



Xe-100 Operator Training / Cold Licensing Approach

Brandon Hartle, P.E., Xe-100 Operations Licensing

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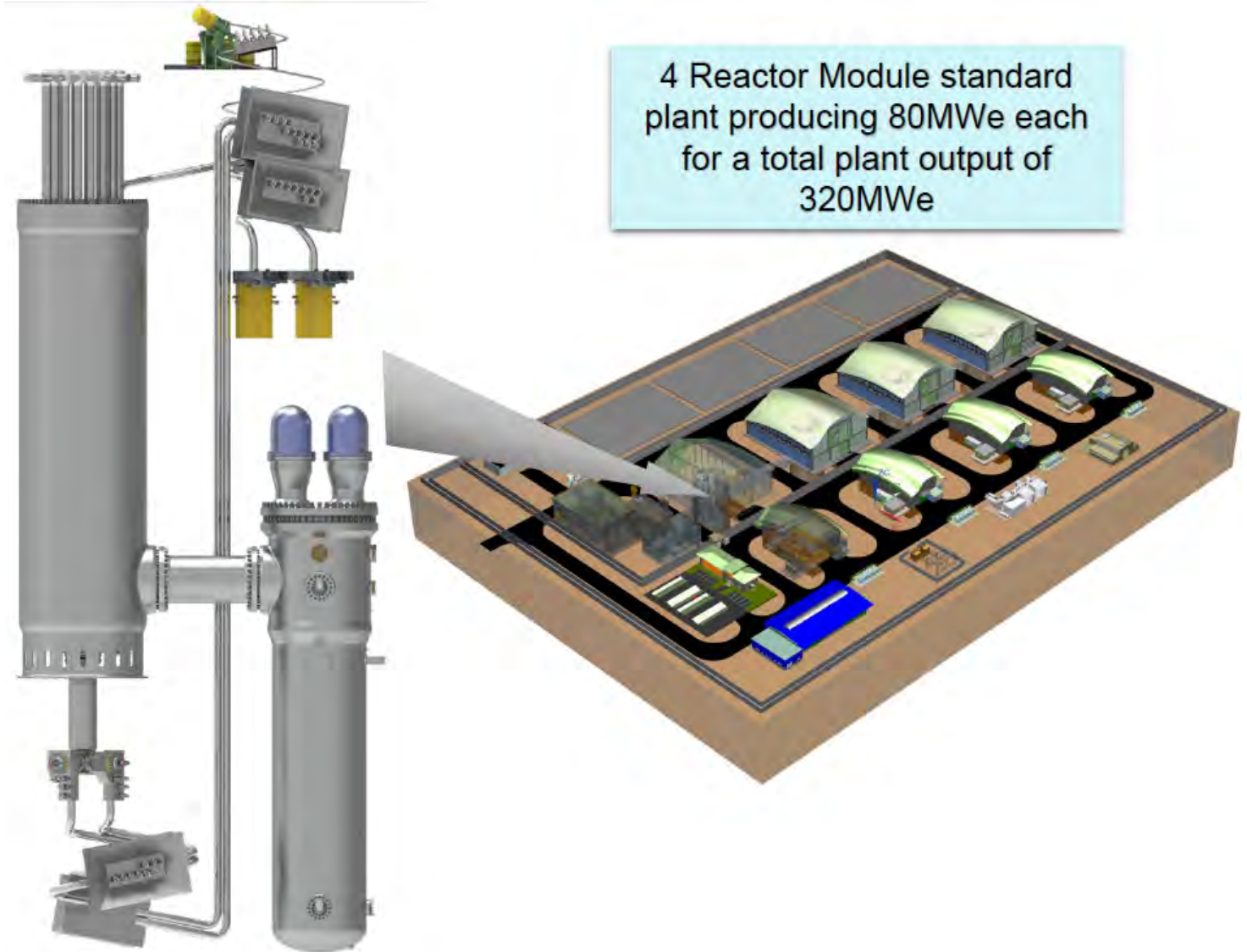
Meeting Agenda

Topic	Time (90 minutes)	Presenter
Opening Remarks	5 minutes	Travis Chapman and Yvotte Brits – X-energy Operator Licensing Branch Chief - NRC
Introductions and Safety Moment	5 minutes	Brandon Hartle – X-energy
Brief Technology Overview	5 minutes	Brandon Hartle
Xe-100 Training Programs	10 minutes	Gregg Crannick – X-energy
Qualified Operators in the Xe-100 Control Room	10 minutes	Gregg Crannick
Operator Training / Cold Licensing Approach	10 minutes	Gregg Crannick
Submittal Schedule	5 minutes	Brandon Hartle
Proposed Future Engagement	5 minutes	Brandon Hartle
NRC Questions and Feedback	30 minutes	NRC staff
Closing Remarks	5 minutes	Brandon Hartle & Operator Licensing Branch Chief – NRC



Brief Technology Overview

- 200 MWt Pebble Bed High Temperature Reactor as the nuclear heat source
- UCO TRISO particle fuel embedded in a graphite matrix spherical fuel element (i.e. pebble)
- Helical coil Steam Generator for producing high quality steam (565 deg C at 16.5 Mpa)
- Standard plant has 4 reactor units that are controlled from a single control room with 3 operators*
- Steam headers can be connected to steam turbines or can provide process heat directly to a plant requiring process steam or heat

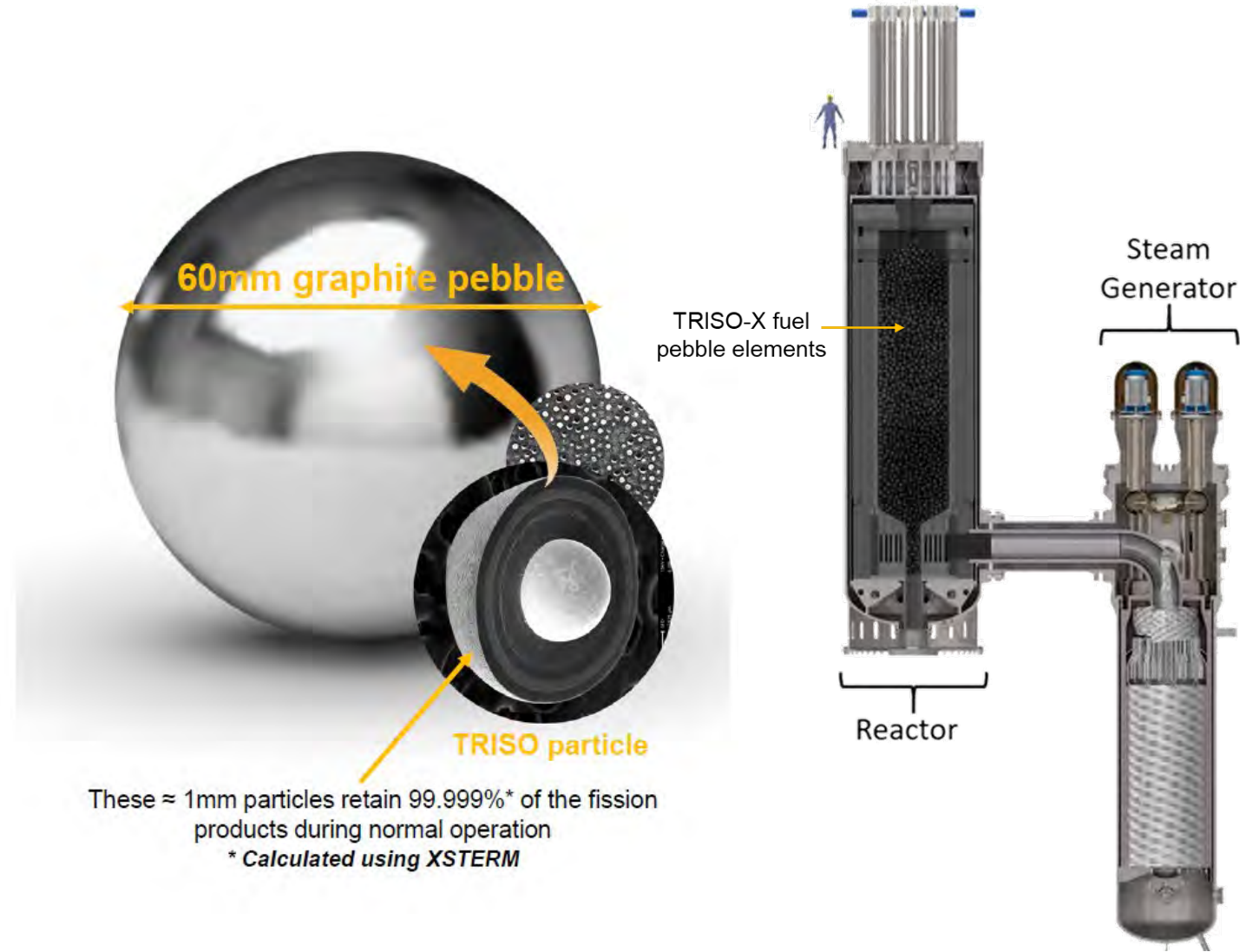


*Topical Report for Control Room Staffing Analysis submitted to the NRC for review (ML22004A333)



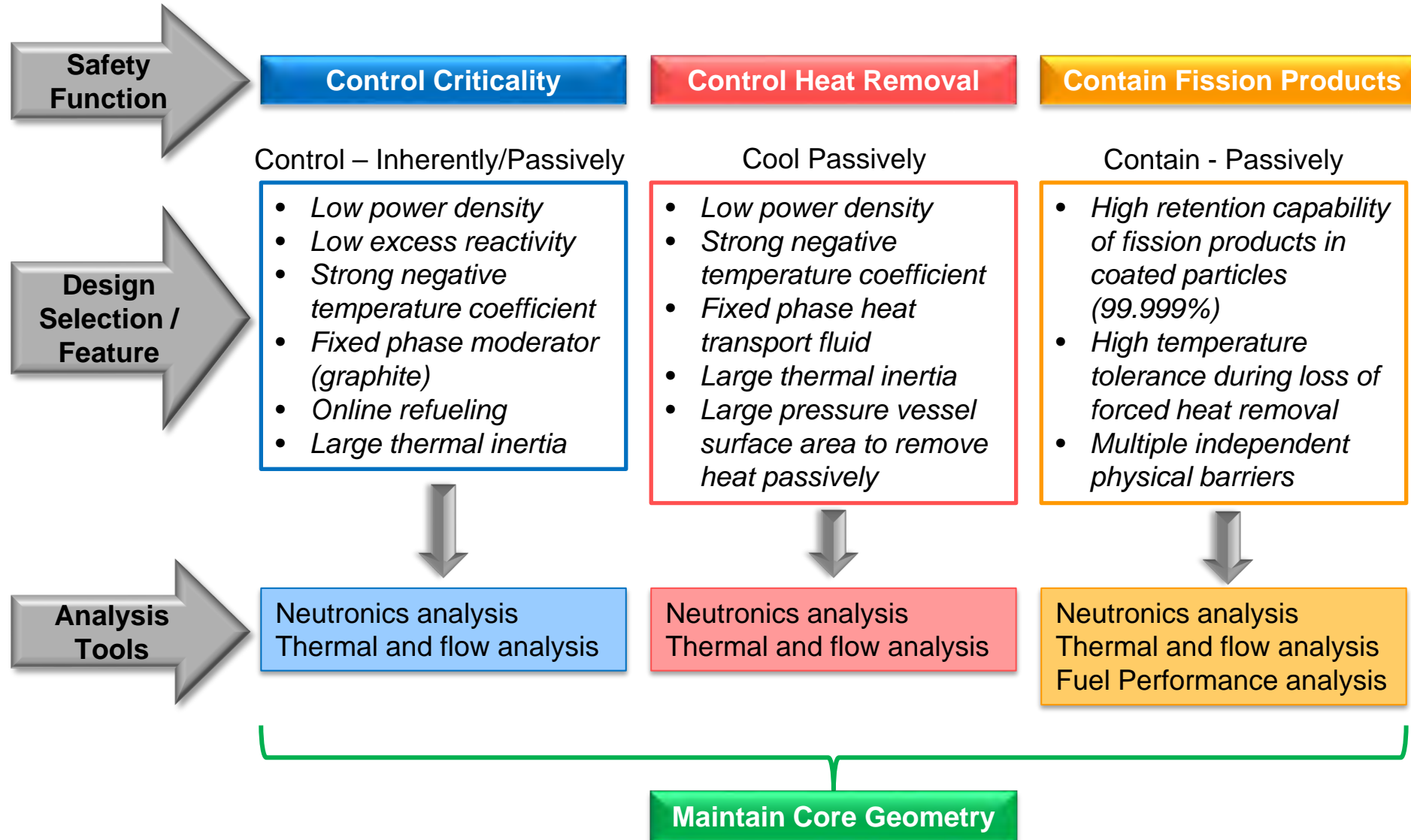
Brief Technology Overview

- TRISO particle fuel has a proven pedigree – more than 30 years of operational and fuel fabrication experience
- Tested to 1800 deg C – remains safe and cannot melt even without active cooling
- Each pebble contains approximately 19,000 TRISO fuel particles
- Each particle retains ~99.999% of fission products, equivalent to each particle being its own functional containment vessel
- These particles replace the need for many complex safety systems required in the current LWR fleet
- Retaining the fission products within the fuel helps engineers simplify the Xe-100 design, which reduces licensing complexity, and increases regulatory efficiency





Brief Technology Overview





Xe-100 Control Room Rendering

Brandon Hartle
Xe-100 Operations Licensing





Xe-100 Training Programs

- Training programs for Xe-100 plant staff
 - Systems Approach to Training process
 - Provide for initial training and continuing training

LWR Positions	Xe-100 Positions
Shift Supervisor / Shift Manager	Shift Supervisor
Senior Reactor Operator	Control Room Operator
Reactor Operator	
Shift Technical Advisor	
Non-licensed Operator	
Instrument and Control Technician	Production Field Technician
Electrical Maintenance Personnel	
Mechanical Maintenance Personnel	
Chemistry Technician	Chemistry / RP Technician
Radiological Protection Technician	
Engineering Support Personnel	Engineering Support Personnel



- SAT Methodology procedure series
 - Analysis Phase
 - Design Phase
 - Development Phase
 - Implementation Phase
 - Evaluation Phase
- Procedure series provides training programs compliant to industry standards and NRC requirements for Systems Approach to Training
 - Uses Phase 1 / Phase 2 approach to address:
 - Initial development
 - Lifetime maintenance
 - Xe-100 being a non-LWR advanced reactor
 - Phase 1 addresses constructing new training programs for the reference plant
 - Phase 2 addresses maintaining Phase 1 training programs for the actual plant
 - Transition from Phase 1 to Phase 2 when plant staff begin performing tasks in their job positions
- References
 - NISP-TR-01, *Systematic Approach to Training Process*
 - NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*



Qualified Operators in the Xe-100 Control Room

Gregg Crannick
Xe-100 Operations Training Manager

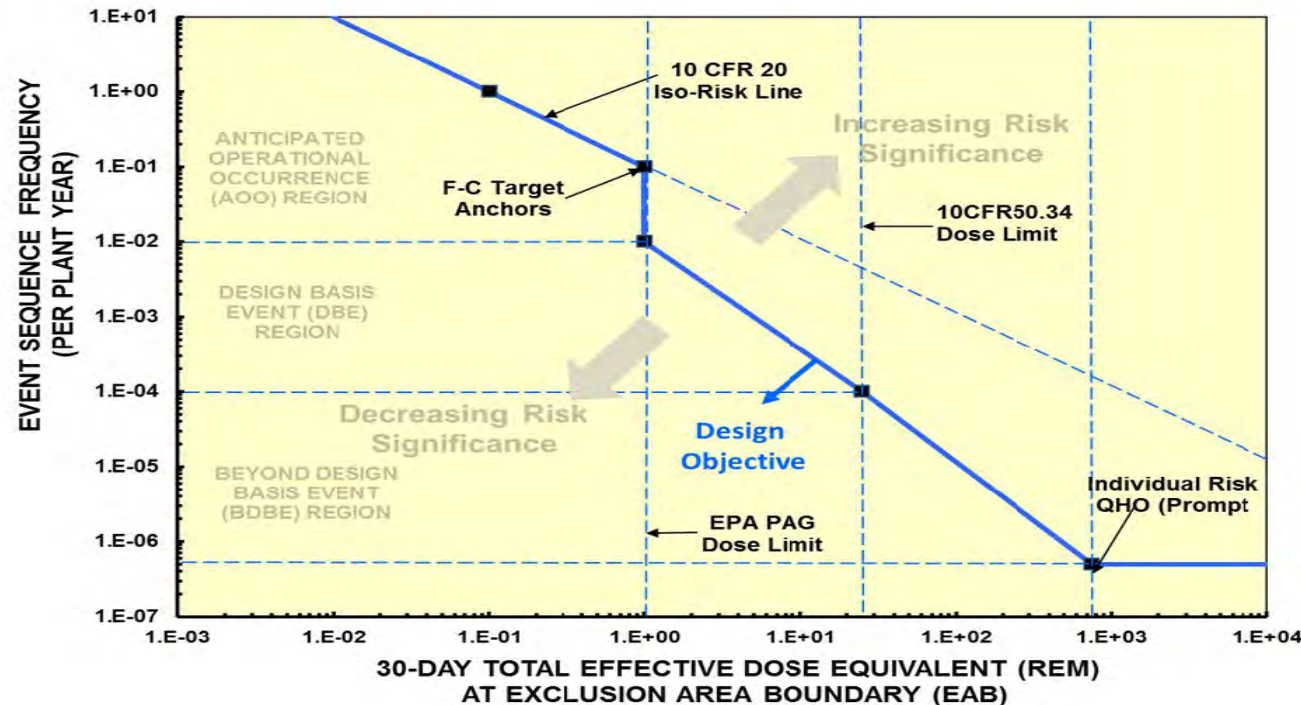
- Xe-100 Operators in the Control Room – Qualified Operators
 - Qualified Operator is similar to Certified Operator from draft Part 53
 - Choosing “Qualified” instead of “Certified” to avoid confusion with other regulatory bodies that use “certified” to mean licensed (e.g., CNSC)
- References:
 - “Risk-Informed and Performance-Based Human-System Considerations for Advanced Reactors” (ML21069A003, March 2021)
 - Part 53 subpart F development
- Purpose/ Definition of a Licensed Operator:
 - “protection of public health from harmful radiation and the management of plant-specific safety functions” – March 2021 paper
- “For an advanced reactor design to be able to justify not using licensed operators, it must be able to demonstrate that adequate protection of the public health and safety will exist in the absence of any operator action for preventing or mitigating accidents” – March 2021 paper
- Six major justifications presented in the March 2021 paper
 - These establish the framework for X-energy’s approach to justify using Qualified Operators



Qualified Operators in the Xe-100 Control Room

Gregg Crannick
Xe-100 Operations Training Manager

1. Accident analysis demonstrates radiological consequence criteria is met without human action needed for mitigation, defense-in-depth, or safe shutdown
 - NEI 18-04 Frequency – Consequence (F-C) plot using PRA results
 - Shows that no human action (error or omission) results in a point exceeding the F-C Target line
 - Remain below and left of the F-C Target line
 - No human action is necessary to protect public health and safety
 - F-C Plot below from NEI-18-04, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development” (ML19241A472)





Qualified Operators in the Xe-100 Control Room

Gregg Crannick
Xe-100 Operations Training Manager

2. Design includes inherent safety characteristics
 - TRISO fuel (each particle acts as its own functional containment; melt-proof)
 - Strong, negative overall reactivity coefficient (strongest contributor is Doppler (fuel temp) coefficient)

3. Full autonomy or degree of autonomy supports safety without operator action
 - Digital Control System (DCS) logics reduce or eliminate human actions, depending on the automated process
 - Reactor Protection System (RPS) overrides DCS and human actions to maintain safety

4. Load-following operations: Demands are assessed and approved by the Control Room Operators to confirm plant conditions support load following
 - Qualified operator retains the ability to resume normal operations at any time (50.54(j) and (k))
 - Multiples layers of checks and balances
 - Grid operator has no ability to manipulate the plant



Qualified Operators in the Xe-100 Control Room

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Xe-100 Operations Training Manager

5. Traditional administrative license duties are maintained by trained on-shift Operators
 - Administrative duties are assigned appropriately to Control Room Operators, Shift Supervisor, etc.
 - Administrative duties are accounted for in Systems Approach to Training process so that the assigned staff position receives the training they need to acquire the necessary knowledge and demonstrate the necessary skills and abilities
 - All Xe-100 Control Room Operators are trained to the same level (equivalent SRO level)

6. STA training is integrated into initial operator training curriculum
 - STA training is integrated into the initial training program for Control Room Operators
 - All Xe-100 Control Room Operators are trained to the same level (equivalent STA level)



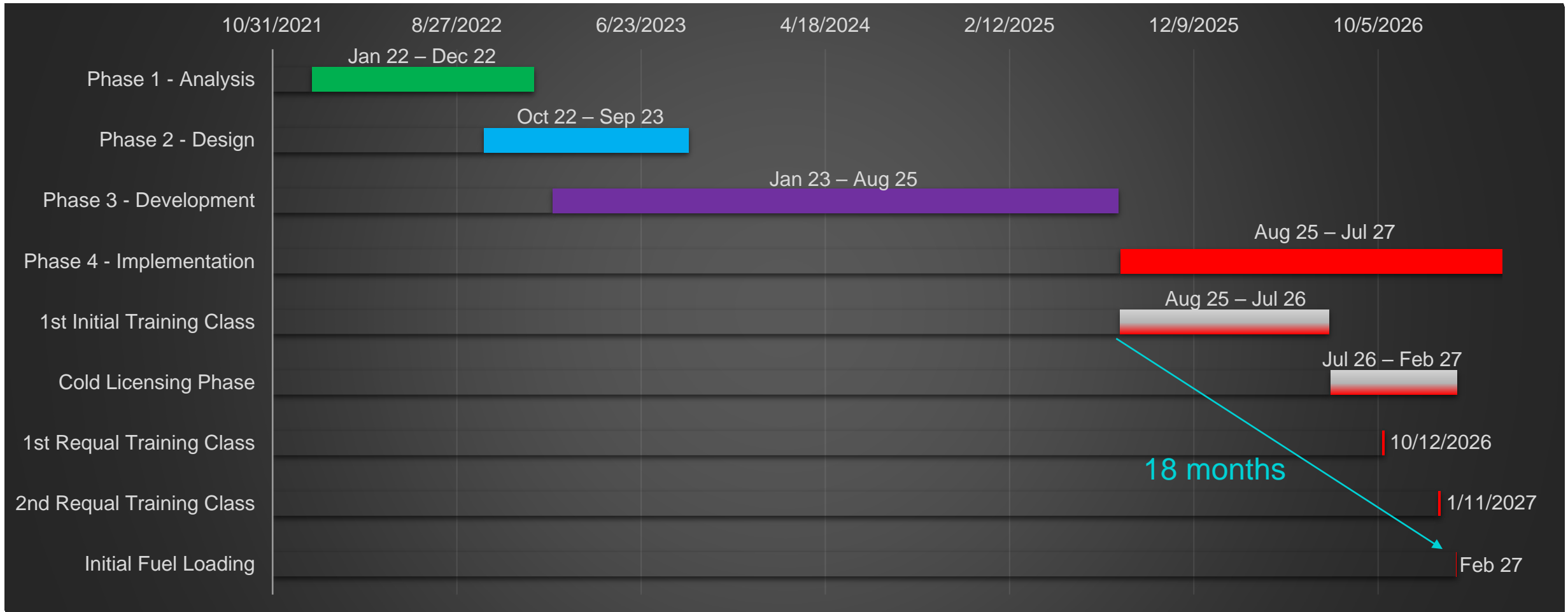
- NEI 06-13A Appendix A is the only industry guideline for Cold Licensing
 - Tied to Part 52 applications
 - LWR-based
 - Developed and implemented to address AP1000 and ABWR installations
- X-energy needs a Cold Licensing strategy that addresses the Xe-100 advanced non-LWR design and a Part 50 application
 - Substantive differences between LWRs and HTGRs
 - Xe-100 utilizes online, automated refueling (no prescribed refueling intervals like LWR)
 - Prior LWR experience does not transfer to Xe-100 the same way it transfers to AP1000
 - Control room staffing numbers are expected to be less than the LWR fleet
 - Eligibility requirements (education and experience) and training durations need to address the following:
 - Smaller crew complements
 - Inherently safer design
 - Simpler operation with greater automation
- X-energy approach is influenced by NEI 06-13A Appendix A guidance but addresses the Xe-100 design and Part 50 application considerations



Tentative Schedule

10 CFR 50.120

(b) *Requirements.* (1)(i) Each nuclear power plant operating license applicant, **by 18 months prior to fuel load**, and each holder of an operating license **shall establish, implement, and maintain a training program** that meets the requirements of paragraphs (b)(2) and (b)(3) of this section.





Submittal Schedule

X-energy Deliverable	Submittal Date	NRC Review
Operator Cold Licensing Approach White Paper	May 2022	45 day comment period
Xe-100 Training Programs Topical Report	October 2022	1 year review with SER
Qualified Control Room Operator Topical Report	December 2022	1 year review with SER
Operator Training / Cold Licensing Approach Topical Report	March 2023	1 year review with SER



Future Engagement Opportunities

- X-energy Operations Licensing is requesting routine regulatory engagement
- Monthly or bi-monthly update meetings if NRC resources are available
- The purposes of these engagements are to:
 - Provide open communication
 - Develop trust with X-energy staff and NRC staff
 - Provide status updates on the Xe-100
 - Receive status updates on Part 53 Rule Language development
 - Identify advanced reactor lessons learned and apply best practices in X-energy deliverables
 - Promote application review efficiency to minimize schedule delays and optimize resources

Questions and Feedback





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