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4 INTEGRATED EVALUATIONS

4.1 Overall Plant Risk Performance Summary

4.1.1 Introduction of Plant Risk Performance

Section 4.1 of the Kemmerer Unit 1 (KU1) preliminary safety analysis report (PSAR) summarizes the preliminary evaluation of the overall plant risk to public health and safety from plant operation. The PSAR discussion compares analysis results to the cumulative risk metric targets described in Nuclear Energy Institute (NEI) 18-04, Revision 1, "Risk-Informed Performance-Based Technology-Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development" (Agencywide Documents Access and Management System (ADAMS) Accession No.: ML19241A472). PSAR section 4.1 describes the cumulative risk metric results of the preliminary integrated performance assessment performed for this purpose and compares them to the NEI 18-04 cumulative risk metric targets. As stated in PSAR section 4.1, the integrated performance assessment uses the same considerations, methodologies, and analytical tools described in PSAR section 3.1, "Probabilistic Risk Assessment." PSAR section 4.1 includes assessment of other quantified events (OQEs) from the PRA in addition to the non-design basis accident (DBA) licensing basis events (LBEs) described and evaluated in PSAR chapter 3.

Section 4.1, "Overall Plant Risk Performance Summary," of NEI 21-07, Revision 1, "Technology-Inclusive Content of Applications – Construction Permits and Operating Licenses for Non-Light Water Reactors," (ML22060A190), endorsed by RG 1.253, Revision 0, "Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," (ML23269A222), states that this section describes the integrated plant performance for the three cumulative plant performance metrics identified in NEI 18-04, section 3.2.2, Task 7b, "Evaluate Integrated Plant Risk Against QHOs and 10 CFR 20." The evaluation of overall risk includes anticipated operational occurrences (AOOs), design basis events (DBEs), and beyond design basis events (BDBEs).

4.1.2 Regulatory Evaluation of Plant Risk Performance

The applicable regulatory requirements for the evaluation of overall plant risk performance are as follows:

- 10 CFR 50.34 sections (a)(1) and (a)(4)
- 10 CFR 50.35

The applicable guidance for the evaluation of overall plant risk performance are follows:

- RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors" (ML20091L698)

- RG 1.253, “Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors” (ML23269A222)

4.1.3 Technical Evaluation of Plant Risk Performance

RG 1.233, which endorses NEI 18-04, with clarifications, both describe the three cumulative risk metrics that need to be met to evaluate the integrated plant performance in any application based on the Licensing Modernization Project (LMP) methodology. As described in NEI 18-04, an applicant using LMP evaluates the integrated risk of all LBEs against three cumulative risk metrics. The first cumulative risk metric is based on the annual radiation dose limit for individual members of the public as specified in 10 CFR 20.1301(a)(1). The other two cumulative risk metrics ensure that the U.S. Nuclear Regulatory Commission (NRC) safety goal quantitative health objectives (QHOs)¹ are satisfied. These three cumulative risk metrics as defined in NEI 18-04 are:

- The total mean frequency of exceeding a site boundary dose of 100 mrem from all LBEs should not exceed one per plant-year.
- The average individual risk of early fatality within one mile of the exclusion area boundary (EAB) from LBEs, based on mean estimates of frequencies and consequences, should not exceed 5×10^{-7} per plant-year.
- The average individual risk of latent cancer fatalities within 10 miles of the EAB from all LBEs, based on mean estimates of frequencies and consequences, should not exceed 2×10^{-6} per plant-year.

The staff compared the cumulative risk metrics in PSAR section 4.1 to the guidance in NEI 18-04 and determined that the metrics were consistent with the exception that OQEs from the PRA were included in the integrated plant performance evaluation in addition to the LBEs required in the LMP methodology. The staff determined that this deviation was acceptable because the content of information in PSAR section 4.1 is consistent with the guidance for the content of construction permit (CP) applications found in section C.4.1 of NEI 21-07, “Overall Plant Risk Performance Summary,” as endorsed by RG 1.253 with certain clarifications, and the inclusion of the OQEs adds additional information in the integrated plant performance evaluation. Further consideration of the inclusion of OQEs in the analysis is discussed later in this section.

As stated in RG 1.253, section C.4.1 of NEI 21-07 provides an acceptable method for developing information related to the integrated risk evaluation and describes that the safety analysis report should include an overall plant risk performance summary and describe margins between predicted plant performance and risk targets. The overall plant risk performance summary and evaluation results are provided in PSAR sections 4.1.1 through 4.1.3. The overall plant risk performance results in these sections are given as mean values without uncertainties. The staff determined this was an acceptable approach because it is consistent with the

¹ “Safety Goals for Operations of Nuclear Power Plants; Policy Statement; Republication,” Federal Register, Vol. 51, No. 162, August 21, 1986, pp. 30028-30033 (51 FR 30028).

guidance in NEI 18-04 for cumulative risk metrics. Additionally, the staff determined the results reported in PSAR sections 4.1.1 through 4.1.3 meet the overall plant risk performance acceptance criteria. Based on available margin to each of the cumulative risk metrics, the staff also determined the evaluations reasonably account for uncertainties.

The staff also reviewed the technical basis for the calculation of overall integrated risk described in the PSAR. The staff's review considered the PSAR chapter 3 subsections that include the description of the PRA, the evaluation of LBEs, and the methods to estimate event frequencies and consequences. As stated in PSAR section 4.1, the integrated risk assessment included the AOOs, DBEs, and BDBEs, but did not include the DBAs, which are evaluated deterministically. The staff compared the selected events for the evaluation and the guidance in NEI 21-07 section C.4.1 (which is endorsed by RG 1.253) and determined the selected events were consistent. The integrated risk assessment includes only internal event LBEs, which is consistent with the state of PRA development for the construction permit application as described in PSAR section 3.1. The integrated risk assessment provided in the final safety assessment report (FSAR) for the operating license (OL) application should be updated to include all modes, all hazards, and all sources. As described in SE section 3.1, the staff determined that the scope, level of detail, and quality of the KU1 PRA are reasonable for the CP application. Therefore, the staff determined that the preliminary integrated risk assessment acceptably uses a PRA which is consistent with the overall PRA acceptability for use in the NEI 18-04 process for the PSAR. As described in SE section 3.3 the staff's review determined that the LBE selection and categorization methodology and analysis methodologies adequately supports the issuance of a CP.

The applicant deviated from the NEI 18-04 methodology for the integrated risk assessment by including OQEs. The applicant stated OQEs are events beyond the LBE frequency cutoff (i.e., with mean frequency less than 5×10^{-7} per plant-year) with quantified consequences. The OQEs provide additional information into the integrated risk assessment regarding radiological release events with very low likelihood. PSAR section 4.1 states that for the OQEs which include sodium pool boiling, the consequence analyses used a local sodium pool boiling source term based on the key assumption that bulk sodium boiling does not occur. The discussion in PSAR section 4.1 acknowledges that this key assumption may underestimate the total calculated cumulative risk results given the analysis which includes these OQEs in the events. However, the PSAR states that the overall integrated risk assessment results are conservative as compared to what would be the results of the NEI 18-04 methodology, which does not include events below the LBE frequency cutoff. The integrated risk results for all non-DBA LBEs and OQEs reported in PSAR section 4.1 demonstrate a large margin to each of the cumulative risk metrics. The staff determined that including OQEs in the integrated risk assessment, even with the potential underestimated results for some of the OQEs, provides additional information than the NEI 18-04 integrated risk assessment envisioned. Therefore, the staff determined that the key assumption of no bulk sodium boiling in the OQEs does not negatively affect the integrated risk assessment and evaluation against the cumulative risk metrics and provides information on the overall plant risk as necessary for the LMP process. As discussed above, the staff determined that the integrated risk assessment information provided in the PSAR is consistent with the applicable guidance documents RG 1.233 and RG 1.253 on the basis that PSAR

section 4.1 is supported by analyses that include the entire range of potential radiological release events (other than DBAs) for the facility.

In evaluating the PSAR basis for concluding that the overall integrated risk methodology and analysis are acceptable, the staff confirmed the PSAR description of the integrated risk evaluation through audit of supporting documentation of the event-specific radiological source terms and consequence analyses. For event quantification, the event-specific source terms are developed through use of an approved methodology, then each source term is input to the separate approved consequence analysis methodology to estimate the event-specific consequence. The event-specific LBE radiological source terms are the same as used in the analyses supporting PSAR Chapter 3, while the OQE radiological source terms were developed using the same approved radiological source term methodology, NAT-9392-A, Rev. 0, "Radiological Source Term Methodology Topical Report" (ML25211A271), as was used to develop source terms for the LBEs. The staff's evaluation of the event-specific radiological source terms and the applicant's implementation of the NAT-9392 methodology is discussed in section 3.3 of this SE.

Through the regulatory audit, the staff confirmed that the integrated risk assessment consequence analyses were performed consistent with the NAT-9391-A, Rev. 0, "Radiological Release Consequences Methodology Topical Report," (ML25211A267) LBE evaluation model, including modeling of the site environs and population as stated in the PSAR. The analyses modeled a uniform population with no credit for emergency response actions consistent with the approved radiological release consequences methodology. The staff determined that this modeling of the population provides consequence results which are bounding for the actual population around the KU1 site. The analyses used generic meteorological data which are based on the Electric Power Research Institute (EPRI) Utility Requirements Document (URD) as described in NAT-9391, based on an assumption that the data is conservatively representative of the KU1 site location. The use of generic meteorological data in lieu of site-specific data in the LBE evaluation model is the subject of a limitation and condition on use of NAT-9391. The staff's evaluation of the PSAR implementation of NAT-9391, including the acceptability of use of generic meteorological data is discussed above in SE section 3.3. To fully meet the limitation and condition on the use of NAT-9391, the consequence analyses supporting the integrated risk assessment provided in the FSAR for the OL application should include a specific justification demonstrating that the generic meteorological data and modeling of atmospheric dispersion are representative of the actual conditions at the KU1 site. Therefore, the staff determined that the integrated risk assessment used acceptable methods to quantify the consequences.

As discussed above, the staff determined that the integrated risk assessment information provided in the PSAR is consistent with the applicable guidance documents RG 1.233 and RG 1.253 on the basis that PSAR section 4.1 is supported by analyses that use approved source term and consequence analysis methods with appropriate input and assumptions to quantify the consequences and provide mean risk results for the KU1 facility to compare to the NEI 18-04 cumulative risk metrics.

4.1.4 Conclusion on Plant Risk Performance

The staff reviewed the overall plant risk performance information described in PSAR section 4.1 and determined that the integrated risk assessment included the range of potential radiological release events for the facility, based on internal events, as consistent with the CP stage of review; used acceptable methods to quantify the consequences; and provided mean risk results to compare to the NEI 18-04 cumulative risk metrics, in accordance with the guidance in RG 1.233. The staff finds that the overall plant risk performance information provided in the PSAR is consistent with the guidance in RG 1.253 and NEI 21-07, and that it provides a complete, consistent, and integrated summary of the plant risk to public health and safety, given the preliminary design information. This is consistent with the overall PRA acceptability for use in the NEI 18-04 process for the PSAR. Therefore, the staff concludes that the overall plant risk performance information adequately supports the issuance of a CP pursuant to the regulations of 10 CFR 50.34(a)(1) and (4) and 10 CFR 50.35.

4.2 Defense-in-Depth

4.2.1 Introduction of Defense-in-Depth

Section 4.2 of the Kemmerer Unit 1 (KU1) PSAR describes the methodology that the applicant used to assess the acceptability of the plant capability and programmatic measures that provide defense-in-depth (DID), and the results of the DID adequacy evaluation.

4.2.2 Regulatory Evaluation of Defense-in-Depth

The applicable regulatory requirements for the evaluation of DID are as follows:

- 10 CFR 50.34 sections (a)(1) and (a)(4)
- 10 CFR 50.35

The applicable guidance for the evaluation of DID is as follows:

- RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors"
- RG 1.253, "Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors"

RG 1.233 endorses, with certain clarifications, the risk-informed and performance-based methods described in NEI 18-04 for assessing the adequacy of DID. In the approach described in NEI 18-04 and RG 1.233, the applicant evaluates the LBEs, which are described in PSAR chapter 3, using an integrated, risk-informed process to ensure DID adequacy. Structures, systems, and components (SSCs) relied on for DID are identified as plant capability DID. Programmatic DID measures (e.g., special treatments, operational programs) are also evaluated through this process, though limited information is expected at the CP stage.

RG 1.253 endorses, with certain clarifications, the guidance in NEI 21-07 regarding the content of applications for non-LWR designs that follow the risk-informed process described in NEI 18-04 and provides guidance regarding implementation of the NEI 18-04 methodologies. RG 1.253, Appendix A, also contains guidance regarding the scope and level of detail in the PRA analysis that is necessary to support a CP application. The NEI 21-07 guidance discusses the level of detail that needs to be in the PSAR to adequately summarize the results of the assessment of the adequacy of DID, recognizing the preliminary nature of the design and PRA analysis.

4.2.3 Technical Evaluation of Defense-in-Depth

The staff evaluated the information in PSAR section 4.2 against the applicable regulations and guidance discussed in the Regulatory Evaluation section above. The staff reviewed the applicant's DID evaluation to ensure consistency with the methodology specified in NEI 18-04 (as endorsed by RG 1.233) and documentation specified in NEI 21-07 (as endorsed by RG 1.253).

Because the CP stage involves preliminary design and analyses, and because programmatic measures have not yet been fully developed, the staff's review only included DID measures associated with the reactor design and full power, low power, and shutdown operating operations, as described in detail below. DID associated with other operating states, non-reactor SSCs, and programmatic measures will be reviewed at the OL stage. In addition, the staff considered RG 1.253, which endorses NEI 21-07 with clarifications, as it provides guidance on the DID adequacy information expected to be included in the PSAR.

4.2.3.1 Plant Capability DID

The staff reviewed USO's technical basis for the plant capability DID, described in PSAR sections 4.2.1, "Plant Capability Summary." The applicant stated that the plant capability DID evaluation provides for the following, consistent with section 5 of NEI 18-04:

- Margin to the frequency-consequence (F-C) target curve is maintained for all individual LBEs
- Frequency of DBEs and BDBEs is maintained below $1 \times 10^{-2}/\text{yr}$ and $1 \times 10^{-4}/\text{yr}$, respectively
- Individual risks are below the QHOs
- There is sufficient independence between defense lines (DLs)
- There is assurance against over-reliance on any single feature across DLs
- There is sufficient balance between prevention and mitigation in the DLs

NEI 21-07 additionally establishes that the plant capability evaluation should (1) address LBE margins for risk-significant LBEs, (2) evaluate the adequacy layers of defense, (3) assess reliance on single-feature, and (4) address the balance between prevention and mitigation features across defense layers. The applicant's PSAR addressed these items and the staff's evaluation below considers both the NEI 18-04 and NEI 21-07 guidance.

4.2.3.1.1 LBE Margin

NEI 21-07 section 4.2.1.1, “LBE Margin,” states that applicants should provide the baseline margins established between the frequencies and consequences of individual risk-significant AOOs, DBEs, and BDBEs, and the F-C target. The guidance states that margins to the F-C target should be demonstrated for both mean and 95th percentile dose consequences.

KU1 PSAR section 4.2.1.1, “LBE Margin,” discusses the LBE margin evaluation. Table 4.2-1, “Mean Risk Margins for Risk-Significant LBEs,” of the PSAR provides the margins from the mean frequency and dose to the F-C target curve for LBEs identified as risk-significant based on the mean risk. Table 4.2-2, “95th Percentile Risk Margins for Risk-Significant LBEs,” provides the margins from the 95th percentile frequency and risk to the F-C target curve for LBEs identified as risk significant based on the 95th percentile risk. USO reported no risk-significant AOOs but identified several risk-significant DBEs and BDBEs. The tables show that the risk-significant LBEs maintain margin to the F-C target curve.

Based on this, the NRC staff determined that margin evaluation is consistent with the guidance in NEI 21-07 by demonstrating that risk-significant LBEs maintain margin to the F-C target curve. The methods used to determine the frequencies and consequences of the LBEs are evaluated in chapter 3 of this safety evaluation (SE).

4.2.3.1.2 Layers of Defense Evaluation

Section 4.2.1.2 of NEI 21-07, “Layers of Defense Evaluation,” states that applicants should discuss the layers of defense relative to the guidelines provided in NEI 18-04 table 5-2, “Guidelines for Establishing the Adequacy of Overall Plant Capability Defense-in-Depth,” and discuss any deviations. KU1 PSAR section 4.2.1 describes the five defense lines (DL) to which functions are assigned:

- DL1: Plant design features that reduce or eliminate postulated initiating events (PIEs).
- DL2: Functions that control AOOs and prevent DBEs.
- DL3: Functions that control DBEs and prevent BDBEs.
- DL4: Functions that control severe plant conditions and mitigate the consequences of DBEs.
- DL5: Functions associated with offsite protective measures, which currently include only post-accident monitoring.

The staff compared the defense layer definitions provided in the PSAR and found them to be consistent with the NEI 18-04, table 5-2, “Guidelines for Establishing the Adequacy of Overall Plant Capability Defense-in-Depth,” guideline and thus to be acceptable.

The staff identified through review of the information in the PSAR that the assignment of functions to defense layers is related, in part, to their safety classification. The PSAR presents DL3 functions as exclusively safety related while DL2 and DL4 functions are a mix of non-safety related with special treatment (NSRST) and non-safety related with no special treatment (NST).

DL1 functions are not evaluated for their safety significance; the staff considers this a deviation from the guidance, as discussed further in section 5.1 of this SE, but also notes that the applicant has developed a process to address the safety classification of these functions for the OL application.

All DL1 functions are listed in table 4 of NAT-4770, Revision 1, "Natrium Demonstration DID Evaluation Report," (ML25205A088) which was submitted as a supplement to the CP by the applicant (ML25205A087) and reviewed by the staff for context on the SSC descriptions, safety classifications, and DID evaluation. The staff reviewed the DL1 functions and features listed in NAT-4770, Rev. 1, against the SSC descriptions provided in chapters 1 and 7 of the PSAR. The staff determined that the system descriptions provided in chapters 1 and 7 of the PSAR appropriately include these DL1 features, thereby ensuring they are part of the design basis.

NEI 21-07 also states that applicants should provide a summary of the layers of defense for each risk-significant LBE and describe the extent of independence among the layers. It also establishes that applicants should address the quantitative and qualitative guidelines for each layer provided in NEI 18-04 table 5-2.

For DL1, the quantitative and qualitative guideline is to maintain frequency of plant transients within designed cycles and meet owner requirements for plant reliability and availability. However, there is also a note that the DL1 features contribute to the protective strategies and should be addressed by design-specific targets. For DL2, the quantitative guideline is that functions should be identified for risk-significant AOOs that serve to keep the frequency of DBEs below 1×10^{-2} /plant-year. Phrased differently, if a function identified in this process had a higher failure rate, an LBE currently identified as a DBE would cross into the AOO region. Similarly, for DL3, functions should be identified for risk-significant DBEs that serve to keep the frequency of BDBEs below 1×10^{-4} /plant-year. For DL4 and 5, the quantitative guideline is to identify those functions relied on for BDBEs to maintain individual risks less than the QHOs.

The DL1 functions are discussed more above, where the staff noted that they will be further dispositioned at the OL. For DL2, no risk-significant AOOs are identified in the application. PSAR table 4.2-3, "Evaluation of DL Functions for Risk-Significant DBEs," provides a list of the functions relied upon in the risk-significant DBE evaluations to maintain frequency of BDBEs less than 1×10^{-4} /plant-year. This table identifies two DL3 functions, both related to the primary functional containment boundary, that maintain the frequency of BDBEs less than 1×10^{-4} /plant-year. PSAR table 4.2-4, "Evaluation of DL Functions for Risk-Significant BDBEs," provides a list of the functions relied on in the evaluation of the risk-significant BDBEs to maintain individual risks less than the QHOs. This table identifies one function needed to maintain individual risks less than the QHOs. The staff determined that the information provided relative to the quantitative guidelines is consistent with the guidance in NEI 21-07 and is thus acceptable.

NEI 18-04 table 5-2 also provides qualitative guidelines for the layers. For DL2, the qualitative guideline is to minimize the frequency of challenges to SR SSCs. While no risk-significant AOOs were identified, the staff also reviewed all of the AOOs in chapter 3.5 of this SE and determined that the DL2 functions relied on act to minimize challenges to SR SSCs – for example, intermediate air cooling (IAC) in the non-passive mode is relied on for decay heat removal so as

not to rely on the SR reactor air cooling system (RAC). For DL3 and DL4, the qualitative guidance relates to avoiding reliance on a single feature in meeting the quantitative DID objectives. PSAR tables 4.2-3 and 4.2-4 provide a column stating that there are no single design or operational features relied on for each LBE family. The staff reviewed the LBEs identified and confirmed that multiple functions are available to meet the quantitative objectives – for example, for RFH-FDIV-1 which relies on the primary functional containment boundary, the head access area (HAA) is also available as a radionuclide retention barrier in DL4. As such, the staff determined the information provided is consistent with the guidance in NEI 21-07 and thus acceptable.

As for independence between the layers, PSAR section 4.2.1 provides information on how the applicant structured the DLs to include diverse and independent means of mitigating LBEs in separate DLs. The method used by the applicant explicitly factors in common-cause failure (CCF). The staff noted that in this approach, DL2 and DL4 are independent from DL3, but DL2 and DL4 may include common systems and may not be fully independent. The staff reviewed this approach and determined that it will result in multiple independent layers of defense available for AOOs (either DL2 and DL3 or DL3 and DL4). The staff also determined that multiple independent layers of defense will be available for DBEs (either DL2 and DL3 or DL3 and DL4), unless the DBE is initiated by a CCF. If the CCF is in DL2 or DL4, only DL3 may be available (though DL2 or DL4 functions may be available if not failed due to the CCF). If the CCF is in DL3, only DL4 may be available (though DL2 may be available if not assumed failed in the analysis). The staff determined these exceptions are reasonable because they ensure at least one independent function is available beyond the initiating CCF. DL4 alone is typically relied on for BDBEs, unless DL2 or DL3 functions are available. This is consistent with the definition of DL4 in NEI 18-04 for controlling severe plant conditions and mitigating the consequences of BDBEs, and is thus acceptable to the staff. As such, the staff considers the overall approach to DL independence to be acceptable.

The applicant performed a detailed evaluation of the layers of defense for all LBEs (not just risk-significant ones) in NAT-4770. Since different events in an LBE family credit different combinations of SSCs to prevent or mitigate the transient, the evaluation considered layers of defense across the LBE family. The staff reviewed the layers of defense credited for each LBE and found them to be consistent with the safety analysis as documented in PSAR chapter 3, as noted for each LBE in the text in SE sections 3.5 through 3.8 and the corresponding rows in the tables in each section which document the credited SSCs. Although some event sequences assume failure of some or all available functions, which is reasonable based on their modeling in the PRA, the staff confirmed that multiple, independent layers of defense remain available for each LBE with respect to all applicable fundamental safety functions. There is one exception, which is discussed below in SE report section 4.2.3.1.3.

4.2.3.1.3 Single Feature Reliance

Section 4.2.1.3 of NEI 21-07 states that applicants should evaluate dependence on a single feature for risk-significant LBEs and DBAs. The applicant should also discuss both the method

used to perform this evaluation as well as any special treatments applied to avoid over-reliance on a single feature across multiple layers of events.

PSAR section 4.2.1.3 summarized the DL function evaluation and identified no single feature that is relied upon for the risk significant LBEs. The staff reviewed the evaluation in NAT-4770 and determined that there is no over-reliance on a single function for the risk-significant LBEs, as discussed above with respect to the layers of defense evaluation.

The applicant's evaluation identified a DBA—RRS-ISPL-CN, a release from the intermediate sodium processing system—that is reliant on a single layer of defense to avoid a release. The function relied on is DL2-RR8, the intermediate cold trap SPS barrier, which is assumed to fail as the initiating event in the DBA. However, because the DBA stays within the 10 CFR 50.34 dose acceptance criterion, the applicant did not identify any additional layers of defense needed to provide adequate DID.

NEI 18-04 indicates in table 5-2, "Guidelines for Establishing the Adequacy of Overall Plant Capability Defense in Depth," that "reliance" in the context of a DID adequacy evaluation is evaluated against the quantitative objective, i.e., the F-C target curve for LBEs and the dose criterion for DBAs, as well as the integrated risk measures. Because the F-C target is met for the DBE and the dose criteria are met for the DBA as discussed in PSAR sections 3.7.3.3 and 3.9.4.2 and sections 3.6.3.3 and 3.8.3.4 of this SE, the staff does not consider the function to be relied on for the purposes of the DID adequacy evaluation. Accordingly, the staff determined that USO's single-feature reliance evaluation is acceptable.

4.2.3.1.4 Prevention-Mitigation Balance

Section 4.2.1.4 of NEI 21-07 states that applicants should evaluate the balance of preventative and mitigative features across layers of defense for all risk-significant LBEs and DBAs. The applicant should also discuss both the method used to perform this evaluation as well as capabilities or programmatic actions added as a result of the evaluation. Additionally, NEI 21-07 refers to section 5.7 of NEI 18-04 which states that the DID evaluation should confirm that a balance between event prevention and mitigation is reflected in the layers of defense for risk-significant LBEs.

PSAR section 4.2.1.4 states that the applicant performed an evaluation to ensure prevention and mitigation DL functions exist for risk-significant LBEs and DBAs, by identifying DLs that are available to prevent or mitigate each event. The defense layer evaluation discussed in PSAR section 4.2.1.3 and provided in NAT-4770 was used to identify preventative and mitigative functions available for each LBE. The applicant stated that prevention-mitigation balance was generally confirmed by ensuring DL1 features are available to prevent events, and that functions are identified for each FSF for each risk-significant LBE. The staff determined that this is an acceptable approach to preventative-mitigative balance because it ensures that features are available to prevent initiating events from occurring in the first place, and also ensures functions are available across multiple defense lines to prevent LBEs from progressing to more severe accidents.

4.2.3.1.5 Conclusion Regarding Plant Capability DID

The staff determined that the information provided in the PSAR is consistent with the guidance documents and that the proposed DID methodology and plant capability DID measures are acceptable on the basis that they are consistent with NEI 18-04 and NEI 21-07, as endorsed by RG 1.233 and 1.253, respectively. As discussed in the previous sections above, the staff's evaluation determined that the DID methodology has been properly applied and results in a reasonable level of plant capability DID, given the current available design information.

4.2.3.2 Programmatic DID

The applicant did not discuss programmatic DID in detail in the PSAR; however, PSAR section 4.2.2 identified that the guidelines for programmatic DID adequacy provided in section 5.8 of NEI 18-04 were evaluated and included in the design and plant programs in PSAR chapters 6, 7, and 8. Those programs are evaluated where applied and in chapter 8 of this SE report. PSAR section 4.2.2.1 states that guidelines for evaluating significant uncertainties were included in the integrated decision making process (IDP). The IDP is discussed in further detail in chapter 3 of this SE report. PSAR section 4.2.2.3 states that plant-specific programs for monitoring NSRST SSCs are identified in PSAR chapter 7. These programs are discussed in chapters 7 and 8 of this SE.

RG 1.253 section C.5 states that the NRC anticipates that the DID discussion at the CP stage may be limited to plant capabilities because programmatic capabilities may not have been established yet. As such, the staff determined that the limited detail provided in the PSAR on programmatic DID is reasonable.

4.2.4 Conclusion on Defense-in-Depth

The staff reviewed the USO's DID evaluation presented in PSAR section 4.2, "Defense-in-Depth Adequacy Evaluation," and supporting document NAT-4770, "Natrium Demonstration DID Evaluation Report." The staff conducted its review in accordance with the guidance in RG 1.233, which endorses NEI 18-04 with clarifications, and RG 1.253, which endorses NEI 21-07 with clarifications.

As discussed in the preceding sections of this SE, the staff verified that the applicant applied the DID methodology consistent with NEI 18-04 and NEI 21-07 and addressed all relevant elements, including (1) LBE margin to the F-C target curve, (2) sufficiency of layers of defense, (3) evaluation of potential single-feature reliance, and (4) balance between preventive and mitigative functions.

Based on its review, the staff concludes that the USO's DID evaluation is consistent with the endorsed guidance and demonstrates sufficiency of DID based on the preliminary design information provided in the CP application for this stage of review. The staff will perform a more

detailed evaluation of DID adequacy, including programmatic measures, at the operating license stage.

4.3 Integrated Decision Process (IDP) and Integrated Decision Process Panel (IDPP)

4.3.1 Introduction of IDP and IDPP

PSAR section 1.3.1 and 4.2.3 describe that the applicant used the LMP methodology, as described in NEI 18-04 and endorsed by RG 1.233, to establish a structured risk-informed, and performance-based framework for the selection of LBEs, classification of safety functions, and determination of the appropriate classification and performance requirements for SSCs. One of the key features of this methodology is the use of the integrated decision process (IDP), implemented through a multidisciplinary integrated decision process panel (IDPP), to ensure that the risk-informed, performance-based approach is consistently and appropriately applied. NEI 18-04 states that the IDP should be conducted by a knowledgeable, multidisciplinary panel, and that the process should be traceable, documented, and consistent with the LMP framework.

Furthermore, the IDP plays a key role in the DID evaluation required by the LMP methodology. The DID evaluation ensures that plant design and operational strategies provide multiple, independent, and layered means to protect public health and safety, consistent with NRC safety philosophy and the Commission's safety goal policy statement.

Specifically, the IDP is a deliberative decision-making process that integrates deterministic requirements, probabilistic risk assessment (PRA) insights, and engineering judgment to make informed and traceable decisions on safety classification, performance criteria, and DID evaluation. The IDPP is the decision-making body responsible for executing the IDP. Members of the IDPP typically include subject matter experts in PRA, design engineering, systems engineering, operations, human factors, and licensing, as well as decision facilitators familiar with the LMP process.

4.3.2 Regulatory Evaluation of IDP and IDPP

The applicable regulatory requirements for the evaluation of IDP and IDPP is 10 CFR 50.34(a)(1) and (4) and 10 CFR 50.35.

The applicable guidance for the evaluation of IDP and IDPP is RG 1.233, which endorses NEI 18-04.

4.3.3 Technical Evaluation of IDP and IDPP

The staff reviewed the applicant's description of the IDP and IDPP implementation in the PSAR and audited supporting documentation to confirm appropriate implementation of the IDP and IDPP. For context, the audited supporting documentation is listed below:

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The staff's review focused on determining if the applicant's IDP approach is consistent with NEI 18-04 as endorsed by RG 1.233, and if the IDPP deliberations resulted in defensible, traceable decisions that support the preliminary licensing basis for the CP stage.

Selection and Confirmation of LBEs

The staff compared the PSAR description of event selection and confirmation of LBEs and the guidance in NEI 18-04 and determined that the applicant's approach was consistent with the guidance. Further, staff confirmed via the audit that USO's IDPP considered the appropriate aspects in the NEI 18-04 guidance (e.g., PRA event sequences and event categorization into AOOs, DBEs, and BDBEs consistent with the LMP process). Additionally, the staff confirmed the panel considered frequency estimates, consequence evaluations, and plant design features, and ensured that low-frequency but potentially high-consequence events were retained in the LBE set where appropriate.

Safety Function Identification and SSC Classification

By auditing the documents above, the staff confirmed that the IDPP reviewed and verified the identification of safety functions credited to prevent or mitigate LBEs. SSCs were classified as safety-related (SR), non-safety-related with special treatment (NSRST), or non-safety-related with no special treatment (NST) based on their role in supporting these functions and their risk significance from the PRA. The staff confirmed that the classification process followed the criteria in NEI 18-04 as stated in the PSAR, and the staff finds the PSAR justified for the CP stage.

Defense-in-Depth Evaluation

By auditing the documents above, the staff confirmed that USO used the IDP to perform a systematic DID evaluation in accordance with NEI 1804 section 5.9 as described in the PSAR and the staff finds the PSAR justified for the CP stage.

Documentation and Traceability

By auditing the documents above, the staff confirmed that USO documentation was maintained in accordance with NEI 18-04 as described in the PSAR.

4.3.4 Permit Condition

The staff recommends that the CP include the following permit condition:

Prior to submittal of the operating licensing application, USO shall notify the NRC within 30 days after an integrated decision-making process panel is convened for internal approval of the safety analysis, risk assessment, or defense-in-depth adequacy of the design. The notification shall include the schedule for when the supporting documentation will be available for NRC examination.

This condition ensures that the staff has the opportunity to verify that the USO's IDP, as executed by the IDPP, has been appropriately conducted in support of the LMP application. The IDP is a key element of the LMP framework, providing a structured, multidisciplinary approach for evaluating safety analysis, risk assessment, and DID adequacy. Requiring notification and availability of supporting documentation prior to submittal of the OLA allows the staff to examine whether the IDPP deliberations were traceable, balanced, and consistent with NEI 18-04 and RG 1.233. This early visibility ensures that regulatory expectations are met, enhances transparency in the applicant's decision-making process, and provides confidence that safety-significant issues are addressed before the OL review stage.

4.3.5 Conclusion on IDP and IDPP

Based on its review of the PSAR, the staff finds that USO's IDP and IDPP implementation for the KU1 CP application is consistent with the methodology described in NEI 18-04 as endorsed by RG 1.233. The IDPP composition included appropriate multidisciplinary expertise, and the process was implemented to ensure balanced consideration of deterministic, probabilistic, and engineering judgment inputs.

Therefore, the staff concludes that USO's IDP and IDPP implementation provides an acceptable basis for supporting the CP application in accordance with 10 CFR 50.34(a)(1) and (4) and 10 CFR 50.35, consistent with NRC-endorsed LMP methodology.