UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 30, 2024

Bruce Montgomery
Director, Decommissioning and Used Fuel
Nuclear Energy Institute
1201 F Street, NW, Suite 1100
Washington, DC 20004

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION OBSERVATIONS AND INSIGHTS OF NUCLEAR ENERGY INSTITUTE (NEI) TECHNICAL REPORT NEI 22-01, "LICENSE TERMINATION PROCESS" (EPID L-2023-NFO-0010)

Dear Bruce Montgomery,

By letter dated February 13, 2023, as supplemented by letters dated April 11, 2023, and December 12, 2023 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML23045A322, ML23102A030, and ML23347A211, respectively), the Nuclear Energy Institute (NEI) submitted technical report NEI 22-01, "License Termination Process," on behalf of its members for U.S. Nuclear Regulatory Commission (NRC) review and endorsement.

NEI 22-01 was developed to assist decommissioning reactor licensees in the development of license termination plans that satisfy NRC requirements and provide an approach that aligns with previously published NRC guidance. Requests for additional information and observations were issued to NEI on November 20, 2023 (ML23325A192) and a public meeting was held on November 29, 2023, to support clarification of the staff's review.

We understand that the draft guidance sent to us is subject to future changes. The NRC staff has completed its review of NEI 22-01 and documented its observations in the enclosed technical review. Consistent with our acknowledgement letter (ML23257A053), the NRC is not endorsing this document. If NEI chooses to resubmit this document for endorsement, they should consider incorporating the observations contained in the enclosure.

Each licensee is responsible for ensuring compliance with NRC regulations. While the NRC does not endorse, accept, or reject NEI 22-01, the NRC will continue to review license

termination plans with applicable guidance and provide oversight through the NRC's inspection program. The NRC appreciates the opportunity to interact with NEI and the industry on NEI 22-01.

Sincerely,

/RA/

Jennifer M. Whitman, Deputy Director,
Division of Decommissioning, Uranium Recovery,
and Waste Programs,
Office of Nuclear Material Safety
and Safeguards.

Enclosure:
NRC Observations and Insights of NEI 22-01

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION OBSERVATIONS AND INSIGHTS OF NUCLEAR ENERGY INSTITUTE (NEI) TECHNICAL REPORT NEI 22-01, "LICENSE TERMINATION PROCESS" (EPID L-2023-NFO-0010) DATED April 30, 2024

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OBSERVATIONS AND INSIGHTS BY

THE OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

RELATED TO NUCLEAR ENERGY INSTITUTE (NEI)

TECHNICAL REPORT NEI 22-01

LICENSE TERMINATION PROCESS

1.0 INTRODUCTION

By letter dated February 13, 2023,[1] as supplemented by letters dated April 11, 2023, [2] and December 12, 2023,[3] the Nuclear Energy Institute (NEI) submitted technical report NEI 22-01, "License Termination Process," on behalf of its members for U.S. Nuclear Regulatory Commission (NRC) review and endorsement. NEI 22-01 was developed to assist decommissioning reactor licensees in the development of license termination plans (LTPs) that satisfy NRC requirements and provide an approach that aligns with previously published NRC guidance.

NEI hopes to increase the efficiency of the license termination process by improving the quality, consistency between, and adherence to LTPs submitted to NRC for review. NEI indicated that this outcome will increase the efficiency of NRC licensing actions and inspection activities associated with the license termination process.

NEI desired to provide industry guidance on how to develop and write an LTP that includes:

- Providing a properly focused final status survey (FSS) plan for a typical commercial nuclear power reactor,
- Providing guidance on the documentation of FSS findings and reports submitted to NRC for review,
- Providing a recommended communications protocol and checklist to follow in setting up interactions between stakeholders, including the NRC and state and local authorities throughout project planning and execution,
- Providing technical solutions for areas not currently addressed in NRC or Environmental Protection Agency (EPA) regulatory guidance,
- Proposing a standard LTP format and content that can be used by both licensees and NRC reviewers to cross-reference against NRC's NUREG-1700 with guidance on an acceptable level of detail for each section,
- Navigating NRC regulatory documents that provide decommissioning guidance,

[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML23045A322
[2] ML23102A030
[3] ML23347A211

1.1 Regulatory Requirements

The regulations and guidance listed in this document are associated with the NRC staffs review and analyses of NEI 22-01.

The regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation," Subpart E, "Radiological Criteria for License Termination," requires licensees to demonstrate compliance with radiological criteria for license termination, including use of radiological surveys to show that release criteria are met to reach favorable decisions regarding license termination.

The regulations in 10 CFR 20.1402, "Radiological criteria for unrestricted use," contains requirements for licensees to demonstrate that a site will be considered acceptable for unrestricted use.

The regulations in 10 CFR 20.1501, "General," requires licensees to demonstrate that residual radioactivity, including existing groundwater, has been adequately characterized.

The regulations in 10 CFR 50.59, "Changes, tests and experiments," contains requirements for the process by which licensees may make changes to their facilities and procedures as described in the safety analysis report, without prior NRC approval, under certain conditions.

The regulations in 10 CFR 50.82, "Termination of license," paragraph 50.82(a)(9) outline the requirements for submitting a license termination plan. It requires the license termination plan include site characterization and an updated site-specific decommissioning cost estimate that includes an estimate of the cost of remaining decommissioning work.

The regulations in 10 CFR 50.83, "Release of part of a power reactor facility or site for unrestricted use," outline release of part of a power reactor facility or site for unrestricted release before termination of the license including the requirement to perform adequate surveys to demonstrate compliance with radiological criteria for unrestricted use specified in 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use," for impacted areas.

The regulations in 10 CFR 51.45, "Environmental report," describe the requirements related to a licensee's environmental report. It provides the requirements associated with the status of compliance with applicable environmental quality standards.

1.2 Applicable Guidance

The guidance in DUWP–ISG-02, "Radiological Survey and Dose Modeling of the Subsurface to Support License Termination," date October 2023,[4] supplements NUREG-1757, Volume 2, and provides guidance on radiological survey approaches for substructures as well as limitations of codes such as RESRAD–ONSITE in assessing groundwater dependent pathway doses for submerged sources such as reactor basement substructures.

[4] ADAMS Accession No. ML23177A008

The guidance in NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM),"[5] guidance focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions. It outlines recommended survey coverage for both structures and land areas.

The guidance in NUREG-1576, "Multi-Agency Radiological Laboratory Analytical Protocols [MARLAP] Manual," dated July 2004,[6] provided definitions for critical level and minimum detectable concentration (or activity) on which to base detection decisions for water samples.

The guidance in NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans," dated April 2018,[7] ensures the quality and uniformity of NRC staff reviews and to present a well-defined base from which to evaluate the requirements for terminating the license of a nuclear power plant. Appendix B, "LTP Areas That Cannot Be Changed Without NRC Approval," outlines LTP areas that cannot be changed without NRC approval, including those that require Commission approval under 10 CFR 50.59.

The guidance in NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS [Office of Nuclear Material Safety and Safeguards] Programs," dated August 2003,[8] provides general procedures for the environmental review of licensing actions that support licensees when preparing environmental reports for submission to the NRC.

The guidance in NUREG-1757, "Consolidated NMSS Decommissioning Guidance – Characterization, Survey, and Determination of Radiological Criteria, Volume 2," Revision 2, dated July 2022,[9] provides guidance on radiological surveys and dose modeling to develop cleanup criteria to support licensees in preparing decommissioning plans, LTPs, FSSs, and other technical decommissioning reports for NRC submittal. The NRC staff also uses this guidance in reviewing these documents and related license amendment requests (LARs).

The guidance in NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning: User's Manual DandD Version 2.1,"[10] Volume 2, dated April 2001, provides a screening methodology to address the technical dose criteria contained in NRC's Radiological Criteria for License Termination rule.

The guidance in NUREG/CR-7021, "A Subsurface Decision Model for Supporting Environmental Compliance," dated January 2012,[11] presents a framework focused on development of a conceptual site model referred to as a contamination concern map and decision framework for conducting a subsurface compliance survey and analysis for sites that have been remediated for radioactive contamination.

The guidance in Regulatory Guide (RG) 1.179, Revision 2 "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," dated July 2019,[12] guides the NRC

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[5] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1575/index.html
[6] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1576/index.html
[7] ADAMS Accession No. ML18116A124
[8] ADAMS Accession No. ML032450279
[9] ADAMS Accession No. ML22194A859
[10] https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr5512/
[11] https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7021/
[12] ADAMS Accession No. ML19128A067

staff in conducting safety reviews and assists licensees in developing an LTP. This RG includes format and technical content of an LTP submittal, including a supporting environmental report and demonstration of dose for residual radionuclides that includes the groundwater media.

2.0 NRC STAFF TECHNICAL REVIEW

The NRC staff evaluated NEI 22-01 to determine if NRC endorsement of the report would increase efficiency, improve quality, and enhance consistency of the license termination process and of the LTPs submitted to the NRC for review. Each of the following sections identifies specific observations or recommendations from the NRC staff's review. The NRC staff utilized the guidance from the previous section to evaluate NEI's document. The guidance documents above can address a wider range of situations than only decommissioned reactors so not all information is applicable in site-specific cases.

2.1 Risk-Informed

NEI stated that NRC's current guidance does not satisfactorily address:

- How to develop and execute survey plans for subsurface soils and below grade structures,
- How to survey and account for discrete radioactive particles, and
- How to analytically deal with hard-to-detect radionuclides.

NEI stated that these issues can be addressed in a risk-informed manner that provides reasonable assurance of adequate protection of the public. The NRC developed NUREG/KM-0016, "Be risk SMART: Guidance for Integrating Risk Insights into NRC Decisions,"[13] which provides a systematic approach to making risk-informed decisions across disciplines.

The NRC also developed NUREG/CR-6676, "Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes,"[14] for demonstration of compliance with the dose/risk criteria, as well as, several documents the NRC has listed in the NUREG for NEI consideration.

2.2 General Information

Section 1.1 of NEI 22-01 stated: "If demolition, remediation and backfill activities begin before NRC approval of the LTP, then site management must be aware that these activities are being conducted at risk." While this is an accurate statement, the NRC staff notes that if the guidance were to provide more examples of facilities that were decommissioned or undergoing decommissioning where demolition and backfill activities were carried out before NRC approval of the LTP, these additional examples could further support clarity/efficiency in assisting licensees in the license termination process. Providing the type of risk incurred in terms of delays in decommissioning schedule and decommissioning reviews and lessons learned based on such actions would be beneficial to licensees.

[13] https://www.nrc.gov/reading-rm/doc-collections/nuregs/knowledge/km0016/index.html
[14] https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6676/

2.3 Communications Among Licensee and Regulators

Section 1.1.1 of NEI 22-01 asks licensees to consider a phased approach to submitting LTP sections and consequently, a phased NRC review and approval. The NRC staff notes that phased submission and review of documents would lengthen review time and inhibit review effectiveness without the ability to cross-reference LTP sections to those that have not yet been submitted. In its letter dated November 20, 2023,[15] the NRC staff asked NEI in request for additional information (RAI) LTP-1 to clarify the concept of phased LTP submittal and explain how this approach fits NRC regulation, guidance, and current best practices.

In its RAI response dated December 12, 2023,[16] NEI stated that they will revise Section 1.1.1 of NEI 22-01 to state that the LTP must be submitted in its entirety in order for the NRC staff to begin the acceptance review and detailed technical review. NEI will state that supporting technical reports referenced in the LTP such as the Site Characterization Report and Background Study should accompany the LAR. The NRC staff notes that this revision would allow the NRC staff to conduct a detailed review and prepare its preliminary technical evaluation with greater efficiency.

2.4 Crosswalk Between LTP and NUREG-1700

The title of section 1.1.4 of NEI 22-01 contains NUREG-1700. NUREG-1700 is not included in the reference section. NRC is supportive of providing licensees a crosswalk to NRC guidance documents if the crosswalk contains the documents that NEI references. NEI 22-01, Appendix C, cites the SRP, NUREG-1757, and RG 1.179. The NRC staff suggests providing a statement that use of the Appendix C crosswalk is a starting point to facilitate regulatory reviews and does not encompass every NRC guidance document that supports an LTP review. Renaming the crosswalk to reflect the various documents listed as sources may be beneficial to licensees.

2.5 Partial Site Release Requirements

Section 1.1.5.1 of NEI 22-01 discusses partial site release requirements for both non-impacted and impacted areas, but inaccurately discusses regulations in 10 CFR 50.83. In two separate instances, NEI 22-01 states that an application must include “information specified above”; however, this language is vague and contrasting from regulations in 10 CFR 50.83 which only require more specific information. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI PSR-1 for NEI to explain the basis for these changes that are not a part of regulation. This discussion in section 1.1.5.1 of NEI 22-01 may confuse applicants/licensees when applying for partial site release.

RAI response dated December 12, 2023, NEI indicated that they will revise section 1.1.5.1 of NEI 22-01 to conform to 10 CFR 50.83 and delete the recommendation to include a reason for removing a non-impacted area from the license prior to LTP approval. The NRC staff notes that this revision would eliminate the inaccurate discussion of the regulations in 10 CFR 50.83.

[15] ADAMS Accession No. ML23325A193
[16] ADAMS Accession No. ML23347A211

2.6 Phase 3–Survey Implementation for Partial Site Release

Section 1.1.5.2.3 of NEI 22-01 discusses scanning survey design in accordance with MARSSIM using the data quality objectives process. The NRC staff notes that there is no requirement in 10 CFR 50.83 for surveying non-impacted areas, and they can be released based on historical data. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI PSR-2 to justify the chosen scan coverage values and the differences from MARSSIM recommended values.

In its RAI response dated December 12, 2023, NEI indicated that they will revise section 1.1.5.2.3 to agree with the scan coverage requirements in MARSSIM. The NRC staff notes that this revision would improve alignment with existing NRC guidance.

2.7 Process for LTP Revisions

Section 1.1.6 of NEI 22-01 discusses the process for LTP revisions including allowed changes without NRC approval. This section inaccurately discusses NUREG-1700, Appendix B, "LTP Areas That Cannot Be Changed Without NRC Approval," in several parts, leaving out partial information or excluding whole points. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI LTP-2 to justify and explain these inconsistencies between NEI 22-01 and applicable guidance.

In its RAI response dated December 12, 2023, NEI indicated that they will revise section 1.1.6 of NEI 22-01 to align with NUREG-1700, Appendix B and that any inconsistent statements will be revised to reflect the applicable NRC guidance. The NRC staff notes that this revision would improve alignment with existing NRC guidance.

2.8 Appendix H – Future Discrete Radioactive Particles Guidance

Section 2.1 of NEI 22-01 discusses Appendix H as future guidance for discrete radioactive particles (DRPs). There is a need to address characterization and survey approaches to DRPs, as well as to address characterization and survey approaches regarding dose impacts and safety of workers, that may constitute an appreciable fraction of NRC dose limit to the public. The methods used and the sensitivities achieved in the search for environmentally dispersed particles during the various decommissioning activities performed have been discussed in several aspects. The NRC staff suggests assessing the following as you prepare Appendix H:

- Discussion questions for DRP in the November 3, 2022, Decommissioning Workshop[17]
- NUREG/IA-0535, "Using VARSKIN for Hot Particles Ingestion Dosimetry Evaluation"[18]
- Estimating Scan Minimum Detectable Activities of Discrete Radioactive Particles - Technical Report[19]
- Renaissance Code Development Presentation of DRP Dose Coefficient[20]

2.9 In-situ Gamma Spectroscopy

Section 2.2.1.4 of NEI 22-01 discusses the mathematical efficiencies that will be gained using a conservative model that will convert the identified spectrum peaks to activity per unit area (i.e.,

[17]ADAMS Accession No. ML22301A161
[18]ADAMS Accession No. ML22255A157
[19]ADAMS Accession No. ML22304A137
[20] ADAMS Accession No. ML22305A584

pCi/m^2) within the assumed geometry. The NRC staff notes that where in-situ gamma spectroscopy is to be used for final status survey, the analysis, conversion, and interpretation of the results in terms of the derived concentration guideline levels (DCGLs) should be "proofed" through the collection and analysis of a series of actual soil samples of varying concentrations. Any such study and associated analysis procedure(s) should be reviewed with stakeholders and submitted to the NRC as part of the LTP.

2.10 Surface Soil Samples

Section 2.2.3 of NEI 22-01 discusses the analysis of sample consistency and considering sample preparation (removal of debris, drying and homogenization) and the analysis of hard-to-detect (HTD) radionuclides. The NRC staff notes that sample collection and sample preparation generally constitute the two largest sources of variation in results. The NRC staff wants to ensure licensee are aware that soil samples should be dry and homogenized before analysis, and large stones, sticks, and other matter which is not representative of the exposure pathway should be removed from the sample. FSS sample procedures should be explicit in these regards and are subject to NRC review during the LTP approval process. NEI should consider adding additional discussion in this regard.

2.11 Subsurface Soil Samples

Section 2.2.4 of NEI 22-01 discusses the collection of subsurface soil samples (depths greater than 15 cm (6 in) and up to several meters below grade level per MARSSIM). NEI stated that the collection is solely dependent on the potential for current or past subsurface leaks of radioactive material. The NRC staff notes that surface-deposited soil contamination generally follows a logarithmic depth profile unless there is a preferential pathway for surface contamination to penetrate to greater depths, such as along building foundations, drain tiles, well casings and/or artificially disturbed soils. NEI should consider adding that the potential for these pathways should be evaluated during the Historical Site Assessment (HSA), scoping, and characterization surveys.

2.12 Onsite Sample Analysis

Section 2.2.5.2 of NEI 22-01 states that most sites have an onsite gamma spectroscopy laboratory that is equipped for the analysis of standard sample geometries. The NRC staff notes that soil sample preparation for analysis is potentially one of the largest sources of variation in sample results. NEI 22-01 should provide a more detailed discussion of this important topic. In particular, soil samples must be dry and homogenized in order to obtain consistent and relevant results.

2.13 Surrogate Radionuclides

Section 2.3.5 of NEI 22-01 discusses a method for determining the surrogate ratio of Sr-90 to Cs-137 before selecting the 95th percentile of the reported concentrations as the chosen surrogate ratio but does not offer any explanation or justification. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI SR-1 for NEI to provide justification for choosing the 95th percentile of the reported concentrations as the surrogate ratio of Sr-90 to Cs-137 and explain why this was chosen over other values listed in Table 2-4.

In its RAI response dated December 12, 2023, NEI stated that additional language will be added in section 2.3.5 to explain the use of the values. The 95th percentile of the radionuclide ratios for the concentrations of the sample data analyzed is chosen as an initial conservative value over the other values in Table 2-4.

2.14 Remediation Plans

Section 4.1 of NEI 22-01 discussed how facility and site areas will be remediated to meet the NRC's release criteria. The NRC staff wants licensees mindful that it is important that remediation plans must also consider occupational exposure monitoring and environmental monitoring plans. The radiological environmental monitoring program may need to be adjusted and, perhaps, the Offsite Dose Calculation Manual may need to be modified to quantify new effluent pathways from open-air demolition and remediation.

Also, Table 4-1 of NEI 22-01 includes a flow chart with a box that states, "perform survey unit-specific ALARA evaluation using method in DG-4006." DG-4006 was withdrawn and NUREG-1757, Volume 2, Revision 2, Appendix N, contains ALARA guidance. Updating the reference to ALARA criteria in Table 4-1 to NUREG-1757, Volume 2, Revision 2, Appendix N, would provide more accurate support for licensees.

2.15 Remediation Levels and ALARA Evaluations

Section 4.3 of NEI 22-01 discussed as low as reasonably achievable (ALARA) evaluation for groundwater in terms of water use analysis. The NRC staff notes that there is no discussion on remediation needs or approaches regarding groundwater contamination on which to base costs in the ALARA analysis. A plan would be needed for cost estimation to support ALARA. A discussion relating subsurface soil remediation to potential existing groundwater contamination, particularly for more mobile radioactive elements, would be beneficial to licensees.

Several sections in NEI 22-01 did not recognize the connection of pre-remediation subsurface soil contamination and potential associated existing groundwater contamination, even when discussing having to drain soils or the possibility of mixing contaminated and clean subsurface soils to reduce overall concentrations to meet soil DCGLs. Section 4 of NEI 22-01 did not discuss groundwater remediation techniques nor explain why it was not included. Electric Power Research Institute (EPRI) Report #1023464, "Groundwater and Soil Remediation Guidelines for Nuclear Power Plants Public Edition," July 2011,[21] could be cited for remediation methods and decision-making.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in GWO-2 providing this insight. In its response dated December 12, 2023, NEI stated that they will include a discussion to address this concern.

2.16 Soils

Section 4.4.4 of NEI 22-01 states that soils not meeting the applicable DCGLs need to be removed and disposed of as radioactive waste. The NRC staff notes that the risk from subsurface soils may be significantly different from surface soils. DCGLs would need to be

[21] ADAMS Accession No. ML113120014

derived for the final configuration of the contaminated soils considering the area, depth, and thickness of the soils. Additionally, the risk-significance of elevated areas in the subsurface may differ from the surface (e.g., elevated areas may not be as important for the subsurface or may be significantly higher).

Finally, it may be possible for individual soil samples to exceed the subsurface DCGLs if the soil samples are less than established DCGLemcs that are derived for the subsurface, and if the average subsurface soil concentration is less than the DCGLw for the subsurface soils. DUWP-ISG-02 provides guidance for the development of DCGLs for open surfaces in the subsurface. Revision 1 to NUREG/CR-7021 is currently being developed which will provide additional guidance on demonstrating compliance with release criteria and treatment of elevated areas in the subsurface. Offsite fill or onsite material shown to meet the site's DCGLs can be used to replace the excavated materials. NEI 22-01 might add a caution as state laws can vary greatly. Some states prohibit any soil from a remediation effort from being used for backfill, regardless of the actual radiological status of the soil.

2.17 Final Radiation Survey Plan

Section 5 of NEI 22-01 states that a survey unit is a geographical area consisting of structures, land areas, or buried piping of specified size and shape for which a separate decision will be made of whether the survey unit meets the radiological release criteria. Survey units are contiguous site areas, with a similar use history and the same classification of contamination potential. The NRC staff notes that survey unit is a MARSSIM term. MARSSIM is applied to the surfaces of buildings and surface soils. It is unclear as to how the concept of a MARSSIM survey (exposure scenario, statistical sampling process, randomness, etc…) could be applied to buried piping (particularly the interior surfaces of such piping). Perhaps NEI 22-01 can clarify that buried piping will be evaluated separately and any residual dose will be added to the cumulative dose from the exposure to multiple media will be assessed.

NEI states that DCGLs are the site-specific release criteria for each media type. DCGLs are radionuclide-specific and are equivalent to the level of residual radioactivity (above background levels) that could result in a total effective dose equivalent of 0.25 mSv (25 mrem) per year to an average member of the critical group. The NRC staff notes that NEI 22-01 frequently mentions 0.25 mSv (25 mrem/yr). NEI should consider providing guidance to licensees that may need to also meet dose requirements set by other laws such as State requirements that may be lower than NRC regulations.

NEI 22-01 states that a typical commercial reactor site has multiple source terms (types of contaminated media) – including surface soil, subsurface soil, surface and subsurface structures, buried pipe, etc. Therefore, the base case DCGLs are reduced for each media type to ensure that the summation of dose from all source terms is less than 0.25 mSv/year (25 mrem/year) after all FSS is complete. The NRC staff notes that MARSSIM does not apply to subsurface soils, subsurface structures, and buried piping. These media present a route of exposure which is not represented properly by the base-case DCGLs. These media will require their own exposure assumptions, with resultant release criteria that is discussed with stakeholders and approved in the LTP. See DUWP-ISG-02 for additional information on how MARSSIM can be applied to open surfaces in the subsurface including open excavations, reactor basement substructures and backfill materials.

2.18 Detection of Radionuclides in Groundwater

Section 5.1.1 of NEI 22-01 discussed data quality objectives (DQOs) which included the water media, and the information needed to make decisions. The NRC staff notes that those decisions would be based on performance measures that included detection limits. MARLAP guidance was not cited in any of these discussions for groundwater, which would be most relevant to DQOs. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI GW-1 to clarify what is meant by detection of radionuclides in groundwater in the context of MARLAP guidance. In its RAI response dated December 12, 2023, NEI stated the NEI 22-01 will be revised to agree with the methodology for determining the detection of radioactivity in groundwater provided in MARLAP.

2.19 Scanning

Section 5.2.1 of NEI 22-01 states that investigation levels for scanning surveys are determined during survey planning to identify areas of elevated activity. Scanning surveys are performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action. The NRC staff notes that the statement might be incomplete. The NRC staff suggests providing information that supports a more complete view. In FSS, scanning is conducted in an effort to identify areas of elevated activity. When found, additional survey is needed to determine the areal extent so that it can be compared to the elevated measurement criteria. Also, when elevated areas are found, then additional scanning above that which was planned is warranted.

2.20 Scan Coverage Requirements

Section 5.2.1.2 of NEI 22-01 differentiates the scan coverage percentage for floors/lower walls and upper walls/ceilings for Class 2 survey units. The NRC staff notes that while this is consistent with Table 5.9 in MARSSIM, Revision 1, MARSSIM, Revision 2 is expected to be published in 2024 and presents an equation for the scan coverage. It may be good to cite both approaches in the guidance document to ensure that the information is not immediately outdated.

2.21 Reference Areas and Materials

Section 5.2.7.2 of NEI-22-01 provides a procedure for determination of background in a survey unit by positioning the detector a sufficient distance away from the surface to eliminate beta particles from reaching the detector and only picking up ambient gamma background radiation that can be subtracted from the survey unit measurement and the Sign test applied. This procedure is stated to provide “conservative” estimates since it is expected to be less than the material specific background for the material in the room as it does not fully account for the naturally occurring radioactivity in the materials.

The NRC staff notes that one effective method that can be used is to shield the beta probe with the probe protective cover and then collect several ambient count-rates that are the result of background gamma interacting with the detector. The NEI 22-01 stated method will be inadequate where Sr-90/Y-90 is present, in particular (10 ft beta in air). These should be collected in areas away from suspected contamination. It is very important to collect a sufficient number of backgrounds, in a sufficiently varied set of locations around the survey unit, and to understand the variation in the measurements. Providing this discussion in the document would be beneficial. Another method is to measure the actual material, concrete (same vintage), glass,

metals, etc in non-impacted areas of the site where there are no other contaminants to impact the background measurements.

NEI 22-01 also states that if applied, media specific backgrounds are determined via measurements made in one or more reference areas and on various materials selected to represent the baseline radiological conditions for the site. The NRC staff notes that the determination of media-specific background is controlled with a documented survey plan, which has been prepared using the DQO process. The NRC staff notes that this statement might be incomplete. The selection of, determination of, and use of media-specific backgrounds generally requires stakeholder and regulator discussion and agreement which needs to be fully described in the LTP. Any media study and plan for use should be a part of the LTP.

NEI states that depending on the values of the applicable DCGLs, an alternative method to using material specific backgrounds has been accepted for use by the NRC during final status surveys. The NRC staff notes that at such a location, the ambient background radiation is due only to ambient gamma radiation and will be a background component of all surface measurements. The NRC staff suggests providing insight about the average background. The average background determined at this location can be used as a conservative estimate since it is expected to be less than the material specific background for the material in the room as it does not fully account for the naturally occurring radioactivity in the materials. This topic of the use of an average background may require additional guidance. The number of measurements taken to determine the average must be sufficient and statistically relevant. Where the backgrounds are taken is important. They should sufficiently describe variations around the survey unit. One set of measurements near one corner of the unit would not be adequate. The average, taken alone, is not a sufficient descriptor. The standard deviation or coefficient of variation should be understood and be reasonable.

2.22 Basement Fill Model

Section 5.2.8.2.1 of NEI 22-01 discusses the basement fill model. The basement fill model is the term used by industry to assess the risk from residual radioactivity associated with substructures. Variations in the approach have been used but typically entail modeling or estimating the release of residual radioactivity into the backfill used to fill the substructure, assessment of dose from a unit concentration in groundwater, and assessment of the amount of residual radioactivity that can remain on the surfaces (or volumetrically near the surface) of substructures and meet the license termination rule criteria.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in DMO-2 to provide a general description of the “basement fill model,” and a more detailed description of the evolution of the basement fill model over time with examples from more recent LTP submittals that have addressed technical issues associated with the use of RESRAD–ONSITE for simulating flow through low hydraulic conductivity basement substructures.

In its response dated December 12, 2023, NEI stated that the examples for the “basement fill model” currently in NEI 22-01 (if retained) will be revised to show the evolution over time to the more recent versions that have been approved by the NRC. As this evolution has occurred, and there is no standard methodology for the “basement fill model,” this term will be eliminated from NEI 22-01. NEI indicated that NEI 22-01 will be revised to include additional approaches for dose modeling for subsurface structures taken from those given in DUWP-ISG-02 and more recent LTPs.

2.23 Use of Soil or Concrete as Backfill

Sections 5.2.8.2.4 and 5.2.8.2.5 (and related examples in Appendix F) of NEI 22-01 discuss consideration of the dose contributions from the reuse of materials to estimate the cumulative dose from all residual radioactivity at decommissioning sites. However, additional details regarding the methods used to determine the cumulative dose would be beneficial. For example, for one site the guidance indicates that if a scan location indicated an activity greater than 50 percent of the soil operational DCGL, then the soil was disposed of as waste. The basis for the operational DCGL and percentage of the operational DCGL used to make decisions regarding reuse of the materials onsite to ensure that the cumulative dose was less than the dose standard was not provided.

In another example, NEI-22-01 discusses what is described as “conservative” dose estimates from reuse of concrete fill for each basement type regardless of the volume of concrete fill used. In the example, the licensee assumed that the radionuclides of concern (ROCs) were present at the minimum detectable concentration (MDC) of 5000 dpm/100 cm^2 for “the survey instrument sensitivity.” The NRC staff notes that while the approaches used to consider dose from reuse of materials may be acceptable for the decommissioned sites referred to in the examples, given uncertainty in the inventory, ROCs, including HTD radionuclides, surrogate ratios, and contaminant distributions, it is difficult to conclude that the approaches used would be “conservative” for other sites. Because the dose contributions of residual radioactivity associated with substructures is site-specific (e.g., characterization would need to support the depth of residual radioactivity, key ROCs, and important exposure parameters used in the dose assessment), general guidance may be beneficial in addition to the site-specific specific examples provided to allow application of the examples to other sites.

NEI 22-01 should indicate that the added risk associated with reuse of impacted materials should be evaluated and added to the risk from other media including surface and subsurface soils; subsurface soils below an excavation or void space; remaining structures; and groundwater. For impacted areas, the dose contributions for ROCs that are below detection limits should also be considered in a conservative manner. Clearly stating what support is needed to conclude that reuse materials contribute no additional dose for unimpacted areas may also be beneficial to decommissioning licensees.

NUREG-1757, Volume 2, Revision 2, Appendix G.3 provides information on consideration of risk from onsite and offsite materials planned for reuse. DUWP–ISG-02 provides detailed guidance on acceptable methods to consider risk from reuse of materials from onsite and offsite sources, as well as guidance to show how reuse materials can be shown to be indistinguishable from background using a modified Scenario B type analysis. DUWP–ISG-02 can be used to supplement the guidance in NEI-22-01. The final DUWP-ISG-02 is expected to be issued in late summer 2024.

2.24 Fixed Measurement Requirements

Section 5.3.1.2 of NEI 22-01 discusses that advanced technology has sufficient sensitivity stating that it may satisfy both the scanning and fixed measurement minimum detectable concentrations in one step. In-situ gamma spectroscopy and Surface Contamination Monitoring are examples of advanced technologies that may have this capability. The NRC staff notes that this assertion needs some clarification or additional information. It is unclear as to how in-situ gamma spectroscopy will satisfy the scanning requirement. The “viewing area” for each in-situ measurement would need to be large enough, with sufficient sensitivity, such that any “missed”

areas in the survey unit would be smaller than the largest allowed under the elevated measurement criteria.

2.25 Background Reference Area Determination

Section 5.3.1.3 of NEI 22-01 stated that the MARSSIM process allows the subtraction of background for radioactivity present in the soil at the site due to fallout from events such as nuclear weapons testing and that it is likely a background study for Cs-137 or Sr-90 unless the site was in an area of unusually high deposition from weapon testing. The NRC staff notes that this is almost never the reason to do a background study, since the Cs-137 and Sr-90 concentrations from fallout are so small compared to the DCGLs. Background samples must be taken from undisturbed soils. A background study can be very important when the ROCs are also present in the natural background (e.g., uranium, thorium, radium, etc...). Any such background study would need to be discussed with stakeholders and the regulator. As well as approved as part of the LTP.

2.26 Exposure Scenarios for Buried Piping

NEI used various examples for buried and embedded piping. It was not clear to NRC staff what exposure pathways were considered in developing the DCGLs. If radionuclide dose is dominated by pathways other than external radiation and inhalation, then the DCGLs could be significantly lower.

In its letter dated November 20, 2023, the NRC staff asked NEI in RAI DM-2 to provide additional clarification of the exposure scenarios and pathways of exposure considered for buried and embedded piping to better support the licensee when determining external dose and inhalation in the building occupancy or an industrial worker scenario only, and to provide information on how the risk from HTD radionuclides was considered, as applicable.

In its RAI response dated December 12, 2023, NEI indicated that the examples for embedded and buried piping currently in NEI 22-01 (if retained in the report) will be revised to include discussion of their limitations in terms of exposure pathways and the effect of HTD radionuclides. NEI also indicated that additional approaches for dose modeling for embedded and buried piping taken from those given in NUREG 1757, DUWP-ISG-02, and more recent LTPs will be added to NEI 22-01.

2.27 Connecticut Yankee Subsurface Soil FSS

Section 5.3.2.1 of NEI 22-01 provides an example where subsurface soil samples are homogenized over a 3 m (10 ft) thickness. The NRC staff notes that although this approach may have been acceptable at the site referred to in the example, it may not be appropriate for other sites. Depending on the depth and thickness of residual radioactivity, depth discrete sampling may be needed. Surface dose pathways may dominate, and elevated surface residual radioactivity should not be composited with subsurface residual radioactivity if there is vertical heterogeneity and a potential to underestimate the dose due to the compositing method. In general, the sampling approach should be compatible with the dose modeling assumptions used to derive DCGLs. Likewise, the dose modeling should reflect the actual distribution of residual radioactivity at the site and consider lateral and vertical heterogeneity in contaminant distributions as appropriate.

The NRC staff suggests providing more insight about surface deposited radioactivity. Surface deposited radioactivity generally follows a logarithmic depth profile. If the surface soils pass FSS, then the deeper soils will generally pass as well, provided that the exposure scenario includes an assumption of contamination >15 cm (>6 in.). This only becomes a problem when the contamination was not surface deposited or there is a preferential pathway for contamination to migrate at depth. Both are special cases. During FSS, licensees should ensure that no layer of clean soil is covering and obscuring a lens of contaminated soil. This is accomplished through characterization and careful checks at depth during RSS when spots are found that need further remediation. Documenting this assures closure of the survey unit.

Homogenization of subsurface soils over an entire 1 m (3 ft) of depth will yield an average contaminant concentration over the whole 1 m (3 ft). This information is only useful if the results are compared to the DCGLs from an exposure scenario that considers such a large layer of contaminated subsurface soil (and technical support is provided showing that the dose results are not sensitive to the depth and thickness of contamination thereby allowing the DCGLs to be derived over a relatively large thickness). This method also obscures any information about the depth profile of the contamination, in a manner that may be non-conservative. For example, the concentration of contaminant in the 16 cm to 31 cm (6 in to 12 in) below ground surface layer may be significantly more important than the concentration in the 85 cm to 100 cm (33 in to 39 in) below ground surface layer. Radiological contaminants generally follow a logarithmic depth profile in soils.

2.28 Subsurface Soil Sampling Density

Section 5.3.2.1 of NEI 22-01 indicates that at Connecticut Yankee (CY) a minimum of 5 % of the samples were analyzed for hard-to-detect HTD radionuclides. The NRC staff notes that the basis for 5 % is not provided. Most licensees measure the HTDs in the samples having the highest activity to verify the surrogate ratios are valid. Because HTD radionuclides can be significantly more mobile in the subsurface compared to easy to measure radionuclides, a larger percentage of samples may need to be analyzed for HTDs at other decommissioning sites depending on the ROCs and list of significant dose contributors. This would be consistent with MARSSIM section 4.3.2 which recommends 10 % of measurements include analyses for all ROCs.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in RSO-1 to provide a basis for the 5 % minimum indicated for Connecticut Yankee. MARSSIM section 4.3.2 which recommends 10 % of measurements include analyses for all ROCs. Because HTD radionuclides can be significantly more mobile in the subsurface compared to easy to measure radionuclides, a larger percentage of samples may need to be analyzed for HTDs at other decommissioning sites depending on the ROCs and list of significant dose contributors.

In its response dated December 12, 2023, NEI stated that the NEI 22-01 will be revised to state that if radionuclide ratios are to be determined using FSS data, that at least 10 percent of measurements should include analysis for all ROCs, including HTD radionuclides in agreement with MARSSIM.

The NRC staff suggests providing information regarding test pitting could be supportive. Test pitting or “trenching” as an aid to characterization can be effective. This method is best used to expose the sides of an excavation in order to scan and sample the faces of the trench, to determine the depth profile of contamination. This method must be employed carefully, since

the excavator bucket can “smear” contamination across the face of the trench. Homogenizing the entire contents of even the smallest excavator bucket will be very difficult. In these scenarios, the resulting sample will have averaged such a large amount of soil as to yield little useful information.

The subsurface survey unit size and density of samples for class “B” and “C” survey units in Section 5.3.2.1, Table 5.4, “CY Subsurface Soil Sampling Density,” is not provided. Because the exposure scenarios, dominant pathways, radionuclides of concern, and risk may differ for surface and subsurface residual radioactivity, the classification, survey unit size, DCGLs, and investigation levels will likely differ for surface versus subsurface residual radioactivity. DUWP-ISG-02 provides additional guidance on consideration of exposure pathways and application of MARSSIM to subsurface residual radioactivity and could be referenced in NEI-22-01.

The first sentence of the following NEI statement is confusing and may not be correct.

> The horizontal extent of contamination was only established for judgmental sampling and for samples within a systematic sampling area that exceeds the $DCGL_{EMC}$. For the case where the $DCGL_{EMC}$ comparison was made, the value used for the area factor was determined from the area bounded by the adjacent samples or by the area bounded by additional samples at or below the $DCGL_w$. This approach is consistent with the model used to calculate DCGLs in Section 6.

The NRC staff notes that the method described in NEI 22-01 seems to assume that the total area between systematic sample points is less than or equal to the maximum allowed under the $DCGL_{EMC}$. If so, this should be explicitly stated. In any case, indicate what the licensee is to do when the area between systematic sample points is greater than that allowed under the $DCGL_{EMC}$. For example, scanning is conducted to look for small areas of elevated activity that were “missed” by the systematic grid. If the scanning instrument is not sufficiently sensitive, then the number of samples may need to be increased to ensure that the smaller elevated area between sample locations could meet the scan MDC requirements.

Consider the following questions:

1. How is the area extent of the found contamination then to be determined? Additional biased samples must be collected around the found contamination in order to correctly identify the total area of the contamination.
2. How should the FSS design be re-evaluated?
3. How will the depth profile be understood (i.e., higher levels of contamination at deeper depths may be seen)?
4. How is scanning satisfied for the subsurface in areas of elevated activity?

2.29 Zion Subsurface Soil FSS

Section 5.3.2.2 of NEI 22-01 discusses subsurface soil. This soil is referred to as “inaccessible soils” or “soils in inaccessible areas.” The NRC staff notes that the presence and handling of inaccessible soils is a very significant consideration in license termination and should be addressed in NEI 22-01. Include identification, communication with the regulator and stakeholders, documentation, and technical evaluation.

NEI 22-01 indicates that sodium iodide or intrinsic germanium detectors with sufficient sensitivity to detect residual radioactivity at the operational DCGL could be used to scan the exposure surfaces in an open excavation to identify the presence or absence of soil contamination, and the extent of contamination with further sampling in suspect areas that were a significant fraction of the operational DCGL. However, validation samples are needed to be able to interpret the gamma spectroscopy results which cannot by themselves tell the depth and distribution of residual radioactivity, particularly for HTDs.

NEI 22-01 discusses the scanning of exposed subsurface soils during the remedial action support survey (RASS) of excavations resulting from any remediation of subsurface soil contamination. The NRC staff notes that RASS should support the conclusion that no risk-significant buried residual radioactivity remains below the bottom of the excavation that would cause the release standard to be exceeded. It is also helpful if the DQOs for RASS scanning satisfy the requirements for FSS, so that RASS data can be used for that function.

NEI-22-01 states that NUREG-1757, Volume 2, Revision 1, Appendix G indicates that if the HSA indicates that there is no likelihood of "substantial" subsurface residual radioactivity, subsurface surveys are unnecessary. The NRC staff notes that NUREG-1757, Volume 2, Revision 2, Section G.3.1 was revised and indicates that if there is "significant" residual radioactivity in the subsurface, the presence of subsurface residual radioactivity should be taken into consideration in designing the FSS. The guidance goes on to state that the HSA (and other scoping surveys), and modeling can be used to support the determination regarding the need for additional subsurface surveys. The NRC also notes that the classification of surface survey units is independent of the classification of subsurface survey units.

NEI stated that subsurface soil samples were segmented and homogenized over each one meter of depth. This may warrant further detail and explanation. FSS is conducted over surface soils at a 6 in (15 cm) depth, and the exposure scenario is based upon this assumption.

2.30 Subsurface Characterization

NEI 22-01 provides a brief discussion of backfill characterization surveys below surface without describing and discussing sampling protocols and without addressing contaminated soils below structures down to the aquifer and within licensed facility boundaries. The NRC staff has addressed subsurface characterization and survey issues in NUREG-1757, Volume 2, Appendix G. The contamination concern map discussed in NUREG/CR-7021 describes the extent, location, and significance of residual radioactivity relative to the decision criteria. This map can be developed with the aid of visualization, geographic information system and geostatistical software. The guidance provided in "Draft Technical Letter Report: Guidance on Surveys for Subsurface Radiological Contaminants" dated April 2021,[22] summarizes industry - accepted practices and references for NRC-proposed activities including historic applications, all focused on subsurface soils. These subsurface documents are additional resources regarding subsurface characterization and survey that should be considered for inclusion in subsequent versions of this document.

2.31 FSS of Caisson Area at Humboldt Bay

Section 5.3.2.3 of NEI 22-01 discusses the construction of subsurface walls around subsurface structures to stop groundwater in-leakage. The NRC staff notes that this section of the report

[22] ADAMS Accession No. ML21123A229

needs additional detail and clarity. Contaminated soils that are mixed with cement are not representative of the exposure scenario upon which the soils DCGLs are based. In addition, these soils were transformed into a structure that remained onsite. NEI 22-01 should clarify why this is conservative and acceptable. Explain how the regulator and stakeholders were involved and how this will be incorporated into the LTP and final site report.

Section 5.3.2.3 of NEI 22-01 includes a discussion of a dewatering well that was used to dispose of excavation groundwater that became plugged with fine material which was radiologically contaminated. The NRC staff notes that the writeup left the staff with several unanswered and technically significant questions. In its letter dated November 20, 2023, the NRC staff asked NEI in RAI RS-1 about the contamination in the gravel pack surrounding the well casing, as well as other concerns regarding the type of material and location in the survey.

In its RAI response dated December 12, 2023, NEI determined that the discussion of the Humboldt Bay caisson area dewatering well presents an unnecessary level of detail in the report. As a result, this example will be removed from NEI 22-01. Guidance regarding this specific case remains available in the EPRI experience report for Humboldt Bay.

2.32 Groundwater Assessment

A generic, overall approach for incorporating existing groundwater contamination into a dose estimate for FSS for the groundwater is not provided in the main text (e.g., Section 5). Section 5.3.4 of NEI 22-01 states that dose from existing groundwater contamination must also be included in the overall dose to demonstrate compliance with site release criteria. Section 5.3.4 cites NEI 07-07, "Industry Groundwater Protection Initiative – Final Guidance Document," Revision 1, dated February 2019,[23] for methods to characterize and monitor effectiveness of any remediation toward showing compliance.

The NRC staff notes that there are different permutations of approaches for estimating dose due to existing groundwater contamination or for incorporation of future groundwater contamination in soil, building, or buried pipe DCGLs. The approach in NEI 22-01 for estimating groundwater contamination input to the dose model may not be adequate for many sites. Sites with identified plumes may have monitoring wells adjacent to the known source area. Other sites have not had wells close to potential source areas.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in GWO-1 recommending that a generic, high-level discussion be added to the main body of the text describing the elements needed for estimating dose due to existing groundwater contamination that includes both the dose model approaches and estimation approaches for groundwater contamination. The latter should account for the fact that monitoring well concentrations may not reflect higher concentrations nearer to known or unknown sources.

In its response dated December 12, 2023, NEI stated that the examples of approaches to determining the dose from existing and potential future groundwater contamination currently in NEI 22-01 (if retained) will be revised to include discussion of their underlying assumptions and other limitations. NEI indicated that additional approaches from DUWP-ISG-02 that provide detail on dose models and inputs to address existing groundwater contamination will be added to NEI 22-01.

[23] ADAMS Accession No. ML19142A074

2.33 Exposure Scenarios for Buried or Subsurface Residual Radioactivity

NEI-22-01 does not appear to provide any guidance on consideration of exposure or intrusion scenarios for buried residual radioactivity and presents several examples of previous approvals where subsurface residual radioactivity was present and only in-situ groundwater leaching scenarios were considered. Lack of discussion or examples of scenarios where buried or subsurface residual radioactivity is disturbed and brought to the surface could lead licensees to think that intrusion scenarios for buried residual radioactivity do not need to be considered. In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in DMO-1 recommending an update to Chapter 6 of NEI 22-01 to provide guidance on exposure or intrusion of buried residual radioactivity.

In its response dated December 12, 2023, NEI stated that additional approaches for dose modeling of exposure scenarios for buried residual radioactivity taken from those given in NUREG 1757, DUWP-ISG-02, and more recent LTPs will be added to NEI 22-01. Additionally, the conservative approach of assuming all buried residual radioactivity is on the surface will be added as a simplistic approach that can be considered where circumstances allow.

2.34 Resident Farmer Scenario

Section 6.1.2.1 of NEI 22-01 indicates that “very conservative, default input parameters” in RESRAD were often used in the late 1990s and early 2000s, implying that these are acceptable values to use although they may overestimate the dose. Similar references are provided in Sections 6.1.6.4 and 6.1.6.5 of NEI-22-01 use default parameters in various applications. The NRC staff notes that NRC guidance found in NUREG-1757, Volume 2, Revision 2, indicates that the RESRAD default parameter values are placeholders and should not be used without additional justification for risk-significant parameters identified during sensitivity analysis. NUREG-1757, Volume 2, Revision 2, Appendix I, indicates that the DandD default metabolic and behavioral parameters found in NUREG/CR-5512, Volume 3, can be used with minimal justification, and Table I.11 crosswalks DandD parameters to RESRAD parameters for ease of reference and therefore, NEI should update this document accordingly, should a revised version of this document be submitted for endorsement.

2.35 Citations

NEI 22-01 references NUREG-1757 for Figure 6-2; however, the figure depicting the dose pathways for the industrial scenario in RESRAD should be from the RESRAD or Argonne National Laboratory (ANL) documentation. The NRC staff notes that checking the citation referenced in NEI 22-01 to ensure that it is correct would be beneficial to licensees.

2.36 NRC Published Screening Values for Soil

Section 6.2.1.1 of NEI 22-01 indicates that the screening values are pre-approved by the NRC. The NRC staff notes that this statement should be caveated to state that only if the assumptions inherent in the screening code are met, are the screening values pre-approved by NRC for use. Section 6.2.1.1 of NEI-22-01 also indicates that the unsaturated zone and the groundwater are initially free of residual radioactivity. The NRC staff notes that this may need to be clarified since technically the surface source is located in the unsaturated zone. Stating that the source is located at the surface and that the “unsaturated zone” below the source (or that “subsurface soils”) and “saturated zone” are initially free of residual radioactivity is more accurate.

Sections 5.3.2.1 and 6.2.1.1 describe use of surface residual radioactivity area factors to assess or account for dose associated with buried residual radioactivity, including use of screening values. The NRC staff notes that NUREG-1757, Volume 2, Revision 2, Section I.2.3.1, states that DandD used to develop screening values only considers surface residual radioactivity and uses a simple method to account for area on dose. The treatment of the area on dose is very different between RESRAD and DandD. Additional justification would be needed to use adjusted screening values when subsurface residual radioactivity is present because DandD is only appropriate for surface residual radioactivity and has a simplistic treatment of area on dose that differs from RESRAD.

2.37 Adjusting NRC Screening Values for Potentially Contaminated Groundwater

Section 6.2.1.2 of NEI 22-01 provides information on consideration of dose from existing groundwater contamination using screening values based on derived Maximum Concentration Levels (MCLs) for drinking water from EPA and DCGLs from Connecticut Yankee for existing groundwater contamination. The NRC staff notes that the DCGLs included exposure pathways for drinking water and ingestion of plant food, meat and milk. NEI indicates that if groundwater contaminants were present at the MCLs, only C-14, Co-60, Cs-134 and Cs-137 would produce a dose due to existing groundwater contamination above 1 mrem/y (i.e., would be insignificant), and only Sr-90 and H-3 have been found at significant concentrations. The text also indicates that even Sr-90 and H-3 are expected to have doses less than 2 mrem/y which could be subtracted from the cumulative dose assigned to other media including substructure leaching. The NRC staff notes that while these observations are based on industry experience, every site is different and site-specific analysis would be needed to support the selection of groundwater ROCs (and insignificant contributors to dose from the groundwater pathway), and also the added risk from existing groundwater contamination). DUWP–ISG-02 provides more detailed guidance on acceptable approaches for consideration of risk from existing groundwater contamination and methods to estimate potential exposure point concentrations if relying on monitoring data to assess risk. Reference to DUWP-ISG-02 with respect to consideration of risk from existing groundwater contamination may be useful to include in NEI-22-01.

2.38 Building Surfaces

Section 6.2.2 of NEI 22-01 states that once the decision on the future use of the site has been determined, there are a number of options in determining the site release limits to be used during different phases of the decommissioning planning and implementation. The NRC staff notes that there is a distinction between the evaluation of building surfaces that will remain onsite and could be occupied, versus building surfaces that will be backfilled (buried) and could eventually contribute to soil and groundwater contamination. The second case may need to be discussed in more detail in NEI-22-01. DUWP-ISG-02 discusses exposure scenarios and survey of substructures that are planned to back-filled which may be useful to reference in NEI-22-01.

2.39 Update on Site-Specific Decommissioning Costs

Section 7 of NEI 22-01 states that “If little decommissioning has been completed, and inflation and disposal costs have not changed, the cost estimate originally submitted pursuant to 10 CFR 50.82(a)(4)(i) and 10 CFR 50.82(a)(8)(iii) may be acceptable.” There is data in the decommissioning funding assurance that is acceptable and determines what is reasonable, as part of the reasonable assurance test. As regulators of the decommissioning process, the NRC staff determines acceptability. NEI should refrain from expressing in the document what may be acceptable to the NRC.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in FO-1 that under section 7.1 of NEI 22-01, there should be a statement that requires the licensee to continue providing the annual decommissioning funding assurance report under 10 CFR 50.75 until the license is terminated and the property is released for use by the public.

In its response dated December 12, 2023, NEI stated that under the chapter on decommissioning, NEI 22-01 would benefit licensees by reiterating that the licensee must continue to provide the annual decommissioning funding assurance report under 10 CFR 50.75, "Reporting and Recordkeeping for Decommissioning Planning," until the license is terminated.

2.40 Supplement to the Environmental Report

Section 8 of NEI 22-01 incorrectly cites RG 1.170, Revision 2. There are several gaps related to threatened and endangered species and historic and cultural resources that are required to support consultations under the Endangered Species Act (ESA) and National Historic Preservation Act (NHPA). In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in EO-1 recommending that providing an accurate and comprehensive list of applicable NRC guidance related to the environmental review in NEI-22-01, Chapter 8, would be useful for licensees when preparing environmental reports or supplemental environmental reports in support of the proposed action of 10 CFR 51.45.

In its response dated December 12, 2023, NEI stated that additional guidance will be added to each section of Chapter 8 consistent with NUREG-1748 and RG 1.179. Section 8.7 of NEI 22-01, "Threatened and Endangered Species," will include a discussion on the NRC data needs and consultation process under the ESA. Section 8.9 of NEI 22-01, "Cultural and Historic Activities Beyond the Operational Area," will include a discussion on the NRC data needs and consultation process under the NHPA. In both cases, close communication with the counterpart state agencies will be emphasized to ensure all parties agree on any mitigation or preservation measures.

NUREG-1748 provides guidance on NRC's environmental review process related to decommissioning, and it is periodically updated as new guidance, regulations, and policies are issued. In addition, the Advisory Council on Historic Properties[24] provides guidance related to the NHPA, U.S. Fish and Wildlife Service (FWS),[25] and the National Oceanic and Atmospheric Administration provides guidance related to the ESA. FWS' Information for Planning and Consultation[26] contains information on threatened and endangered species and critical habitat for project locations. Rather than summarizing portions of the environmental review and consultation process within NEI 22-01, referencing these guidance documents would provide accurate descriptions of NRC's environmental review process and consultation requirements under the NHPA and ESA.

2.41 Final Status Surveys

NEI-22-01 discusses the desire for the LTP to have a well-defined Phase 1 Site Characterization, FSS capabilities, and site-specific release criteria developed prior to initiation of decommissioning, particularly if onsite excavations and backfill are anticipated. However, NEI-22-01 indicates if this is not possible that it is important to obtain adequate information

[24] https://www.achp.gov/protecting-historic-properties
[25] https://www.fws.gov/media/endangered-species-consultation-handbook
[26] https://ipac.ecosphere.fws.gov/

before backfill of excavations, including information on the pedigree of backfill materials (soil characteristics, radiological and hazardous chemical content) to provide support for compliance with the end state criteria.

The NRC staff notes that NUREG-1757, Volume 2, Revision 2, Section G.3.2, emphasizes the need for FSS of open surfaces (e.g., excavations or substructures) be performed prior to backfill due to the difficulty in accessing the surfaces after backfilling. The NRC staff has provided additional guidance in DUWP-ISG-02. This guidance provides lessons learned from inadequate survey of open surfaces in the subsurface, including misapplication of clean-up levels, inadequate depth of sample, and the lack of opportunity for confirmatory survey. Use of this document can provide additional detail on the level of information needed to support FSS for backfill of open surfaces in the subsurface including excavations and substructures.

2.42 Implementation of Groundwater Dose by Survey Unit

Depending on the exposure scenario, people may construct wells in one location and live in another; therefore, well locations should not be constrained to locations of existing monitoring wells. For many sites, placement of wells in the monitoring network is not optimal (often for practical reasons) for identifying the distribution of contamination across the entire site. Furthermore, contaminant plumes migrate over time. Sophisticated flow and transport models in combination with data from well monitoring network may be needed for reasonable assurance that dose for any survey unit is not underestimated.

In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in DMO-3 indicating that there is a range of approaches to use for applying dose to survey units for existing groundwater contamination, each approach having its own graded level of required supporting information. Uncertainty in spatial distribution and seasonal variation of existing residual radioactivity in the groundwater, in part due to uncertainty related to the monitoring well network, and the dynamic nature of contaminant transport both should be addressed in assigning different doses for existing groundwater contamination to different survey units.

In its response dated December 12, 2023, NEI stated that NEI 22-01 will be clarified to state that there are a range of approaches for applying the dose from groundwater contamination. A graded approach will be described in which it may be practical in many cases to conservatively apply the maximum level of groundwater contamination across the site, and in other cases it may be necessary to apply different dose values for individual survey areas/units. NEI indicated that this description will acknowledge the additional data and detailed justification required to support the use of these different dose values.

2.43 Advanced Technologies

Appendix A in NEI-22-01 discusses the application of advanced technologies to show compliance. Consider the use of robotics and drones for radiological survey and characterization as well as the use of Digital Twins for characterization and audiological monitoring. These technologies can provide greater support than some of the conventional techniques for the remediation methods and techniques that the licensee will use to demonstrate that the facility and site areas meet the NRC criteria for license termination in Subpart E of 10 CFR Part 20.

2.44 EPA and NRC Memorandum of Understanding

Section D.4.1 of NEI-22-01 summarizes the MOU between NRC and EPA. The section focuses on sites with groundwater contamination above MCLs. However, NEI-22-01 does not discuss consideration of trigger levels for soil contamination that would cause NRC to consult with EPA for planned or actual residual radioactivity above the trigger levels. The NRC staff notes that the trigger levels are based on either a residential and industrial/commercial soil concentrations and are provided in Table H.1 of NUREG-1757, Volume 1, Revision 2. Providing additional details regarding soil concentrations that trigger NRC consultation with EPA, or citing NUREG-1757, Volume 1, Revision 2, Appendix H, in Section D.4.1 for additional details on the EPA and NRC MOU would be beneficial to licensee. NEI should also consider specific strategies when the consultation trigger level is lower than screening values.

2.45 Connecticut Yankee Experience

Section F.1 of NEI-22-01 states that the "Dose Future Groundwater: The portion of the dose from all pathways due to residual radioactivity that is projected to leach from the concrete buildings at CY and be present at the time of site release…" The NRC staff notes that the dose doesn't have to occur at the time of site release. Rather, residual radioactivity can leach to groundwater within the 1000-year compliance period. Rewording this sentence to account for future leaching to groundwater during the compliance period would support licensees.

2.46 Dose Assessment Model – Soil

Section F.1.1 of NEI-22-01 provides an example where the median values from the parameter range were used in agreement with NRC guidance and goes on to state that more recent NRC guidance is to use the parameter range for parameters shown to have an insignificant impact by the probabilistic sensitivity analysis. The NRC staff suggests stating that NUREG-1757, Volume 2, Revision 2, indicates that for those isotopes where the K_d does not have a significant impact on the dose assessment based on a sensitivity analysis, limited justification will be needed to support selection of the parameter values. Therefore, although not explicitly stated, use of the median value would be acceptable for those parameters where the selection of the median value versus a more extreme value at the tails of the distribution does not have a significant impact on the dose.

2.47 Dose Assessment Model–Groundwater

Section F.1.2 of NEI-22-01 provides guidance on methods to derive dose or DCGLs for existing groundwater contamination. In its letter dated November 20, 2023, the NRC staff asked in RAI DM-1 to clarify the source of the information and provide clear instructions on the method that is being used to consider dose from existing groundwater contamination or derive groundwater DCGLs. In its RAI response dated December 12, 2023, NEI indicated that the information in section F.1.2 was based on verbal guidance provided by ANL personnel that was subsequently used to determine the Groundwater DCGLs provided in the Connecticut Yankee LTP. NEI indicated that NEI 22-01 will be revised to agree with more recent guidance provided in DUWP-ISG-02.

2.48 Conceptual Site Model

Section F.3 of NUREG-1757, Volume 2, described the importance of a conceptual site models (CSMs) for contaminant migration at the site. This information is needed to assure compliance with 10 CFR 20.1402 and that the total dose to potential future site occupants is less than the dose criteria and complies with 10 CFR 20.1501 to ensure the site has been adequately characterized.

NEI 22-01 did not provide guidance related to the importance and utilization of CSMs for the license termination process. The CSM is important for both the characterization of groundwater contamination and the abstraction and development of hydrological inputs for the dose models. In its letter dated November 20, 2023, the NRC staff provided NEI with an observation in GWO-3 recommending an added discussion of CSM and how it is utilized for the license termination process for groundwater system.

In its response dated December 12, 2023, NEI stated that NEI 22-01 will be revised to include a high-level discussion of how CSM is used in the license termination process to support characterization of groundwater contamination through the estimation of contaminant migration and the subsequent placement of groundwater monitoring wells.

2.49 Parameter Sensitivity Analysis

Section F.4 of NEI-22-01 indicates that NUREG-1757, Volume 2, Revision 2, Appendix Q, "recommends increased justification to use the literature probability density functions (PDFs) such as those in Table 12.13.1 through 12.13.5" of the ANL, *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil and Building Surfaces (*ANL 2015), in sensitivity analysis used to determine if the K_d for the ROCs at a particular site is sensitive to the dose to the future user of the site. The NRC staff notes that there are no Tables 12.13.1 to 12.13.5 in ANL (2015). The authors probably meant Tables 2.13.1 to 2.13.5, which provide K_d data for radionuclides in sand, loam, clay, organic material, and generic soil types.

NUREG-1757, Volume 2, Revision 2, Appendix I indicates that for risk-significant parameters additional support may be needed for deterministic values used in the compliance demonstration to ensure that the doses are not under-estimated (i.e., that the 25^{th} or 75^{th} percentile values may not be demonstrably conservative for broad parameter distributions such as distribution coefficients or K_ds). Appendix I and Q discuss the potential for risk dilution if overly broad distributions are used (e.g., generic values from the literature for parameters such as K_d that may span many orders of magnitude) for parameters that primarily affect the timing of peak dose if used in a probabilistic compliance demonstration.

Appendix Q shows the impact on the results of probabilistic compliance demonstrations using a peak of the mean metric when analysts use parameter distributions based on sparse data or generic data. The overall recommendation of NUREG-1757, Volume 2, Revision 2, is to use site-specific values or otherwise provide support for the values selected commensurate with the risk-significance of the parameter. Appendices I and Q do not state that probability density functions from the literature require increased justification and cannot be used in probabilistic sensitivity analysis; however, it is advisable to use site-specific information, if available, in both sensitivity analysis (e.g., K_d parameter distributions based on site-specific soil type and geochemistry) and for assessment of risk/DCGL development.

NUREG-1757, Volume 2, Revision 2, provides acceptable methods for demonstrating that dose criteria are met through dose modeling to develop clean-up criteria (or DCGLs) and radiological survey to demonstrate mean or median concentrations in the survey unit are less than the release criteria while minimizing decision errors. Updating NEI-22-01 to clarify guidance found in NUREG-1757, Volume 2, Revision 2, regarding support for deterministic parameter values as stated above would be beneficial to licensees. Further, the NRC staff suggests that NEI cite the most recent data compilations available in the literature.

NUREG-1757, Volume 2, Revision 2, states that RESRAD defaults for physical parameters important to dose are not acceptable for use without further justification. RESRAD default parameter distributions can be used to perform sensitivity analysis to determine the importance of the parameter on dose. Additionally, default behavioral and metabolic parameters in NUREG/CR-5512, Volume 3, are acceptable for use without further justification (e.g., see Table I.11 and associated text in NUREG-1757, Volume 2, Rev. 2). Clarifying or correcting NEI-22-01 to be consistent with the guidance provided in NUREG-1757, Volume 2, Revision 2, would increase transparency in NRC's guidance related to parameter selection.

Finally, NEI-22-01 cites a technical report on parameter distributions, NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes," in several examples. It is important to note that NRC sponsored the development of an updated parameter report, which presents the latest information available in the literature, "Default Parameter Values and Distributions in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes."[27]

2.50 Critical Group

Table F-4 of NEI-22-01 indicates that for several radionuclides (marked with "note 1") the radionuclides were not detected in significant quantities in soil samples and were excluded from further consideration. The NRC staff notes that the relevance of soil survey results to ROCs for structures is unclear. Expanding this discussion would provide more clarity.

2.51 NRC Published Screening Values for Structures

Section F.7.3 of NEI-22-01 states that NUREG-1757 notes "that use of a single default parameter set for all radionuclides in developing the screening DCGLs (as was done in calculating the NRC screening values) could result in overly conservative limits." The NRC staff thinks this statement was made in reference to an earlier version of DandD. The NRC staff wants to ensure licensees use the latest versions of NUREG-1757, Volume 2, Rev. 2, Appendix H for additional details on current screening values.

2.52 Critical Group and Dose Pathways for Structural Surface Exposure

Section F.8.1 of NEI-22-01 describes use of the building renovation/demotion and industrial worker scenarios for the containment building at Rancho Seco. The NRC staff notes that it is unclear that an industrial worker scenario would be the most applicable exposure scenario for a containment building particularly if those building materials were planned to be demolished and reused for fill.

[27] ANL developed the technical report under contract with NRC which is soon to be issued as NUREG/CR-7267.

Section F.9.3 of NEI-22-01 implies that only the external dose is considered for calculating DCGLs for buried piping. The NRC staff notes that it is unclear if other exposure pathways associated with digging up the piping or leaching of radioactivity from the piping were considered. The embedded piping scenario discusses external exposure to the industrial worker.

Section F.8.1 of NEI-22-01, assumes the industrial worker is present in the building for 4 days per year. Section F.10.3 indicates that 5 of the 25 mrem/yr were allotted to embedded piping and that the embedded piping was grouted to eliminate inhalation as an exposure pathway. The NRC staff notes that it is unclear what exposure pathways were considered in developing the 100,000 dpm/100 cm^2 beta/gamma DCGL for embedded piping for Trojan. Providing an explanation would be beneficial for licensee as well as providing a basis for the exposure scenarios and DCGLs which appear to be based on gross beta/gamma radiation. There is no mention of the survey and consideration of dose from HTD radionuclides.

2.53 Appendix C Crosswalk Between License Termination Plan and NUREG-1700

1. Item 350 in Table C-1 of NEI-22-01 states that "the LTP should demonstrate that the dose from residual radioactivity is distinguishable from background radiation per Subpart E of 10 CFR Part 20. The NRC staff notes that some words appear to be missing like the "dose…. is less than the limits in 10 CFR Part 20.

2. Items 355 and 356 in Table C-1, the entry states that information should be submitted in the LTP and the associated evaluation criteria are described in NUREG-1757. The information goes on to state that this applies to "Group 3 [Broad Scope-most likely]." The NRC staff notes that the reference to the group is unclear. Power reactor licensees submit LTPs (not other types of licensees) and power reactor licensees are typically viewed by NRC as Group 4-5).

3. Item 357 in Table C-1 refers to waste processors for Group 4, and fuel facilities for group 5. The NRC staff notes that the reference to specific types of licensees such as waste processors and fuel facilities for these groups is unclear. Group 4 use site-specific approaches (rather than screening criteria) to developing DCGLs, and Group 5 decommissioning licensees have existing groundwater contamination.

4. Item 361 in Table C-1 indicates that the licensee provide a "description of how the licensee or responsible party will achieve a decommissioning goal below the dose limit." The NRC staff notes that stating that the licensee should demonstrate that residual radioactivity levels are ALARA is more accurate. Reevaluate the wording to provide greater support to licensees.

5. Items 387-390 in Table C-1 incorrectly refers to building surfaces and Table H.2 in NUREG-1757. Table H.2 pertains to screening levels for soils.

2.54 Editorial Comments

1. Chapter 1 should state that the LTP is submitted as a license amendment and replaces the FSAR "And" both are license compliance documents that must be followed. NRC inspections ensure the LTP is being followed.

2. Section 1.1.1 seems focused on NRC's responsibilities. This section should also address licensee responsibilities for quality submittals, submittal schedules and allocation in the licensees' schedule for NRC review.

3. Section 1.1.5.1 has a portion redacted that is already publicly available in the regulations. Remove the redaction in the next revision of the document.

4. Section 1.1.5.2.1 has redacted publicly available guidance in the regulations in the last paragraph. Remove the redaction in the next revision of the document.

5. Section 2.3.3 states that the process for evaluating insignificant contributors needs to be described in the LTP but is not required to be analyzed during the FSS. However, NRC recommends that the initial suite of potential ROCs should be analyzed for during FSS in a typical quality assurance and quality control frequency as described in MARSSIM.

6. Section 3.2 on radiological control procedures is not inclusive of all guidance in NUREG-1700 which states that an LTP should include a summary of all control procedures already authorized under the existing license in addition to any changes or modifications.

7. Section 5.4 discusses FSS data assessment but does not cite any guidance. MARSSIM sections 8.2 and 9 contain additional information not included in this section.

8. Section 9.1, Page 86, refers to Draft NUREG-1757, Volume 2, Rev. 2, which was finalized and published in July 2022. Delete "draft" when referring to NUREG-1757, Volume 2, Rev. 2.

9. Section F.1.3, states the following: "The last column of Table F-1 shows that calculated TEDE dose that corresponds to the MCL concentrations for each recalculate." The word "recalculate" does not make sense in this context. Perhaps the use the word "radionuclide" was intended.

10. Table F-1, The groundwater DCGL for Mn-54 is cut off—it states 2.42E+ with no number after the E+. Please correct this omission.

11. Table F-1, The TEDE Dose Due to the MCL Concentration in Groundwater mrem/yr is reported as 030 for Eu-154. Please check this value, which was likely intended to be 0.30.

12. There are 3 tables labeled "Table 5-4" and 2 tables labeled "Table 5-5." Renumbering the tables would be more supportive. Also, Table 5-5 in section 5.4 does not match Table 8.2 in MARSSIM.

13. The document should address the licensee's agreement with the States, such as the NY-Holtec or the Mass-Holtec Agreements and their relationship to the LTP to distinguish comments to the States versus the NRC requirements.

14. While the document touches on the DQO Process, the document should clearly state their commitment to use the MARSSIM Data Life Cycle process that embellishes the DQO process. Life Cycle is only mentioned once in the Characterization in the Planning Phase, but should be in the implementation and Assessment Phases. Attached is the

ORISE MARSSIM Cheat Sheet for use by the staff that summarizes the MARSSIM process in NUREG 1575.

15. For Characterization, there are 17 objectives in MARSSIM for the planning phase of the decommissioning and these should be clearly spelled out in the Characterization Sections.

16. Reviewers need to be careful of the difference between “Will and May” and “Should and Shall.” In section 4.4, intentional mixing of soil says the NRC has not permitted the intentional mixing of clean soil with non-contaminated soils. But in the bullet below it says, “Clean soil, from outside the footprint of the area contaminated soil, should not be mixed with contaminated soil to lower concentrations although the use of soil from outside the footprint will be considered in rare cases.

17. Should NEI choose to resubmit a version of this document for endorsement, the NRC staff would suggest NEI perform a more thorough review and be prepared with justification for any information that NEI believes should be non-public.

3.0 CONCLUSION

Consistent with our acknowledgement letter (ML23257A053), the NRC is not endorsing this document. However, the NRC staff recognizes the potential benefits of NEI 22-01 for establishing consistency across the industry and improving the quality of future LTP submittals. A revised version of this document, capturing the suggested revisions noted, could help increase the efficiency and effectiveness of our licensing reviews and inspection activities associated with the license termination process.