Kairos Power

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US Nuclear Regulatory Commission
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Subject: Kairos Power LLC
Presentation Materials for Kairos Power Briefing to the Advisory Committee on Reactor Safeguards on the Risk-Informed Performance-Based Licensing Basis Development Methodology Topical Report

This letter transmits presentation materials for the September 24, 2020 briefing for the Advisory Committee for Reactor Safeguards (ACRS), Kairos Power Subcommittee. At the meeting, participants will discuss the Risk-Informed Performance-Based Licensing Basis Development topical report (KP-TR-009-NP) that was submitted to the Nuclear Regulatory Commission for review and approval (ADAMS Accession No. ML20101P623).

Enclosure 1 provides the non-proprietary presentation materials. Kairos Power authorizes the Nuclear Regulatory Commission to reproduce and distribute the submitted non-proprietary content, as necessary, to support the conduct of their regulatory responsibilities.

If you have any questions or need any additional information, please contact Drew Peebles at peebles@kairospower.com or (704) 275-5388 or Darrell Gardner at gardner@kairospower.com or (704)-769-1226.

Sincerely,

Darrell Gardner for

Peter Hastings, PE
Vice President, Regulatory Affairs and Quality

Enclosures:

1) Presentation Materials for the September 24, 2020 ACRS Briefing (non-proprietary)

xc (w/enclosure):

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Weidong Wang, Senior Staff Engineer, Advisory Committee for Reactor Safeguards

Enclosure 1

Presentation Materials for the September 24, 2020 ACRS Briefing (non-proprietary)

Kairos Power

RISK-INFORMED PERFORMANCE-BASED LICENSING BASIS DEVELOPMENT METHODOLOGY

ACRS SUBCOMMITTEE MEETING

SEPTEMBER 24, 2020

Kairos Power’s mission is to enable the world’s transition to clean energy, with the ultimate goal of dramatically improving people’s quality of life while protecting the environment.

Agenda

- Introductions and Opening Remarks
- Background of content in Kairos Power's LMP Topical Report
- Comparison of NEI 18-04 and KP-TR-009-NP

Background

- NEI Papers on LBE, PRA, SSC safety classification, and DID adequacy
  - Reviewed by ACRS
  - Input to an integrated guidance document
- NEI 18-04
  - Integrates the guidance from the NEI papers into a document for NRC endorsement
  - Reviewed by ACRS
  - NRC RG 1.233 endorses guidance in NEI 18-04
- Kairos Power Topical Report is based on NEI 18-04
  - Same fundamental methodology
  - Minor changes/departures
- Kairos Power requested NRC review and approval of the methodology as an adequate means to define and evaluate LBEs, classify SSCs, and assess DID adequacy for KP-FHR technology. The NRC has produced a draft SER to approve this methodology.

Comparison of NEI 18-04 and KP-TR-009-NP

- The Kairos Power topical report (KP-TR-009-NP) replicates the methodology from NEI 18-04 with minor changes to the content.
- This presentation will compare and contrast the substantive differences between the reports.
- Editorial changes are excluded from this comparison, including:
  - Re-formatting
  - Identifying language that indicates Kairos Power is implementing methodology
  - Grammar/syntax corrections
  - Style choices (replace "**modules**" with "**units**", replace "**should be**" with "**is**" or "**are**")

Section 3 Selection of Licensing Basis Events

- NEI 18-04, Rev. 1
  - 3.1 Licensing Basis Event Definitions
  - 3.2 **Advanced Non-LWR** LBE Selection Approach
    - 3.2.1 Frequency–Consequence Evaluation Criteria
    - 3.2.2 LBE Selection Process
    - 3.2.3 Evolution of LBEs Through Design **and Licensing** Stages
  - 3.3 Role of the PRA in LBE Selection
    - 3.3.1 Use of PRA in LBE Selection Process
    - 3.3.2 **Non-LWR** PRA Scope for LBE Selection
    - 3.3.3 PRA Scope Adequacy
    - 3.3.4 **PRA** Safety Functions
    - 3.3.5 **Selection of** Risk Metrics for PRA Model Development
    - 3.3.6 Contributors to Risk and Risk Importance Measures
- KP-TR-009-NP, Rev. 1
  - 3.1 Licensing Basis Event Definitions
  - 3.2 LBE Selection Approach
    - 3.2.1 Frequency–Consequence Evaluation Criteria
    - 3.2.2 LBE Selection Process
    - 3.2.3 Evolution of LBEs Through Design Stages
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    - 3.3.1 Use of PRA in LBE Selection Process
    - 3.3.2 PRA Scope for LBE Selection
    - 3.3.3 PRA Scope Adequacy
    - 3.3.4 Safety Functions
    - 3.3.5 Risk Metrics for PRA Model Development
    - 3.3.6 Contributors to Risk and Risk Importance Measures

Section 3 Comparison of NEI 18-04 and KP-TR-009-NP

- Similarities
  - Definitions for AOOs, DBEs, BDBEs, DBAs
  - Definition of the Frequency-Consequence target criteria
  - Use of PRA in LBE selection to develop a comprehensive set of initiating events and event sequences
  - PRA scope addresses spectrum of internal events and external hazards
  - Reactor safety functions defined to correspond to functions modeled in the PRA
  - Overall plant risk metrics defined and risk-significance evaluations performed
  - Kairos importance measure selected from the list of possible measures given in NEI 18-04
- Kairos-specific implementation
  - Replace "The LBEs **identified** in the PRA…" with "The LBEs **corresponding to event sequence families** in the PRA…"
  - Replace "**PRA** Safety Functions" with "Safety Functions"
  - DBA consequences to be calculated using sufficiently bounding models that may not include direct 95th percentile calculation

Section 4 Safety Class and Performance Criteria for SSCs

- NEI 18-04, Rev. 1
  - 4.1 SSC Safety Classification Approach **for Advanced Non-LWRs**
  - 4.2 Definition of Safety-Significant and Risk-Significant SSCs
    - 4.2.1 Safety-Significant SSCs
    - 4.2.2 Risk-Significant SSCs
  - 4.3 SSCs Required for Defense-in-Depth Adequacy
  - 4.4 Development of SSC Design and Performance Requirements
    - 4.4.1 Required Functional Design Criteria for Safety-Related SSCs
    - 4.4.2 **Regulatory** Design Requirements for Safety-Related SSCs
    - 4.4.3 Evaluation of SSC Performance Against Design Requirements
    - 4.4.4 Barrier Design Requirements
    - 4.4.5 Special Treatment Requirements for SSCs
- KP-TR-009-NP, Rev. 1
  - 4.1 SSC Safety Classification Approach
  - 4.2 Definition of Safety-Significant and Risk-Significant SSCs
    - 4.2.1 Safety-Significant SSCs
    - 4.2.2 Risk-Significant SSCs
  - 4.3 SSCs Required for Defense-in-Depth Adequacy
  - 4.4 Development of SSC Design and Performance Requirements
    - 4.4.1 Required Functional Design Criteria for Safety-Related SSCs
    - 4.4.2 Design Requirements for Safety-Related SSCs
    - 4.4.3 Evaluation of SSC Performance Against Design Requirements
    - 4.4.4 Barrier Design Requirements
    - 4.4.5 Special Treatment Requirements for SSCs

Section 4 Comparison of NEI 18-04 and KP-TR-009-NP

- Similarities
  - SSC safety classification approach
  - Definitions of safety-significant and risk-significant SSCs
  - Safety-significance of SSCs required for Defense-in-Depth adequacy
  - Required functional design criteria for safety-related SSCs includes mitigating DBEs and DBAs, and preventing high-consequence BDBEs
  - Design requirements established for safety-related SSCs fulfilling Required Safety Functions
  - Evaluation of safety-related and NSRST SSC performance against Frequency-Consequence targets
  - Radionuclide retention barriers have design criteria derived from evaluation of LBEs against F-C Targets and RFDCs
  - Special treatment requirements added for safety-related and NSRST SSCs
- Kairos-specific implementation
  - Replace "**shall** not exceed" with "**should** not exceed" for integrated plant risk targets
  - Additional required functional design criterion included for shutting down the reactor and maintaining safe shutdown

Section 5 Evaluation of DID Adequacy (1 of 2)

- NEI 18-04, Rev. 1
- 5.1 Defense-in-Depth Philosophy
- 5.2 Framework for Establishing Defense-in-Depth Adequacy
- 5.3 Integrated Framework for Incorporation and Evaluation of DID
- 5.4 How Major Elements of the **TI-**RIPB Framework are Employed to Establish DID Adequacy
- 5.5 RIPB Compensatory Action Selection and Sufficiency
- 5.6 Establishing the Adequacy of Plant Capability DID
  - 5.6.1 Guidelines for Plant Capability DID Adequacy
  - 5.6.2 DID Guidelines for Defining Safety-Significant SSCs
  - 5.6.3 DID Attributes to Achieve Plant Capability DID Adequacy

- KP-TR-009-NP, Rev. 1
- 5.1 Defense-in-Depth Philosophy
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  - 5.6.3 DID Attributes to Achieve Plant Capability DID Adequacy

Section 5 Evaluation of DID Adequacy (2 of 2)

- NEI 18-04, Rev. 1
  - 5.7 Evaluation of LBEs Against Layers of Defense
    - 5.7.1 Evaluation of LBE and Plant Risk Margins
    - 5.7.2 Integrated Decision-Making **Process** Focus in LBE Review
  - 5.8 Establishing the Adequacy of Programmatic DID
    - 5.8.1 Guidelines for Programmatic DID Adequacy
    - 5.8.2 Application of Programmatic DID Guidelines
  - 5.9 Risk-Informed and Performance-Based Evaluation of DID Adequacy
    - 5.9.1 Purpose and Scope of Integrated Decision-Making **Process**
    - 5.9.2 Risk-Informed and Performance-Based Decision Making
    - 5.9.3 IDP Actions to **Establish** DID Adequacy
    - 5.9.4 IDP Considerations in the Evaluation of DID Adequacy
    - **5.9.5 Baseline Evaluation of Defense-in-Depth**
    - **5.9.6 Considerations in Documenting Evaluation of Plant Capability and Programmatic DID**
    - 5.9.**7** Evaluation of Changes to Defense-in-Depth

- KP-TR-009-NP, Rev. 1
  - 5.7 Evaluation of LBEs Against Layers of Defense
    - 5.7.1 Evaluation of LBE and Plant Risk Margins
    - 5.7.2 Integrated Decision-Making **Panel** Focus in LBE Review
  - 5.8 Establishing the Adequacy of Programmatic DID
    - 5.8.1 Guidelines for Programmatic DID Adequacy
    - 5.8.2 Application of Programmatic DID Guidelines
  - 5.9 Risk-Informed and Performance-Based Evaluation of DID Adequacy
    - 5.9.1 Purpose and Scope of Integrated Decision-Making **Panel**
    - 5.9.2 Risk-Informed and Performance-Based Decision Making
    - 5.9.3 IDP Actions to **Confirm** DID Adequacy
    - 5.9.**4** Evaluation of Changes to Defense-in-Depth

Section 5 Comparison of NEI 18-04 and KP-TR-009-NP

- Similarities
  - Defense-in-depth philosophy
  - Framework for establishing DID adequacy includes Plant Capability, Programmatic, and Risk-Informed elements
  - 18 tasks in an integrated framework for information of evaluation of defense-in-depth
  - Approach to establishing the adequacy of plant capability DID using the same guidelines
  - Evaluation of LBEs against layers of defense
  - Establishing adequacy of programmatic DID using the same guidelines
  - Risk-informed, performance-based evaluation of DID adequacy using the IDP
- Kairos-specific implementations
  - Replace “Integrated Decision-Making **Process**” with “Integrated Decision-Making **Panel**”
  - Programmatic focus on event sequence frequency targets rather than SSC reliability targets (at the SSC level, focus on performance-based measures)
  - Section 5.9.5 and 5.9.6 in NEI 18-04 provided helpful information for developers on internal baselines and documentation, but these sections were relevant to the topical report

Conclusions

- Kairos Power considers the Licensing Modernization Project methodologies as an adequate means to develop Licensing Basis Events, SSC safety classifications, and to confirm the adequacy of the defense-in-depth attributes of the KP-FHR.
- The report details the KP-FHR methodologies, which are based on the methodologies presented in NEI 18-04 and RG 1.233
- Kairos Power requested NRC review and approval of the methodology as an adequate means to define and evaluate LBEs, classify SSCs, and assess DID adequacy for KP-FHR technology. The NRC has produced a draft SER to approve this methodology.


Questions