.17	Passive residual heat removal system	3.7
EK 1.18	Passive core cooling system	4.0
EK 1.19	Reactor coolant pump	2.8
EK 1.20	Reactor coolant system	3.2
EK 1.21	Radiation monitoring system	3.0
EK 1.22	Normal residual heat removal system	2.8
EK 1.23	Rod position indication system	2.6
EK 1.24	Reactor trip system	3.7
EK 1.25	Steam dump control system	2.6
EK 1.26	Steam generator system	2.5
EK 1.27	Service water system	2.1
EK 1.28	Main turbine control and diagnostics system	1.9
EK 1.29	Containment recirculation cooling system	2.7
EK 1.30	Central chilled water system	2.1
EK 1.31	Transmission switchyard and offsite power system	2.1
EK 1.32	Onsite standby power system	2.4
EK 1.33	Nuclear instrumentation system	4.1

EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a reactor trip or safeguards actuation:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Establishing startup feedwater flow to a steam generator that is depressurized	3.1
EK 2.02	Not maintaining reactor coolant system temperature stable	3.1
EK 2.03	Faulted steam generator	3.3
EK 2.04	Steam generator tube rupture	3.6
EK 2.05	Adverse containment conditions	3.6
EK 2.06	Unavailability of either the startup feedwater pumps or passive residual heat removal system	3.6
EK 2.07	Loss-of-coolant accident outside of containment	3.8
EK 2.08	Natural circulation indications	3.3
EK 2.09	Downcomer voiding effects on nuclear instrumentation system	3.2
EK2.10	Failure to diagnose a faulted steam generator	3.4
EK2.11	Failure to diagnose a steam generator tube rupture event (PRA related)	3.7
EK2.12	Failure to depressurize the reactor coolant system during a small loss-of-coolant accident (PRA related)	3.9
EK 3	**Knowledge of the reasons for the following actions as they apply to a reactor trip or safeguards actuation:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Tripping the reactor	4.0
EK 3.02	Tripping the turbine	3.6
EK 3.03	Safeguards actuation	4.2
EK 3.04	Main feedwater isolation actuations	3.4
EK 3.05	Core makeup tank actuation	3.9
EK 3.06	Stopping the reactor coolant pumps	3.6
EK 3.07	Passive residual heat removal system actuation	3.9
EK 3.08	Normal residual heat removal system isolation actuation	3.2
EK 3.09	Steamline isolation actuation	3.3
EK 3.10	Steam generator relief isolation actuation	3.2
EK 3.11	Passive containment cooling system actuation	3.9
EK 3.12	Tripping the pressurizer heaters due to core makeup tank actuation	3.1
EK 3.13	Boron dilution block actuation	3.1
EK 3.14	Containment isolation actuation	3.7
EK 3.15	Closing the automatic depressurization system valve discharge header drain isolation valve	3.2
EK 3.16	Verifying/restoring power to one or both nuclear island switchgear buses	2.7
EK 3.17	Starting and aligning the startup feedwater pumps to feed the steam generators	2.7
EK 3.18	Checking level and/or feedwater flow for both steam generators	2.8
EK 3.19	Checking passive residual heat removal system flow	3.2

EK 3.20	Reducing reactor coolant system T_{cold} equal to or less than the no-load value	2.9
EK 3.21	Stabilizing steam generator pressures at no load value	2.7
EK 3.22	Placing service water system in service	2.6
EK 3.23	Placing component cooling water system in service	2.7
EK 3.24	Aligning chemical and volume control system for reactor coolant system makeup	2.6
EK 3.25	Operating the reactor containment recirculation fans in low speed	2.7
EK 3.26	Checking for steam generator pressure lowering in an uncontrolled manner or completely depressurized	3.1
EK 3.27	Checking radiation monitors for abnormal steam generator blowdown, main steam, and/or turbine island vent radiation	3.2
EK 3.28	Checking for steam generator level rising in an uncontrolled manner	3.2
EK 3.29	Checking for abnormal or rising containment radiation, pressure, level, and/or sump level	3.3
EK 3.30	Checking for abnormal plant vent radiation	3.2
EK 3.31	Passive safety system termination	3.2
EK 3.32	Automatic depressurization system actuation	4.2
EK 3.33	Resetting containment isolation actuation	3.2
EK 3.34	Establishing instrument air to containment	2.8
EK 3.35	Placing central chilled water system in service and/or restoring chilled water to containment	2.5

EA 1 **Ability to operate and/or monitor the following as they apply to a reactor trip or safeguards actuation:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.3
EA 1.02	Steam generator blowdown system	2.6
EA 1.03	Compressed and instrument air systems	2.3
EA 1.04	Component cooling water system	2.6
EA 1.05	Condensate system	2.1
EA 1.06	Chemical and volume control system	2.7
EA 1.07	Diverse actuation system	3.8
EA 1.08	Digital rod control system	2.7
EA 1.09	Engineered safeguards actuation system	4.3
EA 1.10	Main and startup feedwater system	2.9
EA 1.11	Main steam system	2.7
EA 1.12	Passive containment cooling system	3.9
EA 1.13	Pressurizer level control system	2.8
EA 1.14	Pressurizer pressure control system	2.8
EA 1.15	Passive residual heat removal system	3.6
EA 1.16	Passive core cooling system	4.0
EA 1.17	Reactor coolant pump	3.1
EA 1.18	Reactor coolant system	3.2
EA 1.19	Normal residual heat removal system	2.8
EA 1.20	Reactor trip system	3.9
EA 1.21	Steam dump control system	2.7
EA 1.22	Steam generator system	2.7
EA 1.23	Service water system	2.4

EA 1.24	Main turbine control and diagnostics system	2.0	
EA 1.25	Containment recirculation cooling system	2.7	
EA 1.26	Central chilled water system	2.2	
EA 1.27	Nuclear instrumentation system	4.1	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a reactor trip or safeguards actuation:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Rod position indications	3.0	2.9
EA 2.02	Reactor trip breaker status	3.4	3.4
EA 2.03	Reactor power	3.6	3.4
EA 2.04	Reactor coolant system pressure, temperature, and/or pressurizer level	3.2	3.6
EA 2.05	Steam generator level, feedwater flow, steam flow, and/or pressure	2.8	3.0
EA 2.06	Core exit temperatures and/or subcooling	3.8	3.8
EA 2.07	Passive residual heat removal system flow	3.4	3.4
EA 2.08	Containment pressure, level, and/or radiation level	3.6	3.7
EA 2.09	Core makeup tank level	3.2	3.7
EA 2.10	Secondary radiation	3.4	2.7
EA 2.11	In-containment refueling water storage tank level	3.2	3.6

4.1.2 ES-0.1 Reactor Trip Response

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a reactor trip response and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Condensate system	2.1
EK 1.02	Chemical and volume control system	2.5
EK 1.03	Main AC power system	2.4
EK 1.04	Engineered safeguards actuation system	3.6
EK 1.05	Digital rod control system	3.2
EK 1.06	Main and startup feedwater system	2.9
EK 1.07	Class 1E DC and UPS system	2.9
EK 1.08	Main steam system	2.8
EK 1.09	Main turbine system	2.6
EK 1.10	Nuclear instrumentation system	3.4
EK 1.11	Pressurizer level control system	3.1
EK 1.12	Pressurizer pressure control system	3.1
EK 1.13	Passive residual heat removal system	3.2
EK 1.14	Passive core cooling system	3.1
EK 1.15	Reactor coolant pump	2.9
EK 1.16	Reactor coolant system	2.9
EK 1.17	Rod position indication system	3.3
EK 1.18	Reactor trip system	3.8
EK 1.19	Steam dump control system	3.1
EK 1.20	Steam generator system	3.1
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a reactor trip response:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Safeguards actuation	3.8
EK 2.02	Loss of reactor coolant system subcooling or inability to maintain pressurizer level	3.7
EK 2.03	Loss of compressed and instrument air systems	2.6
EK 2.04	Loss of main AC power system	2.5
EK 2.05	Loss of Class 1E DC and UPS system	3.3
EK 2.06	Feedwater flow changes on reactor coolant system pressure, temperature, and/or level	3.1
EK 2.07	Feedwater flow changes on steam generator level and/or pressure	3.0
EK 2.08	Depressurizing a steam generator if secondary makeup is not available (PRA related)	3.2
EK 2.09	Core makeup tank actuation	3.4
EK 2.10	Inability to stabilize reactor coolant system at no-load T_{cold} temperature	3.3
EK 2.11	Configuration and speed of running reactor coolant pumps effect on passive residual heat removal system	3.1
EK 2.12	Configuration and speed of running reactor coolant pumps effect on pressurizer spray flow	3.2

EK 2.13	Failure to recognize the need and failure to manually trip the reactor through protection and safety monitoring system given anticipated transient without scram (PRA related) (OE related)	4.3

EK3 **Knowledge of the reasons for the following actions as they apply to a reactor trip response:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	Tripping the reactor (OE related)	4.2
EK 3.02	Tripping the turbine (OE related)	3.8
EK 3.03	Checking safeguards not actuated	3.8
EK 3.04	Stabilizing reactor coolant system T_{cold}, pressurizer pressure, and/or pressurizer level at the no-load values	3.4
EK 3.05	Stabilizing steam generator pressures and/or levels at the no-load values	3.3
EK 3.06	Checking all switchgear buses energized from offsite power	2.6
EK 3.07	Checking main feedwater is in the low-power operation mode	2.8
EK 3.08	Aligning chemical and volume control system makeup pump suction to the boric acid tank and operate to maintain pressurizer level	2.8
EK 3.09	Borating the reactor coolant system if two or more control rods are not fully inserted	3.4
EK 3.10	Aligning reactor coolant system head vent or chemical and volume control system purification and letdown to maintain pressurizer level	2.8
EK 3.11	Core makeup tank actuation	3.3
EK 3.12	Maintaining saturated conditions in the pressurizer	3.2
EK 3.13	Transferring the steam dump control system to the pressure control mode	2.9
EK 3.14	Returning passive residual heat removal system to standby or actuating passive residual heat removal system	3.2
EK 3.15	Operating the reactor coolant pumps (OE related)	2.9
EK 3.16	Energizing the source range nuclear instrumentation	3.2
EK 3.17	Aligning normal residual heat removal system for cooling the in-containment refueling water storage tank and/or the core makeup tank	2.8
EK 3.18	Performing a natural circulation cooldown (OE related)	3.2

EA 1 **Ability to operate and/or monitor the following as they apply to a reactor trip response:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Condensate system	2.2
EA 1.02	Core makeup tank	3.3
EA 1.03	Chemical and volume control system	2.9
EA 1.04	Digital rod control system	3.1
EA 1.05	Engineered safeguards actuation system	3.9
EA 1.06	Main and startup feedwater system	3.1
EA 1.07	Main steam system	3.0
EA 1.08	Main turbine system	2.9

EA 1.09	Nuclear instrumentation system	3.3	
EA 1.10	Pressurizer level control system	3.1	
EA 1.11	Pressurizer pressure control system	3.1	
EA 1.12	Passive residual heat removal system	3.4	
EA 1.13	Reactor coolant pump	2.9	
EA 1.14	Reactor coolant system	2.9	
EA 1.15	Rod position indication system	3.2	
EA 1.16	Reactor trip system (OE related)	3.9	
EA 1.17	Steam dump control system	3.2	
EA 1.18	Steam generator system	3.1	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a reactor trip response:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Neutron flux	3.4	3.7
EA 2.02	Control rod position	3.4	3.8
EA 2.03	Reactor trip breaker position (OE related)	3.4	4.1
EA 2.04	Main turbine stop valve position	3.0	3.7
EA 2.05	Engineered safeguards actuation system actuations status	3.4	4.0
EA 2.06	Reactor coolant system pressure, temperature, and/or pressurizer level	3.4	3.6
EA 2.07	Steam generator feedflow, level, and/or pressure	3.2	3.3
EA 2.08	Boron required to compensate for rods not fully inserted	3.6	3.3

4.1.3 ES-0.2 Natural Circulation Cooldown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between natural circulation cooldown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	3.8
EK 1.02	Control rod drive mechanism cooling fans	3.0
EK 1.03	Chemical and volume control system	2.8
EK 1.04	Engineered safeguards actuation system	3.7
EK 1.05	Main and startup feedwater system	3.1
EK 1.06	Main steam system	2.8
EK 1.07	Pressurizer pressure control system	3.2
EK 1.08	Pressurizer level control system	3.2
EK 1.09	Passive residual heat removal system	3.5
EK 1.10	Passive core cooling system	3.4
EK 1.11	Reactor coolant pump	2.6
EK 1.12	Reactor coolant system	3.1
EK 1.13	Normal residual heat removal system	2.8
EK 1.14	Steam dump control system	3.1
EK 1.15	Steam generator system	3.2
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to natural circulation cooldown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Excessive cycling of first-stage automatic depressurization system valves	3.6
EK 2.02	Allowing reactor coolant system pressure to rise above 1,970 psig after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 2.03	Depressurizing the steamlines at a high rate after steamline/feedwater isolation actuations are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.3
EK 2.04	Failure to maintain reactor coolant system temperature and pressure within the acceptable operating region of the applicable cooldown curve	3.3
EK 2.05	Having less than one control rod drive mechanism fan running in each plenum	3.1
EK 2.06	Reducing reactor coolant system pressure below the minimum before the soak time has elapsed per the applicable cooldown curve	3.2
EK 2.07	Depressurizing the reactor coolant system before entire reactor coolant system is cooled	3.3
EK 2.08	Steam flow and/or feedwater flow effects on reactor coolant system natural circulation	3.2
EK 2.09	Starting a reactor coolant pump with a steam bubble in the reactor head	3.1

EK 2.10	Configuration and speed of running reactor coolant pumps effect on passive residual heat removal system	3.0
EK 2.11	Configuration and speed of running reactor coolant pumps effect on pressurizer spray flow	3.0
EK 2.12	Inability to isolate the safety injection accumulators	3.3
EK 2.13	Borating the reactor coolant system with no forced reactor coolant system flow	3.2
EK 2.14	Cooling down the reactor coolant system with passive residual heat removal system	3.5

EK 3 Knowledge of the reasons for the following actions as they apply to natural circulation cooldown:

EK 3.01	Restarting reactor coolant pumps	3.2
EK 3.02	Running control rod drive mechanism cooling fans	3.1
EK 3.03	Borating the reactor coolant system to ensure shutdown margin	3.2
EK 3.04	Aligning chemical and volume control system for blended makeup and operate to maintain pressurizer level	2.8
EK 3.05	Aligning reactor coolant system head vent or chemical and volume control system purification and letdown to maintain pressurizer level	2.8
EK 3.06	Isolating or actuating core makeup tank	3.4
EK 3.07	Maintaining saturated conditions in the pressurizer	3.2
EK 3.08	Returning passive residual heat removal system to standby or actuating passive residual heat removal system	3.4
EK 3.09	Aligning startup feedwater to maintain steam generator levels or flow	2.9
EK 3.10	Aligning normal residual heat removal system for cooling the in-containment refueling water storage tank and/or the core makeup tank	2.9
EK 3.11	Ensuring the reactor coolant system T_{hot} is less than 550 degrees Fahrenheit (F) before depressurizing the reactor coolant system below P-11, Pressurizer Pressure below 1,970 psig	3.3
EK 3.12	Lowering reactor coolant system pressure below P-11, Pressurizer Pressure below 1,970 psig	3.1
EK 3.13	Terminating the reactor coolant system depressurization below P-11, Pressurizer Pressure below 1,970 psig	3.2
EK 3.14	Blocking steamline/feedwater isolation actuations and/or safeguards actuation below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 3.15	Cool down the reactor coolant system at a rate not to exceed the limit and operate inside the acceptable operating region of the applicable cooldown curve	3.3
EK 3.16	After cooling down, waiting for time to elapse before reducing reactor coolant system pressure per the applicable cooldown curve	3.2
EK 3.17	Reducing reactor coolant system pressure to minimum allowable	3.1
EK 3.18	Terminating the reactor coolant system depressurization to minimum allowable	3.1
EK 3.19	Repressurizing the reactor coolant system if voiding is indicated	3.4
EK 3.20	Isolating the safety injection accumulators	3.2

EK 3.21	Placing normal residual heat removal system in service in the shutdown cooling mode	2.9	
EK 3.22	Cooling down the inactive portions of the reactor coolant system	2.9	
EK 3.23	Depressurizing the reactor coolant system to atmospheric pressure	2.8	

EA 1 **Ability to operate and/or monitor the following as they apply to natural circulation cooldown:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.0
EA 1.02	Control rod drive mechanism cooling fans	3.2
EA 1.03	Chemical and volume control system	2.9
EA 1.04	Engineered safeguards actuation system	3.8
EA 1.05	Main and startup feedwater system	3.1
EA 1.06	Main steam system	2.8
EA 1.07	Pressurizer pressure control system	3.1
EA 1.08	Pressurizer level control system	3.2
EA 1.09	Passive residual heat removal system	3.5
EA 1.10	Passive core cooling system	3.4
EA 1.11	Reactor coolant pump	2.8
EA 1.12	Reactor coolant system	3.1
EA 1.13	Normal residual heat removal system	2.9
EA 1.14	Steam dump control system	3.2
EA 1.15	Steam generator system	3.1

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to natural circulation cooldown:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Core exit temperatures and/or subcooling	3.4	3.8
EA 2.02	Reactor coolant system temperature, pressure, and/or pressurizer level	3.4	3.8
EA 2.03	Steam generator level, feedwater flow, and/or pressure	2.8	3.3

4.1.4 E-1 Loss of Reactor or Secondary Coolant

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a loss of reactor or secondary coolant and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.3
EK 1.02	Steam generator blowdown system	2.4
EK 1.03	Compressed and instrument air systems	2.3
EK 1.04	Chemical and volume control system	2.8
EK 1.05	Diverse actuation system	3.6
EK 1.06	Main AC power system	2.5
EK 1.07	Engineered safeguards actuation system	4.2
EK 1.08	Main and startup feedwater system	2.7
EK 1.09	Main steam system	2.7
EK 1.10	Passive containment cooling system	3.9
EK 1.11	Passive residual heat removal system	3.7
EK 1.12	Primary sampling system	2.1
EK 1.13	Passive core cooling system	4.0
EK 1.14	Reactor coolant system	3.2
EK 1.15	Radiation monitoring system	3.0
EK 1.16	Normal residual heat removal system	2.8
EK 1.17	Steam dump control system	2.6
EK 1.18	Steam generator system	2.5
EK 1.19	Containment recirculation cooling system	2.7
EK 1.20	Central chilled water system	2.1
EK 1.21	Transmission switchyard and offsite power system	2.1
EK 1.22	Onsite standby power system	2.4
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of reactor or secondary coolant:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Faulted steam generator	3.1
EK 2.02	Steam generator tube rupture	3.1
EK 2.03	Adverse containment conditions	3.3
EK 2.04	Depressurizing a steam generator to cool the reactor coolant system if no makeup water is available to the secondary side of the steam generator (PRA related)	3.6
EK 2.05	Unavailability of either the startup feedwater pumps or passive residual heat removal system	3.6
EK 2.06	Loss-of-coolant accident outside of containment	3.5
EK 2.07	Reducing steam generator pressure below reactor coolant system pressure if fuel damage is suspected (high core exit thermocouple or primary coolant sample)	3.6
EK 2.08	Changes in core cooling mechanisms between normal operations and loss-of-coolant accident	3.8

EK 2.09	Changes in core cooling mechanisms between normal operations and faulted steam generator	3.6
EK 2.10	Natural circulation indications	3.4
EK 2.11	Downcomer voiding effects on nuclear instrumentation system	3.2
EK 2.12	Reactor coolant system pressure remains above normal residual heat removal system shutoff head and automatic depressurization system is not actuated	3.5
EK 2.13	Failure to diagnose a steam generator tube rupture event (PRA related)	3.7
EK 2.14	Failure to depressurize the reactor coolant system during a small loss-of-coolant accident (PRA related)	3.9
EK 2.15	Failure to open the in-containment refueling water storage tank containment recirculation valves during a loss-of-coolant accident (PRA related)	3.8

EK 3 **Knowledge of the reasons for the following actions as they apply to a loss of reactor or secondary coolant:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	Passive containment cooling system actuation	3.9
EK 3.02	Verifying/restoring power to one or both nuclear island switchgear buses	2.7
EK 3.03	Checking level and/or feedwater flow for both steam generators	2.8
EK 3.04	Checking passive residual heat removal system flow	3.2
EK 3.05	Aligning chemical and volume control system for reactor coolant system makeup	2.6
EK 3.06	Operating the reactor containment recirculation fans in low speed	2.7
EK 3.07	Checking for steam generator pressure lowering in an uncontrolled manner or completely depressurized	3.1
EK 3.08	Checking radiation monitors for abnormal steam generator blowdown, main steam, and/or turbine island vent radiation	3.2
EK 3.09	Checking for steam generator level rising in an uncontrolled manner	3.2
EK 3.10	Passive safety system termination	3.2
EK 3.11	Automatic depressurization system actuation	4.2
EK 3.12	Resetting containment isolation actuation	3.2
EK 3.13	Establishing instrument air to containment	2.8
EK 3.14	Placing central chilled water system in service and/or restoring chilled water to containment	2.5
EK 3.15	Checking level and/or feedwater flow for only the intact steam generators	2.7
EK 3.16	Performing periodic activity samples for both steam generators and/or performing local surveys of the steamlines	2.5
EK 3.17	Checking for both steam generators pressures stable or rising and reactor coolant system pressure stable or lowering	2.8
EK 3.18	Periodic sampling of the reactor coolant system for boron, hydrogen, and activity	2.3
EK 3.19	Placing in-containment refueling water storage tank cooling in service	3.0
EK 3.20	In-containment refueling water storage tank injection actuation	3.8

EK 3.21	In-containment refueling water storage tank containment recirculation actuation	3.8
EK 3.22	Depressurizing the intact steam generators	3.1
EK 3.23	Venting the reactor vessel head	3.0
EK 3.24	Checking containment water level	2.9

EA 1 Ability to operate and/or monitor the following as they apply to a loss of reactor or secondary coolant:
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.3
EA 1.02	Steam generator blowdown system	2.6
EA 1.03	Compressed and instrument air systems	2.3
EA 1.04	Chemical and volume control system	2.7
EA 1.05	Diverse actuation system	3.8
EA 1.06	Engineered safeguards actuation system	4.3
EA 1.07	Main and startup feedwater system	2.9
EA 1.08	Main steam system	2.7
EA 1.09	Passive containment cooling system	3.9
EA 1.10	Passive residual heat removal system	3.6
EA 1.11	Passive core cooling system	4.0
EA 1.12	Reactor coolant system	3.2
EA 1.13	Normal residual heat removal system	2.8
EA 1.14	Steam dump control system	2.7
EA 1.15	Steam generator system	2.7
EA 1.16	Containment recirculation cooling system	2.7
EA 1.17	Central chilled water system	2.2

EA 2 Ability to evaluate the following parameters and/or conditions as they apply to a loss of reactor or secondary coolant:
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Reactor coolant system pressure, temperature, and/or pressurizer level	3.2	3.6
EA 2.02	Steam generator level, feedwater flow, steam flow, and/or pressure	2.8	3.0
EA 2.03	Core exit temperature and/or subcooling	3.8	3.8
EA 2.04	Passive residual heat removal system flow	3.4	3.4
EA 2.05	Containment pressure, level, and/or radiation level	3.6	3.7
EA 2.06	Core makeup tank level	3.2	3.7
EA 2.07	Secondary radiation	3.4	2.7
EA 2.08	In-containment refueling water storage tank level	3.2	3.6

4.1.5 ES-1.1 Passive Safety System Termination

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between passive safety system termination and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.0
EK 1.02	Steam generator blowdown system	2.3
EK 1.03	Compressed and instrument air systems	2.3
EK 1.04	Component cooling water system	2.5
EK 1.05	Chemical and volume control system	2.5
EK 1.06	Engineered safeguards actuation system	3.9
EK 1.07	Main and startup feedwater system	2.8
EK 1.08	Main steam system	2.6
EK 1.09	Nuclear instrumentation system	2.8
EK 1.10	Passive containment cooling system	3.6
EK 1.11	Pressurizer level control system	2.9
EK 1.12	Pressurizer pressure control system	2.8
EK 1.13	Passive residual heat removal system	3.7
EK 1.14	Passive core cooling system	3.9
EK 1.15	Reactor coolant system	3.1
EK 1.16	Reactor coolant pump	2.6
EK 1.17	Normal residual heat removal system	2.7
EK 1.18	Rod position indication system	2.2
EK 1.19	Steam dump control system	2.5
EK 1.20	Spent fuel pool cooling system	1.9
EK 1.21	Steam generator system	2.6
EK 1.22	Service water system	2.1
EK 1.23	Nuclear island nonradioactive ventilation system	1.9
EK 1.24	Containment recirculation cooling system	2.3
EK 1.25	Main control room emergency habitability system	2.7
EK 1.26	Central chilled water system	1.9
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to passive safety system termination:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Excessive cycling of first-stage automatic depressurization system valves	3.6
EK 2.02	Depressurizing the reactor coolant system with no reactor coolant pumps running	3.3
EK 2.03	Allowing reactor coolant system pressure to rise above 1,970 psig after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 2.04	Depressurizing the steamlines at a high rate after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.3

EK 2.05	Establishing feedwater flow to a steam generator that is depressurized	3.2
EK 2.06	Starting a reactor coolant pump with a steam bubble in the reactor head	3.1
EK 2.07	Configuration and speed of running reactor coolant pumps effect on passive residual heat removal system	3.4
EK 2.08	Configuration and speed of running reactor coolant pumps effect on pressurizer spray flow	3.1

EK 3 **Knowledge of the reasons for the following actions as they apply to passive safety system termination:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	Resetting safeguards actuation	3.7
EK 3.02	Resetting containment isolation actuation	3.7
EK 3.03	Energize all switchgear buses from offsite power	2.8
EK 3.04	Establishing instrument air to containment	2.9
EK 3.05	Terminating core makeup tank injection	3.8
EK 3.06	Aligning chemical and volume control system for reactor coolant system makeup	2.8
EK 3.07	Reinitiating core makeup tank injection	3.8
EK 3.08	Maintaining saturated conditions in the pressurizer	3.3
EK 3.09	Reinitiating safeguards	3.9
EK 3.10	Reactor coolant system depressurization to P-11, Pressurizer Pressure below 1,970 psig and termination criteria	3.4
EK 3.11	Blocking steamline/feedwater isolation actuations and/or safeguards actuation below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 3.12	Starting and aligning the startup feedwater pumps to feed the steam generators	3.1
EK 3.13	Controlling level and/or feedwater flow only to intact steam generators	3.1
EK 3.14	Stabilizing steam generator pressures at no load value	2.9
EK 3.15	Transferring the steam dump control system to the pressure control mode	2.6
EK 3.16	Terminating passive residual heat removal system flow	3.4
EK 3.17	Energizing the source range nuclear instrumentation	3.2
EK 3.18	Borating the reactor coolant system if two or more control rods are not fully inserted	3.4
EK 3.19	Restoring component cooling water system flow to containment	2.9
EK 3.20	Maintaining pressurizer level less than the high-level setpoint	2.9
EK 3.21	Operating the reactor containment recirculation fans in low speed or high speed	2.8
EK 3.22	Placing central chilled water in service and/or restoring chilled water to containment	2.4
EK 3.23	Terminating passive containment cooling system flow	3.5
EK 3.24	Restoring main control room HVAC to normal alignment	2.8
EK 3.25	Starting reactor coolant pumps	2.7
EK 3.26	Aligning chemical and volume control system makeup pumps to maintain pressurizer level	2.8

EK 3.27	Maintaining stable plant conditions	3.0
EK 3.28	Reinitiating core makeup tank injection	3.9
EK 3.29	Reinitiating safeguards	4.0
EK 3.30	Aligning normal residual heat removal system for cooling the in-containment refueling water storage tank and/or the core makeup tank	3.0
EK 3.31	Realigning equipment to presafeguards configuration	3.1

EA 1 **Ability to operate and/or monitor the following as they apply to passive safety system termination:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.1
EA 1.02	Steam generator blowdown system	2.4
EA 1.03	Compressed and instrument air systems	2.3
EA 1.04	Component cooling water system	2.6
EA 1.05	Chemical and volume control system	2.6
EA 1.06	Engineered safeguards actuation system	4.0
EA 1.07	Main and startup feedwater system	2.8
EA 1.08	Main steam system	2.4
EA 1.09	Passive containment cooling system	3.7
EA 1.10	Pressurizer level control system	3.1
EA 1.11	Pressurizer pressure control system	3.1
EA 1.12	Passive residual heat removal system	3.6
EA 1.13	Passive core cooling system	3.8
EA 1.14	Reactor coolant system	3.2
EA 1.15	Reactor coolant pump	2.9
EA 1.16	Normal residual heat removal system	3.1
EA 1.17	Rod position indication system	2.4
EA 1.18	Steam dump control system	2.9
EA 1.19	Spent fuel pool cooling system	2.0
EA 1.20	Steam generator system	2.6
EA 1.21	Service water system	2.1
EA 1.22	Nuclear island nonradioactive ventilation system	2.1
EA 1.23	Containment recirculation cooling system	2.4
EA 1.24	Main control room emergency habitability system	2.9
EA 1.25	Central chilled water system	2.3

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to passive safety system termination:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Reactor coolant system pressure, temperature, and pressurizer level	3.2	3.7
EA 2.02	Steam generator level, feedwater flow, and pressure	3.2	3.3
EA 2.03	Core exit temperatures and/or subcooling	3.8	3.7
EA 2.04	Containment pressure and/or temperature	3.2	3.7

4.1.6 ES-1.2 Post-Loss-of-Coolant Accident Cooldown and Depressurization

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between post-loss-of-coolant accident cooldown and depressurization and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.1
EK 1.02	Component cooling water system	2.6
EK 1.03	Chemical and volume control system	2.8
EK 1.04	Engineered safeguards actuation system	3.9
EK 1.05	Main and startup feedwater system	2.8
EK 1.06	Main steam system	2.6
EK 1.07	Passive containment cooling system	3.3
EK 1.08	Pressurizer level control system	3.1
EK 1.09	Pressurizer pressure control system	3.1
EK 1.10	Primary sampling system	2.1
EK 1.11	Passive core cooling system	3.9
EK 1.12	Reactor coolant pump	2.8
EK 1.13	Reactor coolant system	3.1
EK 1.14	Radiation monitoring system	2.6
EK 1.15	Normal residual heat removal system	3.0
EK 1.16	Passive residual heat removal system	3.6
EK 1.17	Steam dump control system	2.8
EK 1.18	Spent fuel pool cooling system	2.3
EK 1.19	Steam generator system	2.8
EK 1.20	Service water system	2.3
EK 1.21	Containment air filtration system	2.3
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to post-loss-of-coolant accident cooldown and depressurization:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Allowing reactor coolant system pressure to rise above 1,970 psig after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 2.02	Depressurizing the steamlines at a high rate after steamline/feedwater isolation actuations are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.3
EK 2.03	Establishing feedwater flow to a steam generator that is depressurized	3.1
EK 2.04	Excessive cycling of first-stage automatic depressurization system valves	3.6
EK 2.05	Depressurizing the reactor coolant system with no reactor coolant pumps running	3.1
EK 2.06	Starting a reactor coolant pump with a steam bubble in the reactor head	3.1

EK 2.07	Configuration and speed of running reactor coolant pumps effect on passive residual heat removal system	3.3
EK 2.08	Configuration and speed of running reactor coolant pumps effect on pressurizer spray flow	3.1
EK 2.09	Inability to isolate the safety injection accumulators	3.3
EK 2.10	Depressurizing a steam generator to cool the reactor coolant system if no makeup water is available to the secondary side of the steam generator (PRA related)	3.3

EK 3 **Knowledge of the reasons for the following actions as they apply to post-loss-of-coolant accident cooldown and depressurization:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	Aligning chemical and volume control system for reactor coolant system makeup	2.8
EK 3.02	Blocking steamline/feedwater isolation actuations and/or safeguards actuation below P-11, Pressurizer Pressure below 1,970 psig	3.2
EK 3.03	Starting and aligning the startup feedwater pumps to feed the steam generators	3.0
EK 3.04	Controlling level and/or feedwater flow for only the intact steam generators	2.9
EK 3.05	Initiating a cooldown to cold shutdown	3.1
EK 3.06	Lowering reactor coolant system pressure to a minimum subcooling value	3.3
EK 3.07	Terminating the reactor coolant system depressurization to a minimum subcooling value	3.4
EK 3.08	Terminating core makeup tank injection	3.5
EK 3.09	Reinitiating core makeup tank injection	3.8
EK 3.10	Maintaining saturated conditions in the pressurizer	3.0
EK 3.11	Terminating passive residual heat removal system flow	3.5
EK 3.12	Checking for abnormal plant vent radiation	2.9
EK 3.13	Sampling the reactor coolant system for boron, hydrogen, and/or activity	2.4
EK 3.14	Placing in-containment refueling water storage tank cooling in service	3.1
EK 3.15	Restoring component cooling water system flow to containment	2.8
EK 3.16	Maintaining pressurizer level less than the high-level setpoint	3.0
EK 3.17	Starting reactor coolant pumps	2.8
EK 3.18	Isolating the safety injection accumulators	3.1
EK 3.19	Terminating passive containment cooling system flow	3.4
EK 3.20	Stopping the reactor coolant pumps	2.9

EA 1 **Ability to operate and/or monitor the following as they apply to post-loss-of-coolant accident cooldown and depressurization:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.0
EA 1.02	Component cooling water system	2.7
EA 1.03	Chemical and volume control system	2.6
EA 1.04	Engineered safeguards actuation system	3.9

EA 1.05	Main and startup feedwater system	2.9	
EA 1.06	Main steam system	2.6	
EA 1.07	Passive containment cooling system	3.6	
EA 1.08	Pressurizer level control system	3.2	
EA 1.09	Pressurizer pressure control system	3.1	
EA 1.10	Primary sampling system	2.1	
EA 1.11	Passive core cooling system	3.8	
EA 1.12	Reactor coolant pump	2.8	
EA 1.13	Reactor coolant system	2.9	
EA 1.14	Radiation monitoring system	2.6	
EA 1.15	Normal residual heat removal system	3.1	
EA 1.16	Passive residual heat removal system	3.7	
EA 1.17	Steam dump control system	2.9	
EA 1.18	Spent fuel pool cooling system	2.1	
EA 1.19	Steam generator system	2.7	
EA 1.20	Service water system	2.3	
EA 1.21	Containment air filtration system	2.3	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to post-loss-of-coolant accident cooldown and depressurization:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Plant vent radiation	2.6	2.9
EA 2.02	Reactor coolant system pressure, temperature, level, and/or pressurizer level	3.2	3.7
EA 2.03	Reactor coolant system cooldown rate	3.2	3.6
EA 2.04	Steam generator level, feedwater flow, and/or pressure	2.6	3.0
EA 2.05	Core exit temperature	3.6	3.4
EA 2.06	Core makeup tank level	3.0	3.6
EA 2.07	Containment pressure	3.2	3.7

4.1.7 ES-1.3 ADS Stage 1–3 Actuation Response

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between automatic depressurization system (ADS) Stage 1–3 actuation and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Component cooling water system	2.0
EK 1.02	Chemical and volume control system	2.2
EK 1.03	Diverse actuation system	3.2
EK 1.04	Engineered safeguards actuation system	3.8
EK 1.05	Passive containment cooling system	3.1
EK 1.06	Passive core cooling system	3.6
EK 1.07	Reactor coolant system	3.0
EK 1.08	Radiation monitoring system	2.6
EK 1.09	Normal residual heat removal system	2.6
EK 1.10	Service water system	2.0
EK 1.11	Class 1E 250 V DC battery charger	3.2
EK 1.12	Fuel pool cask loading pit	2.2
EK 1.13	ADS Stage 4	3.8
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to ADS Stage 1–3 actuation:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Maintaining core makeup tank inventory	3.2
EK 2.02	Normal residual heat removal system pump suction sources	2.7
EK 2.03	Proper ADS Stage 1–3 response	3.8
EK 2.04	In-containment refueling water storage tank parameter response	3.0
EK 3	**Knowledge of the reasons for the following actions as they apply to ADS Stage 1–3 actuation:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Proper operation of ADS Stage 1–3	3.8
EK 3.02	Check ADS Stage 4 required	3.8
EK 3.03	Determine normal residual heat removal system suction source(s)	2.7
EK 3.04	Establish normal residual heat removal system injection	2.9
EK 3.05	Align normal residual heat removal system support systems	2.6
EK 3.06	Establish maximum chemical and volume control system makeup	2.7
EA 1	**Ability to operate and/or monitor the following as they apply to ADS Stage 1–3 Actuation:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Component cooling water system	2.2
EA 1.02	Chemical and volume control system	2.5
EA 1.03	Diverse actuation system	3.4
EA 1.04	Engineered safeguards actuation system	3.8

EA 1.05	Passive containment cooling system	3.1
EA 1.06	Passive core cooling system	3.6
EA 1.07	Reactor coolant system	3.1
EA 1.08	Radiation monitoring system	2.4
EA 1.09	Norman residual heat removal system	2.6
EA 1.10	Service water system	2.1
EA 1.11	Class 1E 250 V DC battery charger	2.8
EA 1.12	Fuel pool cask loading pit	2.3
EA 1.13	ADS Stage 4 system	3.6

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to ADS Stage 1–3 Actuation:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	ADS Stage 1–3 proper alignment	3.7	4.0
EA 2.02	Core makeup tank level	3.4	3.6
EA 2.03	Reactor coolant system hot-leg level	3.0	3.1
EA 2.04	Fuel pool cask loading pit level	2.4	2.6
EA 2.05	Containment radiation level	2.6	2.8

4.1.8 ES-1.4 ADS Stage 4 Actuation Response

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between ADS Stage 4 actuation and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Component cooling water system	2.2
EK 1.02	Chemical and volume control system	2.3
EK 1.03	Diverse actuation system	3.4
EK 1.04	Engineered safeguards actuation system	3.6
EK 1.05	Passive containment cooling system	3.4
EK 1.06	Passive core cooling system	3.6
EK 1.07	Reactor coolant system	3.2
EK 1.08	Radiation monitoring system	2.4
EK 1.09	Normal residual heat removal system	2.7
EK 1.10	Service water system	2.2
EK 1.11	Fuel pool cask loading pit	2.5
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to ADS Stage 4 actuation:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Normal residual heat removal system pump suction sources	2.8
EK 2.02	Proper ADS Stage 4 response	3.9
EK 2.03	In-containment refueling water storage tank parameter response	3.4
EK 2.04	In-containment refueling water storage tank alignment	3.5
EK 2.05	Running normal residual heat removal system pumps on time to reach cask loading pit low level	3.3
EK 3	**Knowledge of the reasons for the following actions as they apply to ADS Stage 4 actuation:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Proper operation of ADS Stage 4	3.7
EK 3.02	Determine normal residual heat removal system suction source(s)	2.8
EK 3.03	Establish normal residual heat removal system injection	3.1
EK 3.04	Align normal residual heat removal system support systems	2.6
EK 3.05	Establish maximum chemical and volume control system makeup	2.6
EK 3.06	In-containment refueling water storage tank injection	3.8
EA 1	**Ability to operate and/or monitor the following as they apply to ADS Stage 4 actuation:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Component cooling water system	2.3
EA 1.02	Chemical and volume control system	2.5
EA 1.03	Diverse actuation system	3.3
EA 1.04	Engineered safeguards actuation system	3.7

EA 1.05	Passive containment cooling system	3.4
EA 1.06	Passive core cooling system	3.5
EA 1.07	Reactor coolant system	3.1
EA 1.08	Radiation monitoring system	2.5
EA 1.09	Norman residual heat removal system	2.6
EA 1.10	Service water system	2.2
EA 1.11	Fuel pool cask loading pit	2.4

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to ADS Stage 4 actuation:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	ADS Stage 4 proper alignment	3.6	3.8
EA 2.02	Fuel pool cask loading pit level	2.4	2.6
EA 2.03	Containment radiation level	2.5	2.7
EA 2.04	In-containment refueling water storage tank proper alignment	3.4	2.9
EA 2.05	Normal residual heat removal system alignment	2.9	3.1

4.1.9 ECA-1.1 Loss-of-Coolant Accident Outside Containment

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a loss-of-coolant accident outside containment and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Chemical and volume control system	3.2
EK 1.02	Diverse actuation system	3.7
EK 1.03	Engineered safeguards actuation system	4.2
EK 1.04	Reactor coolant system	3.4
EK 1.05	Normal residual heat removal system	3.5
EK 1.06	Liquid radwaste system	2.4
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss-of-coolant accident outside containment:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	N/A	
EK 3	**Knowledge of the reasons for the following actions as they apply to a loss-of-coolant accident outside containment:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Isolating normal residual heat removal system from the reactor coolant system	3.5
EK 3.02	Isolating the containment sumps	3.4
EK 3.03	Chemical and volume control system isolation actuation	3.3
EK 3.04	Starting a chemical and volume control system makeup pump and checking flow	3.0
EK 3.05	Aligning chemical and volume control system makeup pumps to maintain pressurizer level	3.2
EA 1	**Ability to operate and/or monitor the following as they apply to a loss-of-coolant accident outside containment:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Chemical and volume control system	3.2
EA 1.02	Diverse actuation system	3.6
EA 1.03	Engineered safeguards actuation system	4.1
EA 1.04	Reactor coolant system	3.2
EA 1.05	Normal residual heat removal system	3.4
EA 1.06	Liquid radwaste system	2.4

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a loss-of-coolant accident outside containment:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Chemical and volume control system flow	3.0	3.3
EA 2.02	Plant vent radiation	3.2	3.1
EA 2.03	Pressurizer level and/or pressure	3.2	3.3

4.1.10 E-2 Faulted Steam Generator Isolation

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between faulted steam generator isolation and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Steam generator blowdown system	2.9
EK 1.02	Engineered safeguards actuation system	4.2
EK 1.03	Main and startup feedwater system	3.5
EK 1.04	Main steam system	3.4
EK 1.05	Main turbine system	2.6
EK 1.06	Passive residual heat removal system	3.4
EK 1.07	Radiation monitoring system	3.2
EK 1.08	Steam generator system	3.6
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a faulted steam generator:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Steam generator pressure lowering in an uncontrolled manner or completely depressurized	3.9
EK 2.02	Faulted steam generator that also has a steam generator tube rupture (PRA related)	4.2
EK 2.03	Failure to close the main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event (PRA related)	4.0
EK 2.04	Unisolating a faulted steam generator	3.6
EK 2.05	Abnormal steam generator blowdown, main steam, and/or turbine island vent radiation	3.4
EK 3	**Knowledge of the reasons for the following actions as they apply to a faulted steam generator:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Closing the main steam isolation valves and bypass steam isolation valves	3.6
EK 3.02	Closing the main turbine stop valves and control valves, the turbine bypass control valves, and the main steam to moisture separator reheater second-stage motor-operated valves	3.2
EK 3.03	Isolating the main feedwater lines to the faulted steam generators	3.8
EK 3.04	Checking whether passive residual heat removal system is available prior to isolating the startup feedwater lines to the faulted steam generators	3.4
EK 3.05	Isolating the startup feedwater line to the faulted steam generator	3.7
EK 3.06	Closing the SG PORV and/or SG PORV block valve on the faulted steam generators	3.4

EK 3.07	Isolating steam generator blowdown and/or steamline drains on the faulted steam generators	3.3	

EA 1 **Ability to operate and/or monitor the following as they apply to a faulted steam generator:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Steam generator blowdown system	3.0	
EA 1.02	Engineered safeguards actuation system	4.2	
EA 1.03	Main and startup feedwater system	3.7	
EA 1.04	Main steam system	3.6	
EA 1.05	Main turbine system	3.0	
EA 1.06	Passive residual heat removal system	3.3	
EA 1.07	Steam generator system	3.6	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a faulted steam generator:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Steam generator pressure	3.6	3.8
EA 2.02	Passive residual heat removal system flow	2.2	3.2
EA 2.03	Feedwater flow	3.4	3.3

4.1.11 E-3 Steam Generator Tube Rupture

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a steam generator tube rupture and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.1
EK 1.02	Auxiliary steam supply system	2.4
EK 1.03	Steam generator blowdown system	2.8
EK 1.04	Compressed and instrument air systems	2.2
EK 1.05	Component cooling water system	2.2
EK 1.06	Condensate system	2.2
EK 1.07	Condensate polishing system	2.0
EK 1.08	Chemical and volume control system	2.5
EK 1.09	Diverse actuation system	3.5
EK 1.10	Main AC power system	2.4
EK 1.11	Engineered safeguards actuation system	4.2
EK 1.12	Main and startup feedwater system	3.4
EK 1.13	Main steam system	3.2
EK 1.14	Passive containment cooling system	3.1
EK 1.15	Pressurizer level control system	2.9
EK 1.16	Pressurizer pressure control system	2.9
EK 1.17	Passive residual heat removal system	3.4
EK 1.18	Primary sampling system	2.3
EK 1.19	Passive core cooling system	3.3
EK 1.20	Reactor coolant pump	2.8
EK 1.21	Reactor coolant system	3.3
EK 1.22	Radiation monitoring system	3.3
EK 1.23	Normal residual heat removal system	2.7
EK 1.24	Steam dump control system	2.9
EK 1.25	Steam generator system	3.4
EK 1.26	Containment air filtration system	2.3
EK 1.27	Liquid radwaste system	2.3
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a steam generator tube rupture:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	SG PORV or main steam safety valve failing open on the ruptured steam generator	3.9
EK 2.02	Initiating a reactor coolant system cooldown by steaming the intact steam generator before isolating the ruptured steam generator	3.7
EK 2.03	Continuing to feed a ruptured steam generator after reaching the low-level limit	3.6
EK 2.04	Establishing feedwater flow to a steam generator that is depressurized	3.6

EK 2.05	Allowing reactor coolant system pressure to rise above 1,970 psig after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.5
EK 2.06	Depressurizing the steamlines at a high rate after safeguards are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.5
EK 2.07	A loss-of-coolant accident in addition to a steam generator tube rupture	3.7
EK 2.08	Excessive cycling of first-stage automatic depressurization system valves	3.4
EK 2.09	Depressurizing the reactor coolant system with no reactor coolant pumps running	3.2
EK 2.10	Starting a reactor coolant pump with a steam bubble in the reactor head	3.1
EK 2.11	Configuration and speed of running reactor coolant pumps effect on passive residual heat removal system	3.3
EK 2.12	Configuration and speed of running reactor coolant pumps effect on pressurizer spray flow	3.2
EK 2.13	Starting the reactor coolant pumps in a loop with a ruptured steam generator effect on the steam generator	3.3
EK 2.14	Inability to isolate the safety injection accumulators	3.2
EK 2.15	Releasing steam from a steam generator that has water in the steamline	3.4
EK 2.16	Releasing steam from and/or initiating feedflow to a ruptured steam generator	3.7
EK 2.17	Intact steam generator level rising in an uncontrolled manner	3.6
EK 2.18	Failure of auxiliary spray (PRA related)	3.3
EK 2.19	Failure to close the main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event (PRA related)	3.7
EK 2.20	Failure to actuate automatic depressurization system during a steam generator tube rupture event coincident with a loss-of-coolant accident (PRA related)	3.7
EK 2.21	Changes in core cooling mechanisms between normal operations and steam generator tube rupture	3.4
EK 2.22	Responding to steam generator tube rupture when the passive residual heat removal system heat exchanger is not available	3.8

EK 3 Knowledge of the reasons for the following actions as they apply to a steam generator tube rupture:
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	Adjusting ruptured SG PORV controller to 1,160 psig and in automatic (OE related)	3.3
EK 3.02	Isolating the ruptured steam generator steamlines and blowdown lines	3.6
EK 3.03	Maintaining ruptured steam generator level greater than the low limit and/or less than the high limit	3.6
EK 3.04	Aligning chemical and volume control system for reactor coolant system makeup	2.8

EK 3.05	Starting and aligning the startup feedwater pumps to feed the steam generators	2.9
EK 3.06	Controlling level and/or feedwater flow for only the intact steam generators	3.3
EK 3.07	Checking all switchgear buses energized from offsite power	2.5
EK 3.08	Resetting containment isolation actuation	2.9
EK 3.09	Establishing instrument air to containment	2.7
EK 3.10	Lowering reactor coolant system pressure below P-11, Pressurizer Pressure below 1,970 psig	3.3
EK 3.11	Terminating the reactor coolant system depressurization to below P-11, Pressurizer Pressure below 1,970 psig	3.2
EK 3.12	Blocking steamline/feedwater isolation actuations and/or safeguards actuation below P-11, Pressurizer Pressure below 1,970 psig	3.3
EK 3.13	Initiating a reactor coolant system cooldown by dumping steam	3.4
EK 3.14	Initiating a reactor coolant system cooldown using the passive residual heat removal system	3.6
EK 3.15	Isolating hotwell overflow, condensate polishers, and placing auxiliary steam loads on the auxiliary boiler	2.7
EK 3.16	Energizing the source range nuclear instrumentation	2.7
EK 3.17	Lowering reactor coolant system pressure until reactor coolant system pressure, pressurizer level, or subcooling limits are met	3.6
EK 3.18	Actuating automatic depressurization system	3.8
EK 3.19	Isolating or reinitiating core makeup tank injection	3.4
EK 3.20	Maintaining saturated conditions in the pressurizer	3.2
EK 3.21	Maintaining pressurizer level less than the high-level setpoint	3.2
EK 3.22	Borating to maintain shutdown margin	3.3
EK 3.23	Isolating passive residual heat removal system	3.1
EK 3.24	Checking for abnormal plant vent radiation	3.3
EK 3.25	Periodic sampling of the reactor coolant system and the ruptured steam generator for boron, hydrogen, and activity	2.6
EK 3.26	Placing in-containment refueling water storage tank cooling in service	3.1
EK 3.27	Restoring component cooling water system flow to containment	2.6
EK 3.28	Operating the reactor coolant pumps (OE related)	2.7
EK 3.29	Isolating the safety injection accumulators (OE related)	3.2
EK 3.30	Terminating passive containment cooling system flow	3.2
EK 3.31	Reducing ruptured steam generator pressure	3.4
EK 3.32	Cycling ruptured steam generator level between the low level and the high level	3.4
EK 3.33	Placing normal residual heat removal system in service in the shutdown cooling mode	2.8

EA 1 **Ability to operate and/or monitor the following as they apply to a steam generator tube rupture:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	3.9
EA 1.02	Auxiliary steam supply system	2.3
EA 1.03	Steam generator blowdown system	2.7
EA 1.04	Compressed and instrument air systems	2.2

EA 1.05	Component cooling water system	2.4	
EA 1.06	Condensate system	2.3	
EA 1.07	Condensate polishing system	2.1	
EA 1.08	Chemical and volume control system	2.7	
EA 1.09	Diverse actuation system	3.6	
EA 1.10	Main AC power system	2.5	
EA 1.11	Engineered safeguards actuation system	4.1	
EA 1.12	Main and startup feedwater system	3.1	
EA 1.13	Main steam system	2.9	
EA 1.14	Passive containment cooling system	3.1	
EA 1.15	Pressurizer level control system	2.9	
EA 1.16	Pressurizer pressure control system	2.9	
EA 1.17	Passive residual heat removal system	3.6	
EA 1.18	Primary sampling system	2.1	
EA 1.19	Passive core cooling system	3.4	
EA 1.20	Reactor coolant pump	2.9	
EA 1.21	Reactor coolant system	3.1	
EA 1.22	Normal residual heat removal system	2.8	
EA 1.23	Steam dump control system	3.1	
EA 1.24	Steam generator system	3.4	
EA 1.25	Containment air filtration system	2.3	
EA 1.26	Liquid radwaste system	2.1	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a steam generator tube rupture:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Reactor coolant system pressure, temperature, and/or pressurizer level	3.2	3.7
EA 2.02	Ruptured steam generator feedflow, level, and/or pressure	3.6	3.8
EA 2.03	Intact steam generator feedflow, level, and/or pressure	3.0	3.8
EA 2.04	Subcooling	3.4	3.8
EA 2.05	Shutdown margin	3.4	3.4

4.1.12 FR-S.1 Response to Nuclear Power Generation—ATWS

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between an anticipated transient without scram/loss of core shutdown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Compressed and instrument air systems	2.2
EK 1.02	Chemical and volume control system	2.9
EK 1.03	Diverse actuation system	4.1
EK 1.04	Digital rod control system	3.6
EK 1.05	Engineered safeguards actuation system	3.9
EK 1.06	Main and startup feedwater system	3.2
EK 1.07	Main steam system	2.8
EK 1.08	Main turbine system	2.9
EK 1.09	Nuclear instrumentation system	3.3
EK 1.10	Passive core cooling system	3.5
EK 1.11	Reactor coolant pump	3.1
EK 1.12	Rod position indicator system	3.2
EK 1.13	Reactor trip system	4.0
EK 1.14	Steam dump control system	2.9
EK 1.15	Steam generator system	2.9
EK 1.16	Main turbine control and diagnostics system	2.6
EK 1.17	Containment air filtration system	2.1
EK 1.18	Liquid radwaste system	1.9
EK 1.19	Reactor coolant system	3.0
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to an anticipated transient without scram/loss of core shutdown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Failure of protection and safety monitoring system and/or diverse actuation system to trip the reactor	4.5
EK 2.02	Failure of protection and safety monitoring system and/or diverse actuation system to trip the turbine	4.1
EK 2.03	Failure to recognize the need and failure to manually trip the reactor through the protection and safety monitoring system, given anticipated transient without scram (PRA related)	4.1
EK 2.04	Uncontrolled cooldown or dilution	3.4
EK 3	**Knowledge of the reasons for the following actions as they apply to an anticipated transient without scram/loss of core shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Ensuring the reactor is tripped (OE related)	4.5
EK 3.02	Ensuring the turbine is tripped	4.0
EK 3.03	Actuating passive residual heat removal system	3.8
EK 3.04	Closing the turbine bypass control valves	3.2

EK 3.05	Verifying startup feedwater flow available	3.5
EK 3.06	Verifying core makeup tank actuation and/or reactor coolant pump trip	3.8
EK 3.07	Establishing or terminating reactor coolant system boration	3.6
EK 3.08	Establishing chemical and volume control system letdown (FR-S.2 only)	2.6
EK 3.09	Isolation of containment air filtration system and containment sump	2.5
EK 3.10	Isolation of dilution flowpaths	3.4
EK 3.11	Controlling passive residual heat removal system flow, T_{cold}, and/or steam generator pressure	3.2
EK 3.12	Restoring instrument air to containment	2.7
EK 3.13	Check core exit temperature less than 1,200 degrees F	3.7
EK 3.14	Establish letdown using reactor vessel head vents	3.2

EA 1 **Ability to operate and/or monitor the following as they apply to an anticipated transient without scram/loss of core shutdown:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Reactor trip controls on protection and safety monitoring system and/or diverse actuation system (OE related)	4.3
EA 1.02	Digital rod control system	3.7
EA 1.03	Turbine trip controls	3.5
EA 1.04	Main steamline isolation actuation	3.6
EA 1.05	Passive residual heat removal system actuation, reset, and/or flow control	3.6
EA 1.06	Steam dump control system	3.1
EA 1.07	Main and startup feedwater system	3.2
EA 1.08	Core makeup tank actuation and reactor coolant pump operation	3.7
EA 1.09	Chemical and volume control system makeup and/or letdown	2.9
EA 1.10	Containment air filtration system and/or containment sump valves	2.2
EA 1.11	Compressed and instrument air systems	2.3
EA 1.12	Reactor coolant system (such as head vents, pressurizer level)	3.2

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to an anticipated transient without scram/loss of core shutdown:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Reactor trip breaker position (OE related)	4.0	4.3
EA 2.02	Turbine stop valve and/or main steamline isolation actuation status	4.0	4.0
EA 2.03	Reactor power and startup rate	4.0	4.3
EA 2.04	Reactor coolant system pressure or pressurizer level	3.2	3.6
EA 2.05	M-G set voltage	2.8	3.4
EA 2.06	Control rod position and speed	3.6	3.5
EA 2.07	Steam generator level and/or pressure	2.6	3.3
EA 2.08	Reactor coolant system T_{hot}, T_{cold}, and/or core exit temperatures	3.4	3.5
EA 2.09	Boration flow and/or makeup flow	3.4	3.6
EA 2.10	Passive residual heat removal system flow	3.4	3.5

4.1.13 FR-C.1 Response to Inadequate Core Cooling

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between inadequate core cooling and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.3
EK 1.02	Component cooling water system	2.4
EK 1.03	Condensate system	2.3
EK 1.04	Core makeup tank	3.9
EK 1.05	Chemical and volume control system	3.2
EK 1.06	Diverse actuation system	4.1
EK 1.07	Engineered safeguards actuation system	4.4
EK 1.08	Incore instrumentation system	3.2
EK 1.09	Main steam system	2.7
EK 1.10	Passive residual heat removal system	4.2
EK 1.11	Passive core cooling system	4.2
EK 1.12	Reactor coolant pump	3.3
EK 1.13	Reactor coolant system	3.3
EK 1.14	Radiation monitoring system	2.7
EK 1.15	Normal residual heat removal system	3.5
EK 1.16	Steam dump control system	3.1
EK 1.17	Spent fuel pool cooling system	4.1
EK 1.18	Startup feedwater	3.3
EK 1.19	Steam generator system	3.3
EK 1.20	Containment hydrogen control system	3.1
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to inadequate core cooling:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant pump operation on passive core cooling system operation	3.3
EK 2.02	Loss-of-coolant accident	4.1
EK 2.03	Loss of secondary heat sink	4.1
EK 2.04	Loss of passive residual heat removal system	4.1
EK 2.05	Loss of normal residual heat removal system	3.5
EK 2.06	Reactor coolant system hot-leg level response to automatic depressurization system actuation	3.5
EK 2.07	Depressurizing the steamlines at a high rate after steamline/ feedwater isolation actuations are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 2.08	Depressurizing a ruptured steam generator	3.7
EK 2.09	Maintaining emergency core cooling system design criteria	3.7
EK 2.10	Effect of timely normal residual heat removal system injection on fourth-stage automatic depressurization system	4.0

EK 2.11	Core exit temperature 1, 200 degrees F and rising	4.4

EK 3 **Knowledge of the reasons for the following actions as they apply to inadequate core cooling:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

EK 3.01	In-containment refueling water storage tank containment recirculation actuation	4.2
EK 3.02	Actuating containment hydrogen igniters	3.7
EK 3.03	Core makeup tank actuation	4.2
EK 3.04	Stopping the reactor coolant pumps	3.6
EK 3.05	Passive residual heat removal system actuation	4.2
EK 3.06	Aligning chemical and volume control system for reactor coolant system makeup	3.1
EK 3.07	Opening the safety injection accumulator isolation valves	3.9
EK 3.08	Checking core exit temperature, hot-leg level response, and/or reactor coolant system T_{hot}	3.8
EK 3.09	Terminating reactor cavity flooding	3.4
EK 3.10	Automatic depressurization system actuation	4.3
EK 3.11	Placing normal residual heat removal system in service in the low-pressure reactor coolant system makeup mode	3.6
EK 3.12	In-containment refueling water storage tank injection actuation	4.1
EK 3.13	Checking level and/or feedwater flow for only the intact steam generators	3.4
EK 3.14	Blocking steamline/feedwater isolation actuations below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 3.15	Using passive residual heat removal system to depressurize the reactor coolant system	4.0
EK 3.16	Depressurizing the intact steam generators to 110 psig	3.6
EK 3.17	Isolating the safety injection accumulators	3.3
EK 3.18	Depressurizing the intact steam generators to atmospheric pressure	3.6

EA 1 **Ability to operate and/or monitor the following as they apply to inadequate core cooling:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.4
EA 1.02	Component cooling water system	2.8
EA 1.03	Condensate system	2.6
EA 1.04	Core makeup tank	3.9
EA 1.05	Chemical and volume control system	3.1
EA 1.06	Diverse actuation system	4.0
EA 1.07	Engineered safeguards actuation system	4.3
EA 1.08	Main steam system	2.8
EA 1.09	Passive residual heat removal system	4.0
EA 1.10	Passive core cooling system	4.1
EA 1.11	Reactor coolant pump	3.1
EA 1.12	Reactor coolant system	3.3
EA 1.13	Normal residual heat removal system	3.6
EA 1.14	Steam dump control system	2.9

EA 1.15	Spent fuel pool cooling system	2.4	
EA 1.16	Startup feedwater	3.3	
EA 1.17	Steam generator system	3.3	
EA 1.18	Containment hydrogen control system	3.2	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to inadequate core cooling:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Core exit temperature and/or reactor coolant system wide-range T_{hot}	4.3	4.0
EA 2.02	Reactor coolant system subcooling	3.7	3.5
EA 2.03	Reactor coolant system wide-range pressure and/or pressurizer pressure	3.7	3.4
EA 2.04	Pressurizer level and/or reactor coolant system hot-leg level	3.7	3.5
EA 2.05	Core makeup tank level	3.7	3.8
EA 2.06	In-containment refueling water storage tank level	3.8	4.0
EA 2.07	Steam generator level and/or pressure	3.2	3.4
EA 2.08	Normal residual heat removal system flow	3.2	3.5

4.1.14 FR-C.2 Response to Degraded Core Cooling

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between degraded core cooling and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.3
EK 1.02	Component cooling water system	2.6
EK 1.03	Condensate system	2.3
EK 1.04	Core makeup tank	3.9
EK 1.05	Chemical and volume control system	3.1
EK 1.06	Diverse actuation system	3.9
EK 1.07	Engineered safeguards actuation system	4.3
EK 1.08	Incore instrumentation system	3.4
EK 1.09	Main steam system	2.8
EK 1.10	Passive residual heat removal system	4.1
EK 1.11	Passive core cooling system	4.1
EK 1.12	Reactor coolant pump	3.1
EK 1.13	Reactor coolant system	3.4
EK 1.14	Radiation monitoring system	2.6
EK 1.15	Normal residual heat removal system	3.5
EK 1.16	Steam dump control system	2.9
EK 1.17	Spent fuel pool cooling system	2.4
EK 1.18	Startup feedwater	3.2
EK 1.19	Steam generator system	3.2
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to degraded core cooling:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant pump operation on passive core cooling system operation	3.5
EK 2.02	Loss-of-coolant accident	4.1
EK 2.03	Loss of secondary heat sink	4.1
EK 2.04	Loss of passive residual heat removal system	4.2
EK 2.05	Loss of normal residual heat removal system	3.6
EK 2.06	Reactor coolant system hot-leg level response to automatic depressurization system actuation	3.8
EK 2.07	Depressurizing the steamlines at a high rate after steamline/ feedwater isolation actuations are blocked below P-11, Pressurizer Pressure below 1,970 psig	3.5
EK 2.08	Effect of timely normal residual heat removal system injection on fourth-stage automatic depressurization system	3.9
EK 2.09	Running normal residual heat removal system pumps on time to reach cask loading pit low level	3.2

EK 3	**Knowledge of the reasons for the following actions as they apply to degraded core cooling:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Core makeup tank actuation	4.0
EK 3.02	Stopping the reactor coolant pumps	3.3
EK 3.03	Passive residual heat removal system actuation	4.1
EK 3.04	Aligning chemical and volume control system for reactor coolant system makeup	3.1
EK 3.05	Checking core exit temperature, hot-leg level response, and/or reactor coolant system T_{hot}	3.8
EK 3.06	Opening the safety injection accumulator isolation valves	3.7
EK 3.07	Automatic depressurization system actuation	4.2
EK 3.08	Placing normal residual heat removal system in service in the low-pressure reactor coolant system makeup mode	3.6
EK 3.09	In-containment refueling water storage tank injection actuation	4.1
EK 3.10	In-containment refueling water storage tank containment recirculation actuation	4.0
EK 3.11	Checking level and/or feedwater flow for only the intact steam generators	3.1
EK 3.12	Blocking steamline/feedwater isolation actuations below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 3.13	Depressurizing the intact steam generators to 110 psig	3.6
EK 3.14	Checking normal residual heat removal system flow in the low-pressure reactor coolant system makeup mode	3.4
EK 3.15	Isolating the safety injection accumulators	3.2
EK 3.16	Depressurizing the intact steam generators to atmospheric pressure	3.5

EA 1	**Ability to operate and/or monitor the following as they apply to degraded core cooling:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Automatic depressurization system	4.4
EA 1.02	Component cooling water system	2.7
EA 1.03	Condensate system	2.4
EA 1.04	Core makeup tank	3.9
EA 1.05	Chemical and volume control system	3.2
EA 1.06	Diverse actuation system	3.9
EA 1.07	Engineered safeguards actuation system	4.2
EA 1.08	Main steam system	2.8
EA 1.09	Passive residual heat removal system	4.0
EA 1.10	Passive core cooling system	4.0
EA 1.11	Reactor coolant pump	3.2
EA 1.12	Reactor coolant system	3.4
EA 1.13	Normal residual heat removal system	3.5
EA 1.14	Steam dump control system	2.9
EA 1.15	Spent fuel pool cooling system	2.5
EA 1.16	Startup feedwater	3.2
EA 1.17	Steam generator system	3.2

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to degraded core cooling:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
EA 2.01	Core exit temperature and/or reactor coolant system wide-range T_{hot}	4.3	4.0
EA 2.02	Reactor coolant system subcooling	3.3	3.8
EA 2.03	Reactor coolant system wide-range pressure and/or pressurizer pressure	3.5	3.5
EA 2.04	Pressurizer level and/or reactor coolant system hot-leg level	3.5	3.8
EA 2.05	Core makeup tank level	3.7	3.8
EA 2.06	In-containment refueling water storage tank level	3.5	3.9
EA 2.07	Steam generator level and/or pressure	3.0	3.4
EA 2.08	Normal residual heat removal system flow	3.2	3.1
EA 2.09	Cask loading pit level	2.8	2.6

4.1.15 FR-C.3 Response to Saturated Core Cooling

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between saturated core cooling and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Core makeup tank	3.6
EK 1.02	Chemical and volume control system	2.9
EK 1.03	Diverse actuation system	3.7
EK 1.04	Engineered safeguards actuation system	4.1
EK 1.05	Incore instrumentation system	3.4
EK 1.06	Passive residual heat removal system	3.8
EK 1.07	Reactor coolant pump	3.1
EK 1.08	Reactor coolant system	3.1
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to saturated core cooling:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant pump operation on passive core cooling system operation	3.4
EK 2.02	Loss-of-coolant accident	3.8
EK 2.03	Loss of secondary heat sink	3.5
EK 2.04	Loss of passive residual heat removal system	3.9
EK 2.05	Loss of normal residual heat removal system	3.5
EK 3	**Knowledge of the reasons for the following actions as they apply to saturated core cooling:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Core makeup tank actuation	3.8
EK 3.02	Stopping the reactor coolant pumps	3.2
EK 3.03	Passive residual heat removal system actuation	3.7
EK 3.04	Aligning chemical and volume control system for reactor coolant system makeup	3.1
EA 1	**Ability to operate and/or monitor the following as they apply to saturated core cooling:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Core makeup tank	3.8
EA 1.02	Chemical and volume control system	3.0
EA 1.03	Diverse actuation system	3.8
EA 1.04	Engineered safeguards actuation system	4.1
EA 1.05	Passive residual heat removal system	3.9
EA 1.06	Reactor coolant pump	3.1
EA 1.07	Reactor coolant system	3.1

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to saturated core cooling:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Core exit temperatures and/or subcooling	3.7	4.0
EA 2.02	Pressurizer level	2.7	3.4

4.1.16 FR-H.1 Response to Loss of Heat Sink

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between a loss of heat sink and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	4.2
EK 1.02	Steam generator blowdown system	2.7
EK 1.03	Condensate system	3.1
EK 1.04	Chemical and volume control system	2.7
EK 1.05	Diverse actuation system	3.8
EK 1.06	Demineralized water transfer and storage system	2.6
EK 1.07	Engineered safeguards actuation system	4.2
EK 1.08	Main and startup feedwater system	3.6
EK 1.09	Incore instrumentation system	3.4
EK 1.10	Main steam system	3.1
EK 1.11	Passive containment cooling system	3.8
EK 1.12	Passive residual heat removal system	4.1
EK 1.13	Passive core cooling system	4.1
EK 1.14	Reactor coolant system	3.6
EK 1.15	Reactor coolant pump	3.2
EK 1.16	Normal residual heat removal system	3.4
EK 1.17	Startup feedwater	3.8
EK 1.18	Steam generator system	3.6
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of heat sink:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Loss of secondary heat sink effect on reactor coolant system temperature, pressure, ΔT, and/or pressurizer level	4.1
EK 2.02	Onset of natural circulation effect on reactor coolant system temperature, pressure, ΔT, and/or pressurizer level	4.0
EK 2.03	Changes in core cooling between normal operations and loss of heat sink event	3.8
EK 2.04	Excessive cycling of first-stage automatic depressurization system valves	3.8
EK 2.05	Establishing feedwater flow to a depressurized steam generator	3.6
EK 2.06	Failure to initiate bleed and feed when required	4.3
EK 3	**Knowledge of the reasons for the following actions as they apply to a loss of heat sink:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Stopping the reactor coolant pumps	3.6
EK 3.02	Passive residual heat removal system actuation	4.1
EK 3.03	Checking startup feedwater control valves open	3.6
EK 3.04	Checking if secondary heat sink is required	3.7

EK 3.05	Monitoring for loss of secondary heat sink conditions	4.0
EK 3.06	Ensuring steam generator blowdown is isolated	2.9
EK 3.07	Blocking steamline/feedwater isolation actuations and safeguards actuation below P-11, Pressurizer Pressure below 1,970 psig	3.4
EK 3.08	Checking condensate storage tank level	3.1
EK 3.09	Establish startup feedwater flow to at least one steam generator	3.9
EK 3.10	Establish main feedwater flow to at least one steam generator	3.9
EK 3.11	Monitoring core exit temperature and steam generator narrow-range level	4.0
EK 3.12	Safeguards actuation	4.2
EK 3.13	Core makeup tank actuation	4.0
EK 3.14	Automatic depressurization system actuation	4.4
EK 3.15	Placing normal residual heat removal system in service in the low-pressure reactor coolant system makeup mode	3.6
EK 3.16	Aligning chemical and volume control system for reactor coolant system makeup	3.1
EK 3.17	Passive containment cooling system actuation	3.9

EA 1 **Ability to operate and/or monitor the following as they apply to a loss of heat sink:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

EA 1.01	Automatic depressurization system	4.3
EA 1.02	Steam generator blowdown system	2.8
EA 1.03	Condensate system	3.1
EA 1.04	Chemical and volume control system	2.9
EA 1.05	Diverse actuation system	3.9
EA 1.06	Demineralized water transfer and storage system	2.7
EA 1.07	Engineered safeguards actuation system	4.3
EA 1.08	Main and startup feedwater system	3.8
EA 1.09	Main steam system	3.1
EA 1.10	Passive containment cooling system	3.9
EA 1.11	Passive residual heat removal system	4.1
EA 1.12	Passive core cooling system	4.1
EA 1.13	Reactor coolant system	3.5
EA 1.14	Reactor coolant pump	3.1
EA 1.15	Normal residual heat removal system	3.4
EA 1.16	Startup feedwater	3.7
EA 1.17	Steam generator system	3.5

		RO	SRO
EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a loss of heat sink:** (CFR: 41.7 / 43.5 / 45.6)		
EA 2.01	Passive residual heat removal system flow	3.6	3.7
EA 2.02	Reactor coolant system pressure and/or temperature	3.8	3.7
EA 2.03	Steam generator wide-range level, pressurizer level, and/or reactor coolant system ΔT	3.8	3.6
EA 2.04	Pressurizer pressure	3.2	3.6
EA 2.05	Feedwater flow and/or steam generator narrow-range level	3.4	3.6
EA 2.06	Core exit temperature	4.2	3.9

4.1.17 FR-H.2 Response to Steam Generator Overpressure

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
EK 1	**Knowledge of the relationship between steam generator overpressure and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
EK 1.01	Main and startup feedwater system	2.9	
EK 1.02	Main steam system	2.9	
EK 1.03	Reactor coolant system	3.2	
EK 1.04	Steam dump control system	2.7	
EK 1.05	Steam generator system	3.4	
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to steam generator overpressure:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
EK 2.01	Maintaining feedwater flow isolated until a steam release path is established	3.1	
EK 2.02	Steam generator overfill	3.2	
EK 3	**Knowledge of the reasons for the following actions as they apply to steam generator overpressure:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
EK 3.01	Isolating main feedwater	3.1	
EK 3.02	Verifying C-9, Condenser Available is active and steamlines are not isolated	2.9	
EK 3.03	Verifying SG PORVs are not isolated	3.2	
EK 3.04	Releasing steam using steam dump control system or SG PORV	3.4	
EK 3.05	Maintaining reactor coolant system T_{hot} less than 542 degrees F	3.3	
EA 1	**Ability to operate and/or monitor the following as they apply to steam generator 0verpressure:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
EA 1.01	Main and startup feedwater system	2.9	
EA 1.02	Main steam system	2.9	
EA 1.03	Steam dump control system	3.1	
EA 1.04	Steam generator system	3.4	
EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to steam generator overpressure:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Steam generator pressure and/or level	3.0	3.6
EA 2.02	Reactor coolant system temperature	2.7	3.3

4.1.18 FR-I.1 Response to High Pressurizer Level

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between high pressurizer level and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	3.5
EK 1.02	Compressed and instrument air systems	2.2
EK 1.03	Component cooling water system	2.1
EK 1.04	Chemical and volume control system	3.0
EK 1.05	Engineered safeguards actuation system	3.3
EK 1.06	Pressurizer level control system	3.1
EK 1.07	Pressurizer pressure control system	2.9
EK 1.08	Passive core cooling system	3.3
EK 1.09	Reactor coolant system	3.0
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to high pressurizer level:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Establishing chemical and volume control system letdown with high reactor coolant system activity level	2.9
EK 2.02	Failure to maintain the pressurizer liquid in saturated conditions	2.9
EK 2.03	Loss of pressurizer heaters	2.7
EK 2.04	Establishing chemical and volume control system letdown flow without cooling flow to the regenerative heat exchanger	2.7
EK 3	**Knowledge of the reasons for the following actions as they apply to high pressurizer level:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Isolating Chemical and Volume Control System makeup	3.0
EK 3.02	Isolating Automatic Depressurization System	3.3
EK 3.03	Placing letdown in manual and closed	2.8
EK 3.04	Resetting Containment Isolation Actuation	3.0
EK 3.05	Establishing instrument air to containment	2.6
EK 3.06	Restoring Component Cooling Water System to containment	2.6
EK 3.07	Resetting Chemical and Volume Control System Isolation Actuation	2.9
EK 3.08	Placing Chemical and Volume Control System letdown in service	3.0
EK 3.09	Opening reactor head vents	2.8
EK 3.10	Closing normal pressurizer spray and auxiliary spray lines	2.8
EK 3.11	Maintaining saturated conditions in the pressurizer	2.9

EA 1	**Ability to operate and/or monitor the following as they apply to high pressurizer level:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Automatic depressurization system	3.4
EA 1.02	Compressed and instrument air systems	2.4
EA 1.03	Component cooling water system	2.5
EA 1.04	Chemical and volume control system	3.0
EA 1.05	Engineered safeguards actuation system	3.3
EA 1.06	Pressurizer level control system	3.2
EA 1.07	Pressurizer pressure control system	2.9
EA 1.08	Passive core cooling system	3.1
EA 1.09	Reactor coolant system	2.9

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to high pressurizer level:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Pressurizer level, temperature, and pressure	2.8	3.5
EA 2.02	Chemical and volume control system letdown flow and temperature	2.8	3.1
EA 2.03	Chemical and volume control system makeup flow	2.8	3.0

4.1.19 FR-I.2 Response to Low Pressurizer Level

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
EK 1	**Knowledge of the relationship between low pressurizer level and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
EK 1.01	Component cooling water system	2.6	
EK 1.02	Engineered safeguards actuation system	3.3	
EK 1.03	Pressurizer level control system	2.5	
EK 1.04	Pressurizer pressure control system	2.3	
EK 1.05	Passive core cooling system	3.2	
EK 1.06	Reactor coolant system	2.9	
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to low pressurizer level:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
EK 2.01	Failure to maintain the pressurizer liquid in saturated conditions	2.8	
EK 2.02	Loss of pressurizer heaters	2.5	
EK 2.03	Engineered safeguards actuation	3.4	
EK 2.04	Diverse actuation system actuation	3.1	
EK 3	**Knowledge of the reasons for the following actions as they apply to low pressurizer level:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
EK 3.01	Isolate chemical and volume control system makeup	2.5	
EK 3.02	Establish chemical and volume control system makeup	2.7	
EK 3.03	Actuate core makeup tank and passive residual heat removal	3.4	
EA 1	**Ability to operate and/or monitor the following as they apply to low pressurizer level:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
EA 1.01	Chemical and volume control system	2.6	
EA 1.02	Engineered safeguards actuation system	3.4	
EA 1.03	Pressurizer level control system	2.5	
EA 1.04	Pressurizer pressure control system	2.4	
EA 1.05	Passive core cooling system	3.3	
EA 1.06	Reactor coolant system	2.7	
EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to low pressurizer level:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Pressurizer level, temperature, and pressure	2.6	3.0
EA 2.02	Chemical and volume control system makeup flow	2.6	2.8

4.1.20 FR-I.3 Response to Voids in the Reactor Vessel

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between voids in the reactor vessel and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	3.0
EK 1.02	Chemical and volume control system	2.5
EK 1.03	Engineered safeguards actuation system	2.9
EK 1.04	Pressurizer level control system	2.5
EK 1.05	Pressurizer pressure control system	2.4
EK 1.06	Passive core cooling system	2.9
EK 1.07	Reactor coolant system	2.9
EK 1.08	Containment hydrogen system	2.1
EK 1.09	Containment filtration ventilation system	2.1
EK 1.10	Reactor system	2.4
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to voids in the reactor vessel:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Pressurizer level response	3.1
EK 2.02	Reactor coolant system conditions (temperature, pressure, natural circulation parameters, subcooling)	3.1
EK 2.03	Failure to maintain the pressurizer liquid in saturated condition	2.7
EK 2.04	Loss of pressurizer heaters	2.4
EK 2.05	Operation of head vents	2.9
EK 2.06	Operation of chemical volume and control system	2.3
EK 3	**Knowledge of the reasons for the following actions as they apply to voids in the reactor vessel:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Establish reactor coolant system makeup	2.6
EK 3.02	Repressurize reactor coolant system to condense voids	2.9
EK 3.03	Vent reactor vessel voids	2.8
EA 1	**Ability to operate and/or monitor the following as they apply to voids in the reactor vessel:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Automatic depressurization system	2.9
EA 1.02	Chemical and volume control system	2.5
EA 1.03	Engineered safeguards actuation system	3.0
EA 1.04	Pressurizer level control system	2.5
EA 1.05	Pressurizer pressure control system	2.5
EA 1.06	Passive core cooling system	2.9
EA 1.07	Reactor coolant system	2.9

EA 1.08	Containment hydrogen system	2.2	
EA 1.09	Containment filtration ventilation System	2.2	
EA 1.10	Reactor system	2.5	

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to voids in the reactor vessel:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Pressurizer level, temperature, and pressure	2.9	3.1
EA 2.02	Reactor coolant system temperature and pressure	2.9	3.3
EA 2.03	Chemical and volume control system makeup flow	2.8	2.7

4.1.21 FR-P.1 Response to Imminent Pressurized Thermal Shock Condition

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between pressurized thermal shock and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	3.6
EK 1.02	Compressed and instrument air systems	2.3
EK 1.03	Chemical and volume control system (auxiliary spray, makeup, letdown)	2.7
EK 1.04	Engineered safeguards actuation system	3.5
EK 1.05	Passive core cooling system	3.5
EK 1.06	Reactor coolant pumps	3.0
EK 1.07	Reactor coolant system (head vents, pressurizer normal spray, and/or heaters)	2.9
EK 1.08	Normal residual heat removal system	2.8
EK 1.09	Steam dump control system	2.9
EK 1.10	Steam generator system (main steam isolation valves, bypass steam isolation valves, SG PORV)	3.1
EK 1.11	Startup feedwater system	2.9
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to pressurized thermal shock:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant system loss-of-coolant accident, faulted steam generator, or steam generator tube rupture effect on reactor coolant system temperature	3.5
EK 2.02	Excessive makeup or core makeup tank injection and recirculation effect on reactor coolant system pressure	3.3
EK 2.03	Operating outside the acceptable operating region of the reactor coolant system pressure/temperature cooldown limit curves	3.7
EK 2.04	Adverse containment conditions on chemical and volume control system makeup	3.1
EK 2.05	Loss of subcooling or pressurizer level	3.2
EK 2.06	Reactor coolant system heatup after steam generator dryout during faulted steam generator	3.4
EK 2.07	Reducing reactor coolant system pressure below the minimum subcooling value during subcooling minimization (head voiding)	3.1
EK 2.08	Failure to maintain reactor coolant system pressure and temperature stable during reactor coolant system temperature soak	3.4
EK 2.09	Failure to maintain pressurizer saturated conditions	2.8
EK 2.10	Excessive cycling of automatic depressurization system valves	3.3

EK 3	**Knowledge of the reasons for the following actions as they apply to pressurized thermal shock:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Stopping all reactor coolant pumps	3.2
EK 3.02	Isolating main steamlines and feedwater lines	3.2
EK 3.03	Reducing passive residual heat removal system flow	3.4
EK 3.04	Ensuring chemical and volume control system makeup pumps are maintaining pressurizer level	2.7
EK 3.05	Restoring instrument air to containment	2.6
EK 3.06	Isolating the core makeup tanks	3.2
EK 3.07	Stabilizing T_{hot} and/or T_{cold}	3.4
EK 3.08	Maintaining minimum subcooling	3.2
EK 3.09	Stopping reactor coolant system depressurization if pressurizer level is high	3.1
EK 3.10	Reactor coolant system temperature soak	3.5
EK 3.11	Cooldown limits	3.5
EK 3.12	Methods of reactor coolant system depressurization (automatic depressurization system, normal spray, auxiliary spray) (FR-P.1 or FR-P.2)	3.4
EA 1	**Ability to operate and/or monitor the following as they apply to pressurized thermal shock:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Reactor coolant pump controls	2.9
EA 1.02	SG PORV and/or block valve controls	3.3
EA 1.03	Steam dump control system controls	3.3
EA 1.04	Startup feedwater controls	3.1
EA 1.05	Normal residual heat removal system actuation reset and/or outlet flow controls	3.2
EA 1.06	Main steamline isolation valve and/or main steamline isolation bypass valve controls	3.1
EA 1.07	Chemical and volume control system makeup, letdown, and/or auxiliary spray controls	3.1
EA 1.08	Safeguards actuation reset	3.6
EA 1.09	Containment isolation reset	3.3
EA 1.10	Dilution block reset	3.1
EA 1.11	Core makeup tank actuation reset and/or isolation	3.5
EA 1.12	First, second, and/or third automatic depressurization system reset	3.5
EA 1.13	Auxiliary spray isolation actuation block	3.1
EA 1.14	Accumulator isolation valves	3.2
EA 1.15	Pressurizer heaters and spray valves	3.0

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to pressurized thermal shock:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Reactor coolant system cold-leg temperature change in any 60-minute period	3.6	3.6
EA 2.02	Reactor coolant system T_{hot} and/or T_{cold} temperatures	3.4	3.6
EA 2.03	Reactor coolant system pressure and trend	3.6	3.4
EA 2.04	Subcooling	3.1	3.3

4.1.22 FR-Z.1 Response to High Containment Pressure

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between high containment pressure and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Diverse actuation system	3.7
EK 1.02	Demineralized water transfer and storage system	2.2
EK 1.03	Engineered safeguards actuation system	3.9
EK 1.04	Fire protection system	2.5
EK 1.05	Main steam system	3.0
EK 1.06	Passive containment cooling system	3.9
EK 1.07	Passive residual heat removal system	3.2
EK 1.08	Steam generator system	3.2
EK 1.09	Containment recirculation cooling system	2.9
EK 1.10	Containment hydrogen control system	3.2
EK 1.11	Central chilled water system	2.6
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to high containment pressure:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Effect of containment pressure on instrumentation located inside containment (emergency operating procedure adverse containment values)	3.5
EK 2.02	Hydrogen concentration limits	3.1
EK 3	**Knowledge of the reasons for the following actions as they apply to high containment pressure:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Containment isolation actuation	3.8
EK 3.02	Passive containment cooling system actuation	3.8
EK 3.03	Makeup to the passive containment cooling water storage tank	3.3
EK 3.04	Start all reactor containment recirculation fans in low speed	3.1
EK 3.05	Restore chilled water flow to containment	2.9
EK 3.06	Main steam isolation actuation	3.4
EK 3.07	Feedwater isolation actuations actuation	3.4
EK 3.08	Checking passive residual heat removal system is available	3.1
EK 3.09	Actuating containment hydrogen igniters	3.1
EA 1	**Ability to operate and/or monitor the following as they apply to high containment pressure:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Diverse actuation system	3.8
EA 1.02	Demineralized water transfer and storage system	2.5
EA 1.03	Engineered safeguards actuation system	3.9

EA 1.04	Main and startup feedwater system	3.1
EA 1.05	Main steam system	3.1
EA 1.06	Passive containment cooling system	3.8
EA 1.07	Passive residual heat removal system	3.3
EA 1.08	Steam generator system	3.1
EA 1.09	Containment recirculation cooling system	3.1
EA 1.10	Containment hydrogen control system	3.2
EA 1.11	Central chilled water system	2.7

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to high containment pressure:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Containment pressure and/or temperature	3.6	3.9
EA 2.02	Passive containment cooling system flow	3.2	3.6
EA 2.03	Containment hydrogen concentration	3.4	3.5

4.1.23 FR-Z.2 Response to Containment Flooding

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between containment flooding and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Component cooling water system	2.9
EK 1.02	Chemical and volume control system	2.9
EK 1.03	Demineralized water transfer and storage system	2.6
EK 1.04	Fire protection system	2.6
EK 1.05	Normal residual heat removal system	2.8
EK 1.06	Spent fuel pool cooling system	2.9
EK 1.07	Central chilled water system	2.7
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to containment flooding:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Containment water level greater than design flood level	3.5
EK 3	**Knowledge of the reasons for the following actions as they apply to containment flooding:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Stopping the chemical and volume control system makeup pumps	2.8
EK 3.02	Stopping the normal residual heat removal system pumps and isolating the spent fuel pool cooling system cask loading pit	3.1
EK 3.03	Stopping the spent fuel pool cooling system pumps and closing the spent fuel pool cooling system containment isolation valves	3.1
EK 3.04	Stopping the reactor coolant pumps, isolating chemical and volume control system purification, and/or closing the component cooling water system containment isolation valves	3.2
EK 3.05	Closing the central chilled water system, demineralized water transfer and storage system, fire protection system, and/or normal residual heat removal system suction from spent fuel pool isolation valves	3.1
EK 3.06	Sampling the water in containment	2.7
EA 1	**Ability to operate and/or monitor the following as they apply to containment flooding:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Component cooling water system	2.9
EA 1.02	Chemical and volume control system	3.1
EA 1.03	Demineralized water transfer and storage system	2.8
EA 1.04	Fire protection system	2.9
EA 1.05	Normal residual heat removal system	3.1
EA 1.06	Spent fuel pool cooling system	3.1
EA 1.07	Central chilled water system	2.8

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to containment flooding:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Containment sump level and/or containment water level	3.4	3.6

4.1.24 FR-Z.3 Response to High Containment Radiation

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
EK 1	**Knowledge of the relationship between high containment radiation and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
EK 1.01	Chemical and volume control system	2.4	
EK 1.02	Engineered safeguards actuation system	3.4	
EK 1.03	Radiation monitoring system	3.3	
EK 1.04	Containment air filtration system	3.0	
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to high containment radiation:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
EK 2.01	Effect of containment radiation on instrumentation located inside containment (emergency operating procedure adverse containment values)	3.3	
EK 3	**Knowledge of the reasons for the following actions as they apply to high containment radiation:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
EK 3.01	Containment air filtration system isolation actuation	3.3	
EK 3.02	Chemical and volume control system isolation actuation	2.8	
EK 3.03	Normal residual heat removal system isolation actuation	2.8	
EA 1	**Ability to operate and/or monitor the following as they apply to high containment radiation:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
EA 1.01	Chemical and volume control system	2.9	
EA 1.02	Engineered safeguards actuation system	3.6	
EA 1.03	Containment air filtration system	3.1	
EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to high containment radiation:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Containment radiation	3.0	3.6

4.1.25 FR-Z.4 Response to Low Containment Pressure

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
EK 1	**Knowledge of the relationship between low containment pressure and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
EK 1.01	Passive containment cooling system	2.5	
EK 1.02	Normal containment cooling system	2.1	
EK 1.03	Radiation monitoring system	1.9	
EK 1.04	Containment air filtration system	2.1	
EK 1.05	Engineered safeguards actuation system	2.6	
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to low containment pressure:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
EK 2.01	Containment integrity	3.1	
EK 2.02	Failed containment fan cooler	2.2	
EK 2.03	Malfunction of containment purge system	2.4	
EK 2.04	Inadvertent passive containment cooling system actuation	2.8	
EK 3	**Knowledge of the reasons for the following actions as they apply to low containment pressure:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
EK 3.01	Terminate containment cooling system operation	2.8	
EK 3.02	Actuate the vacuum relief system	2.9	
EK 3.03	Establish normal containment pressure control	2.5	
EK 3.04	Reset containment isolation	2.5	
EA 1	**Ability to operate and/or monitor the following as they apply to low containment pressure:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
EA 1.01	Passive containment cooling system	2.8	
EA 1.02	Normal containment cooling system	2.2	
EA 1.03	Radiation monitoring system	2.1	
EA 1.04	Containment air filtration system	2.3	
EA 1.05	Engineered safeguards actuation system	2.8	
EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to low containment pressure:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Containment pressure	2.8	3.0

4.1.26 SDP-1 Response to Loss of RCS Inventory during Shutdown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between the response to a loss of reactor coolant system (RCS) inventory during shutdown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system	3.8
EK 1.02	Containment system	3.4
EK 1.03	Chemical and volume control system	3.1
EK 1.04	Diverse actuation system	3.6
EK 1.05	Engineered safeguards actuation system	3.8
EK 1.06	Main and startup feedwater system	2.7
EK 1.07	Passive containment cooling system	3.4
EK 1.08	Passive residual heat removal system	3.4
EK 1.09	Passive core cooling system	3.7
EK 1.10	Reactor coolant system	3.4
EK 1.11	Radiation monitoring system	3.2
EK 1.12	Normal residual heat removal system	3.3
EK 1.13	Spent fuel pool cooling system	2.9
EK 1.14	Steam generator system	2.6
EK 1.15	Liquid radwaste system	2.3
EK 1.16	Radiologically controlled area ventilation system	2.6
EK 1.17	Containment recirculation cooling system	3.0
EK 1.18	Containment hydrogen control system	2.6
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the response to a loss of reactor coolant system inventory during shutdown** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant system open strategy	3.6
EK 2.02	Reactor coolant system closed strategy	3.5
EK 2.03	Reactor coolant system makeup boron concentration less than reactor coolant system boron concentration	3.6
EK 2.04	Reactor coolant system hot-leg level less than low-2 setpoint	3.7
EK 2.05	Gas binding of normal residual heat removal system pump (OE related)	3.6
EK 2.06	Interfacing system loss-of-coolant accident	3.5
EK 2.07	Core exit temperature greater than 1,200 degrees F	3.9
EK 2.08	Starting a normal residual heat removal system pump in the shutdown cooling mode	3.2
EK 2.09	Discharging a pressurized accumulator into the reactor coolant system	3.2

EK 3	**Knowledge of the reasons for the following actions as they apply to the response to a loss of reactor coolant system inventory during shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Stopping all reactor coolant pumps	3.3
EK 3.02	Stopping normal residual heat removal system pumps and/or reducing normal residual heat removal system flow	3.3
EK 3.03	Establishing containment closure	3.8
EK 3.04	Starting the containment recirculation cooling fans	2.9
EK 3.05	Opening automatic depressurization system valves/automatic depressurization system actuation	3.6
EK 3.06	Using core makeup tanks, accumulators, or in-containment refueling water storage tank for reactor coolant system makeup	3.6
EK 3.07	Ensuring adequate hot-leg level before placing normal residual heat removal system in the shutdown cooling mode	3.3
EK 3.08	Containment recirculation actuation	3.4
EK 3.09	Initiating passive containment cooling system flow	3.4
EK 3.10	Core makeup tank actuation	3.6
EK 3.11	Passive residual heat removal system actuation	3.6
EK 3.12	Aligning normal residual heat removal system for low-pressure reactor coolant system makeup	3.4
EK 3.13	Establishing a reactor coolant system heat sink using the steam generators	3.2
EK 3.14	Establishing a reactor coolant system heat sink using passive residual heat removal system	3.6
EK 3.15	Establishing passive feed and bleed	3.7
EK 3.16	Energizing the containment hydrogen igniters	2.8
EK 3.17	Order of preference for reactor coolant system makeup sources	3.1

EA 1	**Ability to operate and/or monitor the following as they apply to the response to a loss of reactor coolant system inventory during shutdown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Automatic depressurization system	3.8
EA 1.02	Containment system	3.6
EA 1.03	Chemical and volume control system	3.2
EA 1.04	Diverse actuation system	3.6
EA 1.05	Engineered safeguards actuation system	4.0
EA 1.06	Main and startup feedwater system	2.9
EA 1.07	Passive containment cooling system	3.5
EA 1.08	Passive residual heat removal system	3.6
EA 1.09	Passive core cooling system	3.6
EA 1.10	Reactor coolant system	3.3
EA 1.11	Normal residual heat removal system	3.4
EA 1.12	Spent fuel pool cooling system	2.9
EA 1.13	Steam generator system	2.7
EA 1.14	Liquid radwaste system	2.1
EA 1.15	Radiologically controlled area ventilation system	2.5
EA 1.16	Containment recirculation cooling system	2.9
EA 1.17	Containment hydrogen control system	2.6

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to the response to a loss of reactor coolant system inventory during shutdown procedures:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Reactor coolant system pressure and/or temperature	3.4	3.9
EA 2.02	Pressurizer level and/or reactor coolant system hot-leg level	3.4	3.9
EA 2.03	Core exit temperature	3.6	3.6
EA 2.04	Normal residual heat removal system flow and/or pump amps	3.6	3.3
EA 2.05	Containment temperature	3.0	3.1

4.1.27 SDP-2 Response to Loss of Normal Residual Heat Removal System during Shutdown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between the response to a loss of normal residual heat removal system during shutdown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Automatic depressurization system (OE related)	3.8
EK 1.02	Containment system (OE related)	3.5
EK 1.03	Chemical and volume control system (OE related)	3.0
EK 1.04	Diverse actuation system (OE related)	3.6
EK 1.05	Engineered safeguards actuation system (OE related)	3.6
EK 1.06	Fuel handling and refueling system (OE related)	2.6
EK 1.07	Main and startup feedwater system (OE related)	2.7
EK 1.08	Passive residual heat removal system (OE related)	3.6
EK 1.09	Passive core cooling system (OE related)	3.5
EK 1.10	Reactor coolant system (OE related)	3.1
EK 1.11	Radiation monitoring system (OE related)	2.7
EK 1.12	Normal residual heat removal system (OE related)	3.6
EK 1.13	Steam dump control system (OE related)	2.7
EK 1.14	Spent fuel pool cooling system (OE related)	2.7
EK 1.15	Steam generator system (OE related)	2.8
EK 1.16	Radiologically controlled area ventilation system (OE related)	2.4
EK 1.17	Containment recirculation cooling system (OE related)	2.7
EK 1.18	Liquid radwaste system (OE related)	2.2
EK 1.19	Radioactive waste drain system (OE related)	2.3
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the response to a loss of normal residual heat removal system during shutdown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Reactor coolant system open strategy (OE related)	3.5
EK 2.02	Reactor coolant system closed strategy (OE related)	3.5
EK 2.03	Reactor coolant system makeup boron concentration less than reactor coolant system boron concentration (OE related)	3.5
EK 2.04	Reactor coolant system hot-leg level less than low-2 setpoint (OE related)	3.7
EK 2.05	Gas binding of normal residual heat removal system pump (OE related)	3.7
EK 2.06	Interfacing system loss-of-coolant accident (OE related)	3.6
EK 2.07	Core exit temperature greater than 1,200 degrees F (OE related)	3.9
EK 2.08	Starting a normal residual heat removal system pump in the shutdown cooling mode (OE related)	3.4
EK 2.09	Discharging a pressurized accumulator into the reactor coolant system (OE related)	3.1

EK 3	**Knowledge of the reasons for the following actions as they apply to the response to a loss of normal residual heat removal system during shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Determining refueling cavity level (OE related)	3.1
EK 3.02	Placing normal residual heat removal system in shutdown cooling mode (OE related)	3.4
EK 3.03	Establishing containment closure (OE related)	3.7
EK 3.04	Starting containment fan coolers (OE related)	2.9
EK 3.05	Maintaining reactor coolant system hot-leg level (OE related)	3.7
EK 3.06	Opening automatic depressurization system Stages 1, 2, and 3 (OE related)	3.7
EK 3.07	Opening core makeup tank isolation valves, accumulator isolation valves, or establishing in-containment refueling water storage tank gravity feed (OE related)	3.4
EK 3.08	Closing automatic depressurization system fourth-stage and reactor coolant system head vent valves (OE related)	3.5
EK 3.09	Maintaining pressurizer level (OE related)	3.3
EK 3.10	Establishing a reactor coolant system heat sink using the steam generators (OE related)	3.4
EK 3.11	Establishing a reactor coolant system heat sink using the passive residual heat removal system heat exchanger (OE related)	3.7

EA 1	**Ability to operate and/or monitor the following as they apply to the response to a loss of normal residual heat removal system during shutdown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Automatic depressurization system (OE related)	3.8
EA 1.02	Containment system (OE related)	3.4
EA 1.03	Chemical and volume control system (OE related)	3.1
EA 1.04	Diverse actuation system (OE related)	3.4
EA 1.05	Engineered safeguards actuation system (OE related)	3.7
EA 1.06	Fuel handling and refueling system (OE related)	2.6
EA 1.07	Main and startup feedwater system (OE related)	2.9
EA 1.08	Passive residual heat removal system (OE related)	3.8
EA 1.09	Passive core cooling system (OE related)	3.7
EA 1.10	Reactor coolant system (OE related)	3.1
EA 1.11	Radiation monitoring system (OE related)	2.6
EA 1.12	Normal residual heat removal system (OE related)	3.6
EA 1.13	Steam dump control system (OE related)	2.8
EA 1.14	Spent fuel pool cooling system (OE related)	2.5
EA 1.15	Steam generator system (OE related)	2.9
EA 1.16	Radiologically controlled area ventilation system (OE related)	2.4
EA 1.17	Containment recirculation cooling system (OE related)	2.6
EA 1.18	Liquid radwaste system (OE related)	2.3
EA 1.19	Radioactive waste drain system (OE related)	2.1

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to the response to a loss of normal residual heat removal system during shutdown:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Reactor coolant system pressure and/or temperature (OE related)	3.8	3.6
EA 2.02	Pressurizer level and/or reactor coolant system hot-leg level (OE related)	3.8	3.9
EA 2.03	Core exit temperature (OE related)	3.8	3.6
EA 2.04	Normal residual heat removal system flow and/or pump amps (OE related)	3.8	3.3
EA 2.05	Containment temperature (OE related)	2.8	3.3

4.1.28 SDP-4 Response to Rising Nuclear Flux during Shutdown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between the response to rising nuclear flux during shutdown and the following systems or components:**	
EK 1.01	Core makeup tank	2.9
EK 1.02	Chemical and volume control system	3.4
EK 1.03	Engineered safeguards actuation system	3.5
EK 1.04	Nuclear instrumentation system	3.7
EK 1.05	Primary sampling system	2.3
EK 1.06	Radiation monitoring system	2.4
EK 1.07	Normal residual heat removal system	2.9
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the response to rising nuclear flux during shutdown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Movement of irradiated fuel near source range nuclear instrumentation detectors	3.5
EK 2.02	Inadvertent dilution event	3.5
EK 3	**Knowledge of the reasons for the following actions as they apply to the response to rising nuclear flux during shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Isolating demineralized water and dilution paths and/or aligning makeup pumps to the boric acid tank (OE related)	3.5
EK 3.02	Suspending core alterations (OE related)	3.8
EK 3.03	Borating the reactor coolant system (OE related)	3.8
EK 3.04	Using the core makeup tank for boration (OE related)	3.7
EA 1	**Ability to operate and/or monitor the following as they apply to the response to rising nuclear flux during shutdown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Core makeup tank	3.8
EA 1.02	Chemical and volume control system	3.6
EA 1.03	Engineered safeguards actuation system	3.8
EA 1.04	Normal residual heat removal system	3.4

EA 2 **Ability to evaluate the following parameters and/or conditions as they apply to the response to rising nuclear flux during shutdown:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
EA 2.01	Reactor coolant system boron and/or shutdown margin (OE related)	3.6	3.9
EA 2.02	Reactor coolant system temperature	3.0	3.1
EA 2.03	Source range nuclear instrumentation (OE related)	3.8	3.9
EA 2.04	Reactor coolant system boration flow	3.6	3.7
EA 2.05	Containment radiation	2.6	2.9

4.1.29 SDP-5 Response to RCS Cold Overpressure during Shutdown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between the response to reactor coolant system cold overpressure during shutdown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
EK 1.01	Chemical and volume control system	3.5
EK 1.02	Passive core cooling system	3.6
EK 1.03	Reactor coolant system	3.6
EK 1.04	Reactor coolant pumps	3.4
EK 1.05	Normal residual heat removal system	3.4
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the response to reactor coolant system cold overpressure during shutdown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Starting a reactor coolant pump when a steam generator is hotter than the reactor coolant system	3.5
EK 2.02	Reactor coolant system pressure greater than the reactor coolant system pressure requirement for placing the normal residual heat removal system in service under normal conditions	3.5
EK 3	**Knowledge of the reasons for the following actions as they apply to the response to reactor coolant system cold overpressure during shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Stopping reactor coolant system makeup and placing chemical and volume control system letdown in service	3.4
EK 3.02	Using auxiliary spray to lower reactor coolant system pressure	3.3
EK 3.03	Stopping all reactor coolant pumps	3.4
EK 3.04	Isolating or venting the accumulators	3.2
EK 3.05	Opening normal residual heat removal system suction isolation valves	3.4
EK 3.06	Opening the reactor coolant system head vents	3.2
EA 1	**Ability to operate and/or monitor the following as they apply to the response to reactor coolant system cold overpressure during shutdown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Chemical and volume control system	3.4
EA 1.02	Passive core cooling system	3.5
EA 1.03	Reactor coolant system	3.5
EA 1.04	Reactor coolant pumps	3.1
EA 1.05	Normal residual heat removal system	3.3

EA 2	**Ability to evaluate the following parameters and/or conditions to determine the effectiveness of implementing the response to reactor coolant system cold overpressure during shutdown procedures:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Reactor coolant system level, pressure, and/or temperature	3.4	3.9

4.1.30 SDP-6 Response to Unexpected RCS Temperature Changes during Shutdown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
EK 1	**Knowledge of the relationship between the response to unexpected reactor coolant system temperature changes during shutdown and the following systems or components: (CFR: 41.8 / 41.10 / 45.3)**	
EK 1.01	Component cooling water system	2.8
EK 1.02	In-containment refueling water storage tank	2.9
EK 1.03	Reactor coolant system	3.1
EK 1.04	Normal residual heat removal system	3.5
EK 1.05	Service water system	2.9
EK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to the response to unexpected reactor coolant system temperature changes during shutdown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
EK 2.01	Flooding the reactor cavity with in-containment refueling water storage tank water	3.3
EK 2.02	Adjusting normal residual heat removal system heat exchanger outlet flow	3.4
EK 2.03	Service water system failure	3.1
EK 2.04	Component cooling system failure	3.3
EK 3	**Knowledge of the reasons for the following actions as they apply to the response to unexpected reactor coolant system temperature changes during shutdown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
EK 3.01	Implementing SDP-2 Response to loss of normal residual heat removal system during shutdown	3.4
EA 1	**Ability to operate and/or monitor the following as they apply to the response to unexpected reactor coolant system temperature changes during shutdown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
EA 1.01	Component cooling water system	3.1
EA 1.02	Normal residual heat removal system	3.4
EA 1.03	Service water system	3.0

EA 2	**Ability to evaluate the following parameters and/or conditions as they apply to the response to unexpected reactor coolant system temperature changes during shutdown:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
EA 2.01	Reactor coolant system and/or normal residual heat removal system heat exchanger outlet temperature	3.6	3.7

4.2 Abnormal Plant Evolutions

4.2.1 A-301 Rapid Power Reduction

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between rapid power reduction and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Auxiliary steam system	1.9
AK 1.02	Online power distribution monitoring system	2.9
AK 1.03	Chemical and volume control system	2.8
AK 1.04	Digital rod control system	3.4
AK 1.05	Engineered safeguards actuation system	3.3
AK 1.06	Main and startup feedwater system	3.0
AK 1.07	Main steam system	2.9
AK 1.08	Pressurizer level control system	3.1
AK 1.09	Pressurizer pressure control system	3.2
AK 1.10	Reactor trip system	3.4
AK 1.11	Steam dump control system	3.1
AK 1.12	Steam generator water level control system	3.1
AK 1.13	Main turbine control and diagnostics system	2.8
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to rapid power reduction:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Reducing turbine load at rate less than 1 percent per minute or greater than 5 percent per minute	3.0
AK 2.02	Overboration or excessive control rod insertion	3.4
AK 2.03	Underboration or inadequate rod motion	3.6
AK 2.04	Failure of P-10, Power range neutron flux to reset	3.3
AK 2.05	P-6, Intermediate-Range Neutron Flux resetting before source range nuclear instrumentation power is below the source range nuclear instrumentation reactor trip setpoint	3.2
AK 2.06	Failure of the source range nuclear instrumentation to energize	3.0
AK 3	**Knowledge of the reasons for the following actions as they apply to rapid power reduction:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Consulting online power distribution monitoring system	2.9
AK 3.02	Energizing pressurizer backup heaters	2.6
AK 3.03	Placing steam dump control system in the steam pressure mode	2.9
AK 3.04	Placing digital rod control system in low-power mode	3.0
AK 3.05	Verifying P-10, Power Range Neutron Flux permissive status	3.2
AK 3.06	Verifying source range nuclear instrumentation status	3.0

AK 3.07	Performing reactor trip breaker trip actuating device operational test and/or source range nuclear instrumentation reactor trip channel operational test	2.7	
AK 3.08	Performing reactor coolant system sampling	2.3	
AK 3.09	Resetting C-7, Steam Dump Control System Load Reject Arming Signal	2.8	
AK 3.10	Operating digital rod control system in manual	3.2	

AA 1 **Ability to operate and/or monitor the following as they apply to rapid power reduction:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Chemical and volume control system makeup and letdown	2.9
AA 1.02	Digital rod control system and rod blocks	3.2
AA 1.03	Engineered safeguards actuation system and reactor trip system interlocks and blocks (P-10, P-6)	3.5
AA 1.04	Main and startup feedwater system	2.9
AA 1.05	Heater drain system	2.3
AA 1.06	Main generator output breakers	2.6
AA 1.07	Main steam system	2.7
AA 1.08	Pressurizer level control system	3.1
AA 1.09	Pressurizer pressure control system	3.1
AA 1.10	Reactor trip system	3.4
AA 1.11	Steam dump control system and/or C-7, Steam Dump Control System Load Reject Arming Signal	3.0
AA 1.12	Steam generator water level control	3.1
AA 1.13	Main turbine control and diagnostics system	2.6

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to rapid power reduction:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Control rod positions and control rod insertion limits	3.2	3.7
AA 2.02	Reactor coolant system boron addition volume and rate	3.0	3.1
AA 2.03	Reactor coolant system T_{avg} and/or $T_{avg} – T_{ref}$ deviation	2.8	3.0
AA 2.04	AFD and/or power margin	2.7	3.2
AA 2.05	Turbine load and/or steam dump demand	2.5	3.0
AA 2.06	Pressurizer pressure and/or level	3.0	3.2
AA 2.07	Feedwater flow and/or steam generator levels	3.0	3.1
AA 2.08	Reactor power (nuclear instrumentation system, ΔT, calorimetric)	3.3	3.6
AA 2.09	Condenser vacuum	1.8	2.7

4.2.2 A-302 Emergency Boration

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between emergency boration and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Chemical and volume control system	3.1
AK 1.02	Digital rod control system	3.0
AK 1.03	Engineered safeguards actuation system	3.2
AK 1.04	Nuclear instrumentation system	2.8
AK 1.05	Primary sampling system	2.1
AK 1.06	Reactor coolant system	2.9
AK 1.07	Normal residual heat removal system	2.5
AK 1.08	Steam generator system	2.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to emergency boration:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Reactor coolant system T_{avg} rising in an uncontrolled manner	3.3
AK 2.02	Reactor power rising in an uncontrolled manner	3.6
AK 2.03	Reactor critical with excessive control rod motion	3.4
AK 2.04	Reactor critical with control rods inserted below the rod insertion limit	3.6
AK 2.05	Failure of two or more rods to insert following a reactor trip	3.5
AK 2.06	Inadequate shutdown margin	3.6
AK 2.07	Reactor subcritical with neutron count rising in an uncontrolled manner	3.6
AK 2.08	High flux at shutdown alarm	3.1
AK 2.09	Rapid reactor coolant system boration mandated by technical specifications or another procedure	3.2
AK 2.10	Establishing boration flow	3.4
AK 2.11	Failure of pressurizer level control system	2.8
AK 2.12	Stopping boration flow	2.9
AK 2.13	High steam generator level	2.5
AK 3	**Knowledge of the reasons for the following actions as they apply to emergency boration:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Checking chemical and volume control system makeup and/or purification lines are aligned	3.1
AK 3.02	Checking pressurizer level in normal control band	2.7
AK 3.03	Energizing pressurizer backup heaters	2.7
AK 3.04	Sampling reactor coolant system and/or pressurizer boron	2.3

AA 1 **Ability to operate and/or monitor the following as they apply to emergency boration:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Chemical and volume control system controls and indications and/or normal residual heat removal system controls and indications	3.1
AA 1.02	Safeguards actuation	3.4
AA 1.03	Chemical and volume control system isolation actuation	3.1
AA 1.04	Boron dilution block	3.3
AA 1.05	Pressurizer heater controls and indications	2.7
AA 1.06	Reactor vessel vent controls and indications	2.6
AA 1.07	Control rod motion controls and indications	3.3

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to emergency boration:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Pressurizer level and/or pressure	2.8	3.0
AA 2.02	Pressurizer and/or reactor coolant system boron concentrations	3.0	3.0
AA 2.03	Reactor coolant pump and/or reactor coolant system flow indications	2.7	2.8
AA 2.04	Reactor coolant system T_{avg} and T_{ref}	3.0	3.3
AA 2.05	Reactor power	3.3	3.7
AA 2.06	Control rod position and speed	3.2	3.7
AA 2.07	Shutdown margin	3.2	3.6
AA 2.08	Boron and/or charging flow	3.0	3.2
AA 2.09	Purification and/or letdown flow	2.7	2.7

4.2.3 A-304 Steam Generator Tube Leak

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a steam generator tube leak and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Auxiliary steam system	1.9
AK 1.02	Blowdown system	2.9
AK 1.03	Component cooling water system	2.2
AK 1.04	Condensate system	2.5
AK 1.05	Condensate polishing system	2.3
AK 1.06	Chemical and volume control system	2.8
AK 1.07	Digital rod control system	2.6
AK 1.08	Engineered safeguards actuation system	3.4
AK 1.09	Main and startup feedwater system	2.9
AK 1.10	Main steam system	2.9
AK 1.11	Main turbine system	2.4
AK 1.12	Nuclear instrumentation system	2.6
AK 1.13	Pressurizer level control system	3.2
AK 1.14	Pressurizer pressure control system	3.1
AK 1.15	Passive core cooling system	3.0
AK 1.16	Reactor coolant system	3.1
AK 1.17	Radiation monitoring system	3.3
AK 1.18	Normal residual heat removal system	2.6
AK 1.19	Reactor trip system	3.1
AK 1.20	Steam dump control system	3.0
AK 1.21	Steam generator system	3.1
AK 1.22	Turbine building ventilation system	2.5
AK 1.23	Liquid radwaste system	2.3
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a steam generator tube leak:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Inability to maintain pressurizer level using normal makeup	3.3
AK 2.02	SG PORV failing open on the leaking steam generator	3.9
AK 2.03	Magnitude of tube leak	3.4
AK 2.04	Removing the SG PORV from service on the leaking steam generator	3.4
AK 2.05	Failing to isolate the leaking steam generator	3.8
AK 2.06	Underfilling or overfilling a leaking steam generator	3.4
AK 2.07	Exceeding the cooldown limit in any 60-minute period	3.2
AK 2.08	Using passive residual heat removal system for reactor coolant system cooldown	3.2
AK 2.09	Leaking steam generator pressure lowering to less than or equal to intact steam generator pressure	3.2
AK 2.10	Releasing steam from a steam generator that has water in the steamline	3.4

AK 2.11	Backfill method of reducing leaking steam generator pressure	3.2
AK 2.12	Steam generator blowdown method of reducing leaking steam generator pressure	3.1
AK 2.13	Steam release method of reducing leaking steam generator pressure	3.2
AK 2.14	Auxiliary spray line not being available for reactor coolant system depressurization (PRA related)	3.1
AK 2.15	Using the intact steam generator to cool the reactor coolant system with insufficient water available to secondary prior to depressurization (PRA related)	3.3
AK 2.16	Failure to maintain steam generator water level above steam generator tubes (PRA related)	3.6
AK 2.17	Failure to have the startup feedwater system available (PRA related)	3.2

AK 3 **Knowledge of the reasons for the following actions as they apply to a steam generator tube leak:**
(CFR: 41.5 / 41.10 / 45.6 / 45.13)

AK 3.01	Maintaining pressurizer level above minimum program level	3.1
AK 3.02	Isolating condenser hotwell overflow and condensate polishers and/or transferring auxiliary steam loads to the auxiliary boiler	2.9
AK 3.03	Checking reactor shutdown before depressurizing the reactor coolant system	3.6
AK 3.04	Depressurizing the reactor coolant system to minimize subcooling	3.4
AK 3.05	Choosing different methods of depressurizing Reactor Coolant System in order of preference (normal pressurizer spray, auxiliary spray, and first-stage automatic depressurization system)	3.2
AK 3.06	Stopping the reactor coolant system depressurization if upper head voiding is indicated	3.3
AK 3.07	Maintaining pressurizer pressure below P-11, Pressurizer Pressure below 1,970 psig after blocking steamline isolation actuation, feedwater isolation actuations, and/or safeguards actuations	3.1
AK 3.08	Blocking steamline isolation actuation, feedwater isolation actuations, and/or safeguards actuations	3.2
AK 3.09	Maintaining reactor coolant system temperature stable until beginning the cooldown	3.1
AK 3.10	Borating to cold shutdown and continuously monitoring shutdown margin	3.2
AK 3.11	Using pressurizer heaters and sprays to maintain subcooling at 20 degrees F after the reactor coolant system depressurization	3.2
AK 3.12	Isolating secondary side of the leaking steam generator before cooling the reactor coolant system	3.5
AK 3.13	Raising leaking SG PORV setpoint to 1,160 psig	3.4
AK 3.14	Maintaining leaking steam generator level between 26 and 82 percent	3.3
AK 3.15	Maintaining total feedwater flow to the intact steam generator greater than 400 gallons per minute (gpm) until level is greater than 26 percent	3.2

AK 3.16	Reducing leaking steam generator pressure during reactor coolant system cooldown	2.9	
AK 3.17	Cycling leaking steam generator level between 26 and 77 percent	3.0	

AA 1 Ability to operate and/or monitor the following as they apply to a steam generator tube leak:
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Chemical and volume control system makeup, letdown, and/or auxiliary spray	2.8	
AA 1.02	Reactor trip system and engineered safeguards actuation system	3.4	
AA 1.03	Hotwell level	2.3	
AA 1.04	Condensate polishing system	2.1	
AA 1.05	Passive residual heat removal system	3.1	
AA 1.06	Normal residual heat removal system	2.7	
AA 1.07	Steam dump control system and/or SG PORV	3.1	
AA 1.08	Pressurizer heater and/or spray	3.0	
AA 1.09	Reactor coolant pump	2.9	
AA 1.10	Main steamline isolation actuation block	3.2	
AA 1.11	Feedwater isolation actuations block	3.1	
AA 1.12	Low pressurizer pressure safeguards block	3.1	
AA 1.13	Automatic depressurization system	3.3	
AA 1.14	Component cooling water system	2.4	
AA 1.15	Passive core cooling system	3.1	
AA 1.16	Steam generator system	3.1	
AA 1.17	Main and startup feedwater system	2.9	
AA 1.18	Blowdown system	2.8	

AA 2 Ability to evaluate the following parameters and/or conditions as they apply to a steam generator tube leak:
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Pressurizer level and/or pressure	3.0	3.4
AA 2.02	Steam generator levels and/or pressures	3.3	3.7
AA 2.03	Steam generator leak rate	2.7	3.6
AA 2.04	Core exit temperatures and/or reactor coolant system subcooling	2.8	3.3
AA 2.05	T_{cold} and/or cooldown rate	3.0	3.3
AA 2.06	Main steamline radiation, steam generator blowdown electrodeionization effluent process radiation, and/or turbine island vent effluent radiation	3.2	3.3

4.2.4 A-306 Evacuation of Control Room

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between evacuation of the control room and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Chemical and volume control system	2.7
AK 1.02	Diverse actuation system	3.7
AK 1.03	Digital rod control system	2.9
AK 1.04	Fuel handling system	2.1
AK 1.05	Main and startup feedwater system	2.7
AK 1.06	Main steam system	2.7
AK 1.07	Protection and safety monitoring system	3.6
AK 1.08	Reactor coolant system	2.8
AK 1.09	Remote shutdown workstation	3.9
AK 1.10	Steam dump control system	2.9
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to evacuation of the control room:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Reactor trip or failure of the reactor to trip	3.9
AK 2.02	High control room radiation and/or airborne activity	3.7
AK 2.03	Toxic vapors in the control room	3.7
AK 2.04	Fire, smoke, or explosion in the control room	3.7
AK 3	**Knowledge of the reasons for the following actions as they apply to evacuation of the control room:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Tripping the reactor prior to main control room evacuation	3.8
AK 3.02	Stopping any dilution and/or stabilizing reactor coolant system temperature prior to main control room evacuation	3.6
AK 3.03	Placing the remote shutdown workstation transfer switch to the remote position	3.8
AK 3.04	Placing the diverse actuation system disable switch to the disable position	3.8
AK 3.05	Establishing control of the plant using local diverse actuation system controls	3.7
AK 3.06	Initiating a reactor coolant system cooldown to less than 420 degrees F	3.3
AA 1	**Ability to operate and/or monitor the following as they apply to evacuation of the control room:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Reactor trip controls	3.8

AA 1.02	Chemical and volume control system makeup controls	2.9
AA 1.03	Main and startup feedwater system controls	2.8
AA 1.04	Steam dump control system	2.9
AA 1.05	SG PORV controls	3.0
AA 1.06	Remote shutdown workstation controls	3.7
AA 1.07	Diverse actuation system disable switch	3.6

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to evacuation of the control room:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Reactor trip breaker position, digital rod position indication control rod positions, and/or neutron flux	3.3	3.8
AA 2.02	Chemical and volume control system makeup system flows	2.8	2.9
AA 2.03	Reactor coolant system temperature	3.3	3.0
AA 2.04	Pressurizer level	2.8	3.0

4.2.5 A-307 DAS Operation at Local Cabinets

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between diverse actuation system (DAS) operation at local cabinets and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Passive core cooling system	3.2
AK 1.02	Reactor coolant system	3.0
AK 1.03	Automatic depressurization system	3.5
AK 1.04	Rod drive M-G sets	3.1
AK 1.05	Passive containment cooling system	3.0
AK 1.06	Diverse actuation system critical containment isolations	3.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to diverse actuation system operation at local cabinets:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Squib valve operation	3.8
AK 2.02	Diverse actuation system manual enable switch	3.4
AK 3	**Knowledge of the reasons for the following actions as they apply to diverse actuation system operation at local cabinets:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Check M-G set voltage	2.9
AK 3.02	Operation of diverse actuation system manual enable switch	3.3
AK 3.03	Check reactor coolant system temperature	3.1
AK 3.04	Check pressurizer level	2.9
AK 3.05	Check steam generator level	2.7
AK 3.06	Check diverse actuation system containment temperature	2.9
AK 3.07	Check core exit temperature	3.3
AA 1	**Ability to operate and/or monitor the following as they apply to diverse actuation system operation at local cabinets:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Passive core cooling system	3.4
AA 1.02	Reactor coolant system	2.9
AA 1.03	ADS	3.5
AA 1.04	Rod drive M-G sets	2.9
AA 1.05	Passive containment cooling system	3.1
AA 1.06	Diverse actuation system critical containment isolations	3.2
AA 1.07	Squib valve blasting device	3.2

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to diverse actuation system operation at local cabinets:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Reactor trip	3.6	3.8
AA 2.02	Reactor coolant system conditions	3.1	3.1
AA 2.03	Steam generator conditions	2.7	3.1
AA 2.04	Containment conditions	2.8	3.1

4.2.6 A-308 Loss of Control Room Air Conditioning

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of control room air conditioning and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Ancillary diesel generator	2.6
AK 1.02	Main AC power system	2.6
AK 1.03	Engineered safeguards actuation system (main control room isolation and air supply initiation actuation)	3.6
AK 1.04	Class 1E DC and UPS system	3.2
AK 1.05	Reactor coolant system	2.4
AK 1.06	Radiation monitoring system	2.9
AK 1.07	Nuclear island nonradioactive ventilation system	2.6
AK 1.08	Main control room emergency habitability system	3.7
AK 1.09	Central chilled water system	2.6
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of control room air conditioning:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Main control room isolation and air supply initiation actuation	3.7
AK 2.02	Fire in the main control room or controls service area	3.6
AK 2.03	Placing the main control room ancillary fan in service and propping doors open	3.0
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of control room air conditioning:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Verifying fire damper positions	2.8
AK 3.02	Verify main control room isolation and air supply initiation actuation has not been actuated	3.2
AK 3.03	Verifying no gaseous radiation in main control room air intake	3.3
AK 3.04	Providing alternate main control room cooling if normal cooling cannot be established with fresh air makeup	3.1
AK 3.05	Maintaining main control room temperature less than 75 degrees F	3.2
AK 3.06	Limiting main control room occupancy when main control room emergency habitability system is providing main control room cooling	3.3
AK 3.07	Placing the main control room ancillary fan in service and opening doors	2.9

AA 1	**Ability to operate and/or monitor the following as they apply to a loss of control room air conditioning:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Ancillary diesel generator	2.6	
AA 1.02	Main control room isolation and air supply initiation actuation	3.4	
AA 1.03	Nuclear island nonradioactive ventilation system fire dampers, supply and return fans and dampers, and/or outside air supply dampers	2.8	
AA 1.04	Main control room emergency habitability system	3.6	
AA 1.05	Main control room ancillary fan	2.8	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a loss of control room air conditioning** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Main control room temperature, pressure, and/or main control room radiation	3.3	3.4
AA 2.02	Nuclear island nonradioactive ventilation system flow	2.3	2.8

4.2.7 A-311 Rod Control System Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between rod control system malfunctions and the following systems or components:**	
AK 1.01	Chemical and volume control system	2.8
AK 1.02	Digital rod control system	3.5
AK 1.03	Nuclear instrumentation system	3.4
AK 1.04	Online power distribution monitoring system	3.3
AK 1.05	Reactor coolant system	2.8
AK 1.06	Rod position indication system	3.4
AK 1.07	Reactor trip system	3.6
AK 1.08	Main turbine control and diagnostics system	2.7
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to rod control system malfunctions:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Turbine runback or load rejection	3.5
AK 2.02	Dropped rod effect on nuclear instrumentation system	3.6
AK 2.03	Dropped or misaligned rods effect on reactor poisons and/or fuel (OE related)	3.7
AK 2.04	Retrieval of dropped or misaligned rods effect on reactor poisons and/or fuel (OE related)	3.5
AK 2.05	Dropped control rod during reactor startup (OE related)	3.7
AK 2.06	Effect reducing power has on power margin	3.1
AK 2.07	Control banks not within insertion, sequence, and/or overlap limits specified in the core operating limits report	3.6
AK 2.08	Shutdown banks not within insertion limits specified in the core operating limits report	3.5
AK 2.09	Digital rod position indication failure	3.0
AK 2.10	Group demand indication failure	2.9
AK 2.11	Effect of inoperable (untrippable) rod on shutdown margin	3.3
AK 2.12	Rod control urgent alarm and/or rod control nonurgent alarm	3.1
AK 2.13	Failure of inputs to rod control system	3.2
AK 2.14	Online power distribution monitoring system operability	3.4
AK 3	**Knowledge of the reasons for the following actions as they apply to rod control system malfunctions:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Determining if generator load is stable	3.1
AK 3.02	Checking online power distribution monitoring system is operable	3.3
AK 3.03	Tripping the reactor	3.8
AK 3.04	Choosing to move the rod bank to the misaligned rod vs. the misaligned rod to the rod bank (OE related)	3.2

AK 3.05	Positioning rod control to the affected bank to recover dropped rods or when moving the misaligned rod to the bank (OE related)	2.9	
AK 3.06	Maintaining power margin greater than zero during dropped rod recovery (OE related)	3.6	

AA 1 **Ability to operate and/or monitor the following as they apply to rod control system malfunctions:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Digital rod control system	3.3
AA 1.02	Reactor trip controls	3.7
AA 1.03	Chemical and volume control system makeup and letdown	2.6
AA 1.04	Turbine load	2.9

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to rod control system malfunctions:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Digital rod position indication	2.8	3.4
AA.2.02	Group demand position indication	2.8	3.3
AA 2.03	Power margin	3.2	3.3
AA 2.04	T_{avg} and/or T_{cold}	3.0	3.1
AA 2.05	Reactor power and/or turbine power	3.5	3.6
AA 2.06	AFD and/or quadrant power tilt ratio	3.2	3.6

4.2.8 A-313 Uncontrolled Cooldown

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between uncontrolled cooldown and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Condensate system	2.5
AK 1.02	Containment system	2.5
AK 1.03	Chemical and volume control system	2.8
AK 1.04	Digital rod control system	2.7
AK 1.05	Engineered safeguards actuation system	3.4
AK 1.06	Main and startup feedwater system	3.4
AK 1.07	Main steam system	3.5
AK 1.08	Heater drain system	2.5
AK 1.09	Passive core cooling system	3.3
AK 1.10	Normal residual heat removal system	2.9
AK 1.11	Steam generator system	3.3
AK 1.12	Main turbine control and diagnostic system	3.1
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to uncontrolled cooldown:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Effect of changing steam demand on reactor power (nuclear instrumentation system, calorimetric, and ΔT)	3.6
AK 2.02	Effect of control rod insertion on reactor power (nuclear instrumentation system, calorimetric, and ΔT)	3.4
AK 2.03	Effect of changing feedwater temperature on reactor power (nuclear instrumentation system, calorimetric, and ΔT)	3.7
AK 2.04	Inadvertent passive residual heat removal actuation	3.7
AK 2.05	Normal residual heat removal system malfunction	3.2
AK 3	**Knowledge of the reasons for the following actions as they apply to uncontrolled cooldown:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Reducing steam demand	3.4
AK 3.02	Tripping the reactor	3.9
AK 3.03	Initiating safeguards actuation	3.9
AK 3.04	Ensuring no steam flow/feed flow mismatch exists	3.2
AK 3.05	Checking feedwater heater alignment	2.8
AK 3.06	Checking for passive residual heat removal actuation	3.6
AK 3.07	Checking for normal residual heat removal system malfunction	3.1
AK 3.08	Initiating a boration	3.5

AA 1	**Ability to operate and/or monitor the following as they apply to uncontrolled cooldown:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Main turbine load control	3.0	
AA 1.02	Steam dump control system	3.4	
AA 1.03	SG PORVs	3.5	
AA 1.04	Main and startup feedwater system	3.6	
AA 1.05	Reactor trip controls	3.9	
AA 1.06	Safeguards actuation	3.9	
AA 1.07	Condenser hotwell makeup	2.3	
AA 1.08	Main steam isolation valve controls	3.5	
AA 1.09	Passive residual heat removal system controls	3.4	
AA 1.10	Chemical and volume control system makeup controls	2.9	
AA 1.11	Normal residual heat removal system controls	3.1	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to uncontrolled cooldown:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Reactor power (nuclear instrumentation system, calorimetric, and ΔT)	3.3	3.8
AA 2.02	Pressurizer level and/or pressure	3.3	3.2
AA 2.03	Reactor coolant system temperature	3.5	3.7
AA 2.04	Steam flow and/or feedwater flow	3.0	3.4
AA 2.05	Passive residual heat removal system flow	3.3	3.2
AA 2.06	Steam dump valves and/or SG PORV positions	3.3	3.3
AA 2.07	Containment pressure and/or temperature	3.0	3.1

4.2.9 A-314 Fuel Handling Incidents

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between the fuel handling incidents and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Containment isolation valves	3.3
AK 1.02	Containment equipment and personnel hatches	3.2
AK 1.03	Containment air filtration system	3.1
AK 1.04	Chemical and volume control system makeup	2.7
AK 1.05	Fuel handling area normal HVAC	2.8
AK 1.06	Fuel handling system	3.3
AK 1.07	Reactor containment fan coolers	2.7
AK 1.08	Radiation monitoring system	3.6
AK 1.09	Spent fuel pool makeup	3.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to fuel handling incidents:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Damage to irradiated fuel in the fuel handling building	3.7
AK 2.02	Damage to irradiated fuel in containment	3.7
AK 3	**Knowledge of the reasons for the following actions as they apply to fuel handling incidents:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Evacuation of nonessential personnel from containment and/or fuel handling building	3.7
AK 3.02	Maintaining pressurizer/reactor cavity level and/or spent fuel pool level	3.6
AK 3.03	Suspending core alterations and placing fuel in storage location	3.8
AK 3.04	Closing the fuel transfer tube gate valve, all containment penetrations, and/or open penetrations	3.7
AK 3.05	Running reactor containment fan cooler in low speed	2.8
AK 3.06	Shutting down and isolating the containment air filtration system or fuel handling area normal HVAC	3.1
AA 1	**Ability to operate and/or monitor the following as they apply to fuel handling incidents:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Containment fan coolers	2.7
AA 1.02	Containment isolation valves	3.6
AA 1.03	Containment air filtration system	3.1
AA 1.04	Fuel handling area normal HVAC	2.9
AA 1.05	Fuel handling equipment	3.4

		RO	SRO
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to fuel handling incidents:** (CFR: 41.7 / 43.5 / 45.6)		
AA 2.01	Containment building, fuel handling building, and/or plant vent radiation level	3.3	3.4

4.2.10 A-317 Loss of Component Cooling Water

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of component cooling water and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Chilled water system chillers	2.6
AK 1.02	Condensate pumps	2.2
AK 1.03	Compressed air system	2.6
AK 1.04	Chemical and volume control system makeup pumps and/or letdown heat exchanger	2.9
AK 1.05	Reactor coolant pumps and variable frequency drives	3.2
AK 1.06	Normal residual heat removal system	2.9
AK 1.07	Spent fuel pool cooling system	2.9
AK 1.08	Reactor coolant drain tank heat exchanger	2.3
AK 1.09	Primary sample system	2.3
AK 1.10	Radiation monitoring system	2.7
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of component cooling water:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Leakage into or out of the component cooling water system	3.0
AK 2.02	Loss of service water system to the component cooling water system heat exchanger	3.1
AK 2.03	Chilled water system chillers	2.5
AK 2.04	Loss of component cooling water system to condensate pumps	2.4
AK 2.05	Loss of component cooling water system to chemical and volume control system makeup pumps and/or letdown heat exchanger	2.9
AK 2.06	Loss of component cooling water system to reactor coolant pumps and variable frequency drives	3.3
AK 2.07	Loss of component cooling water system to normal residual heat removal system	3.0
AK 2.08	Loss of component cooling water system to spent fuel pool cooling system	3.1
AK 2.09	Loss of component cooling water system to reactor coolant drain tank heat exchanger	2.3
AK 2.10	Loss of component cooling water system to primary sample system	2.2
AK 2.11	Loss of component cooling water system to compressed air system	2.5

AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of component cooling water:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
AK 3.01	Tripping the reactor	3.6	
AK 3.02	Stopping all reactor coolant pumps and variable frequency drives	3.4	
AK 3.03	Verifying adequate and stable component cooling water system surge tank level	3.0	
AK 3.04	Verifying the component cooling water system heat exchanger outlet temperature is less than 110 degrees F	2.8	
AK 3.05	Isolating the chemical and volume control system purification loop	2.7	
AK 3.06	Maintaining 50 gpm of makeup flow through the running chemical and volume control system makeup pump	2.7	
AK 3.07	Isolating the liquid sample lines	2.1	
AK 3.08	Stopping the reactor coolant drain tank pumps	2.2	
AA 1	**Ability to operate and/or monitor the following as they apply to a loss of component cooling water:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Reactor trip controls	3.4	
AA 1.02	Reactor coolant pumps and variable frequency drives	3.3	
AA 1.03	Component cooling water system	3.1	
AA 1.04	Condensate system	2.3	
AA 1.05	Compressed air system	2.7	
AA 1.06	Central chilled water system chiller pumps	2.4	
AA 1.07	Normal residual heat removal system	2.9	
AA 1.08	Chemical and volume control system makeup, purification, and/or letdown	2.8	
AA 1.09	Spent fuel pool cooling system	2.9	
AA 1.10	Liquid radwaste system and primary sampling system	2.2	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a loss of component cooling water:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Component cooling water system surge tank level	3.3	3.0
AA 2.02	Component cooling water system heat exchanger outlet temperature	3.3	2.9
AA 2.03	Reactor coolant pump and variable frequency drive temperatures	3.3	3.4
AA 2.04	Compressed air system compressor temperatures	3.0	2.7
AA 2.05	Condensate pump temperatures	3.3	2.2
AA 2.06	Spent fuel pool temperature	3.3	2.9

4.2.11 A-318 Condensate System Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a condensate system malfunction and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Steam generator blowdown system	2.1
AK 1.02	Condenser air removal system	2.3
AK 1.03	Condensate polishing system	2.2
AK 1.04	Demineralized water transfer and storage system	2.0
AK 1.05	Main and startup feedwater system	2.9
AK 1.06	Gland seal system	2.1
AK 1.07	Heater drain system	2.4
AK 1.08	Main steam system	2.6
AK 1.09	Main turbine system	2.6
AK 1.10	Hotwell makeup control valve and/or hotwell overflow control valve	2.8
AK 1.11	Condensate pumps	3.1
AK 1.12	Booster/main feedwater pumps	2.9
AK 1.13	Deaerator storage tank	2.6
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a condensate system malfunction:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Loss of condensate pumps	3.3
AK 2.02	Deaerator storage tank level outside of normal operating band	2.7
AK 2.03	Deaerator storage tank recirculation valve/dump valve failure	2.8
AK 2.04	Condensate regulating valve failure	3.0
AK 2.05	Loss of cooling to gland sealing condenser	2.5
AK 3	**Knowledge of the reasons for the following actions as they apply to a condensate system malfunction:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Maintaining hotwell level between the high and/or low limits	2.7
AK 3.02	Starting standby condensate pumps	2.8
AK 3.03	Tripping the turbine	3.0
AK 3.04	Performing a rapid power reduction	3.2
AK 3.05	Verifying both polisher vessels are in service and/or the bypass is open	2.3
AK 3.06	Isolating the condensate pump miniflow	2.2
AK 3.07	Maintaining deaerator storage tank level between the high and/or low limits	2.5
AK 3.08	Isolating steam generator blowdown flow	2.5
AK 3.09	Verifying adequate gland sealing steam condenser flow	2.1
AK 3.10	Stopping booster/main feedwater pumps	3.0

AA 1	**Ability to operate and/or monitor the following as they apply to a condensate system malfunction:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Hotwell level control	2.9	
AA 1.02	Turbine load and trip controls	3.1	
AA 1.03	Condensate pump and/or miniflow controls	2.8	
AA 1.04	Booster/main feedwater pumps	3.2	
AA 1.05	Condensate polisher vessel and/or bypass valve controls	2.5	
AA 1.06	Deaerator storage tank level control	2.7	
AA 1.07	Feedwater heater controls	2.4	
AA 1.08	Moisture separator reheater shell drain tank level controls	2.3	
AA 1.09	Steam generator blowdown system controls	2.5	
AA 1.10	Gland sealing steam condenser flow control	2.3	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a condensate system malfunction:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Hotwell or deaerator storage tank level	3.0	2.8
AA 2.02	Condensate pressure and/or flow	3.0	2.8
AA 2.03	Steam generator blowdown system heat exchanger outlet temperature and/or flow	2.3	2.2
AA 2.04	Gland sealing steam condenser flow	2.3	2.1
AA 2.05	Condensate polisher ΔP	2.7	2.3

4.2.12 A-320 Loss of Circulating Water

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of circulating water and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Condensate system	2.6
AK 1.02	Condenser air removal system	2.6
AK 1.03	Main steam system	2.8
AK 1.04	Main turbine system	3.0
AK 1.05	Turbine building closed cooling water system	2.4
AK 1.06	Liquid radwaste system	2.4
AK 1.07	Turbine and/or auxiliary building sumps	2.2
AK 1.08	Circulating water pumps and/or discharge valves	2.7
AK 1.09	Circulating water trash screens	2.6
AK 1.10	Circulating water system cooling tower makeup sources	2.6
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of circulating water:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Loss of circulating water system effect on steam dump control system	3.0
AK 2.02	Effect or turbine load reduction at a rate that actuates C-7, Steam Dump Control System Load Reject Arming Signal and opens the steam dumps	3.3
AK 2.03	Loss of circulating water effect on liquid radwaste system discharge	2.9
AK 2.04	Loss of circulating water effect on turbine building closed cooling water system	2.6
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of circulating water:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Terminating liquid waste releases	3.1
AK 3.02	Tripping the reactor and stopping all circulating water system pumps	3.3
AK 3.03	Checking turbine and/or auxiliary building sump levels	2.6
AK 3.04	Checking turbine building closed cooling water system heat exchanger discharge flow rate	2.4
AK 3.05	Checking circulating water system to condenser air removal system seal water heat exchanger flow	2.3
AK 3.06	Checking circulating water pump motor cooling water flow is adequate	2.6
AK 3.07	Reducing turbine load	3.3

AA 1 **Ability to operate and/or monitor the following as they apply to a loss of circulating water:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Circulating water pump controls	2.9
AA 1.02	Reactor trip controls	3.3
AA 1.03	Turbine load controls	3.3
AA 1.04	Cooling tower level makeup and/or blowdown control	2.6
AA 1.05	Turbine building closed cooling water system heat exchanger strainer isolation valves and/or backwash controls	2.4
AA 1.06	Condenser air removal system seal water heat exchanger isolation valves	2.3
AA 1.07	Circulating water pump motor cooling water flow	2.6

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a loss of circulating water:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Circulating water flow and/or pressure	3.0	2.9
AA 2.02	Condenser vacuum	3.3	3.1
AA 2.03	Turbine and/or auxiliary building sump level	2.3	2.3
AA 2.04	Cooling tower level	2.7	2.4
AA 2.05	Turbine building closed cooling water system heat exchanger flows and outlet temperatures	2.7	2.3
AA 2.06	Condenser air removal system seal water heat exchanger flows and/or temperatures	2.7	2.2
AA 2.07	Circulating water pump motor temperatures	2.7	2.4
AA 2.08	Trash screen ΔP	2.7	2.4

4.2.13 A-321 Malfunction of Data Display and Processing System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a malfunction of the data display and processing system and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Computerized procedure system	3.1
AK 1.02	Diverse actuation system	3.5
AK 1.03	Qualified dedicated safety panels	3.3
AK 1.04	Nuclear application programs	2.9
AK 1.05	Control room operator workstations	3.3
AK 1.06	Plant control system	3.5
AK 1.07	Protection and safety monitoring system	3.5
AK 1.08	Remote shutdown workstation	2.1
AK 1.09	Wall panel information system	3.0
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a malfunction of the data display and processing system:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Data display and processing system controller failure	3.4
AK 2.02	Data display and processing system network failure	3.4
AK 2.03	Data display and processing system network failure coincident with a loss of more than two protection and safety monitoring system channels	3.8
AK 3	**Knowledge of the reasons for the following actions as they apply to a malfunction of the data display and processing system:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Verifying normal operation of the computerized procedure system	3.1
AK 3.02	Taking manual or local control of individual components for a data display and processing system controller failure	3.4
AK 3.03	Monitoring the plant using diverse actuation system and qualified dedicated safety panels	3.5
AK 3.04	Maintaining the plant stable during a data display and processing system network failure	3.4
AA 1	**Ability to operate and/or monitor the following as they apply to a malfunction of the data display and processing system:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Diverse actuation system	3.7
AA 1.02	Protection and safety monitoring system	3.8

AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a malfunction of the data display and processing system:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Data display and processing system alarms and/or data quality codes	3.3	3.1

4.2.14 A-323 Loss of 6.9-Kilovolt, 4,160-Volt, or 480-Volt Bus Power

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of 6.9-kV or 480-V bus power and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Automatic depressurization system	3.6
AK 1.02	Chemical and volume control system	2.7
AK 1.03	Standby diesel and auxiliary boiler fuel oil system	2.8
AK 1.04	Non-Class IE DC and UPS system	2.6
AK 1.05	Class IE DC and UPS system	3.6
AK 1.06	Passive core cooling system	3.5
AK 1.07	Nuclear island nonradioactive ventilation system	2.4
AK 1.08	Main control room emergency habitability system	3.2
AK 1.09	Transmission switchyard and offsite power system	2.7
AK 1.10	Onsite standby power system	2.9
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of 6.9-kV, 4,160-V, or 480-V bus power:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Loss of AC power for greater than 72 hours	4.0
AK 2.02	Loss of power to Class IE DC and UPS system distribution panels on automatic depressurization system	3.9
AK 2.03	Loss of power to Class IE DC and UPS system distribution panels on chemical and volume control system	3.0
AK 2.04	Loss of power to standby diesel and auxiliary boiler fuel oil system	2.8
AK 2.05	Loss of power to non-Class IE DC and UPS system	2.7
AK 2.06	Loss of power to Class IE DC and UPS system	3.8
AK 2.07	Loss of power to Class IE DC and UPS system distribution panels on passive core cooling system	3.7
AK 2.08	Loss of power to Class IE DC and UPS system distribution panels on nuclear island nonradioactive ventilation system	2.6
AK 2.09	Loss of power to Class IE DC and UPS system distribution panels on main control room emergency habitability system	3.5
AK 2.10	Loss of power to transmission switchyard and offsite power system	2.6
AK 2.11	Loss of power to onsite standby power system	2.7
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of 6.9-kV, 4,160-V, or 480-V bus power:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Performing load management for any bus powered from its standby diesel generator	2.9
AK 3.02	Returning unloaded standby diesel generator to standby	2.4
AK 3.03	Ensuring an instrument air compressor is in service	2.7
AK 3.04	Ensuring a startup feedwater pump is in service	2.7

AK 3.05	Ensuring a train of service water pumps and fans are in service	2.8
AK 3.06	Ensuring a component cooling water system pump is in service	2.8
AK 3.07	Ensuring a normal residual heat removal system pump is in service	2.9
AK 3.08	Operating the reactor containment recirculation fans in low speed	2.3
AK 3.09	Ensuring standby diesel generator support equipment is in service	2.5
AK 3.10	Ensuring battery chargers are in service	3.4
AK 3.11	Ensuring a chemical and volume control system makeup pump is in service	2.6
AK 3.12	Verifying core makeup tank, pressurizer, and in-containment refueling water storage tank levels are stable	3.0
AK 3.13	Removing all loads from the Class IE DC and UPS system batteries	3.5
AK 3.14	Actuating automatic depressurization system stages 1-3	3.9
AK 3.15	Placing the ancillary diesel generator in service	2.9

AA 1 **Ability to operate and/or monitor the following as they apply to a loss of 6.9-kV, 4,160-V, or 480-V bus power:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	6.9-kV and/or 480-V buses	2.9
AA 1.02	Class IE DC and UPS system and/or non-Class IE DC and UPS system equipment	3.4
AA 1.03	Loaded standby diesel generator and support equipment	3.0
AA 1.04	HVAC and chiller equipment	2.4
AA 1.05	Automatic depressurization system Stages 1–3	3.9

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a loss of 6.9-kV, 4,160-V, or 480-V bus power:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	6.9-kV and/or 480-V bus status and/or voltage	2.4	3.3
AA 2.02	Main step-up transformer, unit auxiliary transformer, and/or reserve auxiliary transformer status and/or voltage	2.0	3.0
AA 2.03	Standby diesel generator load	2.4	3.4
AA 2.04	Battery, battery charger, and battery bus status and/or voltage	3.2	3.7

4.2.15 A-326 Feedwater System Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between feedwater system malfunctions and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Condensate system	1.9
AK 1.02	Startup feedwater system	2.2
AK 1.03	Main turbine system	2.0
AK 1.04	Booster/main feedwater pumps	2.2
AK 1.05	Steam generator system	2.5
AK 1.06	Reactor coolant system	2.6
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to feedwater system malfunctions:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Main feed pump malfunction	2.2
AK 2.02	Main feedwater or startup feedwater regulating valve failure	2.3
AK 2.03	Main feed line break	2.6
AK 2.04	Main feed pump miniflow failure	2.1
AK 3	**Knowledge of the reasons for the following actions as they apply to feedwater system malfunctions:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Determine whether the feedwater system is intact	2.6
AK 3.02	Reduce reactor power	2.9
AK 3.03	Maintain lube oil pressure	2.0
AK 3.04	Maintain the minimum flow rate for the main feedwater pumps	2.0
AK 3.05	Maintain lube oil temperature	1.8
AK 3.06	Manually control steam generator level	2.2
AA 1	**Ability to operate and/or monitor the following as they apply to startup feedwater system malfunctions:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Condensate system	2.0
AA 1.02	Startup feedwater system	2.2
AA 1.03	Main turbine system	2.1
AA 1.04	Booster/main feedwater pumps	2.1
AA 1.05	Steam generator system	2.5
AA 1.06	Reactor coolant system	2.6

AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to feedwater system malfunctions:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Steam generator level	2.6	2.7
AA 2.02	Feedwater pressure and/or flow	2.2	2.3
AA 2.03	Reactor power/turbine power	2.6	2.6
AA 2.04	Main feedwater pump operations	2.2	2.6

4.2.16 A-327 Startup Feedwater System Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
AK 1	**Knowledge of the relationship between the startup feedwater system and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
AK 1.01	Condensate storage tank	2.8	
AK 1.02	Makeup sources to the condensate storage tank	2.5	
AK 1.03	Main and startup feedwater system	2.9	
AK 1.04	Steam generator system	2.9	
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to startup feedwater system malfunctions:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
AK 2.01	Startup feedwater pump high discharge temperature	2.5	
AK 2.02	Startup feedwater pump low or high flow rate	2.6	
AK 2.03	Startup feedwater pump trip due to causes other than startup feedwater isolation actuation	2.7	
AK 3	**Knowledge of the reasons for the following actions as they apply to the startup feedwater system:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
AK 3.01	Checking startup feedwater pump discharge temperature less than the high-temperature alarm setpoint	2.3	
AK 3.02	Checking each running startup feedwater pump flow is between minimum and maximum flowrates to support pump operation	2.8	
AA 1	**Ability to operate and/or monitor the following as they apply to startup feedwater system malfunctions:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Startup feedwater pumps and associated discharge valves	2.9	
AA 1.02	Startup feedwater control and isolation valves	3.0	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a Startup Feedwater System Malfunction:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Steam generator level	2.8	3.5
AA 2.02	Startup feedwater pump status (on/off)	2.4	3.0
AA 2.03	Startup feedwater pump discharge temperature	2.0	2.6
AA 2.04	Condensate storage tank level	2.4	3.1
AA 2.05	Startup feedwater flow and/or valve positions	2.4	3.3

4.2.17 A-328 Malfunction of Feedwater Heaters and Extraction Steam

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a malfunction of feedwater heaters and extraction steam and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Steam generator blowdown system	2.0
AK 1.02	Condensate system	2.4
AK 1.03	Main and startup feedwater system	2.6
AK 1.04	Heater drain system	2.5
AK 1.05	Main steam system	2.4
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a malfunction of feedwater heaters and extraction steam:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Loss of feedwater heater	2.9
AK 2.02	Abnormal feedwater heater level	2.6
AK 2.03	Abnormal level in moisture separator reheater, moisture separator reheater shell drain tank, moisture separator reheater first-stage reheater drain tank, or moisture separator reheater second-stage reheater drain tank	2.6
AK 2.04	Abnormal level in deaerator storage tank	2.6
AK 2.05	Effect of changing feedwater temperature on reactor power (nuclear instrumentation system, calorimetric, and ΔT)	3.5
AK 3	**Knowledge of the reasons for the following actions as they apply to a malfunction of feedwater heaters and extraction steam:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Ensuring reactor power is below maximum power limit	3.5
AK 3.02	Ensuring feedwater heaters are in service	2.5
AK 3.03	Ensuring deaerator storage tank level is in normal band and stable	2.5
AK 3.04	Ensuring moisture separator reheater shell drain tank, moisture separator reheater first-stage reheater drain tank, or moisture separator reheater second-stage reheater drain tank levels are in normal band and stable	2.5
AK 3.05	Ensuring feedwater heater levels are in normal band and stable	2.5
AA 1	**Ability to operate and/or monitor the following as they apply to a malfunction of feedwater heaters and extraction steam:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Reactor trip controls	3.6
AA 1.02	Main turbine load controls	3.0
AA 1.03	Deaerator recirculation control valve	2.4
AA 1.04	Booster/main feedwater pumps and/or miniflow control valves	2.4

AA 1.05	Extraction steam isolation and/or drain line valves	2.4	
AA 1.06	Feedwater heater inlet valve, outlet valve, or bypass isolation valves	2.4	
AA 1.07	Feedwater heater normal level control valves or alternate drain control valves	2.5	
AA 1.08	Steam generator blowdown flow control valves and/or steam generator blowdown system heat exchanger outlet to deaerator control valves	2.5	
AA 1.09	Moisture separator reheater shell drain tank or reheater drain tank level control	2.4	

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a malfunction of feedwater heaters and extraction steam:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
AA 2.01	Feedwater heater levels	2.2	2.9
AA 2.02	Deaerator storage tank level	2.0	2.8
AA 2.03	Moisture separator reheater, moisture separator reheater shell drain tank, moisture separator reheater first-stage drain tank, or moisture separator reheater second-stage drain tank level	2.2	2.8
AA 2.04	Maximum reactor power vs. pumps in service (see procedure attachment)	3.4	3.4
AA 2.05	Maximum reactor power vs. feedwater heater out of service (see procedure attachment)	3.2	3.4

4.2.18 A-329 Loss of Instrument Air

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of instrument air and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Component cooling water system cooling flow valves to chemical and volume control system letdown heat exchanger (OE related)	2.6
AK 1.02	Component cooling water system cooling flow valves to reactor coolant pumps (OE related)	3.0
AK 1.03	Core makeup tank discharge isolation valves (OE related)	3.5
AK 1.04	Containment isolation valves (OE related)	3.3
AK 1.05	Chemical and volume control system valves (OE related)	2.7
AK 1.06	Deaerator storage tank level control and/or recirculation valves (OE related)	2.5
AK 1.07	Feedwater regulating and/or isolation valves (OE related)	2.9
AK 1.08	Feedwater heater normal and/or alternate level control valves (OE related)	2.5
AK 1.09	Fuel handling equipment (OE related)	2.3
AK 1.10	In-containment refueling water storage tank gutter isolation valves (OE related)	3.0
AK 1.11	Main feedwater pump miniflow valves (OE related)	2.6
AK 1.12	Main steam isolation valves, SG PORV, and/or steam dump valves (OE related)	3.2
AK 1.13	Passive containment cooling system discharge isolation valves (OE related)	3.4
AK 1.14	Passive residual heat removal system heat exchanger flow control valves (OE related)	3.6
AK 1.15	Pressurizer normal spray valves (OE related)	3.1
AK 1.16	Steam generator blowdown valves (OE related)	2.4
AK 1.17	Normal residual heat removal system heat exchanger outlet, bypass, and/or miniflow valves (OE related)	2.9
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of instrument air:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Effect on passive containment cooling system (OE related)	3.4
AK 2.02	Effect on main steam system (OE related)	2.7
AK 2.03	Effect on normal residual heat removal system (OE related)	2.9
AK 2.04	Effect during fuel movement (OE related)	2.7
AK 2.05	Effect on the core makeup tank, in-containment refueling water storage tank, and/or passive residual heat removal system (PRA related) (OE related)	3.4
AK 2.06	Effect on heater drain system, condensate system, and/or main and startup feedwater system (OE related)	2.5
AK 2.07	Effect on chemical and volume control system (OE related)	2.4
AK 2.08	Effect on normal residual heat removal system (OE related)	2.8

AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of instrument air:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
AK 3.01	Shutdown/trip the reactor (OE related)	3.8	
AK 3.02	Suspending core alterations and/or fuel movement (OE related)	3.2	
AK 3.03	Locally controlling feedwater flow using flow control valve handwheel (OE related)	2.8	
AK 3.04	Locally controlling steam flow using SG PORV handwheel (OE related)	2.8	
AK 3.05	Aligning service air to the instrument air system (OE related)	2.8	
AA 1	**Ability to operate and/or monitor the following as they apply to a loss of instrument air:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Reactor trip controls (OE related)	3.9	
AA 1.02	Instrument and/or service air compressors (OE related)	2.8	
AA 1.03	Instrument and/or service air dryers (OE related)	2.5	
AA 1.04	Instrument and/or service air loads (OE related)	2.6	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to loss of instrument air procedures:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Instrument and/or service air pressure (OE related)	3.0	3.1
AA 2.02	Instrument and/or service air flows (OE related)	2.2	2.7
AA 2.03	Instrument and/or service air dewpoint (OE related)	2.0	2.2
AA 2.04	Reactor coolant system temperature, steam generator level, and/or steam generator pressure (OE related)	3.2	3.2

4.2.19 A-331 Loss of Plant DC Power or AC Instrument Power

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of plant DC power or AC instrument power and the following systems or components** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Hydrogen igniters	2.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of plant DC power or AC instrument power:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	N/A	
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of plant DC power or AC instrument power:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	N/A	
AA 1	**Ability to operate and/or monitor the following as they apply to a loss of plant DC power or AC instrument power:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	250-V DC switchboards Class 1E	3.2
AA 1.02	125-V AC distribution panels Class 1E	2.9
AA 1.03	125-V DC switchboards non-Class1E	2.1
AA 1.04	1E battery charger Class 1E	3.0
AA 1.05	Load shed non-Class 1E DC and UPS system to support hydrogen igniter operation Class 1E	2.2
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a loss of plant DC power or AC instrument power:** (CFR: 41.7 / 43.5 / 45.6)	
AA 2.01	N/A	

4.2.20 A-332 Turbine Trip Without Reactor Trip

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a turbine trip without reactor trip and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Condensate system	2.5
AK 1.02	Chemical and volume control system	2.6
AK 1.03	Condenser air removal system	2.4
AK 1.04	Digital rod control system	3.4
AK 1.05	Main and startup feedwater system	2.9
AK 1.06	Main steam system	2.7
AK 1.07	Main turbine system	2.8
AK 1.08	Pressurizer level control system	2.8
AK 1.09	Pressurizer pressure control system	2.8
AK 1.10	Reactor coolant system	2.9
AK 1.11	Steam dump control system	3.3
AK 1.12	Steam generator system	2.9
AK 1.13	Main turbine control and diagnostics system	2.6
AK 1.14	Main generation system	2.5
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a turbine trip without reactor trip:**	
AK 2.01	Failure to maintain reactor coolant system heat removal	3.8
AK 2.02	Recovering control rods dropped by the rapid power reduction system	3.4
AK 2.03	Failure to control reactivity (i.e., overboration or rising xenon concentration)	3.6
AK 3	**Knowledge of the reasons for the following actions as they apply to a turbine trip without reactor trip:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Checking the turbine tripped	3.1
AK 3.02	Tripping the reactor and actuating main steamline isolation actuation	3.7
AK 3.03	Verifying the condenser steam dumps or SG PORVs are open	3.2
AK 3.04	Verifying steam generator levels are trending to program	2.8
AK 3.05	Verifying a booster/main feedwater pump is running	2.6
AK 3.06	Verifying feedwater is in the low-power mode	2.6
AK 3.07	Placing the steam dump control system in the steam pressure mode and resetting the rapid power reduction signal	2.9
AK 3.08	Placing digital rod control system in the low-power control mode	3.0
AK 3.09	Placing rod control in manual or bank select to perform dropped rod recovery	3.0
AK 3.10	Tripping the reactor if it becomes subcritical	3.7

AA 1 **Ability to operate and/or monitor the following as they apply to a turbine trip without reactor trip:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Main turbine trip	3.4
AA 1.02	Main steam isolation actuation	3.6
AA 1.03	Steam dump control system or SG PORV	3.5
AA 1.04	Main and startup feedwater System	3.1
AA 1.05	Digital rod control system	3.5
AA 1.06	Chemical and volume control system makeup	2.9
AA 1.07	Reactor trip controls	3.8
AA 1.08	Condensate system	2.6
AA 1.09	Circulating water system	2.4
AA 1.10	Steam generator system	3.0

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a turbine trip without reactor trip:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Reactor coolant system temperature	3.2	3.6
AA 2.02	Steam generator level and/or pressure	2.8	3.4
AA 2.03	Reactor power (nuclear instrumentation system, ΔT)	3.4	3.8
AA 2.04	Control rod positions	3.4	3.7

4.2.21 A-333 Main Turbine Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a main turbine malfunction and the following systems or components** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Condensate system	2.5
AK 1.02	Condenser air removal system	2.6
AK 1.03	Circulating water system	2.6
AK 1.04	Gland seal system	2.6
AK 1.05	Main turbine and generator lube oil system	2.6
AK 1.06	Steam dump control system	2.9
AK 1.07	Main turbine control and diagnostics system	2.8
AK 1.08	Main generation system	2.5
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a main turbine malfunction:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Loss of condenser vacuum	2.8
AK 2.02	Effect opening steam dumps has on condenser vacuum	2.9
AK 2.03	Loss of C-9, Condenser Available	3.1
AK 2.04	Main turbine trip	3.1
AK 3	**Knowledge of the reasons for the following actions as they apply to a main turbine malfunction:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Tripping main turbine	3.4
AK 3.02	Ensuring the condenser shell vacuum breakers are closed and water sealed	2.4
AK 3.03	Ensuring all vacuum pumps are running	2.5
AA 1	**Ability to operate and/or monitor the following as they apply to a main turbine malfunction:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Main turbine load and trip controls	3.4
AA 1.02	Condenser shell vacuum breakers and vacuum pumps	2.5
AA 1.03	Steam dump control system	3.3

AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a main turbine malfunction:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Condenser vacuum	2.6	2.9
AA 2.02	C-9, Condenser Available indications	2.6	3.1
AA 2.03	Turbine load	2.6	2.9
AA 2.04	Circulating water system flow and temperature	1.8	2.5
AA 2.05	Turbine vibration	2.4	2.6
AA 2.06	Gland seal system	1.8	2.5

4.2.22 A-336 Malfunction of Protection and Safety Monitoring System

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a malfunction of the protection and safety monitoring system and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Automatic depressurization system	3.9
AK 1.02	Compressed and instrument air systems	2.5
AK 1.03	Component cooling water system	2.4
AK 1.04	Chemical and volume control system	2.5
AK 1.05	Main AC power system	2.4
AK 1.06	Engineered safeguards actuation system	4.0
AK 1.07	Main and startup feedwater system	2.7
AK 1.08	Main steam system	2.6
AK 1.09	Postaccident monitoring system	2.9
AK 1.10	Passive containment cooling system	3.4
AK 1.11	Primary sampling system	2.1
AK 1.12	Passive core cooling system	3.6
AK 1.13	Reactor coolant system	2.7
AK 1.14	Normal residual heat removal system	2.7
AK 1.15	Reactor trip system	4.0
AK 1.16	Spent fuel pool cooling system	2.4
AK 1.17	Steam generator system	2.6
AK 1.18	Nuclear island nonradioactive ventilation system	2.1
AK 1.19	Main control room emergency habitability system	3.2
AK 1.20	Containment air filtration system	2.2
AK 1.21	Central chilled water system	2.1
AK 1.22	Liquid radwaste system	2.0
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a malfunction of the protection and safety monitoring system:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Failure of one or more protection and safety monitoring system divisions	3.9
AK 3	**Knowledge of the reasons for the following actions as they apply to a malfunction of the protection and safety monitoring system:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Monitoring the plant using indications independent of protection and safety monitoring system (diverse actuation system and data display and processing system)	3.8
AK 3.02	Performing system-level functions using diverse actuation system if two or more protection and safety monitoring system divisions have failed	3.9

AK 3.03	Using a protection and safety monitoring system component interface module to operate components	2.9
AK 3.04	Placing the diverse actuation system master enable switch in ENABLE if less than two protection and safety monitoring system divisions are operable	3.7
AK 3.05	Initiating a reactor trip coincident with a core makeup tank and/or passive residual heat removal system actuation	3.9
AK 3.06	Actuating automatic depressurization system	4.1
AK 3.07	Actuating the containment hydrogen igniters	3.1

AA 1 **Ability to operate and/or monitor the following as they apply to a malfunction of the protection and safety monitoring system:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Automatic depressurization system	4.1
AA 1.02	Compressed and instrument air systems	2.6
AA 1.03	Component cooling water system	2.7
AA 1.04	Chemical and volume control system	2.6
AA 1.05	Main AC power system	2.7
AA 1.06	Engineered safeguards actuation system	3.9
AA 1.07	Main and startup feedwater system	2.9
AA 1.08	Main steam system	2.6
AA 1.09	Passive containment cooling system	3.6
AA 1.10	Primary sampling system	2.2
AA 1.11	Passive core cooling system	3.9
AA 1.12	Reactor coolant system	3.0
AA 1.13	Normal residual heat removal system	2.9
AA 1.14	Reactor trip system	4.0
AA 1.15	Spent fuel pool cooling system	2.4
AA 1.16	Steam generator system	2.7
AA 1.17	Nuclear island nonradioactive ventilation system	2.3
AA 1.18	Main control room emergency habitability system	3.2
AA 1.19	Containment air filtration system	2.3
AA 1.20	Central chilled water system	2.1
AA 1.21	Liquid radwaste system	2.1

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a malfunction of the protection and safety monitoring system:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Protection and safety monitoring system alarms, data quality codes, and/or displays updating	3.8	3.3
AA 2.02	Diverse actuation system indications	4.0	3.7
AA 2.03	Postaccident monitoring system indications	4.0	3.1

4.2.23 A-337 Passive Residual Heat Removal System Heat Exchanger Leak

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a passive residual heat removal system heat exchanger leak and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	In-containment refueling water storage tank	3.6
AK 1.02	Passive residual heat removal system isolation and/or flow control valves	3.3
AK 1.03	Reactor coolant system	3.4
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a passive residual heat removal system heat exchanger leak:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Passive residual heat removal system heat exchanger tube leak on in-containment refueling water storage tank parameters (such as temperature, level, radiological conditions, boron)	3.4
AK 2.02	Passive residual heat removal system heat exchanger tube leak effect on containment radiation	3.1
AK 3	**Knowledge of the reasons for the following actions as they apply to a passive residual heat removal system heat exchanger leak:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Determining whether core makeup tank discharge isolation valves are open	3.3
AK 3.02	Determining whether in-containment refueling water storage tank level is rising	3.3
AK 3.03	Ensuring startup feedwater pumps and steam generators are operable	3.0
AK 3.04	Isolating the passive residual heat removal system heat exchanger	3.4
AK 3.05	Sampling the in-containment refueling water storage tank for activity and boron	2.6
AK 3.06	Trending passive residual heat removal system inlet temperatures and pressures	2.7
AK 3.07	Trending passive residual heat removal system inlet pressure over time	2.6
AK 3.08	Restoring the passive residual heat removal system heat exchanger to service	3.0
AK 3.09	Performing a reactor coolant system leakrate determination	2.9

AA 1	**Ability to operate and/or monitor the following as they apply to a passive residual heat removal system heat exchanger leak:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Main and startup feedwater system	2.9	
AA 1.02	Passive residual heat removal system heat exchanger control valves and inlet valve	3.2	
AA 1.03	Steam dump control system and/or SG PORV	3.1	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to a passive residual heat removal system heat exchanger leak:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Passive residual heat removal system inlet temperatures and/or pressures	3.2	3.1
AA 2.02	In-containment refueling water storage tank temperatures, level, activity, and/or boron concentration	3.2	3.1
AA 2.03	Reactor coolant system leakrate	3.2	3.3
AA 2.04	Reactor coolant system pressure	3.2	3.0
AA 2.05	Containment radiation	3.0	3.0

4.2.24 A-340 Reactor Coolant Leak

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a reactor coolant leak and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Steam generator blowdown system	2.6
AK 1.02	Component cooling water system	2.6
AK 1.03	Containment system	3.0
AK 1.04	Chemical and volume control system	3.0
AK 1.05	Engineered safeguards actuation system	3.6
AK 1.06	Primary sampling system	2.5
AK 1.07	Passive core cooling system	3.3
AK 1.08	Radiation monitoring system	3.1
AK 1.09	Normal residual heat removal system	2.9
AK 1.10	Reactor trip system	3.4
AK 1.11	Steam generator system	3.1
AK 1.12	Turbine island vent, drain, and relief valve system	2.4
AK 1.13	Liquid radwaste system	2.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a reactor coolant leak:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Reactor coolant system leakage greater than the capacity of the makeup system	3.6
AK 2.02	Leaking reactor vessel flange	3.0
AK 2.03	Leaking automatic depressurization system valve	3.5
AK 2.04	Leaking pressurizer safety valve	3.4
AK 2.05	Leaking passive residual heat removal system heat exchanger tube	3.4
AK 3	**Knowledge of the reasons for the following actions as they apply to a reactor coolant leak:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Starting makeup pump and isolating chemical and volume control system letdown	3.2
AK 3.02	Actuating safeguards	3.9
AK 3.03	Determining if steam generator tubes are intact	3.7
AK 3.04	Determining total reactor coolant system leakrate	3.3
AK 3.05	Opening the in-containment refueling water storage tank gutter isolation valves	2.9
AK 3.06	Checking reactor vessel flange leakoff temperature, reactor vessel head vent temperature, automatic depressurization system valve temperatures, pressurizer safety valve temperatures, and/or passive residual heat removal system and in-containment refueling water storage tank temperatures	3.0

AK 3.07	Actuating normal residual heat removal system isolation	3.0	
AK 3.08	Performing a chemical and volume control system leakage determination	3.1	

AA 1 **Ability to operate and/or monitor the following as they apply to a reactor coolant leak:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Reactor trip controls	3.9
AA 1.02	Safeguards actuation controls	4.0
AA 1.03	Chemical and volume control system	3.1
AA 1.04	Passive core cooling system	3.6
AA 1.05	Reactor head vent valves	3.1
AA 1.06	Automatic depressurization system valves	3.9
AA 1.07	Normal residual heat removal system	3.1

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a reactor coolant leak:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Containment radiation	3.4	3.0
AA 2.02	Pressurizer level	3.2	3.3
AA 2.03	Makeup frequency	3.2	3.1
AA 2.04	Reactor coolant system leakrate	3.4	3.4
AA 2.05	Containment sump level	3.2	3.3
AA 2.06	Reactor vessel flange leakoff temperature, reactor vessel head vent temperature, automatic depressurization system valve temperatures, pressurizer safety valve temperatures, passive residual heat removal system temperatures and/or in-containment refueling water storage tank temperatures	3.2	2.9
AA 2.07	Reactor coolant drain tank level	3.0	2.9
AA 2.08	Effluent holdup tank level	2.8	2.7
AA 2.09	Auxiliary building sump level	2.8	2.7

4.2.25 A-342 Reactor Coolant Pump Malfunctions

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE	
AK 1	**Knowledge of the relationship between reactor coolant pump malfunctions and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)		
AK 1.01	Component cooling water system	2.7	
AK 1.02	Reactor trip system	3.8	
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to reactor coolant pump malfunctions:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)		
AK 2.01	Reactor coolant pump trip in mode 1 or 2	3.8	
AK 2.02	Reactor coolant pump trip in mode 3, 4, or 5	3.1	
AK 3	**Knowledge of the reasons for the following actions as they apply to reactor coolant pump malfunctions:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)		
AK 3.01	Tripping the reactor if fewer than four reactor coolant pumps are running	3.8	
AK 3.02	Tripping the reactor and stopping all reactor coolant pumps instead of restoring cooling flow to the reactor coolant pumps	3.5	
AK 3.03	Tripping the reactor and stopping the affected reactor coolant pumps	3.7	
AK 3.04	Reducing reactor coolant pump speed	3.0	
AA 1	**Ability to operate and/or monitor the following as they apply to reactor coolant pump malfunctions:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)		
AA 1.01	Reactor coolant pumps and variable speed controllers	3.1	
AA 1.02	Reactor trip controls	3.9	
AA 1.03	Component cooling water system pump controls	2.9	
AA 2	**Ability to evaluate the following parameters and/or conditions as they apply to reactor coolant pump malfunctions:** (CFR: 41.7 / 43.5 / 45.6)		
		RO	**SRO**
AA 2.01	Reactor coolant pump speed or vibration	2.8	3.0
AA 2.02	Reactor coolant pump bearing water or stator temperatures	2.6	3.1
AA 2.03	Component cooling water system flows and/or temperatures	2.6	3.0

4.2.26 A-343 Loss of Normal Residual Heat Removal

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of normal residual heat removal and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Automatic depressurization system	3.6
AK 1.02	Compressed and instrument air systems	2.8
AK 1.03	Component cooling water system	3.0
AK 1.04	Condensate system	2.2
AK 1.05	Containment system	3.1
AK 1.06	Chemical and volume control system	2.6
AK 1.07	Diverse actuation system	3.4
AK 1.08	Engineered safeguards actuation system	3.6
AK 1.09	Main and startup feedwater system	2.6
AK 1.10	Passive containment cooling system	3.3
AK 1.11	Passive core cooling system	3.6
AK 1.12	Reactor coolant system	3.4
AK 1.13	Spent fuel pool cooling system	2.6
AK 1.14	Steam generator system	2.8
AK 1.15	Containment recirculation cooling system	2.2
AK 1.16	Liquid radwaste system	1.9
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of normal residual heat removal:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	Transferring reactor coolant system heat load to the steam generators	3.4
AK 2.02	Transferring reactor coolant system heat load to the passive residual heat removal system heat exchanger	3.5
AK 2.03	Establishing passive feed and bleed	3.6
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of normal residual heat removal:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Checking reactor coolant system temperature greater than 200 degrees	3.1
AK 3.02	Maintaining normal residual heat removal system pump minimum flow	2.9
AK 3.03	Checking status of normal residual heat removal system isolation actuation	3.2

AK 3.04	Opening the reactor coolant system head vent valves if reactor coolant system pressure is greater than the normal pressure for placing normal residual heat removal system in service and reactor coolant system temperature is below low-temperature overpressure protection setpoint	3.2
AK 3.05	Closing the normal residual heat removal system hot-leg suction valves if reactor coolant system pressure is greater than the normal pressure for placing normal residual heat removal system in service and reactor coolant system temperature is above low-temperature overpressure protection setpoint	3.1
AK 3.06	Placing normal residual heat removal system in shutdown cooling mode	2.9
AK 3.07	Verifying component cooling water system pump status and flows	2.8
AK 3.08	Establishing 1,500 gpm normal residual heat removal system flow	3.0
AK 3.09	Adjusting the normal residual heat removal system heat exchanger outlet flow to control reactor coolant system temperature	2.9
AK 3.10	Removing passive residual heat removal system and/or passive containment cooling system from service	2.9
AK 3.11	Stopping all reactor coolant pumps	3.2
AK 3.12	Placing chemical and volume control system letdown in service and throttling flow to maintain letdown heat exchanger outlet temperature less than 140 degrees F	2.6
AK 3.13	Placing emergency letdown in service	2.9
AK 3.14	Checking steam generators are intact, steam generator levels can be maintained in the normal band, and steam can be released using the SG PORV	3.1
AK 3.15	Actuating passive residual heat removal system	3.6
AK 3.16	Establishing containment closure	3.7
AK 3.17	Aligning spent fuel pool cooling system to cool the in-containment refueling water storage tank	2.9
AK 3.18	Operating the reactor containment recirculation fans in low speed	2.4
AK 3.19	Placing passive containment cooling system in service	3.4
AK 3.20	Passive residual heat removal system not being capable of maintaining reactor coolant system temperature less than 420 degrees F	3.4
AK 3.21	Initiating passive feed and bleed	3.5
AK 3.22	Actuating safeguards	3.9
AK 3.23	Actuating automatic depressurization system stages 1, 2, and 3	3.9

AA 1 **Ability to operate and/or monitor the following as they apply to a loss of normal residual heat removal:**
(CFR: 41.5 / 41.7 / 45.5 to 45.8)

AA 1.01	Automatic depressurization system	3.9
AA 1.02	Component cooling water system	2.9
AA 1.03	Condensate system	2.3
AA 1.04	Containment system	3.3
AA 1.05	Diverse actuation system	3.9
AA 1.06	Engineered safeguards actuation system	4.0
AA 1.07	Chemical and volume control system	2.9

AA 1.08	Main and startup feedwater system	2.7	
AA 1.09	Passive containment cooling system	3.3	
AA 1.10	Passive core cooling system	3.6	
AA 1.11	Reactor coolant system	3.3	
AA 1.12	Spent fuel pool cooling system	2.4	
AA 1.13	Steam generator system	2.7	
AA 1.14	Containment recirculation cooling system	2.2	

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a loss of normal residual heat removal:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
AA 2.01	Reactor coolant system temperature and/or pressure	3.6	3.3
AA 2.02	Normal residual heat removal system pump flow	3.0	3.1
AA 2.03	Component cooling water system to normal residual heat removal system heat exchanger flow	2.8	2.7
AA 2.04	Containment pressure and/or temperature	3.4	3.3
AA 2.05	Pressurizer level	3.0	3.0
AA 2.06	Steam generator level and/or feedwater flow	3.2	2.7
AA 2.07	Chemical and volume control system letdown heat exchanger outlet temperature	2.6	2.6

4.2.27 A-345 Loss of Service Water

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a loss of service water and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Booster/main feedwater pumps	2.4
AK 1.02	Compressed and instrument air systems	2.4
AK 1.03	Component cooling water system	2.7
AK 1.04	Condensate pumps	2.4
AK 1.05	Chemical and volume control system letdown heat exchanger and/or makeup pumps	2.4
AK 1.06	Reactor coolant pumps and/or variable frequency drives	2.6
AK 1.07	Normal residual heat removal system	2.6
AK 1.08	Spent fuel pool cooling system	2.6
AK 1.09	Central chilled water system chillers	2.2
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a loss of service water:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	N/A	
AK 3	**Knowledge of the reasons for the following actions as they apply to a loss of service water:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 3.01	Stopping both service water system pumps	2.4
AK 3.02	Control service water system cooling tower basin level and/or temperature	2.5
AK 3.03	Ensuring at least one service water system train is in service	2.9
AK 3.04	Checking pump discharge flow and/or pressure in normal band	2.4
AK 3.05	Checking backwash strainer operation	2.3
AK 3.06	Checking component cooling water system heat exchanger alignment, flow, and temperatures	2.7
AK 3.07	Tripping the reactor and stopping the reactor coolant pumps	3.5
AK 3.08	Cycling the compressed and instrument air system compressors off and on	2.6
AA 1	**Ability to operate and/or monitor the following as they apply to a loss of service water:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Booster/main feedwater pumps	2.4
AA 1.02	Compressed and instrument air systems	2.6
AA 1.03	Component cooling water system	2.7
AA 1.04	Condensate pumps	2.4
AA 1.05	Chemical and volume control system	2.4
AA 1.06	Reactor coolant pumps	2.9

AA 1.07	Reactor coolant pump variable frequency drives	2.7	
AA 1.08	Normal residual heat removal system	2.7	
AA 1.09	Spent fuel pool cooling system	2.6	
AA 1.10	Central chilled water system	2.2	

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a loss of service water:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	**SRO**
AA 2.01	Service water system cooling tower basin level, system flow, pressure, and/or temperature	2.8	2.9
AA 2.02	Component cooling water system heat exchanger operating temperature (OE related)	2.8	3.0

4.2.28 A-348 Degraded Grid

K/A NO.	KNOWLEDGE/ABILITY	IMPORTANCE
AK 1	**Knowledge of the relationship between a degraded grid and the following systems or components:** (CFR: 41.8 / 41.10 / 45.3)	
AK 1.01	Switchyard distribution	2.2
AK 1.02	Online power distribution monitoring system	2.5
AK 1.03	Rapid power reduction logic—rod control system	2.8
AK 1.04	Rod control system	2.6
AK 1.05	Turbine control system	2.2
AK 1.06	AC electrical distribution	2.4
AK 2	**Knowledge of the operational implications or cause-and-effect relationships of the following as they apply to a degraded grid:** (CFR: 41.5 / 41.7 / 45.7 / 45.8)	
AK 2.01	P-17, Negative Nuclear Power Rate	2.6
AK 2.02	Reactor trip requirements	3.1
AK 2.03	Turbine operational limits	2.3
AK 2.04	Diesel generator operation (OE)	2.3
AK 3	**Knowledge of the reasons for the following actions as they apply to a degraded grid:** (CFR: 41.5 / 41.10 / 45.6 / 45.13)	
AK 2.01	Reactor trip	2.9
AK 2.02	Turbine trip	2.3
AK 2.03	M bank manual operation	2.5
AK 2.04	Main generator voltage control	2.1
AA 1	**Ability to operate and/or monitor the following as they apply to a degraded grid:** (CFR: 41.5 / 41.7 / 45.5 to 45.8)	
AA 1.01	Switchyard distribution	2.2
AA 1.02	Online power distribution monitoring system	2.4
AA 1.03	Rapid power reduction logic—rod control system	2.8
AA 1.04	Rod control system	2.7
AA 1.05	Turbine control system	2.2
AA 1.06	AC electrical distribution	2.3

AA 2 **Ability to evaluate the following parameters and/or conditions as they apply to a degraded grid:**
(CFR: 41.7 / 43.5 / 45.6)

		RO	SRO
AA 2.01	Reactor trip	2.9	3.0
AA 2.02	Plant stabilized in island mode	2.5	2.8
AA 2.03	Main generator electrical conditions	2.3	2.6

5 COMPONENTS

5.1 191001 Valves

(CFR: 41.3)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	The function and operation of safety valves	3.4
K1.02	The function and operation of relief valves	3.3
K1.03	The relationship of valve position to flow rate and back pressure	2.9
K1.04	The failed-valve positions for different operators (open, closed, and as-is positions; spring loaded valves; hydraulic, pneumatically controlled valves; electric motor drive valves)	3.2
K1.05	Equipment protection concerns in the use of valves (protect valve seals, open slowly)	2.8
K1.06	Emergency/manual operation of motor-operated valves with motor inoperable	3.7
K1.07	Principles of operation and purpose of check valves	2.8
K1.08	Operation of valves and verification of their position	3.4
K1.09	Reason for using globe valves versus gates valves for throttling	2.4
K1.10	The significance of stem position (valve status) for gate valves	2.9
K1.11	The stroke test for a valve, including the use of a stopwatch	2.7

5.2 191002 Sensors and Detectors

(CFR: 41.7)

K/A NO.	KNOWLEDGE	IMPORTANCE
	Flow	
K1.01	Operational characteristics of venturis and orifices	2.4
K1.02	Temperature/density compensation requirements	2.9
K1.03	Effects of gas or steam on liquid flow rate indications (erroneous reading)	2.9
K1.04	Modes of failure	2.7
K1.05	Operation of a flow differential pressure cell-type flow detector	2.8
	Level	
K1.06	Temperature/pressure compensation requirements	2.6
K1.07	Theory and operation of level detectors	2.6
K1.08	Effects of operating environment (pressure, Temperature and/or radiation)	3.1
K1.09	Modes of failure	3.0
	Pressure	
K1.10	Theory and operation of pressure detectors (bourdon tubes, diaphragms, bellows, forced balance, variable capacitance and D/P cell)	2.5
K1.11	Effects of operating environment (pressure, temperature)	3.0
K1.12	Modes of failure	2.9
	Temperature	
K1.13	Theory and operation of thermocouples, resistance temperature detectors, thermostats, and/or thermometers (expanding fluid)	2.8
K1.14	Failure modes of thermocouples, resistance temperature Detectors, and/or thermometers	2.9
	Position Detectors	
K1.15	Failure modes of reed switches, linear variable displacement transducers, limit switches, and potentiometers	2.4
K1.16	Applications of reed switches, magnets, linear variable displacement transducers, potentiometers, and limit switches	2.7
	Nuclear Instrumentation	
K1.17	Effects of core voiding on neutron detection	3.5
K1.18	Theory and operation of fission chambers and ion chambers	3.1

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.19	Neutron monitoring indication units	3.2
K1.20	Effects of voltage changes on neutron detector performance	2.9
K1.21	Failure modes of fission chambers, ion chambers, and proportional counters	3.1
	<u>Radiation Detection</u>	
K1.22	Theory and operation of ion chambers, Geiger Müller tubes, and scintillation detectors	2.8
K1.23	Use of portable and personal radiation monitoring instruments	3.3
K1.24	Theory and operation of failed-fuel detectors	2.7
	<u>Electrical</u>	
K1.25	Theory and operation of voltmeters, ammeters, frequency detectors, and ground detectors	2.4

5.3 191003 Controllers and Positioners

(CFR 41.7)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Function and operation of flow controller in manual and automatic modes	3.2
K1.02	Function and operation of a speed controller	2.7
K1.03	Operation of valve controllers in manual and automatic modes, including seal-in features	3.1
K1.04	Function and operation of pressure and temperature controllers, including pressure and temperature control valves	3.0
K1.05	Function and characteristics of valve positioners	2.8
K1.06	Function and characteristics of governors and other mechanical controllers	2.6
K1.07	Safety precautions with respect to the operation of controllers and positioners	2.6
K1.08	Theory of operation of the following types of controllers: electronic, electrical, and pneumatic	2.6
K1.09	Effects on operation of controllers due to proportional, integral (reset), derivative (rate), and their combinations	2.5
K1.10	Function and characteristics of air-operated valves, including failure modes	2.8
K1.11	Cautions for placing a valve controller in manual mode	2.9

5.4 191004 Pumps

(CFR 41.3)

K/A NO.	KNOWLEDGE	IMPORTANCE
	Centrifugal	
K1.01	Identification, symptoms, and consequences of cavitation	3.5
K1.02	Reasons for venting a centrifugal pump	3.4
K1.03	Consequences of air steam binding	3.3
K1.04	Consequences of operating a pump dead headed or for extended times without adequate recirculation	3.4
K1.05	Discussion of relationships among head, flow, and power as related to pump speed	2.4
K1.06	Need for net positive suction head; effects of loss of suction	3.3
K1.07	DELETED	
K1.08	Purpose of starting a pump with discharge valve closed	2.6
K1.09	Pressure and flow relationship of pumps in parallel	2.4
K1.10	Pressure and flow relationship of pumps in series	2.4
K1.11	Definition of pump shutoff head	2.4
K1.12	"Runout" of a centrifugal pump (definition, indications, causes, effects, and corrective measures)	2.7
K1.13	Theory of operation of a centrifugal pump	2.1
K1.14	Use of a centrifugal pump characteristic curve and a System characteristic curve; illustration of how the system operating point changes due to system changes	2.5
K1.15	Relationship between flow from a pump and suction heads	2.8
K1.16	Safety procedures and precautions associated with centrifugal pumps	2.9
K1.17	DELETED	
K1.18	DELETED	
K1.19	Explanation of the reason for its shape, given the characteristic curve for a typical centrifugal pump	2.3
K1.20	Description of how a centrifugal pump's characteristic curve will change with pump speed	2.3
	Positive Displacement	
K1.21	Discuss the relationship among head, flow, speed, and power	2.4
K1.22	Net positive suction head requirements for a positive displacement pump	2.8
K1.23	Consequences of operating a positive displacement pump against a closed flowpath	3.1
K1.24	Functions and characteristics of positive displacement pumps	2.5
K1.25	Reason for starting a positive displacement pump with the discharge valve open; need to clear the flowpath	2.9

K1.26	Safety procedures and precautions associated with positive displacement pumps	3.1
K1.27	DELETED	
K1.28	Theory of operation of positive displacement pumps	2.0
K1.29	Discuss the characteristic curve for a typical positive displacement pump and explanation of its shape	2.1

<u>Jet Pumps</u>

K1.30	Describe the principles of operation of a jet pump	1.8

5.5 191005 Motors and Generators

(CFR 41.7)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Indication of a locked rotor	3.1
K1.02	Potential consequences of overheating motor insulation or motor bearings	2.9
K1.03	Causes of excessive current in motors and generators, such as low voltage, overloading, and mechanical binding	2.8
K1.04	Relationship between pump motor current (ammeter reading) and the: pump fluid flow, head, speed, and stator temperature	2.8
K1.05	Explanation of the difference between starting current and operating (running) current in a motor	2.8
K1.06	Reason for limiting the number of motor starts in a given time period	3.1
K1.07	Electrical units: volts, amperes, volt-amperes-reactive, watts, and hertz	2.3
K1.08	Consequences of overexcited/underexcited	2.3
K1.09	Interrelations of the: volt-amperes reactive, watts, amperes, volts, and power factor	2.1
K1.10	Load sharing with parallel generators	2.4
K1.11	Motor and generator protective devices	2.4

5.6 191006 Heat Exchangers and Condensers

(CFR 41.4)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Startup/shutdown of a heat exchanger	2.3
K1.02	Proper filling of a shell-and-tube heat exchanger	2.3
K1.03	Basic heat transfer in a heat exchanger	2.3
K1.04	Effects of heat exchanger flow rates that are too high or too low and methods of proper flow adjustment	2.7
K1.05	Flowpaths for the heat exchanger (counterflow and U-types)	1.9
K1.06	Components of a heat exchanger (e.g., shells, tubes, plates)	1.9
K1.07	Control of heat exchanger temperatures	2.6
K1.08	Relationship between flow rates and temperatures	2.4
K1.09	Definition of thermal shock	2.8
K1.10	Principle of operation of condensers	2.4
K1.11	Relationship between condenser vacuum and backpressure	2.1
K1.12	Effects of tube fouling on heat exchanger operation	2.7
K1.13	Consequences of heat exchanger tube failure	2.9
K1.14	Reasons for noncondensable gas removal	2.6

5.7 191007 Demineralizers and Ion Exchangers

(CFR 41.3)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Effect of excessive differential pressure on demineralizer performance	2.5
K1.02	Effects of channeling in a demineralizer	2.3
K1.03	Reason for sampling inlet and outlet of demineralizer	2.5
K1.04	Reason for demineralizer temperature and flow limits	2.4
K1.05	Principles of demineralizer operation	2.2
K1.06	Demineralizer differential pressure to determine condition of demineralizer resin bed	2.5
K1.07	Effects of demineralizer operation on water conductivity	2.2
K1.08	Demineralizer characteristics that can cause a change in boron concentration	3.2
K1.09	Reasons for bypassing demineralizers	2.7
K1.10	Reasons for using mixed-bed demineralizers to process primary water	2.3
K1.11	Plant evolutions that can cause crud bursts and the effect on demineralizers	2.8
K1.12	Definition of “boron saturated” as it relates to a demineralizer	2.9
K1.13	Definition of “lithium saturated” as it relates to a demineralizer	2.1
K1.14	Effect of temperature on saturated ion exchangers	2.6
K1.15	Purpose of a demineralizer	2.9

5.8 191008 Breakers, Relays, and Disconnects

(CFR 41.7)

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Purpose of racking out breakers (deenergize components and associated control and indication circuits)	2.8
K1.02	Local indication that breaker is open, closed, or tripped	2.9
K1.03	Meaning and/or loss of power supply circuit breaker indicator lights and capability in remote open and close	3.1
K1.04	Operation of various push buttons, switches, and handles and the resulting action on breakers	3.0
K1.05	Function of thermal overload protection device	2.4
K1.06	Interpreting a one-line diagram of control circuitry	3.6
K1.07	Safety procedures and precautions associated with breakers, including motor control center bus breakers, and high-, medium-, and low-voltage breakers, relays, and disconnects	3.3
K1.08	Effects of closing breakers with current out of phase, different frequencies, high voltage differential, low current, or too much load	3.5
K1.09	Effect of racking out breakers on control and indicating circuits and removal of control power on breaker operation	3.1
K1.10	Function, control, and precautions associated with disconnects	3.1
K1.11	Control room indication of a breaker status	3.3
K1.12	Trip indicators for circuit breakers and protective relays	2.9

6 THEORY

6.1 Reactor Theory

(CFR 41.1)

6.1.1 192001 Neutrons

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define fast, intermediate, and slow neutrons	2.0
K1.02	Define prompt and delayed neutrons	2.5
K1.03	Define thermal neutrons	2.3
K1.04	Describe neutron moderation	2.4
K1.05	Identify characteristics of good moderators	2.1
K1.06	Define neutron lifetime	1.6
K1.07	Define neutron generation time	1.6
K1.08	Describe fast flux, thermal flux, and flux distribution	2.0
K1.09	Describe sources of neutrons	2.4

6.1.2 192002 Neutron Life Cycle

K/A NO.	KNOWLEDGE	IMPORTANCE
	Describe the neutron life cycle using the following terms:	
K1.01	-- fast fission factor	1.4
K1.02	-- fast nonleakage probability factor	1.6
K1.03	-- resonance escape probability factor	1.9
K1.04	-- thermal nonleakage probability factor	1.6
K1.05	-- thermal utilization factor	1.9
K1.06	-- reproduction factor	1.6
K1.07	Define K-eff and discuss its relationship to the state of a reactor (critical, subcritical, and supercritical)	3.1
K1.08	DELETED	
K1.09	Define K-excess (excess reactivity)	2.7
K1.10	Define shutdown margin	3.6
K1.11	Define reactivity	3.0
K1.12	State the relationship between reactivity and effective multiplication factor	2.5
K1.13	Calculate shutdown margin using procedures and given plant parameters	3.7
K1.14	Evaluate change in shutdown margin due to changes in plant parameters	3.9

6.1.3 192003 Reactor Kinetics and Neutron Sources

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Explain the concept of subcritical multiplication	2.8
K1.02	Given the simplified formula for subcritical multiplication, perform calculations involving steady-state count rate and source count rate	2.3
K1.03	Describe the production of delayed neutrons	2.4
K1.04	Define delayed neutron fraction and effective delayed neutron fraction and state the reasons for variation	2.4
K1.05	Define startup rate	2.8
K1.06	Describe the factors affecting startup rate	3.3
K1.07	Explain the effect of delayed neutrons on reactor control	3.0
K1.08	Explain the prompt critical, prompt jump, and prompt drop	2.9
K1.09	Given the power equation, solve problems for power changes	2.3
K1.10	Define doubling time and calculate it using the power equation	1.6
K1.11	Explain the necessity for installed neutron sources in a reactor core	2.8
K1.12	Explain why installed sources are not needed after one cycle of core operation	2.4

6.1.4 192004 Reactivity Coefficients

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define the MTC of reactivity	3.2
	<u>Describe the effect on the magnitude of the temperature coefficient of reactivity from changes in the following:</u>	
K1.02	-- moderator temperature	3.1
K1.03	-- core age	3.1
K1.04	-- boron concentration	3.1
K1.05	DELETED	
K1.06	Define fuel temperature (Doppler) coefficient of reactivity	2.7
K1.07	Explain resonance absorption	2.4
K1.08	Explain Doppler broadening and self-shielding	2.4
K1.09	DELETED	
	<u>Describe the effects on fuel temperature (Doppler) coefficient of reactivity for changes in the following:</u>	
K1.10	-- moderator temperature	2.9
K1.11	-- fuel temperature	2.9
K1.12	-- core age	2.9
K1.13	Describe the components of the power coefficient	3.1
	<u>Describe the effect on boron reactivity worth from changes in the following:</u>	
K1.14	-- boron concentration	2.9
K1.15	-- moderator temperature	2.9
K1.16	Explain the change in reactivity addition rate due to boration/dilution over core life	3.1
K1.17	Explain differences between reactivity coefficients and reactivity defects	2.7
K1.18	Explain and describe the effect of power defect and Doppler defect on reactivity	2.9

6.1.5 192005 Control Rods

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Name the material used for thermal neutron absorption in control rods	1.9
K1.02	Describe nuclear properties of active neutron absorber material in the control rod	2.0
K1.03	Predict direction of change in reactor power for a change in control rod position	3.6
K1.04	Define reactor scram/trip	3.2
K1.05	Define control rod worth, differential control rod worth, and integral control rod worth	3.1
K1.06	Explain the shape of curves for differential and integral control rod worth versus rod position	2.9
	<u>Describe the effect on the magnitude of control rod worth for a change in the following:</u>	
K1.07	-- moderator temperature	2.8
K1.08	-- boron concentration	2.8
K1.09	-- fission product poisons	2.8
K1.10	State the purpose of flux shaping	2.9
K1.11	State the purpose of rod sequencing and overlap	3.0
K1.12	DELETED	
K1.13	DELETED	
K1.14	DELETED	
K1.15	DELETED	
K1.16	Explain the effects of full and/or part length rods on delta I (flux distribution)	3.5
K1.17	Discuss rod insertion limits	3.9
K1.18	DELETED	

6.1.6 192006 Fission Product Poisons

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define fission product poison	2.6
K1.02	State the characteristics of xenon-135 as a fission product poison	3.1
K1.03	Describe the production of xenon-135	2.8
K1.04	Describe the removal of xenon-135	2.8
	<u>Describe the following processes and state their effect on reactor operations:</u>	
K1.05	--equilibrium xenon	3.1
K1.06	--transient xenon	3.4
K1.07	--xenon following a scram	3.4
K1.08	Describe the effects that xenon concentration has on flux shape and control rod patterns	3.4
	<u>Plot the curve and explain the reasoning for the reactivity insertion by xenon-135 versus time for the following:</u>	
K1.09	--initial reactor startup and ascension to rated power	3.1
K1.10	--reactor startup with xenon-135 already present in the core	3.2
K1.11	--power changes from steady-state power to another	3.1
K1.12	--reactor scram	3.1
K1.13	--reactor shutdown	3.0
K1.14	Explain the methods and reasons for the operator to compensate for the time-dependent behavior of xenon-135 concentration in the reactor	3.3
K1.15	State the characteristics of samarium-149 as a fission product poison	1.9
K1.16	Describe the production of samarium-149	1.8
K1.17	Describe the removal of samarium-149	1.8
K1.18	Define equilibrium samarium	1.8
	<u>Plot the curve and explain the reasoning for reactivity insertion by samarium-149 versus time for the following:</u>	
K1.19	--initial reactor startup and ascension to rated power	1.9
K1.20	--reactor shutdown	1.8
K1.21	Describe the effects of power changes on samarium concentration	1.8
K1.22	Compare effects of samarium-149 on reactor operation with those of xenon-135	1.8

6.1.7 192007 Fuel Depletion and Burnable Poisons

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define burnable poison and state its use in the reactor	2.5
K1.02	Describe and explain distribution of burnable poisons in the core	2.2
K1.03	Given a curve of K_{eff} versus core age, state the reasons for maximum, minimum, and inflection points	2.1
K1.04	Describe how and why boron concentration changes over core life	3.4
K1.05	Describe the effects of boration/dilution on reactivity during forced flow and natural circulation conditions	3.2

6.1.8 192008 Reactor Operational Physics

K/A NO.	KNOWLEDGE	IMPORTANCE
	Startup and Approach to Criticality	
K1.01	List parameters that should be monitored and controlled during the approach to criticality	3.5
K1.02	List reactivity control mechanisms that exist for plant conditions during the approach to criticality	3.1
K1.03	Describe count rate and instrument response that should be observed for rod withdrawal during the approach to criticality	4.0
K1.04	Relate the concept of subcritical multiplication to predicted count rate response for control rod withdrawal during the approach to criticality	3.8
K1.05	Explain characteristics to be observed when the reactor is very close to criticality	3.9
K1.06	Calculate estimated critical position using a 1/M plot	3.1
K1.07	Calculate estimated critical position using procedures and given plant procedures	3.6
	Criticality	
K1.08	List parameters that should be monitored and controlled upon reaching criticality	3.7
K1.09	Define criticality as related to a reactor startup	3.3
K1.10	Describe reactor power and startup rate response once criticality is reached	3.4
	Intermediate Range Operation	
K1.11	DELETED	
K1.12	List parameters that should be monitored and controlled during the intermediate phase of startup (from criticality to the point of adding heat).	3.6
K1.13	Discuss the concept of the point of adding heat and its impact on reactor power.	3.6
K1.14	Describe reactor power and startup rate response prior to reaching the point of adding heat	3.1
K1.15	Explain characteristics to look for when the point of adding heat is reached	3.4
	Power Operation	
K1.16	Describe monitoring and control of reactor power and primary temperature during 0 to 15 percent	3.3
K1.17	Describe reactor power and startup rate response after reaching the point of adding heat	3.4
K1.18	Describe the monitoring and control of T_{ave}, T_{ref}, and power during power operation	3.6

K1.19	Describe means by which reactor power will be increased to rated power	3.6
K1.20	Explain the effects of control rod motion or boration/dilution on reactor power	3.9
K1.21	Explain the relationship between steam flow and reactor power given specific conditions	3.8
	<u>Reactor Response on a Trip</u>	
K1.22	DELETED	
K1.23	Explain the shape of a curve of reactor power versus time after a scram	3.1
	<u>Normal Reactor Shutdown</u>	
K1.24	Explain reactor power response to a control rod insertion	3.6
K1.25	Explain the necessity for inserting control rods in a predetermined sequence during normal shutdown	3.1
K1.26	Define decay heat	3.2
K1.27	Explain the relationship between decay heat generation and (1) power level history, (2) power production, and (3) time since reactor shutdown	3.4

6.2 Thermodynamics

(CFR 41.1)

6.2.1 193001 Thermodynamic Units and Properties

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Convert between absolute and gauge pressure and vacuum scales	2.7
K1.02	Recognize the difference between absolute and relative (Kelvin) temperature scales	2.0
K1.03	DELETED	
K1.04	Explain relationships between work, power, and energy	2.3
K1.05	DELETED	

6.2.2 193002 Basic Energy Concepts

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define energy and work	2.0
K1.02	Explain the law of conservation of energy	2.1
K1.03	Explain the difference between the state and phase of a working substance	1.7
K1.04	Define enthalpy	2.4
K1.05	Explain the application of enthalpy in the monitoring of plant processes	2.4
K1.06	Identify the relationship between heat flow during a process and a temperature-entropy diagram representing the process	2.2
K1.07	Define specific heat	2.3
K1.08	Apply specific heat in solving heat-transfer problems	1.6

6.2.3 193003 Steam

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	DELETED	
K1.02	Describe effects of pressure and temperature on density or specific volume of a liquid	2.5
K1.03	Describe the effects of pressure and temperature on density or specific volume of a gas	2.4
	Define the following terms:	
K1.04	--latent heat of vaporization	2.3
K1.05	--vaporization line	1.9
K1.06	--critical point	1.9
K1.07	--vapor dome	1.8
K1.08	--saturated liquid	2.8
K1.09	--wet vapor	2.1
K1.10	--saturated vapor	2.3
K1.11	--vapor pressure	1.8
K1.12	--moisture content	2.3
K1.13	--quality	2.3
K1.14	--superheated vapor	2.5
K1.15	--supersaturated vapor	1.9
K1.16	--subcooled and compressed liquids	2.7
K1.17	--subcooling	3.2
K1.18	DELETED	
K1.19	DELETED	
	Identify the following terms on a temperature vs. specific entropy T-s diagram:	
K1.20	--critical point	2.0
K1.21	--saturated liquid line	2.1
K1.22	--saturated vapor line	2.1
K1.23	--solid, liquid, gas, vapor, and fluid regions	1.9
K1.24	Explain the usefulness of steam tables to the Control Room operator	3.1
K1.25	Explain and use saturated and superheated steam tables.	3.4
K1.26	DELETED	

6.2.4 193004 Thermodynamic Processes

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Explain the relationship between real and ideal processes	1.9
K1.02	Explain the shape of the temperature vs. specific entropy diagram process line for a typical secondary system	1.9
	<u>Nozzles</u>:	
K1.03	Describe the functions of nozzles in flow restrictors	1.9
K1.04	Describe the functions of nozzles in air ejectors	2.0
	<u>Turbines</u>:	
K1.05	Explain the function of nozzles fixed blading and moving blading in the turbine	1.7
K1.06	Explain the reason turbines are multistage	1.7
K1.07	Define turbine efficiency	1.6
K1.08	Explain the difference between real and ideal turbine efficiency	1.7
	<u>Pumps</u>:	
K1.09	Define pump efficiency	1.3
K1.10	Explain the difference between ideal and real pumping processes	1.3
	<u>Condensers</u>:	
K1.11	Describe the process of condensate depression and its effect on plant operation	2.5
K1.12	Explain vacuum formation in condenser processes	2.3
K1.13	Explain the condensing process	2.3
	<u>Throttling and the Throttling Process:</u>	
K1.14	Explain the reduction of process pressure from throttling	2.3
K1.15	Determine the exit conditions for a throttling process based on the use of steam and/or water	2.8
K1.16	Define throttling	2.3

6.2.5 193005 Thermodynamic Cycles

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Define thermodynamic cycle	1.7
K1.02	Define thermodynamic cycle efficiency in terms of net work produced and energy applied	1.8
K1.03	Describe how changes in system parameters affect thermodynamic efficiency	2.6
K1.04	Describe the steam quality/moisture effects on turbine integrity and efficiency	2.3
K1.05	State the advantages of moisture separators/repeaters and feedwater heaters for a typical steam cycle	1.9

6.2.6 193006 Fluid Statics and Dynamics

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Distinguish between static pressure, dynamic pressure, and total pressure	2.3
K1.02	Define head loss	1.4
K1.03	Discuss operational considerations of viscosity as related to head loss	1.8
K1.04	Explain operational implications of fluid/water hammer	3.6
K1.05	Discuss methods of prevention of fluid/water hammer	3.2
	Define or explain the following terms and concepts:	
K1.06	--mass flow rate	3.0
K1.07	--two-phase flow	2.9
K1.08	--pressure spike	2.7
K1.09	--gas binding	1.8
K1.10	--recirculation ratio	1.9
K1.11	--water hammer	3.4
K1.12	--cavitation	3.3
K1.13	Explain why flow measurements must be corrected for density changes	2.6
K1.14	Explain the relationship between pressure head and velocity head in a fluid system	2.3
K1.15	Discuss the velocity profiles for laminar flow and turbulent flow	1.9
K1.16	Describe the methods of controlling system flow rates	3.3

6.2.7 193007 Heat Transfer

K/A NO.	KNOWLEDGE	IMPORTANCE
	<u>Heat Transfer</u>:	
K1.01	Describe three mechanisms of heat transfer	2.5
K1.02	Define thermal conductivity	2.2
K1.03	Explain the manner in which fluid films affect heat transfer	2.4
K1.04	Describe how the presence of gases or steam can affect heat transfer and fluid flow in heat exchangers	3.0
	<u>Core Thermal Power</u>:	
K1.05	Define core thermal power	2.9
K1.06	Explain methods of calculating core thermal power	3.3
K1.07	Define percent reactor power	2.8
K1.08	Calculate core thermal power using a simplified heat balance	3.4

6.2.8 193008 Thermal Hydraulics

K/A NO.	KNOWLEDGE	IMPORTANCE
	<u>Departure from Nucleate Boiling</u>:	
K1.01	Distinguish between boiling processes and other heat transfer mechanisms	3.0
K1.02	Describe means by which boiling affects convection heat transfer	3.0
K1.03	Describe the processes of nucleate boiling, subcooled nucleate boiling, and bulk boiling	3.1
K1.04	Describe departure from nucleate boiling	3.3
K1.05	List the parameters that affect DNB and departure from nucleate boiling ratio and describe their effect(s)	3.6
K1.06	Describe critical heat flux	2.9
K1.07	Describe transition (partial film) boiling	2.6
K1.08	Describe film boiling	2.6
K1.09	Describe burnout and burnout heat flux	2.4
K1.10	Define departure from nucleate boiling ratio	3.1
	<u>Two-Phase Flow</u>:	
K1.11	Classify slug flow region along a fuel pin, experiencing two-phase flow	2.1
K1.12	Describe annular flow region along a hypothetical fuel pin, experiencing two-phase flow	1.9
K1.13	Describe dryout region or mist flow region along a hypothetical fuel pin, experiencing two-phase flow	2.1
K1.14	Describe effects of flowrate and phase change on the heat transfer coefficient	2.7
K1.15	Define and describe subcooling margin	3.8
K1.16	Draw the temperature profile from the centerline of a fuel pellet to the centerline of the flow channel	2.6
K1.17	Explain the necessity of determining core coolant flow	3.2
K1.18	Describe the factors affecting single- and two-phase flow resistance	2.5
K1.19	Describe core bypass flow	2.8
K1.20	Explain the need for adequate core bypass flow	2.9
	<u>Natural Circulation</u>:	
K1.21	Explain the conditions that must exist to establish natural circulation	4.2
K1.22	Describe means to determine if natural circulation flow exists	4.2
K1.23	Describe means by which natural circulation can be enhanced	4.1

K1.24	Describe the process of reflux boiling (boiler condenser process)	3.1
K1.25	Describe how gas binding affects natural circulation	3.4
	<u>Sketch the axial temperature and enthalpy profiles for a typical reactor coolant channel and describe how they are affected by the following</u>:	
K1.26	--onset of nucleate boiling	2.4
K1.27	--axial core flux	2.4
K1.28	--inlet temperature	2.4
K1.29	--heat generation rate	2.4
K1.30	--flow rate in the channel	2.4

6.2.9 193009 Core Thermal Limits

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	Explain radial peaking factor	2.8
K1.02	Explain axial peaking factor	2.8
K1.03	Explain local peaking factor	2.7
K1.04	Explain total peaking factor	2.7
K1.05	State the reason thermal limits are necessary	3.5
K1.06	Describe the function of the core protection calculator (thermal margin calculator)	3.7
K1.07	Describe factors that affect peaking and hot-channel factors	3.3
K1.08	Describe axial flux imbalance, including long-range effects	3.3
K1.09	Describe the effects of quadrant power tilt (symmetric offset), including long-range effects	3.2
K1.10	Define and calculate quadrant tilt (symmetric offset) ratio	3.3

6.2.10 193010 Brittle Fracture and Vessel Thermal Stress

K/A NO.	KNOWLEDGE	IMPORTANCE
K1.01	State the brittle fracture mode of failure	3.2
K1.02	State the definition of nil-ductility transition temperature	2.5
K1.03	Define reference temperature	2.4
K1.04	State how the possibility of brittle fracture is minimized by operating limitations	3.7
K1.05	State the effect of fast neutron irradiation on reactor vessel metals	3.0
K1.06	Define pressurized thermal shock	3.8
K1.07	State the operational concerns of uncontrolled cooldown	4.1

APPENDIX A CHANGES FROM DRAFT NUREG-2103

Table of Contents
Added ES-1.3, ADS Stage 1–3 Actuation Response
Added ES-1.4, ADS Stage 4 Actuation Response
Added FR-I.2, Response to Low Pressurizer Level
Added FR-I.3, Response to Voids in the Reactor Vessel
Added FR-Z.4, Response to Low Containment Pressure
Added A-307, DAS Operation at Local Cabinets
Added A-326, Feedwater System Malfunctions
Added A-331, Loss of Plant DC Power or Batteries
Added A-348, Degraded Grid

Section 1
1.10.1, added information related to evolutions not included in Section 4, “Emergency and Abnormal Evolutions”
1.10.1, revised the definitions of emergency and abnormal evolutions to be consistent with the definitions provided in the other NRC K/A catalogs
1.10.1, Emergency Plant Evolutions, added ES-1.3, ADS Stage 1–3 Actuation Response
1.10.1, Emergency Plant Evolutions, added ES-1.4, ADS Stage 4 Actuation Response
1.10.1, Emergency Plant Evolutions, added footnote related to FR-S.2 and FR-P.2 to FR-S.1
1.10.1, Emergency Plant Evolutions, added FR-I.2, Response to Low Pressurizer Level
1.10.1, Emergency Plant Evolutions, added FR-I.3, Response to Voids in Reactor Vessel
1.10.1, Emergency Plant Evolutions, added FR-Z.4, Response to Low Containment Pressure
1.10.1, Abnormal Plant Evolutions, added A-307, DAS Operation at Local Cabinets
1.10.1, Abnormal Plant Evolutions, added A-326, Feedwater System Malfunctions
1.10.1, Abnormal Plant Evolutions, added A-331, Loss of Plant DC Power or AC Instrument Power
1.10.1, Abnormal Plant Evolutions, added A-348, Degraded Grid

Section 2
Changed Section 2 K/A statements and ratings to match Section 2 of NUREG-1122, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors,” Revision 3

Section 3
Safety Function 2, Reactor Coolant System Inventory Control, Engineered Safeguards Actuation System, added knowledge K 4.36, Containment vacuum relief actuation
Safety Function 2, Reactor Coolant System Inventory Control, Engineered Safeguards Actuation System, added knowledge K 6.40, Containment vacuum relief actuation

Safety Function 5, Containment Integrity, Containment System, added knowledge K 4.08, Containment vacuum relief actuation
Safety Function 5, Containment Integrity, Containment System, added knowledge K 6.11, Containment vacuum relief actuation
Safety Function 5, Containment Integrity, Containment System, added ability A 2.08, Containment vacuum relief actuation
Safety Function 5, Containment Integrity, Containment System, added ability A 3.05, Containment vacuum relief actuation
Safety Function 5, Containment Integrity, Containment System, added ability A 4.06, Containment vacuum relief actuation
Safety Function 7, Instrumentation, Diverse Action System, added knowledge K 3.13, Reactor trip system
Safety Function 7, Instrumentation, Incore Instrumentation System, changed knowledge K 3.05 to Reactor system, and added knowledge K 3.06, Special monitoring system
Safety Function 7, Instrumentation, Reactor Trip System, edited knowledge K 4.29 and K 5.05 by adding “in” between “channel” and “bypass,” and edited knowledge K 4.30 and K 5.06 by adding “in” between “channel” and “trip.”
Safety Function 8, Plant Service Systems, Circulating Water System, changed importance rating for knowledge K 2.01.
Safety Function 8, Plant Service Systems, Fuel Handling System, added ability A 2.16, Dropped or damaged fuel assembly
Safety Function 8, Plant Service Systems, Spent Fuel Pool Cooling System, deleted knowledge K 4.13, renumbered knowledge statements K 4.14 and K 4.15
Safety Function 8, Plant Service Systems, Containment Air Filtration System, added knowledge K 4.08, Containment vacuum relief actuation
Safety Function 8, Plant Service Systems, Containment Air Filtration System, added knowledge K 6.24, Inadvertent passive containment cooling system actuation
Safety Function 8, Plant Service Systems, Containment Air Filtration System, added ability A 2.24, Inadvertent passive containment cooling system actuation
Safety Function 8, Plant Service Systems, Containment Air Filtration System, added ability A 3.03, Containment vacuum relief actuation

Section 4
Changed title of Section 4.1 to “Emergency Plant Evolutions” to be consistent with Section 4 title.
Emergency Operating Evolutions, added ES-1.3, ADS Stage 1–3 Actuation Response
Emergency Operating Evolutions, added ES-1.4, ADS Stage 4 Actuation Response
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, added knowledge EK 1.19, Reactor coolant system
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, knowledge EK 2.04, added “or dilution”
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, knowledge EK 3.08, added “(FR-S.2 only)”

Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, added knowledge EK 3.14, Establish letdown using reactor vessel head vents
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, added ability EA 1.12, Reactor coolant system (such as head vents, pressurizer level)
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, ability EA 2.04, added “or pressurizer level”
Emergency Operating Evolutions, FR-S.1, Response to Nuclear Power Generation—ATWS, added ability EA 2.08, Reactor Coolant System T_{hot}, T_{cold}, and/or core exit temperatures
Emergency Operating Evolutions, FR-C-1, Response to Inadequate Core Cooling, knowledge EK 2.11, Running normal residual heat removal system pumps on time to reach cask loading pit low level, moved to ES-1.4, ADS Stage 4 Actuation Response, as EK 2.05; remaining FR-C.1 knowledges renumbered
Emergency Operating Evolutions, added FR-I.2, Response to Low Pressurizer Level
Emergency Operating Evolutions, added FR-I.3, Response to Voids in the Reactor Vessel
Emergency Operating Evolutions, FR-P.1, Response to Imminent Pressurized Thermal Shock Condition, added knowledge EK 3.12, Methods of reactor coolant system depressurization (automatic depressurization system, normal spray, auxiliary spray) (FR-P.1 or FR-P.2)
Emergency Operating Evolutions, added FR-Z.4, Response to Low Containment Pressure
Abnormal Plant Evolutions, added A-307, DAS Operation at Local Cabinets
Abnormal Plant Evolutions, added A-326, Feedwater System Malfunctions
Abnormal Plant Evolutions, A-327, Startup Feedwater System Malfunctions, added ability statement for AA 2
Abnormal Plant Evolutions, added A-331, Loss of Plant DC Power or AC Instrument Power
Abnormal Plant Evolutions, A-337, Passive Residual Heat Removal System Heat Exchanger Leak, added ability AA 1.01, Main and startup feedwater system
Abnormal Plant Evolutions, A-345, Loss of Service Water, added knowledge AK 1.01, Booster/main feedwater pumps
Abnormal Plant Evolutions, added A-348, Degraded Grid

Section 5
Changed Section 5 K/A statements and ratings to match Section 5 of NUREG-1122, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors,” Revision 3

Section 6
Section 6.1, Reactor Theory, 192006 Fission Products Poisons, changed xenon-124 to xenon-135
Changed Section 6 K/A statements and ratings to match Section 6 of NUREG-1122, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors,” Revision 3

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R. Pelton
J. Kellum
M. Scheetz
L.Nist

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11. ABSTRACT (200 words or less)

This catalog provides the basis for the development of content-valid licensing examinations for reactor operators and senior reactor operators. The examinations developed using this catalog along with the Operator Licensing Examination Standards for Power Reactors (NUREG-1021) will sample the topics listed under Title 10, Code of Federal Regulations, Part 55 (10 CFR 55).
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 Operating Evolutions, Components, and Theory. Each knowledge and ability statement has been rated for its importance to safety. This catalog was developed to address the passive nature of the Westinghouse AP1000 design.

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