Reference Based Learning Objectives

Technical Bases

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Reference Based Learning Objectives Technical Bases

Tables

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Introduction

This document sets forth Reference Based Learning Objectives for systems training of nuclear plant operators, system engineers, chemistry and radiation protection technicians, and maintenance personnel. Industry documents establish the minimum standards associated with the content of training programs for these operator categories. This bases document in no way compromises or supplants these industry standards or any individual company procedure, policy, or guide.

Instructional material developers should refer to this document for guidance on the development of materials used to transfer the cognitive skills required by disciplines supporting nuclear operations.

When mastery of these objectives is evaluated using written evaluation, incumbents have access to all reference materials available in the Control Room. Initial candidates demonstrate competence at the "memory" level unless otherwise specified. In local documents, this may be expressed using a *conditional statement of evaluation* similar to "Initial candidates demonstrate from memory or using specifically authorized references and incumbents demonstrate using approved plant reference materials found in the Control Room…"

This document serves as a reference guide only. Specific requirements for the development of examination materials including NRC administered written and operating tests, are contained in NUREG-1021 and the 10CFR55 requirements associated with the NUREG-1123(BWR) items cited in this document.

Minimum Level of Competence (MLC) v. Standards of Performance

The NRC dictates the minimum performance required on licensed operator examinations in various (cited) source documents as "80%". This document presumes this the minimum level of competence (MLC) throughout operations training programs.

In this document the term "standard" refers to the acknowledged measure of comparison for quantitative or qualitative value or the criterion[1] – in other words, the application and performance expectation is the "standard" while the regulatory (or governing) document that establishes the need or requirement for the knowledge or skill is the "reference criterion". This differs from the frequently accepted "standard of performance" being "…successful completion of a written examination with a minimum score of 80%."

The approach used herein views the standard of performance as the ability to apply the required knowledge to the degree specified for the position under consideration[i]. For example, non-licensed operators are required to be familiar with the "normal" range of indications within their operating responsibility – not the normal indications in the control room and not the assessment of system operability. Senior reactor operators, on the other hand, are required to be familiar with the normal indications for all system operation conditions **and** to possess the ability to integrate the indications from multiple systems to determine that plant operation is within design operating

[1] A standard, rule, or test on which a judgment or decision can be based. (In the RBO use of "criterion," the critical word is "rule.")

margins. A similar standard is applied to other disciplines with the required knowledge dictated by the responsibilities and needs of the position.

Performance Criterion

In the RBO approach, plant reference documents establish the performance criterion or job performance standard. These include design and licensing documents, technical specifications, plant operating, maintenance, technical, administrative, and surveillance procedures, and standards for Conduct of Operations (*e.g.*, Operations Manual).

Providing the student with the specific performance criteria for each of the reference-based objectives ensures awareness of the standard of evaluation and establishes the relevance of the objective (and its content) to the student's position. These "application performance standards" also constitute criteria for acceptable performance during Task Performance Evaluations.

Consistent application of the knowledge required by the (job) position under study is the "standard of performance" associated with these Reference Based Learning Objectives. The "application performance standard" provides both student and instructor the boundaries or expectations of performance and behavior the knowledge engenders. This permits the establishment of a direct relationship between the learning objective and actual job performance.

The MLC is often and incorrectly associated with specific learning objectives. Consulting NUREG-1021 and 10CFR55, the NRC and federal requirements, it is apparent that the intent is to deem an operator's knowledge as "competent" IF 80% of the questions on an examination are answered correctly. There is a significant difference between this determination and the assessments made during the operational examination. The examiner has the authority to refuse to pass a candidate or revoke the license of an incumbent based on the failure of any one of the criteria set forth in regulation. The actual "standard of performance" is 100%, not 80%. Therefore, the correct "standard" for any of the reference-based objectives is one of demonstration. The Application Performance Standard identifies the attributes of competence assessed and the mechanisms the candidate or incumbent uses (either in the assessment or on the job.)

Evaluation Instruments

Two targets exist for developed content – both equally important and addressed in the RBO method. The performance criterion (PC), evaluated during operating examinations, shift tours, and management observation; and the MLC as expressed through successful completion of a written (and oral) examination. In the SAT process, definition of these "targets" occurs before content development. Use of the RBO assists the developer by clearly defining the evaluation criteria (MLC and PC) and, to some extent, evaluation instruments for consideration.

Content Development

Content development requires access to and inclusion of plant-specific information and requirements. Senior or experienced line management should identify the expectations for position specific requirements as part of the training design and development process.

Developers using the RBO Basis Document consult the associated sections of the NRC Knowledge and Abilities Catalog (the stem statement plus the items associated with it) to identify the topics required by that catalog, then retrieve the supporting site information from the design, licensing, technical, and operational documents associated with the facility.

The Application Performance Standard associated with each objective determines the level of detail provided in developed content. No universal "rules" exist to guide developers therefore; task analyses, position descriptions, developer competence, and use of templates with some boilerplate all serve important roles in supporting consistent development **and** implementation of material.

Reference Based Learning Objectives Technical Bases

RBO-1, System Function & Purpose

Objective Statement: **Explain** the function and purpose of the XXX system.

Application Performance Standard: Demonstrate the ability to:

- **Recall** the general function of the system and its purpose with regard to overall plant operation
- **Relate** the effect of the system's function to overall plant operation and,
- **Identify** the effect the system's operation (or failure) has on overall plant operation including radioactivity containment

The content for this objective is generally found in the FSAR, System Design Basis Document, or System Design Description. The standard of performance for this objective (for the initial candidate) is to **recognize** and **recall** the general function of the system and its purpose with regard to overall plant operation. For the incumbent, the standard includes the ability to **relate** the effect of the system's function to overall plant operation and **identify** the effect this system has on overall plant operation.

The training materials on system purpose should encompass any emergency operations function the system performs and identify if the system is addressed by Technical Specifications.

Development of initial level questions for this objective should consider how the system affects or interacts with other plant systems to assess trainee mastery. In the continuing training setting, questions should consider how the system is used to accomplish specific plant operations i.e., the role the system plays in the successful outcome of a complex evolution or operation.

Questions developed around this objective support NUREG-1123 (1122) stem statement K1 and Generic KA 2.1.27.

Specific Guidance on Defining "Major" Components

The following explanation ensures standardized interpretation of the phrase "major components" and eliminates the use of minutiae as criteria for successful demonstration of adequate knowledge.

The term "major components" is used as a general statement to identify any component whose failure or inappropriate operation would result in:

1. Damage to the integrity of a fluid boundary sufficient to jeopardize the habitability of an operating space or building,
2. Non-availability[ii] of the associated system to perform its design function under all modes of plant operation,
3. Inability of the facility to operate at rated capacity,
4. Significant material cost to accomplish repairs (generally > $50,000),
5. Immediate hazard to the safety of plant personnel or members of the general public,
6. Entry into a Technical Specification Action Statement, Limiting Condition for Operation, or change in operability,
    a) Sub-components of a protective or engineered safeguards system, instrument or device whose failure alone causes the system, instrument or device to be declared "inoperable" **do not** satisfy the threshold for major components unless items 1, 2, and 5 above are satisfied by the failure of the sub-component.[iii]
    b) The sub-component **will** satisfy the threshold if failure results in limiting or preventing the ability of a safety related system to perform its intended function despite authorized compensatory actions.
7. Loss of an Engineered Safeguards electrical bus or actuation channel,
8. Loss of control of a primary, secondary or related support system that
    a) Is required for safe-shutdown of the facility, or
    b) Could reasonably be inferred to result in a: violation of the facility operating license[iv], loss of containment integrity resulting in an increased risk of radioactivity release, or challenge to core thermal limits

Objective Statement: **Describe** the function, location and principles of operation of the XXX system's major components

Application Performance Standard: Demonstrate the ability, for identified components, to:

- **State** their purpose and function,
- **Describe** their geographic location within the plant and system,
- **Explain** the **cause and effect** relationship existing between components by **predicting** the system's behavior based on their function, and
- **Discriminate** and **distinguish** between components in terms of their operational effect including automatic operation.

Reference Based Learning Objectives Technical Bases

The content for this objective will be derived from system technical documentation. This will include the FSAR for certain high safety value systems and components. System Design Basis Documents, equipment technical manuals, vendor documents and maintenance procedures may offer specific details not otherwise available.

The intent of this objective is, through either a constructive or de-constructive process, to permit the trainee to grasp the component functional interrelationships within the system and the physical (geographic) relationship of the system to the plant and components to the system. Initial candidates state the purpose of identified components within the system, explain the relationships that exist between components and describe the location of identified components, controls and major indicators of component, and system performance. Additionally, trainees should demonstrate the ability to predict system behavior based on the normal function of each of the components identified. Satisfactory knowledge is evaluated by the trainee's ability to discriminate and distinguish one component from another in terms of operational effect on the system including automatic operation of the individual components. This objective introduces the foundation for *analysis* of system interactions.

Questions that assess the trainee's ability to relate one component to another from an operational perspective or apply rules (considering interlocks, permissive or restrictive and controls) are appropriate at the initial level and above.

Questions developed around this objective support NUREG-1123 (1122) stem statements K1, A3, E(A)K1 and Generic KA statements 2.1.28 and 2.1.30.

RBO-3, Functional Arrangement

Objective Statement: For the XXX system, **describe** the arrangement, component relationships, and flow paths (*for mechanical systems the fluid path, for electrical, control, and instrumentation systems the current or signal flow path*)

Application Performance Standard: Demonstrate the ability to:

- **Recall** the system arrangements and major components with sufficient detail to **produce** a functional diagram of the system (or label a simplified diagram),
- **Identify** sampling points for fluid systems with the use of a Piping and Instrumentation Diagram including the purpose of the sample point,
- **Determine** the effect on the system, an interconnected system, or radiological and other environmental conditions resulting from a change in component alignment or condition and,
- **(SRO) Recommend** a course of corrective actions using plant reference documents to mitigate the effects of system component failure.

This objective may be expressed as "label a simplified block diagram of the system…and electrical flow-paths" for electrical systems and electronic components. The term "simplified" may also be replaced with "functional" if appropriate for the system under consideration.

The use of system one-line diagrams, piping, and instrumentation diagrams and logic diagrams from station drawing indices, vendor manuals, and design documents (including the FSAR for items such as station layouts) is an expected resource. The intent is for the student to **recall** the arrangement of system components in sufficient detail to be able to **produce** a functional diagram of the system. Fluid system components such as sample points and instrument taps (and their function) should be identified during training sessions.[v] At higher levels of competence, the trainee should demonstrate the ability to independently or, with the use of plant references, provided plant or system conditions **determine** the effect on the system or an interconnected system resulting from a change in component alignment or condition. This determination includes the effects on environmental conditions (i.e., temperature, noise, radiation levels, or habitability) when flow is initiated in fluid systems. At the highest level of competence, the trainee should be able to **recommend** a course of corrective actions based on knowledge of system arrangement, function and interconnection using plant reference diagrams, prints, and drawings.

The basic skills required to master this objective are (or should be) acquired through fundamental print reading training.

Development of initial candidate questions should require the trainee to identify the sequence of components within the system and the interconnections with other systems. Incumbent mastery of this objective is best assessed by presenting conditions or situations in which a component or series of components have failed or are operating outside of normal limits then requiring the trainee to determine and defend or validate the system alignment required to mitigate the abnormal condition.

Questions developed to assess trainee mastery of this objective will address aspects of NUREG-1123 (1122) stem statement K1 and EK1/AK1 and Generic statements 2.1.24, 2.1.34, and 2.3.10.

RBO-4, System and Component Power Supplies

Objective Statement: **Describe** for the XXX system power supplies:

a) For AC components greater than or equal to 4kv, the power supply.

b) For AC components less than 4kv, the type (voltage, control power, safety or non-safety related) and load sequence (if applicable for safety related) of the power supply

c) For DC components, the type (voltage, control power, safety or non-safety related) of the power supply

Application Performance Standard: Demonstrate the ability to:

- **Recall** and **describe** specific power sources and,
- **Project** or **predict** the effect on system and component operation resulting from power source anomalies

The content of this objective is found in plant reference drawing, specifically one-line electrical diagrams, system design documents, and plant loading data (switchgear general arrangements, electrical load center diagrams, etc.). The ability to state the power supplies to components is typically evaluated by challenging the trainee to **recall** specific power sources and **project** or **predict** the effect on system and component operation resulting from anomalies. The specific delineation based on voltage type and rating is necessary to limit the scope of the objective to the power supply itself rather than the more inclusive scope of knowledge where specific interlocks, controls and indications are considered. When specific components such as instrument channels or safety critical electronic components are considered, vendor manuals in addition to circuit diagrams are appropriate references.

Written examination questions should challenge the trainee to apply their knowledge of power supplies by requiring them to determine the effect on component or system operation, load sequence, or prime mover load resulting from the loss of various types of power (prime voltage, control). When evaluating an incumbent's knowledge of electrical power supplies, this objective is typically not evaluated literally. Rather, an operational condition is established requiring the trainee to analyze the effect of the condition on power supplies and sources then defensibly select the correct course of action or resulting plant condition.

This objective supports NUREG-1123 (1122) stem statement K2.

RBO-5, System Operation, Control and Instrumentation

Objective Statement: For the XXX system **describe**:

a) Flow paths of the system

b) System operations and lineups

c) System instrumentation, controls, setpoints, interlocks, and failure modes

Application Performance Standard: Demonstrate the ability to:

- **Correlate** a set of conditions and sequence of events to operational decisions, control or component manipulations and available indications,
- **Assess (RO)** or **recognize** a plant condition when provided specific indications or component conditions and,
- **(SRO) Prioritize** operator response or actions to achieve the desired operating result.

To support this objective, the developer is required to assemble and relate information previously presented in RBO-1 through RBO-4 with basic operational and design information extracted from plant procedures, vendor manuals, system design documents, and failure analyses. While the objective statement uses the verb **apply**, the expectation is that the trainee will have the ability to **correlate** the sub-parts of the objective given a set of conditions, or sequence of events to operational decisions, component manipulation, and available indications. More advanced trainees and incumbents are expected to **assess** or **recognize** a plant condition given specific indications or component conditions and **prioritize** operator response (or actions). When conducting training on system instrumentation and controls, their function, associated interlocks, protective features (including alarms and set-points), and even construction should be considered and related to the various failure modes identified in technical documents, including plant and industry experience. Operational decisions based on the system response or conditions are explained with the use of specific plant documents.

Evaluation of this objective is best accomplished through the use of situation or event based questioning. That is, provide a set of conditions and require the trainee to demonstrate knowledge of how system flow-path, operation, or alignment must be or has been affected. Equally useful is presenting a set of conditions or events and requiring the trainee to infer from the conditions the type of component (or system) failure evident or the plant (system) event that caused the conditions. Initial candidates may be presented only portions of plant documents or none at all depending on the level of difficulty of the question.

Questions developed to assess competence for this objective will address NUREG-1123 (1122) stem statements: K1, K3, A1, A2, A4, EK1/AK1, AA2 and Generic statement 2.1.7.

RBO-6, Major Operating Parameters

Major operating parameters are those parameters which,

- If not controlled could result in failure or malfunction of the system or an interconnected or related system,
- Result in automatic protective actions if limits are exceeded,
- Are monitored to satisfy an interlock associated with system or component operation or design criteria (e.g., Heatup and Cooldown rates for the RPV, Reactor Chemistry, etc.)

Objective Statement: **Explain** the major operating parameters of the XXX system

Application Performance Standard: Demonstrate the ability to:

State the normal values and range of the parameter

- **Interpret** trends in or absolute values of the parameters
- **Recognize** those parameters with Technical Specification implications or **(RO)** serve as entry conditions for Emergency Operating Procedures
- **Discriminate** between normal and abnormal system response based on the parameters and,

(SRO) Based on provided indications, **predict** the effect on operational decisions, system operability or the operability of an interdependent system.

Content for this objective is generally found in the FSAR, System Design Basis Documents, Vendor Technical Manuals, operations and maintenance procedures, and system drawings and logic diagrams. The knowledge expected of all trainees addresses all monitored parameters whether indicated remotely, locally, or by chemical or other analyses. The parameters knowledge required of trainees **must** be within the scope defined above AND have applicability to the job function of the trainee. When this objective is developed or used for chemistry technicians, additional information regarding the specific chemicals added to a system, monitored chemistry parameters, and the limits associated with on-line monitoring is appropriate.

In addition to the trainee demonstrating an **understanding** of the major operating parameters, he or she must be able to **interpret** trends in or absolute values of those parameters and **relate** them to operating condition (or mode) and **recognize** those parameters with Technical Specification implications. Detailed knowledge of technical specifications is not an expectation of this objective; however, the significance of those parameters that when exceeded result in entry into one-hour technical specifications or entry into emergency or abnormal operating procedures must be **recognized**. Trainees are responsible only for those parameters monitored in their physical domain (responsibility of in-plant operators is limited to in-plant indications).

Provided a set of intended actions and actual or postulated plant, system, or component indications, the trainee is able to discriminate between normal and abnormal system and component response. Based on known or identified conditions, predict the effect on operational decisions including potential effect on system operability or the operability of an interconnected or related system (as in the case of support systems for safety related equipment).

Reference Based Learning Objectives Technical Bases

Non-licensed candidates are expected to recognize monitored parameters that effect the operability of systems with Technical Specification implications. They are NOT required to know the specification potentially challenged. Licensed candidates are expected to recall those parameters that if exceeded result in entry into one-hour technical specifications or entry into emergency or abnormal operating procedures.

This objective and the associated questions support NUREG-1123 (1122) stem statements K1, K4, K5, A2, A4 and Generic statements 2.1.31, 2.1.32 and 2.1.33.

RBO-7, Design and Operational Considerations

Objective Statement: For the XXX system, **describe** the design and operational considerations that assure:

a) System Reliability

b) Personnel Safety

c) Nuclear Safety

Application Performance Standard: Demonstrate the ability to:

- **Explain** the basis for a precaution or limitation
- **(RO) Predict** the effect on reliability or safety of a presented set of conditions or circumstances
- **(SRO)** Given a partial sequence of events with an outcome, **reconstruct** the sequence to **determine** those actions that either violated or reinforced the addressed design and operational considerations
- **(SRO) (ENG)** For those systems having Maintenance Rule applicability, **describe** the Maintenance Rule implications of challenges to system reliability
- **(ENG) State** the operational or design margins applicable to the system and given a set of plant conditions or sequence of events **identify** the challenge presented to those margins or considerations

The content for this objective is extracted from the FSAR, System Design Documents, plant operating experience (specifically basis or root-cause determinations), and operating procedures. Typically, aspects of this objective are intertwined with discussions pertaining to system operating characteristics, procedure reviews, Operating Experience, and operating and design margins. The objective is called out to emphasize not only the importance of these considerations in plant design but especially in plant operation and modification. There have been several instances in the US Nuclear industry where a **failure** to adequately challenge, test, or evaluate modifications to plant design have resulted in core damage, limited plant output, or caused personnel injury and fatalities. ***In those cases where the NRC has been required to intervene to address these "configuration control" issues, NUREG-0350 inspections typically result in forced shutdown and a "Confirmatory Action Letter" from the NRC.*** Highlighting the specific aspects of system design and the bases for them reinforces the need for awareness of the effect unauthorized or poorly evaluated changes or operating practices have on continued plant operation.

This information is best presented using a combination of direct presentation and case study methods. Direct presentation of the factual aspects of design considerations, using an appropriate combination of sources such as the FSAR, General Design Criteria, Code of Federal Regulations, system design basis documentation, and industrial safety resources, is reinforced by correlating these considerations during presentations (discussions) of RBO-9, 10 and 13.

Reference Based Learning Objectives Technical Bases

Initial candidates are expected to explain the bases for design and operational considerations given a procedural precaution or limitation without the use of references. Additionally, the initial licensed candidate should demonstrate the ability to explain the general design features of a system that provide for or ensure that operation remains within design margins, system reliability, and personnel and nuclear safety. At the incumbent level, the expectation is for the trainee to predict the effect on reliability, safety, or proximity to operating and design margins of a presented set of circumstances. And, given a partial sequence of events with an outcome, reconstruct the sequence to determine those actions that either violated or reinforced the addressed design or operational considerations.

Training sessions that include systems engineering personnel should address the sources of information available to identify operating and design margins and support or defend recommendations engineering offers when these margins are challenged. It is **not** the intent of this objective or its content to fully prepare an engineering candidate, rather to provide an overview for all trainees of these issues and introduce the engineering candidate to the resources, concepts, and expectations for their role in defending operating and design margins.

Training of incumbent engineering personnel when conducted with licensed or non-licensed operations personnel should use case studies previously reviewed and developed with input from engineering and licensing management when possible.

This objective and questions written to it support the following statements from NUREG-1123 (1122): K1, K5, A4, 2.1.7, 2.1.14, 2.1.26, and 2.1.32.

RBO-8, Interrelated Systems

Objective Statement: For each system interrelated with the XXX system:

a) Explain the cause and effect relationship between the systems and,

b) Predict the effects on the system under study resulting from a loss of the interrelated system

Application Performance Standard: Demonstrate the ability to:

- **Identify** and **explain** the relationship between the systems
- **Predict** the effect the interrelating system has on the system under study during all modes of plant operation
- **(SRO) Prioritize** crew response to the loss of multiple interrelated systems and **assess** the effect on system operability of the loss

The information for this objective is derived from system design documents, technical specifications (to identify the effect of loss of supporting systems on operability), system diagrams, plant procedures, and technical bases documents where available. As with RBO-7, this objective is the correlation of information presented in earlier topics and is best presented using a combination of methods. The direct presentation method identifies the interrelating systems and whether they are supportive, dependent, or interdependent[1]. Discussion of plant operations, case studies, and operating experience or events begin to draw the relationships of these systems together. Inclusion of intrinsic cause and effect relationships, such as the effect of a loss of chemistry control of the system under study, is appropriate and expected where applicable (as in fluid systems having chemistry controls). The level of knowledge expected of a trainee **must** be appropriate for the responsibilities of their job position (i.e. do not expect the NLO to have the same understanding of the effects of improper H_2 to O_2 relationships in Feedwater as the chemistry technician).

The initial candidate is expected to identify and explain the interrelationships while the incumbent is expected to distinguish or differentiate the type of effect the interrelated system has under all conditions. Both levels of trainee are required to predict the effect on the system under study that results from the loss of the interrelated system. SRO trainees at all levels are additionally expected to prioritize crew response to the loss of multiple interrelated systems and to assess the effect of that loss on operability.[2]

While not specifically evaluated by this objective, technical specification relationships should be identified for supporting systems when loss of that support system affects the operability of the system under study.

This objective and questions written to it support the following statements from NUREG-1123 (1122): K1, K2, K6, A2, 2.1.2, 2.1.10, 2.1.11, 2.1.12, 2.1.33, and 2.4.30 (SRO only).

[2] This skill is addressed in more detail by RBO-14. Without the understanding and knowledge gained by this objective, the higher level ability to assess the effect on system operability is not achievable.

RBO-9, Precautions, Limitations and Operations Fundamentals

Objective Statement: **Describe** the precautions, limitations, and Operations Department Expectations associated with the XXX system procedures to achieve management expectations.[3]

Standard of Performance: Demonstrate the ability, given a plant condition or desired operating result to:

- **Explain** the basis for a given precaution or limitation
- **Recognize** when a precaution or limitation has been violated or is being enforced
- **Illustrate** how the Operations Expectations associated with the operation and control of the system is applied under various modes of operation and,
- **Evaluate** the affect that inadequate application of Core Work Practices could have on continued system operation.

The content for this objective is derived from operating (and frequently maintenance) procedures applicable to all modes of plant operation, system design documents, operating experience reports (including LER, OE, SOER, etc.), and site or corporate procedures applicable to conduct of operations. It is not intended for the developer to list all limits and precautions from procedures in the lesson materials. Detailed discussion of significant items that have direct effect on RBO-7 or 13 topics, are the result of site events, specifically address system reliability, operability, safety, or containment of radioactivity should be included in classroom lesson materials. Initial candidates are expected to review all precautions and limitations found in identified procedures and the classroom instructor should present those precautions and limitations having a direct effect on the operation or control of the system under study. The incumbent setting should review any precautions and limitations associated with infrequently performed procedures with emphasis on those that either are recent additions or have been associated with human performance events.

Operations Fundamentals include the Core Work Practices essential for safe and continuous operation of systems. Content for this objective is also obtained by a review of specific system evolutions such as surveillances and special or infrequent operations (startup, shutdown, testing, post-maintenance testing, etc.) for examples of situations where emphasis on Core Work Practices are indicated.

Core Work Practices that should be stressed include:

- Safety Practices
- Foreign Material Control
- Radiation Work Practices / ALARA
- Self Checking
- Verification Practices
- Three-Way Communications

[3] There are several sources the developer or instructor should consult to adequately address these expectations. This includes the Operations Manual, Conduct of Operations, and Human Performance, Radiation Protection, Foreign Material Exclusion Control programs as a minimum.

- Procedure Use and Adherence / Placekeeping
- Pre-Job Brief
- Questioning Attitude
- Flagging / Robust Operational Barriers
- Stop When Unsure

The expectation is that the initial candidate shall be able to explain the bases for a given precaution or limitation from system operating procedures (normal, abnormal, and emergency) and given plant condition(s), recognize when a precaution or limitation has been violated or is being enforced (in the case of interlocks preventing system response). Additionally, all student levels must illustrate the fundamentals associated with the operation and control of the system under various modes of operation including application of the Core Work Practices.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1, K5, 2.1.1, 2.1.23, and 2.1.32.

RBO-10, Operational Actions and Sequence

Objective Statement: **Describe** the basic operational actions and sequence associated with the XXX system procedures as they apply to:

a) System Startup

b) Normal Operations

c) System Shutdown

d) Off-normal and, Infrequent

e) Special Operations

f) Correcting Alarm Conditions (Annunciator Response Procedures)

g) Surveillance Testing

Application Performance Standard: Demonstrate the ability, given a set of plant conditions, sequence of events or desired operating result, to:

- **Assess** the conditions and **determine** the procedural actions, system configuration or operating result,
- **Identify** the sequence of operational actions to achieve the desired operating result,
- **Predict** the effects on environmental conditions and plant operating area habitability[vii] of operational actions required to achieve the desired operating result,
- **Differentiate** between procedures based on entry conditions or events[4] and,
- **(SRO) Prioritize** operator actions required to achieve the desired operating result

The content for this objective is generally extracted directly from plant-specific operating procedures. It is the intent of this objective that the initial candidate demonstrate the ability to **restate** (in their own words) the general sequence[viii] of operational actions required for the system under the identified modes. Additionally, given a set of plant conditions or sequence of events, the trainee is expected to **assess** the conditions to **determine** the required configuration or outcome and then **prioritize** operational actions to achieve the desired outcome.

Incumbents are generally evaluated on this objective under the simulator setting during operating events. Written questions for incumbents should require the demonstration of the ability to assess plant conditions and events, differentiate between procedures based on entry conditions and events then prioritize operator actions to select the correct procedure and, or action to achieve the required (desired) plant condition or status.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1, K2, K4, K6, A2, A3, A4, 2.1.1, 2.1.7, 2.1.14, 2.3.10, 2.4.1, 2.4.4, 2.4.10, 2.4.31, 2.4.48, 2.4.49, and 2.4.50.

[4] Applicability of this performance standard is determined by corporate or site policy. In some cases, this will apply only to the Unit Reactor Operator (Chief Shift Operator) and licensed supervisors. Generally, it applies to all personnel for those procedures they have the authority to execute independently.

RBO-11, System Loss and Component Level Malfunction

Objective Statement: **Predict** the effects of:

a) Total loss of the XXX system or

b) Malfunctions of system components and equipment

Application Performance Standard: Demonstrate the ability to:

- **Break down** a series of events, facts, conditions, and information regarding plant or equipment status and,
- **Predict** system or plant response to component or system malfunctions and loss including conditions where that loss is the result of a planned maintenance activity

Information to support development of this objective may be found in plant design and licensing documents, vendor technical manuals, maintenance and operating procedures and operating procedure bases (e.g., EOP, SOP, or SAMG Bases). Generally, this objective represents a fairly high level of cognition requiring cause and effect method of presentation. A combination of classroom presentation of facts and relationships, cause and effect or case studies and simulator demonstration provides the most effective method for students to achieve this degree of competence.

The expectation for the trainee is to demonstrate the ability to break down a series of events, facts, conditions, and information regarding plant or equipment status, and to predict system or plant response to component or system malfunction or loss.

Typically, trainees are not significantly assisted by access to plant procedures when answering questions written to this objective. However, access to plant design documentation and bases documents is beneficial.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1, K3, K4, K5, A2, 2.1.7, 2.1.33, and 2.4.30.

RBO-12, EOP Implementation

Objective Statement: **Describe** the XXX system operations required to support implementation of the Emergency Operating Procedures provided system and plant conditions

Application Performance Standard: Demonstrate the ability to:

- **Recognize** the effect system status has on the ability to perform its intended function within the Emergency Operating Procedures
- **Identify** the in-plant operational actions associated with the system during EOP implementation
- **(RO) Identify** the conditions, associated with the system, that require entry into Emergency Operating Procedures
- **(SRO) Formulate** and **prioritize** actions to restore the system's ability to perform its intended function when failure is indicated (including selection of contingency procedures)

Information required for material development to this objective is typically obtained from EOP Bases documents, FSAR, system design documentation, and Technical Specifications.

Trainees are expected, given a set of plant conditions and equipment status, to determine the specific EOP, actions, and system alignment required to support that procedure. Additionally, non-licensed trainees are expected to recognize the effect system status has on the ability of the system to perform its function within EOP "space." Where system status or alarms are associated with EOP entry conditions, trainees are expected to identify that the entry condition exists. Based on system status, trainees recognize the ability of the system to perform its intended function and (for SRO candidates and incumbents) formulate and prioritize actions to restore the system when failure is indicated.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1, EK1/AK1, EK2/AK2, EK3/AK3, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.4.6, 2.4.7, and 2.4.49.

RBO-13, Events and Human Performance

Objective Statement: **Describe** the application of error prevention techniques associated with XXX system operational actions, a related event or operating experience report

Application Performance Standard: Demonstrate the ability to:

- **Analyze** the event and **determine** the contributing error precursors, latent organizational weaknesses and failed or ineffective barriers,
- **Identify** the specific concern of an operating experience report to the plant and system and,
- **Determine** the organizational processes, job-site, and worker behaviors (such as Core Work Practices) used to prevent or mitigate future occurrence of the event.

The material for developing content to this objective is typically extracted from Operating Experience data and should be specific to the system discussed or applicable to the type of operations performed. Discussion of events should focus on the error precursors, latent organizational weaknesses and failed or ineffective barriers that resulted in the initiating event. Use of the INPO[5] Performance Model focusing on organizational processes, job-site and worker behaviors, and plant results is also an effective tool for case study discussions surrounding plant or industry events. When there is a lack of operating experience data for a system or its components, the developer (and instructor) should evaluate attributes of the system and its operation to identify opportunities for reinforcement of specific Core Work Practices (e.g., Error Prevention and FME control).

Specific attention should be given to the affect that consistent application of Core Work Practices such as HU Error Prevention Tools, Safety practices, ALARA considerations, Housekeeping, and Foreign Material Exclusion controls has on:

- Plant operability,
- Reliability of systems, structures, and components,
- Maintenance costs and outage duration, and
- Overall safety (industrial, radiological, and nuclear)

Trainees are expected to recognize the significance of events to plant and personnel safety, identify specific barriers that were violated or absent, and determine the specific actions used to prevent or mitigate future occurrence of the event.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1 and A4.

[5] INPO – Institute of Nuclear Power Operations

RBO-14, Application of Technical Specifications

This objective is applicable only to licensed operators. Certain aspects of the objective are only applicable to Senior Reactor Operators.

Referencing plant Technical Specifications, COLR and ODCM (without bases section or applicable one-hour Technical Specifications for initial candidates);

Objective Statement: Considering the XXX system and given a set of conditions, determine as applicable the:

a) Safety Limits

b) Limiting Safety System Settings

c) Limiting Conditions for Operation

d) Action Requirements

e) Appropriate Bases

Application Performance Standard: Demonstrate the ability, given a set of plant conditions, to:

- **(RO) Recognize** and comply with limiting conditions for operation and action statements, including the entry conditions for Technical Specifications
- **(SRO) Recognize** conditions covered by Technical Specifications
- **(SRO) Locate** the appropriate Technical Specification
- **(SRO) Ensure compliance** with any LCO and action statement,
- **(SRO) Identify** compensatory actions that may be required to accommodate system loss due to maintenance activities and,
- **(SRO) Defend** a Technical Specification judgment using the applicable bases

The information required to develop material for this objective is found in the cited references and may also be available in licensing documents (memos, correspondence, regulatory actions, etc.).

All licensed operator trainees are expected to demonstrate the ability to recognize and comply with limiting conditions for operation and action statements. **SRO** trainees are required to demonstrate the ability to recognize when evolving or existing plant conditions have the potential to affect systems covered by technical specifications, locate the appropriate technical specification, and ensure correct compliance with any limiting conditions for operation and action statements.

This objective and questions developed to it support the following statements from NUREG-1123 (1122): K1, K3, K4, K6, EK3/AK3, 2.1.10, 2.1.11, 2.1.12, 2.1.33, 2.2.10, 2.2.22, 2.2.24, and 2.2.25.

(Tables follow)

Table 1, Addressed NUREG-1123 Knowledge and Ability Stem Statements

Item	Definition
K1	Knowledge of the physical connections and cause effect relationships between the system and…
K2	Knowledge of electrical power supplies
K3	Knowledge of he effect that a loss or malfunction of the SYSTEM will have on…
K4	Knowledge of system design features and or interlocks which provide for …
K5	Knowledge of the operational implications of (the following)concepts as they apply to the system
K6	Knowledge of the effect a loss or malfunction of the following will have on the system
A1	Ability to predict and / or monitor changes in parameters associated with operating the system
A2	Ability to (a) predict the impacts of the following on the (SYSTEM) and (b) based on those predictions, use procedures to correct, control or mitigate the consequences of those abnormal operations (conditions)
A3	Ability to monitor automatic operations of the system
A4	Ability to manually operate and, or monitor in the control room
EK1/AK1	Knowledge of the operational implications of the following concepts as they apply to the loss of the (system) or as they apply to (an) the event
EK2/AK2	Knowledge of the interrelations between the loss of (SYSTEM) and … Knowledge of the interrelations between the event and (system) components…
EK3/AK3	Knowledge of the reasons for the following responses as they apply to the loss of the system (or as they apply to the event)
EA2/AA2	Ability to determine and interpret (the following) as they apply to the loss of the SYSTEM (or the event)

Table 2, Addressed NUREG-1123 Generic Knowledge and Abilities Statements

Item	Definition
2.1.1	Knowledge of conduct of operations requirements
2.1.2	Knowledge of operator responsibilities during all modes of plant operation
2.1.7	Ability to evaluate plant performance and make operational judgements based on operating characteristics, reactor behavior, and instrument interpretations.
2.1.10	Knowledge of conditions and limitations in the facility operating license
2.1.11	Knowledge of less than one-hour technical specification action statements for systems
2.1.12	Ability to apply technical specifications for a system
2.1.14	Knowledge of system status criteria which require notification of plant personnel
2.1.23	Ability to perform specific system and integrated plant procedures during all modes of operation
2.1.24	Ability to obtain and interpret station electrical and mechanical drawings
2.1.26	Knowledge of non-nuclear safety procedures
2.1.27	Knowledge of system purpose and, or function
2.1.28	Knowledge of the purpose and function of major system components and controls
2.1.30	Ability to locate and operate components, including local controls
2.1.31	Ability to locate control room switches, controls and indications and to determine that they are correctly reflecting desired plant lineup
2.1.32	Ability to explain all system limits and precautions
2.1.33	Ability to recognize indications for system operating parameters which are entry conditions for technical specifications.
2.1.34	Ability to maintain primary and secondary plant chemistry within allowable limits.
2.2.10	Knowledge of the process for determining if the margin of safety, as defined in the basis of (any) technical specification(s) is reduced by a proposed change, test or experiment
2.2.22	Knowledge of the limiting conditions for operations and safety limits
2.2.24	Ability to analyze the affect of maintenance activities on LCO status
2.2.25	Knowledge of the bases in technical specifications for limiting conditions of operations and safety limits
2.3.10	Ability to perform procedures to reduce excessive levels of radiation and guard against personnel exposure
2.4.1	Knowledge of EOP entry conditions and immediate action steps
2.4.2	Knowledge of system setpoints, interlocks and automatic actions associated with EOP entry conditions
2.4.3	Ability to identify post-accident instrumentation
2.4.4	Ability to recognize abnormal indications for system operating parameters which are entry level conditions for emergency and abnormal operating procedures

Reference Based Learning Objectives Technical Bases

Item	Definition
2.4.6	Knowledge of symptom based EOP mitigation strategies
2.4.7	Knowledge of event based EOP mitigation strategies
2.4.10	Knowledge of annunciator response procedures
2.4.30	Knowledge of which events related to system operations/status should be reported to outside agencies.
2.4.31	Knowledge of annunciators, alarms and indications, and use of the response procedures
2.4.48	Ability to interpret control room indications to verify the status and operation of systems, and understand how operator actions and directives affect plant and system conditions
2.4.49	Ability to perform, without reference to procedure those action that require immediate operation of system components and controls
2.4.50	Ability to verify system alarm setpoints and operate controls identified in the alarm response manual.

Table 3, RBO to ACAD 00-003 (LO) Cross-reference

Supporting RBO	ACAD 00-003 Section 3.3 Item
1	Purpose of the system
1, 3, 7	Importance of the system to nuclear safety, including why the proper lineup is necessary for system operability
4	Normal and alternate power supplies
9	Associated system operating precautions, limitations, and setpoints, and the bases for these
8	Interrelationships with other systems and units (if applicable)
8, 3, 5, 11, 12	Alternate methods for accomplishing the purpose of the system through the use of another system
5, (10)	Automatic features of system operations
2, 5, 10	Alternate/manual/local methods of system and component operation
2, 5, 6	Effective monitoring of the system (local, remote, computer displays and alarms)
5	Associated remote and local instrumentation, indications, alarms, and controls
5, 6	Knowledge of data logging devices
2, 4, 5	Failure modes of controls and vital instruments, including design features that could result in erroneous operation or indication
6	Normal values of significant parameters
6, (5), (10)	Relationships between significant parameter values
7, 11, 13, 14	Chemistry control and potential adverse effects of inadequate chemistry control
14	Related technical specifications, with emphasis on action statements requiring prompt actions (for example, one hour or less)
9, 10	Related normal operating procedures
10	Related surveillance procedures

Reference Based Learning Objectives Technical Bases

Supporting RBO	ACAD 00-003 Section 3.3 Item
10	Related alarm response procedures
10, 12	Related abnormal and emergency operating procedures
5, 6	Effects of changing environmental conditions
2, 7	Function and purpose of system components, including their importance to nuclear safety
2, 3	Components, including locations and characteristics
2	Types of components, with emphasis on those applications common to the plant
5	Methods for determining the positions of the various valves
2, 7	Design considerations, capabilities, and limitations related to component operation
2, 5	Interlocks associated with components
13	Associated industrial safety precautions
2, 5, 10, 13	Potential modes of component failures and industry experience related to component failure (for example, thermal binding of gate valves)
7, 10, 13, 14	Importance of and method for testing redundant components or systems

The Reference Based Learning Objectives satisfy the guidelines published by INPO in ACAD 00-003 when considered as a "whole". The 00-003 document provides guidance on the content of the licensed operator-training program. As a component of that program, the Referenced Based Objectives help the facility satisfy those guidelines.

Items expressed parenthetically partially address the ACAD section item cited.

Table 4, RBO to ACAD 90-016 (NLO) Cross-reference

Supporting RBO	ACAD 90-016 Section 7.2 Item
1	State the purpose.
2	Identify the major components and equipment.
3	For selected systems, draw a basic system diagram.
3	Given a copy of the system piping and instrument drawing, explain the system flow paths.
2, 3	Explain the purpose and location of major components and equipment.
12	Explain system operations necessary to support implementation of emergency operating procedure actions outside the control room.
2, 5	Explain the basic principles of operation for the system and the major components and equipment.
5	Describe instrumentation and controls, including symptoms of failure modes.
5	Describe system automatic features.
6	Identify normal and alarm values for significant monitored parameters.
7	Identify the basic interrelationships with other plant systems.
9	Describe system precautions and limitations.
9, 10	Identify any hazards associated with the system.
2, 3, 4, 5, 6, 7, 13	Assist in diagnosing the cause of abnormal system conditions.
10	Appropriately respond to abnormal system conditions.
7	Explain the importance to plant safety.
2, 5, 6, 13	Identify conditions that preclude safe work in the vicinity of system components.
1, 6	Identify the effect of system operability on technical specifications.

The Reference Based Learning Objectives satisfy the guidelines published by INPO in ACAD 90-016 when considered as a “whole”. The 90-016 document provides guidance on the content of the non-licensed operator-training program. As a component of that program, the Referenced Based Objectives help the facility satisfy those guidelines.

Table 5, RBO to ACAD 98-004 (ENG) Cross Reference

Supporting RBO	ACAD 98-004, Rev 1, Appendix B Items
1	Purpose of the system
2	Location and purpose of major components and equipment
5	Modes of operation for major components and equipment
8	Basic interrelationships among plant systems
1, 2, 7, 9	Importance to plant safety and/or radioactivity containment
7	System and major component design bases
14	System technical specifications, including safety limits and their bases
1, 7	Maintenance Rule applications

Table 6, RBO to ACAD 92-008 (MTCE) Cross Reference

Supporting RBO	ACAD 93-008 Section 8.1 Items
2	Identify major plant equipment.
2	Explain the purpose, application, and principles of operation of key components.
3, 5.a, 5.c	Explain system flowpaths.
1, 7	Explain the importance of the system to nuclear safety.
8.a	Identify the basic interrelationships with other plant systems and units.
5	Describe normal values of important parameters.
1	Identify systems affected by the plant technical specifications.
11.b	Describe the basic effect on system operation from a selected maintenance activity.

Table 7, RBO to ACAD 93-008 (RP) Cross Reference

Supporting RBO	ACAD 93-008, Section 8 Items
1	State the purpose.
2	Identify the major components and equipment.
3	Draw a basic system block diagram.
3, 5, 7 (Note[6])	Identify conditions that preclude safe work in the vicinity of system components.
8	Identify the basic interrelationships with other plant systems.
7	Explain importance to plant safety and radioactivity containment.
3	Identify any radiological hazards associated with the system.
2	Explain the purpose and location of major components and equipment.
1, 2, 5.a, 5.b	Explain the basic principles of operation for the system and the major components and equipment.
5 (Note[7])	Describe radiological precautions associated with maintenance tasks.

[6] This is more an industrial safety concern than an issue of system operation. From the perspective of system operation, aspects of RBO-3 and RBO-5 address effects on surroundings of system operation and RBO-7 addresses the nuclear and personnel safety issues.

[7] RBO-3 includes radiological considerations associated with operation of systems. Detail to the level required to assure radiological safety during maintenance (as when systems are opened) is beyond the scope of the systems objectives and is addressed in other training settings including GET and discipline specific training.

Table 8, RBO to ACAD 97-012 (CHEM) Cross Reference

Supporting RBO	ACAD 97-012, Chapter VII Items
1	State the purpose.
2	Identify major components and equipment.
3	Draw a basic system block diagram.
(Note[8])	Identify conditions that preclude safe work in the vicinity of system components.
8	Describe effects of chemistry changes on system and plant operation.
8	Identify the basic interrelationships with other plant systems.
1, 2, 7	Explain the importance to plant safety and radioactivity containment.
2	Explain the purpose and location of major components and equipment.
6	Identify chemicals added to the system.
2, 5.a, 5.b	Explain basic principles of operation for the system and major components and equipment.
6	Identify chemistry limits and on-line monitoring requirements.
1, 2, 6	Explain chemistry concerns associated with the system.
3	Identify chemistry sampling points.

[8] This is more an industrial safety concern than an issue of system operation. From the perspective of system operation, aspects of RBO-3 and RBO-5 address effects on surroundings of system operation and RBO-7 addresses the nuclear and personnel safety issues.

Change Summary

1	Editorial corrections to several sections and removal of electronic bookmarks
2	Clarified intent of RBO-3 to include ability to identify the location and function of sample points and instrument taps. Included expectation that effects on environmental conditions and habitability of system operation be included in RBO-3 and RBO-10. Provided explanation for breadth of knowledge expected for changes to RBO-3 and RBO-10. Modified objective statements to eliminate the phrase “apply knowledge of” in lieu of “describe” to align objectives more closely with those traditionally used in the industry.
3	Modifications to RBO explanations and application performance standards to include consideration of accredited non-operations disciplines. Addition of cross-reference tables for all reviewed ACAD documents Added level of detail discussion to introduction and notes
4	Added NUREG-1123 generic knowledge and ability 2.1.34 to RBO-3 to provide documentation for question and examination development.
5	Clarified RBO-9 and RBO-13 with respect to Core Work Practices and Foreign Material Exclusion Control considerations. Minor typographical corrections.

End Notes

[i] The applicability of either general or specific system knowledge (or abilities) is delineated in the content for each objective. Typically, an abbreviation for the applicable position is used. These abbreviations are NLO, RO, SRO, CHEM, RP, MTCE, and ENG and correspond to non-licensed operators, licensed reactor operators, senior reactor operators (licensed or certified), chemistry technicians, radiation protection technicians, maintenance craft personnel, and system engineers.

[ii] The term "non-availability" is used to account for safety-related systems or their associated support systems where operability is required in order for a system to automatically perform the intended function. A system may be classified as "inoperable but available" if manual action feasibly results in accomplishment of the design function.

[iii] This clause limits the degree to which knowledge of minutiae is required to satisfy Generic Knowledge and Ability statement 2.1.28 from NUREG-1123 and 10CFR55.41 (b)(7).

[iv] This includes all aspects of the operating license with special emphasis on rated core thermal power and environmental limits.

[v] It is not the intent of this objective for the student to memorize specific locations. It is sufficient that the student recall the general location and purpose of sample points and instrument taps.

[vi] An interdependent system is one that the operation of the system under study indirectly affects or that indirectly affects the operation, including control, of the system under study. Interdependency is generally discussed from the perspective of integrated plant operation using the cause and effect method of presentation. For example, the station battery chargers have an interdependent effect on the Feed System. The breakers to the main feed pumps receive DC control power, a change in DC control power has an effect on the ability to control the feed system. Therefore, perturbations in the battery chargers could have an effect on feed pump breaker control, which effects the operation of the feed system.

[vii] Environmental conditions include temperature, noise level, humidity, and radiation levels including radioactivity release. Habitability refers to those conditions required to gain access to and operate plant equipment including release of system fluids, steam, heat, radiation, hazardous materials, or other conditions that challenge the ability of personnel to operate plant components.

[viii] The phrase "general sequence" implies that the trainee, at the initial candidate level, is not expected to recall from memory exact procedure wording or component identification. For example; if a pump's driver or gearing requires a pre-lubrication period before introducing flow through the pump, the trainee should recognize that placing this step (action) after opening both suction and discharge valves is incorrect.