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Submittal of X Energy, LLC (X-energy), Xe-100 Licensing White Paper: Training Programs, Control Room Operator Qualification, and Control Room Operator Eligibility

The purpose of this letter is to submit the subject white paper to the U.S. Nuclear Regulatory Commission (NRC) on behalf of X Energy, LLC ("X-energy"). This submission describes the approach X-energy has taken in developing the training programs for Xe-100 plant staff, the approach to qualifying Control Room Operators, and the approach to establishing eligibility requirements for Control Room Operators. It is provided for NRC review and comments as indicated in the report and is expected to be referenced in future Xe-100 licensing applications. X-energy has determined this report is available for unrestricted release. The specific review schedule will be developed with X-energy's NRC project manager.

This letter contains no commitments. If you have any questions or require additional information, please contact Ingrid Nordby at inordby@x-energy.com.

Sincerely,

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Xe-100 Licensing White Paper

Training Programs, Control Room Operator Qualification, and Control Room Operator Eligibility

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EXECUTIVE SUMMARY

The Xe-100 pebble-bed high-temperature gas-cooled reactor is a Generation IV advanced reactor. The Xe-100 is a small modular reactor designed for simplicity of operations and relies primarily on inherent safety characteristics as part of its safety design approach, leading to a design that requires fewer human tasks and no credited human actions to perform required safety functions.

This white paper discusses the approach that X-energy is taking to develop, implement, and maintain initial and continuing/requalification training programs for Xe-100 plant staff. This paper also discusses the methodologies used by X-energy to conduct a Systems Approach to Training to produce the suite of training programs necessary for safe plant operation and maintenance. Additionally, this paper discusses the approach that X-energy is taking to establish the requirements for the position of Qualified Control Room Operators (QCROs) that will provide safe and reliable plant operation, in lieu of the positions of licensed Senior Reactor Operator (SRO) and licensed Reactor Operator (RO). This paper also discusses the approach that X-energy is taking to establish plant personnel eligibility requirements (i.e., education, experience, and training minimum requirements), with a focus on the required eligibility for QCROs. Furthermore, X-energy will be proposing that the need for engineering expertise on-shift (i.e., as addressed in the typical STA role) is not required for this assurance of public health and safety.

The approach and methodologies described in this white paper are intended to initiate pre-application engagement with the NRC to foster a transparent, inclusive, and open relationship. Our goal is to establish the process and identify the information the NRC requires from X-energy for the purpose of reviewing and accepting these proposals. X-energy will be submitting topical reports in the future to seek formal NRC approval for the Xe-100 Training Programs, approach for utilizing QCROs, and the approach for eligibility criteria for plant personnel (including QCRO).

X-energy will be staggering submittal of these three topical reports to achieve the following benefits:

1) A more manageable workload for reviewers that is spread out over a longer review period;
2) Opportunities for earlier feedback allowing revisions and improvements to be made in a timely fashion;
3) Improved review efficiency since each submittal will benefit from review of prior submittals; and
4) Reduced risk of the ongoing training development and implementation requiring significant revision, which would negatively affect achieving the planned milestones for Xe-100 construction, commissioning, and operation.

CONTENTS

FIGURES

TABLES

ABBREVIATIONS

This list contains the abbreviations or acronyms used in this document.

Abbreviation or Acronym	Definition
AR	Advanced Reactor
AR/VR	Augmented Reality / Virtual Reality
ASME	American Society of Mechanical Engineers
BWR	Boiling Water Reactor
CB	Core Barrel
CFR	Code of Federal Regulations
DBA	Design Basis Accident
DCS	Distributed Control System
DID	Defense-In-Depth
DIF	Difficulty, Importance, Frequency
EOP	Emergency Operating Procedure
F-C	Frequency-Consequence
FOAK	First-of-a-kind
GL	Generic Letter
HFE	Human Factors Engineering
HSI	Human-System-Interfaces
HTGR	High-Temperature Gas-Cooled Reactor
IMAC	Intelligent Modular Autonomous Control
IPS	Investment Protection System
JPM	Job Performance Measure
K&A	Knowledge and Abilities
KSA	Knowledge, Skills and Abilities
LOFC	Loss of Forced Cooling
LBE	Licensing Basis Event
LWR	Light-Water Reactor
MWe	Megawatt electric (net)
MWt	Megawatt thermal
NEI	Nuclear Energy Institute

Abbreviation or Acronym	Definition
NPP	Nuclear Power Plant
NRC	(U.S.) Nuclear Regulatory Commission
OE	Operating Experience
OJT	On the Job Training
P&ID	Piping and Instrumentation Diagram
PEMS	Post Event Monitoring System
PWR	Pressurized Water Reactor
QCRO	Qualified Control Room Operator
RB	Reactor Building
RO	Reactor Operator
RPS	Reactor Protection System
S&Q	Staffing and Qualifications
SAT	Systems Approach to Training / Systematic Approach to Training
SDD	System Design Description
SME	Subject Matter Expert
SMR	Small Modular Reactor
SRO	Senior Reactor Operator
SSCs	Structures, Systems, and Components
STA	Shift Technical Advisor
TMI	Three Mile Island
TPE	Task Performance Evaluation
TRISO	Tri-structural isotropic particle
UCO	Uranium Oxy-Carbide
VR	Virtual Reality
X-energy	X Energy, LLC

DEFINITIONS

This list contains a glossary of terms used in this document.

Term	Definition
Job Analysis	A systematic process used to identify the tasks associated with a specific job and identify those tasks that require training.
Difficulty, Importance, and Frequency (DIF)	Process used during a Job Analysis to determine which tasks are selected for initial and continuing/requalification training.
E-Learning	Learning conducted via electronic media.
Knowledge	Understanding of facts, principles, or concepts. Knowledge includes cognitive (mental) processes necessary for applying information.
Learning Objective	A statement that specifies measurable behavior that a trainee should exhibit after instruction.
Lesson Plan	Materials used to deliver training content to trainees, which includes instructor guidance and trainee information.
Skill	The use of one's knowledge and/or physical attributes in executing an action.
Systems (Systematic) Approach to Training (SAT)	A five-step process of analysis, design, development, implementation, and evaluation used to ensure that training is an appropriate and efficient solution to performance improvement.
Subject Matter Expert (SME)	Person with attained level of expertise by virtue of education, experience, and/or plant/vendor task qualification.
Task	A well-defined unit of work having an identifiable beginning and end with two or more elements. It results in an observable and measurable output or accomplishment.
Task Analysis	A systematic process used to define elements and their associated skills and knowledge needed for task performance.
Training Methods	Techniques, methods, and/or strategies used to provide the most efficient and effective learning process possible (e.g., lectures, demonstration, discussion, seminar, verbal questions, role playing, case study, walk throughs, etc.).
Training Program	Training programs incorporate instructional requirements to qualify personnel to operate and maintain the facility in a safe manner in all modes of operation. The programs are developed and maintained in compliance with the facility license and applicable regulations.

1. INTRODUCTION

1.1. PURPOSE

The purpose of this white paper is to provide the NRC staff with an overview of the X-energy approach for Training Programs, Control Room Operator Qualification, and Control Room Operator Eligibility. The report documents X-energy's systematic and comprehensive approach to identifying and evaluating the regulatory requirements delineated in Title 10 of the U.S. Code of Federal Regulations (10 CFR) across multiple Parts with an emphasis on Part 50 as the likely principal and initial regulation for licensing the Xe-100. It also captures X-energy's effort to assess the applicability of regulatory requirements in line with the NRC staff's efforts to prepare for advanced reactor license applicants and to align with draft review guidance and application development guidance where available.

As a white paper, X-energy requests informal feedback from the NRC staff on the acceptability of the overall proposed approach, feedback on assessment of regulation applicability, and continued dialogue on the Safety Analysis Report content format and structure.

The white paper specifically provides the following:

- Describes the X-energy Systems Approach to Training (SAT) for the development of initial and continuing/requalification training programs for Xe-100 plant personnel. These training programs will form the bases for establishing the qualifications of personnel required for safe plant operations.
- Describes the X-energy approach for developing the technical basis for the Xe-100 Qualified Control Room Operator (QCRO), and the basis for requesting exemptions from 10 CFR Part 55 for licensed Senior Reactor Operators (SROs) and licensed Reactor Operators (ROs).
- Describes the approach to establish the eligibility criteria (i.e., education, experience, and training minimum requirements) for staffing plant personnel.
- Requests informal NRC feedback of the aforementioned approaches.

1.2. SCOPE

As discussed in Section 4, this white paper describes the approach and methods X-energy is using to develop the Xe-100 training programs (initial and continuing training programs). This includes application of the SAT methodology and an overview of training programs being developed. The approach follows the guidance included in Nuclear Energy Institute (NEI) 06-13A, "Template for an Industry Training Program Description" [1].

As discussed in Section 5, this white paper also describes the approach for developing the technical basis for the Xe-100 QCRO, and the basis for X-energy requesting exemptions from 10 CFR Part 55 for licensed SROs and licensed ROs.

As discussed in Section 6, this white paper also describes the approach X-energy is using to establish the eligibility criteria for the selection, qualifications, and training for Xe-100 nuclear power plant personnel, with a focus on QCROs. X-energy generally intends to follow the guidance of Regulatory Guide 1.8

(Revision 4), “Qualification and Training of Personnel for Nuclear Power Plants,” [2] which endorses ANSI/ANS 3.1-2014, “Selection, Qualification, and Training of Personnel for Nuclear Power Plants,” [3].

1.3. RELATIONSHIP TO OTHER DOCUMENTS

This white paper is the first step towards X-energy’s development of three future topical reports for NRC review and approval of the following topics:

- Xe-100 Training Programs Using Systems Approach to Training (SAT) Methodology
- Xe-100 Qualified Control Room Operator (QCRO) Approach
- Xe-100 Eligibility Requirements for Qualified Control Room Operators (QCROs)

Xe-100 Licensing Topical Report Control Room Staffing Analysis Methodology, as well as the associated X-energy Human Factors Engineering (HFE) Program Management and Implementation Plans, [4] provides additional details of interrelated SAT elements, which are consistent with the guidance of NUREG-0711, “Human Factors Engineering Program Review Model” [5].

1.4. DOCUMENT LAYOUT

Section 2 provides an overview of the Xe-100 design. Section 3 discusses relevant regulatory requirements and guidance applicable to the development of the Xe-100 Training Programs, the QCRO position, and the approach used to establish eligibility criteria for plant personnel. Section 4 presents an overview of the X-energy approach and methodology for Xe-100 SAT training elements. Section 5 presents an overview of the X-energy approach for appropriate “qualification” (in lieu of “licensing”) of Xe-100 QCROs. Section 6 presents the approach used for establishing the eligibility requirements for the QCRO position. Section 7 presents conclusions and recommendations. Section 8 lists references used. Appendix A presents an outline of planned exemptions to 10 CFR Part 55.

2. OVERVIEW OF THE XE-100 PLANT DESIGN (SAFETY DESIGN APPROACH)

The standard Xe-100 plant consists of four 200 MWt (80 MWe) units (total plant output of 320 MWe) with shared infrastructure and integrated plant systems. The Xe-100 safety design approach supports the objectives of designing, constructing, operating, and maintaining the plant while providing for reasonable assurance of the protection of the health and safety of the public and workers and the protection of the environment throughout the spectrum of Licensing Basis Events (LBEs).

2.1. PASSIVE SAFETY FEATURES AND INHERENT SAFETY CHARACTERISTICS

The Xe-100 reactor design includes passive safety features and inherent safety characteristics.

The first passive safety feature is the inherent radionuclide retention capabilities of the pebble-bed configuration (spherical fuel elements or pebbles) made of Uranium Oxy-Carbide (UCO) tri-structural isotropic particle (TRISO) fuel. This configuration confines the radionuclides within the fuel under operating and accident conditions in such a way that there is no significant radioactive release from the fuel. The excellent fission product retention capability of UCO TRISO-coated particle fuel has been demonstrated for temperatures up to 1800°C.

The second passive safety feature is that the Xe-100 is designed to be intrinsically safe, which means that in the event of any DBA no human action or actively powered system is required to stabilize the maximum fuel temperature at levels significantly lower than the maximum fuel temperature limit or to maintain off-site dose below the regulatory limits of 10 CFR 50.34. Human actions are not relied upon for public health and safety.

Passive safety features are design features engineered to meet their required functional design criteria without (a) needing successful operation of active systems with mechanical components; (b) depending on alternating current electric power source; or (c) relying on human operator actions.

Inherent safety characteristics are those characteristics associated with the reactor concept and the properties of the materials selected for the basic reactor components. In addition to the inherent safety characteristics of the fuel mentioned above and detailed further in Section 2.3, other specific inherent characteristics of the Xe-100 design that contribute to safety include:

- A large solid graphite moderator structure with very high temperature capability. The graphite provides large heat capacity that increases the transient's time constants and reduces the magnitude of core thermal transients. Limiting transients occur over hours and days, instead of seconds as is typical for an LWR. No fast-acting active safety systems are required to maintain the fuel within specified acceptable fuel design limits.
- A passive heat transfer path from the fuel to the ultimate heat sink. This heat transfer path through the reactor vessel, graphite moderator/reflector, to the reactor cavity cooling system and to the external atmosphere and/or ground has the capacity, without requiring any active systems, to limit fuel, reactor pressure vessel, and reactor cavity structural concrete temperatures. This prevents degradation of the core geometry and limits degradation of the fuel pebble barriers to acceptable levels.
- A low core power density and high core surface-to-volume ratio. This limits the fuel temperature rise during the most limiting conditions of loss-of-forced cooling and depressurization of the primary circuit.

- Low excess reactivity. Online refueling allows for reduced excess reactivity in the reactor at any given time, limiting the magnitude of and contributing to the slow response of reactivity transients.
- A single-phase, chemically inert, neutronically transparent, and high thermal conductivity helium heat transport fluid with low stored energy. This minimizes the functional requirement for containment of energy in a postulated breach of the reactor helium pressure boundary.
- A large negative fuel temperature coefficient. This inherently limits reactor power excursions under accident conditions without the need for reactivity control system or reactivity shutdown system rod insertion of negative reactivity.

The above safety features in the Xe-100 design maintain the off-site dose in the event of any Licensing Basis Event (LBE) (Anticipated Operational Occurrences [AOO], Design Basis Events [DBE], Beyond Design Basis Events [BDBE], and Design Basis Accidents [DBAs]) below regulatory limits. These features also prevent severe accident escalation for events that are beyond the design basis.

2.2. DEFENSE-IN-DEPTH APPROACH

The principles of Defense-in-Depth (DID) are applied in the design, licensing, construction, and operation of the Xe-100. In the design and analysis process, a traditional deterministic approach is integrated with a risk-informed evaluation methodology. The result is a set of conservative design features combined with inherent reactor characteristics, passive design features, and active systems to:

- Prevent transients and accidents;
- Provide the necessary safety functions;
- Prevent the release of radioactive material; and
- Mitigate the consequences of accidents.

The principles of multiple, independent, and concentric barriers to radionuclide transport are assessed for each significant source of radioactive material to maintain the DID. In addition, the principles of design margin, redundancy, and diversity are applied in the design of the structures, systems, and components (SSCs) that support the required safety functions and serve to support and maintain the integrity and effectiveness of these barriers. The DID strategies meet the top-level regulatory criteria, achieve adequate safety margins, and apply deterministic principles of DID. In addition, DID adequately addresses uncertainties in the reliabilities and capabilities of the SSCs providing the required safety functions over the life of the plant.

DID is also demonstrated using conservative assumptions and methods in a risk-informed safety evaluation process. This is achieved using conservative assumptions and treatment of uncertainties in the evaluation of event frequency and dose consequences used in defining and selecting LBEs, performing deterministic analyses of DBAs, performing safety classifications of SSCs, and developing reliability and capability targets and associated special treatment requirements for those SSCs. The Xe-100 approach to DID is structured to permit an objective, quantitative evaluation of the roles that specific SSCs and design features play in the prevention and mitigation of accidents. This approach uses information developed in the plant probabilistic risk assessment (PRA) and includes an evaluation of uncertainties to identify the need for deterministic requirements and compensatory measures to achieve the appropriate level of reliability and safety over the life of the plant. This risk-informed evaluation of the adequacy of DID is discussed in further detail in NEI 18-04, “Risk-Informed, Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor

Licensing Basis Development" [6], which forms the basis for X-energy's process for conducting DID adequacy evaluations.

The Xe-100 implementation of this DID framework recognizes the following three major elements, also illustrated in Figure 1 below.

1) Plant Capability Defense-In-Depth

   The decisions made by the designer in the selection of functions, structures, systems, and components for the design that provide DID in the physical plant.

2) Programmatic Defense-In-Depth

   The decisions made regarding the processes of manufacturing, constructing, operating, maintaining, testing, and inspecting the plant and the processes undertaken that provide plant safety throughout the lifetime of the plant.

3) Risk-Informed Evaluation of Defense-In-Depth

   The development and evaluation of strategies that manage the risks of accidents, including the strategies of accident prevention and mitigation. This aspect of DID also provides the framework for performing deterministic and probabilistic safety evaluations that help determine how well various plant capability and programmatic DID strategies have been implemented. The goal of this evaluation is to demonstrate the adequacy and sufficiency of plant capability (i.e., physical) and programmatic measures to maintain the DID in the design.

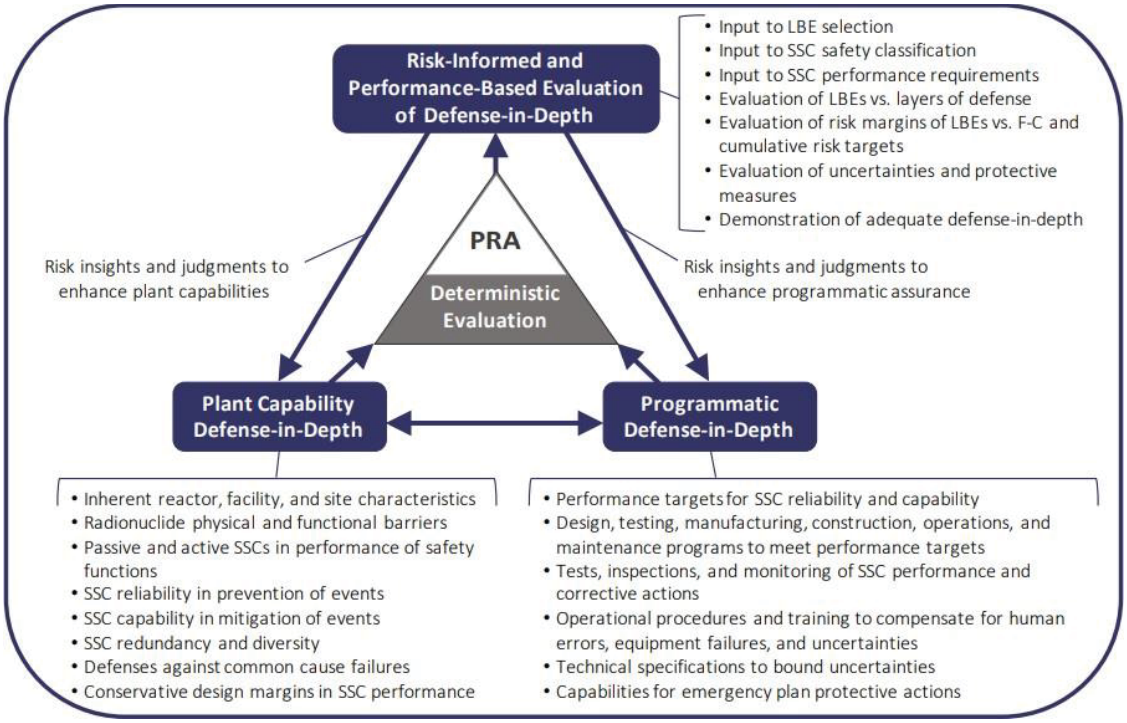

Figure 1: Elements of the Xe-100 Plant Defense-in-Depth Framework from NEI 18-04

Additional details related to the physical barriers considered in DID are explained in Section 2.3.2 (Barriers to Radionuclide Release).

2.3. TECHNICAL DESIGN FEATURES

For the XE-100 design helium is used as an inert fluid for transporting thermal energy produced in the reactor to the steam generator where heat is transferred to the secondary loop via helical cooling coils. The helium is circulated through the pebble-bed, reactor internals, cross vessel, and steam generator utilizing a pair of helium circulators to maintain helium flow. The reactor inlet (260°C) and outlet (750°C) temperatures were selected to provide significant design margins for the fuel, core metallic structures, and the RPV. The maximum fuel temperatures during normal operation are below 1000°C.

The Xe-100 control philosophy utilizes automation to control plant operation, thereby minimizing required operator actions to transition between operating modes and respond to abnormal events. This design enhances the safety of the Xe-100 plant, while also reducing the operator load. The Xe-100 is ideally suited for automated control given its intrinsic safety and other features that result in stable and predictable operation. Of primary importance is a strong negative temperature coefficient over the entire operating range, resulting in the Xe-100 reactor self-moderating its power level whenever there is an imbalance such that less heat is removed from the core than is produced. This characteristic combined with its low power density and large thermal inertia, ensures that the Xe-100 reactor can never become unstable irrespective of what the I&C systems do.

The Xe-100 is capable of load following in base load mode (reactor master and turbine slave) or load following mode (turbine master and reactor slave) automatically at a rate up to 5% per minute in the operational range of 40% - 100% power. The Xe-100 has a Distributed Control System (DCS) that is capable of load following automatically during normal operation and mitigates AOOs within its capability. The DCS will automatically adjust parameters during load following (e.g., helium mass flow rate, control rod positioning) resulting in low temperature variations (i.e., minimizing thermal transients) in core inlet and outlet temperatures.

2.3.1. Reactivity control

Reactivity control is established through three independent mechanisms which include a strong negative temperature coefficient of the fuel, controls rods, and shutdown rods.

The first and most important of these is the negative temperature coefficient of reactivity. This plays a significant role during both normal operation and off-normal events. For this intrinsic mechanism, which is based exclusively on the laws of physics, as system temperatures increase it causes reactor power to be reduced due to doppler broadening of U-238 that causes more neutrons to be absorbed in resonance peaks and it causes reduced moderation by the graphite (carbon) due to expansion. During normal operation, this means that, to a large extent, reactor thermal power can be controlled simply by changing the flow rate of helium circulating through the reactor. If the ability to transport heat is lost, the reactor inherently reduces the rate of fission to a point that results in the reactor shutting down to a hot standby condition.

In addition, two diversely actuated means of reactivity control and shutdown are provided. These are the Reactivity Control System (RCS) and Reserve Shutdown System (RSS), each of these systems consists of a bank of nine control rods, one bank used during normal power operation to control the steam generator inlet temperature and to bring the reactor to a subcritical condition, and the other bank being the Reserve Shutdown Rods provided for diversely actuated negative reactivity insertion and to bring the reactor to a safe shutdown condition and to maintain it in that safe shutdown condition indefinitely. Both banks of control rods are used for reactor trip when actuated by the Reactor Protection System (RPS). Each of the two independent control rod systems can shut the reactor down to hot conditions, but both are needed to bring the reactor to a cold shutdown condition.

2.3.2. Barriers to radionuclide release

The Xe-100 design has five main barriers to prevent and mitigate radionuclide release. The first barrier is the UCO fuel kernel itself.

The second barrier is the system of TRISO coatings, comprised of tiny individual multi-layer containment structures that are capable of withstanding very high temperatures and pressures.

The third barrier is the matrix graphite. For the Xe-100 design, the TRISO coated fuel particles are embedded within fuel pebbles designed with high strength and toughness. These fuel pebbles include a 5 mm graphite fuel-free zone at its circumference.

The fourth radionuclide barrier is the ASME-code designed, nuclear-grade steel pressure vessel that forms the helium pressure boundary.

The fifth and final radionuclide barrier is the reactor building (RB) structure which provides a pressure-controlled volume that directs any released radioactivity through a filtered vent path.

The notable attribute of the Xe-100 radionuclide barriers is that they are completely independent of one another and sequential, meaning that there is no single event that would simultaneously breach multiple barriers and that all barriers must be compromised before large radionuclide release is possible. These characteristics provide for adequate DID.

2.4. INTEGRATED PLANT SYSTEMS

The Plant Control and Protection System architecture for the Xe-100 reactor consists of three layered systems:

1. The Distributed Control System (DCS)
2. The Investment Protection System (IPS)
3. The Reactor Protection System (RPS)

The DCS is responsible for the operational control of the plant; the IPS limits risks to the plant equipment and systems; and the RPS provides a means to perform certain safety functions that prevent or mitigate the release of radionuclides from licensing basis events (Figure 2).

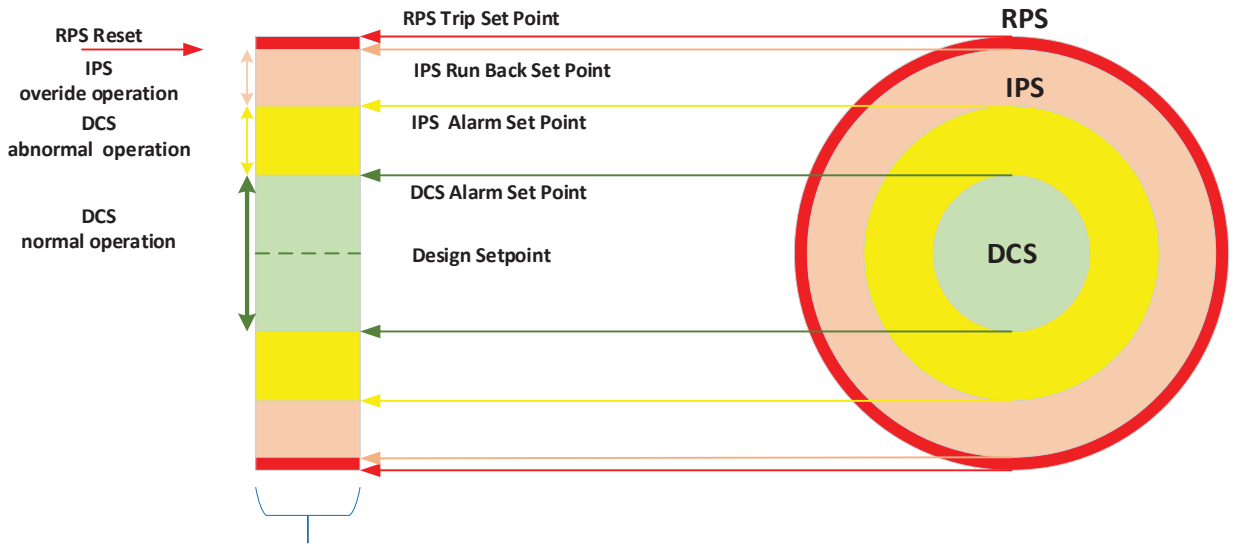

Figure 2: High Level Control Design Approach for the Instrumentation and Controls (I&C) System Interactions

The Xe-100 uses an Intelligent Modular Autonomous Control (IMAC) approach with a pre-programmed operational envelope that executes autonomously. The control system allows the operator to observe plant status, control actions, and to trip any actuators manually if desired (manual tripping of the plant is permitted although is not required as part of the safety design approach). It does not require the operator to directly control any of the actuators, thus certain typical, frequent maneuvers are accomplished automatically using integrated control loops and control logics. This control design approach provides the framework to significantly reduce operator cognitive and task load and, as a result, requires fewer operators to control the plant.

From Figure 2, the colored bandwidths are the area where each system has primary control. Setpoints, runbacks, and other limits are set so that the controls will respond to maintain control within the bandwidth while considering the instrument accuracy and the response time of the measurements and actuation devices.

As part of the design phase, transients where no protection systems actuate are analyzed to determine bandwidths and limits in which the DCS, IPS, and RPS operate and respond.

1. Distributed Control System (DCS)

   DCS bandwidth, demarcated with the green band in Figure 2, describes the allowable bandwidth in which the DCS will control the plant during operation. When plant parameters move into the yellow area within the DCS control range, annunciators are activated to alert the operators of the specific plant parameter which has deviated from the normal operating range.

   The yellow area of Figure 2 is defined as an extended normal operation envelope. Parameters in this range will not immediately result in damage to the plant but may have time limits associated

with operation in this range. When the plant is operating in this range the DCS will perform actions such as shimming target setpoints to attempt to bring the plant parameter back into the inner green band. Plant parameters that initiate this response are recorded and alarmed for further investigation. Procedures provide operator instruction for controlling and correcting an upset parameter that remains in the yellow band (i.e., DCS is unable to automatically return the parameter to the green band). The purpose of the extended normal operation band is to limit the number of plant trips while highlighting to the operator that a parameter is not within the optimal operating range.

2. Investment Protection System (IPS)

   IPS bandwidth, demarcated with the orange band in Figure 2**,** describes the limits for the plant parameters which pose a risk to the plant investment. If a plant parameter exceeds the yellow limits and moves into the orange band, the IPS will override DCS control and force a transition to a lower operating mode to allow the plant operators to find and respond to the root cause of the abnormal plant parameter.

3. Reactor Protection System (RPS)

   RPS bandwidth, demarcated with the red band in Figure 2, limits the plant parameters when they deviate to the point that they pose a potential risk to public health and safety. When a plant parameter reaches the red bandwidth, the RPS sends trip signals to dedicated and isolated actuators per a hard-wired trip matrix to ensure the plant maintains safe operation.

The Xe-100 has a Post Event Monitoring System (PEMS) that continuously collects and stores predefined plant parameters during and after an event, so that an analysis of the plant behavior pre- and post-event can be performed. The non-safety related PEMS display will be in the Control Room and Remote Shutdown Room where it is available for operators to use to diagnose events.

3. OVERVIEW OF REGULATORY REQUIREMENTS

3.1. BACKGROUND

Relevant regulatory requirements and guidance applicable to the development of the Xe-100 Training Programs, the QCRO position, and the approach used for developing plant personnel eligibility criteria are outlined below. In some cases, compliance with the intent of certain regulations will involve granting of specific exemptions, which will be submitted for approval in a future action. The potential exemptions outlined below are not intended to be a complete exhaustive list of these planned exemptions.

It is noted that X-energy is not currently a “licensee” and certain regulations being addressed in this white paper and the forthcoming topical reports will apply to prospective “licensees” of Xe-100 plants that could include a traditional owner/operator or separate owner and operator organizations. Such arrangements are currently under investigation by X-energy and interested customers.

The exemptions outlined below will be presented in future submittal(s) with the final scope to be determined. The three topical reports associated with the topics of this paper share some exemptions in common (e.g., utilizing QCRO in lieu of “licensed” operators). As such, requesting such exemptions may be better accommodated in a single separate submittal. Further interaction with the NRC is anticipated to finalize the most appropriate and efficient approach to achieve regulatory approval for X-energy, prospective Xe-100 operating organizations, and facility licensees.

3.2. CODE OF FEDERAL REGULATIONS REQUIREMENTS

3.2.1. Draft 10 CFR Part 53

While X-energy does not anticipate applying for an operating license under 10 CFR Part 53 (once approved), X-energy is following the development and consensus of new approaches embodied in this effort. X-energy intends to maintain alignment with these developments (as applicable to Xe-100 design), which will facilitate development of the future requested exemptions. In this regard, a few notable Draft Part 53 developments are highlighted as potentially useful examples:

- The option for using certified (non-licensed) operators in place of traditional licensed operators. X-energy will be aligned with this option; however, X-energy is utilizing the title “Qualified” (in lieu of “certified”) Control Room Operator.
- Operator certifications are not issued by the Commission. X-energy will be seeking exemption to similarly issue certifications (qualifications) for the QCRO.

3.2.2. 10 CFR 50.34(b)(8)

This requirement in part addresses that the operator requalification program meet the requirements of 10 CFR 55.59. The X-energy approach (as detailed in Section 5) will be requesting an exemption from 10 CFR Part 55 as discussed below.

3.2.3. 10 CFR 50.54(i), (j), (k), (l), and (m), Conditions of Licenses

The requirements in 10 CFR 50.54(i) and (j) address manipulation of controls and manipulation of mechanisms that affect reactor core reactivity or power by a "licensed operator" or "senior operator." 10 CFR 50.54(k), (l), and (m) identify the minimum number of "licensed operators" or "senior operators" that must be on site, in the Control Room, and at the reactor controls. X-energy intends to comply with each provision, with the following exemptions to be requested:

- "Licensed operator" or "senior operator" is deemed to be QCRO (i.e., an exemption to "operator" being defined as "licensed").
- The Xe-100 anticipated crew of three QCROs will oversee the operation of four operating reactors from a single Control Room. Final evaluations to determine staffing size are ongoing. However, exemption to the shift manning Table in 10 CFR 50.55(m)(2)(i) will be necessary.

3.2.4. 10 CFR 50.54(y), Conditions of Licenses

The requirement of 10 CFR 50.54(y) requires that a "licensed senior operator" pre-approve the allowance of 10 CFR 50.54(x) to take action that departs from a license condition or a technical specification. X-energy intends to comply, with the exception that "licensed senior operator" is deemed to be QCRO (i.e., an exemption to "licensed operator").

3.2.5. 10 CFR 50.74 Notification of change in operator or senior operator status

This requirement addresses certain reporting requirements in regard to a licensed operator or senior operator in accordance with the requirements of various 10 CFR Part 55. Since X-energy will be requesting exemptions from Part 55 that will make this reporting moot, X-energy will be seeking exemption from 10 CFR 50.74.

3.2.6. 10 CFR 50.120, Training and Qualification of Nuclear Power Plant Personnel

10 CFR 50.120 requires that the training program must be derived from a systems approach to training (SAT) as defined in 10 CFR 55.4. The X-energy approach (as outlined in Section 4) includes applying the SAT training and qualification methodology as required by 10 CFR 50.120 and defined in 10 CFR 55.4 for the categories of individuals listed in 10 CFR 50.120(b)(2).

3.2.7. 10 CFR Part 55

The X-energy approach for QCRO (in lieu of "licensed operator" as detailed in Section 5) will involve requesting exemptions from 10 CFR Part 55. The following are two specific examples of expected exemption topics. The more detailed outline of the full scope of expected exemptions is included in Appendix A. The complete exemption request with basis supporting that the exemptions will not endanger life or property, and are otherwise in the public interest, will be provided in a future submittal.

- 10 CFR 55.40 Implementation.
  10 CFR 55.41 Written examination: Operators.
  10 CFR 55.43 Written examination: Senior operators.
  10 CFR 55.45 Operating Test.
  10 CFR 55.59, Requalification.

  X-energy intends to prepare, proctor, and grade the written QCRO examinations, including requalification exams. However, the X-energy approach is that the QCRO is a single position with a single exam (content and length to be determined based on SAT methodology and the HFE Program using the HFE Task Analysis as input for the knowledge, skills, abilities, and job definition). There are not separate RO and SRO or "licensed" operators for Xe-100.

- 10 CFR 55.46 Simulation facilities

  X-energy intends to design and qualify a simulation facility (i.e., simulator) for use in the administration of training, QCRO testing, and required QCRO experience requirements. The Xe-100 simulator will be designed using Xe-100 applicable guidance of ANSI/ANS-3.5-2009, "Nuclear Power Plant Simulators for Use in Operator Training and Examination," [7], 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" [8]. X-energy intends to request exemption from 10 CFR 55.46 requirements for Commission-approval of the simulation facility. This is consistent with the X-energy approach to conduct the training and qualification programs for QCROs.

3.3. 10 CFR 50.120 IMPLEMENTATION GUIDELINES

While regulations clearly define the responsibilities of the NRC and the licensee to confirm training programs are in place and meet requirements, it does not specifically address methods for developing and reviewing training programs for the purpose of program approval. The Xe-100 Training Program will be developed using the following as applicable to X-energy-specific plant personnel and the QCROs to demonstrate compliance with 10 CFR 50.120:

- NUREG-0700, "Human-System Interface Design Review Guidelines" [9]
- NUREG-0711, "Human Factors Engineering Program Review Model"[5]
- NUREG-0800, "Standard Review Plan" [10]
  - 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]
- NUREG-1220, "Training Review Criteria and Procedures" [12]
- NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements" [13]
- NRC Inspection Manual, Inspection Procedure 41501, "Review of Training and Qualification Programs" [14]
- NRC Inspection Manual, Inspection Procedure 41502, "Nuclear Power Plant Simulation Facilities" [15]

The currently available knowledge and abilities (K&A) catalogs are based on LWR designs. However, since the Xe-100 is not a LWR design, there is not currently a K&A catalog defined for the Xe-100. Therefore, a K&A catalog will be developed to address the Xe-100 that supports its training programs. For this effort, existing K&A catalogs, such as those listed below, will be considered.

- NUREG-1122, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactor (PWR)” [16]
- NUREG-1123, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactor (BWR)” [17]
- NUREG-2103, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized Water Reactor” [18]
- NUREG-2104, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Advanced Boiling Water Reactor (ABWR)” [19]

Various guidance documents outline training program development and content. To the extent that these documents align with the specific Xe-100 design and the X-energy staffing approaches (e.g., QCRO versus SRO or RO) the Xe-100 Training Program compliance with 10 CFR 50.120 will also be developed using the following as applicable:

- Regulatory Guide 1.8, Qualification and Training of Personnel for Nuclear Power Plants, Rev. 4
- ANSI/ANS-3.1-2014, Selection, Qualification, and Training of Personnel for Nuclear Power Plants
- NEI 06-13A, Template for an Industry Training Program Description, Rev. 2
- NISP-TR-01, Systematic Approach to Training Process
- NISP-TR-02, On-The-Job Training and Task Performance Evaluation Process
- NISP-TR-03, Engineering Training Program Description

3.4. QUALIFIED CONTROL ROOM OPERATOR (QCRO) AS SHIFT TECHNICAL ADVISOR (STA)

Generic Letter (GL) 86-04, “Policy Statement on Engineering Expertise on Shift,” [20] provided the NRC Staff position on the STA role. The staff offered two options for meeting these requirements: 1) eliminate the separate STA position by combining one of the required SRO positions with the STA position into a dual-role SRO/STA position; or 2) continue the NRC-approved STA program. GL 86-04 also noted that the Commission encouraged licensees to move to the dual-role SRO/STA position. X-energy intends to combine the QCRO position with the STA role. As such, the requirements of the STA function are adequately fulfilled by the QCRO since every member of the Control Room crew will have completed a training program that includes curriculum normally found in a traditional STA training program. This means the Xe-100 Training Program will not have a stand-alone STA training program or qualification, because the training and qualification are inherently part of the QCRO training and qualification.

4. XE-100 TRAINING PROGRAMS APPROACH

4.1. SYSTEMS APPROACH TO TRAINING (SAT) METHODOLOGY

The X-energy approach to training development includes applying the SAT methodology as required by 10 CFR 50.120 and defined in 10 CFR 55.4. The main activities to be carried out in each of the element phases are detailed in the subsections to follow, as well as the key factors considered in each of them in accordance with Regulatory Guide 1.8, (which endorses ANSI/ANS-3.1-2014) using five interrelated elements: analysis, design, development, implementation, and evaluation. This methodology provides the workers with the knowledge and skills necessary to correctly and safely perform the tasks associated with their job position.

By applying the following SAT methodology, Xe-100 Training Programs meet the applicable requirements and guidance for all Xe-100 staff positions required by 10 CFR 50.120. These SAT elements are interrelated with elements of the HFE Program Management Plan (and referenced HFE Implementation Plans), which is consistent with the guidance of NUREG-0711. The HFE Program's support to the Control Room staffing approach provides proper correspondence between the Training Program development and the HFE Program by following the SAT process and using the HFE Task Analysis as input for the knowledge, skills, and abilities (KSA) list and job definition. Additionally, X-energy will follow the guidance of NUREG-0700 to apply the Human-System Interface (HSI) design to the Control Room design (and extended to other facilities that are provided out in the plant) and NUREG-0700 Appendix B.1.4, Training Program Development, elements will be addressed in the training program.

The QCRO training program includes training on the Xe-100 simulator. The simulator training will also provide operations personnel with sufficient knowledge and experience required for QCRO eligibility to perform their required duties during the unique conditions of new plant construction and initial operation. Xe-100 QCRO candidates will also be trained to the curriculum normally found in a traditional STA training program, as applicable to the Xe-100. Shift Supervisors are also trained as QCROs and receive additional training that addresses higher-level management skills and behaviors and provides a broader perspective of plant operations.

In addition to the technical training that is required for each plant staff position, training also addresses the following areas: physical security, emergency protection, radiological emergency, administrative procedures, radiation protection, fire protection, quality assurance, and fitness for duty. The training program will also address initial training as well as continuing training for these areas.

The Xe-100 Training Programs are structured to provide reasonable assurance that personnel have the qualifications commensurate with the performance requirements of their jobs. Training will address:

- The full range of positions of plant personnel (including QCRO) listed in 10 CFR 50.120, as shown in Table 1, Xe-100 Equivalent Positions;
- The full spectrum of plant functions and systems;
- The full range of relevant HSI (e.g., main Control Room, remote shutdown panel, and local control stations); and
- The full extent of plant conditions.

Table 1 lists the various categories of personnel that are typical for a traditional commercial light-water reactor (LWR) and a cross reference to the equivalent position for the Xe-100 plant. The Xe-100 plant uses cross-trained, multi-skilled personnel to safely operate and maintain the plant.

Table 1: Xe-100 Equivalent Positions to 10 CFR 50.120

10 CFR 50.120 Personnel Categories	Xe-100 Equivalent Position
Shift Supervisor/Shift Manager	Shift Supervisor (*)
Senior Reactor Operator	Qualified Control Room Operator (*)
Reactor Operator	
Shift Technical Advisor	
Non-licensed Operator	Production Field Technician (**)
Instrumentation and Control Technician	
Electrical Maintenance Personnel	
Mechanical Maintenance Personnel	
Chemistry Technician	Chemistry/Radiation Protection Technician
Radiological Protection Technician	
Engineering Support Personnel	Engineering Support Personnel

- *(*) Tentative Xe-100 Control Room Complement: 1 Shift Supervisor and 2 Qualified Control Room Operators for the multi-unit site. Shift Supervisor is also a QCRO.*
- *(**) Tentative Xe-100 Complement: 3 Production Field Technicians for the multi-unit site.*

4.1.1. Analysis

Main activities:

- Perform a job analysis by reviewing existing station or industry job data and procedures, tabletop analyses, interviews, and job survey questionnaires to select job tasks for which training is required.
- Conduct task analyses to determine methods of task performance and associated knowledge and skills, using a tabletop approach, questionnaires, or interviews.
- Use technical documentation, SMEs, and management to define proper task performance and the underlying knowledge and skills required for new tasks.
- Use SMEs and existing station or industry training program products to identify which portions of the tasks have changed for modified tasks.
- When training is used to improve plant or personnel performance, traditional training performance measures, such as examination pass rates, may be insufficient to provide a complete assessment of training effectiveness.

A job is a group of tasks and functions that are assigned to a specific operational position. It is necessary to precisely define the qualifications KSAs with the tasks that an individual must perform. The job definition will be addressed within the SAT process after the HFE Task Analysis as the activities are connected and take the

same task analysis as input. The HFE Staffing & Qualifications (S&Q) element activities describe and define the scope and impacts on the roles, responsibilities, and qualifications of Control Room personnel. By following the SAT process for the training material development, alignment between the KSAs list, job definition, and staffing & qualifications is provided.

To perform the job analysis, X-energy is following these steps:

- Assemble a generic task list for Xe-100 QCROs by referencing the existing generic task lists for PWR, BWR, ABWR, and AP1000 nuclear power plants (NPPs), and reviewing the industry data available.
- Assemble a specific task list for Xe-100 QCROs by reviewing plant information including Xe-100 system design descriptions (SDDs), procedures, and other design and technical documentation.
- Compile both task lists to obtain a unique specific matrix.
- Hold table-top meetings and workshops with X-energy engineers to review all plant systems.
- Apply DIF (difficulty, importance, and frequency) Analysis to determine which tasks require training. The DIF process includes participation from SMEs, design engineers, and personnel with prior nuclear operator or instructor experience. Participants' knowledge, competencies, and experiences influence their role in the DIF process, and results are reviewed and approved by the Xe-100 Training Manager.

To perform the task analysis, X-energy will use the aforementioned task list and DIF results to identify task conditions and standards for each task that requires training.

The needs and performance analyses are the process of identifying causes and solutions for a new Task, modified Task, or performance issues, identifying training and non-training solutions, and selecting a solution that best fits the needs of the organization. Due to Xe-100 being a new NPP, X-energy is working on defining the process to be accomplished, which will include the use of a training committee, training requests, and corrective action program.

This analysis element and its various activities are subject to an iterative revision process to update the training program as the Xe-100 design matures and new needs are identified. The documentation obtained here serves as the basis for the next element of the SAT methodology, the design element.

4.1.2. Design

Main activities:

- Develop learning objectives. These written objectives define exactly what, when, and how the trainee must perform during and after training. They address the desired knowledge, skills, and attributes of the relevant dimensions of the trainee's job, such as interactions with the plant, the human-system-interfaces (HSI), and other personnel, as identified during the analysis element to determine what is to be learned in terms of measurable trainee performance.
- Prepare performance tests. These are prepared at the task level to measure the adequacy of the trainee's task performance. They define the cue that will initiate task performance, identify the task performance conditions, and establish standards of successful task performance.
- Determine methods to observe and measure trainee performance for evaluating the overall effectiveness of the training programs and trainee mastery of training objectives. Examples of methods considered include written and oral tests, laboratory evaluations, job performance measures (JPMs),

task performance evaluations (TPEs), on-the-job evaluations, simulator evaluations, and simulated environment evaluations using mock-ups or AR/VR technology. Test items and examination banks are developed to objectively measure how well trainees achieve the learning objectives.

- Determine the setting in which training is conducted. The training environment is determined based on the knowledge and skill requirements identified during the analysis element.

The design element defines how to select training settings, which evaluation methods are most appropriate, and the success (passing) criteria. Additionally, question banks are developed for each initial training objective.

X-energy is in the process of developing the learning objectives based on the data identified during the in-progress analysis element.

The design element is in lockstep with the analysis element allowing further learning objectives to be developed as soon as their supporting data from the analysis element is available. To this extent, as the analysis element progresses so does the design element.

Like the analysis element, the design element and its relation to the HFE Program Management Plan are subject to an iterative revision process to update the training program as the Xe-100 design matures and the analysis element produces further results and data.

4.1.3. Development

Main activities:

- Identify learning activities for each learning objective. This is accomplished by classifying learning objectives as either knowledge or skill-related and then developing or adapting existing learning activities to support the objective.
- Select training methods. These are techniques that are employed to enhance the learning process, such as: lecture, walk-through, demonstration or practice, discussion, role-playing, case study, and other similar techniques.
- Develop, modify, or obtain training materials such as written texts, computer software, equipment, audiovisual materials, models, simulation devices, examinations, and performance tests, based on the method of instruction. Then, the means of using these materials are specified.

The development element will be undertaken progressively as the steps of the previous elements are completed.

In this element, X-energy will develop the training materials necessary for training implementation. The selected training methods will be based on the training setting decided in the design element, with consideration given to optimizing the training process wherever possible. This approach sets the following priorities: face-to-face training for defined high cognitive level learning objectives, blended learning for intermediate cognitive level learning objectives, and self-study for low cognitive level learning objectives. Training material development will include things like lesson plans, e-learning material, simulator scenarios, recordings, etc. Training material development activities will give priority to include those persons involved in the previous processes such as SMEs, design engineers, etc.

For the main activities of the development element, X-energy will generate standard training materials for the generic fundamentals, including components, reactor theory, and thermodynamics. These materials will be reviewed to ensure the specific scope for an Xe-100 is fully covered. Additionally, these fundamentals topics will be integrated into the training program such that they are taught and examined routinely throughout the training program. This approach reinforces fundamentals with plant-specific and design-specific topics over the entirety of the training program.

Like the previous elements, the development element and its various activities will be subject to an iterative revision process to update the training program as the Xe-100 design matures and the previous elements produce further outputs.

4.1.4. Implementation

Main activities:

- Select and train instructors and subject matter experts and confirm the availability of trainees and facilities.
- Collect feedback on training content and delivery. This will include information from the following sources: the effects of training on personnel and plant performance, reinforcement of management expectations, trainee test and evaluation performance, and instructor, trainee, and management critiques of training.
- Maintain records of training attendance, content, results, and feedback to support management information needs and to document trainee and instructor performance.
- An observation program will be defined and implemented during this element.
- Training will be documented including preparing, distributing, storing, controlling, and recording information that addresses the training program and trainee participation.

The inaugural class for the QCRO Training Program will be taught by personnel directly involved in developing the training program who have prior instructor/operator experience and are knowledgeable of the Xe-100. The trainees in this inaugural class will be QCRO candidates and future instructor candidates. Since this inaugural class serves the first-of-a-kind (FOAK) Xe-100 plant, training will be tailored to meet experience eligibility specific to the unique design of the Xe-100.

The implementation element will address the inaugural iteration for a FOAK plant, including FOAK experience requirements where there is no prior experience to reference, as well as n^{th} iterations where existing experience on operating Xe-100 unit(s) may exist. Candidate eligibility requirements will be defined for the inaugural class and subsequent classes with consideration given to the unique circumstances of a FOAK Xe-100 plant.

X-energy will develop a specific training program for instructor candidates (train-the-trainer/instructor certification guide), which includes pedagogical and methodological skills. Completion of the instructor certification guide is in-addition to the initial training program completion discussed above for instructor candidates. Instructor candidate eligibility requirements will be defined, and candidate selection will prioritize personnel involved in SAT activities for the related training program, instructor experience, operator experience, and knowledge of Xe-100 design, operation, maintenance, and procedures.

Student evaluation examinations will be carried out, and training feedback will be collected from students and instructors for subsequent analysis to improve the training process.

The Xe-100 Training Program will also address the periodic continuing training and requalification of plant personnel, including the QCRO requalification requirements as detailed in the final approved Xe-100 Training Program. Subsequent NRC independent oversight of the Training Program implementation provides assurance of personnel qualifications and program compliance.

4.1.5. Evaluation

Main activities:

- Analyze and trend feedback collected during training (implementation element), such as trainee evaluation results, instructor observations, management observations, and student feedback.
- Analyze job performance feedback and other information collected to determine training effectiveness to identify training program improvement opportunities.
- Perform periodic training self-assessments.
- When evaluating results, determine if a desired performance improvement was achieved.
- When evaluation results confirm training program gaps, processes will initiate corrective actions, and will track them to completion using a corrective action program.
- Periodically review corrective actions for effectiveness.

The evaluation element will include a process that determines training effectiveness using job performance, self-assessments, observations, and feedback to determine systematic improvements to the programs as well as the implementation of these improvements.

4.2. TRAINING PROGRAM APPROVAL

The Xe-100 Training Program topical report will address the details outlined above as applicable to the standard Xe-100 “four-pack” electrical generation design and be submitted for NRC approval. The Training Program implementation at each Xe-100 site will address any site-specific and application-specific training needs following the Training Program SAT methodology and HFE interface detailed in the topical report. Review of the Training Program implementation at one of these site-specific applications (e.g., single unit process steam station) would occur with the NRC review of the construction permit and operating license applications, but would retain the approved Xe-100 Training Program as the foundation, which will avoid re-development and re-review of the generic Xe-100 Training Programs.

5. QUALIFIED CONTROL ROOM OPERATORS (QCRO) IN LIEU OF LICENSED OPERATORS AND ENGINEERING EXPERTISE ON-SHIFT

The future X-energy topical report will be proposing that the requirements for the position of QCROs, would not require an NRC issued license. The facility licensee (or applicant) will be responsible to prepare, proctor, and grade the written QCRO examinations, as well as any simulator and oral exams. The X-energy approach will provide reasonable assurance of the protection of the health and safety of the public and workers, and the protection of the environment throughout the spectrum of LBEs. Furthermore, X-energy will be proposing that the need for engineering expertise on-shift (i.e., as addressed in the typical STA role) is also not required for this assurance of public health and safety. The X-energy approach comports with the NRC Draft White Paper, "Risk Informed and Performance based Human System considerations for Advanced Reactors" [21], that the proposals to be evaluated for staffing facilities that do not require licensed operators should be based on demonstration that reasonable assurance of the adequate protection of the public health and safety will exist in the absence of any operator action for preventing or mitigating accidents.

It is also noted that X-energy is proposing "qualified" as similar in concept to the "certified" operator from Draft Part 53. Prospective international X-energy clients use "certified" to mean the US equivalent of licensed. Since we are pursuing application of the Xe-100 internationally, X-energy desires to avoid the confusion that international clients could have by using "certified."

NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," recognizes that "Current regulations regarding control room staffing, which are based on the concept of operation for existing light-water reactors, may no longer apply." Advanced reactor designs (e.g., Xe-100), with the increased use of advanced automation, allows changes in the roles, responsibilities, composition, and size of the crews required to control plant operations.

The following are criteria used in the case of the Xe-100 reactor for assessing the acceptability of an advanced reactor design operating without using any licensed operators or requiring any explicit engineering expertise on shift. These criteria are also referenced in the NRC Draft White Paper, as examples applicable to advanced reactors.

Criterion 1: The accident analysis for the design should demonstrate that radiological consequence criteria will be met without reliance on human actions for event mitigation, defense in depth, or safe shutdown.

Criterion 2: The safety of the design should be reliant upon inherent safety characteristics.

Criterion 3: The design may be either fully autonomous or have a sufficient degree of autonomy to support safety without human action.

Criterion 4: If load-following will be incorporated into the design, then the autonomous control system should be capable of refusing demands from the grid operator when they could challenge the safe and reliable operation of the plant, or when precluded by the plant equipment conditions.

Criterion 5: License conditions should be established for the facility by which those administrative responsibilities with safety implications that would otherwise have been allocated to licensed operators are reassigned appropriately (such as to a designated licensee manager).

Criterion 6: For the STA position, the staff would need to engage with the Commission on a proposed departure from Commission policy should an advanced reactor applicant propose a staffing plan that does not include on-shift engineering expertise (either by a dedicated STA or a dual-role qualified operator).

5.1. ANALYSIS OF CRITERION 1: RADIOLOGICAL CONSEQUENCE CRITERIA MET WITHOUT RELIANCE ON HUMAN ACTIONS

The accident analysis for the design should demonstrate that radiological consequence criteria will be met without reliance on human actions for event mitigation, defense in depth, or safe shutdown.

X-energy is currently developing the PRA for the Xe-100 plant, which will provide the sequence of events analysis and reflect the current state of knowledge regarding the plant response to events. The PRA development includes a set of LBEs using the approach defined in NEI 18-04. The treatment of operator actions in the modelling and quantification of event sequences uses the same process as for LWR PRAs.

In addition, a human reliability analysis is also being developed, which includes an assessment of the impact of human errors of omission and commission. X-energy anticipates, based on preliminary analyses, the PRA and human reliability analysis results will conclude no LBE exceeds the NEI 18-04 F-C target curve (refer to Figure 3) using the following conditions:

- No reliance on human action, which includes no operator action (omission) and operator error (commission)
- Selection of conservative assumptions

A future PRA topical report will incorporate the up-to-date design details of the Xe-100 and PRA model.

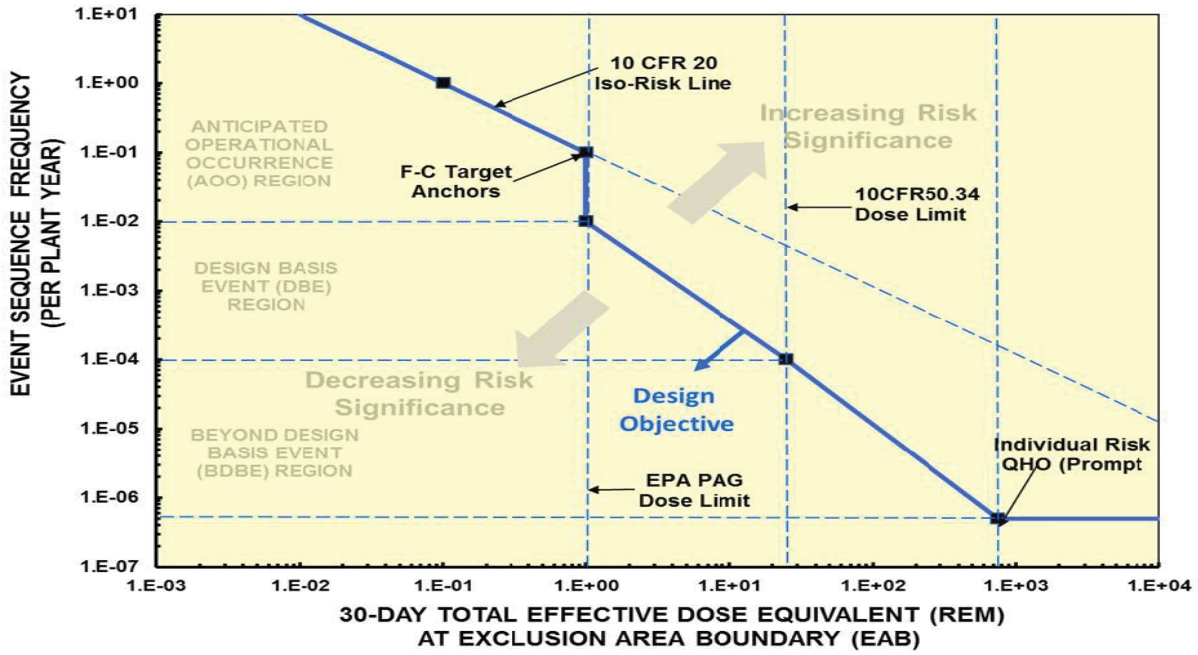

Figure 3: Frequency-Consequence Target

As previously discussed in Section 2, the Xe-100 safety design approach is built upon two characteristic safety features: (1) the inherent radionuclide retention capabilities of TRISO fuel, and (2) the design being intrinsically safe. Implementing the safety features in the Xe-100 design maintains the off-site dose in the event of the DBAs below regulatory limits without reliance on any human action. These features also preclude severe accident escalation for events that are beyond the design basis events.

As explained in Section 2.3.2 (Barriers to Radionuclide Release), the Xe-100 design has five main barriers to prevent and mitigate radionuclide release which are completely independent of one another (i.e., no single event that would simultaneously breach multiple barriers) and that all barriers must be compromised before major radionuclide release is possible, which does not rely on human action.

In summary, X-energy anticipates the PRA insights will demonstrate than even with the conservative assumptions, including human errors of omission and commission, that no LBE exceeds the F-C target curve. Furthermore, the Xe-100 design maintains off-site dose in the event of any DBA below the regulatory limits of 10 CFR 50.34, meaning human actions are not relied upon for public health and safety.

5.2. ANALYSIS OF CRITERION 2: SAFETY DESIGN BASED ON INHERENT CHARACTERISTICS

The safety of the design should be reliant upon inherent safety characteristics.

Detailed information that supports this section is included in Section 2 (Characteristic Safety Features and Technical Design Features).

5.3. ANALYSIS OF CRITERION 3: AUTOMATION

The design may be either fully autonomous or have a sufficient degree of autonomy to support safety without human action.

The Xe-100 uses an IMAC approach, previously explained in Section 2, that has a pre-programmed operational envelope that executes autonomously. The control system allows the operator to observe plant status, control actions, and to trip any actuators manually if desired. It does not however require the operator to directly control any of the actuators during normal operation, abnormal events, or accident conditions. As described in Section 2, the Plant Control and Protection System architecture in the Xe-100 consists of three systems: the DCS, responsible for the operational control of the plant; the IPS that limits risks to the plant equipment and systems; and the RPS that prevents or mitigates the release of radionuclides during licensing basis events.

In a layered defense, the plant control systems are designed to detect and trip the plant automatically should any parameter exceed its allowable limits.

The Xe-100 pebble-bed reactor is ideally suited for this type of control because of its inherent feedback characteristics, such as its strong overall negative temperature coefficient and large thermal mass. This passive means of control results in reactor safety being maintained without reliance on human action.

5.4. ANALYSIS OF CRITERION 4: LOAD FOLLOWING

If load-following will be incorporated into the design, then the autonomous control system should be capable of refusing demands from the grid operator when they could challenge the safe and reliable operation of the plant, or when precluded by the plant equipment conditions.

The Xe-100 design includes load-following capability from 100% to 40% of rated reactor power and from 40% to 100% or rated reactor power. For Xe-100, load-following can only be authorized by QCROs in the Control Room. No one outside the Control Room (e.g., the grid operator) can approve or initiate a load change.

5.5. ANALYSIS OF CRITERION 5: ADMINISTRATIVE RESPONSIBILITIES

License conditions should be established for the facility by which those administrative responsibilities with safety implications that would otherwise have been allocated to licensed operators are reassigned appropriately (such as to a designated licensee manager).

This criterion suggests reassigning responsibilities such as:

- Responsibilities established in 10 CFR 50.54(x) and (y)
- Oversight of maintenance
- Compliance with technical specifications
- Operability determinations
- NRC notifications
- Emergency declarations

However, X-energy does not anticipate reassigning typical administrative responsibilities. In particular, the responsibilities listed above are deemed integral to the appropriate plant safety oversight role expected of the QCRO.

As indicated in NRC Draft White Paper, the existing regulatory framework assigns certain responsibilities of licensee organizations to their licensed operators that are beyond those covered in the positions as required in 10 CFR 50.54 and 10 CFR Part 55. As an example, the current regulations 10 CFR 50.54(x) and (y) establish the conditions to be fulfilled by the licensee for reasonable actions that depart from a license condition or a technical specification in an emergency. This example makes it clear that the hypothetical absence of licensed operators at an advanced reactor facility would require resolution of how, in part, the intent of this requirement (i.e., authorizing an emergency related departure from license conditions for the protection of the public) would still be accomplished such that a reasonable assurance of public health and safety could be demonstrated.

For the Xe-100 the Control Room crew includes QCROs and a Shift Supervisor (also a QCRO). The entire crew complement goes through the QCRO Training Program (initial and continuing/requalification) and every person is trained to the equivalent level of a traditional RO, SRO, and STA. As such, the Xe-100 QCRO and Shift Supervisor are equally competent to be authorized to depart from regulations during emergencies and take reasonable actions that depart from a license condition or a technical specification when this action is immediately needed to protect the public health and safety, and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.

Similarly, each QCRO with equivalent training to a traditional SRO and STA is capable of performing the range of administrative duties expected of traditional licensed operators. The planned submittal of the topical report requesting approval of the QCRO approach will address these duties in more detail.

Additionally, given the reduced reliance on human actions for normal control functions in the Xe-100 design, the expected daily burden will be significantly less at an Xe-100 than the current LWR. As such, the QCRO workload does not need relief from expected administrative duties.

Below is a summary outline of the discussion on Criterion 5:

- A QCRO with training equivalent to a traditional licensed operator is capable of performing similar administrative duties.
- QCROs are trained to perform administrative duties and their competency is tested during initial qualification training and continuing training.
- The XE-100 design increases the use of automation technologies, and innovative control station design that is being developed in accordance with guidance in NUREG-0700, results in fewer and simpler operator tasks and no human actions to fulfil required safety functions. This allows administrative responsibilities traditionally assigned to licensed operators to be more easily performed.

5.6. ANALYSIS OF CRITERION 6: ENGINEERING EXPERTISE ON SHIFT (STA)

For the STA position, the staff would need to engage with the Commission on a proposed departure from Commission policy should an advanced reactor applicant propose a staffing plan that does not include on-shift engineering expertise (either by a dedicated STA or a dual-role qualified operator).

A well-defined process does not currently exist for applicants to propose the elimination of the engineering expertise on shift that is typically required of the STA position. However, as outlined in the March 2021 NRC Draft White Paper, the below items c, d, e, and f are some factors that, when considered in aggregate, could potentially support such a proposal. The X-energy evaluation of this proposal also provides insights in items a and b below:

a) Analysis of the Shift Technical Advisor position
b) Industry upgrades to qualification on Shift Supervisors and senior operators
c) Licensed/Certified operator qualifications and training
d) Design features
e) Limited reliance on human actions for safety
f) Automated capabilities that supply additional DID and reduce crew workload

5.6.1. STA / Engineering On Shift - Background

Following the accident at Unit 2 of the Three Mile Island plant (TMI-2) on March 28, 1979, NRC staff and industry conducted several studies to determine why the accident occurred and what could be done to prevent the recurrence of the same or a similar accident. These studies concluded, among other things, that several actions should be taken to improve the ability of the shift operating personnel to recognize, diagnose, and effectively deal with plant transients or other abnormal conditions. To address the recommended improvements, the NRC initiated short and long-term efforts. One short-term effort required each nuclear power plant to have on duty by January 1, 1980, a Shift Technical Advisor (STA) whose function was to

provide engineering and accident assessment expertise and advice to the Shift Supervisor (i.e., Shift Manager) in the event of abnormal or accident conditions. The STA was required to have a bachelor's degree in engineering or the equivalent and specific training in plant response to transients and accidents.

The NRC published guidance on the STA requirement through NUREG-0737, “Clarification of TMI Action Plan” [22], Section I.A.1.l, “Shift Technical Advisor,” and later mandated it by plant-specific confirmatory orders.

On September 25, 1985, the Commission approved the final “Policy Statement on Engineering Expertise on Shift,” published in Volume 50 of the Federal Register, page 43621 (50 FR 43621: October 28, 1985). The policy provides facility licensees with two options for providing engineering expertise on shift: a dedicated STA or a combined Senior Reactor Operator (SRO)/STA, which the Commission stated as its preference. The background section of the FR notice promulgating the policy statement described the staff's long-term initiatives for improving the capabilities and qualifications of the members of shift crews and for enhancing their ability to diagnose and respond to accidents. It also states, “At the time the STA requirement was imposed, it was intended that the use of the dedicated STA would be an interim measure only until these longer-term goals were achieved.”

The Commission’s Policy Statement on “Education for Senior Reactor Operators and Shift Supervisors at Nuclear Power Plants,” dated August 15, 1989, presents the policy on education for senior operators and Shift Supervisors at nuclear power plants. It states, in part, the following:

> *The Commission believes that the safety of commercial power reactors is enhanced by having on each shift a team of NRC licensed professionals that combine technical and academic knowledge with plant- specific training and substantial hands-on operating experience. The Commission reaffirms its position, set forth in the Policy Statement on Engineering Expertise on Shift, that it is important to have engineering and accident assessment expertise available to the operating crew at all nuclear power plants. The STA has proven to be a worthwhile addition to the operating staff by providing an independent engineering and accident assessment capability, and we support continuation of this position.*

In SECY-93-193, “Policy on Shift Technical Advisor Position at Nuclear Power Plants,” [23], the staff discussed the achievement of the long-term efforts, such as the implementation of symptom-based emergency operating procedures (EOPs), the systems approach to training (SAT) process for operator and SRO training programs, and incorporation of much of the STA training program material into SRO training programs. SECY-93-193 also states the following:

- The staff believes that the need for an assigned STA at individual reactor sites remains and should be considered with respect to the primary goal of maintaining a Control Room staff organization that is effective in responding to plant events.
- The staff also believes that NRC and industry long-term initiatives have collectively led to significant improvements in on-shift engineering expertise, including the capabilities, training, and qualifications of the shift crews and their ability to diagnose and respond to events.

NUREG-1791 contains guidance the staff uses to determine whether an applicant’s staffing proposal provides adequate assurance that public health and safety will be maintained at a level comparable to that afforded by compliance with the current regulations. Specifically, it describes a process for systematically reviewing

and assessing alternative staffing plans. This process includes reviewing the results of validation tests specifically performed to demonstrate that the proposed staffing plan is acceptable.

NUREG-0800, Chapter 18, Attachment B, provides a methodology to identify high-workload operational conditions and analyze the associated workload.

NUREG-0711 contains guidance related to staffing and qualifications of nuclear power plant personnel and HFE validation testing.

5.6.2. Analysis

a) Analysis of the Shift Technical Advisor position.

The STA was created following the Three Mile Island accident to ensure a nuclear power plant Control Room included an individual knowledgeable in engineering principles. This recommendation was incorporated into NUREG-0737, which states that "the need for the STA position may be eliminated when the qualification on the Shift Supervisor/SRO have been upgraded and the man machine interface in the Control Room has been acceptably upgraded." No further guidance has been developed to establish the required level of upgrade to the man-machine interface or what upgrades to senior reactor qualifications are required.

The Xe-100 Human Factors Engineering (HFE) Program Management Plan (and referenced HFE Implementation Plans) is consistent with the guidance of NUREG-0711. The HFE Program's support to the Control Room staffing approach provides proper correspondence between the Training Program development and the HFE Program by following the SAT process and using the HFE Task Analysis as input for knowledge, skills, and abilities (KSA) list and job definition. These upgrades to the man-machine interface and upgrades to QCRO training provides the appropriate support for the elimination of the need for the additional requirement for engineering expertise on shift.

b) Industry upgrades to qualification of Shift Supervisors and senior operators and Licensed/Certified operator qualifications and training.

The Control Room crew includes QCROs and a Shift Supervisor (also a QCRO). The entire crew complement goes through the QCRO SAT-based Training and Qualification Program (initial and continuing/requalification) and every person is trained to the equivalent level of a traditional RO, SRO, and STA (Table 2).

Table 2: Xe-100 Control Room Crew Complement

Category from 10 CFR 50.120	Xe-100 Position	Xe-100 Training Program(s)
Shift Supervisor/Shift Manager	Shift Supervisor (*)	• QCRO Training Program • Shift Supervisor Training Program
Senior Reactor Operator	Control Room Operator (*)	• QCRO Training Program
Reactor Operator		
Shift Technical Advisor		

(*) Tentative Xe-100 Control Room Complement :1 Shift Supervisor and 2 Qualified Control Room Operators for the multi-unit site. Shift Supervisor is also a QCRO

The QCROs receive STA training as part of their initial training program. The integration of STA knowledge and abilities into the QCRO training program benefits the QCROs by providing more comprehensive training as compared to STA training being reserved solely for SROs or Shift Supervisors. This approach aligns with Commission policy and goes above current industry standards by increasing the training scope for the QCROs. Providing STA training to the QCROs gives flexibility to crew staffing, fosters an inclusive teamwork environment, and allows each operator to provide backup to their peers.

Since STA training is integrated into QCRO training, X-energy proposes that the traditional engineering degree eligibility requirements for STA qualification be waived to permit candidates eligible to be QCROs to also be STA qualified without the added degree (or equivalent) requirements. QCRO training includes fundamentals training, systems training, simulator training, procedures training, and STA training, among other topics, making this curriculum the most comprehensive program among all Xe-100 staff. It is more beneficial to waive engineering degree eligibility requirements and provide STA training to the QCROs than to limit the STA qualification to select individuals based on additional eligibility requirements. Additionally, the simplicity of the Xe-100 design, including its inherent safety features and automation, eliminate much of the potential complexity that drove the need for the Commission to require a traditional engineering degreed individual be on shift.

A candidate that satisfies QCRO training eligibility requirements, demonstrates satisfactory knowledge, skills, and abilities throughout the program, and successfully completes the comprehensive course is equally capable of performing STA duties as a traditional dual-role STA from the current LWR fleet, regardless of differences in past education and experience. Past education and experience are ways to evaluate candidates objectively during the hiring and selection process; however, categorical criterion can overlook relevancy. For example, someone with no practical work experience as an engineer and perhaps decades removed from attaining that degree, including individuals without extensive LWR experience that does not directly transfer to Xe-100 experience, does not provide relevant benefits above someone that may not have similar college education or LWR experience, but is highly trained and competent, as determined through objective evaluation methods, such as achieving qualifications of the Xe-100 QCRO SAT-based training program.

c) Design features and Automated capabilities that supply additional defense-in-depth and reduce crew workload.
The Xe-100 design features (low excess reactivity, low power density, optimal core geometry, optimized moderation ratio, strong negative temperature coefficient, passive decay heat removal capability, pebble-bed core design, core graphite structures design, complete independence of the radionuclides barriers design, etc.) and the autonomous design (IMAC) provides adequate defense in depth and reduces crew workload for the Xe-100.

d) Limited reliance on human actions for safety.

As has been discussed earlier, even with the conservative assumptions, and including human errors of commission and omission, the dose consequences of PRA postulated LBEs remain below the F-C target defined in NEI 18-04.

In summary:

- Xe-100 QCRO SAT-based training is equivalent to traditional licensed operator training and has corresponding training programs to provide for QCRO qualification.
- QCRO training includes fundamentals training, systems training, simulator training, procedures training, and STA training, among other topics, that provide the necessary engineering and plant knowledge expertise without the requirement of an engineering degree or equivalent.
- Since STA equivalent training is integrated into QCRO training, it is more beneficial to waive STA eligibility requirements and provide STA equivalent training to the QCROs than to limit the STA qualification to select individuals based on additional eligibility requirements.
- Xe-100 reactor design features and automated capabilities supplies robust defense-in-depth.
- Xe-100 Probabilistic Risk Assessment Human Reliability Analysis demonstrates meeting the F-C target with no reliance on human actions for safety.

This approach focuses on relevant XE-100 training and experience to provide reasonable assurance of adequate protection of the public health and safety; minimizing excessive regulatory burden with no public health and safety benefit.

6. ELIGIBILITY REQUIREMENTS FOR QUALIFIED CONTROL ROOM OPERATOR (QCRO)

Eligibility refers to the necessary qualifications and training for applicants seeking an operator license. Qualifications include minimum education, experience, and other special requirements to meet job performance criteria. Regulatory Guide 1.8 provides guidance for complying with the qualifications and training requirements of plant personnel except licensed operators (i.e., the QCRO for Xe-100) by endorsing ANSI/ANS-3.1-2014, with noted exceptions. For plant personnel other than QCRO, X-energy intends to follow the Regulatory Guide 1.8 guidance. Additional detail and any planned exceptions will be presented in the future Topical Report.

For the QCRO, the X-energy eligibility criteria are presented as an alternative to the Regulatory Guide 1.8 guidance, which states in the Background Section: "*the NRC removed the applicability of 10 CFR Part 55 from this revision of RG 1.8 so that NRC guidance for operator license qualifications will be located solely in NUREG-1021, which references the NANT qualification standards.*" The X-energy approach to establish QCRO eligibility qualification and training criteria is based on ANSI/ANS 3.1-2014, with exceptions as outlined below. The proposed criteria also address the unique conditions of new plant construction and initial operation. The complete proposal and basis will be presented in the future Topical Report.

These Xe-100 QCRO alternative eligibility qualification and training criteria are aligned with NRC requirements and expectations to provide reasonable assurance of adequate protection of the public health and safety.

Table 3 identifies the ANSI/ANS 3.1-2014 personnel categories and the corresponding Xe-100 equivalent. This white paper focuses on the eligibility qualification and training criteria for the QCRO and additional criteria applicable to the Shift Supervisor (i.e., ANSI/ANS 3.1 shift manager, senior operator, reactor operator, and shift technical advisor).

Table 3: Xe-100 Equivalent Positions to ANSI/ANS 3.1-2014

ANSI/ANS 3.1-2014 Personnel Categories (Section No.)	Xe-100 Equivalent Position
Shift Manager (4.3.7)	Shift Supervisor *
Senior Operator (4.4.1)	Qualified Control Room Operator *
Reactor Operator (4.5.1)	
Shift Technical Advisor (4.6.2)	
Operator *[Non-licensed]* (4.5.2)	Production Field Technician
Instrumentation and Control Technician (4.5.3.3)	
Electrical Maintenance Personnel (4.5.7.1)	
Mechanical Maintenance Personnel (4.5.7.2)	
Chemistry Technician (4.5.3.1)	Chemistry/Radiation Protection Technician
Radiological Protection Technician (4.5.3.2)	
Engineering Personnel (4.6.1)	Engineering Support Personnel

(*) Tentative Xe-100 Control Room Complement: 1 Shift Supervisor and 2 Qualified Control Room Operators for the multi-unit site. Shift Supervisor is also a QCRO.

(**) Tentative Xe-100 Complement: 3 Production Field Technicians for the multi-unit site.

6.1. ANSI/ANS 3.1, SECTION 4.3.7, CRITERIA FOR SHIFT MANAGER

ANSI/ANS 3.1-2014, Section 4.3.7, Shift Manager provides the following education, experience, and special requirements:

> ***Education**:* *High school diploma.*
> ***Minimum experience for the position**:*
> *Power plant experience which shall include:* *3 yr,*
> *Nuclear power plant experience* *3 yr.*
> ***Special requirements:***
> *(1) Hold a senior operator's license for the unit(s) assigned;*
> *(2) During the years of nuclear power plant experience, the individual shall have participated in licensed operator activities at a nuclear power plant during the following periods:*
> *(a) 6 months with at least 6 weeks of operation above 20% power,*
> *(b) Startup from subcritical to 20% power,*
> *(c) Shutdown from above 20% power to cold (less than 212°F) and subcritical,*
> *(d) Startup preparations following a fueling or refueling outage.*

X-energy analysis and evaluation as applicable to the Shift Supervisor (also a QCRO)

X-energy intends to apply the following eligibility criteria (which are not required to be completed prior to taking the qualification exam) in lieu of ANSI/ANS 3.1-2014, Section 4.3.7:

> **Education:** High school diploma.
> **STA Training in:**
> (1) Response to accidents and analysis of plant transients;
> (2) Application of engineering principles to protection of the core;
> (3) Mitigation of plant accidents; and
> (4) Basis of plant design and systems.
>
> **Minimum experience for the position:**
>
> (1) Responsible nuclear power plant experience for 3 yrs; and have participated in licensed operator activities at a nuclear power plant during the following periods:
> (a) 6 months with at least 6 weeks of operation above 20% power,
> (b) Startup from subcritical to 20% power,
> (c) Shutdown from above 20% power to cold (less than 212°F) and subcritical,
> (d) Startup preparations following a fueling or refueling outage.
>
> OR
>
> (2) Completing one of the following:
> (a) 18 months previous active RO or SRO license,
> (b) 24 months military RO or equivalent experience
> (c) 18 months instructing as SRO certified instructor
> (d) 12 months previous active QCRO qualification
>
> **Special requirements:**
>
> (1) Facility issuance of a qualification as QCRO.

6.2. ANSI/ANS 3.1, SECTION 4.4.1, CRITERIA FOR SENIOR OPERATOR

ANSI/ANS 3.1-2014, Section 4.4.1, senior operator provides the following education, experience, and special requirements:

Education: *High school diploma.*

Minimum experience for the position:

Responsible nuclear power plant experience	*1.5 yr;*
On-site experience	*0.50 yr.*

Special requirements:

(1) Hold a senior operator's license for the unit(s) assigned.

X-energy analysis and evaluation as applicable to the QCRO

X-energy intends to apply the following eligibility criteria (which are not required to be completed prior to taking the qualification exam) in lieu of ANSI/ANS 3.1-2014, Section 4.4.1:

Education: High school diploma.

STA Training in:

(1) Response to accidents and analysis of plant transients;
(2) Application of engineering principles to protection of the core;
(3) Mitigation of plant accidents; and
(4) Basis of plant design and systems.

Minimum experience for the position:

(1) Responsible nuclear power plant experience for 1.5 yr;

OR

(2) Completing all of the following:
   (a) Completing an Xe-100 site layout course;
   (b) Completing an Xe-100 Production Field Technician OJT course. The OJTs that are performed for this course are pre-selected based on their importance to plant operation with regard to nuclear safety, defense in depth, or risk significance; and
   (c) Completing six months meaningful work assignments, which may include one or more of, but is not limited to: testing assignment (e.g., preoperational testing, surveillance testing), procedure development, validation, or maintenance, HFE activities, task analysis verification, and participating in QCRO training activities.

Special requirements:

(1) Facility issuance of a qualification as QCRO.

6.3. ANSI/ANS 3.1, SECTION 4.5.1, CRITERIA FOR REACTOR OPERATOR

ANSI/ANS 3.1-2014, Section 4.5.1, reactor operator provides the following education, experience, and special requirements:

Education: *High school diploma.*

Minimum experience for the position:

Power plant experience which shall include:	*2 yr,*
Nuclear power plant experience	*1 yr;*
On-site experience	*0.50 yr.*

Special requirements:

(1) Hold a reactor operator's license for the unit(s) assigned

X-energy analysis and evaluation as applicable to the QCRO

X-energy intends to apply the QCRO eligibility criteria (which are not required to be completed prior to taking the qualification exam) specified in Section 6.2 above in lieu of ANSI/ANS 3.1-2014, Section 4.5.1..

6.4. ANSI/ANS 3.1, SECTION 4.6.2, CRITERIA FOR SHIFT TECHNICAL ADVISOR (STA)

ANSI/ANS 3.1-2014, Section 4.6.2, STA provides the following education, experience, and special requirements:

Education: *Baccalaureate in engineering or related science.*

Minimum experience for the position:

Nuclear power plant experience which shall include:	*1 yr;*
On-site experience	*0.50 yr.*

Special requirements:

Training in:

(1) Response to accidents and analysis of plant transients;
(2) Application of engineering principles to protection of the core;
(3) Mitigation of plant accidents;
(4) Basis of plant design and systems.

X-energy analysis and evaluation as applicable to the QCRO

X-energy intends to apply the QCRO eligibility criteria (which are not required to be completed prior to taking the qualification exam) specified in Section 6.2 above in lieu of ANSI/ANS 3.1-2014, Section 4.6.2.

6.5. INITIAL QUALIFIED CONTROL ROOM OPERATOR (QCRO) EXAMINATION SCHEDULE

10 CFR 50.120(b)(1)(i) requires:

"Each nuclear power plant operating license applicant, by 18 months prior to fuel load, ... shall establish, implement, and maintain a training program ... "

X-energy analysis and evaluation

The Xe-100 Training Programs for each license application will meet the 10 CFR 50.120(b)(1)(i) requirement by commencing the initial QCRO training class at least 18-months prior to fuel load. Subsequent required training for other plant staff positions will commence commensurate with requisite staffing needs to provide qualified personnel to operate and maintain the facility in a safe manner in all modes of operation.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. XE-100 TRAINING PROGRAMS

Section 4 details the planned topical report that will provide the X-energy approach and methodologies to develop Xe-100 Training Programs and seeks to initiate an NRC review of the X-energy proposal to ultimately seek formal NRC approval for the Xe-100 Training Programs. The relevant elements that X-energy is implementing to develop these training programs, as described in this white paper, are:

- Training programs will be developed according to the SAT methodology, in accordance with the highest standards.
- The initial and continuing training programs for the different positions provide the knowledge and skills to be acquired by the personnel necessary to support the safe operation of the plant.
- The continuing training programs of the different positions promote the retention and improvement of knowledge and skills for the safe operation of the plant.

Xe-100 Training Programs will be aligned with NRC endorsed guidance with the planned exceptions and exemptions as presented. An objective of this white paper is to initiate discussions, feedback, and comments between X-energy and the NRC that support training program development, implementation, and maintenance and ultimately support successful licensing of the Xe-100.

7.2. QUALIFIED CONTROL ROOM OPERATOR (QCRO) APPROACH

Section 5 details the planned topical report that will provide the X-energy approach for qualification of Xe-100 QCRO in support of safe and reliable plant operations. This will be in lieu of requiring licensed ROs and SROs and in lieu of requiring engineering expertise on shift. The approach will also provide for the integration of the STA function into the QCRO qualifications, instead of having an additional stand-alone STA qualification. This approach focuses on relevant XE-100 training and experience to provide reasonable assurance of adequate protection of the public health and safety; minimizing excessive regulatory burden with no public health and safety benefit.

The relevant elements as described in this white paper include:

- The accident analysis for the design will demonstrate that radiological consequence criteria (F-C Target) will be met without reliance on human actions for event mitigation, defense in depth, or safe shutdown.
- The safety of the design will be reliant upon inherent safety characteristics.
- The design will be either fully autonomous or have a sufficient degree of autonomy to support safety without human action.
- Load-following control will include the capability for the QCRO to refuse requests from the grid operator when they could challenge the safe and reliable operation of the plant or when precluded by the plant equipment conditions.

- QCRO administrative responsibilities will be consistent with training and competency testing and the appropriate plant safety oversight role.
- The STA function (assumed by the QCRO) will not include requirements for on-shift engineering expertise.

X-energy considers the planned Xe-100 QCRO position to be aligned with NRC requirements and expectations to provide reasonable assurance of adequate protection of the public health and safety. The objective of this white paper is to initiate discussions, feedback, and comments between X-energy and the NRC that support this qualification approval process and ultimately support successful licensing of the Xe-100.

7.3. ELIGIBILITY REQUIREMENTS FOR QUALIFIED CONTROL ROOM OPERATOR (QCRO)

The future topical report to propose the eligibility requirements for the QCRO position will describe the candidate education, experience, and training minimum requirements to acquire the knowledge and experience required for QCRO duties, including addressing the unique conditions of new plant construction and initial power operation.

The relevant elements to consider, as described in this white paper, are:

- The simplicity and automated operation processes of the Xe-100 reactor.
- The Xe-100 design features and automated capabilities, which provide safe and reliable plant operation. Xe-100 start-up, heat-up, shutdown, and cooldown are mostly automated and are not as complex as the same evolutions at an LWR.
- The Xe-100 reactor is a first of a kind design, therefore there is no current similar nuclear power plant from which experience can be drawn from. Focusing on relevant XE-100 training and experience provides reasonable assurance of adequate protection of the public health and safety; minimizing excessive regulatory burden with no public health and safety benefit.

X-energy considers the planned alternatives for XE-100 QCRO eligibility requirements to be aligned with NRC requirements and expectations to provide reasonable assurance of adequate protection of the public health and safety. The objective of this white paper is to initiate discussions, feedback, and comments between X-energy and the NRC that support the future topical report on plant personnel eligibility requirements submittal, and ultimately support successful licensing of the Xe-100.

7.4. SUMMARY

The future submittal of these three topical reports is intended to facilitate pre-application engagement with the NRC to foster a transparent, inclusive, and open relationship. X-energy will be staggering submittal of the three topical reports outlined above to achieve the following benefits:

1) A more manageable workload for reviewers that is spread out over a longer review period;
2) Opportunities for earlier feedback allowing revisions and improvements to be made in a timelier fashion;
3) Improved review efficiency since each submittal will benefit from review of prior submittals; and

4) Reduced risk of the ongoing training development and implementation requiring significant revision, which would negatively affect achieving the planned milestones for Xe-100 construction, commissioning, and operation.

8. REFERENCES

The following documents are referenced within this document.

	Document Title	Preparer/Author	Document Number	Revision or Date of Issue
[1]	NEI 06-13A, "Template for an Industry Training Program Description"	NEI	n/a	Revision 2
[2]	Regulatory Guide 1.8, Qualification and Training of Personnel for Nuclear Power Plants	NRC	n/a	Revision 4
[3]	ANSI/ANS 3.1-2014, "Selection, Qualification, and Training of Personnel for Nuclear Power Plants"	ANS	n/a	2014
[4]	Submission of Revision 2 to X Energy, LLC (X-energy) Xe-100 Licensing Topical Report: Control Room Staffing Analysis Methodology and Associated Implementation Plans (ML22004A333)	X Energy	000714	Jan 2022
[5]	NUREG-0711, "Human Factors Engineering Program Review Model"	NRC	n/a	Revision 3
[6]	NEI 18-04, "Risk-Informed, Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development"	NEI	n/a	Revision 1
[7]	ANSI/ANS-3.5-2009, "Nuclear Power Plant Simulators for Use in Operator Training and Examination"	ANS	n/a	2009
[8]	Regulatory Guide 1.149, "Nuclear Power Plant Simulation Facilities for Use in Operator Training, License Examinations, and Applicant Experience Requirements"	NRC	n/a	Revision 4
[9]	NUREG-0700, "Human-System Interface Design Review Guidelines"	NRC	n/a	Revision 3
[10]	NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" • 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"	NRC	n/a	Revision 4 Revision 4 Revision 3

	Document Title	Preparer/Author	Document Number	Revision or Date of Issue
[11]	NUREG-1021, “Operator Licensing Examination Standards for Power Reactors”	NRC	n/a	Revision 12
[12]	NUREG-1220, “Training Review Criteria and Procedures”	NRC	n/a	Revision 1
[13]	NUREG-1791, “Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements”	NRC	n/a	July 2005
[14]	IP 41501, Inspection Manual (Part 52, Review of Training and Qualification Programs)	NRC	n/a	June 2019
[15]	IP 41502, Inspection Manual (Nuclear Power Plant Simulation Facilities)	NRC	n/a	Oct 2012
[16]	NUREG-1122, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors”	NRC	n/a	Revision 3
[17]	NUREG-1123, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Boiling Water Reactors”	NRC	n/a	Revision 3
[18]	NUREG-2103, “Knowledge and Abilities Catalog for Nuclear Power Operators: Westinghouse AP1000 Pressurized Water Reactors”	NRC	n/a	Jan 2021
[19]	NUREG-2104, “Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Advanced Boiling Water Reactor (ABWR)”	NRC	n/a	Dec 2011
[20]	Generic Letter 86-04, “Policy Statement on Engineering Expertise on Shift”	NRC	n/a	Feb 1986
[21]	Risk Informed and Performance based Human System considerations for Advanced Reactors	NRC	n/a	March 2021
[22]	NUREG-0737, “Clarification of TMI Action Plan”	NRC	n/a	Nov 1980
[23]	SECY-93-193, “Policy on Shift Technical Advisor Position at Nuclear Power Plants”	NRC	n/a	July 1993
[24]	U.S. Nuclear Regulatory Commission, “Policy Statement on Engineering Expertise on Shift,” Federal Register, Vol. 50, No. 208, October 28, 1985, pp. 43621-43623	NRC	n/a	Oct 1985

APPENDIX A: 10 CFR PART 55 PROPOSED EXEMPTION BASIS DISCUSSION

Xe-100 Control Room operations personnel are proposed to be "qualified" operators by the facility licensee rather than licensed by the Commission. Qualification will be in accordance with the approved Xe-100 Training Program and utilize an approved X-energy Xe-100 simulator. Additional changes are proposed addressing the other portions of the Part 55 regulation. The following outlines the planned replacement to Part 55, which reflects this intended approach, and is provided to initiate discussions for a future request for exemption from Part 55, and other related regulations.

NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements," recognizes that "Current regulations regarding control room staffing, which are based on the concept of operation for existing light-water reactors, may no longer apply." Advanced reactor designs (e.g., Xe-100), with the increased use of advanced automation, allows changes in the roles, responsibilities, composition, and size of the crews required to control plant operations. As such, an exemption to 10 CFR Part 55 is appropriate.

The X-energy approach comports with the NRC Draft White Paper, "Risk Informed and Performance based Human System considerations for Advanced Reactors," that the Xe-100 staffing exemption will be based on demonstrating that adequate protection of the public health and safety will exist in the absence of any operator action for preventing or mitigating accidents.

Included in the planned support for the exemption, X-energy will outline the role of the systematic analysis of operational staffing requirements that includes a thorough understanding of QCRO task requirements using the HFE Functional Requirements Analysis and Function Allocation, Task Analysis, and Job Definitions. This will provide the necessary elements to validate Control Room staffing and qualification approach provides proper correspondence between the Training Program and the HFE Program.

To provide context with Part 55, no attempt at reformatting or re-numbering was made. While the final location of this information is yet to be determined, X-energy's current intent is to incorporate the post-exemption requirements into the various Topical Reports (i.e., the (a) Training Program description, (b) Qualified Control Room Operator (QCRO) versus Licensed Control Room Operator, and (c) the QCRO Eligibility criteria), while other portions may be adequately addressed by the Quality Assurance Program Description. The complete exemption request with basis supporting that "*the exemptions are authorized by law, the exemptions will not endanger life or property and are otherwise in the public interest*," will be provided in a future submittal.

Table A-1 provides a comparison between the current 10 CFR Part 55 text and the text anticipated for the future exemption request. A Basis Category provides general topic(s) associated with the basis for the difference. These categories are defined below:

- **Qual vs License**: The intent of applicable sections of this part are revised to reflect that the licensed *operator* and licensed *senior operator* positions will be combined as a Qualified Control Room operator (QCRO), with applications, medical certifications, and examinations implemented by the facility licensee.

- **Non-Regulation**: With the exemption certain requirements will no longer be regulations; as such, some portions of the requirements would no longer apply to the Xe-100.
- **Simulator**: This requirement revised to reflect use of a plant-referenced Xe-100 simulator and eliminate the option for Commission approved simulator.
- **QAPD**: Some requirements intended to be moved to, or adequately addressed by, the Quality Assurance Program Document (QAPD) to prevent duplication.
- **Training**: Some requirements revised to reflect incorporated into the X-energy Training Programs, which will be approved as part of the application.

Table 4-1: 10 CFR Part 55 Proposed Exemption with Basis Category

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
§ 55.1 Purpose. The regulations in this part: (a) Establish procedures and criteria for the issuance of licenses to operators and senior operators of utilization facilities licensed under the Atomic Energy Act of 1954, as amended, or Section 202 of the Energy Reorganization Act of 1974, as amended, and part 50, part 52, or part 54 of this chapter, (b) Provide for the terms and conditions upon which the Commission will issue or modify these licenses, and (c) Provide for the terms and conditions to maintain and renew these licenses.	**§ 55.1 Purpose.** The requirements in this part: (a) Establish procedures and criteria for the qualification of control room operators of utilization facilities licensed under the Atomic Energy Act of 1954, as amended, or Section 202 of the Energy Reorganization Act of 1974, as amended, and part 50, part 52, or part 54 of 10 CFR, (b) Provide for the terms and conditions upon which the facility licensee will issue or modify these qualifications, and (c) Provide for the terms and conditions to maintain and renew these qualifications.	• Non-Regulation • Qual vs License
§ 55.2 Scope. The regulations in this part apply to -- (a) Any individual who manipulates the controls of any utilization facility licensed under parts 50, 52, or 54 of this chapter, (b) Any individual designated by a facility licensee to be responsible for directing any licensed activity of a licensed operator. (c) Any facility license.	**§ 55.2 Scope.** The requirements in this part apply to -- (a) Any individual who manipulates the controls of any utilization facility licensed under parts 50, 52, or 54. (b) Any individual designated by a facility licensee to be responsible for directing any activity those identified in (a). (c) Any facility license.	• Non-Regulation • Qual vs License
§ 55.3 License requirements. A person must be authorized by a license issued by the Commission to perform the function of an operator or a senior operator as defined in this part.	**§ 55.3 Qualification requirements.** A person must be authorized by a qualification issued by the facility licensee to perform the function of a control room operator as defined below.	• Qual vs License

§ 55.4 Definitions. As used in this part: *Act* means the Atomic Energy Act of 1954, including any amendments to the Act. *Actively performing the functions of an operator or senior operator* means that an individual has a position on the shift crew that requires the individual to be licensed as defined in the facility's technical specifications, and that the individual carries out and is responsible for the duties covered by that position. *Commission* means the Nuclear Regulatory Commission or its duly authorized representatives. *Controls* when used with respect to a nuclear reactor means apparatus and mechanisms the manipulation of which directly affects the reactivity or power level of the reactor. *Facility* means any utilization facility as defined in part 50 of this chapter. In cases for which a license is issued for operation of two or more facilities, facility means all facilities identified in the license. *Facility licensee* means an applicant for or holder of a license for a facility. Licensee means an individual licensed operator or senior operator. *Operator* means any individual licensed under this part to manipulate a control of a facility. *Performance testing* means testing conducted to verify a simulation facility's performance as compared to actual or predicted reference plant performance. *Physician* means an individual licensed by a State or territory of the United States, the District of Columbia or the Commonwealth of Puerto Rico to dispense drugs in the practice of medicine. *Plant-referenced simulator* means a simulator modeling the systems of the reference plant with which the operator interfaces in the control room, including operating consoles, and which permits use of the reference plant's procedures.	**§ 55.4 Definitions.** As used in this part: *Act* means the Atomic Energy Act of 1954, including any amendments to the Act. *Actively performing the functions of a qualified control room operator* means that an individual has a position on the shift crew that requires the individual to be qualified as defined in the facility's training program or Quality Assurance Program Description, and that the individual carries out and is responsible for the duties covered by that position. *Commission* means the Nuclear Regulatory Commission or its duly authorized representatives. *Controls* when used with respect to a nuclear reactor means apparatus and mechanisms the manipulation of which directly affects the reactivity or power level of the reactor. *Facility* means any utilization facility as defined in part 50. In cases for which qualification is issued for operation of two or more facilities, facility means all facilities identified in the qualification documentation. *Facility licensee* means an applicant for or holder of a license for a facility. *Control Room Operator or Qualified Control Room Operator (or QCRO)* means any individual qualified to manipulate a control of a facility. *Performance testing* means testing conducted to verify a simulation facility's performance as compared to actual or predicted reference plant performance. *Physician* means an individual licensed by a State or territory of the United States, the District of Columbia or the Commonwealth of Puerto Rico to dispense drugs in the practice of medicine. *Plant-referenced simulator* means a simulator modeling the systems of the Xe-100 plant with which the QCRO interfaces in the control room, including operating consoles, and which permits use of the plant's procedures. *Reference plant* means the specific nuclear power plant from which a simulation facility's control room configuration, system control arrangement, and design data are derived.	• Qual vs License • Simulator • Non-Regulation • QAPD

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
Reference plant means the specific nuclear power plant from which a simulation facility's control room configuration, system control arrangement, and design data are derived. *Senior operator* means any individual licensed under this part to manipulate the controls of a facility and to direct the licensed activities of licensed operators. *Simulation facility* means one or more of the following components, alone or in combination: used for either the partial conduct of operating tests for operators, senior operators, and license applicants, or to establish on-the-job training and experience prerequisites for operator license eligibility: (1) A plant-referenced simulator; (2) A Commission-approved simulator under § 55.46(b); or (3) Another simulation device, including part-task and limited scope simulation devices, approved under § 55.46(b). *Systems approach to training* means a training program that includes the following five elements: (1) Systematic analysis of the jobs to be performed. (2) Learning objectives derived from the analysis which describe desired performance after training. (3) Training design and implementation based on the learning objectives. (4) Evaluation of trainee mastery of the objectives during training. (5) Evaluation and revision of the training based on the performance of trained personnel in the job setting. *United States*, when used in a geographical sense, includes Puerto Rico and all territories and possessions of the United States.	*Simulation facility* means an Xe-100 plant-referenced simulator used for either the partial conduct of operating tests for QCROs and QCRO candidates, or to establish on-the-job training and experience prerequisites for QCRO eligibility. *Systems approach to training* means a training program that includes the following five elements: (1) Systematic analysis of the jobs to be performed. (2) Learning objectives derived from the analysis which describe desired performance after training. (3) Training design and implementation based on the learning objectives. (4) Evaluation of trainee mastery of the objectives during training. (5) Evaluation and revision of the training based on the performance of trained personnel in the job setting.	

§ 55.5 Communications. (a) Except as provided under a regional licensing program identified in paragraph (b) of this section, an applicant or licensee or facility licensee shall submit any communication or report concerning the regulations in this part and shall submit any application filed under these regulations to the Commission as follows: (1) By mail addressed to—Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; or (2) By delivery in person to the NRC's offices at 11555 Rockville Pike, Rockville, Maryland, or (3) Where practicable, by electronic submission, for example, via Electronic Information Exchange, or CD-ROM. Electronic submissions must be made in a manner that enables the NRC to receive, read, authenticate, distribute, and archive the submission, and process and retrieve it a single page at a time. Detailed guidance on making electronic submissions can be obtained by visiting the NRC's Web site at http://www.nrc.gov/site-help/e-submittals.html; by e-mail to MSHD.Resource@nrc.gov; or by writing the Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001. The guidance discusses, among other topics, the formats the NRC can accept, the use of electronic signatures, and the treatment of nonpublic information. (b)(1) Except for test and research reactor facilities, the Director, Office of Nuclear Reactor Regulation, has delegated to the Regional Administrators of Regions I, II, III, and IV authority and responsibility under the regulations in this part for the issuance and renewal of licenses for operators and senior operators of nuclear power reactors licensed under 10 CFR part 50 or part 52 of this chapter and located in these regions. (2) Any application for a license or license renewal filed under the regulations in this part involving a nuclear power reactor licensed under 10 CFR part 50 or part 52 of this chapter and any related inquiry, communication, information, or report must be submitted to the Regional Administrator by an appropriate method listed in paragraph (a) of this section. The Regional Administrator or the Administrator's designee will transmit to the Director, Office of Nuclear Reactor Regulation, any matter that is not within the scope of the Regional Administrator's delegated authority. (i) If the nuclear power reactor is located in Region I, submissions must be made to the Regional Administrator of Region I. Submissions by mail or hand	{*deleted*}	• Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
delivery must be addressed to the Administrator at U.S. Nuclear Regulatory Commission, 475 Allendale Road, Suite 102, King of Prussia, PA 19406–1415; where email is appropriate it should be addressed to RidsRgn1MailCenter.Resource@nrc.gov. (ii) If the nuclear power reactor is located in Region II, submissions must be made to the Regional Administrator of Region II. Submissions by mail or hand delivery must be addressed to the Regional Administrator at U.S. Nuclear Regulatory Commission, 245 Peachtree Center Avenue, NE., Suite 1200, Atlanta, Georgia 30303–1257. Where e-mail is appropriate, it should be addressed to RidsRgn2MailCenter@nrc.gov. (iii) If the nuclear power reactor is located in Region III, submissions must be made to the Regional Administrator of Region III. Submissions by mail or hand delivery must be addressed to the Administrator at U.S. Nuclear Regulatory Commission, 2443 Warrenville Road, Suite 210, Lisle, IL 60532–4352; where e-mail is appropriate it should be addressed to RidsRgn3MailCenter@nrc.gov. (iv) If the nuclear power reactor is located in Region IV, submissions must be made to the Regional Administrator of Region IV. Submission by mail or hand delivery must be addressed to the Administrator at U.S. Nuclear Regulatory Commission, 1600 E. Lamar Blvd., Arlington, TX 76011–4511; where email is appropriate, it should be addressed to RidsRgn4MailCenter@nrc.gov. (3) Any application for a license or license renewal filed under the regulations in this part and all other submissions involving a test and research reactor or non-power reactor facility licensed under 10 CFR part 50 and any related inquiry, communication, information, or report must be submitted to the Office of Nuclear Reactor Regulation, Director of the Division of Advanced Reactors and Non-Power Production and Utilization Facilities at the NRC's headquarters, by an appropriate method listed in paragraph (a) of this section.		

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
§ 55.6 Interpretations. Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.	{*deleted*}	• Non-Regulation
§ 55.7 Additional requirements. The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health and to minimize danger to life or property.	{*deleted*}	• Non-Regulation
§ 55.8 Information collection requirements: OMB approval. (a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act (44 U.S.C. 3501 et seq.). The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. OMB has approved the information collection requirements contained in this part under control number 3150-0018. (b) The approved information collection requirements contained in this part appear in §§ 55.11, 55.25, 55.27, 55.31, 55.35, 55.40, 55.41, 55.43, 55.45, 55.47, 55.53, 55.57, and 55.59. (c) This part contains information collection requirements in addition to those approved under the control number specified in paragraph (a) of this section. These information collection requirements and the control numbers under which they are approved are as follows: (1) In §§ 55.23, 55.25, 55.27, 55.31, NRC Form 396 is approved under control number 3150-0024. (2) In §§ 55.31, 55.35, 55.47, and 55.57, NRC Form 398 is approved under control number 3150-0090. (3) in § 55.45, NRC Form 474 is approved under control number 3150-0138.	{*deleted*}	• Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(4) In §§ 55.41, 55.43, 55.45, and 55.59, clearance is approved under control number 3150-0101.		
§ 55.9 Completeness and accuracy of information. Information provided to the Commission by an applicant for a license or by a licensee or information required by statute or by the Commission's regulations, orders, or license conditions to be maintained by the applicant or the licensee shall be complete and accurate in all material respects.	{*deleted*}	• Non-Regulation
§ 55.11 Specific exemptions. The Commission may, upon application by an interested person, or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not endanger life or property and are otherwise in the public interest.	{*deleted*}	• Non-Regulation
§ 55.13 General exemptions. The regulations in this part do not require a license for an individual who -- (a) Under the direction and in the presence of a licensed operator or senior operator, manipulates the controls of -- (1) A research or training reactor as part of the individual's training as a student, or (2) A facility as a part of the individual's training in a facility licensee's training program as approved by the Commission to qualify for an operator license under this part. (b) Under the direction and in the presence of a licensed senior operator, manipulates the controls of a facility to load or unload the fuel into, out of, or within the reactor vessel.	**§ 55.13 General exemptions.** The requirements in this part do not require qualification for an individual who -- (a) Under the direction and in the presence of a QCRO, manipulates the controls of -- (1) A research or training reactor as part of the individual's training as a student, or (2) A facility as a part of the individual's training in a facility licensee's training program to qualify as a QCRO under these requirements. (b) Under the direction and in the presence of a QCRO, manipulates the controls of a facility to initiate loading of fuel into the reactor vessel.	• Non-Regulation • Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
§ 55.21 Medical examination. An applicant for a license shall have a medical examination by a physician. A licensee shall have a medical examination by a physician every two years. The physician shall determine that the applicant or licensee meets the requirements of § 55.33(a)(1).	**§ 55.21 Medical examination.** An candidate for a QCRO shall have a medical examination by a physician. A QCRO shall have a medical examination by a physician every two years. The physician shall determine that the QCRO candidate or QCRO meets the requirements of modified § 55.33(a)(1).	• Qual vs License
§ 55.23 Certification. To certify the medical fitness of the applicant, an authorized representative of the facility licensee shall complete and sign NRC Form 396, "Certification of Medical Examination by Facility Licensee," which can be obtained by writing the Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, by calling (301) 415-5877, or by visiting the NRC's Web site at http://www.nrc.gov and selecting forms from the index found on the home page. (a) Form NRC-396 must certify that a physician has conducted the medical examination of the applicant as required in § 55.21. (b) When the certification requests a conditional license based on medical evidence, the medical evidence must be submitted on NRC Form 396 to the Commission and the Commission then makes a determination in accordance with § 55.33.	**§ 55.23 Certification.** To confirm the medical fitness of the QCRO candidate, an authorized representative of the facility licensee shall complete and sign a QCRO medical examination form. This form will provide information consistent with the content of appropriate portions of NRC Form 396 but will be retained by the facility licensee. (a) The QCRO medical examination form will certify that a physician has conducted the medical examination of the QCRO candidate as required in modified § 55.21. (b) The QCRO medical examination form will document all relevant medical information such as prescriptions, medical devices, etc. This additional medical information and whether it is deemed acceptable for passing the medical examination is the responsibility of the facility licensee and the authorized representative (i.e., physician).	• Qual vs License
§ 55.25 Incapacitation because of disability or illness. If, during the term of the license, the licensee develops a permanent physical or mental condition that causes the licensee to fail to meet the requirements of § 55.21 of this part, the facility licensee shall notify the Commission, within 30 days of learning of the diagnosis, in accordance with § 50.74(c). For conditions for which a conditional license (as described in § 55.33(b) of this part) is requested, the facility licensee shall provide medical certification on Form NRC 396 to the Commission (as described in § 55.23 of this part).	**§ 55.25 Incapacitation because of disability or illness.** If, the QCRO develops a permanent physical or mental condition that causes the QCRO to fail to meet the requirements of modified § 55.21 will be removed from minimum control room staffing.	• Non-Regulation • Qual vs License
§ 55.27 Documentation. The facility licensee shall document and maintain the results of medical qualifications data, test results, and each operator's or senior operator's medical history for the current license period and provide the documentation to the Commission upon request. The facility licensee shall	**§ 55.27 Documentation.** The facility licensee shall document and maintain the results of medical qualifications data, test results, and each QCRO's medical history. The facility licensee shall retain this documentation while an individual performs the functions of a QCRO.	• Non-Regulation • Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
retain this documentation while an individual performs the functions of an operator or senior operator.		
§ 55.31 How to apply. (a) The applicant shall: (1) Complete NRC Form 398, "Personal Qualification Statement--Licensee," which can be obtained by writing the Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, by calling (301) 415-5877, or by visiting the NRC's Web site at http://www.nrc.gov and selecting forms from the index found on the home page; (2) File an original of NRC Form 398, together with the information required in paragraphs (a)(3), (4), (5) and (6) of this section, with the appropriate Regional Administrator; (3) Submit a written request from an authorized representative of the facility licensee by which the applicant will be employed that the written examination and operating test be administered to the applicant; (4) Provide evidence that the applicant has successfully completed the facility licensee's requirements to be licensed as an operator or senior operator and of the facility licensee's need for an operator or a senior operator to perform assigned duties. An authorized representative of the facility licensee shall certify this evidence on Form NRC-398. This certification must include details of the applicant's qualifications, and details on courses of instruction administered by the facility licensee, and describe the nature of the training received at the facility, and the startup and shutdown experience received. In lieu of these details, the Commission may accept certification that the applicant has successfully completed a Commission-approved training program that is based on a systems approach to training and that uses a simulation facility acceptable to the Commission under § 55.45(b) of this part; (5) Provide evidence that the applicant, as a trainee, has successfully manipulated the controls of either the facility for which a license is sought or a plant-referenced simulator that meets the requirements of § 55.46(c). At a minimum, five significant control manipulations must be performed that affect reactivity or power level. Control manipulations performed on the plant-referenced simulator may be chosen from a representative sampling of the control manipulations and plant evolutions described in §	**§ 55.31 How to apply.** (a) A QCRO candidate shall: (1) Complete a licensee provided form documenting the appropriate information reflecting the candidate’s readiness to begin QCRO training. (2) Provide verifiable documentation of the candidate’s education and any previous pertinent work experience. (3) Successfully complete the facility licensee's requirements to become a QCRO. An authorized representative of the facility licensee shall document completion of a training program that is based on a systems approach to training and that uses a simulation facility that meets modified § 55.46, and evidence that the candidate, as a trainee, has successfully manipulated the controls of either the facility for which qualification is sought or a plant-referenced simulator. At a minimum, five significant control manipulations must be performed that affect reactivity or power level. Control manipulations performed on the plant-referenced simulator may be chosen from a representative sampling of the control manipulations and plant evolutions described in modified § 55.59(c)(3)(i)(A-F), (R), (T), (W), and (X) of this part, as applicable to the design of the plant for which the qualification is sought; and (4) Be confirmed by the facility licensee of medical condition and general health.	• Non-Regulation • Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
55.59(c)(3)(i)(A-F), (R), (T), (W), and (X) of this part, as applicable to the design of the plant for which the license application is submitted. For licensed operators applying for a senior operator license, certification that the operator has successfully operated the controls of the facility as a licensed operator shall be accepted; and (6) Provide certification by the facility licensee of medical condition and general health on Form NRC - 396, to comply with §§ 55.21, 55.23 and 55.33(a)(1). (b) The Commission may at any time after the application has been filed, and before the license has expired, require further information under oath or affirmation in order to enable it to determine whether to grant or deny the application or whether to revoke, modify, or suspend the license. (c) An applicant whose application has been denied because of a medical condition or general health may submit a further medical report at any time as a supplement to the application. (d) Each application and statement must contain complete and accurate disclosure as to all matters required to be disclosed. The applicant shall sign statements required by paragraphs (a)(1) and (2) of this section.		
§ 55.33 Disposition of an initial application. (a) *Requirements for the approval of an initial application*. The Commission will approve an initial application for a license pursuant to the regulations in this part, if it finds that – (1) *Health*. The applicant's medical condition and general health will not adversely affect the performance of assigned operator job duties or cause operational errors endangering public health and safety. The Commission will base its finding upon the certification by the facility licensee as detailed in § 55.23. (2) *Written examination and operating test.* The applicant has passed the requisite written examination and operating test in accordance with §§ 55.41 and 55.45 or 55.43 and 55.45. These examinations and tests determine whether the applicant for an operator's license has learned to operate a facility competently and safely, and additionally, in the case of a senior operator, whether the applicant has learned to direct the licensed activities of licensed operators competently and safely.	**§ 55.33 Disposition of an initial application.** *(a) Requirements for the approval of an initial application.* The facility licensee will approve a QCRO candidate as a QCRO pursuant to these requirements, if it finds that -- (1) *Health*. The candidate's medical condition and general health will not adversely affect the performance of assigned QCRO job duties or cause operational errors endangering public health and safety. The facility licensee will base its finding upon the information detailed in modified § 55.23. *(2) Written examination and operating test.* The candidate has passed the requisite written examination and operating test in accordance with modified §§ 55.41 and 55.45. These examinations and tests determine whether the candidate for a QCRO has learned to operate a facility competently and safely.	• Non-Regulation • Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(b) *Conditional license.* If an applicant's general medical condition does not meet the minimum standards under § 55.33(a)(1) of this part, the Commission may approve the application and include conditions in the license to accommodate the medical defect. The Commission will consider the recommendations and supporting evidence of the facility licensee and of the examining physician (provided on Form NRC-396) in arriving at its decision.		
§ 55.35 Re-applications. (a) An applicant whose application for a license has been denied because of failure to pass the written examination or operating test, or both, may file a new application two months after the date of denial. The application must be submitted on Form NRC-398 and include a statement signed by an authorized representative of the facility licensee by whom the applicant will be employed that states in detail the extent of the applicant's additional training since the denial and certifies that the applicant is ready for re-examination. An applicant may file a third application six months after the date of denial of the second application, and may file further successive applications two years after the date of denial of each prior application. The applicant shall submit each successive application on Form NRC-398 and include a statement of additional training. (b) An applicant who has passed either the written examination or operating test and failed the other may request in a new application on Form NRC-398 to be excused from re-examination on the portions of the examination or test which the applicant has passed. The Commission may in its discretion grant the request, if it determines that sufficient justification is presented.	**§ 55.35 Reconsideration.** (a) A candidate whose qualification has been denied because of failure to pass the written examination or operating test, or both, may request reconsideration after remediation in the areas related to the failure. (b) A candidate who has passed either the written examination or operating test and failed the other may request consideration to be excused from re-examination on the portions of the examination or test which the candidate has passed. The facility licensee may in its discretion grant the request, if it determines that sufficient justification is present.	• Non-Regulation • Qual vs License
§ 55.40 Implementation. (a) The Commission shall use the criteria in NUREG-1021, "Operator Licensing Examination Standards for Power Reactors,"[1] in effect six months before the examination date to prepare the written examinations required by §§ 55.41 and 55.43 and the operating tests required by § 55.45. The Commission shall also use the criteria in NUREG–1021 to evaluate the written examinations and operating tests prepared by power reactor facility licensees pursuant to paragraph (b) of this section.	**§ 55.40 Implementation.** (a) The facility licensee may prepare the written examinations required by modified §§ 55.41 and the operating tests required by modified § 55.45. (b) The facility licensees may proctor and grade the written examinations required by modified §§ 55.41 and may prepare the operating tests required by modified § 55.45, subject to the following: (1) The facility licensee shall prepare the required examinations and tests in accordance with prepared writer's guides based on the systems approach to training process;	• Training • Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(b) Power reactor facility licensees may prepare, proctor, and grade the written examinations required by §§ 55.41 and 55.43 and may prepare the operating tests required by § 55.45, subject to the following conditions: (1) Power reactor facility licensees shall prepare the required examinations and tests in accordance with the criteria in NUREG-1021 as described in paragraph (a) of this section; (2) Pursuant to § 55.49, power reactor facility licensees shall establish, implement, and maintain procedures to control examination security and integrity; (3) An authorized representative of the power reactor facility licensee shall approve the required examinations and tests before they are submitted to the Commission for review and approval; and (4) Power reactor facility licensees must receive Commission approval of their proposed written examinations and operating tests. (c) In lieu of paragraph (b) of this section and upon written request from a power reactor facility licensee pursuant to § 55.31(a)(3), the Commission shall, for that facility licensee, prepare, proctor, and grade, the written examinations required by §§ 55.41 and 55.43 and the operating tests required by § 55.45. In addition, the Commission may exercise its discretion and reject a power reactor facility licensee's determination to elect paragraph (b) of this section, in which case the Commission shall prepare, proctor, and grade the required written examinations and operating tests for that facility licensee. (d) The Commission shall use the criteria in NUREG–1478, "Operator Licensing Examiner Standards for Research and Test Reactors," for all test and research reactors to prepare, proctor, and grade the written examinations required by §§ 55.41 and 55.43 and the operating tests required by § 55.45 for non-power reactor facility licensees. [1]Copies of NUREGs may be purchased from the Superintendent of Documents, U.S. Government Publishing Office, P.O. Box 38082, Washington, DC 20402–9328. Copies are also available from the National Technical Information Service, 5301 Shawnee Road, Alexandria, VA 22312. A copy is available for inspection and/or copying in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike (O–1 F21), Rockville, MD.	(2) The facility licensees shall establish, implement, and maintain procedures to control examination security and integrity; and (3) An authorized representative of the power reactor facility licensee shall approve the required examinations and tests.	

§ 55.41 Written examination: Operators. (a) *Content.* The written examination for an operator will contain a representative selection of questions on the knowledge, skills, and abilities needed to perform licensed operator duties. The knowledge, skills, and abilities will be identified, in part, from learning objectives derived from a systematic analysis of licensed operator duties performed by each facility licensee and contained in its training program and from information in the Final Safety Analysis Report, system description manuals and operating procedures, facility license and license amendments, Licensee Event Reports, and other materials requested from the facility licensee by the Commission. (b) The written examination for an operator for a facility will include a representative sample from among the following 14 items, to the extent applicable to the facility. (1) Fundamentals of reactor theory, including fission process, neutron multiplication, source effects, control rod effects, criticality indications, reactivity coefficients, and poison effects. (2) General design features of the core, including core structure, fuel elements, control rods, core instrumentation, and coolant flow. (3) Mechanical components and design features of the reactor primary system. (4) Secondary coolant and auxiliary systems that affect the facility. (5) Facility operating characteristics during steady state and transient conditions, including coolant chemistry, causes and effects of temperature, pressure and reactivity changes, effects of load changes, and operating limitations and reasons for these operating characteristics. (6) Design, components, and functions of reactivity control mechanisms and instrumentation. (7) Design, components, and functions of control and safety systems, including instrumentation, signals, interlocks, failure modes, and automatic and manual features. (8) Components, capacity, and functions of emergency systems. (9) Shielding, isolation, and containment design features, including access limitations.	**§ 55.41 Written examination: Qualified Control Room Operators.** (a) *Content*. The written examination for a QCRO will contain a representative selection of questions on the knowledge, skills, and abilities needed to perform QCRO duties. The knowledge, skills, and abilities will be identified, in part, from learning objectives derived from a systematic analysis of QCRO duties performed by each facility licensee and contained in its training program and from information in the Final Safety Analysis Report, system description manuals and operating procedures, facility license and license amendments, Licensee Event Reports, and other pertinent materials. (b) The written examination for a QCRO for a facility will include a representative sample from among the following 21 items, to the extent applicable to the facility. (1) Fundamentals of reactor theory, including fission process, neutron multiplication, source effects, control rod effects, criticality indications, reactivity coefficients, and poison effects. (2) General design features of the core, including core structure, fuel elements, control rods, core instrumentation, and coolant flow. (3) Mechanical components and design features of the reactor primary system. (4) Secondary coolant and auxiliary systems that affect the facility. (5) Facility operating characteristics during steady state and transient conditions, including coolant chemistry, causes and effects of temperature, pressure and reactivity changes, effects of load changes, and operating limitations and reasons for these operating characteristics. (6) Design, components, and functions of reactivity control mechanisms and instrumentation. (7) Design, components, and functions of control and safety systems, including instrumentation, signals, interlocks, failure modes, and automatic and manual features. (8) Components, capacity, and functions of emergency systems. (9) Shielding, isolation, and containment design features, including access limitations.	• Training • Qual vs License • Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(10) Administrative, normal, abnormal, and emergency operating procedures for the facility. (11) Purpose and operation of radiation monitoring systems, including alarms and survey equipment. (12) Radiological safety principles and procedures. (13) Procedures and equipment available for handling and disposal of radioactive materials and effluents. (14) Principles of heat transfer thermodynamics and fluid mechanics.	(10) Administrative, normal, abnormal, and emergency operating procedures for the facility. (11) Purpose and operation of radiation monitoring systems, including alarms and survey equipment. (12) Radiological safety principles and procedures. (13) Procedures and equipment available for handling and disposal of radioactive materials and effluents. (14) Principles of heat transfer thermodynamics and fluid mechanics. (15) Conditions and limitations in the facility license. (16) Facility operating limitations in the technical specifications and their bases. (17) Facility licensee procedures required to obtain authority for design and operating changes in the facility. (18) Radiation hazards that may arise during normal and abnormal situations, including maintenance activities and various contamination conditions. (19) Assessment of facility conditions and selection of appropriate procedures during normal, abnormal, and emergency situations. (20) Procedures and limitations involved in initial core loading, alterations in core configuration, control rod programming, and determination of various internal and external effects on core reactivity. (21) Fuel handling facilities and procedures.	
§ 55.43 Written examination: Senior operators. (a) *Content.* The written examination for a senior operator will contain a representative selection of questions on the knowledge, skills, and abilities needed to perform licensed senior operator duties. The knowledge, skills, and abilities will be identified, in part, from learning objectives derived from a systematic analysis of licensed senior operator duties performed by each facility licensee and contained in its training program and from information in the Final Safety Analysis Report, system description manuals and operating procedures, facility license and license amendments, Licensee	{*NOTE: § 55.43 combined with § 55.41 above*}	• Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
Event Reports, and other materials requested from the facility licensee by the Commission. (b) The written examination for a senior operator for a facility will include a representative sample from among the following seven items and the 14 items specified in § 55.41 of this part, to the extent applicable to the facility: (1) Conditions and limitations in the facility license. (2) Facility operating limitations in the technical specifications and their bases. (3) Facility licensee procedures required to obtain authority for design and operating changes in the facility. (4) Radiation hazards that may arise during normal and abnormal situations, including maintenance activities and various contamination conditions. (5) Assessment of facility conditions and selection of appropriate procedures during normal, abnormal, and emergency situations. (6) Procedures and limitations involved in initial core loading, alterations in core configuration, control rod programming, and determination of various internal and external effects on core reactivity. (7) Fuel handling facilities and procedures.		
§ 55.45 Operating tests. (a) *Content.* The operating tests administered to applicants for operator and senior operator licenses in accordance with paragraph (b)(1) of this section are generally similar in scope. The content will be identified, in part, from learning objectives derived from a systematic analysis of licensed operator or senior operator duties performed by each facility licensee and contained in its training program and from information in the Final Safety Analysis Report, system description manuals and operating procedures, facility license and license amendments, Licensee Event Reports, and other materials requested from the facility licensee by the Commission. The operating test, to the extent applicable, requires the applicant to demonstrate an understanding of and the ability to perform the actions necessary to accomplish a representative sample from among the following 13 items.	**§ 55.45 Operating tests.** (a) *Content*. The operating tests administered to QCRO candidates in accordance with paragraph (b)(1) of this section are generally similar in scope. The content will be identified, in part, from learning objectives derived from a systematic analysis of QCRO duties performed by each facility licensee and contained in its training program and from information in the Final Safety Analysis Report, system description manuals and operating procedures, facility license and license amendments, Licensee Event Reports, and other pertinent materials. The operating test, to the extent applicable, requires the QCRO candidate to demonstrate an understanding of and the ability to perform the actions necessary to accomplish a representative sample from among the following 13 items. (1) Perform pre-startup procedures for the facility, including operating of those controls associated with plant equipment that could affect reactivity.	• Training • Qual vs License • Non-Regulation • Simulator

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(1) Perform pre-startup procedures for the facility, including operating of those controls associated with plant equipment that could affect reactivity. (2) Manipulate the console controls as required to operate the facility between shutdown and designated power levels. (3) Identify annunciators and condition-indicating signals and perform appropriate remedial actions where appropriate. (4) Identify the instrumentation systems and the significance of facility instrument readings. (5) Observe and safely control the operating behavior characteristics of the facility. (6) Perform control manipulations required to obtain desired operating results during normal, abnormal, and emergency situations. (7) Safely operate the facility's heat removal systems, including primary coolant, emergency coolant, and decay heat removal systems, and identify the relations of the proper operation of these systems to the operation of the facility. (8) Safely operate the facility's auxiliary and emergency systems, including operation of those controls associated with plant equipment that could affect reactivity or the release of radioactive materials to the environment. (9) Demonstrate or describe the use and function of the facility's radiation monitoring systems, including fixed radiation monitors and alarms, portable survey instruments, and personnel monitoring equipment. (10) Demonstrate knowledge of significant radiation hazards, including permissible levels in excess of those authorized, and ability to perform other procedures to reduce excessive levels of radiation and to guard against personnel exposure. (11) Demonstrate knowledge of the emergency plan for the facility, including, as appropriate, the operator's or senior operator's responsibility to decide whether the plan should be executed and the duties under the plan assigned. (12) Demonstrate the knowledge and ability as appropriate to the assigned position to assume the responsibilities associated with the safe operation of the facility.	(2) Manipulate the console controls as required to operate the facility between shutdown and designated power levels. (3) Identify annunciators and condition-indicating signals and perform appropriate remedial actions where appropriate. (4) Identify the instrumentation systems and the significance of facility instrument readings. (5) Observe and safely control the operating behavior characteristics of the facility. (6) Perform control manipulations required to obtain desired operating results during normal, abnormal, and emergency situations. (7) Safely operate the facility's heat removal systems, including primary coolant, emergency coolant, and decay heat removal systems, and identify the relations of the proper operation of these systems to the operation of the facility. (8) Safely operate the facility's auxiliary and emergency systems, including operation of those controls associated with plant equipment that could affect reactivity or the release of radioactive materials to the environment. (9) Demonstrate or describe the use and function of the facility's radiation monitoring systems, including fixed radiation monitors and alarms, portable survey instruments, and personnel monitoring equipment. (10) Demonstrate knowledge of significant radiation hazards, including permissible levels in excess of those authorized, and ability to perform other procedures to reduce excessive levels of radiation and to guard against personnel exposure. (11) Demonstrate knowledge of the emergency plan for the facility, including, as appropriate, the QCRO’s responsibility to decide whether the plan should be executed and the duties under the plan assigned. (12) Demonstrate the knowledge and ability as appropriate to the assigned position to assume the responsibilities associated with the safe operation of the facility. (13) Demonstrate the candidate's ability to function within the control room team as appropriate to the assigned position, in such a way that the facility	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(13) Demonstrate the applicant's ability to function within the control room team as appropriate to the assigned position, in such a way that the facility licensee's procedures are adhered to and that the limitations in its license and amendments are not violated. (b) *Implementation--Administration*. The operating test will be administered in a plant walkthrough and in either-- (1) A simulation facility that the Commission has approved for use after application has been made by the facility licensee under § 55.46(b); (2) A plant-referenced simulator (§ 55.46(c)); or (3) The plant, if approved for use in the administration of the operating test by the Commission under § 55.46(b).	licensee's procedures are adhered to and that the limitations in its license and amendments are not violated. (b) *Implementation--Administration*. The operating test will be administered in a plant walkthrough and in an Xe-100 plant-reference simulator.	
§ 55.46 Simulation facilities. (a) *General.* This section addresses the use of a simulation facility for the administration of the operating test and plant-referenced simulators to meet experience requirements for applicants for operator and senior operator licenses. (b) *Commission-approved simulation facilities and Commission approval of use of the plant in the administration of the operating test*. (1) Facility licensees that propose to use a simulation facility, other than a plant-referenced simulator, or the plant in the administration of the operating test under §§ 55.45(b)(1) or 55.45(b)(3), shall request approval from the Commission. This request must include: (i) A description of the components of the simulation facility intended to be used, or the way the plant would be used for each part of the operating test, unless previously approved; and (ii) A description of the performance tests for the simulation facility as part of the request, and the results of these tests; and (iii) A description of the procedures for maintaining examination and test integrity consistent with the requirements of § 55.49. (2) The Commission will approve a simulation facility or use of the plant for administration of operating tests if it finds that the simulation facility and its proposed use, or the proposed use of the plant, are suitable for the conduct of operating tests for the facility licensee's reference plant under § 55.45(a).	**§ 55.46 Simulation facilities.** (a) *General.* This section addresses the use of a simulation facility for the administration of the operating test and to meet experience requirements for QCRO candidates. (b) *Simulation facility:* A plant-referenced simulator description shall include: (1) the components of the simulation facility intended to be used, or the way the plant would be used for each part of the operating test; and (2) the performance tests for the simulation facility, and the results of these tests; and (3) the procedures for maintaining examination and test integrity consistent with the requirements of modified § 55.49. (c) *Plant-referenced simulators.* (1) A plant-referenced simulator used for the administration of the operating test or to meet experience requirements in modified § 55.31(a)(3) must demonstrate expected plant response to operator input and to normal, transient, and accident conditions to which the simulator has been designed to respond. The plant-referenced simulator must be designed and implemented so that it: (i) Is sufficient in scope and fidelity to allow conduct of the evolutions listed in modified §§ 55.45(a)(1) through (13), and modified 55.59(c)(3)(i)(A) through (AA), as applicable to the design of the plant.	• Simulator • Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(c) *Plant-referenced simulators.* (1) A plant-referenced simulator used for the administration of the operating test or to meet experience requirements in § 55.31(a)(5) must demonstrate expected plant response to operator input and to normal, transient, and accident conditions to which the simulator has been designed to respond. The plant-referenced simulator must be designed and implemented so that it: (i) Is sufficient in scope and fidelity to allow conduct of the evolutions listed in §§ 55.45(a)(1) through (13), and 55.59(c)(3)(i)(A) through (AA), as applicable to the design of the reference plant. (ii) Allows for the completion of control manipulations for operator license applicants. (2) Facility licensees that propose to use a plant-referenced simulator to meet the control manipulation requirements in § 55.31(a)(5) must ensure that: (i) The plant-referenced simulator utilizes models relating to nuclear and thermal-hydraulic characteristics that replicate the most recent core load in the nuclear power reference plant for which a license is being sought; and (ii) Simulator fidelity has been demonstrated so that significant control manipulations are completed without procedural exceptions, simulator performance exceptions, or deviation from the approved training scenario sequence. (3) A simulation facility consisting solely of a plant-referenced simulator must meet the requirements of paragraph (c)(1) of this section and the criteria in paragraphs (d)(1) and (4) of this section for the Commission to accept the plant-referenced simulator for conducting operating tests as described in § 55.45(a) of this part, requalification training as described in § 55.59(c)(3) of this part, or for performing control manipulations that affect reactivity to establish eligibility for an operator's license as described in § 55.31(a)(5). (d) *Continued assurance of simulator fidelity.* Facility licensees that maintain a simulation facility shall: (1) Conduct performance testing throughout the life of the simulation facility in a manner sufficient to ensure that paragraphs (c)(2)(ii), as applicable, and (d)(3) of this section are met. The results of performance tests must be	(ii) Allows for the completion of control manipulations for QCRO candidates. (2) The plant-referenced simulator to meet the control manipulation requirements in modified § 55.31(a)(3) must ensure that: (i) The plant-referenced simulator utilizes models relating to nuclear and thermal-hydraulic characteristics that replicate the Xe-100 core; and (ii) Simulator fidelity has been demonstrated so that significant control manipulations are completed without procedural exceptions, simulator performance exceptions, or deviation from the training scenario sequence. (3) A simulation facility must meet the requirements of paragraph (c)(1) of this section and the criteria in paragraphs (d)(1) and (4) of this section for conducting operating tests as described in § 55.45(a) of this part, requalification training as described in § 55.59(c)(3) of this part, or for performing control manipulations that affect reactivity to establish eligibility for control room operator qualifications as described in modified § 55.31(a)(3). (d) *Continued assurance of simulator fidelity.* Facility licensees that maintain a simulation facility shall: (1) Conduct performance testing throughout the life of the simulation facility in a manner sufficient to ensure that paragraphs (c)(2)(ii), as applicable, and (d)(3) of this section are met. The results of performance tests must be retained for four years after the completion of each performance test or until superseded by updated test results; (2) Correct modeling and hardware discrepancies and discrepancies identified from scenario validation and from performance testing; (3) Make results of any uncorrected performance test failures that may exist at the time of the operating test or requalification program inspection available for test preparer review, prior to or concurrent with preparations for each operating test or requalification program test; and (4) Maintain the provisions for license application, examination, and test integrity consistent with modified § 55.49.	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
retained for four years after the completion of each performance test or until superseded by updated test results; (2) Correct modeling and hardware discrepancies and discrepancies identified from scenario validation and from performance testing; (3) Make results of any uncorrected performance test failures that may exist at the time of the operating test or requalification program inspection available for NRC review, prior to or concurrent with preparations for each operating test or requalification program inspection; and (4) Maintain the provisions for license application, examination, and test integrity consistent with § 55.49.		
§ 55.47 Waiver of examination and test requirements. (a) On application, the Commission may waive any or all of the requirements for a written examination and operating test, if it finds that the applicant -- (1) Has had extensive actual operating experience at a comparable facility, as determined by the Commission, within two years before the date of application; (2) Has discharged his or her responsibilities competently and safely and is capable of continuing to do so; and (3) Has learned the operating procedures for and is qualified to operate competently and safely the facility designated in the application. (b) The Commission may accept as proof of the applicant's past performance a certification of an authorized representative of the facility licensee or of a holder of an authorization by which the applicant was previously employed. The certification must contain a description of the applicant's operating experience, including an approximate number of hours the applicant operated the controls of the facility, the duties performed, and the extent of the applicant's responsibility. (c) The Commission may accept as proof of the applicant's current qualifications a certification of an authorized representative of the facility licensee or of a holder of an authorization where the applicant's services will be utilized.	{*deleted*}	• Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
§ 55.49 Integrity of examinations and tests. Applicants, licensees, and facility licensees shall not engage in any activity that compromises the integrity of any application, test, or examination required by this part. The integrity of a test or examination is considered compromised if any activity, regardless of intent, affected, or, but for detection, would have affected the equitable and consistent administration of the test or examination. This includes activities related to the preparation and certification of license applications and all activities related to the preparation, administration, and grading of the tests and examinations required by this part.	**§ 55.49 Integrity of examinations and tests.** QCRO candidates, QCROs, and facility licensees shall not engage in any activity that compromises the integrity of any qualification, test, or examination required by this part. The integrity of a test or examination is considered compromised if any activity, regardless of intent, affected, or, but for detection, would have affected the equitable and consistent administration of the test or examination. This includes activities related to the preparation and certification of any activities related to the preparation, administration, and grading of the tests and examinations required by this part.	• Qual vs License • Non-Regulation
§ 55.51 Issuance of licenses. *Operator and senior operator licenses.* If the Commission determines that an applicant for an operator license or a senior operator license meets the requirements of the Act and its regulations, it will issue a license in the form and containing any conditions and limitations it considers appropriate and necessary.	**§ 55.51 Issuance of qualifications.** *Qualified Control Room Operator qualifications.* If the facility licensee determines that a QCRO candidate meets the requirements, it will issue a qualification in the form and containing any conditions and limitations it considers appropriate and necessary.	• Qual vs License
§ 55.53 Conditions of licenses. Each license contains and is subject to the following conditions whether stated in the license or not: (a) Neither the license nor any right under the license may be assigned or otherwise transferred. (b) The license is limited to the facility for which it is issued. (c) The license is limited to those controls of the facility specified in the license. (d) The license is subject to, and the licensee shall observe, all applicable rules, regulations, and orders of the Commission. (e) If a licensee has not been actively performing the functions of an operator or senior operator, the licensee may not resume activities authorized by a license issued under this part except as permitted by paragraph (f) of this section. To maintain active status, the licensee shall actively perform the functions of an operator or senior operator on a minimum of seven 8-hour or five 12-hour shifts per calendar quarter. For test and research reactors,	**§ 55.53 Conditions of QCRO qualifications.** Each QCRO qualification contains and is subject to the following conditions whether stated in the qualification document or not: (a) Neither the QCRO qualification nor any right under the qualification may be assigned or otherwise transferred. (b) The QCRO qualification is limited to the facility for which it is issued. (c) The QCRO qualification is limited to those controls of the facility specified in the qualification. (d) The QCRO qualification is subject to, and the QCRO shall observe, all applicable rules, regulations, and orders of the Commission. (e) If a QCRO has not been actively performing the functions of a QCRO, the QCRO may not resume activities requiring qualification except as permitted by paragraph (f) of this section. To maintain active status, the QCRO shall actively perform the functions of a QCRO on a minimum of seven 8-hour or five 12-hour shifts per calendar quarter.	• Training • Qual vs License • Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
the licensee shall actively perform the functions of an operator or senior operator for a minimum of four hours per calendar quarter. (f) If paragraph (e) of this section is not met, before resumption of functions authorized by a license issued under this part, an authorized representative of the facility licensee shall certify the following: (1) That the qualifications and status of the licensee are current and valid; and (2) That the licensee has completed a minimum of 40 hours of shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned. The 40 hours must have included a complete tour of the plant and all required shift turnover procedures. For senior operators limited to fuel handling under paragraph (c) of this section, one shift must have been completed. For test and research reactors, a minimum of six hours must have been completed. (g) The licensee shall notify the Commission within 30 days about a conviction for a felony. (h) The licensee shall complete a requalification program as described by § 55.59. (i) The licensee shall have a biennial medical examination. (j) The licensee shall not consume or ingest alcoholic beverages within the protected area of power reactors, or the controlled access area of non-power reactors. The licensee shall not use, possess, or sell any illegal drugs. The licensee shall not perform activities authorized by a license issued under this part while under the influence of alcohol or any prescription, over-the-counter, or illegal substance that could adversely affect his or her ability to safely and competently perform his or her licensed duties. For the purpose of this paragraph, with respect to alcoholic beverages and drugs, the term "under the influence" means the licensee exceeded, as evidenced by a confirmed test result, the lower of the cutoff levels for drugs or alcohol contained in subparts E, F, and G of part 26 of this chapter, or as established by the facility licensee. The term "under the influence" also means the licensee could be mentally or physically impaired as a result of substance use including prescription and over-the-counter drugs, as determined under the provisions, policies, and procedures established by the facility licensee for its	(f) If paragraph (e) of this section is not met, before resumption of QCRO functions, an authorized representative of the facility licensee shall certify the following: (1) That the qualifications and status of the QCRO are current and valid; and (2) That the QCRO has completed a minimum of 40 hours of shift functions under the direction of a QCRO and in the position to which the individual will be assigned. The 40 hours must have included a complete tour of the plant and all required shift turnover procedures. (g) The QCRO shall notify the facility licensee promptly about a conviction for a felony. (h) The QCRO shall complete a requalification program as described by modified § 55.59. (i) The QCRO shall have a biennial medical examination. (j) The QCRO shall not consume or ingest alcoholic beverages within the protected area of power reactors. The QCRO shall not use, possess, or sell any illegal drugs. The QCRO shall not perform QCRO activities while under the influence of alcohol or any prescription, over-the-counter, or illegal substance that could adversely affect his or her ability to safely and competently perform his or her licensed duties. For the purpose of this paragraph, with respect to alcoholic beverages and drugs, the term "under the influence" means the licensee exceeded, as evidenced by a confirmed test result, the lower of the cutoff levels for drugs or alcohol contained in subparts E, F, and G of part 26 of this chapter, or as established by the facility licensee. The term "under the influence" also means the QCRO could be mentally or physically impaired as a result of substance use including prescription and over-the-counter drugs, as determined under the provisions, policies, and procedures established by the facility licensee for its fitness-for-duty program, in such a manner as to adversely affect his or her ability to safely and competently perform licensed duties. (k) Each QCRO at power reactors shall participate in the drug and alcohol testing programs established pursuant to 10 CFR part 26. (l) The QCRO shall comply with any other conditions that the facility licensee may impose to protect health or to minimize danger to life or property.	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
fitness-for-duty program, in such a manner as to adversely affect his or her ability to safely and competently perform licensed duties. (k) Each licensee at power reactors shall participate in the drug and alcohol testing programs established pursuant to 10 CFR part 26. Each licensee at non-power reactors shall participate in any drug and alcohol testing program that may be established for that non-power facility. (l) The licensee shall comply with any other conditions that the Commission may impose to protect health or to minimize danger to life or property.		
§ 55.55 Expiration. (a) Each operator license and senior operator license expires six years after the date of issuance, upon termination of employment with the facility licensee, or upon determination by the facility licensee that the licensed individual no longer needs to maintain a license. (b) If a licensee files an application for renewal or an upgrade of an existing license on Form NRC–398 at least 30 days before the expiration of the existing license, it does not expire until disposition of the application for renewal or for an upgraded license has been finally determined by the Commission. Filing by mail will be deemed to be complete at the time the application is deposited in the mail.	**§ 55.55 Expiration.** (a) Each QCRO qualification expires upon termination of employment with the facility licensee, or upon determination by the facility licensee that the licensed individual no longer needs to maintain qualification as a QCRO.	• Training • Qual vs License • Non-Regulation
§ 55.57 Renewal of licenses. (a) The applicant for renewal of a license shall -- (1) Complete and sign Form NRC-398 and include the number of the license for which renewal is sought. (2) File an original of NRC Form 398 with the appropriate Regional Administrator specified in § 55.5(b). (3) Provide written evidence of the applicant's experience under the existing license and the approximate number of hours that the licensee has operated the facility. (4) Provide a statement by an authorized representative of the facility licensee that during the effective term of the current license the applicant	{*deleted*}	• Training • Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
has satisfactorily completed the requalification program for the facility for which operator or senior operator license renewal is sought. (5) Provide evidence that the applicant has discharged the license responsibilities competently and safely. The Commission may accept as evidence of the applicant's having met this requirement a certificate of an authorized representative of the facility licensee or holder of an authorization by which the licensee has been employed. (6) Provide certification by the facility licensee of medical condition and general health on Form NRC-396, to comply with §§ 55.21, 55.23 and 55.27. (b) The license will be renewed if the Commission finds that -- (1) The medical condition and the general health of the licensee continue to be such as not to cause operational errors that endanger public health and safety. The Commission will base this finding upon the certification by the facility licensee as described in § 55.23. (2) The licensee -- (i) Is capable of continuing to competently and safely assume licensed duties; (ii) Has successfully completed a requalification program that has been approved by the Commission as required by § 55.59; and (iii) Has passed the requalification examinations and annual operating tests as required by § 55.59. (3) There is a continued need for a licensee to operate or for a senior operator to direct operators at the facility designated in the application. (4) The past performance of the licensee has been satisfactory to the Commission. In making its finding, the Commission will include in its evaluation information such as notices of violations or letters of reprimand in the licensee's docket.		

§ 55.59 Requalification. (a) *Requalification requirements.* Each licensee shall — (1) Successfully complete a requalification program developed by the facility licensee that has been approved by the Commission. This program shall be conducted for a continuous period not to exceed 24 months in duration. (2) Pass a comprehensive requalification written examination and an annual operating test. (i) The written examination will sample the items specified in §§ 55.41 and 55.43 of this part, to the extent applicable to the facility, the licensee, and any limitation of the license under § 55.53(c) of this part. (ii) The operating test will require the operator or senior operator to demonstrate an understanding of and the ability to perform the actions necessary to accomplish a comprehensive sample of items specified in § 55.45(a) (2) through (13) inclusive to the extent applicable to the facility. (iii) In lieu of the Commission accepting a certification by the facility licensee that the licensee has passed written examinations and operating tests administered by the facility licensee within its Commission-approved program developed by using a systems approach to training under paragraph (c) of this section, the Commission may administer a comprehensive requalification written examination and an annual operating test. (b) *Additional training.* If the requirements of paragraphs (a) (1) and (2) of this section are not met, the Commission may require the licensee to complete additional training and to submit evidence to the Commission of successful completion of this training before returning to licensed duties. (c) *Requalification program requirements.* A facility licensee shall have a requalification program reviewed and approved by the Commission and shall, upon request consistent with the Commission's inspection program needs, submit to the Commission a copy of its comprehensive requalification written examinations or annual operating tests. The requalification program must meet the requirements of paragraphs (c) (1) through (7) of this section. In lieu of paragraphs (c) (2), (3), and (4) of this section, the Commission may approve a program developed by using a systems approach to training. (1) *Schedule.* The requalification program must be conducted for a continuous period not to exceed two years, and upon conclusion must be	**§ 55.59 Requalification.** (a) *Requalification requirements*. Each QCRO shall — (1) Successfully complete a requalification program developed by the facility licensee. This program shall be conducted for a continuous period not to exceed 24 months in duration. (2) Pass a comprehensive requalification written examination and an annual operating test. (i) The written examination will sample the items specified in modified §§ 55.41 of this part, to the extent applicable to the facility, the QCRO, and any limitation of the QCRO under modified § 55.53(c) of this part. (ii) The operating test will require the QCRO to demonstrate an understanding of and the ability to perform the actions necessary to accomplish a comprehensive sample of items specified in modified § 55.45(a)(2) through (13) inclusive to the extent applicable to the facility. (b) *Additional training*. If the requirements of paragraphs (a) (1) and (2) of this section are not met, the facility licensee may require the QCRO to successfully complete additional training before returning to QCRO duties. (c) *Requalification program requirements*. A facility licensee shall have a requalification program. The requalification program must meet the requirements of paragraphs (c) (1) through (6) of this section. In lieu of paragraphs (c) (2), (3), and (4) of this section, the program may be developed by using a systems approach to training. (1) *Schedule*. The requalification program must be conducted for a continuous period not to exceed two years, and upon conclusion must be promptly followed, pursuant to a continuous schedule, by successive requalification programs. (2) *Lectures*. The requalification program must include pre-planned lectures on a regular and continuing basis in those areas where QCRO written examinations and facility operating experience indicate that emphasis in scope and depth of coverage is needed in the following subjects: (i) Theory and principles of operation. (ii) General and specific plant operating characteristics. (iii) Plant instrumentation and control systems.	• Training • Qual vs License • Non-Regulation • Xe-100 Design • QAPD

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
promptly followed, pursuant to a continuous schedule, by successive requalification programs. (2) *Lectures.* The requalification program must include preplanned lectures on a regular and continuing basis throughout the license period in those areas where operator and senior operator written examinations and facility operating experience indicate that emphasis in scope and depth of coverage is needed in the following subjects: (i) Theory and principles of operation. (ii) General and specific plant operating characteristics. (iii) Plant instrumentation and control systems. (iv) Plant protection systems. (v) Engineered safety systems. (vi) Normal, abnormal, and emergency operating procedures. (vii) Radiation control and safety. (viii) Technical specifications. (ix) Applicable portions of title 10, chapter I, Code of Federal Regulations. (3) *On-the-job training.* The requalification program must include on-the-job training so that — (i) Each licensed operator of a utilization facility manipulates the plant controls and each licensed senior operator either manipulates the controls or directs the activities of individuals during plant control manipulations during the term of the licensed operator's or senior operator's license. For reactor operators and senior operators, these manipulations must consist of the following control manipulations and plant evolutions if they are applicable to the plant design. Items described in paragraphs (c)(3)(i) (A) through (L) of this section must be performed annually; all other items must be performed on a two-year cycle. However, the requalification programs must contain a commitment that each individual shall perform or participate in a combination of reactivity control manipulations based on the availability of plant equipment and systems. Those control manipulations which are not performed at the plant may be performed on a simulator. The use of the Technical Specifications should be maximized during the simulator control	(iv) Plant protection systems. (v) Engineered safety systems. (vi) Normal, abnormal, and emergency operating procedures. (vii) Radiation control and safety. (viii) Technical specifications. (ix) Applicable portions of title 10, chapter I, Code of Federal Regulations. (3) *On-the-job training*. The requalification program must include on-the-job training so that — (i) Each QCRO manipulates the plant controls or directs the activities of individuals during plant control manipulations. For QCROs, these manipulations must consist of the following control manipulations and plant evolutions if they are applicable to the plant design. Items described in paragraphs (c)(3)(i) (A) through (L) of this section must be performed annually; all other items must be performed on a two-year cycle. However, the requalification programs must contain a commitment that each individual shall perform or participate in a combination of reactivity control manipulations based on the availability of plant equipment and systems. Those control manipulations which are not performed at the plant may be performed on a simulator. The use of the Technical Specifications should be maximized during the simulator control manipulations. QCROs are credited with these activities if they direct control manipulations as they are performed. (A) Plant or reactor startups to include a range that reactivity feedback from nuclear heat addition is noticeable and heatup rate is established. (B) Plant shutdown. (C) Manual control of steam generators or feedwater or both during startup and shutdown. (D) Significant (≥10 percent) power changes in manual rod control or recirculation flow. (E) Reactor power change of 10 percent or greater where load change is performed with load limit control or where flux, temperature, or speed control is on manual (for HTGR).	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
manipulations. Senior operator licensees are credited with these activities if they direct control manipulations as they are performed. (A) Plant or reactor startups to include a range that reactivity feedback from nuclear heat addition is noticeable and heatup rate is established. (B) Plant shutdown. (C) Manual control of steam generators or feedwater or both during startup and shutdown. (D) Boration or dilution during power operation. (E) Significant (≥10 percent) power changes in manual rod control or recirculation flow. (F) Reactor power change of 10 percent or greater where load change is performed with load limit control or where flux, temperature, or speed control is on manual (for HTGR). (G) Loss of coolant, including — (1) Significant PWR steam generator leaks (2) Inside and outside primary containment (3) Large and small, including leak-rate determination (4) Saturated reactor coolant response (PWR). (H) Loss of instrument air (if simulated plant specific). (I) Loss of electrical power (or degraded power sources). (J) Loss of core coolant flow/natural circulation. (K) Loss of feedwater (normal and emergency). (L) Loss of service water, if required for safety. (M) Loss of shutdown cooling. (N) Loss of component cooling system or cooling to an individual component. (O) Loss of normal feedwater or normal feedwater system failure. (P) Loss of condenser vacuum.	(F) Loss of coolant, including — (1) Significant steam generator leaks (2) Inside and outside reactor building (3) Large and small, including leak-rate determination (H) Loss of instrument air (if simulated plant specific). (I) Loss of electrical power (or degraded power sources). (J) Loss of core coolant flow/natural circulation. (K) Loss of feedwater (normal and emergency). (L) Loss of service water, if required for safety. (M) Loss of shutdown cooling. (N) Loss of component cooling system or cooling to an individual component. (O) Loss of normal feedwater or normal feedwater system failure. (P) Loss of condenser vacuum. (Q) Loss of protective system channel. (R) Mispositioned control rod or rods (or rod drops). (S) Inability to drive control rods. (T) Conditions requiring use of shutdown reactivity insertion. (U) Fuel cladding failure or high activity in reactor coolant or offgas. (V) Turbine or generator trip. (W) Malfunction of an automatic control system that affects reactivity. (X) Malfunction of reactor coolant pressure/volume control system. (Y) Reactor trip. (Z) Main steam line break (inside or outside containment). (AA) A nuclear instrumentation failure. (ii) Each QCRO has demonstrated satisfactory understanding of the operation of the apparatus and mechanisms associated with the control	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(Q) Loss of protective system channel. (R) Mispositioned control rod or rods (or rod drops). (S) Inability to drive control rods. (T) Conditions requiring use of emergency boration or standby liquid control system. (U) Fuel cladding failure or high activity in reactor coolant or offgas. (V) Turbine or generator trip. (W) Malfunction of an automatic control system that affects reactivity. (X) Malfunction of reactor coolant pressure/volume control system. (Y) Reactor trip. (Z) Main steam line break (inside or outside containment). (AA) A nuclear instrumentation failure. (ii) Each licensed operator and senior operator has demonstrated satisfactory understanding of the operation of the apparatus and mechanisms associated with the control manipulations in paragraph (c)(3)(i) of this section, and knows the operating procedures in each area for which the operator or senior operator is licensed. (iii) Each licensed operator and senior operator is cognizant of facility design changes, procedure changes, and facility license changes. (iv) Each licensed operator and senior operator reviews the contents of all abnormal and emergency procedures on a regularly scheduled basis. (v) A simulator may be used in meeting the requirements of paragraphs (c)(3)(i) and (3)(ii) of this section, if it reproduces the general operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator is similar to that of the facility involved. If the simulator or simulation device is used to administer operating tests for a facility, as provided in § 55.45 (b)(1), the device approved to meet the requirements of § 55.45(b)(1) must be used for credit to be given for meeting the requirements of paragraphs (c)(3)(i) (G through AA) of this section.	manipulations in paragraph (c)(3)(i) of this section, and knows the operating procedures in each area for which the QCRO is qualified. (iii) Each QCRO is cognizant of facility design changes, procedure changes, and facility license changes. (iv) Each QCRO reviews the contents of all abnormal and emergency procedures on a regularly scheduled basis. (v) A simulator may be used in meeting the requirements of paragraphs (c)(3)(i) and (3)(ii) of this section, if it reproduces the general operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator is similar to that of the facility involved. If the simulator or simulation device is used to administer operating tests for a facility, as provided in modified § 55.45 (b)(1), the device documented to meet the requirements of modified § 55.45(b)(1) must be used for credit to be given for meeting the requirements of paragraphs (c)(3)(i) (G through AA) of this section. (4) *Evaluation*. The requalification program must include — (i) Comprehensive requalification written examinations and annual operating tests which determine areas in which retraining is needed to upgrade QCRO knowledge. (ii) Written examinations which determine QCRO knowledge of subjects covered in the requalification program and provide a basis for evaluating their knowledge of abnormal and emergency procedures. (iii) Systematic observation and evaluation of the performance and competency of QCROs by supervisors and/or training staff members, including evaluation of actions taken or to be taken during actual or simulated abnormal and emergency procedures. (iv) Simulation of emergency or abnormal conditions that may be accomplished by using the control panel of the facility involved or by using a simulator. When the control panel of the facility is used for simulation, the actions taken or to be taken for the emergency or abnormal condition shall be discussed; actual manipulation of the plant controls is not required. If a simulator is used in meeting the requirements of paragraph (c)(4)(iii) of this section, it must accurately reproduce the operating characteristics of the	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(4) *Evaluation.* The requalification program must include — (i) Comprehensive requalification written examinations and annual operating tests which determine areas in which retraining is needed to upgrade licensed operator and senior operator knowledge. (ii) Written examinations which determine licensed operators' and senior operators' knowledge of subjects covered in the requalification program and provide a basis for evaluating their knowledge of abnormal and emergency procedures. (iii) Systematic observation and evaluation of the performance and competency of licensed operators and senior operators by supervisors and/or training staff members, including evaluation of actions taken or to be taken during actual or simulated abnormal and emergency procedures. (iv) Simulation of emergency or abnormal conditions that may be accomplished by using the control panel of the facility involved or by using a simulator. When the control panel of the facility is used for simulation, the actions taken or to be taken for the emergency or abnormal condition shall be discussed; actual manipulation of the plant controls is not required. If a simulator is used in meeting the requirements of paragraph (c)(4)(iii) of this section, it must accurately reproduce the operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator must closely parallel that of the facility involved. After the provisions of § 55.46 have been implemented at a facility, the Commission approved or plant-referenced simulator must be used to comply with this paragraph. (v) Provisions for each licensed operator and senior operator to participate in an accelerated requalification program where performance evaluations conducted pursuant to paragraphs (c)(4) (i) through (iv) of this section clearly indicated the need. (5) *Records. T*he requalification program documentation must include the following: (i) The facility licensee shall maintain records documenting the participation of each licensed operator and senior operator in the requalification program. The records must contain copies of written examinations administered, the answers given by the licensee, and the results of evaluations and documentation of operating tests and of any additional training	facility involved and the arrangement of the instrumentation and controls of the simulator must closely parallel that of the facility involved. (v) Provisions for each QCRO to participate in an accelerated requalification program where performance evaluations conducted pursuant to paragraphs (c)(4) (i) through (iv) of this section clearly indicated the need. (5) *Records*. The requalification program documentation must include the following: (i) The facility licensee shall maintain records documenting the participation of each licensed operator and senior operator in the requalification program. The records must contain copies of written examinations administered, the answers given by the QCRO, and the results of evaluations and documentation of operating tests and of any additional training administered in areas in which a QCRO has exhibited deficiencies. The facility licensee shall retain these records throughout the QCRO qualification. (ii) Each record required by this part must be legible throughout the retention period specified by the Quality Assurance Program Document. The record may be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. (6) *Alternative training programs*. The requirements of this section may be met by requalification programs conducted by persons other than the facility licensee if the requalification programs are similar to the program described in paragraphs (c) (1) through (5) of this section and the alternative program has been approved by the facility licensee.	

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
administered in areas in which an operator or senior operator has exhibited deficiencies. The facility licensee shall retain these records until the operator's or senior operator's license is renewed. (ii) Each record required by this part must be legible throughout the retention period specified by each Commission regulation. The record may be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. (iii) If there is a conflict between the Commission's regulations in this part, and any license condition, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified for these records by the regulations in this part apply unless the Commission, pursuant to § 55.11, grants a specific exemption from this record retention requirement. (6) *Alternative training programs.* The requirements of this section may be met by requalification programs conducted by persons other than the facility licensee if the requalification programs are similar to the program described in paragraphs (c) (1) through (5) of this section and the alternative program has been approved by the Commission. (7) *Applicability to research and test reactor facilities.* To accommodate specialized modes of operation and differences in control, equipment, and operator skills and knowledge, the requalification program for each licensed operator and senior operator of a research reactor or test reactor facility must conform generally but need not be identical to the requalification program outlined in paragraphs (c) (1) through (6) of this section. Significant deviations from the requirements of paragraphs (c) (1) through (6) of this section will be permitted only if supported by written justification and approved by the Commission.		
§ 55.61 Modification and revocation of licenses. (a) The terms and conditions of all licenses are subject to amendment, revision, or modification by reason of rules, regulations, or orders issued in accordance with the Act or any amendments thereto. (b) Any license may be revoked, suspended, or modified, in whole or in part:	**§ 55.61 Modification and revocation of qualifications.** (a) The terms and conditions of all qualifications are subject to amendment, revision, or modification by reason of rules, regulations, or orders issued in accordance with the Act or any amendments thereto.	• Qual vs License

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(1) For any material false statement in the application or in any statement of fact required under section 182 of the Act, (2) Because of conditions revealed by the application or statement of fact or any report, record, inspection or other means that would warrant the Commission to refuse to grant a license on an original application, (3) For willful violation of, or failure to observe any of the terms and conditions of the Act, or the license, or of any rule, regulation, or order of the Commission, or (4) For any conduct determined by the Commission to be a hazard to safe operation of the facility. (5) For the sale, use or possession of illegal drugs, or refusal to participate in the facility drug and alcohol testing program, or a confirmed positive test for drugs, drug metabolites, or alcohol in violation of the conditions and cutoff levels established by § 55.53(j) or the consumption of alcoholic beverages within the protected area of power reactors or the controlled access area of non-power reactors, or a determination of unfitness for scheduled work as a result of the consumption of alcoholic beverages.	(b) Any qualification may be revoked, suspended, or modified, in whole or in part: (1) For any material false statement in the QCRO application or in any statement of fact required under section 182 of the Act, (2) Because of conditions revealed by the QCRO application or statement of fact or any report, record, inspection or other means that would warrant the facility licensee to refuse to grant a QCRO qualification, (3) For willful violation of, or failure to observe any of the terms and conditions of the Act, or the qualification, or of any rule, regulation, or order of the Commission, or (4) For any conduct determined by the Commission to be a hazard to safe operation of the facility. (5) For the sale, use or possession of illegal drugs, or refusal to participate in the facility drug and alcohol testing program, or a confirmed positive test for drugs, drug metabolites, or alcohol in violation of the conditions and cutoff levels established by modified § 55.53(j) or the consumption of alcoholic beverages within the protected area of power reactors or the controlled access area of non-power reactors, or a determination of unfitness for scheduled work as a result of the consumption of alcoholic beverages.	
§ 55.71 Violations. (a) The Commission may obtain an injunction or other court order to prevent a violation of the provisions of -- (1) The Atomic Energy Act of 1954, as amended; (2) Title II of the Energy Reorganization Act of 1974, as amended; or (3) A regulation or order issued pursuant to those Acts. (b) The Commission may obtain a court order for the payment of a civil penalty imposed under section 234 of the Atomic Energy Act: (1) For violations of -- (i) Sections 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Atomic Energy Act of 1954, as amended;	{*deleted*}	• Non-Regulation

10 CFR Part 55 Original Text	Proposed Exemption Text	Basis Category
(ii) Section 206 of the Energy Reorganization Act; (iii) Any rule, regulation, or order issued pursuant to the sections specified in paragraph (b)(1)(i) of this section; (iv) Any term, condition, or limitation of any license issued under the sections specified in paragraph (b)(1)(i) of this section. (2) For any violation for which a license may be revoked under section 186 of the Atomic Energy Act of 1954, as amended.		
§ 55.73 Criminal penalties. (a) Section 223 of the Atomic Energy Act of 1954, as amended, provides for criminal sanctions for willful violation of, attempted violation of, or conspiracy of violate, any regulation issued under sections 161b, 161i, or 161o of the Act. For purposes of section 223, all the regulations in part 55 are issued under one or more of sections 161b, 161i, or 161o, except for the sections listed in paragraph (b) of this section. (b) The regulations in part 55 that are not issued under sections 161b, 161i, or 161o for the purposes of section 223 are as follows: §§ 55.1, 55.2, 55.4, 55.5, 55.6, 55.7, 55.8, 55.11. 55.13, 55.31, 55.33, 55.35, 55.41, 55.43, 55.47, 55.51, 55.55, 55.57, 55.61, 55.71, and 55.73.	{*deleted*}	• Non-Regulation