# Xe-100 Licensing Topical Report
# Xe-100 Training Programs Methodology

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**Department of Energy Acknowledgement and Disclaimer**

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## SYNOPSIS

This licensing topical report provides the X Energy, LLC (X-energy) approach and methodology for developing, implementing, and maintaining the initial, continuing, and requalification training programs for Xe-100 plant staff. The approaches and methodologies in this topical report specifically include the X-energy methodology for conducting a systems approach to training to produce the suite of Xe-100 training programs necessary for safe Xe-100 plant operation and maintenance under all operating conditions. This report is provided to request NRC review and approval of the Xe-100 methodology for developing facility training programs derived from a systems approach to training as required by 10 CFR 50.120 and defined in 10 CFR 55.4. Future approval of the Xe-100 training programs developed with these methodologies, which is outside the scope of this report, may be used by an applicant or facility licensee to satisfy the 10 CFR Part 55 requirements for “Commission-approved training program that is based on a systems approach to training” as referenced in a construction permit application, operating license or combined license application.

## CONFIGURATION CONTROL/DOCUMENT CHANGE HISTORY

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| **2** | 12-DEC-2022 | D. Williamson | All | Incorporated comments from NRC white paper |
| **3** | 01-MAY-2023 | D. Williamson | All | Combined training program methodology, control room operator licensing, and plant staff qualification requirements into one LTR. |
| **4** | 01-NOV-2023 | G. Crannick | All | Removed control room operator licensing and plant staff qualification requirements that were added in revision 3 in response to NRC feedback to revision 3.<br>Addressed NRC acceptance review comments. |

## EXECUTIVE SUMMARY

This licensing topical report presents the X Energy, LLC (X-energy) approach and methodology for developing, implementing, and maintaining the initial, continuing, and requalification training programs for Xe-100 plant staff required by the categories of personnel listed in Title 10 of the Code of Federal Regulations (10 CFR) 50.120, *Training and qualification of nuclear power plant personnel*, as well as control room operators. The approach described in this report focuses on the methodologies for X-energy to develop facility training programs derived from a systems approach to training as defined in 10 CFR 55.4. This report is provided to request a NRC review and approval of the Xe-100 methodology for developing facility training programs derived from a systems approach to training as required by 10 CFR 50.120 and defined in 10 CFR 55.4. Future approval of the Xe-100 training programs developed with these methodologies is outside the scope of this report. It should be noted that X-energy does not intend to seek accreditation by the National Nuclear Accrediting Board (NNAB); rather X-energy is seeking a "Commission-approved Facility-developed Training Program Methodology" by the Commission.

X-energy recognizes that Commission approval of completed training programs compliant with 10 CFR 50.120 and 10 CFR Part 55.4, as well as the necessary training for control room operations personnel and personnel qualification requirements, is ultimately the responsibility of an "applicant" and/or "licensee." However, X-energy's intent is to fully develop, implement, and maintain the Xe-100 training programs as Commission approved, vendor-supplied, facility training programs for initial and continuing/requalification training of Xe-100 plant staff to meet 10 CFR 50.120(b)(2) and 10 CFR Part 55 requirements for "Commission-approved training program that is based on a systems approach to training," as referenced in a future construction permit application, operating license application, or combined license application.

The methodologies provided in this report are also applicable to initial training as well as continuing training in the following areas:

- General Access
- Security
- Emergency Planning
- Radiological Worker
- Administrative Procedures
- Fire Protection
- Quality Assurance
- Fitness for Duty

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## Abbreviations/Acronyms

**Abbreviations/Acronyms**

| Short Form | Phrase |
|---|---|
| **ANS** | American Nuclear Society |
| **ANSI** | American National Standards Institute |
| **CFR** | Code of Federal Regulations |
| **CHM/RPT** | Chemistry and Radiation Protection Technician |
| **CRO** | Control Room Operator |
| **DIF** | Difficulty, Importance, Frequency |
| **DOE** | Department of Energy |
| **HFE** | Human Factors Engineering |
| **HMI** | Human-Machine Interface |
| **HSI** | Human-System Interface |
| **I&C** | Instrumentation and Control |
| **IAEA** | International Atomic Energy Agency |
| **IAW** | In Accordance With |
| **LWR** | Light-Water Reactor |
| **NEI** | Nuclear Energy Institute |
| **NNAB** | National Nuclear Accrediting Borad |
| **NRC** | U.S. Nuclear Regulatory Commission |
| **OJT** | On-the-Job Training |
| **P&ID** | Piping and Instrumentation Diagram |
| **PFT** | Plant Field Technician |
| **QA** | Quality Assurance |

| Short Form | Phrase |
|---|---|
| **RG** | Regulatory Guide |
| **RO** | Reactor Operator |
| **SAT** | Systems Approach to Training |
| **SOP** | System Operating Procedure |
| **SRO** | Senior Reactor Operator |
| **SSS** | Startup & Shutdown System |
| **TMX** | Xe-100 Training Manual |
| **TPE** | Task Performance Evaluation |
| **V&V** | Verification and Validation |
| **X-energy** | X Energy, LLC |

# 1. Introduction

## 1.1 Purpose

The purpose of this licensing topical report (LTR) is to:

- Describe the methodologies for developing the initial and continuing/requalification training programs of Xe-100 plant staff, derived from a systems approach to training as defined in 10 CFR 55.4, required by the categories of personnel listed in 10 CFR 50.120, as well as control room operators (CROs), for safe and reliable Xe-100 plant operations in a multi-unit plant configuration across various modes, states, and operating conditions
- Describe the methodologies for implementing the Xe-100 training programs as Commission approved, vendor-supplied, facility training programs for initial and continuing/requalification training of Xe-100 plant staff to meet 10 CFR 50.120(b)(2) and 10 CFR Part 55 requirements for "Commission-approved training program that is based on a systems approach to training," as referenced in a future construction permit application, operating license or combined license application, and licensee operating license
- Describe the approach and methodology that an applicant commencing the inaugural initial training programs at least 18 months prior to initial fuel loading on the first Xe-100 complies with the 10 CFR 50.120(b)(1), *Requirement*, that "Each nuclear power plant operating license applicant, by 18 months prior to fuel load, and each holder of an operating licensee shall establish, implement, and maintain a training program that meets the requirements of paragraphs (b)(2) and (b)(3) of this section"

## 1.2 Scope

This report describes:

- The approach and methodologies X-energy is using to develop the Xe-100 training programs (initial and continuing training programs)
- The approach and methodologies X-energy is using to implement the Xe-100 training programs as Commission approved, vendor-supplied, facility training programs for initial and continuing/requalification training of Xe-100 plant staff.
- The approach X-energy is using to satisfy the 10 CFR 50.120(b)(1), *Requirement*, that 18 months prior to fuel load an applicant and/or licensee "shall establish, implement, and maintain a training program that meets the requirements of paragraphs (b)(2) and (b)(3) of this section."

## 1.3 Interfacing Documents

This LTR interfaces with the following documents:

- Xe-100 Licensing Topical Report Control Room Staffing Analysis Methodology and Associated HFE Implementation Plans [1]. This LTR provides additional details of interrelated training elements, which are consistent with the guidance of NUREG-0711, "Human Factors Engineering Program Review Model" [2].

## 1.4 Outcome Objectives

Future applicants for an Xe-100 construction permit, operating license, or combined license application will be able to seek Commission approval of the completed Xe-100 training programs using the approaches and methodologies discussed in this LTR. Commission Approval of the completed Xe-100 training programs developed with these methodologies is outside the scope of this report. However, it should be noted that X energy does not intend to seek accreditation of the Xe-100 training programs by the National Nuclear Accrediting Board (NNAB). X-energy is seeking a "Commission-approved Facility-developed Training Program Methodology" by the Commission.

X-energy is requesting NRC review and approval of the methodologies to develop the Xe-100 training programs described in Sections 3 and 4 of this LTR to demonstrate compliance with developing facility training programs derived from a systems approach to training as required by 10 CFR 120 and defined in 10 CFR 55.4.

# 2. Xe-100 Training Programs Approach and Methodology

## 2.1 Regulatory Basis and Applicability

This report describes the X-energy approach and methodology for developing, implementing, and maintaining facility training programs for Xe-100 staff using a systems approach to training (SAT) as required by 10 CFR 50.120 and defined in 10 CFR 55.4. An additional description of the SAT process is located in ANSI/ANS-3.1-2014, "Selection, Qualification, and Training of Personnel for Nuclear Power Plants" [3] section 6.2.1, as endorsed by RG 1.8, Rev. 4, "Qualification and Training of Personnel for Nuclear Power Plants," [4] as well as NUREG-0711, "Human Factors Engineering Program Review Model," [2] Section 10.

An applicant that utilizes the X-energy SAT methodology as described in Section 3, to develop Xe-100 training programs adheres to NRC endorsed guidance and will meet the applicable requirements for the Xe-100 staff positions required by 10 CFR 50.120 and for control room operators (CROs).

However, 10 CFR 50.120(a), *Applicability*, states (emphasis added):

> The requirements of this section apply to each **applicant for and each holder of an operating license** issued under this part **and each holder of a combined license** issued under part 52 of this chapter for a nuclear power plant of the type specified in § 50.21(b) or § 50.22.

Similar references to "applicant" and "license" are used in 10 CFR 50.120(b)(1)(i) and (ii).

X-energy recognizes that compliance with 10 CFR 50.120 is ultimately the responsibility of an applicant and/or licensee and approved by the NRC staff during review of the applicant's operating license application.

X-energy also intends to fully develop, implement, and maintain the Xe-100 training programs as Commission-approved, vendor-supplied, facility-developed training programs for initial, continuing, and requalification training of Xe-100 plant staff to meet 10 CFR 50.120(b)(2) and 10 CFR Part 55.4 requirements for "Commission-approved training program that is based on a systems approach to training," as referenced in a future construction permit application, operating license or combined license application, and licensee operating license. This includes conduct of training by qualified X-energy instructors. However, future approval of the Xe-100 training programs developed using the X-energy SAT methodology is outside the scope of this report.

## 2.2 Xe-100 Training Programs Compliance with 10 CFR 50.120(b)(1)

The Xe-100 training programs satisfy the 10 CFR 50.120(b)(1), *Requirement*, that 18 months prior to fuel load an applicant and/or licensee "shall establish, implement, and maintain a training program that meets the requirements of paragraphs (b)(2) and (b)(3) of this section," by being prepared to commence the inaugural Xe-100 initial training classes, utilizing established Xe-100 training programs, at least 18 months prior to the initial fuel load for the first Xe-100 deployment and with each site-specific staff member

completing an initial requalification module (gap training) prior to the issuance of an operating or combined license where those members are part of the qualified staff.

Additionally, the Xe-100 training programs' material is maintained as outlined in Section 3, and plant staff training is considered maintained in accordance with the Evaluation element of SAT, which commences during implementation of the inaugural initial training classes.

Continuing and requalification training program content and frequency (i.e., duration of each class and how often classes are conducted) is determined using the same SAT methodology as the initial training programs.

## 2.3 Xe-100 Categories of Nuclear Power Plant Personnel

The Xe-100 training programs are structured and designed to provide reasonable assurance that personnel obtain and maintain the qualifications commensurate with the performance requirements of their jobs. Xe-100 training programs addresses:

- The range of categories of plant personnel shown in *Table 1*, *Xe-100 Equivalent Positions*
- Control Room Operations personnel
- The spectrum of plant functions and systems
- The range of relevant Human System Interface (e.g., Control Room, remote shutdown area, and local control stations)
- The extent of plant conditions (normal, upset, and emergency) including preoperational testing and low-power operation

Table 1 lists the various 10 CFR 50.120 categories of personnel, including control room operations personnel that are typical for a traditional commercial light-water reactor (LWR). The table provides a cross reference to the equivalent position for the Xe-100 plant personnel. The Xe-100 plant uses cross-trained, multi-skilled personnel to safely operate and maintain the plant to meet the categories of nuclear power plant personnel required by 10 CFR 50.120.

**Table 1: *Xe-100 Equivalent Positions***

| 10 CFR 50.120 and Control Room Operations Personnel Categories | Xe-100 Equivalent Position |
|---|---|
| Shift Supervisor (or Shift Manager) | Shift Supervisor |
| Senior Reactor Operator (SRO) | Control Room Operator (CRO) |
| Reactor Operator (RO) | |
| Shift Technical Advisor | N/A – to be addressed in a future report |
| Non-licensed Operator | Plant Field Technician (PFT) |
| Instrumentation and Control Technician | |
| Electrical Maintenance Personnel | |
| Mechanical Maintenance Personnel | |
| Radiological Protection Technician | Chemistry & Radiation Protection Technician (CHM/RPT) |
| Chemistry Technician | |
| Engineering Support Personnel | Engineering Support Personnel |

## 2.4 General Approach to Training

X-energy is developing the Xe-100 Training Manual (TMX) that contains all the procedures, forms, and guides used by X-energy to develop, implement, and maintain facility-specific training programs for the Xe-100 following a SAT methodology. The TMX procedure series is developed to detail the SAT methodology and implementation for the Xe-100 training programs.

The TMX procedure series is developed using the guidance in DRO-ISG-2023-04, “Advanced Reactor Content of Application ‘Facility Training Programs’ Draft Interim Staff Guidance” [5]. Additional references were reviewed and incorporated into TMX development. To the extent these reference documents align with the Xe-100 design, Xe-100 staffing approaches (e.g., CRO versus SRO or RO), and DRO-ISG-2023-04, [5], the X-energy TMX procedure series incorporates the following guidance to provide procedure level details to demonstrate acceptable SAT methodology:

- DOE Handbook, Training Program Handbook: A Systematic Approach to Training [6]
- IAEA Nuclear Energy Series No. NG-T-2.8, Systematic Approach to Training for Nuclear Facility Personnel: Processes, Methodology and Practices [7]
- NUREG-0711, Chapter 10, Training Program Development [2]
- NUREG-0700, Appendix B, Design Process Guidelines [8]
- NEI 06-13A, Template for an Industry Training Program Description [9]
- NUREG-0800, Section 13.2.1, Reactor Operator Requalification Program; Reactor Operator Training [10]

- NUREG-0800, Section 13.2.2, Non-Licensed Plant Staff Training [10]

The regulatory acceptance criteria applicable to the Xe-100 training programs, to the extent that these documents align with the Xe-100 design and staffing approaches, are found in:

- DRO-ISG-2023-04, Advanced Reactor Content of Application "Facility Training Programs" Draft Interim Staff Guidance [5]
- NUREG-0711, "Human Factors Engineering Program Review Model," Section 10, Training Program Development [2]
- NUREG-0700, "Human-System Interface Design Review Guidelines" [8]. Specifically, the criteria applicable to Training Program Development (Appendix B)
- NUREG-0800, "Standard Review Plan," [10] Acceptance Criteria sections for:
  - Chapter 13.2.1, "Reactor Operating Requalification Program; Reactor Operator Training"
  - Chapter 13.2.2, Non-licensed Plant Staff Training"
  - Chapter 18, Human Factors Engineering, Attachment B, "Methodology to Assess the Workload of Challenging Operational Conditions in Support of Minimum Staffing Level Reviews"
- NUREG-1021, "Operator Licensing Examination Standards for Power Reactors" [11] is based on LWR technology and the associated LWR Knowledge and Abilities Catalogs (NUREG-1122, -1123, -2103, -2104 [12] [13] [14] [15]) and is therefore not effective for the development Xe-100 training programs Licensed operator examination policies, procedures, and practices for examining incumbents is contained in the Xe-100 Training Manual which will be submitted for approval with the Xe-100 training programs for the operating license application

The X-energy maintenance strategy [16] includes a population of maintenance tasks. Each task requires qualified personnel, appropriate level of work instructions, time, and materials to be allocated in the schedule to execute each task in accordance with approved procedures/ instructions. The maintenance strategy and included tasks are inputs to the training development process to provide training on the elements necessary to qualify the personnel performing the tasks. In this way, the Xe-100 training programs support compliance with 10 CFR 50.65 and conformance to the guidance of RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" [17].

In addition to the technical training that is required for each plant staff position, the Xe-100 training programs also address initial training as well as continuing training in the following areas:

- Administrative Procedures
- Emergency Planning
- Fire Protection
- Fitness for Duty
- General Access
- Quality Assurance
- Radiological Worker
- Security

The Xe-100 training programs are also designed to address performance under degraded conditions by including:

- Understanding how and why the instrumentation and control (I&C) subsystems might degrade or fail
- The implications of degradations in the human system interfaces (HSIs) for task performance
- Monitoring the I&C system's performance, so degradations are detected and recognized via the control room's HSIs
- Performing recovery actions and compensatory actions in the event of a degraded condition
- Transitioning to backup systems when needed
- Teamwork as an operator fundamental. Additionally, CROs receive supervisor training since they direct the work and oversee the actions of others
- Decision-making skills in addressing each of the above challenges

Training records are maintained and kept available for NRC inspection in accordance with the record retention requirements described in Section 4.4, Records, to verify adequacy of the Xe-100 training programs.

## 2.5 X-energy Training Organization for Xe-100

The X-energy training organization for the Xe-100 develops the training requirements, policies, procedures, training materials, examinations, and evaluations and implements and maintains the training programs. The development of these training programs and related elements is conducted by personnel with prior experience in training development and/or prior experience in the specific (or equivalent) role that is the subject of the training. TMX-6.0 specifies the education and experience requirements for X-energy instructors, which align with ANSI/ANS-3.1-2014 [3], Section 4.5.4 as follows:

- Education: High school diploma
- Minimum experience for the position:
    - Related experience which shall include: 2 years
    - Nuclear power plant experience 0.25 year
- Special requirements:

    1. Shall have demonstrated knowledge of instructional techniques through training or experience and be certified as a qualified instructor for the material being presented
    2. Instructors of licensed personnel who provide instruction on the simulator shall hold, or shall have held, a senior operator's license or have been certified for equivalent senior operator knowledge

# 3. X-energy Systems Approach to Training for Xe-100

X-energy training programs for the Xe-100 utilize a SAT methodology as required by 10 CFR 50.120 and defined in 10 CFR 55.4. Specific details of X-energy's approach and methodologies for SAT are contained in the Xe-100 TMX procedure series.

The SAT process consists of five interrelated elements: analysis, design, development, implementation, and evaluation. These five elements are interrelated with elements of the HFE Program Management Plan (and referenced HFE Implementation Plans) [1], which is consistent with the guidance of NUREG-0711 [2]. The HFE Program's support for the Control Room staffing approach provides proper correspondence between developing the Xe-100 training programs and the HFE Program by following the SAT process and using the HFE Task Analysis as input to the SAT analysis phase/element.

The Xe-100 training programs also address the periodic continuing training and requalification of plant personnel, including the CRO requalification requirements. Continuing training reinforces initial training by reiterating selected portions of the material. Continuing training also addresses new and modified procedures and plant design changes. Additionally, fundamentals defined during the analysis phase are integrated into the training programs such that they are taught and examined routinely throughout both the initial and the requalification Xe-100 training programs. This approach reinforces fundamentals with plant-specific and design-specific topics over the entirety of the Xe-100 training programs.

The main activities carried out in each of the element phases as well as the key factors considered in each are discussed in the subsections to follow.

## 3.1 Analysis Phase

TMX-1.1 governs the Analysis Phase of the X-energy SAT process for the Xe-100. The purpose of the analysis phase is to determine training needs and identify job specific training requirements. The main activities of the Analysis Phase are: Needs Analysis, Job Analysis, Task Analysis, and Competency Analysis.

### 3.1.1 Needs Analysis

A Needs Analysis is performed to identify potential training needs, to suggest and approve training solutions, and where possible recommend non-training solutions to improve personnel performance.

A Needs Analysis is entered as the result of evaluation phase activities (e.g., training request, post-training student and line feedback, observation of task performance, audit or assessment finding, plant or human performance event, or engineering change with training program impact). Training required by a regulatory agency does not require further documented analysis because the analysis was completed by the regulator. This required training is included and addressed in the design and development phases of the SAT process.

A Needs Analysis may result in the following training related outputs:

- The need for a new training module or activity for a particular job or task
- The need to modify an existing training module or activity

- A new or modified task or competency to be addressed in the training program
- Particular cognitive and performance elements to be addressed in training, to improve performance

These outputs are considered as inputs to the Job Analysis and subsequent Task Analysis. The Needs Analysis may also generate additional training program improvement opportunities, such as the following:

- Changes to the organization or sequence of training
- Changes to the training methods, training facilities, or training tools
- Enhancement of instructor competence
- Estimation of resources required for training (human resources, time, and cost) from the Xe-100 staff and Operating Company

The Needs Analysis may generate non-training recommendations, which are communicated through appropriate channels (e.g., corrective action program).

### 3.1.2 Job Analysis

A Job Analysis is conducted to produce a list of duty areas and tasks for a specific job or position. A Job Analysis evaluates what the individual does on the job (performance and cognitive based tasks) rather than what the individual must know to perform the job.

Job incumbents and subject matter experts participate in Job Analysis by providing input and reviewing job requirements. Training and Line supervision review and approve Job Analysis results. To ensure the Job Analysis is congruent with the HFE program, the following HFE items are considered as inputs to the Job Analysis:

- HFE Concept of Operations Report
- HFE Task Analysis
- HFE Plant Staffing Report
- HFE Staffing & Qualifications Report
- HFE Control Room Staffing Analysis and associated Licensing Topical Report
- HFE Operating Experience Report
- HFE Functional Requirements Analysis and Function Allocation Report
- HFE Treatment of Important Human Actions Report

Additional inputs considered for Job Analysis include:

- Xe-100 design (e.g., system design descriptions, system drawings, etc.)
- Safety analysis
- Licensing Basis
- Human System Interface (HSI) / Human Machine Interface (HMI)
- Plant Procedures
- Verification and Validation (V&V)

Personnel familiar with the Job Analysis process (e.g., job incumbents, subject matter experts, training staff) generate a task list derived from a Job Analysis. Task statements address the following systematic criteria:

- Consist of a logically ordered set of steps
- Are observable and measurable or produce an observable and measurable result
- Have one action verb and one object
- Have a specific beginning and end
- Occur over a short period of time
- Can be executed with consistent results on different occasions by different people
- Requires a record of review and/or approval for historical record
- Results in a consistently formatted, quality product

#### 3.1.2.1 Difficulty, Importance, and Frequency Analysis

Difficulty, Importance, and Frequency (DIF)Analysis uses three factors – difficulty, importance, and frequency – to determine whether a task should be trained and how often the task should be retrained. DIF analysis is performed using deterministic DIF worksheets where job analysis participants assign a difficulty score, an importance score, and a frequency score for each task. The DIF results are averaged to determine one of the following outcomes for each task: no training, initial training only, or initial and continuing training. Tasks that screen for initial and continuing training are assigned a retraining frequency based on their DIF scoring.

### 3.1.3 Task Analysis

A Task Analysis evaluates tasks selected for training to determine the scope of the activity. Task Analysis produces a defined list of job attributes required for satisfactory task performance.

Task Analysis reviews task statements within the context to their plant application to identify the characteristics of the task. These characteristics are used to design and develop training content for incumbent qualification.

Task Analysis considers the following characteristics:

- Initial conditions (prerequisites) required for task performance
- Standards (criteria) for acceptable task performance (i.e. limits, ranges, time requirements)
- Critical elements (steps) that must be performed to accomplish the task properly
- Tools, equipment, and safety concerns related to task performance
- Associated performance or cognitive statements required to perform particular elements of the task or the overall task
- Branch steps/alternate paths that result in additional actions or performance or cognitive elements to accomplish satisfactory performance

Task Analysis includes all aspects of job performance, including but not limited to tasks important to safe plant operation and tasks related to the foundational theory of plant operations.

### 3.1.4 Competency Analysis

A Competency Analysis gathers information from the collective experience, knowledge, and judgement of a group of experts to identify all competencies needed for a particular job. A Competency Analysis can evaluate a particular job, task, or a set of related tasks. The following expertise categories are considered when assembling a group of experts:

- Technical:
  - Plant design safety guidelines
  - Job requirements
  - Plant specific design and operation
  - Methods used in the performance of tasks and constraints under which they are performed
  - Operational experience feedback
  - Training needs resulting from procedure changes or plant modifications
- Management systems and human factors:
  - Communication, leadership and other human factors cognitive and performance elements required of the job incumbent
  - Range of experience and education of the potential trainees
  - Legal and other mandatory requirements of the job incumbent
  - QA system at the plant
  - Safety culture
  - Management systems and plant organization
  - Use of procedures for operations, maintenance and other activities
- Training:
  - Knowledge of each phase of SAT, its inputs, outputs and purposes
  - Knowledge of the details of existing training programs

The group's composition is intended to be large enough to provide the breadth of expertise needed while being small enough to be of a workable size. The responsibilities of the expert group may include the recommendation of learning objectives, thus combining parts of the analysis and design phases of SAT.

### 3.1.5 Additional Requirements

When an analysis results in modification to an approved task list and associated elements, changes are allowed provided the changes are analyzed using a Needs Analysis.

If a change results in the deletion of task(s) and/or associated elements that meet any of the following criteria:

- Related to systems or equipment important to safety
- Related to systems or equipment required by technical specifications
- Related to systems or equipment required by NRC regulation
- Currently utilized in the Operator Examination process

Then, Commission approval is required prior to making the changes. Commission approval is not required for task selection changes – i.e., selecting and deselecting tasks for initial or initial and continuing training.

#### 3.1.5.1 Task List Reviews

The objectivity of the deterministic DIF process eliminates the need for a scheduled task list review. A change to the task list occurs as an output of a task review, which is initiated through the needs analysis process and reviewed by job incumbents, line personnel, and training staff. A task review occurs when performance improvement and change management processes outside of the SAT process capture potential task impacts, through items such as:

- Differences in desired and actual job performance
- Changes to a job
- Changes to procedures
- Modifications of plant systems
- Incorporation of lessons learned

This approach does not require formal documentation of a full program review, but it ensures that all tasks, both selected and deselected, are consistently evaluated as needed.

The analysis phase results serve as the basis for the next SAT element, the design phase.

## 3.2 Design Phase

TMX-1.2 governs the Design Phase of the X-energy SAT process for the Xe-100. The purpose of the Design Phase is to develop clear training objectives organized in a logical, pedagogical sense for effective learning in modules, courses, and training programs to achieve desired results. The main activities of the Design Phase are: Define target student population, develop learning objectives, determine training setting, organize learning objectives, and prepare examination items.

### 3.2.1 Define Target Student Population

The first process of the Design Phase is to define the target student population. Training program design is focused on the results of the analysis phase and identified prerequisite education and experience. Learning objectives and content align with minimum education and experience requirements to enable knowledge transfer with appropriate detail and rigor.

### 3.2.2 Develop Learning Objectives

Learning objectives are created, validated, or revised from results of the Analysis Phase. Learning objectives are organized into terminal and enabling objectives. Learning objectives are built of three components: a condition, an action, and a standard that are clearly written to distinguish each component.

**Terminal Objectives**

A terminal objective is written for each major topic/ task. The terminal objective is derived from the task statement and focuses on the overall results of the training.

**Enabling Objectives**

An enabling objective is written for each task element that a trainee must master to successfully complete the associated terminal objective.

Enabling objective creation is focused on the elements identified in the job and task analyses. Enabling objectives are further refined into cognitive and performance objectives to distinguish the associated learning domain and aid in selection of the appropriate setting for training and evaluation.

Cognitive enabling objectives are typically trained in a self-paced or classroom setting. Cognitive objectives are usually evaluated in a written or electronic examination.

Performance enabling objectives are typically trained in an on-the-job setting. Performance objectives are usually evaluated in a laboratory, simulator, or task performance evaluation.

**Learning Objective Conditions**

The condition statement clearly states the condition(s) that will exist at the time of trainee performance. Conditions of performance define the facility situation, environmental aspects, and resources available to aid trainee performance.

Learning objective conditions are derived from various job conditions identified during analysis. When developing learning objective conditions, adjustments may be necessary to reflect the degree of fidelity desired and achievable within the training setting. For example, job conditions may be simulated with high fidelity during on-the-job and simulator training, because they mirror the actual job conditions. When classroom or self-paced learning is used, the learning objective conditions are limited by the constraints of the classroom or self-paced environment.

**Learning Objective Action Statements**

The action statement consists of an action verb and a direct object. The action verb should identify trainee behavior that is observable, measurable, and applicable to trainee performance.

**Learning Objective Standards**

The standard statement identifies the standard for evaluating student performance. The trainee's action should result in an output, and the required quantity or quality of that output is the standard of performance. Standards can include step-by-step processes that do not permit deviation. Others may prescribe the product of performance and the factors for judging that product.

Standards are derived from job standards identified during analysis. Like the selection process for conditions, learning objective standards should be adjusted to reflect fidelity to job standards. If an action is required to be performed within a specified period, the standard must include the time requirement.

### 3.2.3 Training Setting

The training setting is the environment or location in which training takes place. A decision on an appropriate setting for a specific training session is made during the Design Phase. The type and cognitive level of training and learning objectives have a direct bearing on the method of instruction and the subsequent selection of the training setting. Setting selection also considers the optimal method of evaluation. Examples of training settings are provided in the TMX procedure series and may include but are not limited to:

- Xe-100 Control Room Simulation Facility
- In-plant
- Classroom
- Laboratory
- Augmented/Virtual Reality

### 3.2.4 Organize Learning Objectives

Learning objectives are organized in a lesson plan to facilitate student learning and mastery. Instructional design addresses temporal order of learning objectives and their related content as well as scheduling.

Temporal order is primarily based on progressing the content from low cognitive learning objectives to high cognitive learning objectives and providing trainees with introduction, background, fundamental, simple concepts before presenting detailed, advanced, complex concepts within a given curriculum topic.

Scheduling is primarily based on estimated duration for each learning activity and any resource constraints that may occur. The estimated duration for each learning activity is based on various considerations (e.g., number of slides, multimedia length, verification, and validation duration data). Training resources and assets (e.g., staff availability, simulator availability, lab availability, etc.) are examples of possible constraints that may influence scheduling.

### 3.2.5 Prepare Examination Items

Examination items are prepared to objectively measure a trainee's mastery of the learning objectives and gauge the effectiveness of the training program. Examination items are categorized as cognitive examinations and performance evaluations. Cognitive examinations (e.g., written exams) are addressed in TMX-1.6. Performance evaluations (e.g., simulator evaluations, laboratory evaluations, and task performance evaluations) are addressed in TMX-1.9.

The design phase results serve as the basis for the next SAT element, the development phase.

## 3.3 Development Phase

TMX-1.3 governs the Development Phase of the X-energy SAT process for the Xe-100. The purpose of the Development Phase is to develop materials necessary to conduct training and evaluation activities. Materials include lesson plans, simulator guides, laboratory guides, self-led training materials, and associated evaluation items and exams. The main activities of the Development Phase are: creating material, revising material, reviewing material, and approving material.

### 3.3.1 Creating Training Material

Training materials are developed based on the plant design, as specified by the job and task analysis and their corresponding elements, and as analyzed and selected for training. Training materials contain enough detail for trainees to successfully master the associated learning objectives and provide direction for consistent delivery of the information.

Effective knowledge transfer is addressed, in part, by selecting an appropriate delivery method of instructional content and developing student material with this decision in mind. For example, relying solely on self-study of written guidance for tasks that will be evaluated in a performance setting, with no guided performance practice, is not an appropriate delivery method. However, self-study using augmented, simulated, or virtual reality training that allows interactive demonstration of the skill may be acceptable depending on the difficulty and importance of the topic being trained.

An appropriate delivery method aligns with the cognitive level of the learning objective. For example, if a learning objective requires analysis of a system fault, the supporting material cannot solely focus on the purpose and general function of the system; instead, the content must incorporate learning at the higher cognitive learning objective.

**Learning Objects**

Note – "learning object" and "learning objective" are different terms and are not interchangeable in this document.

A learning object contains one learning objective and all related learning resources. Learning resources are any content that supports the learning objective, such as text, diagrams, media, student reinforcement activities, and exam items. Figure 1, *Learning Object Model,* below describes this learning object methodology used in the X-energy SAT process for the Xe-100.

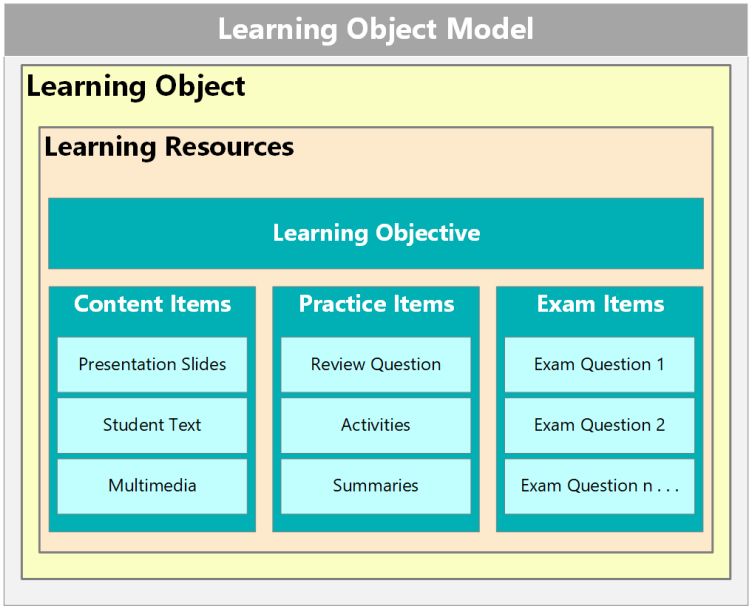


**Figure 1: *Learning Object Model***

A key benefit to the learning object methodology is that once a learning object is created, it may be used as standalone training material. Learning objects establish the premise behind cross-training multi-skilled personnel and establishing a modular approach to training methodology.

Multiple learning objects can be sequenced into a lesson plan, as shown in the Figure 2, *Lesson Plan Model,* below. This is another example where the learning object methodology supports a modular approach to training.

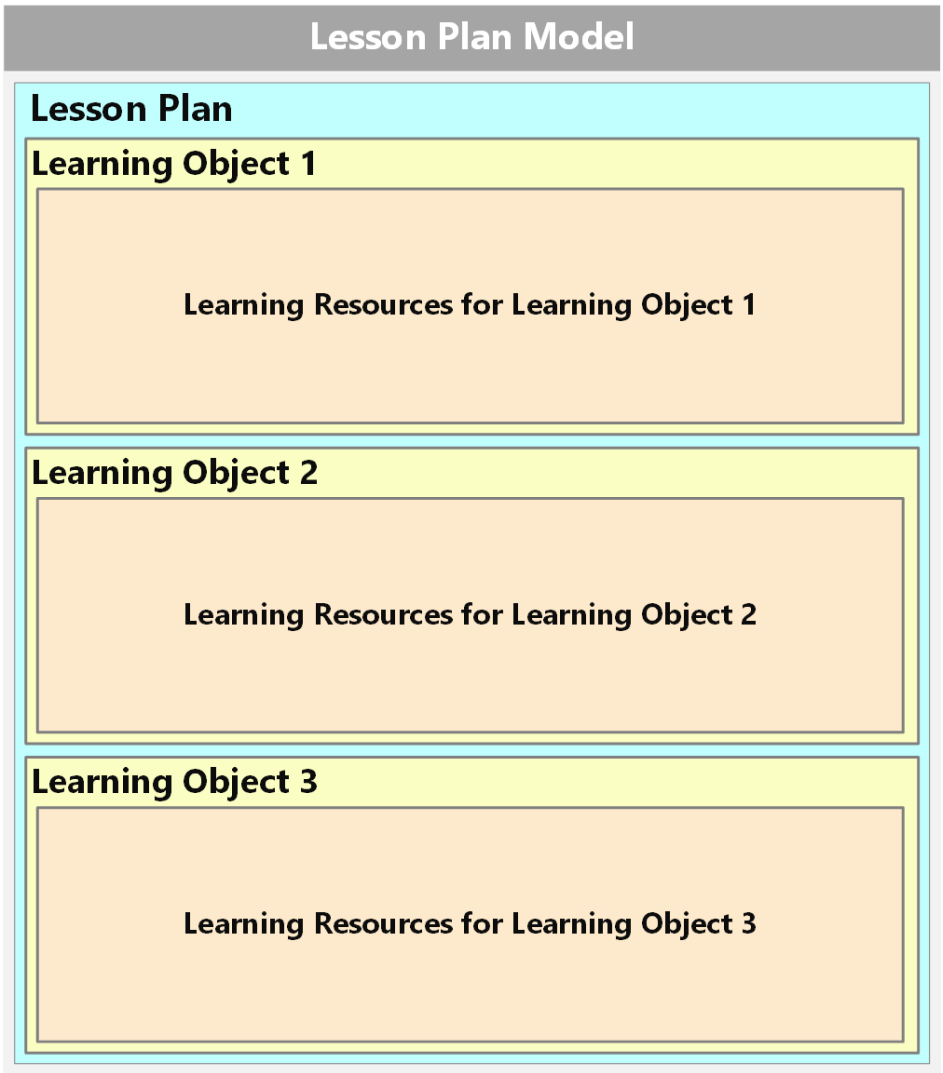


**Figure 2: *Lesson Plan Model***

TMX-1.9 addresses sequencing learning objects into performance training.

### 3.3.2 Revising Training Material

If materials are revised, the revisions are deemed either major or minor as follows:

- Major revisions are changes either to the technical content supporting a learning objective or to the learning objective itself.
- Minor revisions are non-technical changes to learning resources or learning objects or editorial changes to learning objectives.

Table 2, *Major and Minor Revisions* below provides examples of major and minor revisions.

**Table 2: *Major and Minor Revisions***

| Revision Example | Revision Type |
|---|---|
| Updating a photograph to one of higher resolution. | Minor |
| Correcting typographical errors in training content. | Minor |
| Correcting a typographical error in a learning objective statement. | Minor |
| Updating a supporting P&ID to reflect plant design changes. | Major |
| Altering a learning objective condition to allow references. | Major |

### 3.3.3 Reviewing Training Material

Material is reviewed prior to use to ensure it is complete, accurate, relevant, and supports the learning objectives. Whenever possible, the material is piloted in advance of implementation.

Reviews are performed by knowledgeable individuals who provide feedback to the instructor. Lesson plans and test questions are reviewed, and deficiencies are identified for correction.

To maximize review efficiency and depth of reviews, classroom and self-guided/self-paced training materials are reviewed by training and knowledgeable individuals per Table 3: Review Requirements, *Review Requirements,* below.

**Table 3: *Review Requirements***

| Type of Material | Required Reviewer | Required Approver |
|---|---|---|
| Learning Resource | None | Instructor |
| Learning Object (First or Major Revision) | Knowledgeable Individual | Training Manager (or designee) |
| Learning Object (Minor Revision) | Instructor (not the author) | Training Program Lead |
| Lesson Plan | Instructor (not the author) | Training Manager |

### 3.3.4 Piloting Training Material

After training material review is complete, a pilot may be conducted with a small group, including trainees who possess the entry level requirements expected of future trainees.

During pilots, the training environment should be simulated as closely as practicable. Training materials are presented as intended for actual use. Data is collected for subsequent analysis to improve lesson plans and learning resources and to validate instructor (teaching) skills.

Trainees who participate in a pilot session may be granted credit for completion if all the following are true:

- There are no major changes (as defined in *Revising Training Material* section) to any learning object
- The trainee passed the examination or performance evaluation associated with the piloted learning objectives and training material

If a major change to any learning object is warranted, gap training on the changes is an appropriate method to grant credit for the pilot session.

### 3.3.5 Approving Training Material

Training materials are reviewed by training and line management for accuracy and adequacy prior to instruction.

### 3.3.6 Developing Examinations and Performance Evaluations

TMX-1.6 governs developing written examinations. Cognitive examinations adequately sample the course objectives to ensure trainee mastery of the course content requisite knowledge. Lesson plan sequencing and course curriculum, the number of objectives, and objective difficulty are considered when developing exams. A sufficient number of test items from each lesson plan's learning objectives are included on the exam to adequately assess student comprehension and mastery of the content. For objectives that cover multiple tasks and elements, the exam sufficiently samples the tasks and elements tied to the objective. The number of tasks and elements tied to the objective and the associated importance to risk and safety are considered when choosing tasks and elements for exam development. For exams that cover multiple lessons, learning objectives that will adequately cover the content and confirm overall mastery of the material may be chosen. Exam development includes higher cognitive learning objectives that build on the understanding of lower cognitive learning objectives.

If different versions of the same exam are being given in a short period, the questions on each version of the written exam must differ by at least 40%. Exam questions are reviewed to ensure they are not duplicated and cannot be used to aid in answering another question.

TMX-1.9 governs developing performance evaluations. Performance evaluations include laboratory, simulator, or task performance evaluations (TPE) requiring hands-on or simulated performance by the trainee to demonstrate mastery. Performance objectives derived from tasks or skills selected for training are evaluated with performance evaluations as identified in the design phase. For both cognitive examinations and performance evaluations, clear grading methods and success criteria are defined, understood by students and evaluators, and applied uniformly.

The Development Phase materials are used in the next SAT element, the Implementation Phase.

## 3.4 Implementation Phase

TMX-1.4 governs the Implementation Phase of the X-energy SAT process for the Xe-100. The purpose of the Implementation Phase is to deliver the training, examination, and evaluation materials created in the development phase. Successful performance of the Implementation Phase requires the training instructors to promote trainee mastery of the learning objectives and to ensure a transfer of student knowledge and skills from the instructional setting to the job.

Applicants and/or licensees committing to implementing X-energy facility training programs for the Xe-100 also commit to interfacing with X-energy to update and maintain the training materials with new and modified procedures and plant changes, as well as communicating applicable operating experience. In this way the implementation element supports maintaining the Xe-100 training programs as required by 10 CFR 50.120(b)(1).

The main activities of the Implementation Phase are preparation and scheduling, delivery of training, exam administration and remediation, and collecting feedback post training.

### 3.4.1 Preparation and Scheduling

Train-the-trainer is conducted to train and qualify Xe-100 instructors. This includes pedagogical and methodological skills as well as the technical elements from the training program the instructor is being qualified to instruct.

Training instructors execute training, examination, and evaluation activities per training program schedules using approved materials from the Development Phase. Instructors ensure training assets and resources are available, suitable, and reserved for use. Instructors coordinate the training schedule to align with the target audience identified in the Design Phase.

### 3.4.2 Delivery of Training

Training instructors who deliver training are qualified and proficient in the methods and techniques for successful presentation in the training setting and asset they are using. Instructors should be prepared, as evident by their performance in the classroom using questioning skills, coaching skills, and learning techniques for optimal trainee mastery of the learning objectives. Effective delivery of training includes consistent adherence to the approved training material and reinforcing line standards where appropriate.

The inaugural initial training classes will be prepared to commence at least 18 months prior to the initial fuel loading for the first Xe-100 deployment.

### 3.4.3 Exam Administration and Remediation

The examination process is used to verify trainee comprehension of the topics and mastery of the learning objectives. Cognitive learning objectives are examined using cognitive examination methods. Performance learning objectives are examined using performance evaluation methods.

All training requires trainee examination or evaluation. Successful execution of trainee examinations and evaluations includes appropriate exam security standards, examination administration, grading, and remediation.

### 3.4.4 Post-Training Activities

Following examination and evaluation activities, training instructors collect training feedback and document the training occurrence. Training feedback should be collected promptly to capture initial impressions of effectiveness. The feedback is used for course (program) evaluation in the Evaluation Phase of the SAT process.

Documentation of training should include, as applicable, the lesson plan, examination or evaluation, curriculum completed, instructor, training completion date, and names of trainees who completed the training. Qualification records should be updated, as applicable.

Gap training is considered based on any differences between the training provided to the student and any changes impacting learning objects, including:

- Modifications to the training materials that were used to conduct the initial training
- New tasks that need to be trained
- Design modifications
- Changes in regulatory requirements
- Any changes that affect the workers' knowledge and skills before the next task re-training date

The Implementation Phase provides data (input) to the next SAT element, the Evaluation Phase.

## 3.5 Evaluation Phase

TMX-1.5 governs the Evaluation Phase of the X-energy SAT process for the Xe-100. The purpose of the Evaluation Phase is to assess the effectiveness and efficiency of the training programs. Evaluation is the feedback component of the performance-based training model. The outcome of the Evaluation Phase is the initiation of necessary actions to improve gaps identified in the training programs.

Applicants and/or licensees committing to implementing X-energy facility training programs for the Xe-100 also commit to interfacing with X-energy to provide job performance, self-assessments, observations, and feedback to maintain the training materials with new and modified procedures and plant changes, as well as communicating applicable operating experience. In this way the Evaluation Phase supports maintaining the Xe-100 training programs as required by 10 CFR 50.120(b)(1).

The main activities of the Evaluation Phase are: evaluation intake, information assessment, and initiate corrective actions.

### 3.5.1 Collect and Analyze Feedback

Training and line personnel should be aware of conditions and events that indicate training effectiveness. The method of data collection and review should be continuous to ensure the currency and adequacy of the training program to sustain program effectiveness in line performance.

Training evaluation consists of receiving and analyzing feedback on the effectiveness of the training program. There are multiple methods of receiving feedback, including from trainees in the program, management observations of the program, analyzing exam results, and assessing the effectiveness of the

training program by evaluating on-the-job performance of personnel who completed the training program.

**Trainee Feedback Analysis**

Training personnel collect trainee feedback during the Implementation Phase. Effective evaluation of the training program includes reviewing the trainee feedback and initiating actions, when necessary, to improve the training program curriculum for future offerings.

**Management Observations of Training**

Line management should observe training delivery on a routine basis and provide feedback on the adequacy of the training. Effective evaluation of the training program includes reviewing and analyzing the feedback for potential improvements.

**Exam Item Analysis**

Following exam administration, an exam item analysis should be conducted to review the effectiveness of the exam and ensure exam item topics were adequately addressed during training.

**Post Training Effectiveness Evaluation**

When a trainee completes the initial training program, a Post Training Effectiveness Evaluation is conducted to assess the effectiveness of the training program to prepare the trainee for the job. Feedback from the trainee, job incumbents, and line management is included in the evaluation to assess how well the training program prepared the trainee for independent job performance. This information is typically collected six months to a year following course graduation.

**Assessing the Approved Training Program Scope**

Information can also be reviewed for any potential changes in training program job requirements (i.e., tasks or elements) that are not currently selected for training but have been flagged as being affected by a change or potentially contributed to an event. Data can be identified through any intake method, such as trainee feedback, facility modifications and procedure changes, industry event reports, or inspection results.

### 3.5.2 Facility Issues and Events

Facility events should be evaluated for potential training program impact. Human errors, equipment damage or unavailability, or rework could be an indicator that the associated training program inadequately or improperly trained a task or identify a task that needs to be trained. For significant events, training and line supervision evaluate whether training was a causal factor.

### 3.5.3 Inspection, Assessment, and Corrective Action Reports

Any inspection, assessment, or corrective action report that explicitly mentions a training weakness needs to be evaluated. Facility reports from causal evaluation, internal and external inspections and evaluations, and routine program assessments should be reviewed for potential training related weaknesses or recommendations.

### 3.5.4 Facility Modifications and Procedure Changes

Facility design changes, modifications, or procedure changes that impact equipment operation, maintenance, or user interface could alter the original information assessed in the training program job and task analysis and associated elements to which the training curriculum was designed. Consequently, any design changes to the facility must be reviewed for potential impact to the training program.

### 3.5.5 Industry Regulatory Changes and Operating Experience

Regulatory changes and industry operating experience shall be reviewed for applicability and incorporated into the associated training programs accordingly. Operating experience should be selected to provide personnel with actual examples of good practices and lessons learned, and collected from Licensee Event Reports, corrective action databases, industry groups, and other sources.

### 3.5.6 Assessing the Approved Training Program Effectiveness

Information should be reviewed for any potential objective or factual data related to training program performance by evaluating the analyzed elements associated with the tasks selected for training as identified in the analysis phase. Data can be identified through any method, such as trainee feedback, line performance, or assessments and analyzed into a Post Training Effectiveness Evaluation.

# 4. Xe-100 Control Room Operator Training Program

The Xe-100 Control Room Operator (CRO) Training Program includes an initial training program, a requalification training program, and examination and remediation standards.

The CRO Training Program incorporates the instructional requirements necessary for CROs to obtain and maintain the necessary knowledge, skills, and abilities to operate and maintain the facility in a safe manner in all modes of operation.

The CRO Training Program:

- Complies with the facility license, including all technical specifications and applicable regulations
- Is periodically evaluated and revised as appropriate to reflect industry experience and relevant changes, including changes to the facility, procedures, regulations, and QA requirements
- Is periodically reviewed by training and line personnel for effectiveness
- Includes the CRO manipulating the controls of either the facility or the Xe-100 simulation facility that demonstrates compliance with the requirements of § 55.46

The CRO Training Program includes training conducted using the control room simulator, which is designed by adhering to the guidance of ANSI/ANS-3.5-2009, “Nuclear Power Plant Simulators for Use in Operator Training and Examination” [18], as endorsed by the NRC in Regulatory Guide 1.149, “Nuclear Power Plant Simulation Facilities for Use in Operator Training, License Examinations, and Applicant Experience Requirements” [19]. The simulator training provides operations personnel with sufficient knowledge and experience required for CRO qualifications. This enables operations personnel to perform their required duties during the unique conditions of new plant construction and initial operation. The control room simulator is of sufficient scope and fidelity for individuals to acquire and demonstrate the necessary knowledge, skills, and abilities to safely perform licensed duties.

Shift Supervisors are also trained as CROs and receive additional training that addresses higher-level management skills and behaviors and provides a broader perspective of plant operations.

## 4.1 Initial Training

For the CRO Training Program, the SAT methodology includes tasks and elements for foundational theory of plant operations and systems important to safety as applicable to the Xe-100 design, including:

- Reactor theory, thermodynamic principles, and chemical theory associated with the technologies, materials, and processes of the Xe-100 design
- Safety-significant plant systems and components
- Reactivity management and manipulations
- Radiation control and safety
- Emergency, abnormal, and normal operations
- Administrative requirements and conditions of the facility license
- Technical specifications

This training is designed to provide the requisite task training (as defined by the SAT process) to support the qualification requirements for CROs. These qualification requirements are outside the scope of this document.

Additionally, CROs are trained to safely and competently:

- Perform administrative tasks, including compliance with technical specifications, and perform operability determinations
- Implement maintenance and configuration controls
- Comply with radioactive release limitations
- Understand plant operating data, including reactor parameters, and evaluate emergency conditions
- Initiate a reactor shutdown from necessary locations
- Dispatch and direct operations and maintenance personnel
- Implement any applicable responsibilities under the facility emergency plan
- Make required notifications to local, State, and participating Tribal and Federal authorities

## 4.2 Requalification Training

The SAT methodology used in the CRO requalification program provides for the continuing training and examination to ensure that CROs maintain the knowledge and abilities needed to support the safe and reliable performance of job duties following the completion of an initial training and examination program The requalification program specifies an appropriate periodicity for administering a complete requalification examination.

## 4.3 Examination and Remediation

Examinations provide a means of assessing that individuals have achieved a degree of knowledge and ability that will be sufficient to enable them to carry out assigned duties as CRO in a manner that is both safe and reliable.

Examinations can be cognitive exams or performance evaluations, based on the associated learning objective. The examination program tests a representative sample (determined by the SAT process) of the knowledge, skills, and abilities needed to safely perform CRO duties, and includes the examination methods and criteria to be used to assess passing performance. Successful execution of training examinations includes exam security standards, examination administration and grading, and remediation.

Examination administration includes establishing and implementing a standard that ensures test integrity. The examination standard includes sufficient provisions to ensure that exams are not inadvertently compromised during exam development, exam administration, or post exam activities. Each examination will provide the opportunity for a representative of the Commission to be present during examination administration.

Remediation includes, at a minimum, reviewing the missed content of the exam for knowledge gaps, studying, and reattempting a new examination. At a minimum, the remediation exam must retest on the concepts missed by the trainee on the original exam through new exam items covering those learning objectives. For the requalification training program, a CRO will be removed from the performance of watchstanding duties during the remediation process until such time that any necessary remedial training has been completed and a reexamination has been passed.

CROs, the facility licensee, and X-energy will not engage in any activity that compromises the integrity of any examination conducted under the CRO Training Program. The integrity of an examination is considered compromised if any activity, regardless of intent, affected, or, but for detection, could have affected the equitable and consistent administration of the examination. This includes all activities related to the preparation, administration, and grading of examinations.

## 4.4 Records

The following is required regarding the CRO Training Program records:

1. Sufficient records are maintained providing documentation of the integrity of the program and are available for NRC inspection to verify the adequacy of the program.

2. Records are maintained documenting the participation of each CRO in the training program. The records contain copies of examinations administered, the answers given by the CRO, documentation of the grading of examinations, and documentation of any additional training administered in areas in which a CRO exhibited deficiencies.

3. Each of these records will be legible throughout the retention period. The record may be the original, a reproduced copy, or an electronic copy provided that the copy is authenticated by authorized personnel.

# 5. Conclusions

X-energy has reviewed, identified, and analyzed relevant NRC regulations and guidance applicable to the Xe-100 Training Programs for X-energy and prospective applicants and licensees. This Xe-100 Training Programs Methodology LTR provides the approaches and methodologies applicable for developing the Xe-100 Training Programs for plant staff. The Xe-100 Training Programs methodologies are derived from SAT as required by 10 CFR 120 and defined in 10 CFR 55.4. The SAT methodologies follow industry best practices and long-standing precedence in the nuclear training community and will result in the establishment, implementation, and maintenance of the necessary training programs.

X-energy is requesting NRC review and approval of the methodologies to develop the Xe-100 training programs described in Sections 3 and 4 of this LTR to demonstrate compliance with developing facility training programs derived from a systems approach to training as required by 10 CFR 120 and defined in 10 CFR 55.4.

Future applicants for an Xe-100 construction permit, operating license, or combined license application will be able to seek NRC approval of the completed Xe-100 training programs using the approaches and methodologies discussed in this LTR. NRC Approval of the completed Xe-100 training programs developed with these methodologies is outside the scope of this report. X-energy does not intend to seek accreditation of the Xe-100 training programs by the National Nuclear Accrediting Board (NNAB). Rather, X-energy is seeking a “Commission-approved Facility-developed Training Program Methodology” by the Commission.

## 6. Cross References and References

| Document Title<br>Cross References: X-energy documents that may impact the content of this document.<br>References: X-energy or other documents that will not impact the content of this document | | Document No. | Rev./ Date of Issuance | Cross Reference/ Reference |
|---|---|---|---|---|
| [1] | Xe-100 Licensing Topical Report: Control Room Staffing Analysis Methodology and Associated HFE Implementation Plans (ML22004A333) | 000714 | Jan 2022 | Reference |
| [2] | Human Factors Engineering Program Review Model | NUREG-0711 | Revision 3 | Reference |
| [3] | Selection, Qualification, and Training of Personnel for Nuclear Power Plants | ANSI/ANS-3.1 | 2014 | Reference |
| [4] | Qualification and Training of Personnel for Nuclear Power Plants | RG 1.8 | Revision 4 | Reference |
| [5] | Advanced Reactor Content of Application "Facility Training Programs" Draft Interim Staff Guidance | DRO-ISG-2023-04 | Apr 2023 | Reference |
| [6] | Department of Energy (DOE) Handbook, Training Program Handbook: A Systematic Approach to Training | DOE-HDBK-1078-94 | Jun 2014 | Reference |
| [7] | Systematic Approach to Training for Nuclear Facility Personnel: Processes, Methodology and Practices | NG-T-2.8 | Apr 2021 | Reference |
| [8] | Human-System Interface Design Review Guidelines | NUREG-0700 | Revision 3 | Reference |
| [9] | Template for an Industry Training Program Description | NEI 06-13A | Revision 2 | Reference |
| [10] | Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition | NUREG-0800 | | Reference |
| • | Chapter 13.2.1, "Reactor Operating Requalification Program; Reactor Operator Training | NUREG-0800 | Revision 4 | Reference |
| • | Chapter 13.2.2, "Non-licensed Plant Staff Training" | NUREG-0800 | Revision 4 | Reference |
| • | Chapter 18, "Human Factors Engineering, Attachment B, "Methodology to Assess the Workload of Challenging Operational Conditions in Support of Minimum Staffing Level Reviews" | NUREG-0800 | Revision 3 | Reference |
| [11] | Operator Licensing Examination Standards for Power Reactors | NUREG-1021 | Revision 12 | Reference |
| [12] | Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors | NUREG-1122 | Revision 3 | Reference |
| [13] | Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactors | NUREG-1123 | Revision 3 | Reference |
| [14] | Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized-Water Reactors | NUREG-2103 | Jan 2021 | Reference |

| | Document Title<br>Cross References: X-energy documents that may impact the content of this document.<br>References: X-energy or other documents that will not impact the content of this document | Document No. | Rev./ Date of Issuance | Cross Reference/ Reference |
|---|---|---|---|---|
| **[15]** | Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Advanced Boiling-Water Reactors | NUREG-2104 | Dec 2011 | Reference |
| **[16]** | Xe-100 Maintenance Strategy Analysis | 002123 | Revision 2 | Reference |
| **[17]** | Monitoring the Effectiveness of Maintenance at Nuclear Power Plants | RG 1.160 | Revision 3 | Reference |
| **[18]** | Nuclear Power Plant Simulators for Use in Operator Training and Examination | ANSI/ANS-3.5 | 2009 | Reference |
| **[19]** | Nuclear Power Plant Simulation Facilities for Use in Operator Training, License Examinations, and Applicant Experience Requirements | RG 1.149 | Revision 4 | Reference |
| **[20]** | Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors | SECY-23-0021 | Mar 2023 | Reference |
| **[21]** | Risk Informed and Performance based Human System considerations for Advanced Reactors (ML21069A003) | ML21069A003 | Mar 2021 | Reference |
| **[22]** | Xe-100 Licensing Maintenance Staff Optimization White Paper (ML21362A751) | ML21362A751 | Dec 2021 | Reference |
| **[23]** | Xe-100 SAT Methodology: Analysis Procedure | TMX-1.1 | Revision 2 | Reference |
| **[24]** | Xe-100 SAT Methodology: Design Procedure | TMX-1.2 | Revision 2 | Reference |
| **[25]** | Xe-100 SAT Methodology: Development Procedure | TMX-1.3 | Revision 2 | Reference |
| **[26]** | Xe-100 SAT Methodology: Implementation Procedure | TMX-1.4 | Revision 2 | Reference |
| **[27]** | Xe-100 SAT Methodology: Evaluation Procedure | TMX-1.5 | Revision 2 | Reference |
| **[28]** | Xe-100 Exam Standard | TMX-1.6 | | Reference |
| **[29]** | Xe-100 OJT, TPE, and Lab Standard | TMX-1.9 | | Reference |
| **[30]** | Xe-100 Training Department Training Program Manual | TMX-6.0 | | Reference |