APPENDIX D
SIMULATOR TESTING GUIDELINES

A. PURPOSE

This Appendix provides a framework for preparing and evaluating simulator scenarios to ensure they are of appropriate scope, depth, and complexity for initial operator licensing and requalification examinations. The following elements are discussed in detail or attached for information:

- a basic procedure for developing new simulator scenarios (Section B), including a description of the associated qualitative and quantitative attributes (Section C) and the critical task methodology (Section D)

- the competencies in which reactor operators (ROs) and senior reactor operators (SROs) are expected to be proficient (Section E)

- the simulator security considerations that should be kept in mind during scenario validation and administration (Section F)

- selected examples of initial and requalification scenarios (Attachments 1 and 2)

Adhering to the concepts and guidelines discussed herein, in association with the specific criteria cited in ES-301 or ES-604, as applicable, will enhance the consistency and validity of the dynamic simulator operating tests.

B. INTEGRATED SCENARIO DEVELOPMENT

The major activities applicable to the development of dynamic simulator scenarios are summarized below. The instructions apply to both the initial and the requalification examination programs, except as noted. Although they are written from the perspective of new scenario development, the instructions should also be referenced, as necessary, when modifying existing scenarios for reuse and while reviewing proposed scenarios for quality.

1. <u>Identify Scenario Objectives</u>

A scenario should ~~explicitly identify its~~ have specific objectives. For a requalification examination, these should come, in part, from the facility's requalification training program objectives. However, 10 CFR Part 55 requires that the initial licensing and the annual requalification operating tests be a comprehensive sampling of items (2) through (13) listed in 10 CFR 55.45. Therefore, both tests should sample from all the operating skills and abilities required of an operator and the operating crew. Limiting the requalification examination to topics covered in the requalification cycle is not sufficient.

The basic objective of a scenario should be to evaluate the operators' ability to respond to events that are most appropriately tested in a dynamic simulator environment. These are events that require the operators to demonstrate their knowledge of integrated plant operations, diagnose abnormal plant conditions, and demonstrate their ability to work together and to mitigate plant transients that exercise their knowledge and use of AOPs and EOPs. Additionally, the scenario should require the operators (usually the SROs) to utilize technical specifications (TS) and, for requalification examinations, to implement the emergency plan. The full range of competencies in which the operators must demonstrate proficiency during the simulator test are described in Section E of this Appendix.

~~Briefly describe the objectives in the space provided at the top of Form ES-D-1, "Simulator Outline," or equivalent. Also enter an identifying number for the scenario and the name of the plant after which the simulator is modeled.~~

2. <u>Select Initial Conditions</u>

Initial conditions must be established that will allow the scenario to commence realistically. The initial conditions should be representative of a typical plant status, with various components, instruments and annunciators out of service. To have maintenance or surveillance activities in progress is realistic. All, some, or even none of these initial conditions may have a bearing on subsequent scenario events. Initial conditions should be frequently changed, to prevent predictability of future events. The initial conditions should be varied among the scenarios and should include startup, low-power, and full-power situations.

Briefly describe the initial conditions, including any items that should be addressed during the shift turnover, in the space provided at the top of Form ES-D-1, or equivalent.

3. <u>Select and Document Events</u>

Once the initial conditions are established, select a sequence of events designed to attain the stated objectives. Section C discusses a number of qualitative and quantitative criteria that should be considered when selecting events. The specific requirements for each quantitative criterion are enumerated in ES-301 and ES-604, as applicable.

Each event should have or contribute to an objective, whether it is to evaluate the operators' knowledge of a recent system modification, evaluate their ability to respond to a safety-significant event, or assess their use of TS for a particular safety-related component. Uncomplicated events that require no operator action beyond the acknowledgment of alarms and verification of automatic actions provide little basis for evaluating the operators' competence and should not be included on the operating test unless they are necessary to set the stage for subsequent events.

The scenarios should be developed so that a variety of systems is affected within each type of event (i.e., normal evolutions, instrument failures, component failures, and major plant transients). Having one equipment failure cause or exacerbate another can be used to evaluate the operators' understanding of system and component interactions. Balancing the severity of events and the demands they place on each operating position (e.g., RO and BOP) will allow each operator to demonstrate his or her competence across a range of conditions.

All events do not have to be linked, that is, one event need not occur for the next event to logically occur, although in many instances, such a relationship adds to the credibility of the scenario. However, the scenario should not consist of a series of totally unrelated events. A well-crafted scenario should flow from event to event, giving the operators sufficient time in each event to analyze what has happened, evaluate the consequences of their action (or inaction), assign a priority to the event given the existing plant conditions, and determine a course of action. Exercise care that one event does not fully mask the symptoms of another because the operators could overlook the malfunction and cause the event or competency coverage for the scenario set to be deficient.

Record each planned operation, malfunction, and transient on Form ES-D-1 and number them sequentially. Cross-reference each event to a simulator malfunction number, if applicable, or briefly describe the simulator instructions that must be entered.

For each event listed on Form ES-D-1, prepare a Form ES-D-2, "Operator Actions," (or equivalent) by entering the scenario, event, and page numbers and a brief description of the event at the top of the form. Each event description should include when it is to be initiated, whether by signal of the lead examiner/evaluator, time line, or plant parameter. The form shall also identify the symptoms or cues that the operators will be provided, the expected actions to be taken, communications to be made, the references to be used by each operating position (e.g., the SRO, RO, and BOP operators) on the crew, and the event terminus (i.e., the anticipated point at which the examiners or evaluators will have enough information on operator performance to move on to the next event).

Every expected operator action should be included on the form, particularly the critical tasks (refer to Section D, “Critical Task Methodology”) and other verifiable actions and behaviors that will provide a useful basis for evaluating the operators' competence. Critical tasks (CTs) shall be flagged in a manner that makes them apparent to the individuals who will be administering the operating test (e.g., by using underlines, asterisks, or bold type) and the measurable performance indicators shall be identified. When possible, set points and other parameters should be included to provide an objective method for evaluating the operators' performance. Statements such as "Performs actions in accordance with Procedure XXXXX" generally do not provide sufficient guidance and are inadequate. However, the statement "Performs actions of steps XXX of Procedure XXX (attached)" is acceptable.

> Although the expected actions should, to the extent possible, be listed in chronological order, certain actions may be required throughout the event (for instance, if a safety or relief valve fails open, the operators should continually monitor pressure and water level). Flag these actions to show that they are continuous.

The expected actions on Form ES-D-2 should be widely spaced to leave room for notes to document the operator's performance during the simulator test. The far-left column of the form should also be left blank so that it may be used to record the actual time at which key actions occurred while giving the test.

4. Determine the Scenario Endpoint

The last operator action sheet (Form ES-D-2) in the scenario should specify the endpoint of the scenario by identifying a particular plant condition, procedural step, or other point that is clearly recognizable. The scenario should not be terminated until the stated objectives have been achieved.

5. Validate the Scenario

Every scenario should be validated to ensure that it will run as intended. If a previously validated scenario is being modified slightly, real-time validation may not be necessary. However, if there are major changes or if someone questions the validity, revalidation in real-time is recommended.

C. SCENARIO ATTRIBUTES

All valid scenarios contain common elements that make them useful as evaluation tools. A properly constructed scenario provides for an accurate test of each individual operator's skills and abilities as well as an opportunity to evaluate the crew members' team-dependent skills and abilities. The scenario should be of sufficient scope and complexity to demonstrate the difference between competent operators and crews and those that are not performing at an acceptable level. It also should require that the crew demonstrate its ability as a team to adequately protect the public health and safety in emergency conditions, using the facility's emergency operating procedures (EOPs).

Scenario attributes can be characterized as both qualitative and quantitative. No single qualitative or quantitative attribute or group of attributes can be used to determine the acceptability of a scenario. However, a trained examiner should be able to assess of the adequacy of a scenario or develop a new scenario, using both sets of attributes. This assessment, combined with validation of the scenario on a real-time basis, should be sufficient to determine if a scenario provides an acceptable tool to measure the competency of a crew and/or its individual members.

1. Qualitative Attributes

a. Realism/Credibility

Introducing unrealistic or incredible events into a scenario can affect the validity of the scenario and provide negative training. Piping, component, and instrument failures often occur in such a way that deterioration can be tracked over a discrete time period (e.g., a small leak that propagates over time or a pump failure preceded by a high vibration condition). Including such precursors into scenarios is important, where appropriate. A great deal of evaluative feedback can be obtained by observing how an operator and crew responds to a gradually worsening condition. A good technique inserts an event precursor (e.g., small steam generator tube leak) and maintains the plant at a slightly degraded condition to observe how the crew incorporates that condition into its conduct of subsequent plant operations.

Although faults that occur with little or no warning (e.g., valve operators fail, fires occur in breakers or transformers, undetected pipe erosion results in piping failures) may be included in scenarios, they often provide minimal evaluative benefits because they happen so suddenly that operators have little to do but watch the event unfold. These events are most useful when trying to establish a plant condition for subsequent evaluation goals or to assess an operator's or a crew's ability to use procedures in a symptom-based rather than an event-based mode.

Mechanistic component failures are well documented events that occur each year, many times in multiple numbers. However, non-mechanistic failures (e.g., pipe breaks) generally occur singularly; therefore, unless there is a connective precursor, such as a seismic event, it would not be realistic or credible to have several piping systems fail during any one scenario.

Simulated events that appear to violate the laws of physics and thermodynamics contribute to negative training and are to be avoided. Time compression techniques, which are discussed later, may contribute to negative training. However, if the intent of a scenario is to evaluate a crew's ability to execute procedural steps that may take a long time to reach during an event (e.g., hydrogen generation during a core uncover event), such a technique may be useful. However, the scenario must contain a cue that, when the indications for such events are detected by the crew, the crew is informed that the parameters are not responding as expected for the actual plant and that time is being compressed. This cue should be presented at the first opportunity that does not distract the crew from responding to available indications and before the crew challenges the validity of the indications. For example, in the first PWR scenario (Attachment 1), the cue should be given following the crew's determination that a reactor coolant system (RCS) feed and bleed may be necessary (per FR-H.1) but prior to steam generator levels requiring initiation.

b. Event Sequencing

The sequence of events has a major effect in establishing the complexity of a simulator scenario. The pace at which malfunctions are entered can adversely affect the way an operator or a crew responds.

Malfunctions may be entered simultaneously at separate control panel locations if each event can be handled by an individual applicant and does not require extensive assistance.

Too short a time between malfunctions may mask the effects of a particular malfunction and divert the operators' attention. This cuts short the observers' ability to evaluate the operators' response to the prior malfunction and may be prejudicial to a fair evaluation. Conversely, extending the time between malfunctions so that no operator activity is in progress may cause undue stress. During an examination, the operators expect something to occur; too much time between events should be avoided.

Therefore, insertion of malfunctions in the scenario should be carefully timed. Rigorously following a planned time sequence of events is often less valid than initiating malfunctions on the basis of plant parameters or operator actions. The appropriate sequencing of events relates directly to the objectives of the scenario.

Event sequencing may involve time compression to speed up the response of key parameters so that the scenario can proceed to the next event within a reasonable time. Time compression may be accomplished by adjusting parameter indications or accelerating plant behavior characteristics so that an event is triggered by plant indications more quickly than would typically occur in reality (e.g., opening a drain path from a steam generator that is not noticeable to the operator so that the entry conditions for a loss of heat sink are reached.) This method is acceptable as long as the time compression allows the operators time to perform tasks that they would typically perform during the period in which time is compressed. To avoid wasting the operators' time determining the validity of their indications, the crew should be informed before the scenario begins that time compression may be used during an event and debriefed after the scenario to minimize the potential for negative training.

Frequently, important evaluative benefit in terms of safety significance is gained by having key components or instruments fail after entering the EOPs. This process compels the operators to respond immediately to a safety-related situation by taking alternate actions to mitigate the event. This process also allows for a better evaluation of the operators' overall knowledge of plant procedures and systems because the event must be incorporated into the mitigation strategy for the remainder of the scenario. Conversely, instrument and component failures that are initiated after the major transient sometimes require little action and may provide little insight to the operators’ competence.

c. Simulator Modeling

Despite the certification of simulators to a set standard (ANSI/ANS-3.5), not all simulators are equally capable of performing major transients. The scenario should not exceed the limits of the facility licensee's configuration management system by altering a simulator model to obtain a desired effect. For example, increasing the post-trip decay heat input in order to maximize internal core temperatures during a loss of cooling event is not appropriate; the simulator model should be allowed to perform as designed. The scenario may simulate events for which a simulator malfunction does not exist by using overrides or remote functions for local operator actions. An example would be failing indicators to simulate an inoperable component.

d. Evaluating Competencies

Each scenario set shall ensure that all of the rating factors within each competency can be evaluated and that, if the crew performs poorly, their performance could cause plant degradation or threaten the public health and safety. Therefore, events must be incorporated into the scenario that will allow an unsatisfactory evaluation of an operator or crew in a particular rating factor if they perform poorly. Scenarios that require little analysis or problem-solving and few operator actions may not provide an adequate basis to evaluate the required rating factors.

The individual competencies applicable to the RO and SRO license levels during initial and requalification examinations are described in Section E; the rating factors within each competency are identified in ES-303 (specifically, on Forms ES-303-3 and ES-303-4 for RO and SRO applicants, respectively). The crew competencies applicable to requalification examinations only are identified in ES-604.

e. Level of Difficulty

The dynamic simulator operating test must discriminate between those examinees who have and those who have not adequately mastered the knowledge, skills, and abilities required to be licensed operators. Simulator scenarios that are either too easy or difficult are not effective discriminators.

In general, as the quantitative attributes, such as the number of malfunctions or critical tasks (discussed below), of a simulator scenario increase, the level of difficulty of the scenario will increase as well. However, counting the number of scenario quantitative attributes is not always indicative of the scenario's level of difficulty; two scenarios having the same quantitative attributes can vary significantly in level of difficulty. There are no definitive minimum or maximum attribute values that can be used to identify inappropriate scenarios that will not discriminate because they are too easy or difficult.

The two most important determinants of the level of difficulty of a simulator scenario are the amount of analysis and problem-solving and the number of operator actions required to mitigate the events in the scenario. Malfunctions that require analysis or problem-solving increase the level of difficulty because they require the examinees to integrate a number of system conditions, evaluate their interrelationships, and take actions that demonstrate an understanding of the underlying knowledge. Scenarios that consist of a number of unrelated malfunctions that require little or no operator analysis or response are generally less challenging.

2. <u>Quantitative Attributes</u>

Those traits discussed in the previous section provide for a qualitative assessment of the complexity of a simulator scenario. However, there are some characteristics of a scenario that can be quantified and that generally have a bearing on the complexity and level of difficulty of the scenario. These characteristics are described below, and a target range for each trait that is applicable to the initial and requalification examination is enumerated in ES-301 and ES-604, respectively. The ranges are not absolute limitations; some scenarios may be an excellent evaluation tool but may not fit within the ranges. A scenario that does not fit into these ranges should be evaluated to ensure the scenario is appropriate.

a. <u>Normal Evolutions</u>

Normal evolutions include activities such as a feed pump startup, turbine loading, generator synchronization, and reactivity manipulations, which include evolutions such as a reactor startup or changing power with boron concentration, control rods, or core flow. Reactivity manipulations are considered significant if they produce a *clearly observable plant response*, such as bringing the reactor critical from a substantially subcritical state, raising power to the point that reactivity feedback from nuclear heat addition is noticeable and a heatup rate is established, or changing reactor power manually with control rods or recirculation flow.

Normal evolutions can be used as a backdrop on which to stage the emergency or abnormal situations. For example, a main feedwater control valve may fail passively (i.e., as is) before the operators conduct a normal power change.

Time consuming normal evolutions such as a power escalation from low power can provide an opportunity to evaluate the SRO's supervisory or resource management skills. Events such as component or instrument failures may be added to challenge the operators while continuing the power escalation.

Short surveillances (e.g., exercising safety rods or paralleling the emergency diesel generator with the grid) may be used to examine the operators' dexterity on the control panels or to involve operators who are not engaged in other activities.

b. Total Malfunctions

Total malfunctions are the number of instrument (e.g., nuclear, control, or process) and component failures (e.g., pump, motor, valve, or pipe) used to initiate the events that constitute a scenario, including those initiated after EOP entry (see Item C.2.c below). To count as a separate malfunction, they must involve a significant system response and require operator action to correct. For example, an anticipated transient without scram or trip (ATWS/ATWT) is a single malfunction, regardless of how many instructions a simulator operator must program to produce it.

Components that are placed out of service at the beginning of a scenario as part of the shift turnover conditions, and which the crew is made aware of, are not considered malfunctions. Component or instrument failures that require no operator actions or response do not count toward the recommended total number of malfunctions.

c. Malfunctions After EOP Entry

Some malfunctions should result in vital instruments or components failing after the EOPs have been entered (these may have been inoperable at the beginning of the scenario or before EOP entry) and influence the operators' choice of mitigation strategy. For example, failing a high head safety injection (SI) pump to start on a large-break loss-of-coolant accident (LOCA) does not affect the mitigation strategy; however, this would have an effect if it were the only available high head SI pump on a small-break LOCA.

d. Abnormal Events

Each scenario should evaluate the operators' ability to implement abnormal operating procedures (AOPs). An abnormal event may or may not be a precursor to the major transient (see Item C.2.e below), although it can add to the credibility of a scenario, such as preceding a total loss of feed water with a single feed pump trip. However, certain events may cue the operators about subsequent events. Therefore, if a scenario is derived from the facility licensee's bank, it is wise to vary or modify the precursor events that lead to the major transient. It is also good to insert abnormal events that are not always predictive of the same major transient (e.g., a steam generator tube leak does not always lead to a subsequent tube rupture).

Some abnormal events for each scenario should require that the operators recognize and interpret technical specifications. This recognition and interpretation can also be incorporated into the scenario by designating TS-related equipment that is out of service at the start of the scenario.

Components or instrument failures that occur following EOP entry do not count toward the recommended total number of abnormal events.

e. Major Transients

A major transient is one that has a significant effect on plant safety and that leads to an automatic (or manual, if initiated by an operator) protective system actuation, such as a reactor trip or an engineered safety system actuation. A single major transient that actuates more than one automatic protective system actuation will be counted as a single major transient. Examples include loss of offsite power, LOCA, steam or feed line break, steam generator tube rupture, and loss of feed water. A major transient should normally involve activation of the facility's emergency plan.

f. EOPs Used

A scenario that requires the operators to refer to many different EOPs may not be as complex as a scenario for which only one EOP is used, but which requires use of alternative decision paths and prioritization of actions within the EOP to deal with the situation. Therefore, this attribute should reflect the EOPs that have measurable actions that the crew must take. Moreover, the primary scram response procedure that serves as the entry point for the EOPs is not counted.

For BWRs, the number of "EOPs Used" should be counted consistent with the following four top level guidelines of the Emergency Procedures Guidelines: (1) RPV Control, (2) Primary Containment Control, (3) Secondary Containment Control, and Radioactivity Release Control. Use of multiple control sections of the above listed guidelines do not count separately as "EOPs Used." For example, use of RPV level control and RPV pressure control should be counted as one EOP Used - RPV Control.

g. EOP Contingency Procedures Used

Contingency procedures are used when there is a challenge to a critical safety function or if plant conditions have become severely degraded. Therefore, using them in a scenario provides an opportunity to observe the operators attempt to execute a mitigation strategy that clearly has safety significance to the plant and the public health and safety. Each scenario set should require the operators to enter and perform safety-related tasks within an EOP contingency procedure at least once.

The following list of contingency procedures is not unique or all-inclusive. Scenario developers and reviewers should consider it as a set of general guides that may not fully apply to all scenarios.

(1) <u>Westinghouse</u>

Optimal Recovery Procedures designated as Emergency Contingency Action (ECAs) procedures:

- Loss of All AC Power With or Without SI Required
- Loss of Emergency Coolant Recirculation
- LOCA Outside Containment
- Uncontrolled Depressurization of All Steam Generators
- Steam Generator Tube Rupture (SGTR) With Loss of Reactor Coolant-Subcooled Recovery
- SGTR With Loss of Reactor Coolant-Saturated Recovery
- SGTR Without Pressurizer Pressure Control

Functional Recovery Procedures entered as a result of RED or ORANGE conditions on the Critical Safety Function Status Trees:

- Response to Nuclear Power Generation/ATWS
- Response to Inadequate Core Cooling
- Response to Degraded Core Cooling
- Response to Loss of Secondary Heat Sink
- Response to Imminent Pressurized Thermal Shock Conditions
- Response to High Containment Pressure
- Response to Containment Flooding

(2) Combustion Engineering

- Entry into Functional Recovery Procedures (FRPs)
- Transition among Functional Recovery Safety Function success paths
- Transition from one safety function to another within the FRPs

(3) Babcock and Wilcox (B&W)

The B&W EOP structure does not identify procedures that can be easily recognized as contingency procedures. However, use of the descriptions given above for Westinghouse contingency procedures provides guidance on the type of events to be considered.

(4) General Electric

- Alternate Level Control
- Emergency Reactor Pressure Vessel (RPV) Depressurization
- Primary Containment Flooding
- Level/Power Control
- RPV Flooding
- Steam Cooling

h. Simulator Run Time

A scenario should be designed to run approximately 60 to 90 minutes. However, this does not preclude scenarios taking more or less time. The nominal run time of 60 minutes may not provide sufficient time to conduct a scenario that progresses through several EOPs or that requires performance of fairly involved procedural steps. It is possible to conduct very meaningful and involved scenarios in less time, but care should be taken not to place an undue burden on the operators by initiating malfunctions at too rapid a pace. This parameter is one of many that should be considered in assessing the overall quality of a scenario, and as long as the scenario meets the other criteria stated in this guidance, the scenario run time is a secondary concern.

I. EOP Run Time

The time during which the operators are involved in EOPs has a strong relationship to the complexity of the scenario because most critical tasks occur in the EOPs and the actions the operators take have the most potential for affecting the health and safety of the public. Therefore, a significant percentage of the time a scenario is progressing should be spent in the EOPs. Usually, more time is required when contingency procedures are in effect, because it generally takes some time for the plant to degrade to a point where critical safety functions are jeopardized. However, operators should be evaluated in EOP activities beyond the point at which an event is diagnosed and initial mitigation actions are taken. Many of the actions taken to stabilize the plant and recover from a transient are safety significant. Therefore, scenarios should be allowed to progress so that these operations can be observed.

Scenarios should not be just EOP oriented. Valuable assessments can be made within AOPs with the plant at power because of the level of safety significance associated with transients in these conditions.

j. Critical Tasks

Critical tasks range between fairly simplistic but safety-significant tasks (starting the standby liquid control system on an anticipated transient without scram condition or tripping a reactor coolant pump during a small-break LOCA) and other tasks that require a much higher level of skill involving several crew members (executing a rapid cooldown within predefined limits using steam generator power-operated relief valves or using low pressure injection systems to maintain the vessel level while cooling the suppression pool). Therefore, the difficulty level must be considered to judge the appropriateness of the number of CTs in a scenario or scenario set.

Refer to Section D for a detailed explanation of the critical task methodology.

D. CRITICAL TASK METHODOLOGY

The requalification examination uses critical tasks (CTs) for evaluating crew performance on tasks that have safety significance to the plant or the public. The CTs are objective measures for determining whether an individual's or a crew's performance is satisfactory or unsatisfactory.

On the initial licensing examinations, CTs are used to provide a basis for the individual operator competency evaluations because they help the examiner focus on those tasks that have a significant impact on the safety of the plant or the public. Refer to ES-303 and ES-604 for specific instructions on the use of CTs in grading initial and requalification examinations.

1. Identification of Critical Tasks

A critical task must include the following elements:

a. Safety Significance

In reviewing each proposed CT, assess the task to ensure that it is essential to safety. A task is essential to safety if the improper performance or omission of this task by an operator will result in direct adverse consequences or in significant degradation in the mitigative capability of the plant.

If an automatically actuated plant system would have been required to mitigate the consequences of an individual's incorrect performance or the performance necessitates the crew taking compensatory action that would complicate the event mitigation strategy, the task is safety significant.

Examples of CTs involving essential safety actions include those for which operation or correct performance prevents the following:

- degradation of any barrier to fission product release
- degraded emergency core cooling system (ECCS) or emergency power capacity
- a violation of a safety limit
- a violation of the facility license condition
- incorrect reactivity control (such as failure to initiate emergency boration or standby liquid control, or manually insert control rods)
- a significant reduction of safety margin beyond that irreparably introduced by the scenario

Examples of CTs involving essential safety actions include those for which a crew demonstrates the following abilities:

- effectively direct or manipulate engineered safety feature (ESF) controls that would prevent any condition described in the previous paragraph
- recognize a failure or an incorrect automatic actuation of an ESF system or component

- take one or more actions that would prevent a challenge to plant safety

- prevent inappropriate actions that create a challenge to plant safety (such as an unintentional reactor protection system (RPS) or ESF actuation)

b. Cueing

For a CT to be valid, an external stimulus prompts at least one operator to perform the task. A cue prompts the operators to respond by taking certain actions and provides the initial conditions. The cue need not indicate the task as "critical."

Appropriate cues include the following examples:

- verbal direction by or reports from other crew members

- procedural steps, such as satisfying entry conditions, flow chart decision points, and "response not obtained" columns

- indication of a system or a component malfunction (including passive failures) by meters or alarming devices

c. Measurable Performance Indicators

A measurable performance indicator consists of positive actions that an observer can objectively identify taken by at least one member of the crew.

The NRC and facility licensee should review each critical task to ensure it is objective. For example, "If pressure falls below 1400 psi, start pump xyz," is a performance measure that is not objective. The operator performing this task could conceivably start the pump when pressure reaches zero psi and still not violate the performance measure stated in the procedure, even though the facility licensee expects the operator to start the pump sooner. The NRC and facility licensee should agree in writing that the limits for each CT are acceptable before the requalification examination begins. For the example given above, adding an acceptable pressure tolerance (e.g., within 200 psi) would clarify the standard of performance that is expected.

Measurable performance indicators include the following examples:

- actions taken as the result of transitioning in emergency operating procedures (EOPs), for example transitioning to and performing the actions required in FR-S.1 if the reactor does not trip (Westinghouse), or performing an automatic depressurization after confirming indications of high suppression pool temperature (General Electric)

- control manipulations such as a manual reactor trip or the start of an ECCS pump

- verbal reports or notifications of abnormal parameters or conditions such as "all control rods are not inserted" or "containment pressure is greater than 2 psi"

The following are examples of performance indicators that *cannot* be measured objectively during a simulator scenario:

- understanding, such as of the significance of a certain plant response

- verification that an expected response has occurred

- passive observations such as monitoring the performance of a system

d. Performance Feedback

Each CT must provide at least one member of the crew with performance feedback. The feedback provides the crew member with information about the effect of the crew's actions or inaction on the CT. This requirement must be met for all CTs.

2. <u>Critical Tasks as "Generic" Safety Tasks</u>

Avoid assigning the "CT" designation to generic tasks that have safety significance but that do not meet all of the criteria required to identify a critical task.

Although a crew is not performing optimally if it fails to anticipate an automatic action given sufficient time to assess plant behavior, crew members are not required to anticipate an automatic action. A crew member may, at any time, take manual action in advance of an automatic action if, in the crew member's judgement, manual action is needed to place the reactor in a safe condition. If an operator takes an action that the examiners did not expect, the examiners must further evaluate the individual's rationale for taking those actions. This preemptive action may indicate a misunderstanding of plant conditions or a weakness in integrated plant knowledge that should be clarified with follow-up questions.

Taking manual control of an automatic safety system qualifies as a CT only if the auto-initiation feature fails to work. It is then safety significant for the crew to take manual actions, as plant conditions clearly indicate that an automatic action should have occurred and did not. Moreover, during scenario development and validation, identification of CTs is based on those actions which, if performed incorrectly or omitted, degrade the mitigation strategy needed in the scenario. If the manual system has also failed and no action will be effective, this should not be identified as a CT. However, if an operator or the crew significantly deviate from or fail to follow procedures affecting assurance of basic safety functions, those actions may form the basis of a CT identified in the post-scenario review.

Experience has shown emergency event classification to be an important evaluation area, but generally not a critical task. The argument is made that an incorrect classification could adversely affect the public health and safety if the appropriate instructions are not given to public service agencies in a timely manner. If a misclassification occurs, the emphasis for corrective action is placed on the facility licensee and an appropriate period allotted for implementation of the corrective actions.

Therefore, although emergency classification is still an area that is to be evaluated, it should not receive the weight of a critical task. If a misclassification occurs, the examiners should determine the rationale used to establish the classification in order to determine if the crew understood the status of the plant and incorporate into the program evaluation those pertinent corrective actions deemed appropriate. If a widespread problem during a program evaluation is observed, the examiner should share this information with other inspection program managers.

E. COMPETENCY DESCRIPTIONS

1. <u>Reactor Operator</u>

a. Understand and Interpret Annunciators and Alarm Signals

This competency involves the ability to *notice and acknowledge* alarms. It includes the abilities to prioritize one's attention in keeping with the severity and importance of annunciators and alarm signals and to correctly *interpret and verify* that signals are *consistent with plant and system conditions* (with the use of alarm response procedures, as appropriate). This competency deals strictly with the understanding and interpretation of annunciators and alarm signals and, therefore, does not include knowledge of, or the ability to diagnose, overall plant and system status on the basis of other indications.

b. Diagnose Events and Conditions Based on Signals and Readings

This competency involves the ability to accurately and promptly *recognize and analyze* off-normal *trends* and *diagnose* plant conditions to guard against and mitigate conditions that are out of specification. It includes the *use of* control room *reference materials*, such as prints, books, and charts, to aid in the diagnosis and classification of events and conditions. It does *not* include knowledge of system operation, such as set points, interlocks, or automatic actions, or the understanding of how one's actions affect the plant and system conditions.

c. Understand Plant and System Response

This competency involves *knowledge of system operation*, including set points, interlocks, and automatic actions. It includes the abilities to *locate and interpret* plant and system *instruments* and to understand how one's actions *affect* plant and system conditions. It does *not* include the ability to notice or attend to annunciators and alarm signals or the ability to diagnose or classify events and conditions on the basis of control room indications.

d. Comply With and Use Procedures and Technical Specifications

This competency involves the ability to *refer to and comply with* normal, abnormal, emergency, and administrative *procedures* in a timely manner (i.e., in sufficient time to avoid adverse impacts on plant status). It includes the ability to *recognize* emergency operating procedure *entry conditions, carry out immediate actions* without assistance, and *recognize and comply* with required *limiting conditions for operation and action statements*.

e. Operate the Control Boards

This competency involves the ability to *locate and manipulate controls* to attain a desired plant and system response or condition. It includes the ability to take *manual control* of automatic functions, when appropriate.

f. Communicate and Interact With Other Crew Members

This competency involves the ability to *provide and receive* pertinent information, both oral and written (e.g., log entries). It includes the ability to *carry out supervisory instructions* and to *interact with other crew members* with respect to conditions affecting safe plant operation regardless of which applicant's control board is directly affected.

2. <u>Senior Reactor Operator</u>

a. Understand and Interpret Annunciators and Alarm Signals

This competency involves the ability to *notice and attend* to alarms. It includes the ability to prioritize one's attention in keeping with the severity and importance of the annunciators and alarms and the ability to correctly *interpret the significance* of each alarm and *verify* that it is *consistent* with plant and system conditions (with the use of alarm response procedures, as appropriate). This competency deals strictly with the understanding and interpretation of annunciators and alarm signals and, therefore, does *not* include knowledge of, or the ability to diagnose, overall plant and system status on the basis of other indications.

b. Diagnose Events and Conditions Based on Signals and Readings

This competency involves the ability to *diagnose* plant conditions to guard against and mitigate conditions that do not meet specifications. It includes the ability of both the supervisor and the crew to *recognize and analyze off-normal trends* in an accurate and timely manner and to *use* control room *reference materials*, such as prints, books, and charts, to aid in diagnosing and classifying events and conditions. It does *not* include knowledge of system operation, such as set points, interlocks, or automatic actions, or the understanding of how one's actions affect the plant and system conditions.

c. Understand Plant and System Response

This competency involves *knowledge of system operation*, including set points, interlocks, and automatic actions. It includes the ability to *locate and remain attentive* to control room indicators, *interpret* those indicators to *verify* the status and operation of systems, and *understand* how one's *actions and directives affect plant and system conditions*. It does *not* include the ability to notice or attend to annunciator and alarm signals or to diagnose or classify events and conditions on the basis of control room indications.

d. Comply With and Use Procedures

This competency involves the ability to *refer to and comply with* normal, abnormal, emergency, and administrative *procedures* in a timely manner (i.e., in sufficient time to avoid adverse impacts on plant status). It includes the ability to *use procedures correctly* and ensure correct *implementation by the crew*.

e. Operate the Control Boards

This competency involves the ability to *locate and manipulate* controls to attain a desired plant and system response or condition. It includes the ability to take *manual control* of automatic functions, when appropriate.

f. Communicate and Interact With the Crew and Other Personnel

This competency involves the ability to *provide and receive* pertinent *information* in a clear, easily understood manner. It includes the ability to *keep crew members and personnel outside* the control room *informed* of plant status.

g. Direct Shift Operations

This competency involves the ability to take *timely and decisive actions* in response to problems during both normal and off-normal situations. It includes the ability to provide *timely and well thought out directions* that indicate *concern for safety*; to encourage a *team approach* to problem solving and decision making by *soliciting and incorporating feedback* from members of the crew; and to remain in a position of *oversight* to maintain the "big picture."

h. Comply With and Use Technical Specifications

This competency involves the ability to *recognize* when conditions are covered by technical specifications. It includes the ability to *locate* the appropriate technical specification and *ensure correct compliance* with any limiting conditions for operation and action statements.

F. SECURITY CONSIDERATIONS FOR SIMULATOR OPERATING TESTS

Simulators present a unique set of integrity concerns during the development and administration of operating tests. NRC examiners and facility licensees should be aware of the simulator's vulnerabilities and take appropriate measures to ensure that operating test security is maintained in three areas: the instructor station, the programmers' tools, and the external interconnections. Because facility licensees are more familiar with their simulator's unique capabilities, limitations, and vulnerabilities than the NRC examiners are, it is expected that the licensees will take responsibility for determining and implementing whatever measures might be necessary to ensure the integrity of the operating tests.

Most of the instructor station features can be checked through the tableau or graphic interface provided at the instructor's console. The programmers' tools and the external interconnections are not generally apparent to the instructor or the examiner. The simulator staff should be consulted to determine the status of those items.

1. Instructor Station Features

· *Snapshots* - All simulators have snapshot capability. Initial conditions (ICs) are recorded for future recall.

· *Backtrack* - Backtrack files are snapshots that are automatically recorded at pre-determined intervals, usually up to 1 hour of operation at intervals as frequent as 1 minute. Backtrack files are usually only accessible through the BACKTRACK feature. The files typically cannot be erased, only overwritten by real-time operation.

· *Replay/Playback* - The replay/playback feature steps through a series of snapshots and displays the I/O status (lights, meters, etc.) for each sequentially. Often, the replay feature uses the backtrack files, although separate replay file storage may be provided.

· *Scripts/Computer Assisted Exercises* - Many simulators have a feature that allows pre-programmed implementation of malfunctions and remote functions based on time and/or logical conditions. Scripts may be used by the simulator staff to facilitate scenario administration. Scripts can typically be stored for future use. Stored scripts can also be selected for review and editing from the instructor station.

- *Initial Conditions Summary* - Snapshots are usually labeled on the instructor station IC menu with date/time recorded, pertinent plant parameter status, and instructor comments. Even if the comment field has been changed to indicate that a snapshot is available for re-use, the data (scenario initialization) may still be representative of test conditions until the snapshot is actually overwritten or updated.

- *Malfunction Summary* - Malfunction summary menus display the status of selected malfunctions, both active and inactive. The malfunction summary is usually IC dependent and therefore depicts the malfunctions that were active or staged when an IC, such as a scenario validation, was stored.

- *Monitored Parameters* - Instructors are afforded the capability to define individual or groups of parameters for display or printout. The monitored parameter group assignments can be recalled for review and editing. If used to facilitate scenario validation or examination administration, the monitored parameters can provide insight into the focus of the examination.

- *Trend Recording* - Groups of parameters can be defined and assigned to trend recorders. The recorders may be, but is not necessarily, located at the instructor station. The recording may also be in file format for presentation on instructor station screens. Recording sessions are typically activated or de-activated at the instructor station.

- *Student Performance Monitoring* - Special groups of parameters and simulated plant operating conditions can often be assigned to a tracking and recording function that plots an individual student's performance during training exercises. Recording sessions are typically activated or de-activated at the instructor station.

- *Video and Audio Recording* - Many simulators are equipped with video and audio recording capability in the control room. Video and audio controls are typically located at the instructor station.

2. <u>Programmers' Tools</u>

- *Software Terminals* - Simulator engineers have access to real-time monitoring and control of simulator and model conditions through software support terminals. These terminals may be located in the computer facility or at the engineer's desk.

- *Independent Executives* - The conditions for scenarios can sometimes be replicated off-line using independent executive programs. These programs should not be in communication with the I/O. Independent executives and their associated initialization files may provide an indication of planned exercises if they have been used to resolve problems during scenario validation.

- *Graphical User Interfaces* - Instructor station graphical user interfaces often display simulated plant conditions and performance in real-time. At remote locations, such as a programmer's desk, the GUI could display the full scenario.

3. <u>External Interconnections</u>

- *ESF Feeds* - Many simulators have data links to the ESF and the operations management offices for emergency planning drills. These links can display simulated plant condition to observers outside the simulated control room during scenario validation or examinations.

- *Remote Plant Process Computer and Instructor Station Screens* - Repeater screens in the training area can display scenarios in real time to observers outside the simulated control room.

- *Modems and Remote Simulator Support Systems* - Many simulators are equipped with modems from the instructor station or simulation computers for outside monitoring and control of simulator status and activities by parties off site.

E. ATTACHMENTS/FORMS

Attachment 1,	"Example Initial Dynamic Simulator Scenarios"
Attachment 2,	"Example Requalification Dynamic Simulator Scenarios"
Form ES-D-1,	"Scenario Outline"
Form ES-D-2,	"Operator Actions"

Facility: ________PWR_________ Scenario No.: ____1___ Op-Test No.: ___1___

Examiners: ______________________________ Operators: ______________________________

~~Objectives: To evaluate the applicants' ability to implement the AOPs for a SG tube leak and a loss of charging, to reduce power per GOP-3, and to execute the EOPs for a loss of all AC power (ECA 0.0), loss of coolant (E-1), and a SG tube rupture (E-3), with a success path via ES-3.1, post-SGTR cooldown using backfill.~~

Initial Conditions: IC-38; 100% power, middle of life; CCP "B" is running; Unit 2 is in Mode 5.

Turnover: The following equipment is out of service: DG "A" (6 hrs); CCW pump "A" (2 days); VCT level transmitter LT-185; the block valve for PORV 456 is inoperable with power removed; MFP "A;" and AFW pump "A" (30 hrs). All required surveillances have been done. A severe thunderstorm warning is in effect.

Event No.	Malf. No.	Event Type*	Event Description
1	XXX, XXX	C(RO) N(BOP) R(RO)	70 gpm tube leak on "A" SG (ramped over 5 min) with running CCP trip and failure of standby pump to start; requires power reduction
2	XXX	I(RO)	pressurizer level instrument L-459 fails low
3	XXX	C(ALL)	instrument bus 112 inverter failure
4	XXX, XXX	M(ALL) I(BOP)	450 gpm tube rupture on "A" SG (ramped over 3 min) with an "A" SG pressure transmitter failure causing the PORV to open
5	XXX, XXX, XXX	M(ALL) C(BOP)	concurrent failures of the station auxiliary transformer and the "B" DG result in a loss of all AC power; power remains available through Unit 2 TDAFW pump trips on overspeed (can be reset)

* (N)ormal, (R)eactivity, (I)nstrument, (C)omponent, (M)ajor

Note: The scenarios in this attachment are individual examples; they are not intended to represent complete scenario sets/operating tests.

For each of the planned events, enter on a Form ES-D-2 (or equivalent) a description of the event and detailed actions required by the applicable plant procedures (e.g., normal, abnormal, emergency, and administrative, including the TS and emergency plan) for each operating position (i.e., SRO, RO, BOP) in a manner similar to the first event on the next page.

Op-Test No.: __1__	Scenario No.: __1__	Event No.: __1__	Page _1_ of _5_

Event Description: A 70 gpm tube leak on the "A" SG (ramped over 5 minutes), combined with a trip of the running CCP and a failure of the backup CCP to start, forces a reduction in power because RCS leakage exceeds TS limits.

Time	Position	Applicant's Actions or Behavior
	RO/SRO/BOP	Recognize indications of the tube leak on the "A" SG - - air ejector off gas radiation monitor - steam line radiation monitor - charging/letdown mismatch - SG blowdown radiation monitor
	SRO	Direct RO/BOP actions per AOP-1.2 - - monitor and control pzr level & pressure - monitor and control VCT level - verify leakage greater than TS limit - announce possible high radiation in turbine bldg - verify tube leak with SG samples - have health physics verify release calculation - commence unit shutdown - notify NRC - minimize secondary contamination - classify the event per the EPIPs (unusual event)
	RO/BOP	Execute AOP actions per SRO directions
	SRO/RO	Recognize running CCP tripped - - no charging flow - pump tripped light - various charging/letdown annunciators
	SRO	May direct RO/BOP per AOP-1.3 - - isolate letdown - monitor pressurizer level and pressure - start the standby CCP - reestablish letdown - refer to TS 3.8.1 - initiate repairs
	SRO	Supervise/coordinate power reduction - - review precautions in GOP-3 - ensure delta-I maintained within limits - verify load reduction rate
	RO	Coordinate with BOP to initiate power reduction - - review GOP-3 precautions - calculate/estimate boration required for shutdown - contact load dispatcher - borates and/or inserts rods to maintain T-ave within 5F of T-ref and maintains delta-I within limits
	BOP	Coordinate with RO to initiate power reduction - - review GOP-3 precautions - operate turbine controls to maintain unloading rate

Facility: ________PWR_______ Scenario No.: ____2___ Op-Test No.: ___2___

Examiners: ______________________________ Operators: ______________________________

______________________________ ______________________________

______________________________ ______________________________

~~Objectives: To evaluate the applicants' ability to implement the AOPs for a loss of CCW to the RCPs, loss of reactor makeup control, and the loss of an emergency bus; to initiate a normal plant shutdown; and to execute the EOPs for a steam line break in containment with an ATWS (FR-S.1) and a subsequent loss of all feed flow (FR-H.1) requiring bleed and feed operations.~~

Initial Conditions: IC-20; approximately 100% power, 218 ppm boron (EOL), equilibrium xenon; bank "D" rods are at step 216

Turnover: The operations department is making preparations to shut down the plant due to equipment problems. Train "B" CSS logic failed an actuation test last shift; the LCO for TS 3.3.2 was entered 2 hrs ago; I&C is working on the problem. MDAFW pump "B" is out of service to repair an oil leak and should be back in about 45 min. The block valve for PORV 445A is closed and deenergized for leakage control.

Event No.	Malf. No.	Event Type*	Event Description
1	XXX, XXX	I(BOP)	spurious containment spray actuation, phase "B" isolation, and CSS pump "A" failure to auto start (reset malf. to allow equipment restoration and before required stop of RCPs)
2	N/A	N(BOP) R(RO)	begin normal shutdown due to CS problems
3	XXX	C(RO)	boric acid filter plugged (100% in 1 min) at start of boration; when asked, filter d/p is 80# (remove when backflushed)
4	XXX	I(RO)	narrow range RCS temperature detector fails high
5	XXX, XXX	C(BOP)	emergency bus 1A-SA normal feeder breaker trips and DG "A" breaker trips 2 min later
6	XXX, XXX, XXX, XXX	M(ALL) C(BOP) C(RO)	"A" SG line break in containment with auto SI on high containment pressure but failure of reactor and turbine trip; the local manual breaker is operable and the turbine will follow; TDAFW pump overspeed on SI; PORV "B" failure to open in auto or manual

* (N)ormal, (R)eactivity, (I)nstrument, (C)omponent, (M)ajor

For each of the planned events, enter on a Form ES-D-2 (or equivalent) a description of the event and detailed actions required by the applicable plant procedures (e.g., normal, abnormal, emergency, and administrative, including the TS and emergency plan) for each operating position (i.e., SRO, RO, BOP) in a manner similar to the first event for the first PWR scenario (page 2 of this Attachment).

Facility: _______BWR_______ Scenario No.: ____1___ Op-Test No.: ___1___

Examiners: ____________________________ Operators: ____________________________

____________________________ ____________________________

____________________________ ____________________________

~~Objectives: To evaluate the applicants' ability to raise and subsequently lower reactor power in response to a TS 3.0.5 assessment; to implement the AOP for a loss of UPS; to execute the EOPs for a turbine trip on high vibration with a failure of all control rods to insert and a loss of RPIS; to determine power by alternate means due to APRM failure; and to control pressure with SRVs due to the inoperability of the bypass valves.~~

Initial Conditions: IC-11; approximately 90% reactor power at dispatcher request; at power for 28 days, beginning of cycle; core spray pump 2A is out of service to replace a breaker closing coil; APRM F failed downscale last shift and is bypassed

Turnover: Raise power to 100% when contacted by dispatcher; test core spray pump 2A when the clearance is lifted (imminent)

Event No.	Malf. No.	Event Type*	Event Description
1	N/A	R(RO)	raise reactor power to 100% upon load dispatcher's request
2	XXX	N(BOP) C(BOP)	test core spray pump 2A starting at step 7.9.2 of PT-07.2.4a and respond to the motor overload
3	XXX	C(SRO)	individual bus breaker failure (MCC DGD), requiring DG #4 to be declared inoperable and a plant shutdown per TS 3.0.5
4	XXX	I(RO) C(BOP)	UPS inverter 2A malfunction and loss of UPS (no APRMs, rod positions, or rod control)
5	XXX	C(BOP)	turbine bearing #3 vibration alarm
6	XXX, XXX, XXX, XXX	M(ALL) C(ALL)	turbine trip and reactor scram with very few rods inserted (SLC pump 2A will trip after initiation and the scram discharge volume vents and drains fail to reopen when RPS is reset) bypass valves fail closed after turbine coasts down (no UPS)

* (N)ormal, (R)eactivity, (I)nstrument, (C)omponent, (M)ajor

For each of the planned events, enter on a Form ES-D-2 (or equivalent) a description of the event and detailed actions required by the applicable plant procedures (e.g., normal, abnormal, emergency, and administrative, including the TS and emergency plan) for each operating position (i.e., SRO, RO, BOP) in a manner similar to the first event for the first PWR scenario (page 2 of this Attachment).

Facility: _______BWR_______ Scenario No.: ____2___ Op-Test No.: ___2___

Examiners: ______________________________ Operators: ______________________________

______________________________ ______________________________

______________________________ ______________________________

~~Objectives: To evaluate the applicants' ability to lower reactor power in accordance with plant procedures; to respond to an SSW pump failure with TS implications (EDG operability); diagnose and respond to a feedwater master controller failure with rising RPV level; respond to a loss of an ESF bus and the running CRD pump; and implement the EOPs and an emergency depressurization in response to a loss of service transformers, failure of the second EDG to start, and a recirculation loop break.~~

Initial Conditions: IC-17; 100% reactor power; B CRD pump is in service

Turnover: The load dispatcher has asked that power be lowered to 70%, and chemistry requests an SSW surveillance to be run at the beginning of the shift.

Event No.	Malf. No.	Event Type*	Event Description
1	N/A	R(RO)	decrease power to 70%
2	XXX	N(BOP) C(BOP)	perform SSW surveillance per chemistry request; SSW pump B will trip shortly after start
3	XXX	I(RO)	feedwater master controller fails as is
4	XXX	C(BOP)	loss of power to Division 2 ESF bus
5	XXX, XXX, XXX	M(ALL) C(BOP) M(ALL) C(BOP)	1.5 minutes after event 4, the service transformers lock out, the Division 1 EDG fails to start, and a 5% recirculation loop break develops in the drywell 30 seconds after initiating, the high pressure core spray pump trips

* (N)ormal, (R)eactivity, (I)nstrument, (C)omponent, (M)ajor

For each of the planned events, enter on a Form ES-D-2 (or equivalent) a description of the event and detailed actions required by the applicable plant procedures (e.g., normal, abnormal, emergency, and administrative, including the TS and emergency plan) for each operating position (i.e., SRO, RO, BOP) in a manner similar to the first event for the first PWR scenario (page 2 of this Attachment).

The following are two PWR and two BWR simulator scenario outlines that can be used for reference when developing or reviewing requalification examinations.

PWR SCENARIO ONE - LOSS OF HEAT SINK

Scenario Objectives

- Evaluate the operators in their use of the "Loss of Heat Sink" procedure, FR-H.1.
- Evaluate the crew in performing a "bleed-and-feed" sequence, using reactor head vents and pressurizer vents.

Scenario Summary

Initial Conditions:

- 75 percent power
- "B" auxiliary feedwater pump inoperable
- One PORV (A) leaking and isolated

Events:

- Feed pump control problem that will eventually trip causing a partial loss of feed
- Total loss of main feedwater
- Loss of all feedwater

Scenario Sequence

- "A" feedwater pump hydraulic control unit problems prompt the crew to reduce power.
- During power reduction, the "A" feedwater pump trips, causing a plant runback.
- Feedline break occurs causing a reactor trip.
- Auxiliary feedwater pumps fail over several minutes, causing a loss of all feedwater, and prompting the crew to initiate a bleed-and-feed procedure.

Event one - malfunction/loss of feed pump

Crew responds to a problem with the "A" feed pump, which eventually trips causing a runback.

Malfunctions required: 2 (RFP "A" HCU failure and RFP "A" Trip)

Objectives:

- Evaluate the crew in using normal operating procedures to reduce power when the feed pump starts to fail.
- Evaluate the crew in using abnormal operating procedures (AOPs) to respond to a partial loss of feed.

Success Path:

- Use the normal operating procedures to reduce power when initial problems occur with the feedwater pump.
- Use the AOPs to respond to the partial loss of feed water and stabilize the plant to avoid a reactor trip.

Event two - feedline rupture/reactor trip

Crew responds to a total loss of feed flow with only the remaining motor-driven AFW pump available.

Malfunctions required: 1 (feedline rupture)

Objective:

Evaluate the crew's response to a loss of feed transient requiring a reactor trip by using the reactor trip response and reactor trip recovery EOPs.

Success Path:

- Recognize the impending reactor trip, trip the reactor if time permits, and implement the appropriate immediate actions.
- Make the correct transition to the reactor trip recovery EOP upon completing the immediate and applicable subsequent actions of the reactor trip EOP.

Event three - loss of all AFW/PORV failure

Crew responds to a total loss of feed flow, eventually implementing a bleed-and-feed procedure with a failed PORV. Evaluators inform the crew that time compression is being used to accelerate the decrease in steam generator level.

Malfunctions required: 2 (failure of all AFW and "B" PORV fails to open)

Objective:

Evaluate the crew's ability to recognize that there is no longer a heat sink, and correctly implement the applicable contingency procedure (loss of heat sink), including performing the bleed-and-feed procedure.

Success Path:

- Implement the EOP for loss of heat sink.
- Attempt to reestablish auxiliary feed flow; when SG levels become too low, initiate the bleed-and-feed procedure.
- Recognize the failure of the available PORV and reenergize, unblock, and open the leaking PORV; open both pressurizer and reactor head vents to ensure adequate bleed flow.

<u>Scenario Recapitulation</u>

Total Malfunctions:	5	
Abnormal Events:	1	
Major Transients:	2	(loss of main feed and total loss of feed)
EOPs Entered:	1	
EOP Contingencies:	1	(loss of heat sink)

PWR SCENARIO TWO - LOCA AND COLD LEG RECIRCULATION

Scenario Objectives

- Evaluate the crew's response to unidentified primary leakage.
- Evaluate the crew's response to a circulating water pump trip and a condenser tube leak.
- Evaluate the crew in using the EOPs during a LOCA with adverse containment conditions.
- Evaluate the crew's sensitivity to key parameters and ability to implement cold leg recirculation.

Scenario Summary

Initial Conditions:

- 100 percent power
- Inoperable "A" diesel generator and "A" instrument air compressor
- Seismic event occurred during last shift

Events:

- Primary leak increases to a point requiring a reactor trip.
- AFW pumps fail to automatically start on reactor trip.
- Leak leads to a safety injection (SI) and high pressure SI pumps fail to start automatically; LOCA occurs, RWST leak occurs, and crew must initiate cold leg recirculation.

Scenario Sequence

- A small pressurizer steam space leak increases to a point requiring a reactor trip and eventually to the point of SI initiation.
- The high pressure SI pumps fail to start automatically.
- A LOCA occurs as a result of the seismic event.
- When the SI pumps start, the thermal shock causes a LOCA in the RCS.
- The high pressure of the LOCA causes adverse containment conditions.
- An RWST leak will also occur concurrent with the SI that will eventually prompt the crew to initiate cold leg recirculation.
- RWST level will eventually drop to the point where the crew must initiate cold leg recirculation.

Event one - Unidentified leakage due to pressurizer steam space leak

The crew reacts to unidentified primary leakage, eventually requiring a reactor trip.

Malfunctions required: 1 (pressurizer steam space leak)

Objectives:

- Evaluate the crew's use of AOPs and TS to respond to unidentified primary leakage.
- Evaluate the crew's knowledge of parameters in the AOP that require a trip because of primary leakage.

Success Path:

- Use the AOPs, increase reactor make-up and calculate a leak rate.
- Use the NOPs to commence a reactor shutdown in accordance with TS.
- When leakage exceeds the AOP parameters, trip the reactor.

Event two - reactor trip/AFW pump fails to start automatically

The crew trips the reactor on excessive leakage per the AOP. The AFW pumps fail to start automatically, requiring manual initiation.

Malfunctions required: 1 (AFW failure to auto start)

Objective:

Evaluate the crew's use of the EOPs following a reactor trip, with the complication of the AFW pumps failing to start automatically.

Success Path:

- Recognize that the AFW pumps failed to start automatically and manually start the pumps.
- Correctly perform the reactor trip EOP and make the transition to the reactor trip recovery EOP once the immediate actions and applicable subsequent actions are completed.

Event three - increasing pressurizer leak/SI pumps fail to start

The pressurizer leak increases causing a loss of pressurizer level/pressure requiring an SI. The charging pumps fail to automatically start requiring manual start.

Malfunctions required: 2 (pressurizer leak increases and charging pumps fail to auto start)

Objectives:

- Evaluate the crew's ability to monitor important parameters in the EOPs and initiate SI when required.
- Evaluate the crew's ability to manually start the charging pumps following a SI signal.

Success Path:

- Initiate SI when pressurizer level and pressure decrease to the values stated in the EOPs.
- Recognize the failure of charging pumps to automatically start and manually start the required charging pumps to complete the SI initiation sequence.

Event four - LOCA/adverse containment

A LOCA occurs as a result of the seismic event, which leads to adverse containment conditions. RWST level decreases to the point where the crew must enter the EOP for initiating cold leg recirculation. Evaluators inform the crew that time compression is being used to accelerate the decrease in RWST level.

Malfunctions required: 2 (LOCA and RWST leak)

Objectives:

- Evaluate the crew's use of the EOPs with adverse containment.
- Evaluate the crew's ability to recognize the need for and use the cold leg recirculation procedure.

Success Path:

- Correctly enter and use the LOCA EOP and the containment functional recovery EOP using adverse containment criteria.
- When RWST levels reach the low-low alarm and the reactor sump level is high enough, enter and implement the cold leg recirculation EOP.

Scenario Recapitulation

Total Malfunctions:	6	
Abnormal Events:	2	
Major Transients:	2	(leak requiring SI and LOCA with high containment pressure)
EOPs Entered:	4	(enter LOCA EOP twice)
EOP Contingencies:	1	(containment safety)

BWR SCENARIO ONE - LOSS OF OFFSITE POWER WITH A LOCA

Scenario Objective

Evaluate the operators in using the "Emergency Depressurization" and "RPV Flooding" EOP contingency procedures.

Scenario Summary

Initial Conditions:

- 98 percent power
- "A" average power range monitor (APRM) failed and bypassed

Events:

- Reactor core isolation cooling (RCIC) becomes isolated during a RCIC flow surveillance.
- Loss of offsite power/division III diesel generator fails to start, disabling the high pressure (HP) core spray.
- Small break LOCA occurs.
- Adverse containment conditions make the reactor level instrumentation unusable.

Scenario Sequence

- The RCIC becomes isolated during surveillance testing, rendering the RCIC system inoperable.
- Faults in the 345 KV switchyard and the reserve auxiliary transformer result in a loss of offsite power and a reactor scram.
- The Division III diesel generator fails to start and will not start manually, disabling the HP core spray system.
- The plant transient causes a recirculation line break resulting in a small break LOCA that develops over several minutes.
- Reactor level instrumentation becomes erratic and unusable because of the rapid decrease in pressure and the elevated drywell temperature.

Event one - RCIC isolation

The crew responds to an isolation of the reactor core isolation cooling (RCIC) system during a full flow test surveillance.

Malfunctions required: 1 (RCIC isolation)

Objective:

Evaluate the crew in using technical specifications to determine that RCIC is inoperable.

Success Path:

Use technical specifications to recognize that the RCIC system should be declared inoperable until the problem can be investigated and corrected.

Event two - loss of offsite power with concurrent division III diesel generator failure (HP core spray)

The crew responds to the loss of offsite power, reactor scram and loss of high pressure injection sources.

Malfunctions required: 2 (loss of offsite power and HPCS failure)

Objective:

Evaluate the crew's response to a plant transient that causes a reactor scram and a loss of high pressure injection sources by using the reactor pressure vessel (RPV) and primary containment control EOPs.

Success Path:

- Maintain RPV pressure at less than 1065 psig using the main turbine bypass valves.
- Manually control pressure with safety relief valves (SRVs) upon a loss of electro-hydraulic control (EHC) hydraulic pressure because of the loss of power to the EHC pumps.
- Initiate suppression pool cooling and pump down in accordance with EOPs if the temperature in the suppression pool exceeds 90 degrees or the level exceeds 18.5 feet.

Event three - small break LOCA

The crew responds to a loss of vessel inventory and an inability to maintain a level greater than top of active fuel, eventually implementing emergency depressurization.

Malfunctions required: 1 (LOCA)

Objective:

Evaluate the crew's ability to recognize an inability to maintain reactor water level and correctly implement the applicable contingency procedures including emergency depressurization.

Success Path:

Execute RPV emergency depressurization so reactor pressure can be decreased to allow injection by the low pressure ECCS systems.

Event four - reactor level instrumentation failure

The crew recognizes a loss of reactor level instrumentation and responds in accordance with RPV flooding EOP.

Malfunctions required: 1 (reactor level instrumentation failure)

Objective:

Evaluate the crew's ability to recognize failed reactor level instrumentation and correctly implement the applicable actions of the RPV flooding EOP to ensure adequate core cooling.

Success Path:

Reflood the RPV in accordance with the EOPs and establish adequate core cooling. Adequate core cooling will be ensured when reactor pressure can be maintained greater than 120 psig with at least 3 SRVs opened by manually controlling low pressure ECCS injection flow.

Scenario Recapitulation

Total Malfunctions:	5	
Abnormal Events:	3	
Major Transients:	2	(emergency depressurization and RPV flooding)
EOPs Entered:	2	
EOP Contingencies:	3	(alternate level control, emergency depressurization, and RPV flooding)

BWR SCENARIO TWO - POWER OSCILLATIONS WITH AN ATWS

Scenario Objective

Evaluate the operators in using the "Level/Power Control" and "Emergency Depressurization" EOP contingency procedures.

Scenario Summary

Initial Conditions:

- 75 percent reactor power
- High Pressure Core Spray pump out of service
- "B" recirculation pump flow control valve is locked

Events:

- The "A" reactor recirculation pump trips, causing power oscillations, and an SRV fails open during the power oscillations.
- Anticipated transient without scram (ATWS) requiring lowering of level to control power.
- Feed system pumps will fail to restart and standby liquid control (SLC) pumps and RCIC pump trip during the transient, complicating recovery from the event.

Scenario Sequence

- The "A" recirculation pump trips resulting in power oscillations within 5 minutes. The reactor fails to manually scram.
- The safety relief valve (SRV) sticks open during power oscillations.
- Condensate booster and feedwater pumps fail to restart, and the SLC pumps trip after power is reduced less than 3 percent.
- RCIC pump trips after it is restarted by an operator.

Event one - "A" recirc pump trip resulting in power oscillations

The crew responds to a recirculation pump trip and a failure of the reactor scram system.

Malfunctions required: 2 (recirculation pump trip and ATWS)

Objectives:

- Evaluate the crew's use of AOPs and EOPs to respond to an ATWS and to restore the power and flow parameters to acceptable values.
- Evaluate the crew's use of TS that apply to single recirculation loop operation.

Success Path:

- Recognize power to be in region B or C of the power and flow map and initiate control rod insertion to reduce thermal power.
- Recognize symptoms of thermal hydraulic instability and attempt to manually scram.
- Use the EOP flow charts for RPV level, power, and pressure control.
- Trip the "B" recirculation pump and initiate actions to achieve control rod insertion and to actuate the standby liquid control system in accordance with the EOPs.

<u>Event two - SRV sticks open during power oscillations</u>

The crew recognizes and responds to the stuck open SRV, eventually implementing the actions of the primary containment control EOP.

Malfunctions required: 1 (SRV sticks open)

Objective:

Evaluate the crew's ability to recognize the failed open SRV and implement the applicable abnormal and emergency procedure actions.

Success Path:

- Initiate actions to close the SRV.
- Use EOPs to initiate suppression pool cooling and reduce the level.
- Terminate all injection into the RPV except for the control rod drive and SLC systems when suppression pool temperature exceeds 110 degrees with reactor power less than 3 percent.

<u>Event three - failure of injections sources after control rod insertion</u>

The crew responds to a loss of vessel inventory and the inability to maintain level greater than top of active fuel by eventually implementing emergency depressurization.

Malfunctions required: 3 (feedwater system failure, SLC pump trip, and RCIC fails to start)

Objective:

Evaluate the crew's use of EOPs to respond to an inability to maintain reactor water level and to initiate an emergency depressurization.

Success Path:

Execute RPV emergency depressurization to allow for injection by the low pressure ECCS systems.

Scenario Recapitulation

Total Malfunctions:	6	
Abnormal Events:	2	
Major Transients:	2	(ATWS and emergency depressurization)
EOPs Entered:	2	
EOP Contingencies:	3	(level and power control, alternate level control, and emergency depressurization)

Facility: ___________________ Scenario No.: _________ Op-Test No.: ________

Examiners: ______________________________ Operators: ____________________________

______________________________ ____________________________

______________________________ ____________________________

~~Objectives:~~ ____

Initial Conditions: ____

Turnover: ____

Event No.	Malf. No.	Event Type*	Event Description

* (N)ormal, (R)eactivity, (I)nstrument, (C)omponent, (M)ajor

Op-Test No.: _____ Scenario No.: _____ Event No.: _____ Page ___ of ___

Event Description: ____

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Time	Position	Applicant's Actions or Behavior